FIRST DINOSAUR FOSSILS FROM GEORGIA, WITH NOTES ON ADDITIONAL CRETACEOUS VERTEBRATES FROM THE STATE

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Note errors in proof-
p. 147, Abstract, line 3: hadrosaur
p. 149, Geological Setting, line 5: bones
p. 153, Discussion, line 15: typical

ABSTRACT

New Collections of Upper Cretaceous (Campanian) vertebrate fossils from Stewart County, Georgia, contain isolated bones from two dinosaur taxa: a hadrossaur (Ornithischia, Ornithopoda) of undetermined genus, and tyrannosaur (Saurischia, Theropoda) comparable to *Albertosaurus*. Numerous individuals are represented in the collections. The fossils are found at the upper formational contact of the Blufftown Formation but appear to be redeposited from lower down in the unit. These dinosaur fossils probably represent shore-living or river-transported animals preserved in back-barrier or estuarine pericontinental-marine environments of deposition.

INTRODUCTION

The Atlantic and Gulf of Mexico coasts of the eastern U.S. contain broad areas of Upper Cretaceous sediments exposed in the Coastal Plain Province. These sediments have yielded an abundance of vertebrate fossils, largely of marine animals and in marine lithofacies; however, numerous discoveries of non-marine animals of the late Mesozoic Era, including dinosaurs, have been made in localities distributed around the Coastal Plain from New Jersey to Missouri. The first dinosaur skeleton found in North America, in fact, came from marine sediments of the Coastal Plain of New Jersey near the town of Haddonfield.

Disproportionately few Mesozoic vertebrates have been reported from Georgia, for reasons that are not apparent. There is a substantial Upper Cretaceous outcrop in the lower Chattahoochee River valley, in the western part of the state (Fig. 1), containing thick, fossiliferous marine units. Indeed, based on observation and collecting which led to this report, the slim record of Mesozoic vertebrate fossils in Georgia appears to be an artifact of little study rather than the result of lack of available material.

The purpose of this paper is to announce and briefly describe the first documentable dinosaur fossils from Georgia. This report includes work still in progress and precedes a formal systematic paper which will describe fully a substantial new dinosaur fauna collected in the lower Chattahoochee River valley from both sides of the Georgia/Alabama border, within a single lithologic unit. This report will also briefly note some additional vertebrate discoveries which

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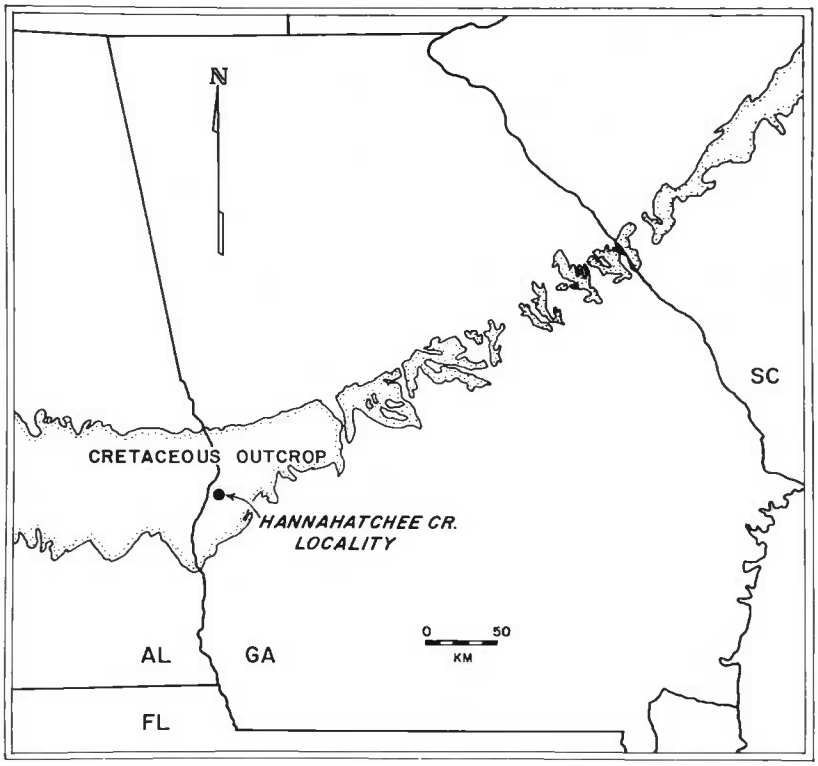

