

Hind wing in basal birds and the evolution of leg feathers

Supported by the National Natural Sciences Foundation of China, Prof. Xu Xing and his colleagues published their research findings in an article “Hind Wing in Basal Birds and the Evolution of leg Feathers” in *Science* (2013, 339: 1309—4).

This study provided the first solid evidence for the existence of enlarged distal leg feathers on a variety of basal birds. The results of a detailed analysis of 11 basal avialan specimens from Jehol Group deposits approximately 125 Ma, indicate that the evolution of hindlimb feathers parallels that of forelimb feathers in basal paravians and suggest that extensively scaled feet may have secondarily evolved during an early stage in ornithuromorph evolution. Avialans show a distal-to-proximal pattern of reduction in the leg feathers.

A ‘hind wing’ formed by large pennaceous feathers attaching to the metatarsus is known in some paravian dinosaurs including the basal dromaeosaurids *Microraptor* and *Sinornithosaurus*, the basal deinonychosaurs *Anchiornis* and *Xiaotingia*, and the maniraptoran *Pedopenna*. Metatarsal feathers also occur in the basal birds *Sapeornis* (STM16-18, 16-19). In these paravians, the leg feathers are similar in general arrangement and in having stiff vanes, suggesting that these leg feathers had aerodynamic functions and may have played an important role in the evolution of avialan flight. In *Confuciusornis* (STM13-32, 13-44, 13-55, 13-57, 13-331) and the enantiornithines (STM7-50, 7-161, 7-215), feathers are preserved only along the tibiotarsus, indicating that these birds had reduced hindwings.

Among the new specimens described in this study, only the basal ornithuromorph STM9-5 preserves large scales covering the anterior surfaces of the digits and tarsometatarsus. Extensively scaled feet are unknown in any non-ornithuromorph coelurosaurian specimen. The discovery of STM9-5, in combination with data from other recently reported coelurosaurian fossils, suggests that feathered feet might be primitive to Coelurosauria, and extensively scaled feet might have appeared secondarily during an early stage in ornithuromorph evolution. Although avian bird flight may initially have involved four wings, the locomotor system of birds is characterized by a combination of flight using feathered forelimbs and bipedal terrestrial locomotion using the hindlimbs. The reduction and loss of distal feathers on the legs probably co-occurred with the decoupling of the forelimbs from the hindlimbs in the locomotor system in ornithuromorph birds, in which the arms became specialized for flight and the legs for terrestrial locomotion.

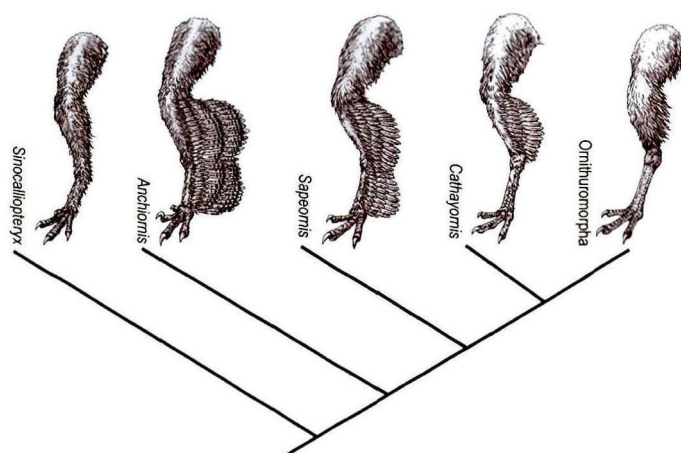


Figure Evolution of leg feathers in coelurosaurian dinosaurs. Four major stages in the evolution of integumentary structures on the hindlimb are represented by the compsognathid *Sinocalliopteryx* (short filamentous feathers covering legs, including feet); the basal deinonychosaurian *Anchiornis* and the basal avialan *Sapeornis* (large pennaceous feathers on legs, including feet, forming a winglike structure); the enantiornithine *Cathayornis* (large femoral and crural feathers forming a reduced winglike structure); and ornithuromorphs (small femoral and crural feathers and featherless feet).