

**STATE OF FLORIDA**  
**DEPARTMENT OF CONSERVATION**

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**R. L. DOWLING, Supervisor**

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**GEOLOGICAL BULLETIN No. 18**

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**NOTES ON THE UPPER TERTIARY AND PLEISTOCENE  
MOLLUSKS OF PENINSULAR FLORIDA**

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**By**

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**Geologist, U. S. Geological Survey**

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## LETTER OF TRANSMITTAL

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HONORABLE R. L. DOWLING,  
*Supervisor of Conservation.*

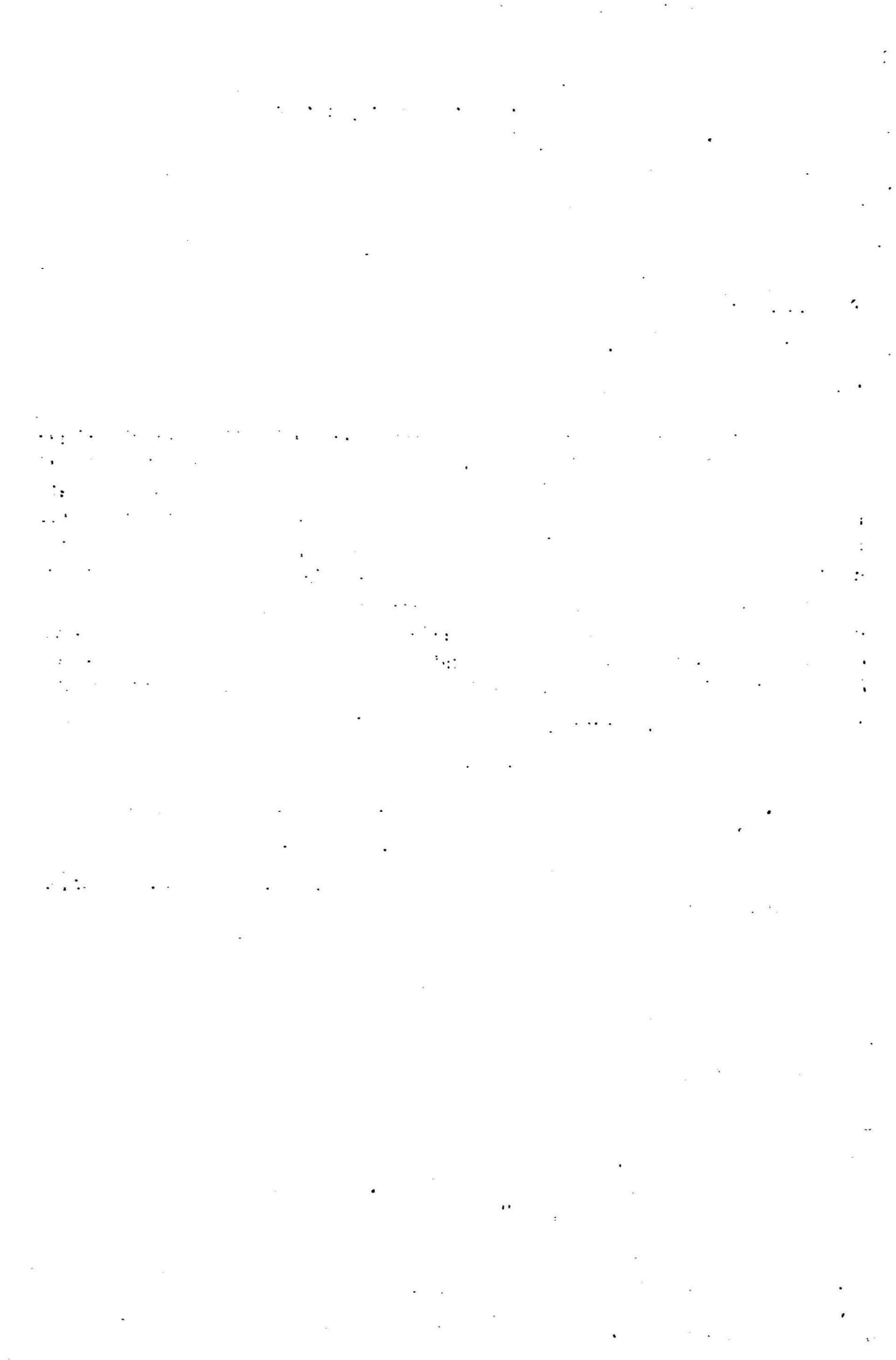
SIR:

I have the honor to transmit a short report entitled: "Notes on the Upper Tertiary and Pleistocene Mollusks of Peninsular Florida," by Dr. W. C. Mansfield of the United States Geological Survey. This report presents the results of Dr. Mansfield's studies of a molluscan fauna near Buckingham, Lee County, Florida, and its stratigraphic position with respect to the Caloosahatchee marl and also correlates the Pliocene deposits of the western side of Florida with those of the eastern side. It also presents a study of certain Pleistocene deposits associated with the Pliocene deposits. It is a contribution to our knowledge of the formations of the State and the Florida Geological Survey is indebted to the United States Geological Survey for this paper of Dr. Mansfield's. It will form Geological Bulletin No. 18 of our series of reports.

Very respectfully,

HERMAN GUNTER, *Geologist,*  
*Assistant Supervisor*  
*State Board of Conservation.*

Tallahassee, Florida  
June 14, 1939.



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# NOTES ON THE UPPER TERTIARY AND PLEISTOCENE MOLLUSKS OF PENINSULAR FLORIDA<sup>1</sup>

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BY W. C. MANSFIELD

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## INTRODUCTION\*

The major purposes of this paper are to present, (1) the results of a study of a molluscan fauna found near Buckingham, Lee County, Florida, and of its distribution elsewhere, in order to determine its stratigraphic position relative to the Pliocene Caloosahatchee marl; and (2) an attempt to correlate the Pliocene deposits of the western side of Florida with those of the eastern side. A secondary purpose of the paper is to present a study of certain Pleistocene deposits associated with the Pliocene deposits. No attempt is made in this paper to study or list all of the many species so ably described by Dall<sup>2</sup> from the Pliocene of Florida, but an effort is made to note some of the characteristic species in certain beds and to determine their relationship with those of other beds.

Most of the type material of the Caloosahatchee Pliocene marl is deposited in the U. S. National Museum, and grateful acknowledgment is herewith made to the authorities of this institution for access to this material for study.

Most of the other fossil material studied in this paper was collected by the writer, F. S. MacNeil, or by C. W. Mumm, all of the U. S. Geological Survey. This material was obtained in place along the Caloosahatchee River or from spoil thrown out by the dredge in deepening the channel or making cutoffs in the river during the recent work of the U. S. Army Engineers.

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<sup>1</sup> Published with the permission of the Director of the United States Geological Survey, United States Department of the Interior.

\*Dr. Wendell Clay Mansfield passed away July 24, 1939, while this paper was in press. He had seen the galley proofs, but the page proofs have been read by others. It is greatly to be regretted that his fruitful labor on the Tertiary of the southeastern United States is at an end.—EDITOR.

