AGE AND STRATIGRAPHIC RELATIONSHIP OF THE CALOOSAHATCHEE MARL OF FLORIDA

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Introduction

Lower shell beds exposed along Caloosahatchee River in southern Florida were assigned a Pliocene age by Heilprin (1887:32) in 1886 and named the Floridian beds. A year later William Healy Dall (1887) changed the name of the formation to the Caloosahatchie beds and confirmed Heilprin's assignment as Pliocene. Since that time the deposits have been studied by many geologists, and numerous papers have been written concerning the Caloosahatchee marl. All subsequent investigators have agreed with Heilprin and Dall and classified the Caloosahatchee marl as Pliocene in age. This age-assignment has been based primarily on the nature of the molluscan faunal assemblages and secondarily on the incorrect assumption that the formation is unconformably overlain by beds of early Pleistocene age.

My investigations and those of several other workers during the past five years have uncovered evidence which strongly suggests that the Caloosahatchee marl should be reclassified as a Pleistocene deposit, probably post-Kansan and pre-Wisconsinan in age. The most compelling evidence supporting a Pleistocene classification is derived from the vertebrate remains contained in the upper beds of the Caloosahatchee marl. Most of the vertebrate species have never been recorded from pre-Pleistocene deposits.

I wish to express my sincere thanks to those who have made contributions to this study. The Florida Geological Survey, under the direction of Dr. Herman Gunter, paid field expenses and made available the facilities of the Survey. Mr. Herbert Winters identified most of the vertebrate remains and supplied many valuable data concerning the stratigraphy of Florida. The corals were identified by Dr. John Wells of Cornell University.

Distribution and Nature

The Caloosahatchee marl underlies the surface of much of southern Florida (Fig. 1). The type deposits are exposed along Caloosahatchee River which flows westward from Lake Okeechobee. The Caloosahatchee marl extends along the west coast of Florida as far north as north St. Petersburg. The formation also has been recognized in subsurface at approximately N.29.5°. Exposures along St. Mary's River in Nassau County in northeastern Florida that have been assigned to the Charlton formation probably represent a facies of the Caloosahatchee marl.

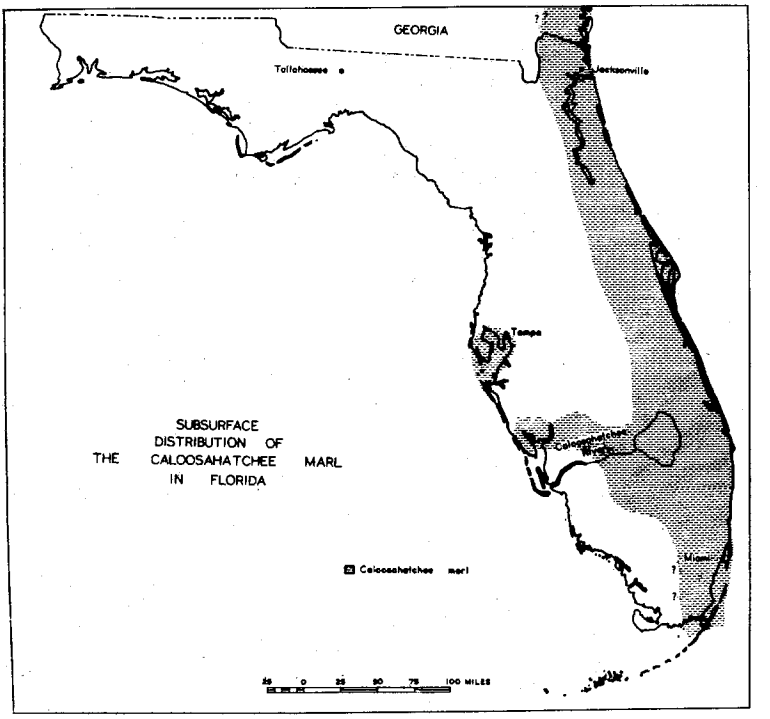

FIGURE 1.

