

A GIANT *PRESBYORNIS* (AVES: ANSERIFORMES)  
AND OTHER BIRDS FROM THE PALEOCENE AQUIA  
FORMATION OF MARYLAND AND VIRGINIA

Storrs L. Olson

*Abstract.*—*Presbyornis isoni*, new species, is described from a humerus and an alar phalanx from marine sediments of the late Paleocene Aquia Formation in Maryland. About the size of the smallest living species of crane (Gruidae), it was much larger than any previously known member of the Presbyornithidae. Other fragmentary bird remains from the Aquia Formation are noted, several of which may be referable to the suborder Phaethontes of the Pelecaniformes. Additional Paleocene birds from eastern North America occur in the Hornerstown Formation of New Jersey, which is now considered to be Danian (early Paleocene) in age, rather than late Cretaceous.

The marine sediments of the Aquia Formation crop out in the Chesapeake Bay area of Maryland and Virginia. They are of late Paleocene (Landenian) age and overlie the Brightseat Formation (Danian), between which there is a disconformity representing about 3.6 million years, a period of time approximately equivalent to that of the exposed Aquia Formation (Hazel 1969). The Aquia is divided into an upper Paspotansa Member and a lower Piscataway Member, the latter having sometimes been designated in earlier literature as the Piscataway Formation or Piscataway Indurated Marl Member of the "early Eocene." These sediments accumulated in a pelagic environment, well off shore, and are reasonably productive of vertebrate fossils, e.g., turtles (Weems 1988), but so far have yielded very few bird remains. A recently collected humerus is the largest and most diagnostic avian fossil yet discovered in the Aquia Formation. As it merits description, I have taken the opportunity to review the few other avian fossils found so far in the same strata.

Class Aves  
Order Anseriformes  
Family Presbyornithidae Wetmore, 1926

Genus *Presbyornis* Wetmore, 1926

*Presbyornis isoni*, new species

Figs. 1, 2

*Holotype.*—Left humerus lacking proximal third, collections of the Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, USNM 294116. Collected in March 1993 by Ronald M. A. Ison.

*Type locality.*—Maryland, Charles County, east bank of the Potomac River, from the area designated as Bluebanks, south of Liverpool Point and north of Douglas Point (Widewater Quadrangle, USGS 7.5 minute series).

*Horizon and age.*—Near the base of the Upper Paleocene (Landenian), Aquia Formation, Piscataway Member. The specimen came from near the base of the bluff exposed at the type locality, which is probably upper nannoplankton zone NP5, but possibly lower NP6 (Laurel M. Bybell, USGS, pers. comm.). On the scale of Berggren et al. (1985), the age would be somewhere between 61 and 62 million years.

*Measurements of holotype (mm).*—Distal width, 23.3; depth through radial condyle, 12.9; greatest diameter of brachial depression, 8.8; width and depth of shaft at approximate midpoint, 10.8 × 8.2.



Fig. 1. Humeri in palmar view (A–C) and phalanx 1 of major alar digit (D–E) of Presbyornithidae: A, *Presbyornis isoni* new species, holotype (USNM 294116); B, *Telmabates antiquus* (AMNH 3170); C, *Presbyornis pervetus* (cast, USNM 483163); D, *Presbyornis isoni* new species, paratype (USNM 294117); E, *Presbyornis pervetus* (cast, USNM 483164). All figures natural size.

*Paratype*.—Left phalanx 1 of major alar digit, abraded along the posterior edge, USNM 294117. Collected in June 1984 by Eugene Hartstein at the same locality as the holotype.

*Measurements of paratype* (mm).—Length, 40.6; greatest diameter of proximal articulation, 9.5.

*Etymology*.—Named in honor of the collector, Ronald M. A. Ison, an enthusiastic amateur paleontologist.

*Diagnosis*.—Much larger than *Presbyornis pervetus* Wetmore, 1926, or any other known members of the family. Apart from

size, there are no discernable differences between *P. isoni* and *P. pervetus*, save that the olecranal fossa appears less distinct in the former, which may be a size-related factor.