## NEW NAMES FOR FORMATIONS

The correlation of some of the later deposits of southern Florida is somewhat uncertain. In view of this fact, it seems desirable to apply local formational names to certain of them in order that they may be more readily referred to in this paper, or may be shifted, if necessary, at a future time to their proper niches. These names are as follows:

*Buckingham limestone.*—A new formational name is here proposed for a limestone cropping out in Lee County, Florida. The type locality is at a quarry near State Highway no. 25, half a mile west of Orange River, Lee County, Florida (sec. 5, T. 44 S., R. 26 E.). The age is believed to be uppermost Miocene. The fossils and other characteristics pertaining to this limestone will be discussed at another place in this paper.

*Tamiami limestone.*—A new formational name is proposed for a limestone penetrated in digging shallow ditches to form the road bed of the Tamiami Trail over a distance of about 34 miles in Collier and Monroe Counties, Florida. The character of the matrix and the included fossils were described elsewhere by W. C. Mansfield.<sup>6</sup>

The matrix of the Tamiami limestone consists mainly of a dirty-white to gray, rather hard, porous, nonoolitic limestone with inclusions of clear quartz grains. The faunas, so far as studied, include 6 genera of gastropods, 15 genera of pelecypods, and 2 genera of echinoids. Aside from these, Foraminifera, barnacles, and Bryozoa were observed at a few localities. Among the pelecypods the scallops and oysters are the most conspicuous forms, both in the number of species and individuals and in the rather large size which some of them attained. The echinoid, *Encope macrophora tamiamiensis* Mansfield, was found at three localities, and the species *Cassidulus evergladensis* Mansfield at two localities.

The character of the faunas indicates that they lived near the shore in comparatively shallow water.

The age was, and still is, assigned to the Pliocene, but the exact position in the Pliocene has not been definitely determined. Tentatively, it is placed at the base of the Pliocene below the Caloosahatchee marl.



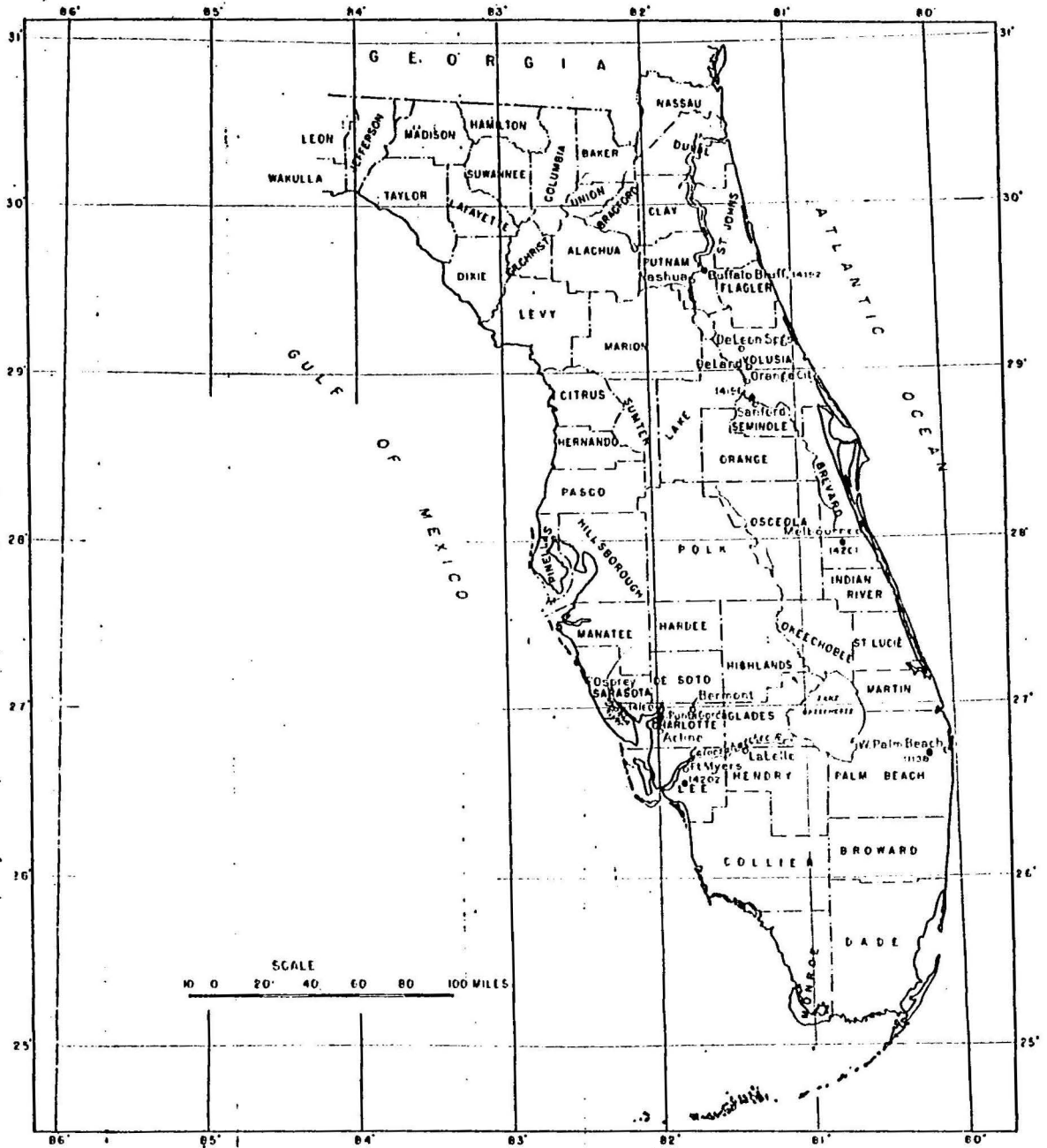


Fig. 1. Map of Peninsular Florida

Figure 1.—Map of Peninsular Florida. A rough map of Peninsular Florida shows general relations of the areas discussed and the locations of the fossil collections except those along the Caloosahatchee River, which are shown on Figure 2.

