

# The oldest record of webbed bird and pterosaur tracks from the Cretaceous Haman Formation, Changseon and Sinsu Islands, southern coast of Korea.

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## Abstract

Tracks of web-footed birds and pterosaurs from the Lower Cretaceous (Aptian–Albian) Haman Formation, of Changseon and Sinsu Islands respectively (southern coast of Korea), represent the oldest records for these footprint types in Asia. The morphology of the bird tracks, with prominent posteriorly-directed hallux impression, semipalmate web, and small ratio of length to width is similar to *Hwangsanipes* from the Upper Cretaceous (Cenomanian) Uhangri Formation. However, they are about 20–25% smaller, and therefore much closer to the size of North American *Ignotornis* (size difference less than 10%). The development of the web appears intermediate in size between *Hwangsanipes* and *Ignotornis*. This leads us to infer a new ichnotaxon herein named *Ignotornis yangi*. This is the first Asian report of a bird track similar to the type material of *Ignotornis*.

Pterosaur tracks consist predominantly of clear impressions of tridactyl manus (length 9–13 cm) characterized by strongly asymmetric digit impressions that outnumber less-clear elongated pes traces by a ratio of about 10 to 1. Clusters of short digit impressions or parallel to subparallel scrape marks indicate incomplete pes traces, probably made by swimming animals. The pterosaur tracks, here provisionally identified as *Pteraichnus*, represent the first record of this ichnogenus from Korea. The trackmaker represents a species quite different from the giant trackmaker represented by the ichnogenus *Haenamichnus* from the Cenomanian Uhangri Formation, but it is similar to recent reports

of Pteraichnus-like forms from the Lower Cretaceous of China.

These new records shed light on patterns of bird track diversity and abundance in the "mid" Cretaceous of Korea (Aptian–Cenomanian) and show that at least two quite distinct pterosaurian species coexisted with at least six distinct species of trackmaking birds. When combined with additional reports of bird track ichnotaxa from China, the picture emerges of a remarkably diverse Lower Cretaceous avifauna. Such diversity is consistent with the skeletal record for this region, though the types of birds represented by tracks are "shorebird-like" and therefore distinct from the skeletal avifauna.

The ability of tracks to record whole foot morphology including details of web and hallux configuration, allows for fine discrimination of foot morphology, and comparison with web-footed tracks from other regions and geologic time periods. As is the case with modern shore birds, Cretaceous tracks were probably mostly made by adults, whose foot size, as well as shape, is probably indicative of the identity of the trackmaker at low taxonomic levels.

**Key Words** : webbed bird tracks; pterosaur tracks; Cretaceous; Haman Formation; Korea