Figure 1. Cretaceous outcrop in Georgia and adjacent portions of Alabama and South Carolina. Approximate location of the study area is indicated by the arrow. Detailed locality data may be obtained by contacting the senior author.

have come within the past decade from the paleontology laboratory at Columbus College.

PREVIOUS WORK

The history of dinosaur studies in Georgia may have begun in 1878, with a single paragraph by E. D. Cope (1) in which he mentioned examining dinosaur bones dredged from the Chattahoochee River near Florence, Stewart County, and attributed them to the species *Hadrosaurus tripos*. Unfortunately, neither illustrations nor descriptions were included in the report, and the specimens themselves cannot be located in any repository. Further, "*Hadrosaurus tripos*" was subsequently shown to be an invalid taxon, based on a pair of misidentified whale vertebrae from North Carolina (2). Although it is possible Cope did indeed examine a duckbill dinosaur vertebra from the Chattahoochee River, its geologic source and firm identity will probably never be known. The sole additional dinosaur report from the state was in 1911 by L. W. Stephenson (3), which again included neither description nor illustration and cannot be associated with any

retrievable specimens. Stephenson merely noted discovery of "dinosauroid bones" from the general locality covered by the present study.

Cope (1) Stephenson (3), C. W. Cooke (4), and H. G. Richards and B. M. Hand (5) included lists of taxa collectively containing all the additional vertebrates known from the Cretaceous of Georgia, prior to recent studies discussed below. As with the dinosaur reports, neither description, illustration nor specimens accompanied these lists. The pre-1980 composite vertebrate fauna of Georgia, as reported, included: (with original identification and modern terminology, if any):
-unidentified mosasaur bones and teeth,
-crocodiles:
Polydectes biturgidus (= Thoracosaurus neocesariensis)
Thecachampsa rugosa (= Deinosuchus rugosus)
-turtles:
Peritresius ornatus
Taphrosphys sp. indet. (= *Bothremys barberi)*
-selachians:
Lamna texana (= Scapanohynchus texanus)
Otodus appendiculatus (= Cretolamna appendiculata)
Corax falcatus (= Squalicorax kaupi)
Ischyrhiza mira

A series of modern studies on the Cretaceous vertebrates of Georgia were initiated at Columbus College, sparked by new collecting from the banks of Hannahatchee Creek, in Stewart County, and from two localities in Fort Benning, Chattahoochee County. Written reports include summaries of taxa and stratigraphic settings by D. R. Schwimmer (6, 7, 8), description of the first pterosaur (flying reptile) bones from Georgia by Schwimmer and others (9), and systematic descriptions of 25 taxa of chondrichthyan and osteichthyan fishes by G. R. Case and Schwimmer (10, 11, 12). Studies of Cretaceous crocodiles, turtles, and mosasaurs from the state are in preparation. In striking disagreement with a report recently published in this journal (13), vertebrate fossil collections at Columbus College currently include more than six thousand specimens: the combined teaching and research collections of vertebrate and invertebrate fossils currently housed at the college exceed the numbers presented in (13) by a factor of more than 30X.

GEOLOGICAL SETTING

The fossils to be described here, and the majority of known Cretaceous vertebrates in Georgia, come from a limited stretch of Hannahatchee Creek in Stewart County. The locality is described fully in (12). Fossils are largely derived from a 2m-thick horizon which includes an erosional surface with overlying lag concentration. The vertebrate bone and teeth in this locality are well-preserved due to permineralization and replacement with collophane, but larger bones are invariably ablated and water-rounded. Fossil occurrences largely consist of isolated bones and teeth. Observations in the field show that all of the taphonomic loss occurred prior to burial or during re-exposure, transportation, and reburial in the Mesozoic marine environment.