*Discussion*.—*Presbyornis* is a remarkable bird that exemplifies an early stage in the evolution of the Anseriformes, combining a long-legged, shorebird-like body with the head of a duck (Olson & Feduccia 1980). *Presbyornis pervetus* occurs abundantly in lacustrine deposits of the early Eocene Green River Formation of Wyoming, Colorado, and Utah, and a slightly smaller form is found in the Paleocene of Utah and Mon-



Fig. 2. Left humeri of *Presbyornis*: (A, C, E) *P. isoni* new species, holotype (USNM 294116); (B, D, F) *P. pervetus* (part of UCMP 136541). A-B, palmar view; C-D, anconal view; E-F, distal view. Specimens coated with ammonium chloride. 1.5 $\times$ .

golia (Olson 1985a:171). The contemporaneous genus *Telmabates*, from Patagonia, is very similar to *Presbyornis* and was synonymized with that genus by Feduccia & McGrew (1974). Further study, however, has shown that the limb proportions of *Telmabates* differ sufficiently from *Presbyornis* to merit retention of the genus (Per Ericson, Swedish Museum of Natural History,

Stockholm, pers. comm.). The type species, *T. antiquus*, was considerably larger than *Presbyornis pervetus*.

*Presbyornis isoni* was much larger than either. To put the relative differences in terms of modern analogs for size, *Presbyornis pervetus* would have been about the size of the largest species of *Burhinus*, the Bush Stone-curlew, *B. magnirostris*, of Australia.

*Telmabates antiquus* was about the size of a Limpkin, *Aramus guarauna*, whereas *Presbyornis isoni* would have been the size of a Demoiselle Crane, *Anthropoides virgo*.

It is possible, given its much larger size, that the feeding adaptations of *P. isoni* may have been different from those of *P. pervetus*, and that were the entire skeleton available it might be assigned to a different genus. As it is, however, there is no distinction whatever to be made between these taxa except on size.

The considerable assemblage of birds known from the Hornerstown Formation of New Jersey (Olson & Parris 1987) are now believed to be Danian (early Paleocene) rather than latest Cretaceous in age (see below), and are older than *P. isoni*. Most of these birds were referred to the "form family" Graculavidae, which shares similarities with the Presbyornithidae. *Presbyornis isoni* was larger than any of these species except *Laornis edwardsianus*, which was much larger than *P. isoni*. The species in the Hornerstown most similar to *P. isoni* is *Anatalavis rex*, which was a much smaller bird in which the brachial depression is longer, narrower, and not as deep, and in which the shaft appears to have been relatively shorter and more curved.

Although the alar phalanx referred to *P. isoni* is not a particularly diagnostic element, its size and overall similarity to the same element in *Presbyornis* makes it highly unlikely that it would belong to some other family altogether. That two elements of this presumed land bird were discovered at the same site, the sediments of which were deposited well off shore and where bird bones are scarce, suggests that they may have come from the same individual, despite having been collected years apart.

Order Pelecaniformes Sharpe  
Suborder Phaethontes

The modern tropicbirds (Phaethontidae, *Phaethon*), are the most primitive and di-

vergent of the Pelecaniformes, relegated to a separate suborder Phaethontes. The first fossil assigned to the family was *Prophaethon shrubsolei* Andrews (1899), known from a skull, mandible, and partial postcranial skeleton from the early Eocene (Ypresian) London Clay of England. Harrison & Walker (1976) restudied the specimen and created a new order and family for it, only the latter being justified, however (Olson 1985a). The only other fossil member of the Phaethontes is *Heliadornis ashbyi* Olson (1985b), known from three associated bones from the Middle Miocene (Langhian) Calvert Formation of Maryland, which was referred to the Phaethontidae.

Family Prophaethontidae

Harrison & Walker, 1976

Genus *Prophaethon* Andrews, 1899

*Prophaethon?* sp.

*Material examined.*—Distal end of right humerus, USNM 483158. Collected 1 m from top of chalky shell band of Aquia Formation at Capital Beltway and Central Avenue, Prince Georges, County, Maryland (Lanham Quadrangle, USGS 7.5 minute series), by Calvin F. Allison, Jr. in 1973. Distal width, 7.6 mm.

Right coracoid lacking part of the acrocoracoid and the lateral process of the sternal end, USNM 483159. Collected by T. B. Ruhoff at a road cut on Indian Head Highway, about 200 m north of Piscataway Creek, Prince Georges County, Maryland (Piscataway Quadrangle, USGS 7.5 minute series). "About 10–12 feet above road." This is evidently the same as the type locality of the fossil turtle *Catapleura ruhoffi* (Weems 1988). Length to internal distal angle 28.5 mm.

*Remarks.*—The humerus is extremely similar to that in modern tropicbirds of the genus *Phaethon*, practically the only noticeable difference being the indistinctness of the external tricipital groove, but this may be an artifact as the specimen is consider-

ably worn in this area. It comes from a bird much smaller than any living tropicbird, about the size of a Common Tern, *Sterna hirundo*, and thus much smaller than *Prophaethon shrubsolei* or *Heliadornis ashbyi*, although the distal end of the humerus is unknown in either of those species.