Typically, beds of the Caloosahatchee formation consist of marls composed primarily of quartz sand, silt, clay, and shells, and a few beds of sand. Most of the strata are soft or only slightly indurated, but some are calcareous and very hard. Most layers are moderately to abundantly fossiliferous, although some, especially sands, are almost or completely devoid of fossils. Fresh exposures are generally light-colored with white, light gray, cream, and buff predominating. In subsurface many sand layers are light green to olive green. Weathered marls are usually light to dark gray on the surface.

In most areas that I studied, the Caloosahatchee marl is less than 50 feet in thickness and averages less than 40 feet. In many places the formation is absent, either because it was never deposited or has been eroded.

STRATIGRAPHIC RELATIONSHIPS

Upper and lower limits.—I have observed the base of the Caloosahatchee marl only in southern Florida, where it lies unconformably on the heavily dissected Tamiami formation of late Miocene age. Along the Caloosahatchee River and to the south, the Caloosahatchee deposits are thickest over the old Tamiami valleys, and they thin or pinch out over the old hills and divides. Little is known about the base of the Caloosahatchee marl to the north,

but presumably the formation is unconformable with underlying beds throughout the state. In wells in Seminole County it rests on the Ocala (Eocene) limestone (Cooke, 1945: 215).

The Caloosahatchee marl is exposed at the surface only in canals, pits, and river banks. Everywhere it is overlain unconformably by late Pleistocene deposits. In the type locality the overlying beds most commonly belong to the Ft. Thompson formation, but in some places the formation is overlain by Pamlico sands. To the south, east, and southeast the overlying beds belong either to the Anastasia formation, Key Largo limestone, Miami oolite, or one of the late Pleistocene terrace sand formations.

Correlation with other units. — Several formations have been considered to be facies of the Caloosahatchee marl, representing varied deposits of Pliocene age. Among these is the Tamiami formation (discussed above) now regarded as late Miocene in age. Other so-called facies or correlatives include the Bone Valley, Charlton, Alachua, Citronelle, Waccamaw, and Croatan formations. The Bone Valley formation of west-central Florida was considered by Cooke (1945: 18) to represent an estuarine facies of the Caloosahatchee, although the formations are not known to intergrade or interfinger. The vertebrate fossils of the Bone Valley beds include a mixture of Pliocene and Miocene species, none of which is known from the Caloosahatchee marl. With little doubt the Bone Valley beds are considerably older than the Caloosahatchee formation, and they possibly represent an estuarine facies of the Tamiami formation.

The Alachua of west-central Florida is a residual formation derived from weathering of pre-existing formations. The only fossils are vertebrates which comprise a mixture of Miocene, Pliocene, and Pleistocene species and show no close relationship to the vertebrate species of the Caloosahatchee marl.

Cooke (1945: 227-229) and Cole (1944: 23) seem to have correlated correctly the estuarine Charlton formation of northeastern Florida with the Caloosahatchee marl, although the Charlton could represent a slightly younger deposit, judging from its molluscan assemblage.

The Citronelle formation has been traced into northwestern Florida at least as far as Appalachiocola River and may be represented also by red sands in central Florida. Berry (1916: 195) dated the formation as late Pliocene on the basis of plant fossils contained in clay at the type locality. Roy (1939: 1557) believed that the plant-bearing clay was faulted up against the Citronelle gravel and that, therefore, it is older than the gravel. In Mississippi the Citronelle overlies the Graham Ferry formation, which is supposed to be Pleistocene in age, and the Citronelle is there considered of undoubted Pleistocene age (Brown, *et al.*: 45-59). The "Citronelle" deposits in central Florida were thought by Cooke (1945: 231) to comprise a Pliocene near-shore and beach facies of the Caloosahatchee marl. No intergradation of the two formations has ever been observed.

Fossils are rare in the Citronelle of Florida, but according to Cooke

and Mossom (1929 : 147) a few poorly preserved casts of marine gastropods and pelecypods were collected in Escambia County from beds that belong to the Citronelle. The occurrence of the Miocene *Ostrea* sp. *cf. O. westi* Mincher is reported from Okaloosa County by Cooke (1945: 231), but he is uncertain about the exact stratigraphic position of the fossils; it is possible that the oysters were not in the Citronelle beds.

