

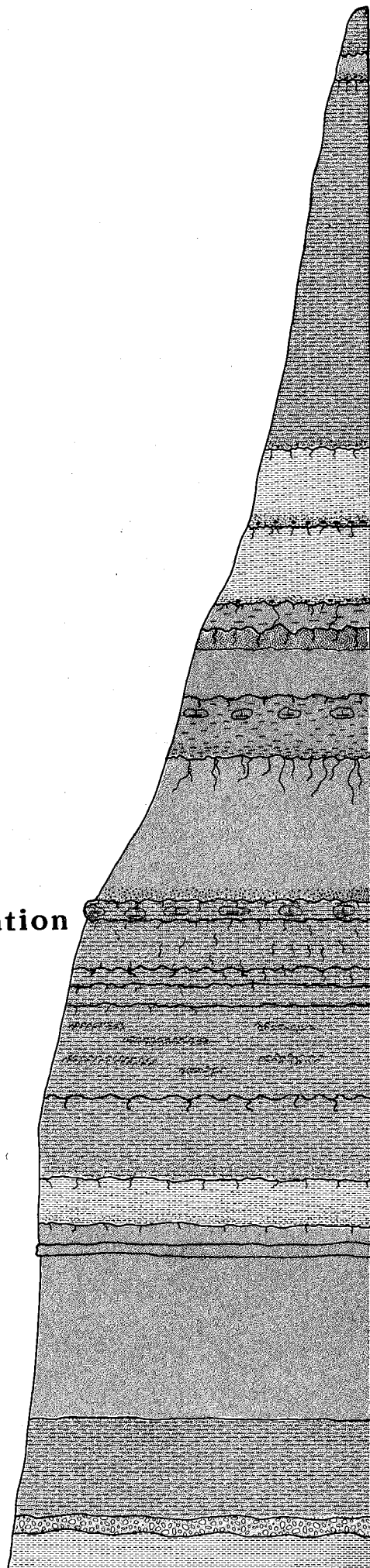
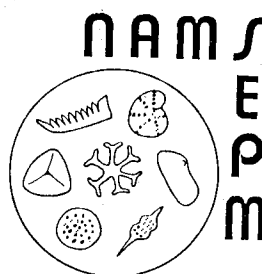
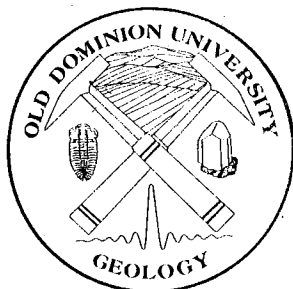
**Stratigraphy and Paleontology**  
**of the**  
**Outcropping Tertiary Beds**  
**in the**  
**Pamunkey River Region,**  
**Central Virginia Coastal Plain**

**Guidebook for the 1984 Field Trip**  
**Atlantic Coastal Plain Geological Association**

REMINGTON KELLOGG  
LIBRARY OF  
MARINE MAMMALOLOGY  
SMITHSONIAN INSTITUTION

Edited by

**Lauck W. Ward and Kathleen Krafft**



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A Brief Synopsis of the Fossil Birds from the Pamunkey River  
and other Tertiary Marine Deposits in Virginia

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Washington, D.C.

ABSTRACT

The fossil marine avifaunas of the western North Atlantic are briefly reviewed, with emphasis on the Neogene of Virginia and on specimens from the middle Miocene Calvert Formation along the Pamunkey River. The avifaunas of the Neogene marine sequences of eastern North America are composed almost entirely of pelagic species, such as albatrosses, shearwaters, pseudodontorns, gannets, and auks; they were deposited in offshore, open-ocean environments. Terrestrial, littoral, and estuarine components are almost completely absent. The birds of the Calvert Formation along the Pamunkey River are characteristic of temperate waters and lived following a period of relative stability in the oceanic environment. This period was evidently succeeded by an episode of cold upwelling at the end of the Miocene that was accompanied by a marked increase in species diversity of seabirds, which probably resulted from an influx of forms from higher latitudes.

INTRODUCTION

Although publications on the subject are still rather meager, the fossil record of birds from marine deposits of the western North Atlantic is actually quite good. Given the span of time involved and the total number of specimens now available, the paleontological record of seabirds from New Jersey to South Carolina surpasses that known from any other area of the world; only the Tertiary marine sequences from southern California begin to approach the Eastern United States in this regard.