The coracoid from the Aquia was compared directly to that from the holotype of *P. shrubsolei* and is very similar in overall shape and proportions, but much smaller. At the sternal end, the specimens are lacking complementary portions and hence can scarcely be compared. Both have a shallow scapular facet. It is apparent that in the smaller species the procoracoid process would not have projected as much anteriorly, and the procoracoid foramen is more sternally situated (i.e., farther from the scapular facet). Also the triossial groove in the procoracoid is deeper in *Prophaethon*.

The Aquia coracoid is small and if not from a bird the same size as represented by the humerus, would be from a slightly larger individual or species. These two bones seem to be sufficiently diagnostic to be referred to the Phaethontes, but they are assigned only provisionally to the Prophaethontidae on the basis of their age.

#### Aves Incertae Sedis

##### Size 1

Distal third of right ulna, USNM 483160. Same collection data as the coracoid of *Prophaethon?* sp. mentioned above. Depth of distal end through external condyle, 4.4 mm. This specimen is from a small bird, possibly smaller than *Prophaethon?* sp. Its morphology is quite unlike the distinctive condition in modern *Phaethon*, in which the carpal tubercle is developed as a strong hook, and is more similar to that in Procellariiformes, but as we do not know what the ulna looked like in ancient Phaethontes, it cannot be ruled out that this fossil belongs in that group.

Abraded distal end of left tibiotarsus lacking internal condyle, USNM 294118. Collected from "Top Gully" of Aquia Formation at the Hampton Mall Site, Central Avenue near Capital Beltway, Prince Georges County, Maryland (Lanham Quadrangle, USGS 7.5 minute series), in 1984 by Eugene Hartstein. Depth through external condyle, 3.7 mm. This is from a species small enough to be of comparable size to *Prophaethon?* sp., but it bears no resemblance to the tibiotarsus in *Phaethon*. It is similar, however, to that element in the genus *Palaeotringa*, from the Hornerstown Formation (Olson & Parris 1987), though much smaller than any of its known species.

##### Size 2

Proximal half of phalanx 1 of major alar digit, USNM 483161. Same collection data as USNM 483159. Greatest diameter of proximal articulation, 5.0 mm.

Proximal shaft of left humerus including pectoral crest, USNM 483162. The label with this specimen, in Alexander Wetmore's hand, says only "Piscataway Formation, Virginia, from Ted Ruhoff." Width and depth of shaft just distal to pectoral crest, 4.0 × 5.0 mm.

These two specimens come from a bird the size of modern *Phaethon lepturus*, and such little morphology as remains on them is actually quite similar to that of *Phaethon*, so that they might well be from the same species and perhaps belong among the Phaethontes.

##### Size 3

Proximal end of right carpometacarpus New Jersey State Museum 13532. Collected as float at Belvedere Beach, Potomac River, King George County, Virginia (Passapatanzy Quadrangle, USGS 7.5 minute series), 27 Dec 1985 by Eugene Hartstein. Proximal depth through alular metacarpal, 13.3 mm. Although not found in situ, the specimen is

most probably Paleocene as the exposures at this locality are entirely a green glauconitic sandy marl of the Paspotansa Member of the Aquia Formation. The bone comes from a bird slightly larger than *Phaethon rubricauda*, the largest modern tropicbird, but differs considerably from that genus. It has some resemblance to the carpometacarpus in the Sulidae but again is quite different, though it could still belong to some member of the Pelecaniformes.

*The age of the "Cretaceous" birds of New Jersey.*—The record of Paleocene birds from marine deposits is quite scanty and the specimens discussed above would probably be the only ones known from North America were it not for the fact that the fairly diverse avifauna derived from the marine sediments of the basal Hornerstown Formation in New Jersey, long considered to be late Cretaceous (Maastrichtian) in age, are probably Paleocene as well. These fossil birds have received attention since the early 1870's, when many of the taxa were originally described by O. C. Marsh. The fauna has been recently revised by Olson & Parris (1987).

The age of the basal Hornerstown has been, and still is, a highly contentious issue. The birds from here were originally regarded as Cretaceous (Marsh 1870, 1872), then Paleocene (Wetmore 1930), then Cretaceous (Baird 1967). Weems (1988) cites some of the more recent literature giving evidence for the basal Hornerstown being Paleocene, but still notes some dissention.