The fossil beds are located in the uppermost Blufftown Formation, virtually on the formational contact with the overlying Cusseta Formation (Fig. 2). Since redeposition from underlying beds is evident for most fossils here, the ages represented are imprecisely known. The minimum age is 75 Myr. (based on 13, 14). The assemblage of fossils, especially species of sharks and exogyrine oysters, suggests the maximum age to be around 80 Myr, but even older material may be indistinguishably admixed into the fauna. Detailed stratigraphy of the fossil beds is presented in (7, 8).

THE DINOSAURS

Since the dinosaur material consists of isolated, fragmented bones, it has required 9 years of collecting and analysis subsequent to the first discoveries [noted by Schwimmer (6)], to firmly identify the taxa present. Current knowledge shows that two very different types of dinosaur are represented in the Blufftown collections: a hadrosaur (duckbilled ornithischian), not determinable below the familial level; and *Albertosaurus*, a large theropod (carnivorous saurischian) in the tyrannosaur family, also the most common predatory dinosaur in the Late Cretaceous of North America. It is entirely possible that more than one hadrosaur taxon is represented in the collections, and that some indeterminate theropod bones may represent additional taxa.

Repository

Materials collected for this report are presently housed at Columbus College. Permanent storage at the U.S. National Museum of Natural History (Smithsonian Institution) has been offered, but a permanently-endowed repository, located in the

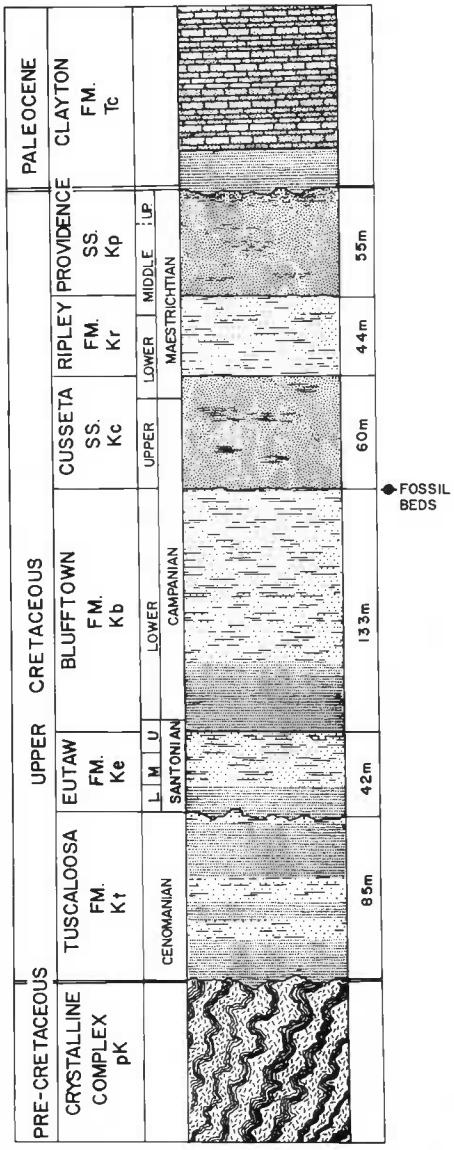

Figure 2. Stratigraphic column of the Late Cretaceous rocks in the study area. The dinosaur fossil beds occur at the indicated horizon. The base of the Campanian is generally dated at 84 Myr. and the top of the Campanian is at 74.5 Myr; thus, the dinosaur beds date to approximately 80 Myr.

region, would be preferable. The proposed Fernbank Science Center in Atlanta is a likely candidate for this purpose, should plans and funding materialize.

Systematic Paleontology

ORDER ORNITHISCHIA
SUBORDER ORNITHOPODA
FAMILY HADROSAURIDAE
Gen. and sp. indet.
(Fig. 3.1-3.9)

Material.— A small, distal caudal vertebra with neural arch ablated. A posterior left dentary fragment with part of the coronoid process. Distal half of a left metacarpal III. A large, proximal femoral fragment, preserving the dorsal surface immediately below the fourth trochanter. Two large fragments from either tibiae or femora. Fifteen indeterminate small fragments.