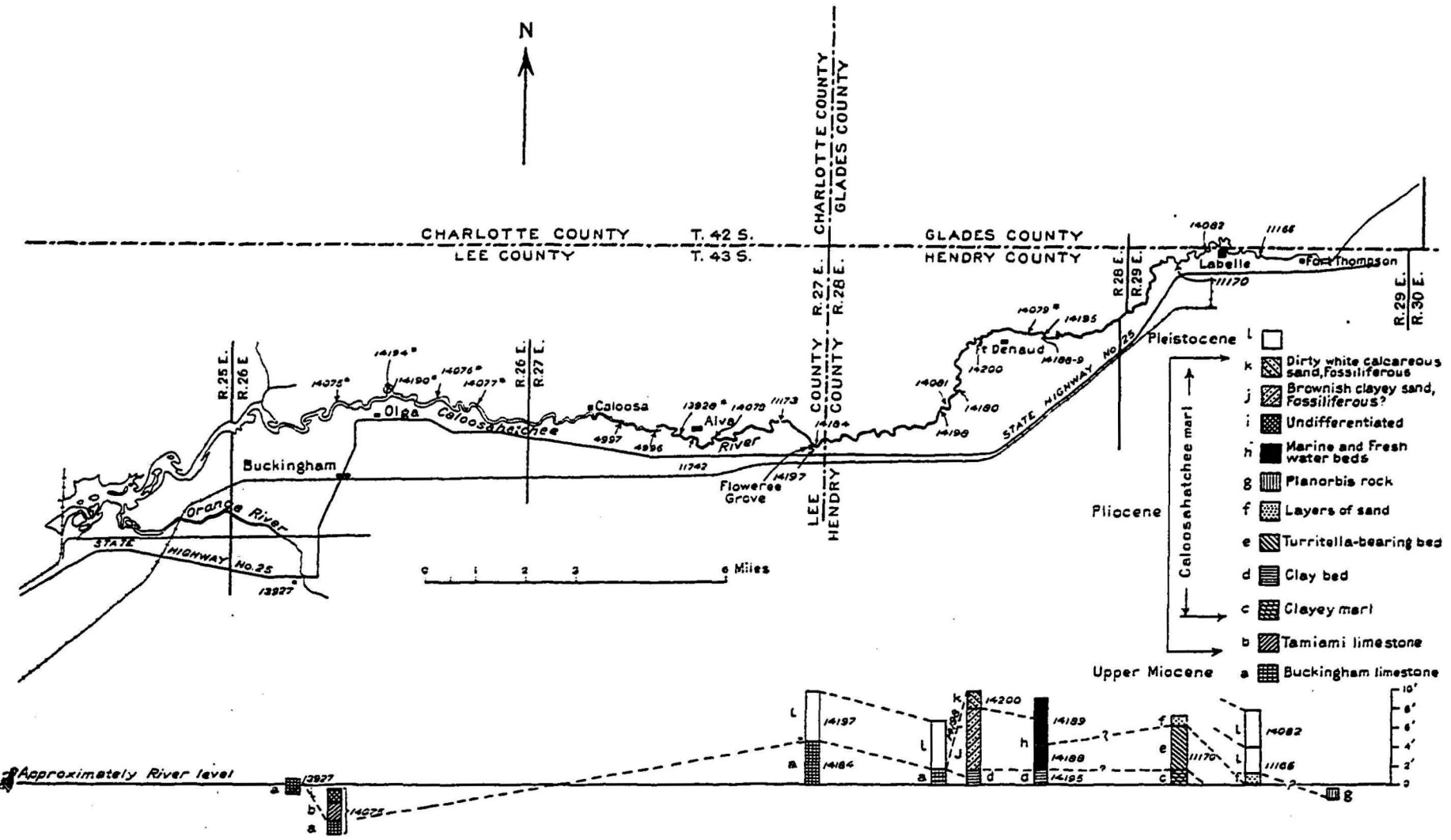


Fig. 2

MAP OF THE CALOOSAHATCHEE RIVER AND CORRELATION OF THE DEPOSITS

Figure 2.—Map of the Caloosahatchee River and correlation of the deposits. This figure shows the localities—upper Miocene to Pleistocene—along the Caloosahatchee River from Fort Thompson to a point a short distance below Olga. An asterisk following the station number indicates that fossils at this place were taken from the spoil bank.

The sections along the river, with a tentative correlation of the deposits, are projected to the bottom of Figure 2.

## UPPER TERTIARY DEPOSITS OF SOUTHERN FLORIDA

The fauna of the southwest side of Florida will be considered first, then that of south-central and eastern side will follow.

### BUCKINGHAM LIMESTONE

A list of species, as then recognized by the writer, from the vicinity of Buckingham is given by Cooke and Mossom.<sup>24</sup> The limestone in which these species occur is tentatively classified in the same report as Choctawhatchee formation.

*List of species.*—The species listed below and now referred to the Buckingham limestone have been collected in place. The species followed by the letter "A" are from the vicinity of Buckingham. Those marked "B", "C", "D", and "E" are from several places along the Caloosahatchee River: "B", about 1 mile above (station 4997) and about 2 miles above Caloosa (station 4996); "C", at low tide at Alva (station 11742); "D", half a mile above Alva (station 14078); "E", lower bed across from Floweree Grove, about 3 miles above Alva (station 14184).

- Cancellaria* cf. *C. tabulata* Gardner and Aldrich, E
- Cancellaria* aff. *C. venusta* Tuomey and Holmes, E
- Dorsanum?* cf. *D.?* *plicatilum* (Böse), A
- Turritella* aff. *T. cartagenensis* Brown and Pilsbry, D, E
- Turritella* cf. *T. pontoni* Mansfield, A
- Turritella buckinghamensis* Mansfield, n. sp., A, C, E
- Nuculana* sp., A, C, D, E
- Navicula umbonata* Lamarck?, C
- Navicula umbonata* Lamarck, C
- Arca lienosa* Say, A, E
- Arca* (*Cunearca*) *scalaris* Conrad, variety?, A, C, D, E
- Ostrea meridionalis* Heilprin, A, B, C
- Ostrea disparilis* Conrad, A, D
- Pecten* (*Pecten*) *ochlockoneënsis leënsis* Mansfield, n. subsp., A
- Pecten* (*Nodipecten*) *nodosus floridensis* Tucker and Wilson, A
- Pecten* (*Chlamys*) *caloosensis* Mansfield, n. sp., A, B
- Pecten* (*Chlamys*) *eboreus buckinghamensis* Mansfield, n. subsp., A, B, C, D, E
- Lima* (*Mantellum*) *carolinensis* Dall, A
- Anomia simplex* D'Orbigny, A, C, D
- Phacoides chrysostoma* (Meuschen), A
- Dosinia elegans* Conrad?, C
- Chione ulocyma* Dall, A, C, E

The fauna from station 14184, across the river from Floweree Grove, is considered to come from the uppermost part of the Buckingham limestone.

Tucker and Wilson<sup>16a</sup> reported *Pecten interlineatus* Gabb from Buckingham, also *Ostrea haitensis* Sowerby (= *O. meridionalis* Heilprin).<sup>16b</sup> The molluscan fauna of the Buckingham limestone consists mainly of *Pecten* and *Ostrea*, which are well-preserved; but most of the other genera are preserved only as casts or molds.

*Character of matrix.*—The matrix in which the fossils are embedded consists of a chalky limestone that contains a little sand and many small grains of brown phosphorite. The rock hardens on exposure and changes to a brownish color.

*Species dredged along Caloosahatchee River.*—The species listed below were dredged from Caloosahatchee River one mile below Olga (station 14075). Those followed by the letter "B" strongly indicate that they came from the Buckingham limestone, the lowest stratum.

*Helisoma conanti* (Dall)

*Cancellaria* aff. *C. tabulata* Gardner and Aldrich, B

*Oliva sayana* Ravenel

*Marginella culima* Dall

*Mitra lincolata* Heilprin

*Fasciolaria tulipa* Linnaeus

*Cypraea problematica* Heilprin

*Cypraea carolinensis floridana* Mansfield, B

*Strombus pugilis alatus* Gmelin

*Cerithium ornatissimum* Heilprin

*Cerithium floridanum* Mörch

*Potamides scalatus* Heilprin

*Turritella apicalis* Heilprin

*Turritella perattenuata* Heilprin

*Turritella subannulata acropora* Dall

*Turritella buckinghamensis* Mansfield, B

*Turritella* aff. *T. cartagenensis* Pilsbry and Brown, B

*Turritella* cf. *T. pontoni* Mansfield, B

*Glycymeris pectinata* Gmelin

*Navicula umbonata* Lamarck

*Navicula wagneriana* Dall

*Arca rustica* Tuomey and Holmes

*Arca aequalitas* Tucker and Wilson

*Arca catararca* Dall

*Arca lienosa* Say

*Arca (Cuncarca) scalaris* Conrad, variety?, B

*Ostrea meridionalis* Heilprin, B

*Ostrea disparilis* Conrad, B

*Pecten (Nodipecten) nodosus floridensis* Tucker and Wilson?

