

## GENERAL NOTES

**Age of fossil birds from the greensands of New Jersey.**—Several species of fossil birds from the glauconitic marls of New Jersey, originally described by O. C. Marsh as Cretaceous in age, have been re-dated as Eocene by Wetmore (1930) and more recently as late Paleocene by Pierce Brodkorb (1963). Progress in the stratigraphic analysis of Atlantic coastal sediments now requires a reassessment of these age assignments.

The type specimens of *Graculavus velox*, *G. pumilis*, *Telmatornis priscus*, *Palaeotringa littoralis*, *P. vetus*, *P. vagans*, and *Laornis edwardsianus* (Marsh, 1870, 1872) and *Telmatornis rex* (Shufeldt, 1915) were all found in 19th-century commercial pit-mines in which marl was dug for use as fertilizer. To determine their ages we must first try to interpret the stratigraphic terms used by the miners a century ago.

The marl bed richest in glauconitic greensand, and therefore most sought after for fertilizer, is that which is known today as the Hornerstown Formation, below which lies either the more clayey New Egypt Formation (Olsson, 1960) or its lateral (partial) equivalents the Navesink and the Redbank. In pits where both marl beds were exposed, the Hornerstown was called the "upper marl" or "the greensand" while the New Egypt and its equivalents were called the "lower" or "chocolate marl." In areas where the Shark River-Manasquan Formation occurs higher in the section, the latter was likely to be termed the "upper marl" and the Hornerstown would then become the "middle marl." This usage was by no means invariable, however, for a case is noted below in which the chocolate-colored Navesink was called the "middle marl." Miners' terms were thus inconsistent and should be interpreted with caution.

Both the "upper" (alias "middle") and "lower" marls were and are productive of vertebrate fossils. From which, then, were Marsh's bird specimens derived? In most cases we cannot be certain after the lapse of nearly a century, although modern revisers such as Wetmore (1930) and Miller (1955) have assumed that the specimens came from the Hornerstown Marl, equating it with the "upper" or "middle marl" of Marsh's original descriptions.

An exception must definitely be made in the cases of *Telmatornis priscus* and *T. affinis* (Marsh, 1870), the type specimens of which "were found in the Cretaceous greensand of the middle marl bed, in pits of the Cream Ridge Marl Company, near Hornerstown," Monmouth County. Mr. Eugene S. Gaffney of Columbia University informs me that he has relocated the Cream Ridge Marl Company pits and reports that no Hornerstown is exposed; the marl is lithologically typical of the Navesink and contains abundant *Gryphaea*, *Exogyra*, and *Belemnitella*, the invertebrate fossils characteristic of the Navesink. These two bird specimens may therefore be assigned with some confidence to the Navesink Formation and dated as approximately middle Maestrichtian, late Cretaceous.

With the exceptions noted below, the type specimens of the other species mentioned were found in the vicinity of Hornerstown, Monmouth County, which is the type area of the Hornerstown Formation. It should be noted, however, that some of the old mining operations in this area penetrated well into the underlying "chocolate marl" of the New Egypt Formation. Thus in cases where the source bed is not specified (and perhaps in other cases as well) we cannot be certain that the specimens are not from the New Egypt rather than the Hornerstown. In that case they might be as old as middle Maestrichtian.

Over the years the Hornerstown Formation itself has been variously dated as

Cretaceous, Eocene, and Paleocene. Olsson (1963: 655) has demonstrated that Hornerstown sedimentation extended from early Paleocene to early Eocene (Sparnacian) time. However, recent studies by Miller, Olsson, and Baird (see Baird, 1964, and references cited) have now established that the basal member of the Hornerstown (the "middle greensand unit" of Miller) is latest Cretaceous (late Maestrichtian) in age. The presence of Maestrichtian foraminifera, the ammonite *Sphenodiscus lenticularis* (Princeton University specimen no. 87231, identified by Dr. Karl M. Waage), and the turtle *Toxochelys atlantica* (PU 18709) in the basal part of the Hornerstown provides a firm basis for this dating.