Discussion.— Duckbill dinosaurs are among the most common Late Cretaceous dinosaurs globally, and are by far the most common dinosaurs of the eastern U.S. Coastal Plain. They were probably semi-aquatic and may have enjoyed habitats on or near coastal beaches and salt marshes. The hadrosaurs are traditionally classified into two subfamilies (Hadrosaurinae and Lambeosurinae), although recently (15) it has been suggested that these should be elevated to distinct families. Either classification discriminates among the duckbilled dinosaurs largely on features of the skull, especially the nasal bones which may form a bizarre variety of cranial crests in the lambeosaurs, and by the shape of the distal end of the ischium, which flares in the lambeosaurs. Both flat-headed duckbills (hadrosaurines) and crested duckbills (lamberosaurines) are known in the East, although the former are far more common. Other conventional distinguishing characteristics may be invalid, including tooth morphology (16) and limb proportions.

The fossils listed above from Hannahatchee Creek are definitely attributable to hadrosaurs in the larger sense, but there are no characteristics which allow futher breakdown of the taxa. The most common taxon of eastern American hadrosaurs is *Hadrosaurus (= Kritosaurus, = Lophorothon, = Claosaurus) foulkii* (2, 17, 18, DRS pers. obs.), which is a possible identity for these individuals. The holotype of *H. foulkii* was discovered in New Jersey and was the first dinosaur found in North America. In overall form, it is a typical Roman-nosed hadrosaurine reaching relatively large sizes.

Among the materials listed here, the dentary fragment (3.1, 3.2) comes from a relatively small individual, although it is too fragmentary to judge the state of maturity. The remaining bones are from adults of sizes comparable to typical hadrosaurs from the U.S. western interior (adult weights approximately of 2 to 3 tonnes, lengths of 8 to 10 m.). A new hadrosaur specimen from Russell County, eastern Alabama, is currently under study at Columbus College and consists of 11 intact bones from the left leg. This specimen is also from the Blufftown Formation and is sufficiently complete to allow accurate extrapolation of body proportions. The leg was approximately 2.9m in length, which yields an overall body length of 8.4 meters. A second specimen under study from the Blufftown Formation in eastern Alabama is approximately 13% larger that the above, but consists only of an isolated, distal tibial fragment.