*Pecten (Pecten) ochlockoneënsis leënsis* Mansfield, B  
*Pecten eboreus buckinghamensis* Mansfield, B  
*Pecten caloosensis* Mansfield, B  
*Spondylus rotundatus* Heilprin  
*Anomia simplex* D'Orbigny  
*Lithophaga* sp.  
*Thracia* sp., B  
*Eucrassatella mansfieldi* MacNeil  
*Cardita arata* Conrad  
*Venericardia olga* Mansfield  
*Chama crassa* Heilprin  
*Phacoides chrysostoma* (Meuschen) Philippi  
*Phacoides pensylvanicus* Linnaeus  
*Codakia Jagonia speciosa* Rogers  
*Cardium isocardia* Linnaeus  
*Dosinia elegans* Conrad  
*Chione cancellata* Linnaeus  
*Chione ulocyma* Dall, B  
*Chione latilirata athleta* Conrad, B  
*Cytherea rugatina* Heilprin  
*Metis biplicata* Conrad, B  
*Panope floridana* Conrad  
*Encope* cf. *E. michelini* Agassiz  
 Corals, 2 or 3 species

All the above material was taken below stream level as the banks are low here, and no marl was observed in them. Some of the shells are clean and appear to have come from a sand (many of the shells are believed to be Pliocene); others from an indurated light gray limestone (probably also Pliocene); and others from a light tan argillaceous limestone (probably Buckingham limestone).

The species listed below were dredged from Caloosahatchee River a quarter to half a mile above Olga (stations 14190, 14194). A number of species indicate that they came from the Pliocene (marked "P"), some suggest that they came from the Buckingham limestone (marked "B"), and one from the Tamiami limestone (marked "T"). The matrix with the specimens that resemble Pliocene species may have been reworked with material from a lower stratum.

*Terebra dislocata* Say  
*Mitra* aff. *M. lineolata* Heilprin  
*Fasciolaria* aff. *F. gigantea* Kiener  
*Solenosteira vaughani* Dall?  
*Cerithium ornatissimum* Heilprin, P  
*Turritella apicalis* Heilprin, P  
*Turritella* aff. *T. cartagenensis* Pilsbry and Brown, B  
*Turritella buckinghamensis* Mansfield, B

*Barbatia candida* Gmelin var.  
*Barbatia irregularis* Dall?  
*Arca lienosa* Say  
*Ostrea* cf. *O. tamiamiensis* Mansfield  
*Pecten wendelli olgensis* Mansfield, P  
*Pecten (Chlamys) fuscopurpureus* Conrad, P  
*Pecten tamiamiensis* Mansfield, T  
*Pecten eboreus solaroides* Heilprin, P  
*Pecten evergladensis* Mansfield var.  
*Thracia* sp., B  
*Spondylus* sp.  
*Dosinia elegans* Conrad?  
*Chione cancellata* Linnaeus, P  
*Chione ulocyma* Dall, B  
*Chione latirata athleta* Conrad  
*Rangia cuneata* Gray

The matrices of the harder material consist of a light gray and a dark gray indurated limestone differing from the buff-colored Buckingham limestone.

The fauna, taken from the sides and bottom of the river, is interesting because it probably represents two or more horizons. *Rangia cuneata* was observed to be farther out from the river than the harder rock, and it is assumed that it came from a position above it.

*Geographic distribution.*—Matson and Clapp,<sup>10a</sup> in referring to species collected in place on the Caloosahatchee River, write, "Species of *Pecten eboreus* Conrad and *Pecten gibbus* Linnaeus together with *Ostrea haitensis* [*O. meridionalis*] Sowerby were also found about one mile above Caloosa on the Caloosahatchee River [station 4997]. The presence of these fossils is believed to indicate that the beds are Miocene; but this conclusion is held subject to revision in case subsequent investigations should result in finding larger collections which belong to some other period. This locality is of special interest because, heretofore, no Miocene has been reported so far south on the Gulf coast of the State." The top of the Buckingham limestone is about five feet above water level at Floweree Grove, where it is unconformably overlain by Pleistocene deposits. It was traced upstream for over a mile and probably is exposed four or five miles above Floweree Grove. Only typical Caloosahatchee species were found in the dredged material near Fort Denaul. It is exposed at low tide at Alva (station 11742) and one mile (station 4997) and two miles (station 4996) above Caloosa. Between Caloosa and Olga and one mile below Olga no exposures were seen, only fossils from the dredgings were obtained.

The information so far obtained indicates that the Buckingham limestone forms an arch that crosses the Caloosahatchee River, the highest point of the arch being near Floweree Grove. It is not certain whether the limestone arch exposed near Buckingham is continuous with that a little farther east across the Caloosahatchee River or is a distinct, parallel arch. It may be the same, as the upper surface of the limestone, where observed, has been denuded. To the northwest the Buckingham limestone probably was penetrated in digging pits west of Acline. In a list of species collected from these pits and published by Tucker and Wilson<sup>12a</sup>, the following species in their list are reported not to occur above the Miocene: *Cancellaria tabulata* Gardner and Aldrich, *Fasciolaria sparrowi* Emmons, *Dorsanum? plicatilum* (Böse), and *Natica guppyana* Toula. The *Ostrea* identified as *O. haitensis* Sowerby may be the same as that which the writer has identified from Buckingham and elsewhere as *O. meridionalis* Heilprin. The pits were filled with water and inaccessible to the writer in 1938. The following species that came from some position in the pit were collected,—*Ostrea* cf. *O. tamiamiensis* Mansfield, *Ostrea* gr. *O. trigonalis* Conrad, and *Encope macrophora tamiamiensis* Mansfield. The uppermost bed in the area of the pits carries typical Caloosahatchee Pliocene species, and there may be, consequently, three horizons represented here—the Buckingham limestone (upper Miocene), Tamiami limestone (lower Pliocene), and the Caloosahatchee marl (Pliocene).

The distribution of the Buckingham limestone to the southeast has not been fully determined. The specimens from the limestone now referred to Tamiami limestone were obtained along the Tamiami Trail within a northwest-southwest distance of about 34 miles in Collier and Monroe Counties. The nearest locality of this limestone to Buckingham is about 45 miles distant. The fauna of the Tamiami limestone appears to have lived at a later time than that of the Buckingham limestone, and the Tamiami was, and still is, regarded as of Pliocene age, but the exact position in the Pliocene has not been determined. The Tamiami limestone contains two species of echinoderms, *Encope macrophora tamiamiensis* Mansfield and *Rhyncholampas evergladensis* (Mansfield). The latter species has been reported by Cooke<sup>11</sup> to occur in the Waccamaw formation (Pliocene) of South Carolina. The writer has not found these two species in the Buckingham limestone. The two subspecies of *Pecten*, (*Nodipecten*) *pittieri evergladensis* Mansfield (Tamiami limestone) and *P. (N.) pittieri floridensis* Tucker and Wilson (Buckingham limestone), are somewhat similar but appear to have subspecific differences.

