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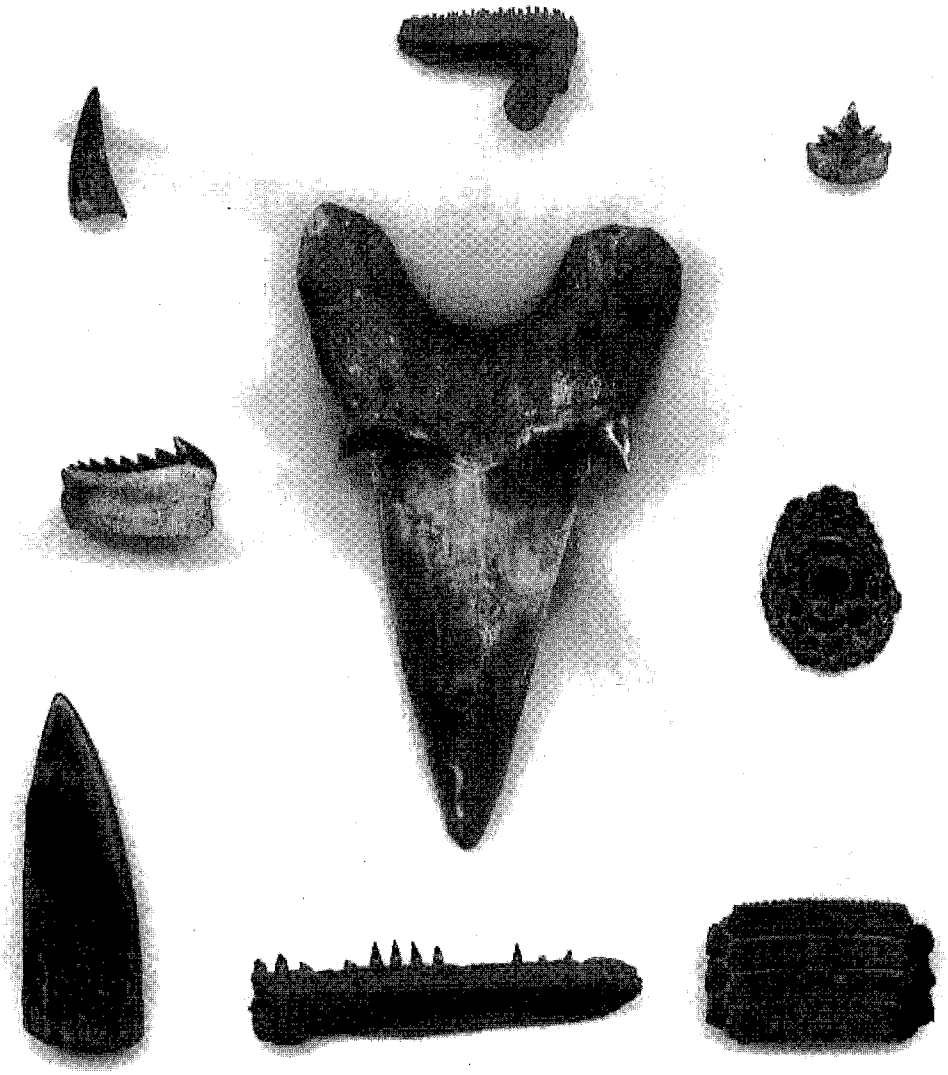

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
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Stanley S. Johnson, State Geologist
CHARLOTTESVILLE, VIRGINIA

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Early Eocene Vertebrates and Plants from the Fisher/Sullivan Site (Nanjemoy Formation) Stafford County, Virginia

Robert E. Weems and Gary J.Grimsley, Editors

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Part 6. Early Eocene Birds from Eastern North America: A Faunule from the Nanjemoy Formation of Virginia

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ABSTRACT

Fossil bird remains from the Fisher/Sullivan Site, Stafford County, Virginia, come from marine sediments of the Potapaco Member of the early Eocene Nanjemoy Formation and are equivalent in age to the London Clay of southeastern England, which has produced many fossil birds. The 33 specimens from the Fisher/Sullivan Site are referable to at least 11 species and constitute the first early Eocene avifauna known from eastern North America. The taxa represented include a pseudodontorn (Pelagornithidae); various shorebird-like species, some with similarities to the Burhinidae, Rostratulidae, and Phoenicopteridae; and three species of Caprimulgiformes/Apodiformes. Only the pseudodontorn was pelagic, all the other being shore or land birds, which suggests rather unusual depositional circumstances.

INTRODUCTION

The earliest part of the Tertiary was a critical time in the origin of orders and families of modern birds. This was a period when birds were diversifying rapidly and were making many evolutionary experiments in response to the new regimes of climate and vegetation that appeared after the end of the Cretaceous. Our knowledge of birds of this age comes mainly from two geographic areas---western North America and western Europe, especially England. In the American west, particularly Wyoming, very fragmentary and minimally informative bird remains have long been known from Paleocene and early Eocene mudstones that have been so thoroughly prospected for mammalian teeth (e.g., Gingerich, 1980). From many of the same deposits, excellent material of fossil birds has been found in recent years in freshwater limestone nodules (e.g., Houde, 1988; Houde and Olson, 1989; 1992). Another prime source of birds of this age has been the lacustrine deposits of the Green River Formation (e.g., Olson, 1987).

On the eastern side of the Atlantic, the beds of the early Eocene London Clay have produced fossil birds in great number, the very best originating in the mudflats at Walton-on-the-Naze in Essex. Most of these are in a private collection and have not been documented in the scientific literature. Although there is a rich Neogene record of birds in eastern North America, fossils of early Paleogene age are quite scarce, consisting mainly of a few Paleocene fossils from Maryland and Virginia (Olson, 1994), and a single toe bone of *Diatryma* from the Lower Eocene of New Jersey (Andors, 1988:42-44).

