



## Research Highlight

## A new skin-winged dinosaur from the Jurassic of northeast China

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Over approximately the past quarter-century, fine-grained sedimentary rocks deposited in Mesozoic lakes in what is now northeast China have produced numerous spectacular fossils of primitive birds and closely-related non-avian theropod dinosaurs. Supplemented by other discoveries from around the world, these specimens have demonstrated that the transition to birds was not an orderly linear progression but rather an evolutionary radiation that gave rise to a number of disparate, often short-lived clades [1]. Perhaps the most unusual such clade is the Scansoriopterygidae. These small (<1 kg) theropods are undoubtedly cousins of birds but essentially lack the pennaceous, blade-like feathers seen in birds and most of their close relatives. The scansoriopterygid *Epidexipteryx hui* does possess ribbon-like, presumably ornamental tail feathers [2] that likely represent pennaceous feathers of a highly modified type [3], but scansoriopterygid plumage is otherwise limited to short, filamentous structures that could not have produced substantial aerodynamic forces [2,4].

The absence of typical pennaceous feathers suggested originally that scansoriopterygids must have been flightless [2], but the single known specimen of the recently described scansoriopterygid *Yi qi* shows indications of an unexpected type of flight apparatus unlike that of any other theropod [4]. Long, rod-like bones known as “styliform elements” extend from the wrists and resemble skeletal struts that support membranous wings in a variety of non-dinosaurian vertebrates, ranging from flying squirrels to pterosaurs. Evidence that this was also the function of the styliform elements in *Yi* comes from patches of membranous tissue preserved in association with the styliform elements and fingers. In isolation, however, *Yi* has been something of an enigma. Because the hindquarters of the single preserved skeleton are fragmentary, the overall proportions and potential aerodynamic stability of the body have been uncertain. Furthermore, there has been no clear indication of whether a membranous flight apparatus might have been present in other scansoriopterygids.

In the May 9, 2019 issue of *Nature*, Wang and colleagues [5] report an important new scansoriopterygid fossil (Fig. 1) that sheds light on these questions, and corroborates the original interpretation of *Yi* as possessing a membranous flight apparatus. Like all other scansoriopterygids that have been discovered to date, the new specimen belongs to the Yanliao Biota, a diverse and increas-

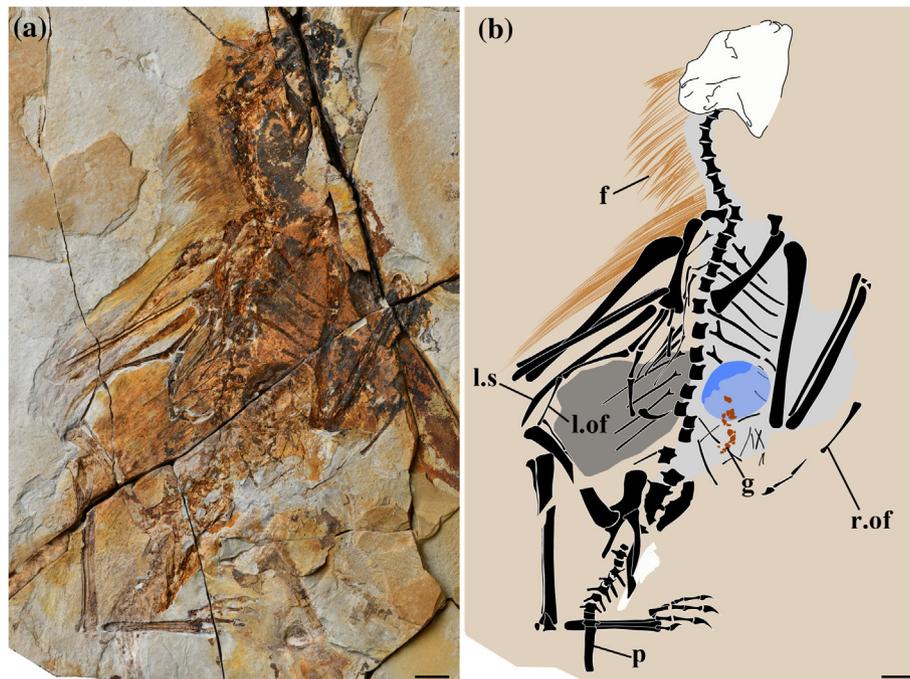
ingly well-known assemblage of fossil plants and animals dating to near the boundary between the Middle and Late Jurassic [6,7]. Like the Early Cretaceous Jehol Biota, the Yanliao Biota comes from the northeast Chinese lake deposits and is famous for preserving the delicate bones of small vertebrates, often accompanied by remnants of soft tissue such as feathers or hair. The new fossil fits this pattern, being the largely complete skeleton of a pigeon-sized dinosaur with a fringe of non-pennaceous feathers preserved adjacent to the head, neck and shoulder [5].