Knowledge of the fossil birds from the Chesapeake area began in the days of Leidy, Cope, and Marsh. Scattered additional specimens came to light throughout the first half of the present century and then appeared with increasing frequency as a result of heightened interest on the part of collectors, many of them enlightened amateurs. In the past, most such specimens found their way into the hands of the late Alexander Wetmore, former Secretary of the Smithsonian Institution, who published several short notes on Tertiary birds of the Chesapeake Group. In his later years, Wetmore accumulated still more such specimens, most of which remained unstudied because of his commitments to other research. Unfortunately, these specimens were largely unnumbered and uncataloged, and in some instances had become mixed, so that when I took over the curation of this material some 10 years ago, it was badly disorganized. Luckily, however, Mr. Wallace Ashby, who was responsible for collecting dozens of important fossil birds from Maryland, kept a detailed list of the specimens that he had donated and by consulting this I was able to clear up many of the problems. Curiously enough, the only seriously jumbled material that remains is some of that collected from the Pamunkey River.

Additional fossil birds have continued to be collected from traditionally productive exposures in the Chesapeake Group and have been forwarded to me, so that at present there are between 200 and 300 avian specimens at hand from Neogene outcrops in Maryland and Virginia, most of which were found in situ. With the opening of the phosphate mine at Lee Creek, North Carolina, and the subsequent collection of fossils from spoil piles there beginning in 1967 (Ray, 1983), the study of fossil birds from the western North Atlantic took a giant leap forward. Since then, thousands of fossil birds have been recovered at Lee Creek, mostly of early Pliocene age (Yorktown Formation) but also from the middle Miocene (Pungo River Formation). Terrestrial species of birds are only incidental in any of the Tertiary marine deposits of the eastern United States, but pelagic species, such as albatrosses, shearwaters, gannets, and auks, are sufficiently abundant to permit generalizations about the evolution, zoogeography, and paleoecology of these groups.

a/ The fossil record of marine birds in the western North Atlantic begins in the late Cretaceous (Maastrichtian); a relatively small assemblage from New Jersey provides one of the more diverse Cretaceous avifaunas yet known, consisting mainly of primitive Charadriiformes and possible Procellariiformes (Olson, in press). A handful of specimens from the Aquia Formation in Maryland and Virginia provides the only Paleocene (Lan-denian) record of seabirds anywhere that I am aware of. These specimens include a diminutive species of Prophaethontidae (Pelecaniformes) and an albatross-like procellariiform. No birds have as yet been recovered from Eocene marine deposits in the Eastern United States; the Oligocene record consists of a small but significant assemblage from the late Oligocene (Chattian) of South Carolina that includes albatrosses, shearwaters, pseudodontorns, gannets, and a few other marine birds.

Neogene birds from the western North Atlantic come from marine deposits laid down in a series of embayments ranging from middle Miocene (Langhian) to Pleistocene (Gibson, 1983), although fossil birds younger than early Pliocene (Zanclian) are rare. These Neogene avifaunas are briefly summarized below.

#### NEOGENE MARINE AVIFAUNAS OF VIRGINIA

##### Calvert Formation

The middle Miocene (Langhian) Calvert Formation has produced numerous fossil birds both in Virginia and Maryland. The temporally equivalent Pungo River Formation in North Carolina has likewise yielded bird remains from spoil piles at the Lee Creek mine. At least one bird bone, the holotype of the gannet Sula atlantica Shufeldt, 1915 (= Morus loxostylus (Cope), 1870), is known from the contemporaneous Kirkwood Formation in New Jersey. All fossil birds from the Pamunkey River area have come from the Calvert Formation, and any of the commoner species represented elsewhere in the Calvert Formation in Virginia and Maryland can be expected along the Pamunkey.

##### Order Galliformes Temminck 1820 Family Phasianidae Vigors 1825

Two fossils of pheasant- and quail-like birds from the Pamunkey River are among the very exceptional occurrences of land birds in the Calvert Formation (as is the indeterminate charadriiform discussed below). One of these fossils is the proximal end of a tibiotarsus of a fairly large pheasant-sized bird collected at Gravatts Mill, near Hanover Court House, by R. Weems, and the other is the distal portion of a humerus of a quail-sized bird from the right bank of the Pamunkey near Old Church, collected by D. Massie in 1965.

Order Charadriiformes Huxley 1867  
Family Stercorariidae Gray 1871

At least two species of jaegers, one of which is much smaller than any extant species, are known from the Calvert Formation in Maryland, although no specimens have as yet been found anywhere in Virginia.