Recently, however, an intriguing faunule consisting of 33 specimens belonging to at least 11 species of birds offers a first glimpse into the birdlife of eastern North America in the early Eocene. These come from sediments of the Potapaco Member of the Nanjemoy Formation of the early Tertiary Pamunkey Group that are exposed in the bed of an unnamed tributary of Muddy Creek, north of Virginia State Highway 3, in Stafford County, east of Fredericksburg, Virginia. The age of the deposit is early Eocene, corresponding to the early part of calcareous nannoplankton Zone NP 11, and overlaps broadly in age with the London Clay (for details of the geology and paleoecology of this site, termed the Fisher/Sullivan Site, see Weems and Grimsley, Part 1, and other papers in this volume). The fossils were deposited in a nearshore marine environment and were recovered by quarrying the sediment and washing it through screens. The specimens have been cataloged in the collections of the Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D. C. (acronym USNM). Identifications were based on comparisons with modern skeletal material housed in the collections of the Division of Birds, Department of Vertebrate Zoology, of the same institution.

SYSTEMATIC PALEONTOLOGY

Pelecaniformes
Pelagornithidae
Odontopteryx? sp.

Material: Carpometacarpus, left proximal end lacking most of the alular metacarpal, USNM 496364 (Fig. 1a,b). Collected by Mike Folmer. Width and depth of carpal trochlea, 12.5 X 18.0 mm.

Carpometacarpus, left distal end, USNM 496417 (Fig. 1c,d). Collected by Mike Folmer. Width and depth of articular surface, 10.7 X 14.7 mm. This is quite conceivably from one and the same bone as the proximal fragment.

Pedal digit III, phalanx 1, proximal half, USNM 496365 (Fig. 1e,f). Collected by Mike Folmer. Width and depth of proximal articulation, 9.5 X 9.8 mm. The precise bone of the foot represented by this fragment is only a guess.

Discussion: These bones come from a bird about the size of the Peruvian Brown Pelican, *Pelecanus thagus*. The very large pseudotoothed birds of the family Pelagornithidae range in age from Paleocene to relatively late in the Neogene (Olson, 1985). A much needed revision of the complexities of this group has been initiated by K. I.

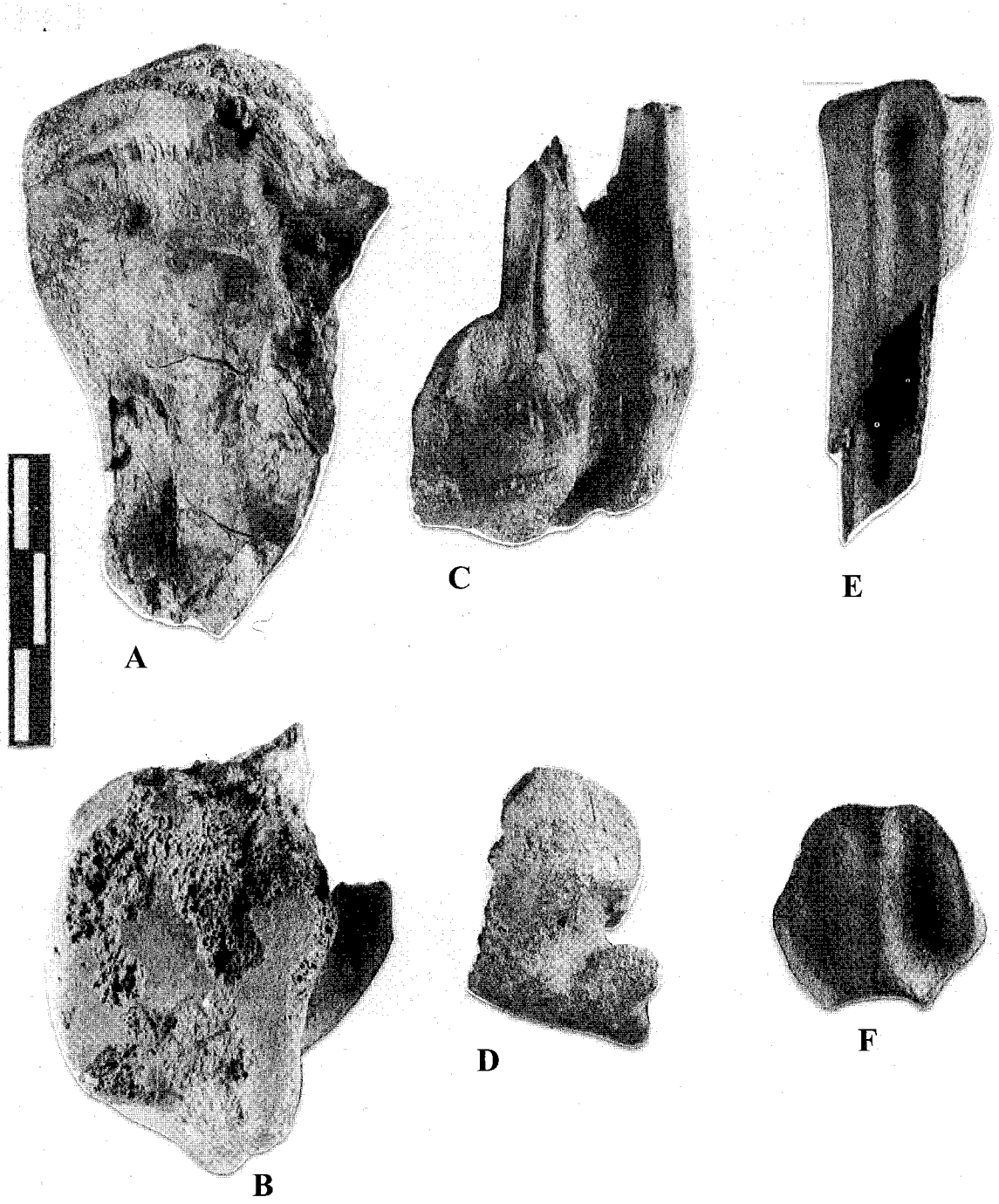

Figure 1. *Odontopteryx*? sp.: A, carpometacarpus, left proximal end lacking most of the alular metacarpal, USNM 496364 (internal view); B, same, proximal view; C, carpometacarpus, left distal end, USNM 496417 (external view); D, same, distal view; E, pedal digit III, phalanx 1, proximal half, USNM 496365 (ventral view); F, same, proximal view. Scale is in 0.5 cm increments.