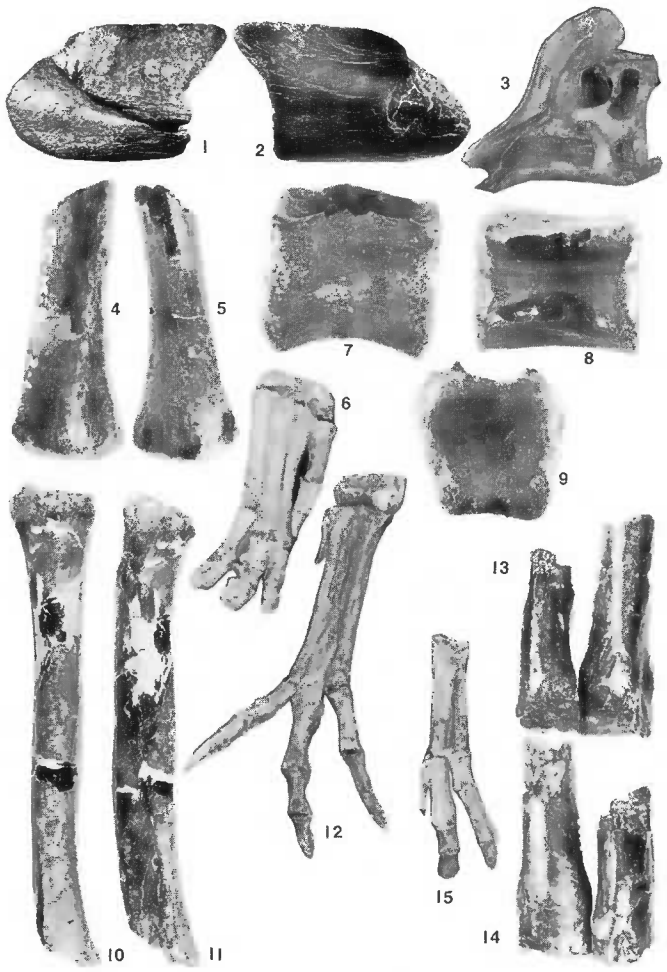

Figure 3. Diagnostic dinosaur fossils discussed in text. Specimens from Georgia are listed with Columbus College Cretaceous (CCK) catalog numbers. Comparative specimens of articulated dinosaurs come from the Judith River Formation, (Campanian age), photographed at the Tyrrell Museum of Palaeontology (TMP), Alberta, Canada.

3.1 — 3.9 *Hadrosauridae. 3.1, 3.2, posterior left dentary fragment (CCK-79-3-1), lingual and labial views, x0.2. 3.3, skull of Hadrosaur (**Corythosaurus**) from TMP, to show morphology of the posterior dentary. 3.4, 3.5, distal half of left metacarpal III (CCK-85-2-1), anterior (ventral) and posterior (dorsal) views, x0.25. 3.6, articulated left manus of **Corythosaurus** (same as 3.3) from TMP: the largest metacarpal is III. 3.7-3.9, posterior caudal verterbra (CCK-88-16-1), lateral, dorsal, anterior views, x0.45.*

3.10 — 3.15 Albertosaurus. *3.10, 3.11, left metatarsal IV (CCK-87-5-1), anterior (ventral) and medial views, x0.1. 3.12, left pes of **A. libratus** from TMP for comparison; metatarsal IV is on the right. 3.13, 3.14, right radius and ulna (CCK-84-4-7, CCK-84-8), posterior (dorsal) and anterior (ventral) views, x0.15. 3.15, right manus of **A. libratus** (same as 3.12) for reference.*

ORDER SAURISCHIA
SUBORDER THEROPODA
INFRAORDER CARNOSAURIA
FAMILY TYRANNOSAURIDAE
Albertosaurus sp.
(Figs. 3.10-3.15)

Material. — A left metarsal IV, lacking the distal one-eighth. Associated right radial and ulnar fragments, proximal halves and part of distal ends ablated. Three fragments of large theropod limbbones, positions uncertain.

Discussion. — Isolated bones and teeth of large theropod dinosaurs are commonly found in the Upper Cretaceous of the eastern continent, but few of these can be reliably identified. The usual practice has been to identify the sources of these fossils either as indeterminate tyrannosaurid carnosaurs, or to assign them to *Dryptosaurus aquilunguis* Cope, a large theropod based on a single, partial skeleton from the latest Cretaceous of New Jersey. Both forms of assignment are based on probabilities rather than knowledge. Since most late Cretaceous predatory dinosaurs around the world are indeed tyrannosaurids, that form of assignment seems reasonable for isolated, non-diagnostic large theropod remains. Conversely, since the *Dryptosaurus* type has been until very recently the only large theropod skeleton known from the eastern continent, many Eastern workers have understandably used that monotypic genus as the identification for their miscellaneous large theropod fragments. However, the *Dryptosaurus* type specimen, although poorly preserved and incomplete, is clearly not a typicl tyrannosaur (19, and DRS observation). It may, in fact, be representative of an entirely separate lineage of predatory dinosaurs, or the specimen may simply have suffered sufficient damage and distortion to make its identity indeterminable.

Fortunately, the specimens from Georgia can be assigned with some certainty to *Albertosaurus*, a genus in the tyrannosaur family containing the most common Late-Cretaceous carnivorous dinosaurs of western American deposits. The identification is based on the near-complete metatarsal IV from Hannahatchee Creek, which was directly compared with the same bone in several individuals of *Albertosaurus* from the Judith River Formation in Alberta, Canada (at the Tyrell Museum, Drumheller, Alberta). Specific identification cannot be based on these theropod leg bones, but the Georgia specimen does fall within the typical size range of young individuals of *Albertosaurus libratus* Lambe, the most common Campanian-age species in the West (Fig. 3.12). Recent discovery of a partial theropod skeleton in central Alabama confirms that *Albertosaurus* was present in the Southeast during the Late Cretaceous (J Lamb, pers. comm. and DRS pers. obs.). The left metatarsal IV from the undescribed Alabama specimen is also essentially identical to the Georgia specimen (Fig. 3.10, 3.11).