The fauna of the sand penetrated in digging a ditch along the Tamiami Trail, 42 miles west of Miami in Dade County is tentatively placed in the upper Miocene; it is probably closely related to the fauna of the Buckingham limestone. The *Turritellas* in both formations are similar, and *Cypraea carolinensis floridana* Mansfield has been reported at Acline by Tucker and Wilson.<sup>12a</sup>

## CALOOSAHATCHEE MARL

### INTERPRETATION BY DALL AND HARRIS OF THE BEDS ALONG CALOOSAHATCHEE RIVER

Dall and Harris<sup>a</sup> divided the strata along the Caloosahatchee River into the "Oyster reef marl beds, conchiferous or *Turritella* marl, and layers of sand; which intergrade without distinction and have no invariable succession, but always grade into the shallow-water fauna at the top, which is overlain by the *Planorbis* rock, and this in turn by post-Pliocene deposits which are seldom of great thickness." The writer is unable to interpret fully the succession of beds given by Dall and Harris, because they cite for some of the units no definite locality along the river where beds may be exposed.

*Oyster marl.*—The type locality of the "Oyster marl" of Dall and Harris<sup>b</sup> is at a point on the west bank of Peace Creek, three miles below Mare Branch. The oyster from this place belongs to the group of *Ostrea trigonalis* Conrad and probably is the same species that occurs at Alligator Creek (see p. 22), the horizon of which is tentatively referred to the Tamiami limestone. The writer has not seen this species from Peace Creek in the typical Caloosahatchee marl, the oysters occurring in the Caloosahatchee being *O. sculpturata* Say and *O. virginica* Gmelin. The latter species is more abundant in shallow-water deposits. Matson and Clapp<sup>10b</sup> state that a conspicuous oyster bed, about one foot thick, rises above the level of the stream  $3\frac{1}{2}$  miles below Labelle. As the writer has not seen this bed, he does not know the name of the species. He has noted, however, that specimens of *Ostrea* occur directly above a clay bed in the section above Fort Denaud, but they are not confined to any position in the section.

*Turritella marl.*—The *Turritella* marl of Dall and Harris is somewhat indefinite, as no section has been found in which they indicate its position. They may have had in mind the "compact marl" in their section along the Caloosahatchee River two miles below Fort Thomp-



son.<sup>4f</sup> The writer assumes that this section is at the locality about three-fourths of a mile below Labelle where there are many individuals of *Turritella perattenuata*, as well as other species of *Turritella* in the marl.

*Layers of sand.*—The layers of marine sand, which may be in part equivalent to the *Chione cancellata* bed, are said to overlie the *Turritella*-bearing marl.

*Planorbis rock.*—The *Planorbis* rock, which contains "*Planorbis*" [*Helisoma*] *conanti* Dall and "*P*". [*H.*] *disstoni* Dall, is a thin bed (about three feet thick) of silicified mud which covers the marl beds near Fort Thompson. These two species of *Helisoma* ("*Planorbis*") appear to belong to the Pliocene, and at this locality are probably near the top of the Pliocene, but in the section above Fort Denaud, as will be discussed later, these species occur directly above a marine clay bed.

#### OBSERVATIONS BY THE WRITER ALONG CALOOSAHATCHEE RIVER

In the Pliocene strata between Fort Thompson and a point three-fourths of a mile below Fort Denaud there appear, as suggested by Dall and Harris,<sup>4c</sup> to be gentle undulations, exposing more sediments above stream level in some places than in others. At Fort Thompson the Pliocene appears to dip below stream level.

*Localities near Labelle.*—At Labelle a gray to yellow sand is exposed one foot or more above stream level; it contains *Potamides scalatus* Heilprin, *Phacoides anodonta* Say, and *Cardium medium* Linnaeus. This bed represents the highest part of the Pliocene at this place and is unconformably overlain by the Pleistocene. Farther upstream, the *Planorbis* bed of Dall and Harris occurs. The writer assumes that it overlies the marine bed, but the assumption has not been confirmed. About one mile below Labelle a very fossiliferous, somewhat indurated gray marl containing many individuals of *Turritella* (station 11170) rises about 6 feet above stream level. This bed is believed to be stratigraphically below the Pliocene exposed farther upstream, and to have been deposited in rather deep water. It is inferred to be the *Turritella* bed of Dall. Matson and Clapp<sup>10b</sup> report two feet of fossiliferous, stratified, greenish-gray marl at the base of a section one mile below Labelle. They also state that the Caloosahatchee marl attains a thickness of 7 feet at a locality 1½ miles below Labelle and, as mentioned before, that it contains an oyster bed 1 foot above water level at a point 3½ miles below Labelle.

*Localities near Fort Denaud.*—The following section was noted on the left bank of the Caloosahatchee River about three-fourths of a mile above Fort Denaud, or about five miles below Labelle, near or at the place described by Matson and Clapp.<sup>10b</sup>

STRATIGRAPHIC SECTION THREE-FOURTHS OF A MILE ABOVE FORT DENAUD

	Feet
(1) Calcareous marl with many <i>Chione cancellata</i> and other marine shells, and a few fresh water shells (station 14189) .....	4 ±
(2) Calcareous marl with many fresh water and marine shells and a large number of individuals of <i>Ostrea</i> at the base (station 14188)	3 ±
(3) Sticky clay with fragments of shell and brownish pebbles in the upper part; contains <i>Pecten eboreus solaroides</i> Heilprin (station 14195) .....	1-3

The following species were collected: From the second bed (No. 2), indicated by "A"; from the upper bed (No. 1), indicated by "B"; and from station 14193, in place, 1 mile above Fort Denaud, left bank of the river, indicated by "C." (The relationship of "C" to "A" or "B" was not determined):

- Physa meigsii* Dall, A
- Uglandina truncata* Gmelin, C
- Vivipara georgiana* Lea, A, B
- Helisoma conanti* (Dall), A, B
- Acteocina canaliculata* Say, A
- Bulla striata* Bruguière?, 1 small spec. A
- Cancellaria conradiana* Dall, C
- Melongena subcoronata* Heilprin, A
- Cypraea problematica* Heilprin, B
- Bittium podagrimum* Dall, A
- Bythinella nickliniana attenuata* Haldeman, A
- Hydrobia annicoloides* Pilsbry, A
- Potamides scalatus* Heilprin, B
- Turritella apicalis* Heilprin, A, B
- Turritella subannulata* Heilprin, A
- Calliostoma* sp. (young), A
- Crepidula aculeata* Gmelin, A
- Astraliium precursor* Dall, B
- Neritina edentula* Dall, A
- Glycymeris pectinata* Gmelin, A
- Calloarca taeniata* Dall, A
- Eontia variabilis* cf. *E. v. quadrata* MacNeil, B
- Eontia platyura* (Dall), A
- Arca campyla* Dall, B
- Arca rustica* Tuomey and Holmes B
- Ostrea virginica* Gmelin, A, B
- Ostrea sculpturata* Conrad, A
- Pecten (Nodipecten) caloosaënsis* Dall, B