Warheit and Olson but is still far from completion. At least two species differing in size are known from the London Clay, for which there are numerous names available, the oldest being *Odontopteryx toliapica* Owen, a species that was smaller than the one indicated by the Nanjemoy bones.

The Eocene pseudodontorns were more primitive and differed considerably from the species known from the late Oligocene onward, most of which are referable to the genus *Pelagornis* Lartet. The carpometacarpus from the Fisher/Sullivan Site differs from a specimen from the late Oligocene of South Carolina in having the trochlea in proximal view higher and narrower (Fig. 1b). The two were similar, however, in the flattened rather than rounded trailing edge of the trochlea.

Charadriiformes
Graculavidae?
genus and species indeterminate #1

Material: Scapula, left, worn and lacking posterior third, USNM 496367 (Fig. 2d). Collected by Tom Parks. Shaft width posterior to articular expansion, 4.3 mm.

Coracoid, left shaft, USNM 496368 (Fig. 2e). Collected by Mike Folmer. Shaft width and depth at midpoint, 4.6 X 3.6 mm.

Humerus, left distal condyles, USNM 496369 (Fig. 2c). Collected by Gary Grimsley. Depth through radial condyle, 8.5 mm.

Ulna, right proximal end, USNM 496370 (Fig. 2a). Collected by Dick Grier, Jr. Proximal width and depth, 8.6 X 9.2 mm. A piece of shaft (USNM 496371) collected independently by Ron Keil appears as if it may have come from the same specimen, although there is no point of contact between the two.

Tibiotarsus, left distal third lacking condyles, USNM 496366 (Fig. 2b). Collected by Richard Brezina. Width at proximal opening of tendinal canal, 8.0 mm; width and depth of shaft approximately one-third the length from the distal end, 4.7 X 4.4 mm.

Discussion: Olson and Parris (1987) used the name Graculavidae as a form family to encompass various late Cretaceous/early Tertiary taxa based on fragmentary material showing similarities to basal "charadriiforms" such as the Burhinidae, and to *Presbyornis*, a primitive waterfowl (Anseriformes). It is a convenient catch-all, intended as such, members of which will presumably be removed to their correct families as their anatomy becomes better known (e.g., Olson, in press).

The tibiotarsus listed above (Fig. 2b) is very similar in size and overall morphology to that of the Australian Bush Stone-curlew, *Burhinus magnirostris*, and hence a good candidate for referral to the Graculavidae. Per Ericson (Swedish Museum of Natural History, Stockholm, personal communication) examined it and was convinced that it was not referable to *Presbyornis*. It differs from *Palaeotringa* Marsh, and *Dakotornis* Erickson, in lacking a foramen in the groove for the tendon of M. peroneus brevis (Olson and Parris, 1987). The other elements (Fig. 2a, c-e), though very scrappy, would be compatible with a bird of this size and general structure.

Figure 2. Graculavidae?, genus and species indeterminate #1: A, ulna, right proximal end, USNM 496370 (internal view), with possibly associated piece of shaft, USNM 496371; B, tibiotarsus, left distal third lacking condyles, USNM 496366 (anterior view); C, humerus, left distal condyles, USNM 496369 (palmar view); D, scapula, left, worn and lacking posterior third, USNM 496367 (dorsal view); E, coracoid, left shaft, USNM 496368 (ventral view). Scale is in 0.5 cm increments.

genus and species indeterminate #2

Material: Ulna, right distal end, USNM 496372 (Fig. 3a). Collected by Ron Keil. Distal width and depth, 5.9 X 5.4 mm.

Carpometacarpus, right distal symphysis, USNM 496373 (Fig. 3b). Collected by Mike Folmer. Distal width

and depth, 3.7 X 4.8 mm.

Discussion: These are from a bird the size of the Old World Stone-curlew, *Burhinus oedicnemus*, to which the carpometacarpus bears some resemblance, although the ulna lacks the deep ligamental pit on the dorsal surface seen in the modern bird. They are here tentatively included as a smaller species of Graculavidae.

Scolopaci
family, genus, and species indeterminate

Material: Humerus, right distal end lacking condyles, USNM 496374 (Fig. 3c). Collected by Tom Parks. Width just above ectepicondylar spur, 4.1 mm; width and depth of shaft at approximate midpoint, 3.0 X 2.3 mm.

Tarsometatarsus, right distal end, USNM 496375 (Fig. 3d). Collected by Tom Parks. Distal width, 5.0 mm; width through outer and middle trochleae, 3.8 mm.

Pedal phalanx, probably phalanx 1 digit III, USNM 496376 (Fig. 3e). Collected by Mark Bennett. Length, 12.0 mm.

Discussion: These elements would all be compatible with a shorebird intermediate in size between the Old World and New World painted snipes (*Rostratula benghalensis* and *R. semicollaris*). The tarsometatarsus and humerus are clearly from some sort of limicoline charadriiform and the former compares better with the Rostratulidae than with the more derived families Scolopacidae and Charadriidae. The humerus differs considerably from that of *Rostratula*, however, in the much deeper brachial depression and the better development of the area where the ectepicondylar spur arises. I would not have attempted to identify the toe bone but it is exactly of the size expected for the species represented by the other two bones and is very similar to phalanx 1 digit III in *Rostratula*. The Rostratulidae and Jacanidae are early offshoots of the suborder Scolopaci. Shorebirds apparently having some affinity with these two families are also known in the London Clay.

