

**Comment on "Narrow Primary Feather Rachises in *Confuciusornis* and *Archaeopteryx* Suggest Poor Flight Ability"**Xiaoting Zheng *et al.**Science* **330**, 320 (2010);

DOI: 10.1126/science.1193223

This copy is for your personal, non-commercial use only.

If you wish to distribute this article to others, you can order high-quality copies for your colleagues, clients, or customers by [clicking here](#).

Permission to republish or repurpose articles or portions of articles can be obtained by following the guidelines [here](#).

The following resources related to this article are available online at www.sciencemag.org (this information is current as of March 29, 2012):

Updated information and services, including high-resolution figures, can be found in the online version of this article at:

<http://www.sciencemag.org/content/330/6002/320.3.full.html>

A list of selected additional articles on the Science Web sites **related to this article** can be found at:

<http://www.sciencemag.org/content/330/6002/320.3.full.html#related>

This article **cites 2 articles**, 1 of which can be accessed free:

<http://www.sciencemag.org/content/330/6002/320.3.full.html#ref-list-1>

This article has been **cited by** 1 articles hosted by HighWire Press; see:

<http://www.sciencemag.org/content/330/6002/320.3.full.html#related-urls>

This article appears in the following **subject collections**:

Paleontology

<http://www.sciencemag.org/cgi/collection/paleo>

Technical Comments

http://www.sciencemag.org/cgi/collection/tech_comment

Comment on “Narrow Primary Feather Rachises in *Confuciusornis* and *Archaeopteryx* Suggest Poor Flight Ability”

Xiaoting Zheng,^{1,2} Xing Xu,^{3*} Zhonghe Zhou,³ Desui Miao,⁴ Fucheng Zhang³

Nudds and Dyke (Reports, 14 May 2010, p. 887) compared the rachis diameters of the primary feathers of *Archaeopteryx* and *Confuciusornis* to those of modern birds and found that the primary feathers of these two basal birds were too weak to support sustained flight. Our measurements of *Confuciusornis* specimens suggest that their conclusions need to be further evaluated.

Nudds and Dyke reported their latest analysis on the flight capability of two famous basal birds, *Archaeopteryx* and *Confuciusornis* (1). By comparing the rachis (central shaft) diameters of the primary feathers of these two basal birds to those of modern birds, the authors found that the primary feathers of these birds were too weak to support sustained flight and thus concluded that flapping flight might have originated relatively late in avian evolution (1).

Nudds and Dyke’s innovative analysis offers important new insights into early avian evolution. However, we noticed a substantial discrepancy between their presented data based on specimens with dubious origins and our recently collected data on confuciusornithids and believe that their conclusions need to be further evaluated. Our measurements show that the primary feathers of confuciusornithids have considerably thicker rachises than Nudds and Dyke suggest (1).

Measuring the rachis diameter in modern birds appears to be straightforward and easy, but this might not be true for fossil feathers—even for those of confuciusornithids, which are the best documented Mesozoic fossil birds and have some exquisitely preserved feathers (2). The Shandong Tianyu Museum of Nature has 536 specimens of confuciusornithids, but only four specimens preserve clear impressions of the rachis

of the primary feathers (Fig. 1A). Many specimens exhibit relatively thick parallel lines throughout the wing, but they are preservational artifacts between remiges (flight feathers of a bird’s wing) rather than rachises. Several other possibilities leading to smaller measured values include mistaking a covert rachis as a primary feather rachis



Fig. 1. (A) Well-preserved primary feathers of a *Confuciusornis* specimen (STM13-62, housed at Shandong Tianyu Museum of Nature). (B) Right wing of a pigeon in dorsal view. Note rachises of coverts. (C) Close-up of a primary feather of a pigeon in ventral (top) and dorsal (bottom) views. Note the considerably wider rachis in ventral view than in dorsal view.

(Fig. 1B), mistaking the longitudinal ventral furrow of the rachis of primary feathers as the whole rachis, or measuring rachis diameter of primary feathers on the dorsal side rather than ventral side (the diameter is considerably larger on the ventral side) (Fig. 1C).

The rachises of primary feathers of confuciusornithids measure 2.1 to 2.3 mm in diameter on four Tianyu specimens, about twice as large as the measurements reported by Nudds and Dyke (1). Because the specimen we measured is similar in size to those studied by Nudds and Dyke, it is unlikely that the difference is caused by different body sizes. Nudds and Dyke’s study thus underestimates the thickness and strength of the rachises of confuciusornithid primary feathers. Their resulting inference that confuciusornithids were not able gliders and could only parachute thus needs to be further evaluated based on newly collected, more accurate data.

However, even our measurements are considerably smaller than the predicted rachis diameter of primary feathers with similar feather length in similarly sized extant birds. This lends support to Nudds and Dyke’s conclusion that basal birds have narrow rachises of primary feathers and thus had poorer flight capability than extant birds (1), which is consistent with previous studies (3). Furthermore, rachis diameter of the primary feathers is only one of several useful indicators of flight capability, and other features such as the curvature of flight feathers, asymmetry of vanes, and the right angle between the scapula and coracoid in both *Archaeopteryx* and *Confuciusornis* also should be considered. Although Nudds and Dyke’s inference about flight capability of basal birds needs more data to be verified, their study outlines one of the future directions on early avian flight. Further investigations on strength of flight feathers of other basal birds, including enantiornithines and basal ornithuromorphans, promise to shed new light on this interesting evolutionary issue.

References and Notes

1. R. L. Nudds, G. J. Dyke, *Science* **328**, 887 (2010).
2. L. M. Chiappe, S.-A. Ji, Q. Ji, M. A. Norell, *Bull. Am. Museum Nat. Hist.* **242**, 1 (1999).
3. Z. Zhou, J. A. Farlow, in *New Perspectives on the Origin and Early Evolution of Birds*, J. A. Gauthier, L. F. Gall, Eds. (The Peabody Museum of Natural History, Yale University, New Haven, 2001), pp. 237–254.
4. Support for this research was provided by the Shandong Tianyu Museum of Nature, Major Basic Research Projects of the Ministry of Science and Technology, China, the National Natural Sciences Foundation of China, and the Chinese Academy of Sciences.

3 June 2010; accepted 20 September 2010
10.1126/science.1193223

¹Shandong Tianyu Museum of Nature, Pingyi, Shandong 273300, China. ²Linyi Normal College, Linyi, Shandong 276000, China. ³Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, 142 Xiwai Street, Beijing 100044, China. ⁴Biodiversity Institute, University of Kansas, Lawrence, KS 66045–7561, USA.

*To whom correspondence should be addressed. Email: xingxu@vip.sina.com