

PHYLOGENY OF EXTINCT HAWAIIAN GOOSE DETERMINED BY SUB-FOSSIL DNA

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Associated skeletons of a very large, extinct, flightless goose were discovered recently in lava tubes on the island of Hawaii. Based on radiocarbon dates, the species became extinct subsequent to human colonization of the archipelago ca. 1400 years ago. Osteological studies show that this was a true goose (tribe: Anserini) unrelated to the moa-nalos, which were large, flightless anseriforms found as fossils elsewhere in the main Hawaiian Islands. Moa-nalos were derived from ducks rather than geese. The new flightless goose of Hawaii was considerably larger than any living goose, with a massive head and bill, and the greatly reduced wings and pectoral girdle associated with flightlessness. It is so specialized that further determination of its relationships, even to the level of genus (*Anser* vs. *Branta*) was not possible using morphology. It was therefore the aim of this project to determine the generic and specific affinities of this large goose using DNA from subfossil bones.

DNA was successfully extracted from four individuals of the subfossil species and compared with that from all living species of *Branta* and *Anser*, using sequences from three gene regions: Cytochrome *b* (244 bases), the mitochondrial control region (450 bp), and ATPase 8 (190 bp). The data indicate not only that the extinct species is referable to the genus *Branta*, but strongly support recent ancestry from the Canada goose (*B. canadensis*). Further, this ancestor was likely part of the **small** Canada goose clade, implying that the ancestor of the Hawaiian bird colonized Hawaii **subsequent** to the division of the Canada goose into "small and "large" lineages. In contrast, the data place the divergence of the extant Hawaiian goose, or nene (*B. sandvicensis*), from the *B. canadensis* complex **prior** to this split between lineages, thus indicating two successful colonizations of the archipelago by this genus. These data are also consistent with the biogeographic evidence: the nene was once present throughout the main Hawaiian Islands, whereas the large flightless species is present only on the youngest island, where it appears to have evolved convergently with the moa-nalos in its morphology and ecological requirements. Most strikingly, its high degree of morphological divergence must have evolved very rapidly; Given present estimates of the age of Hawaii and the time needed for suitable habitats to develop, this distinctive species must have differentiated and specialized in less than half a million years.