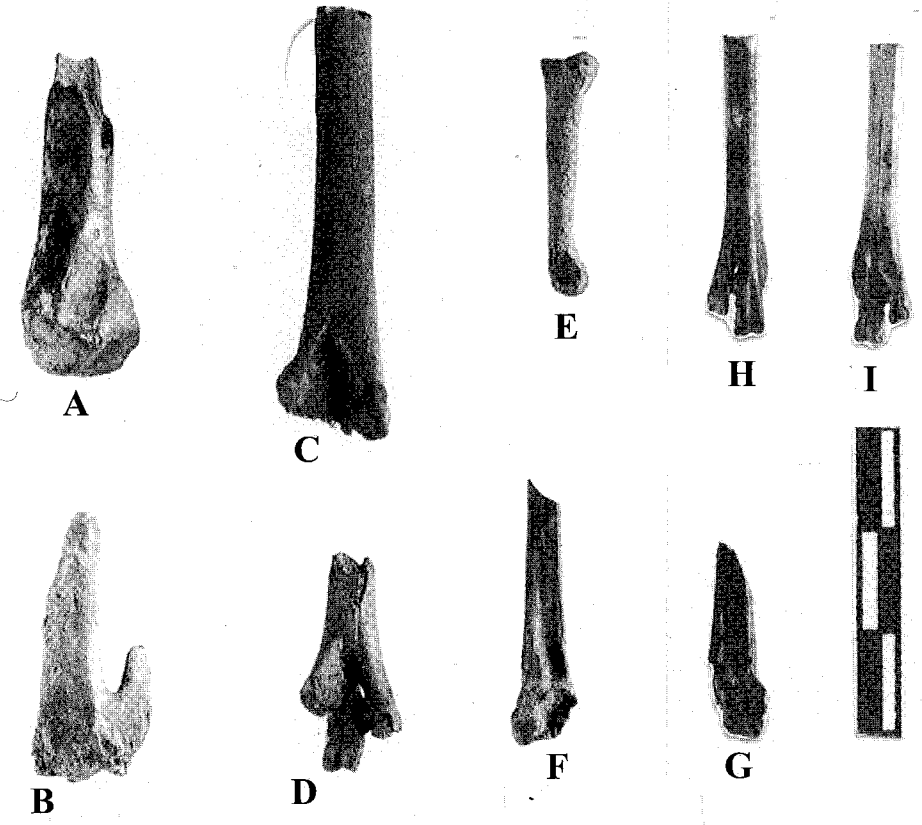

Figure 3. Various shorebird-like taxa. Graculavidae, genus and species indeterminate #2 : A, ulna, right distal end, USNM 496372 (internal view); B, carpometacarpus, right distal symphysis, USNM 496373 (internal view). Scolopaci, family, genus, and species indeterminate: C, humerus, right distal end lacking condyles, USNM 496374 (palmar view); D, tarsometatarsus, right distal end, USNM 496375 (posterior view); E, pedal phalanx, probably phalanx 1 digit III, USNM 496376 (lateral view). cf. *Coturnipes cooperi*: F, tibiotarsus, right distal end lacking inner condyle, USNM 496377 (anterior view); G, tibiotarsus, left distal end lacking inner condyle, USNM 496420 (anterior view); H, tarsometatarsus, right distal end lacking inner condyle, USNM 496419 (anterior view); I, same, posterior view. Scale is in 0.5 cm increments.

Phoenicopteridae?
genus and species indeterminate

Material: Radii, right and left proximal ends, USNM 496388, 496389 (Fig. 4d). Collected by Tom Parks. Greatest proximal diameter, 6.7 mm.

Carpometacarpus, right proximal end, USNM 496385 (Fig. 4c). Collected by Chuck Ball. Proximal depth through alular metacarpal 14.1 mm, width of carpal trochlea 6.1 mm.

Discussion: The carpometacarpus is distinctive in the very long proximal symphysis, in which respect it is similar to modern flamingos (Phoenicopteridae), which have been shown to be derived from the Charadrii (Olson and Feduccia, 1980). The fossil carpometacarpus is from a bird slightly larger than in three females of the Lesser Flamingo (*Phoeniconaias minor*) but smaller than an unsexed, presumably male, individual of that species. The carpal trochlea is narrower in the fossil. The primitive flamingo *Juncitarsus* is known from early and middle Eocene deposits in Wyoming and Germany (Olson and Feduccia, 1980; Peters, 1987; Ericson, in press), although the two known species would probably have been somewhat smaller than the bird under consideration here.

The two radii listed above are most undiagnostic and are included here solely on size. Although they are from an individual smaller than that represented by the carpometacarpus, they could possibly be from the same species if the radii were from a female and the carpometacarpus from a male.

Order Incertae Sedis

cf. *Coturnipes cooperi* Harrison and Walker, 1977

Material: Tibiotarsus, right distal end lacking inner condyle, USNM 496377 (Fig. 3f). Collected by Mike Folmer. Depth of outer condyle, 3.2 mm.

Tibiotarsus, left distal end lacking inner condyle, USNM 496420 (Fig. 3g). Collected by Gary Grimsley. Width through outer and middle trochleae, 3.0 mm, depth of middle trochlea 2.0 mm.

Tarsometatarsus, right distal end lacking inner condyle, USNM 496419 (Fig. 3h,i). Collected by Mike Folmer. Depth of outer condyle, 3.2 mm.

Discussion: *Coturnipes cooperi* was described by Harrison and Walker (1977) as a new genus and species of small quail-like bird (Phasianidae) based on the distal end of a very small tarsometatarsus from the London Clay. I examined an associated skeleton from the London Clay in the collection of Michael Daniels, the tarsometarsus of which I compared with the holotype of *Coturnipes cooperi*. I would consider these two specimens to be referable to the same species. The distal end of the tarsometatarsus is rather like that in the Phasianidae, but is also as similar to some of the Charadriiformes, with which the very long slender tibiotarsi and tarsometatarsi of the associated specimen are in better accord. Much of the remainder of the skeleton, however, is very suggestive of that in the Falconidae, which would be about as strange and inexplicable a mosaic as might be imagined. The phylogenetic significance of this weird bird remains to be investigated.