Family Alcidae Vigors 1825

Compared to the great diversity of alcids (over a dozen species) in the early Pliocene Yorktown Formation, the fauna of the Calvert Formation, with only two species known so far, is quite depauperate. Both species are small auks, the commonest being the species Miocepphus mcclungi Wetmore; a larger, as yet undescribed species apparently is also referable to Miocepphus, but is rather rare. Five specimens of M. mcclungi have been found in the Pamunkey area: two from Mill Pond Creek and one from Gravatts Mill, near Hanover Court House, and another from the roadcut where U.S. Rte. 360 crosses the Pamunkey; a tibiotarsus probably referable to this species was collected upstream from the tributary upstream from Grimes Landing. Despite its name, Miocepphus is not closely related to the guillemots of the genus Cepphus but is instead part of the Atlantic radiation of auks that includes Alca, Australca, and Pinguinus (Olson, in press). Auks are confined to the Northern Hemisphere and occur almost exclusively in temperate areas.

Family Incertae Sedis

The distal end of a humerus of a small shorebird, somewhat resembling the painted snipes of the family Rostratulidae but not clearly referable to any living family, was among the material collected by S. Applegate from the Pamunkey River (see Sulidae).

Order Anseriformes Wagler 1831  
Family Anatidae Vigors 1825

Ducks are rare in the Calvert Formation, the record being confined to a merganser, Mergus miscellus Alvarez and Olson, from Westmoreland County, Virginia, and a shelduck from Maryland (Alvarez and Olson, 1978).

Order Pelecaniformes Sharpe 1891  
Suborder Odontopterygia Spulski 1910  
Family Pelagornithidae Furbringer 1888

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These were gigantic pseudotoothed birds that are frequently referred to under the names pseudodontornis and Pseudodontornithidae. The family name Pelagornithidae, however, is the earliest applied to birds of this group, the systematics of which is still in dire need of revision (Olson, in press). The family first appeared in the early Eocene of England and was probably cosmopolitan in distribution during most of the Tertiary; it apparently died out at the end of the Miocene, as there are no Pliocene records except possibly in New Zealand, where anomalously late occurrences of various organisms seem to be the rule. The pseudodontorns were extremely large (estimated wingspans are 16 to 20 feet) and were gliders like albatrosses but were probably incapable of much flapping flight and therefore would have been very dependent on winds to provide lift. Pseudodontorns are strictly marine in distribution and may have fed principally on squid. Their bones were extremely light and pneumatic and so far have almost always been found in very fragmentary and unsatisfactory condition.

It is quite likely that some of the pseudodontorn remains from Maryland and Virginia are referable to the French species Pelagornis miocaenus Lartet, 1857, because many of the seabirds reported by Milne-Edwards (1874) from the middle Miocene of France (molasse de Leognan and Faluns de Saucats, the latter attributed to the Burdigalian) appear very similar, if not identical, to some of those known from the Calvert Formation. Size differences indicate that as many as three species of pseudodontorns may be represented in the Calvert and Pungo River Formations (Olson, in press). In addition to a number of specimens found in Maryland, four others, two consisting of a few associated elements, have been collected in Virginia, all from along the Potomac in Westmoreland County. Pseudodontorn fossils will undoubtedly be found along the Pamunkey in due course.

Suborder Sulae Sharpe 1891  
Family Sulidae Reichenbach 1849

Gannets of the genus Morus, or closely related thereto, are the most frequently found birds in the Calvert Formation and are the birds most often collected on the Pamunkey River. Over a dozen sulid bones, some of which were probably once associated, were collected by S. P. Applegate at Waldemyer's Bluff, Pamunkey River, 1/2 mile south of the old town of Newcastle, 3 miles east of Old Church. Some were collected in 1956 and others in 1959, but these are among the specimens that suffered the most from mixing and dissociation from their data while in Wetmore's cabinets. Four additional sulid bones were recovered at Piping Tree Ferry and two at Gravatts Mill, near Hanover Court House, by R. Weems and others. A well-preserved coracoid of a large species was obtained by R. Foos from the roadcut where U.S. Rte. 360 crosses the Pamunkey.