*Pecten (Nodipecten) nodosus* Linnaeus, C  
*Pecten gibbus gibbus* Linnaeus, B  
*Pecten eboreus solaroides* Heilprin, A  
*Anomia simplex* D'Orbigny, A  
*Spondylus rotundatus* Heilprin, B  
*Unio caloosaënsis* Dall, A  
*Congeria lamellata* Dall, A  
*Mytilus exustus* Linnaeus, A  
*Venericardia tridentata decemcostata* Conrad, A  
*Cardita* cf. *C. arata* Conrad, 2 small specimens, A  
*Phacoides pensylvanicus* Linnaeus, A  
*Phacoides (Miltha) disciformis* Heilprin, B  
*Cardium isocardia* Linnaeus, B  
*Laevicardium mortoni* Conrad, A  
*Cardium (Fragum) medium* Linnaeus, A, B  
*Cardium oedalius* Dall, A, B  
*Gafrarium (Gouldia) metastriatum* Conrad, A  
*Macrocallista maculata* Linnaeus, B  
*Anomalocardia caloosana* Dall, B  
*Chione cancellata* Linnaeus, A, B  
*Cytherea rugatina* Heilprin, B  
*Tellidora cristata* Recluz, B  
*Tellina sayi* Dall, A  
*Abra aequalis* Say, A  
*Rangia cuneata* Gray, A  
*Mulinia sapotilla* Dall, A  
*Tagelus* sp. A  
*Corbula barrattiana* Adams, A  
*Corbula* sp., A  
*Barnea (Scobina) costata* Linnaeus, A

From the above list it may be noted that the larger number of fresh-water shells occur in bed No. 2, directly overlying the clay bed, and that bed No. 1 contains many more individuals of *Chione cancellata*. *Ostrea virginica* and *O. sculpturata* occur throughout both beds, *O. virginica* being abundant and *O. sculpturata* very rare.

The following species not included in the above list have been collected in this area:

*Conus perversus* Linnaeus  
*Mitra lineolata* Heilprin  
*Fasciolaria scalarina* Heilprin  
*Vasum horridum* Heilprin  
*Pyrula papyratia* Say  
*Strombus leidyi* Heilprin  
*Navicula wagneriana* Dall  
*Chama crassa* Heilprin  
*Cardium dalli* Heilprin  
*Panope floridana* (Heilprin)

*Exposure three-fourths of a mile below Fort Denaud.*—The following species were obtained from an indurated bed, about three feet thick and about eight feet above stream level, in a cut-off three-fourths of a mile below Fort Denaud (station 14200):

*Helisoma* cf. *H. disstoni* Dall

*Turritella* sp.

*Ostrea sculpturata* Conrad?

*Pecten gibbus gibbus* Linnaeus, with smooth submargins

*Pecten* (*Pecten*) aff. *P. raveneli* Dall

*Phacoides* sp.

*Anomia simplex* D'Orbigny

*Other localities.*—From a point about one mile below Fort Denaud downstream (west) to Olga, no characteristic Caloosahatchee Pliocene fossils were obtained. About one mile above Olga some dredged species indicate that they came from the Tamiami limestone; and about one mile below Olga some typical Caloosahatchee Pliocene shells were thrown out by the dredge. These Pliocene shells have affinities both with the faunas in the upper bed at Alligator Creek and that at Shell Creek (see below), suggesting they were deposited by the same sea.

#### INTERPRETATION OF DEPOSITION

The writer's interpretation of the deposition of the Pliocene deposits between Fort Thompson and a point about one mile below Fort Denaud is as follows: The sea advanced from the east, and in it was deposited material, of which the lowest bed exposed, one mile below Labelle, is the 2-foot bed of greenish, stratified marl reported by Matson and Clapp.<sup>10b</sup> The sea then became deeper in the area around Labelle, and the Conchiferous or *Turritella* bed of Dall and Harris was deposited. Later, in this same area, the sea became shallower, and material containing near-shore marine shells was deposited, and later still material containing fresh water shells.

In the area between Labelle and Fort Denaud, little evidence was obtained indicative of conditions or of correlation, though among the dredged fossils examined at localities between the two places, none were found that indicate an older fauna than that of the Caloosahatchee marl.

Near Fort Denaud the oldest material visible is the clay deposit containing *Pecten eboreus solaroides*, a purely marine sediment. Apparently the sea that deposited the succeeding materials was shallower, for they contain marine, fresh-water, and land shells, the fresh-water shells being more abundant in the lower part. This fauna strongly

indicates that the shore line of the Caloosahatchee Pliocene sea was nearby. Whether or not the stratified marl at the base of the section near Labelle represents the clay bed at the base of the section near Fort Denaud is unknown, but the probability is that it does not. Possibly the clay bed is as old as the Tamiami limestone. Of the near-shore deposits near Fort Denaud, in the writer's opinion, the lower part containing fresh-water shells is nearly contemporaneous with that part of the deposits in the east, near Labelle, containing a deeper water fauna (*Turritella*-bearing marl); and the upper part is nearly contemporaneous with the shallow-water deposits of the area around Labelle.

#### BEDS ON SHELL CREEK

Shell Creek is a south fork of Prairie Creek, which enters Peace Creek north of Cleveland, Charlotte County. Dall and Harris,<sup>40</sup> in referring to the section on Shell Creek, write: "The banks are higher here than on the Caloosahatchee, being 25 feet at the highest point, but the difference is chiefly of unfossiliferous marine sand 12 feet deep. Then comes about 2 feet of shallow water fauna with some Pliocene species, below which is a hard limestone stratum 2 or 3 feet thick, beneath which is a bed of conchiferous marl, like that of the Caloosahatchee. There are slight differences in the fauna, such as might be expected at points 20 miles apart." Dall<sup>41</sup> reports, after an exhaustive study of the fauna at Shell Creek, a total of 256 species, of which 59 percent are Recent and 7 percent are peculiar. In comparison, the fauna on the Caloosahatchee River he reports to include 639 species, of which 48 percent are Recent and 28 percent are peculiar.

*Helisoma conanti* (Dall), and *H. disstoni* (Dall) occur at both places as well as *Ostrea virginica* Gmelin. An excellent collection obtained by the late Frank Burns from Shell Creek is deposited in the U. S. National Museum under the U. S. Geological Survey station no. 3300. These were collected along Shell Creek over a distance of about six miles. This collection probably includes fossils from more than one bed, though, if so, the fossils from the individual beds have not been isolated.

As a whole the Pliocene faunas at Shell Creek and along the Caloosahatchee River are similar, and there seems to be no reason for separating them stratigraphically. Probably the same horizons are represented at both places.

## BEDS ON ALLIGATOR CREEK

Dall and Harris<sup>40</sup> write: "Near the north end of Charlotte harbor a small creek comes in from the east called Alligator Creek. Here Mr. Willcox found an extension of the Caloosahatchee beds. The banks are about 12 feet high, the upper half being pure sand; the lower half contains fossils of Pliocene age, mollusks, barnacles, and flat Echinidae. They differ from the Caloosahatchee deposits in being in pure sand instead of marl as a matrix. The upper half of the fossiliferous stratum shows the shallow-water fauna, with its usual partial admixture of strictly Pliocene extinct species. Some parts of the bed are united by silicious cementation into a hard rock." Dall<sup>41</sup> records for Alligator Creek a total of 73 species, of which 63 percent are Recent and none peculiar.