Did Marsh's bird fossils come from the Paleocene or the Cretaceous part of the formation? Again, we cannot be certain in all cases; but in the experience of present-day collectors the Cretaceous member of the Hornerstown is decidedly the more productive of vertebrate fossils. According to Miller (1956: 728-729) and Eugene S. Gaffney (*in litt.*, 1966), the formation as exposed in the immediate vicinity of Hornerstown bears a Cretaceous fauna. Thus Marsh's bird specimens from the Hornerstown area are probably no younger than latest Cretaceous.

The type specimen of *Palaeotringa vetus* (Marsh, 1870) was found "in friable green marl near Arneytown" on the Monmouth-Burlington county boundary. In this area the Hornerstown caps small hills and is underlain by yellow and reddish-brown sand of the Redbank Formation, so on lithological grounds the bird fossil can be assigned to the lower, i.e., Cretaceous, part of the Hornerstown.

At Birmingham, Burlington County, the type specimen of *Laornis edwardsianus* (Marsh, 1870) was found in the "greensand of the upper, Cretaceous marl bed . . . in pits of the Pemberton Marl Company." In this vicinity two genera of Cretaceous turtles, *Toxochelys* (Baird, 1964: 22) and *Prionocheilus* (Baird and Case, 1966), have been collected in the Hornerstown, and Miller (1956: 729) reports that the late Maestrichtian ammonite *Sphenodiscus* is present in old collections from the Pemberton Marl Company pits. The most probable age of *Laornis edwardsianus* is therefore latest Cretaceous.

In summary, available evidence indicates that all the specimens of fossil birds from the greensand marls of New Jersey are late or latest Cretaceous in age. They are thus essentially contemporaneous with the avifaunas of the Lance and Hell Creek Formations of Wyoming and Montana, which are currently being studied by Dr. Pierce Brodkorb. This re-dating of the New Jersey specimens strengthens the belief that most Cretaceous birds were of essentially modern types, and that archaic, toothed forms such as *Hesperornis*—which undue publicity has fixed in the public mind as typical Cretaceous birds—are better regarded as specialized relict types which were "living fossils" in their own day.

Observations on the probable age of another fossil bird from New Jersey may be added appropriately here. The type specimen of *Diatryma* [*Barornis*] *regens* (Marsh, 1894) was collected in the "upper marl beds" now known as the Manasquan Formation (Olsson, 1963: 645), evidently in the small deposit along the Manasquan River northwest of Squankum, Monmouth County. The Manasquan had earlier been correlated with the Wilcox (Ypresian-Cuisian, early Eocene) of the Gulf Coast, but Miller (1956: 733) has advanced evidence that it is instead equivalent to the Claiborne (Lutetian-Auversian, middle Eocene).

The stratigraphic evidence may be stated briefly. As noted above, the uppermost Hornerstown is dated as Sparnacian (early Eocene) on the basis of foraminifera; it is gradationally overlain by the Vincentown Formation of late Sparnacian age

(Olsson, 1963: 647). As the Manasquan conformably overlies the Vincentown it is evidently post-Sparnacian.

Although the correlation chart of the Geological Society of America (Cooke *et al.*, 1943) shows the Manasquan and Shark River marls as separate formations of different ages, Miller (1956: 733) and others consider them to be a single unit. The Shark River, which carries an invertebrate fauna of Claiborne age, has also yielded the type specimen (a single tooth) of the tillodont mammal *Anchippodus riparius*. Gazin (1953: 34) considers *Anchippodus* to be generically indeterminate but points out that it is comparable in size to *Tillodon fodiens* from the Bridger B Member of Wyoming.

From these several lines of evidence it seems probable that the age of *Diatryma regens* is middle Eocene (Bridgerian). Another middle Eocene occurrence of *Diatryma*, a femur from the Lutetian of Messel near Darmstadt, Germany, has recently been reported by Berg (1965).

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