Most of the "Citronelle" strata of central Florida appear to lie above the 100-foot contour line, or above the Wicomico terrace, and, therefore, they could represent a facies of the Caloosahatchee marl. If this is true, at least the so-called Citronelle of central Florida should be classified as Pleistocene in age.

The Waccamaw and Croatan formations of North Carolina and South Carolina were correlated by Cooke, Gardner, and Woodring (1943) with the Caloosahatchee marl. The Molluscan assemblages of the Caloosahatchee marl in Putnam and Volusia counties of east-central Florida are intermediate between the tropical assemblages of the type Caloosahatchee to the south and the temperate assemblages of the Waccamaw and Croatan formations. It appears then that the Waccamaw and Croatan beds represent a cooler water facies of the Caloosahatchee marl.

Age

Evidence from the invertebrate fauna.—The molluscan fauna of the Caloosahatchee marl is distinctive, containing many species not known from other deposits. Dall (1903: 1604-1605) recognized 639 species of mollusks as occurring in the formation, of which 314 (49%) are also Recent. Thus, on the basis of percentage of extinct molluscan species the Caloosahatchee seems to have been correctly placed in the Pliocene. However, differences between many Caloosahatchee species and their present-day descendants are slight and are probably of no more than subspecific value. Other species thought to be extinct probably survive in more southern latitudes where they have not yet been observed. It appears probable then that considerably less than 51% of the species are extinct. In addition, none of the Caloosahatchee molluscan species is elsewhere restricted to deposits of undoubted Pliocene age.

Foraminiferans are relatively abundant in the Caloosahatchee marl, but studies by Cole (1931) and Cushman and Ponton (1932) failed to demonstrate important differences between late Miocene, Caloosahatchee, late Pleistocene, and Recent assemblages. A more recent study of the foraminifers has led Puri (1956, pers, comm.) to assign at least the upper Caloosahatchee beds to the Pleistocene.

Wells (1955, pers. comm.) considered several species of corals in the upper Caloosahatchee beds to be of late Pliocene age or younger. Two of the coral species are restricted to the Caloosahatchee marl and, on this basis, were judged by Wells to be Pliocene in age. Two species are restricted to the Pleistocene and Recent, and one species ranges from Miocene to Recent. If the two species restricted to the Caloosahatchee be omitted from consideration, then

it seems that the coral fauna represents a Pleistocene rather than a Pliocene age.

No attempt has been made to analyze in detail the echinoid fauna; however, the largest and most conspicuous species in the formation is *Clypeaster rosaceus* which also occurs in the Recent fauna and apparently is unknown from beds older than the Caloosahatchee marl.

The invertebrate fauna does not seem to offer a definite solution to the problem of the age of the Caloosahatchee marl. Most species, however, are known to occur in late Pleistocene or Recent deposits, and those restricted to the Caloosahatchee formation offer conclusive evidence neither for nor against a Pleistocene age.

Evidence of the vertebrate fauna.—The vertebrate assemblage which I collected from the type Caloosahatchee marl presents convincing evidence of Pleistocene age for the formation. There is no doubt that the bones were collected in place, and most of them were covered by several feet of marl and limestone bearing many of the most typical Caloosahatchee molluscan species. Most of the fossil vertebrates were collected from an upper shell bed, but some were found in the lower beds. The Caloosahatchee vertebrates are:

Alligator mississippiensis
Cetacean remains
Equus leidyi
?Holmesina septentrionalis
Odocoileus sp.
?Machrochelys temminki
Tanupolama sp.
Testudo sellardsi
Trachemys sculpta

The cetacean remains are being studied by Dr. Remington Kellogg of the U. S. National Museum in Washington, D. C.

None of the Caloosahatchee vertebrates are restricted elsewhere to Pliocene deposits, and in fact most are known only from the Pleistocene. According to Savage and Winters (1955, pers. comm.) ". . . one of the species of turtles is still living in Florida, and the other two are found only in Pleistocene and early Recent deposits. The equid teeth are indistinguishable from those of the so-called *Equus leidyi*, the medium sized, late Pleistocene and early Recent horse. The Chlamytheriinae seem to be restricted to the Pleistocene of North America. The evidence is strongly in favor of a post-Blancan age for at least the upper part of the Caloosahatchee formation, and it possibly dates from one of the interglacial stages when the sea level stood some 15 to 20 feet higher than at present."