The Fisher/Sullivan Site tarsometatarsus is similar in size and morphology to the holotype of *Coturnipes cooperi*

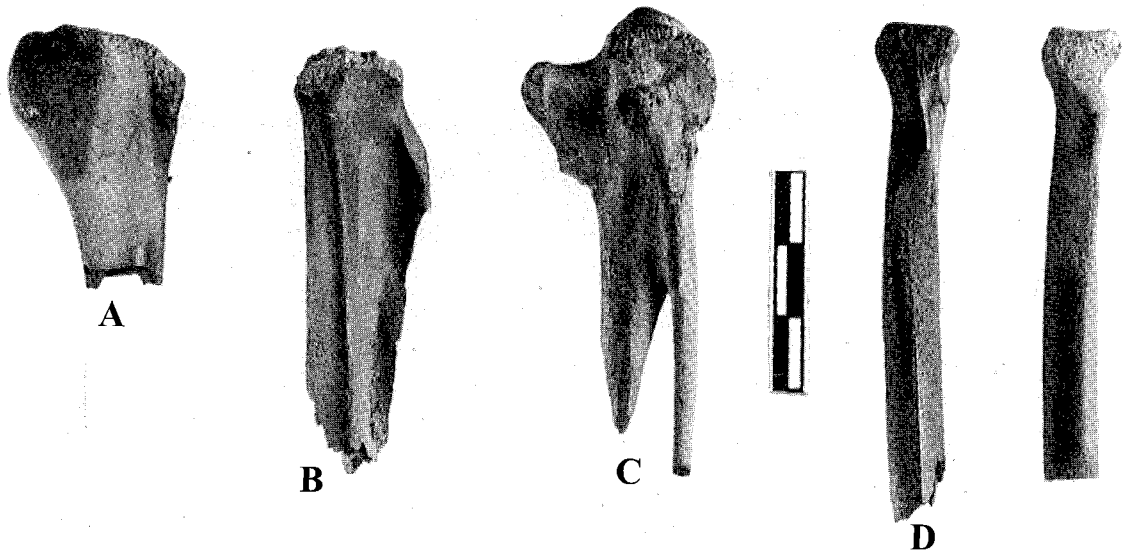

Figure 4. Crane-sized and flamingo-sized birds. Indeterminate crane-sized species: A, radius, left distal end with associated portion of shaft (not shown), USNM 496386 (exterior view); B, major alar digit, phalanx 1, USNM 496387 (external view). Phoenicopteridae?, genus and species indeterminate: C, carpometacarpus, right proximal end, USNM 496385 (internal view); D, radii, right and left proximal ends, USNM 496388, 496389. Scale is in 0.5 cm increments.

as described and illustrated by Harrison and Walker (1977). The two tibiotarsi referred here are very similar to each other and and appear to be of a size and slenderness that would be compatible with the tarsometatarsus. They have a deep tendinal groove on the anterior face; a well-developed, wide, supratendinal bridge; and a long, triangular external ligamental prominence, in which respects they bear close resemblance to limicoline Charadriiformes, as does the tarsometatarsus. Referral of any of these specimens to *Coturnipes* must be considered tentative pending direct comparisons with the London Clay material.

Caprimulgiformes
Steatornithidae?
genus and species indeterminate

Material: Humerus, left proximal end, USNM 496378 (Fig. 5a-c). Collected by Ron Keil. Proximal width, 15.7 mm; depth of external tuberosity, 4.6 mm.

Humerus, left distal end, USNM 496379 (Fig. 5d-f). Collected by Mike Folmer. Distal width, 13.1 mm; depth through radial condyle, 7.3 mm; length of radial condyle, 7.3 mm.

Tarsometatarsus, right outer trochlea, USNM 496418 (not figured). Collected by Mike Folmer. Depth of trochlea, 3.3 mm.

Discussion: The size, exquisite preservation, morphology, and the fact that both of the humeral fragments (Fig. 5a-f) are from the same side of the body make it virtually certain that they are ends of one and the same bone. They come from a bird intermediate in size between the Long-tailed Potoo, *Nyctibeus aethereus*, and the smaller Common Potoo, *N. griseus*.

The closest overall similarity of these fragments is to the Nyctibiidae, but it must be kept in mind that the humerus in the living Oilbird, *Steatornis caripensis*, is highly specialized and does not resemble that in the only known Eocene member of the Steatornithidae, *Prefica nivea* (Olson, 1987). Most details of the humerus cannot be made out in the holotype of *Prefica nivea*, although this was a considerably smaller species than the one under consideration here (Olson, 1987).

The proximal end of the humerus closely resembles that of *Nyctibius* in the long, flat head; wide capital groove; and high, pointed internal tuberosity overhanging a small pneumatic opening in the tricipital fossa. It differs from *Nyctibius* in the more prominent median ridge on the anconal surface of the shaft and particularly in the less developed bicipital crest, so that the margin tapers directly from the internal tuberosity to the shaft rather than being rounded.

The distal end is also rather like that in *Nyctibius*, but is distinctive in being very flattened, with very little curvature of the shaft as viewed internally or externally. The distal end is not as broadly expanded, particularly in the entepicondylar region, as in *Nyctibius*, and the brachial depression differs considerably in being less extensive but much deeper.

The shape of the bicipital crest and the brachial depression can be viewed as similar to, or approaching, the condition in *Steatornis*. Thus it seems possible that this bird may have been a larger relative of *Prefica*, without the more specialized modifications of the humerus seen in *Steatornis*.

At first sight the metatarsal trochlea would appear to defy identification but it preserves enough of the shaft and the impression of the extensor groove as to be highly diagnostic. This trochlea would have been highly flared laterally and the distal foramen clearly exited between the outer and middle trochleae and not on the plantar surface of the shaft, both of which features are found in the Nyctibiidae and Steatornithidae. The articular surface for the proximal phalanx is not highly modified as in modern Nyctibiidae. On size, the specimen appears to be compatible with the same species as represented by the humeral fragments.