At least three species of sulids can be recognized in the Calvert Formation. The most common is the medium-sized species Morus loxostylus (Cope), originally described from Maryland. A larger species is less common and was somewhat smaller than the living North Atlantic gannet Morus bassanus. The third species is smaller than any living sulid and is known as Microsula avita (Wetmore), being the type of the genus Microsula. This could well be conspecific with Microsula pygmaea (Milne-Edwards) from the middle Miocene of France, however. Both of the larger species occur in the Pamunkey deposits, and Microsula is certainly to be expected, although it has not yet been found in Virginia.

Microsula appears to be more closely related to Morus than to the tropical boobies of the genus Sula. Morus and Sula are easily distinguished osteologically, and the fact that all the Calvert sulids are more similar to Morus may have some ecological significance; the modern species of this genus are all coldwater forms, whereas most of the species of Sula are found in warmer tropical waters.

Order Procellariiformes Furbringer 1888  
Family Diomedidae Gray 1840

Two specimens of small albatrosses have been found in the Calvert Formation in Maryland and at Stratford Bluffs, Virginia.

Family Procellariidae Boie 1826

There may be as many as four species of shearwaters of the genus Puffinus represented in the Calvert Formation. Only one has certainly been named, Puffinus conradi Marsh, which is closely related to the living species P. gravis. The distal half of a tarsometatarsus of a species of Puffinus smaller than P. conradi was obtained on the

right bank of the Pamunkey near Old Church by D. Massie in June 1965. Shearwaters are strictly pelagic and highly migratory, often wintering thousands of miles from their breeding grounds.

Order Gaviiformes Wetmore and Miller 1926  
Family Gaviidae Allen 1897

A loon of the genus Gavia, much smaller than any extant species, is uncommon in the Calvert Formation in both Maryland and Virginia, although no loon fossils have yet been taken along the Pamunkey.

#### Later Miocene Formations of the Chesapeake Group

The deposits representing the series of Miocene embayments that succeeded the Calvert Formation (Gibson, 1983) have produced lamentably few avian fossils; a total of no more than four or five specimens have been recovered from the Choptank and St. Marys Formations. This may be due at least in part to the fact that in most places the pertinent exposures occur too high in cliffs to be readily accessible to collectors. At least five fossil birds have been found in what is now known as the Eastover Formation (Ward and Blackwelder, 1980), which was for a long time known informally as the "Virginia St. Marys" (Gibson, 1983) and is of late Miocene age. For various reasons, each of these specimens is of unusual significance.

The distal end of an alcid humerus collected in 1961 by R. Weems from "the basal ferruginous layer of the Virginia St. Marys," 60 feet above the beach immediately below the trailer campground at Westmoreland State Park, is very similar in size and morphology to Miocepheus mcclungi and is probably the temporal representative of that species, which would indicate that it had changed very little since the middle Miocene. Another alcid specimen from the Eastover Formation consists of a complete skull and mandible with an associated wing that was collected on the Mattaponi River at White Oak Landing, King William County, Virginia, by W. Blow. This belongs with the Atlantic Alca group but is not referable to any extant genus. It is much larger than either of the auks known from the Calvert Formation. A third alcid specimen, collected in 1975 by J. Westgate, comes from the basal part of the Claremont Manor Member of the Eastover Formation at Stratford Cliffs east of Big Meadows Creek, Westmoreland County. This specimen consists of an associated sternum, coracoid, humerus, radius, and ulna of a giant auk, nearly as large as the Great Auk (Pinguinus) but fully volant. It appears to be referable to the genus Australca, which is abundant in the Yorktown Formation and also occurs in the Bone Valley deposits in Florida. From the same layer as the giant auk came the distal end of an ulna of a very large gannet (Sulidae) and the tibiotarsus of a turkey (Phasianidae, Meleagridinae), which latter is the earliest record of typical turkeys of the genus Meleagris (Steadman, 1980). Apart from the humerus of Miocepheus, there is no hint in the Calvert Formation of any of the avian species found in the Eastover Formation.

#### Yorktown Formation

Bird bones from natural exposures in the Yorktown Formation are quite rare. Most of the few found in Virginia were collected as float, their stratigraphic position being inferred from their identity with Yorktown-age species known from the Lee Creek mine in North Carolina. The tremendous sample of seabird bones from the Yorktown Formation at Lee Creek greatly exceeds that available from the Tertiary anywhere else in the world, both in numbers of individuals and in species diversity. This sample permits a very accurate reconstruction of the composition of the marine avifauna in the western North Atlantic in the early Pliocene.