Winters (1956, pers. comm.) has found no record of either *Equus* or a chlamytherid from the Blancan faunas. The earliest record of *Equus* known to him is from late Kansan deposits of the Nebraska-Kansas area and there is no known pre-Sangamonian record of the chlamytherid from North America. The giant armadillo, *?Holmesina septentrionalis*, has been recorded from 18 to 20 localities in Texas, Florida, Oklahoma, and Mexico, and all localities, except three where reworking has occurred, present strong evidence of Sangamonian or later age.

The Caloosahatchee fish and reptile fossils are considered by Auf-

fenberg (1956, pers. comm.) definitely to represent a Pleistocene age.

The vertebrate species, accordingly, present strong evidence of a post-Kansan age for the Caloosahatchee beds and the presence of the giant armadillo points to a Sangamonian or later age.

Relationship to Pleistocene shorelines. — The type Caloosahatchee marl contains a tropical molluscan assemblage which probably lived during a warm interglacial stage. If, as the vertebrate fauna suggests, the formation is no older than Kansan, then it must be assigned either to the Yarmouthian or Sangamonian interglacial stage. The inland limits of known Caloosahatchee deposits, as shown by Cooke's geologic map of Florida (1945), correspond closely to the Wicomico and Okefenokee shorelines as distinguished by MacNeil (1949) but appear to coincide most closely with the Wicomico at an elevation approximately 100 feet above present sea level. The Wicomico is regarded as Sangamonian in age (MacNeil, 1949: 99; Cooke, 1945: 17; Vernon, 1951: 21-27), and the Okefenokee is classified as Yarmouthian by MacNeil (1949: 99). It is possible that both shorelines were formed by successive stands of the Caloosahatchee sea during the same interglacial stage. Winters (1956, pers. comm.), however, thinks that the Okefenokee shoreline is Aftonian. This opinion is based on the occurrence near Brewster, Florida, of Blancan vertebrates just below the 150-foot contour.

Paleoecological studies indicate that the middle (Bee Branch, Table 1) member of the Caloosahatchee marl in southern Florida was deposited in an offshore continental shelf environment where the water depth probably exceeded 15 fathoms. The upper shell bed was probably deposited closer to shore in shallower water. If the water depth of the Caloosahatchee sea were approximately 90 to 100 feet where the middle member was being deposited, the corresponding shoreline should have closely approximated the level and outline of the Wicomico shoreline. As shown by MacNeil's map (1949), the distance is approximately 30 miles from the Caloosahatchee type area to the nearest point on the Wicomico shoreline. All of the lower Caloosahatchee beds appear to have been deposited in shallower water than the strata of the Bee Branch member, and, therefore, most traces of additional Caloosahatchee shorelines probably have been destroyed.

TABLE 1.—Stratigraphy of the Caloosahatchee River Area, Southern Florida.

Age			Formation
NEOGEN	Pleistocene	Wisconsinan	Lake Flirt marl Pamlico formation Ft. Thompson formation Coffee Mill Hammock marl member Okaldakoochee marl member
		Sangamonian	Caloosahatchee marl Ayers Landing member Bee Branch limestone member Ft. Denaud member
	Miocene	Pontian?	Tamiami formation

Summary

1. The Caloosahatchee marl rests unconformably on dissected strata of late Miocene or earlier age and is in turn unconformably overlain by beds deposited during the late Pleistocene.

2. The Tamiami and probably the Bone Valley and Alachua formations are older than the Caloosahatchee marl. The Charlton, Waccamaw, and Croatan formations are probably true facies of the Caloosahatchee. The relationship of the "Citronelle" of central Florida is uncertain, although it is possibly a near-shore or beach facies of the Caloosahatchee marl.

3. On the basis of faunal, paleogeographic, and paleoecological evidence, the Caloosahatchee marl seems to be Kansan or younger in age. The presence of *Equus leidyi* in the middle and upper members dates the Caloosahatchee marl as Post-Kansan, and the remains of *?Holmesina septentrionalis* in the same beds suggest that formation should be assigned to a Sangamonian or later age.

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