Among the additional theropod fragments from Hannahatchee Creek, only the partial radius and ulna (3.13, 3.14) offer reasonable opportunity for identification. They are of proper size and morphology to correspond with the same *Albertosaurus* individual responsible for the metatarsal. However, they were found approximately 100m farther downstream along the outcrop, and there is insufficient material to be certain of their full reconstructed sizes and proportions.

ADDITIONAL CONSIDERATIONS

The discovery of dinosaur fossils in Georgia is not unexpected from a geological viewpoint, as explained in the opening of this paper. These finds add significantly to the record of southeastern dinosaurs by filling a large gap in their distribution around the Coastal Plain, which prior to this study existed between central Alabama and central North Carolina. These dinosaurs also represent other important paleobiogeographical data, as discussed below.

During the Late Cretaceous, the study area lay squarely between the Atlantic and Gulf of Mexico coasts (Fig. 4). Coastal areas immediately to the east, and

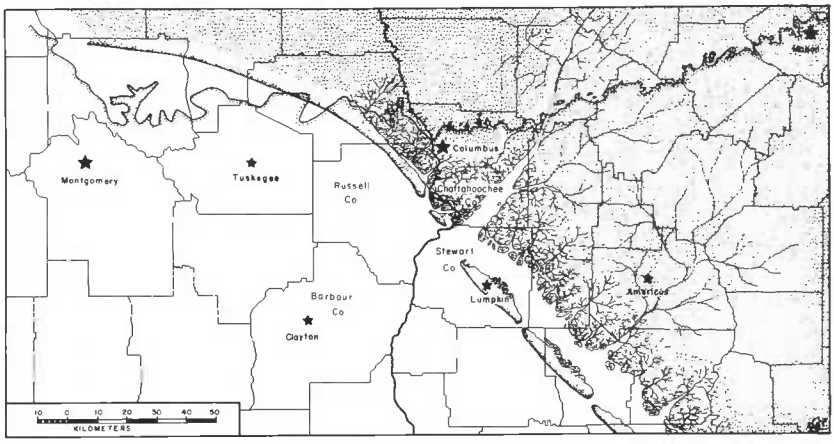

Figure 4. Paleogeography of the study area during the mid-Campanian. To the east and north along the coast were Atlantic-type environments whereas to the west lay a relatively deep, epicontinental sea. (Drawing Courtesy of WJ Frazier)

from there all the way to New England, featured siliciclastic sedimentation in back-barrier and estuarine environments adjacent to the open ocean. These environments were commonly influenced by storms, and fossils tend to show great effects of transportation and redeposition. Immediately west of the study area in Alabama, the preserved strata reflect an environment that was carbonate-rich. These deposits apparently formed below wave-base, suggesting deposition in offshore, epicontinental marine waters. The study area, therefore, ties together the two eastern dinosaur-bearing provinces (i.e. Atlantic/pericontinental-marine and Gulf Coast/epicontinental-marine) and shows that they contain a single dinosaur assemblage. In terms of preservation and sedimentological characteristics, the study area shows an Atlantic-type coastal environment.