## DISCUSSION

The avifaunas of the various units of the Chesapeake Group, including the Yorktown Formation, are overwhelmingly dominated by pelagic birds such as albatrosses, shearwaters, pseudodontorns, gannets, jaegers, and auks. There is practically no indication of estuarine or littoral elements. The depositional environment throughout the entire sequence, at least in such facies as bird bones came to rest in, was undoubtedly one of open ocean, although not necessarily far removed from land, as attested to by the occasional presence of land-bird remains.

The marine birds of the Calvert Formation are characteristic of temperate waters; neither markedly tropical nor strongly boreal elements are represented in the avifauna. The transition from the middle Miocene Calvert avifauna to that of the late Miocene is poorly documented by fossils, but four of the five species so far recovered from the upper Miocene Eastover Formation in Virginia are very different from anything in the Calvert. The early Pliocene avifauna of the Yorktown Formation, which is very extensive, was much more diverse than that of the Calvert Formation, even given the difference in the sample size. This is especially true of alcids, of which there are but two small species in the Calvert, versus more than a dozen in the Yorktown. The number of species of albatrosses and loons, and probably of shearwaters and gannets as well, also increased in early Pliocene time.

The species of marine birds of the Calvert Formation, such as are present in the deposits along the Pamunkey River, had probably enjoyed a fairly long period of relative oceanographic stability, as the avifauna so far known from the late Oligocene of South Carolina is for the most part very similar to that in the Calvert. The evidence currently available seems to indicate that evolution in seabirds was very slow during the Neogene, particularly in highly mobile pelagic forms such as shearwaters. Thus it seems unlikely that the great increase in diversity of species in the western North Atlantic from the middle Miocene to the early Pliocene was the mainly the result of numerous speciation events and *in situ* adaptive radiation. Instead, it is more likely that the close of the Miocene was marked by increased upwelling of cold waters off eastern North America and that the consequent increase in marine productivity was accompanied by shifts in the distribution of birds that had previously been confined to higher latitudes. A similar set of circumstances appears to have influenced the composition of the marine avifauna off the southwestern coast of Africa in the early Pliocene (Olson, 1983). It is not unlikely that the global climatic events associated with the "Messinian salinity crisis" and the onset of the Benguela Current in the South Atlantic would have influenced seabird distributions in the North Atlantic.

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Plate 1. Selected bones of pseudodontorns (Pelecaniformes, Pelagornithidae) from the Calvert Formation. Some of these elements may possibly be referable to the French species Pelagornis miocaenus Lartet; the two hindlimb elements (B, C) are from a smaller than usual species. Photographs by Victor E. Krantz, Smithsonian Institution.

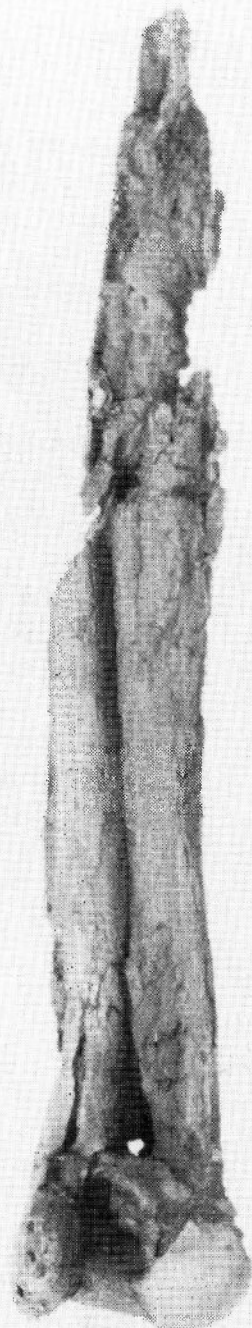
- A. Fragmentary right coracoid in ventral view (USNM 237199) from zone 12 (of Shattuck, 1904) near Parkers Creek, Calvert County, Maryland, collected by W.L. Ashby.
- B. Left femur in anterior view (USNM 237153) from zone 12 near Popes Creek, Westmoreland County, Virginia, collected by F.C. Whitmore and A.C. Myrick.
- C. Distal portion of left tibiotarsus in anterior view found in association with the preceding femur.
- D. Section of premaxilla showing the pseudoteeth and the characteristic groove (USNM 187373) from Horsehead Cliffs, Westmoreland County, Virginia, collected by R. Ludwig.
- E. Tip of premaxilla (USNM 237203) from zone 12 near Parkers Creek, Calvert County, Maryland, collected by W.L. Ashby.