Caprimulgidae?
genus and species indeterminate #1

Material: Humerus, left proximal two-thirds, USNM 496380 (Fig. 6a,b). Collected by Tom Parks. Proximal width, 9.0 mm; width and depth of shaft at approximate midpoint, 2.8 X 2.5 mm.

Radius, right distal half, USNM 496381 (Fig. 6c,d). Collected by Tom Parks. Greatest distal diameter, 3.1 mm.

Tarsometatarsus, left distal end lacking inner trochlea and with remaining trochleae quite worn, USNM 496382 (Fig. 6e,f). Collected by Dick Grier, Jr. Width through outer and middle trochleae, 3.4 mm.

Discussion: These three elements appear to be from a nightjar-like bird about the size of a Parauque, *Nyctidromus albicollis*. The humerus and radius were obtained by the same collector, were evidently found about the same time, and have very similar preservation. The radius shows some differences from that of *Nyctidromus albicollis* but is almost exactly the same size and would be much larger than in a shorebird of otherwise comparable size, so its association with the same species as the humerus seems reasonable.

The humerus (Figure 6a,b) is very similar in size and overall configuration of the proximal end to that of *Nyctidromus albicollis* (Caprimulgidae). It differs in the more slender shaft, longer and more distally situated pectoral crest, more prominent median ridge, and much less prominent area below the internal tuberosity for the attachment of the scapulohumeralis posterior muscle.

The tarsometatarsus (Figure 6e,f), with its rather broad, flattened end and widely splayed trochleae, is highly

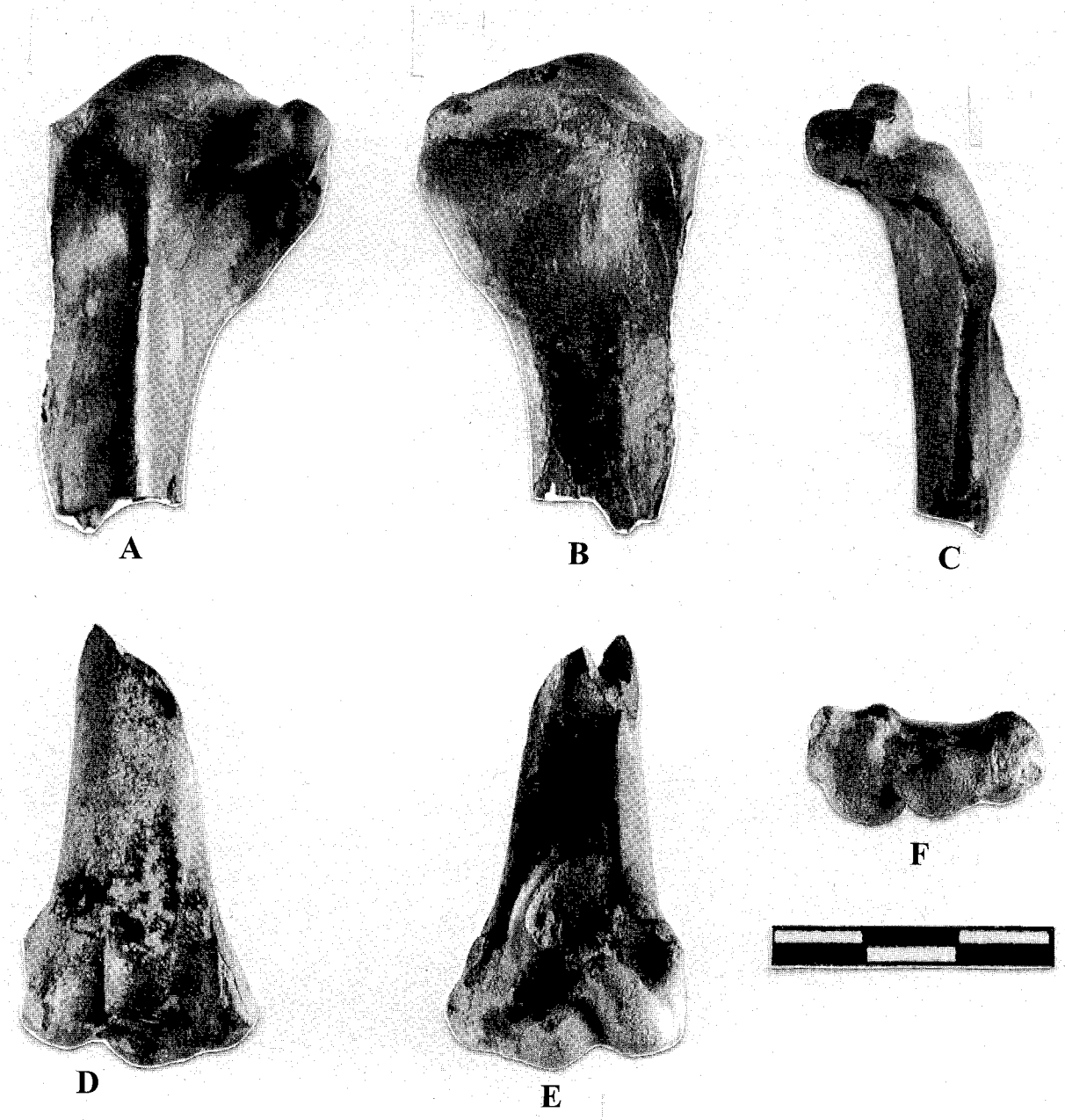

Figure 5. Steatornithidae?, genus and species indeterminate: A-C, humerus, left proximal end, USNM 496378 (A, anconal; B, palmar; and C, internal view); D-F, humerus, left distal end, USNM 496379 (D, anconal; E, palmar; and F, distal view). Scale is in 0.5 cm increments.