There appear to be at least two and perhaps three horizons represented in this area—the Buckingham limestone, the Tamiami limestone, and an upper bed containing Caloosahatchee Pliocene fossils. A collection was made by the writer and F. S. MacNeil from Alligator Creek above the highway bridge near Acline. Most of the species previously reported from Alligator Creek were found, except *Ostrea* of the group of *O. trigonalis* Conrad and *Encope macrophoru tamiamiensis* Mansfield.

*Species from the upper beds.*—The following species were collected from Alligator Creek about half a mile above the railroad bridge (station 13975):

- Terebra protexta* Conrad
- Cancellaria* aff. *C. agassizii* Dall
- Oliva sayana* Ravenel
- Fasciolaria gigantea* Kiener
- Fasciolaria apicina* Dall
- Melongena subcoronata* Heilprin
- Strombus pugilis* Linnaeus
- Cerithium floridanum* Mörch
- Modulus modulus* Linnaeus
- Turritella subannulata* Heilprin
- Hydrobia amnicoloides* Pilsbry
- Natica canrena* Linnaeus
- Neritina merida* Dall
- Nucula proxima* Say
- Nuculana acuta* Conrad
- Glycymeris pectinata* Gmelin
- Glycymeris americana* Defrance
- Arca campyla* Dall
- Barbatia adamsi* Dall
- Arca lienosa* Say

*Arca catasarca* Dall  
*Eontia platyura* (Dall)  
*Pecten (Pecten) siczac* Linnaeus  
*Pecten fuscopurpureus* Conrad  
*Pecten gibbus gibbus* Linnaeus  
*Plicatula marginata* Say  
*Anomia simplex* D'Orbigny  
*Crassinella acuta* Dall  
*Crassinella lunulata* Conrad  
*Crassatellites gibbesii* Tuomey and Holmes  
*Cardita arata* Conrad  
*Echonochama arcinella* Linnaeus  
*Phacoides waccamawensis* Tuomey and Holmes  
*Phacoides multilineatus* Tuomey and Holmes  
*Phacoides nassula caloosana* Dall  
*Phacoides pensylvanicus* Linnaeus (came from the highest bed)  
*Phacoides chrysostoma* Philippi  
*Cardium robustum* Solander  
*Cardium isocardia* Linnaeus  
*Dosinia elegans* Conrad  
*Gafarium (Gouldia) metastriatum* Conrad  
*Macrocallista maculata* Linnaeus  
*Anomalocardia caloosana* Dall  
*Chione cancellata* Linnaeus  
*Chione athleta* Conrad  
*Venus campechiensis* Gmelin  
*Tellina sayi* Dall  
*Tellina alternata* Say  
*Semele bellastriata* Conrad  
*Abra aequalis* Say  
*Corbula barrattiana* Adams  
*Corbula caloosae* Dall  
*Psammosolen cumingianus* Dunker  
*Rangia cuneata* Gray (came from the highest bed)

The above list of species represents the latest Pliocene fauna in this area and may be nearly equivalent to the Pliocene fauna around Fort Denaud, or perhaps a little later than it. A few species collected from the top of the section a little farther up the stream appear to be a little younger than those in the bed below.

#### BEDS ON MYAKKA RIVER

Dall and Harris write: "The Myakka or Miacca River comes into the Charlotte harbor from the northwest parallel with the Gulf Coast, and its estuary is nearly at right angles to that of Peace Creek. Here Mr. Willcox found a bed of lime rock at the sea level with uncharacteristic species poorly preserved. Above the lime rock are beds of

shell marl considerably mixed with sand. In this deposit was collected about 40 species of shells of which about 10 per cent were extinct Pliocene species. This bed seems to have fewer extinct species than the Caloosahatchee marls and may be regarded as a little younger, perhaps corresponding to the *Planorbis* rock, which seems to be absent on the Myakka." Dall<sup>30</sup> writes that the fauna of the Myakka River has a total of 73 species, of which 72 percent are Recent and none peculiar to the locality.

The exact place at which Mr. Willcox obtained his fossils is unknown. It is also not known with certainty that all the species recorded came from a single bed, and the fossils are, consequently, unsatisfactory as horizon markers. Pleistocene fossils are found on North Creek, near Osprey, which locality is nearer the coast but not far away from Myakka River and a number of the species are common to both places. The following species reported from Myakka River indicate Pliocene age (those with an asterisk were not found in the U. S. National Museum collection):

*Aetaeon myakkanus* Dall, *Mitra willcoxii* Dall\*, *Potamides scalatus* Heilprin, *Turritella perattenuata* Heilprin, *Collonia elegantula* Dall (young specimen), *Arca rustica* Tuomey and Holmes\*, *Navicula wagneriana* Dall (young), *Gafarium metastriatum* Conrad\*, *Mactra willcoxii* Dall (not known elsewhere), *Corbula caloosae* Dall.

The following species, and perhaps others, indicate a Pleistocene age: *Fasciolaria distans* Lamarck, *Cerithium muscarum* Say, *Modulus floridanus* Conrad.

#### SPECIES FROM A LOCALITY ONE MILE NORTH OF BERMONT.

The following species were collected from a bed of sand in a marl pit one mile north of Bermont, Charlotte County, and about three miles south of Prairie Creek by the writer and F. S. MacNeil (station 13835):

##### Gastropods

*Hydrobia amnicoloides* Pilsbry  
*Acteocina canaliculata* Say  
*Atys* cf. *A. sandersoni* Dall  
*Ringicula floridana* Dall  
*Terebra protexta* Conrad  
*Terebra dislocata* Say  
*Conus floridanus* Gabb  
*Conus pygmaeus* Reeve  
*Conus proteus* Hwass  
*Mangelia* cf. *M. melanitica oxia* Bush  
*Mangelia* aff. *M. eritima* Bush



*Mangelia* n. sp.?  
*Olivella mutica* Say  
*Oliva sayana* Ravenel  
*Marginella ovuliformis* D'Orbigny  
*Marginella precursor* Dall  
*Turbinella scolymoides* Dall  
*Fasciolaria apicina* Dall  
*Fasciolaria gigantea* Kiener  
*Busycon perversum* Linnaeus  
*Melongena subcoronata* Heilprin  
*Alectrion vibex* Say  
*Astyris* cf. *A. multilineata* Dall  
*Pyrula papyratia* Say  
*Strombus pugilis* Linnaeus  
*Bittium adamsi* Dall  
*Cerithium algicolum* C. B. Adams  
*Cerithium glaphyreum litharium* Dall  
*Potamides scalatus* Heilprin  
*Caecum cooperi* S. Smith  
*Caecum regulare* Carpenter  
*Turritella subannulata* Heilprin  
*Turritella subannulata acropora* Dall  
*Assimineia* sp.  
*Crepidula fornicata* Say  
*Crucibulum auriculum* Gmelin  
*Tectonatica pusilla* (Say)  
*Polynices duplicatus* Say  
*Neritina merida* Dall  
*Diodora alternata* (Say)

#### Scaphopods

*Cadulus quadridentatus* Dall  
*Dentalium* sp.