**A**



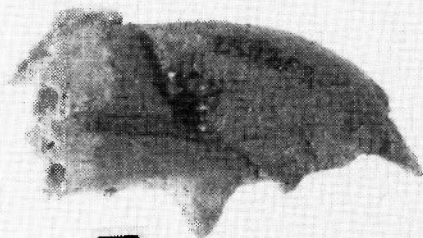
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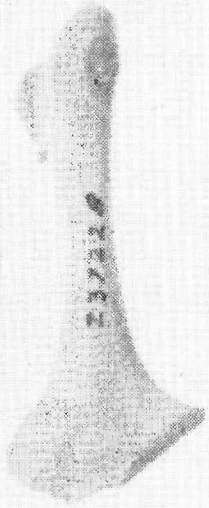


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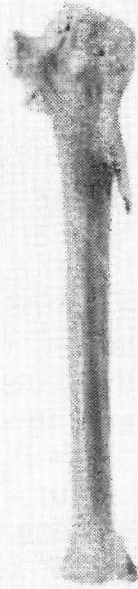


Plate 2. Some characteristic marine birds from the Calvert Formation.

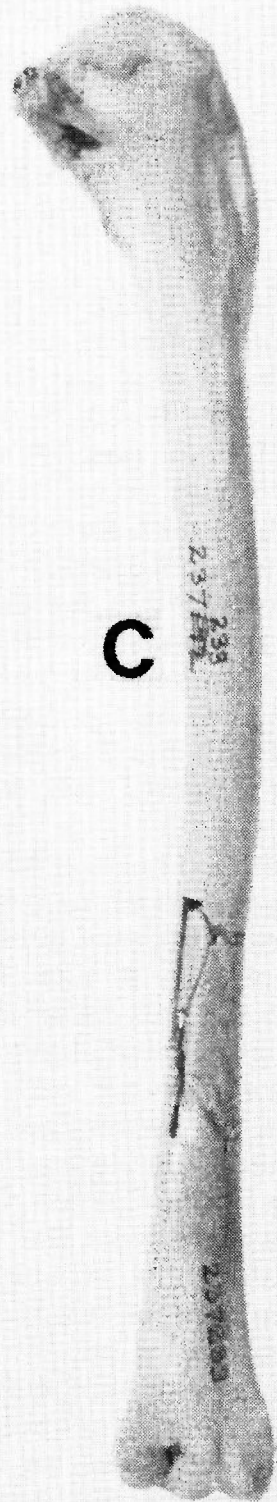
- A-C. Bones of a gannet (cf. Morus loxostylus Cope) from Waldemyers Bluff, Pamunkey River, Hanover County, Virginia, collected by S.P. Applegate, D.H. Massey, and T. Ruhoff.
- A. Right coracoid in dorsal view (USNM 237228).
  - B. right carpometacarpus in internal view (USNM 237230).
  - C. Right humerus in anconal view (USNM 237233).
- D. Left humerus in anconal view of the auk Miocepphus mcclungi Wetmore (USNM 25668) from zone 13, near Parkers Creek, Calvert County, Maryland, collected by A.C. Myrick and R. Eshelman.
- E. Right ulna in palmar view of the auk Miocepphus mcclungi Wetmore (USNM 237219) from zone 13(?), near Stratford Landing, Westmoreland County, Virginia, collected by J. Westgate and P. Heater.
- F. Left humerus in anconal view (USNM 237251) of a shearwater (Puffinus sp.) smaller than Puffinus conradi Marsh, from zone 12 at Wakefield, Westmoreland County, Virginia, collected by J. Westgate.



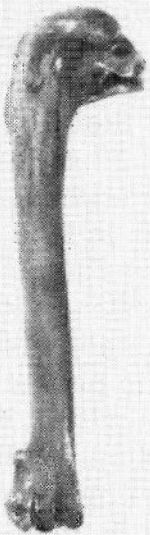
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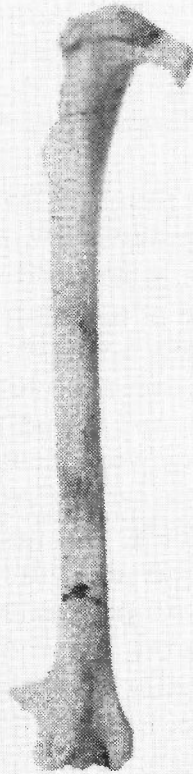
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**D**



**E**



**F**



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