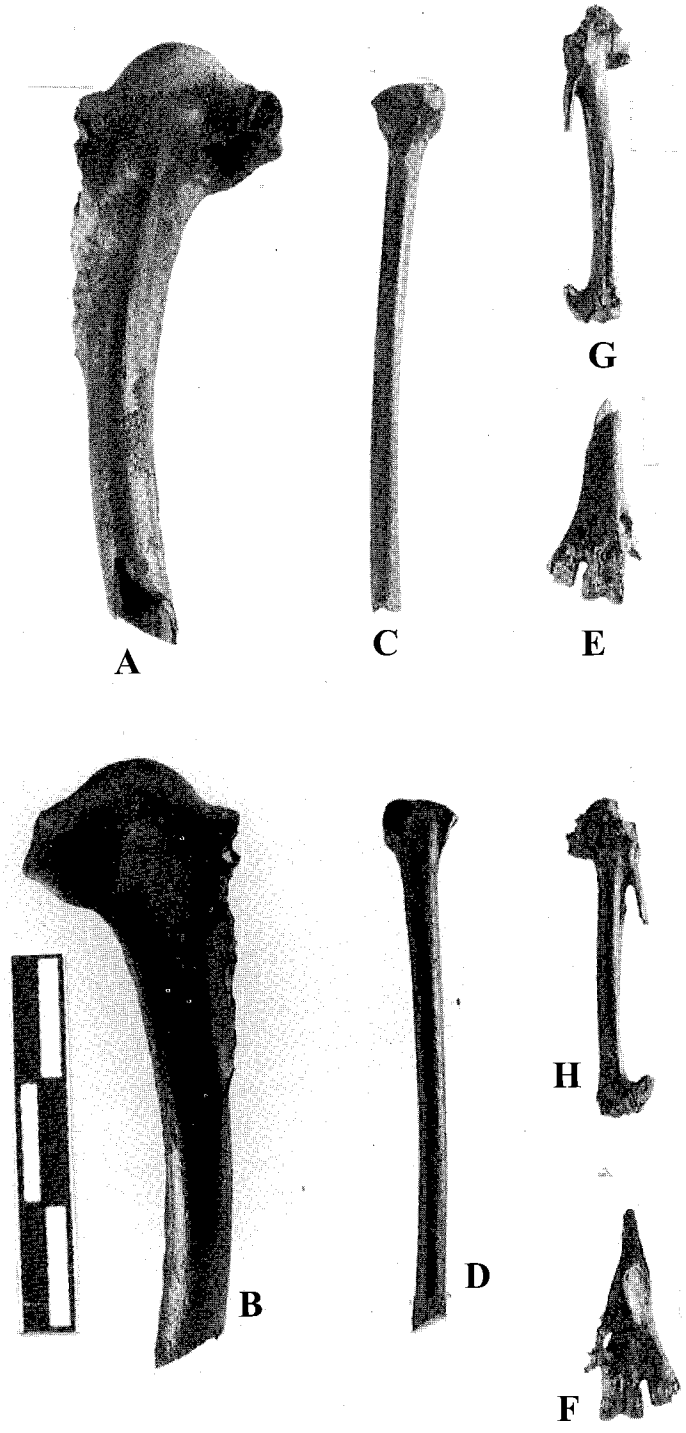

Figure 6. Two species similar to modern Caprimulgidae. Caprimulgidae?, genus and species indeterminate #1: A-B, humerus, left proximal two-thirds, USNM 496380 (A, anconal; B, palmar view); C-D, radius, right distal half, USNM 496381 (C, internal; D, external view); E-F, tarsometatarsus, left distal end, USNM 496382 (E, anterior; F, posterior view). Caprimulgidae?, genus and species indeterminate #2: G-H, carpometacarpus, right USNM 496383 (G, external; H, internal view). Scale is in 0.5 cm increments.

reminiscent of that in the Caprimugidae, but differs from *Nyctidromus* in the much larger distal foramen, and in the size and positioning of the scar for the hallux. In the fossil, this scar is very well developed, being long and deep, whereas in the Caprimulgidae the scar, although large, is flatter and has a medially projecting lip that extends beyond the outline of the shaft, unlike the fossil. I regard it as highly likely that this specimen belongs to the same species as the humerus.

genus and species indeterminate #2

Material: Carpometacarpus, right lacking most of minor metacarpal, USNM 496383 (Fig. 6g,h). Collected by Mike Folmer. Length, 13.2 mm.

Discussion: This is from a quite small bird, the carpometacarpus being only slightly longer than that of a House Sparrow, *Passer domesticus*, though the bird was doubtless of very different proportions. Compared with *Nyctidromus albicollis*, the fossil is almost identical except for smaller size and the more rounded external margin of the trochlea, which is thus not as sharply set off from the alular metacarpal. There is even a small protuberance on the trailing edge of the proximal end of the major metacarpal--probably an incipient intermetacarpal tubercle--just as in the Caprimulgidae.

The resemblances are so great that there can be no doubt that this bone is correctly referred to the Caprimulgiformes. Were it not for the fact that it is early Eocene in age and that there are no species in this size range among the modern Caprimulgidae, I would have little hesitation in referring it with certainty to that family. The species may have occupied a different niche from that of modern nightjars, although the bone shows no indication of any of the adaptations of the wing found in swift-like birds (Apodiformes).

Order Apodiformes
Aegialornithidae
genus and species indeterminate

Material: Tarsometatarsus, right complete, USNM 496384 (Fig. 7a,b). Collected by Chuck Ball. Length 11.8 mm, proximal width 3.8 mm, distal width 3.8 mm.