Of equal paleobiological significance is the latitudinal setting of this fauna. Figure 5 is a reconstruction of the continental position during the Campanian Epoch, synthesized from a survey of geophysical data (eg. 20, 21). Although various sources differ in location of the spin axis, all agree the continent was rotated clockwise significantly relative to modern orientation. The dinosaur locality in Georgia occurs on what was the southernmost coast of eastern North America (22). Further, one may observe that the dinosaur localities on the

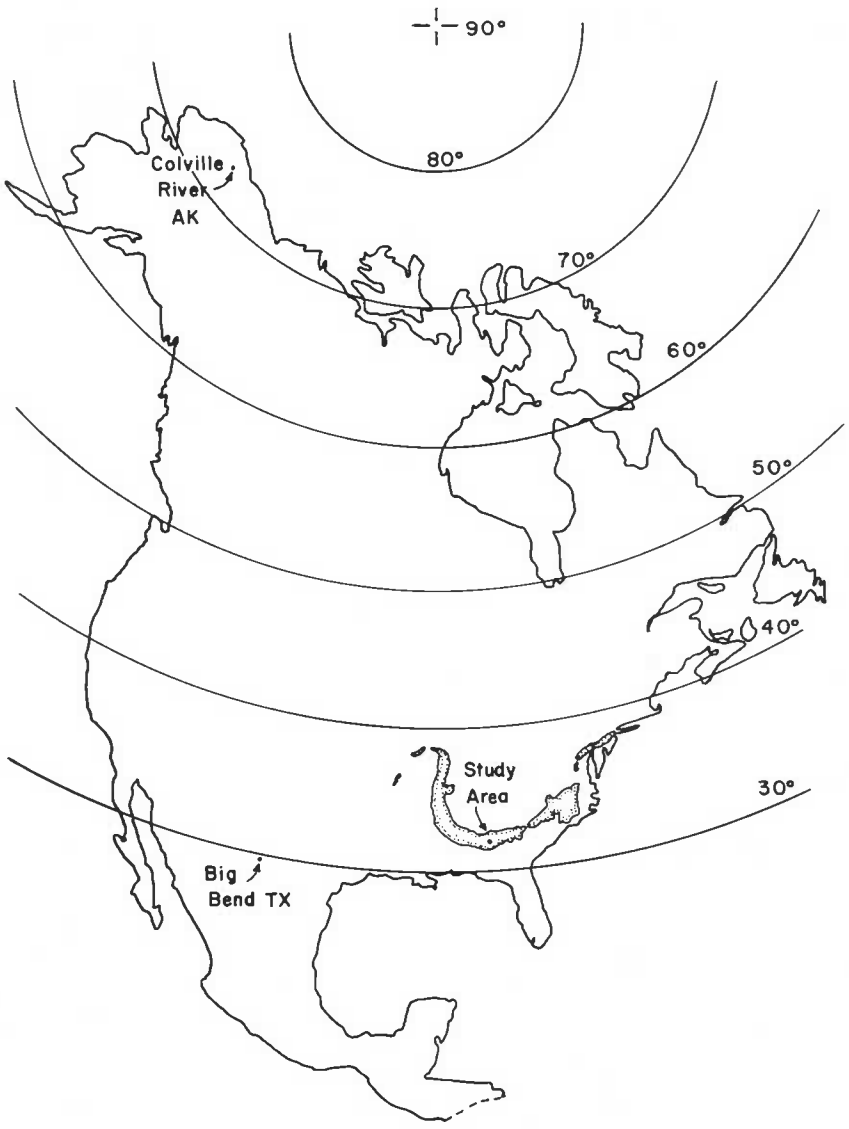

Figure 5. A possible Mid-Campanian orientation of North America, reconstructed from paleomagnetic data (chiefly 20, 21). The position of the eastern Late Cretaceous outcrop is shown, as are the locations of dinosaur localities at extreme latitude ranges. Note the relative clockwise rotation (by modern orientation) of the landmass, which positions the study area in western Georgia at the extreme southern end of the eastern Cretaceous outcrop, and which simultaneously extends the Alaskan locality far northward.

Atlantic Coastal Plain lay south of their modern positions, whereas the western Gulf Coast localities reached farther north. The occurrence of dinosaurs in

western Georgia at Late Cretaceous mid-thirties latitudes is especially significant in light of reports of near-contemporary dinosaurs in northern Alaska (23, 24, 25). Between the Arctic dinosaur occurrences (Fig. 5) and those in western Georgia was over 40° of latitude range, which is extraordinary for any terrestrial animal group, reptile or mammal. These data may have application to studies of dinosaur metabolism, migration, and extinction.

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