There seems to be consensus that the upper Hornerstown is definitely Paleocene, so that if the basal part were Cretaceous, then the K/T boundary would have to lie *within* the Hornerstown, which, if true, should have attracted international attention. I get the impression that local pride may be involved, with the New Jersey contingent holding out for a Cretaceous attribution, Mesozoic fossils presumably being more glamorous than Cenozoic ones. Nevertheless, personnel of the U.S. Geological Sur-

vey will have none of this and place the outcropping portions of the basal Hornerstown in nannoplankton zone NP 3 (Laurel M. Bybell, USGS, pers. comm.), which is Danian, Lower Paleocene, between about 64 and 65 million years in age (Berggren et al. 1985). A Cretaceous assignment may have arisen either through reworking of Mesozoic macrofossils into the younger sediments, or through the persistence of otherwise Mesozoic taxa into the earliest Tertiary.

Although it makes no great difference one way or another as far as avian evolutionary history is concerned, as birds with some of the same general morphological attributes existed before and after the Hornerstown Formation, the refinements brought about by modern microfossil analysis would appear to necessitate the New Jersey birds being relinquished as part of Mesozoic history.

#### Acknowledgments

I thank Ron Ison and Eugene Hartstein, for collecting and donating the fossils of *Presbyornis* described here. Laurel M. Bybell, Thomas Gibson, and Robert Weems of the U.S. Geological Survey provided stratigraphic information, maps, and references. For lending various fossils I am grateful to Charlotte Holton, American Museum of Natural History, New York (AMNH); Howard Hutchison, Museum of Paleontology, University of California, Berkeley (UCMP); David C. Parris, New Jersey State Museum, Trenton (NJSM); and Cyril Walker, British Museum (Natural History). The photographs are by Victor E. Krantz. I thank Robert Weems for comments on the manuscript and Mark Florence for curatorial assistance.

#### Literature Cited

- Andrews, C. W. 1899. On the remains of a new bird from the London Clay of Sheppey.—Proceedings of the Zoological Society of London 1899: 776–785.

- Baird, D. 1967. Age of fossil birds from the greensands of New Jersey.—*Auk* 84:260–262.
- Berggren, W. A., D. V. Kent, J. J. Flynn, & J. A. Van Couvering. 1985. Cenozoic geochronology.—*Geological Society of America Bulletin* 96:1407–1418.
- Feduccia, A., & P. O. McGrew. 1974. A flamingolike wader from the Eocene of Wyoming.—*Contributions to Geology University of Wyoming* 13:49–61.
- Harrison, C. J. O., and C. A. Walker. 1976. A reappraisal of *Prophaethon shrubsolei* Andrews (Aves).—*Bulletin of the British Museum (Natural History), Geology* 27:1–30.
- Hazel, J. E. 1969. Faunal evidence for an unconformity between the Paleocene Brightseat and Aquia Formations (Maryland and Virginia).—U.S. Geological Survey Professional Paper 650-C: C58–C65.
- Marsh, O. C. 1870. Notice of some fossil birds from the Cretaceous and Tertiary formations of the United States.—*American Journal of Science* ser 2., 49:205–217.
- . 1872. Preliminary description of *Hesperornis regalis*, with notices of four other new species of Cretaceous birds.—*American Journal of Science* ser 3., 3:360–365.
- Olson, S. L. 1985a. The fossil record of birds. Pp. 79–238 in D. Farner, J. King, and K. Parkes, eds. *Avian Biology*, volume 8. Academic Press, New York.
- . 1985b. A new genus of tropicbird (Pelecaniformes: Phaethontidae) from the Middle Miocene Calvert Formation of Maryland.—*Proceedings of the Biological Society of Washington* 98:851–855.
- , & A. Feduccia. 1980. *Presbyornis* and the origin of the Anseriformes (Aves: Charadriomorphae).—*Smithsonian Contributions to Zoology* 323:1–24.
- , & D. C. Parris. 1987. The Cretaceous birds of New Jersey.—*Smithsonian Contributions to Paleobiology* 63:1–22.
- Weems, R. E. 1988. Paleocene turtles from the Aquia and Brightseat Formations, with a discussion of their bearing on sea turtle evolution and phylogeny.—*Proceedings of the Biological Society of Washington* 101:109–145.
- Wetmore, A. 1926. Fossil birds from the Green River deposits of eastern Utah.—*Annals of the Carnegie Museum* 16:391–402.
- . 1930. The age of the supposed Cretaceous birds from New Jersey. *Auk* 47:186–188.

Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, U.S.A.