Discussion: The extinct fossil family Aegialornithidae is generally thought to be related to swifts (Apodidae) but has also been placed in the

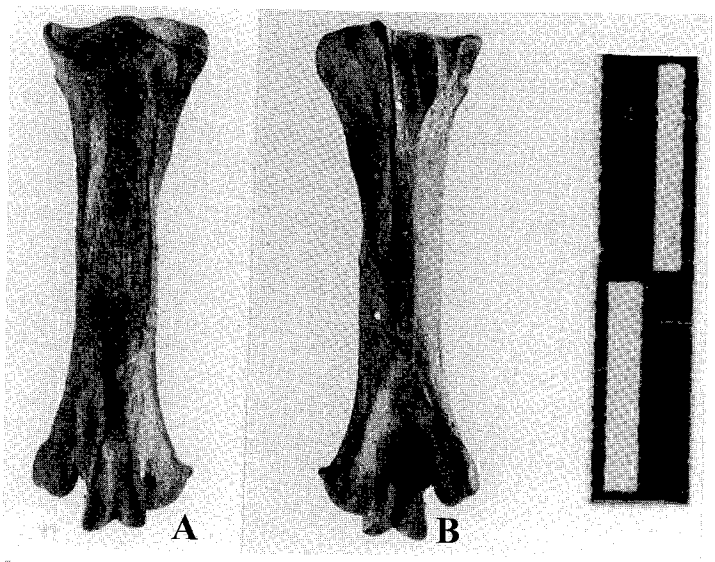

Figure 7. Aegialornithidae, genus and species indeterminate: tarsometatarsus, right complete, USNM 496384 (A, anterior; B, posterior view). Scale is in 0.5 cm increments.

Caprimulgiformes (Collins, 1976). The genus *Aegialornis* is known from four species from the late Eocene and Oligocene of France, the most abundant element of which is the humerus. A much smaller species, also based on humeri, was described from the London Clay as *Primapus lacki* (Harrison and Walker, 1975). In describing another small species from the middle Eocene of Germany, Peters (1985) considered that the differences between *Primapus* and *Aegialornis* were not as great as between the species of the latter and synonymized the two genera, naming his new bird *Aegialornis szarskii*. Mourer-Chauviré (1988) resurrected *Primapus* for *P. lacki* and *P. szarskii*.

A beautifully preserved tarsometatarsus from the Fisher/Sullivan Site (Fig. 7a,b) is similar to that of *Aegialornis gallicus* illustrated by Mourer-Chauviré (1988: 375) but is much stouter. The tarsometatarsus in *A. gallicus* ranges from 13.3 to 14.7 mm in length (Mourer-Chauviré, 1988: 377), so the present fossil could possibly fall within the size range of the smaller species *A. wetmorei* or *A. broweri* (Collins, 1976), for which the tarsometatarsus is apparently unknown. The tarsometatarsus of *Primapus lacki* has not been described and Peters gives no measurements for that of *P. szarskii*, although from his photographs it is seen that the tarsometatarsus is about equal in length to phalanx 1 of the major alar digit, the length of which is given as 6 mm. Thus the two known species of *Primapus* are much too small for the bird considered here. If correctly referred to the Aegialornithidae, the present specimen would constitute the first record of the family outside of Europe.

Aves, indeterminate species
(crane-sized)

Material: Radius, left distal end with associated portion of shaft, USNM 496386 (Fig. 4a). Collected by Chuck Ball. Greatest distal diameter, 12.5 mm.

Major alar digit, phalanx 1, proximal half lacking much of the trailing edge, USNM 496387 (Fig. 4b). Collected by Mike Folmer. Greatest proximal diameter, 9.8 mm.

Discussion: The radius is similar in size to that of a Sandhill Crane, *Grus canadensis*, and is also reasonably similar in morphology. The wing finger is of a size possibly compatible with the radius. Although the radius is at least roughly similar to that of cranes, the wing finger is quite different in having the external surface deeply excavated, whereas the internal surface is peculiar in being almost [illegible] synoptic series of avian skeletal elements at the Smithsonian does not include this element, so further comparisons were not attempted. Size, therefore, is the only reason for associating these two elements, which come from a species smaller than the pseudodontorn but larger than any other taxon yet recognized in the fauna.

Indeterminate avian pedal phalanges

Material: Two pedal phalanges collected by Mike Folmer, USNM 496390, 496391 (lengths, 6.4 and 9.3 mm). Two pedal phalanges collected by Chuck Ball, USNM 496421, 496422 (lengths, 12.2 and 11.2 mm).

Discussion: I have made no attempt to identify these four toe bones, all of which, however, appear to be too short or curved to be likely to be from terrestrial or wading birds and hence may have been from arboreal species. Some or all of the specimens may be referable to one or more of the species already noted in the fauna.

CONCLUSION

The avifauna from the Fisher/Sullivan Site is represented only by 33 bones or fragments thereof, yet these few remains appear to belong to a minimum of 11 different species, so that the faunule is extremely diverse given the very small sample size. Although coming from a marine deposit, only one of the 11 species (the pseudodontorn) was certainly pelagic, the rest being land birds. Some of these may have inhabited littoral environments, but at least the four species of Caprimulgiformes/ Apodiformes would have been dependent upon purely inland ecosystems, probably forested. Although the Caprimulgidae proper are now widespread in temperate and tropical regions, all other families of the order are confined to tropical forests. A similar environment may thus be inferred for the Fisher/ Sullivan Site deposits, particularly from the presence of the specimens tentatively referred to the Steatornithidae.

There is some similarity to the early Eocene London Clay deposits at Walton-on-the-Naze, Essex, England. There the deposits, the exposures of which are relatively limited in area, are strictly offshore marine in nature, yet the fossil vertebrates are dominated by birds, particularly small arboreal species. One wonders if the parallels between the deposits at Walton-on-the-Naze and those at the Fisher/Sullivan Site, where a considerable diversity of land birds also occurred in a very small area, might be due to the effects of similar depositional conditions. In any case, the Fisher/Sullivan Site material provides us with a tantalizing first glimpse into the early Eocene avifauna of eastern North America. The deposits here would be well worth working for additional fossils. The birds from this site will assume even greater importance when they can be compared in detail with other specimens of similar age, particularly those from the London Clay. It is highly likely that correlations at the species level will be possible, because certain species of birds are already known to be shared between the London Clay and deposits of similar age in Wyoming.

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