Although undoubtedly a member of Scansoriopterygidae, based on features of the forelimb including an elongated outer finger, the specimen differs in many anatomical details from other known scansoriopterygids and has accordingly been placed in the newly erected species *Ambopteryx longibrachium* [5]. The right forelimb of *Ambopteryx* is rather incomplete, but the left includes a long, curved bone extending from the wrist that clearly represents a styliform element similar to that of *Yi*. A wrinkled patch of membranous tissue is preserved between the left hand and the vertebral column, in close association with the fingers.

The discovery of a second scansoriopterygid with a styliform element and membranous tissue provides strong confirmation that the equivalent structures in *Yi* were indeed correctly identified in the original description of that species [4], and did not represent some sort of preservational anomaly. *Ambopteryx* further demonstrates that these structures were not unique to *Yi* but rather shared among at least a subset of scansoriopterygids. Even more importantly, *Ambopteryx* preserves some interesting features that shed new light on scansoriopterygid biology [5]. The hindquarters are very incomplete in the only known specimen of *Yi*, but *Ambopteryx* has a well-preserved short tail, ending as in birds in a series of fused vertebrae known as a pygostyle, and a hindlimb that is surprisingly short in proportion to the forelimb. The small size of the tail and hindlimbs would have ensured that the center of gravity was relatively far forward within the trunk, contributing to aerodynamic stability. A patch of gizzard stones is situated in the abdominal region, along with what may be bone fragments from some ingested prey animal. Gizzard stones can occur in animals with a variety of diets, but bone in the stomach would unambiguously indicate that *Ambopteryx* was at least partly carnivorous [5].

Some mysteries remain. The orientation of the styliform element and the shape of the wing cannot be confidently reconstructed in either *Yi* or *Ambopteryx*, although the patch of membranous tissue preserved in *Ambopteryx* is tantalizingly close

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**Fig. 1.** (Color online) Photo (a) and drawing (b) of the only known specimen of *Ambopteryx longibrachium*, IVPP (Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China) V24192. Dark gray area represents preserved membranous tissue; blue area represents mass containing possible bone fragments. Abbreviations: f, non-pennaceous feathers; g, gizzard stones; l., left; of, outer finger; p, pygostyle; r., right; s, styliiform element. Scale bars are 1 cm long. Modified from Ref. [5].

to the left femur [5]. Is this a hint that the membranous wing would have been anchored partly by the hindlimb, as in bats, flying squirrels, and probably pterosaurs [8]? It is also uncertain whether a similar wing was present in *Epidendrosaurus* and *Epidexipteryx*, the only other members in good standing of Scansoriopterygidae, although *Epidendrosaurus* certainly resembles *Yi* and *Ambopteryx* in having a long outer finger [9] whose main function may well have been to support a flight membrane [5]. Nevertheless, *Ambopteryx* represents exciting confirmation that at least some scansoriopterygids were equipped with a membranous type of wing otherwise unknown among dinosaurs, and throws new light on the anatomy and even the digestive physiology of this most enigmatic, distinctive and short-lived group of theropods.

### Conflict of interest

The author declares that he has no conflict of interest.

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