#### Pelecypods

*Nuculana acuta* (Conrad)  
*Glycymeris pectinata* Gmelin  
*Barbatia adamsi* Dall  
*Eontia platyura* (Dall)  
*Arca lienosa* Say  
*Arca campyla* Dall  
*Arca aequalitas* Tucker and Wilson  
*Ostrea sculpturata* Conrad  
*Pecten gibbus gibbus* Linnaeus  
*Plicatula* n. sp.  
*Anomia simplex* D'Orbigny  
*Mytilus exustus* Linnaeus  
*Crassinella acuta* Dall  
*Crassinella dupliniana* Dall  
*Cardita arata* Conrad

*Venericardia tridentata* Say  
*Echinochama arcinella* Linnaeus  
*Phacoides anodonta* Say  
*Phacoides pensylvanicus* Linnaeus  
*Phacoides waccamawensis* Tuomey and Holmes  
*Phacoides multilineatus* Tuomey and Holmes  
*Phacoides trisulcatus* Conrad  
*Phacoides radians* Conrad  
*Diplodonta acclinis* Conrad  
*Bornia* sp.  
*Cardium isocardia* Linnaeus  
*Cardium robustum* Solander  
*Laevicardium mortoni* Conrad  
*Dosinia elegans* Conrad  
*Macrocallista nimbosa* Solander  
*Parastarte triquetra* Conrad  
*Chione cancellata* Linnaeus  
*Anomalocardia caloosana* Dall  
*Transennella caloosana* Dall  
*Tellina sayi* Dall  
*Tellidora cristata* Recluz  
*Corbula barrattiana* Adams  
*Mulinia lateralis* Say  
*Gastrochaena cuneiformis* Spengler

*Chione cancellata* is very abundant, and the fauna appears to have been deposited in comparatively shallow water near a former shore line. Most of the species also occur in the highest bed at Alligator Creek (station 13975). The sand bed near Bermont may have been deposited by the same sea as that in which the bed at Alligator Creek was laid down but appears to be a little younger. About 46 percent of the species occur in recognized Pleistocene faunas.

The following species occurring above Fort Denaud were not found at Bermont: *Cypraea problematica* Heilprin, *Arca rustica* Tuomey and Holmes, *Pecten (Nodipecten) caloosaënsis* Dall, *Pecten (Nodipecten) nodosus* Linnaeus, *Spondylus rotundatus* Heilprin, *Phacoides (Miltha) disciformis* Heilprin, *Cardium oedaliium* Dall, *Cardium (Fragum) medium* Linnaeus, *Macrocallista maculata* Linnaeus, *Cytherea rugatina* Heilprin and others. The absence of these forms indicates that the fauna at Bermont lived in cooler water than that suited to the fauna found on the Caloosahatchee River near Fort Denaud, and suggests that the Bermont fauna probably lived at a little later time.

## TENTATIVE CORRELATION OF THE UPPER TERTIARY DEPOSITS OF SOUTHWESTERN FLORIDA

Table 1 presents a tentative correlation of the Tertiary deposits of southwestern Florida, which are discussed in the preceding pages of this paper. As is noted at various places, the correlation of some of these beds is uncertain, but it seems desirable to offer an interpretation and leave to future time the adjustments that may be needed.

### THE MORE CHARACTERISTIC SPECIES OF THE PLIOCENE CALOOSAHATCHEE FAUNA

Forty of the more characteristic species of the Pliocene Caloosahatchee fauna are recorded in the list below. Of these, 8, or 20 percent, occur in the living fauna. All occur in the Shell Creek fauna. Nearly all the species were collected by the writer from the left bank of Caloosahatchee River about 1 mile below the highway bridge at Labelle (station 11170).

- Conus proteus* Hwass
- Cancellaria conradiana* Dall
- Mitra lineolata* Heilprin
- Scaphella floridana* Heilprin
- Vasum horridum* Heilprin
- Fasciolaria tulipa* Linnaeus
- Fasciolaria apicina* Dall
- Strombus leidy* Heilprin
- Niso willcoxiana* Dall
- Cypraea problematica* Heilprin
- Turritella perattenuata* Heilprin
- Turritella subannulata* Heilprin and var. *acropora* Dall
- Natica canrena* Linnaeus
- Missuridea carditella* Dall
- Arca aguila* Heilprin
- Arca campyla* Dall (typical)
- Arca rustica* Tuomey and Holmes
- Arca scalarina* Heilprin
- Navicula wagneriana* Dall
- Pecten eboreus solaroides* Heilprin
- Pecten evergladensis charlottensis* Mansfield = "*P. gibbus concentricus* Say
- Pecten exasperatus* Sowerby
- Pecten anteamplicostatus* Mansfield
- Pecten (Nodipecten) caloosaënsis* Dall
- Chama crassa* Heilprin
- Chama willcoxii* Dall
- Phacoides amabilis* Dall
- Phacoides caloosaënsis* Dall

TABLE 1  
TENTATIVE CORRELATION OF THE UPPER TERTIARY DEPOSITS OF SOUTHWESTERN FLORIDA

		CALOOSAHATCHEE RIVER		SHELL CREEK	ALLIGATOR CREEK	BERMONT	MYAKKA RIVER	TAMIAMI TRAIL
		Near Labelle	Near Fort Denaud					
PLIOCENE	UPPER						Beds on Myakka River (in part)	
	MIDDLE	CALOOSAHATCHEE MARL	<i>Planorbis</i> rock and marine sand (a)	Upper bed (c)	Highest bed	Beds at Bermont		
	LOWER		<i>Turritella</i> -bearing bed (Deeper water phase)	Lower bed (d)				
			Clayey marl (b)	Clay bed (e)				
			Tamiami limestone			Tamiami limestone		
MIOCENE	UPPER	Buckingham limestone			Buckingham (?) limestone			Sand in Dade County

(a) Probably below *Planorbis*-bearing bed to the east, but this has not been fully confirmed.

(b) and (e) may represent the same bed, but this has not been fully confirmed.

(c) and (d) are near-shore deposits; the equivalence of the lower bed to the *Turritella*-bearing bed is not fully confirmed but is assumed to be little higher stratigraphically.

*Phacoides pensylvanicus* Linnaeus  
*Phacoides (Miltha) disciformis* Heilprin  
*Cardium willcoxi* Dall  
*Cardium medium* Linnaeus  
*Cardium dalli* Heilprin  
*Cardium emmonsii* Conrad  
*Cytherea rugatina* Heilprin  
*Semele leana* Dall  
*Mulinia sapotilla* Dall  
*Mulinia caloosaënsis* Dall  
*Corbula willcoxi* Dall  
*Corbula caloosae* Dall

#### AREA ON THE SOUTH AND SOUTHWESTERN SIDES OF LAKE OKEECHOBEE

Many species of Pliocene shells have been thrown out by the dredge along the south and southwestern shores of Lake Okeechobee especially above Clewiston to Moorehaven and between Moorehaven and Lake Hicpochee. The dredge probably penetrated two horizons in places. The lower horizon has characteristic Pliocene shells like those in the lower strata on Caloosahatchee River and Shell Creek. An *Arca* aff. *A. plicatura* grading toward *A. transversa* was obtained 6½ miles northwest of Clewiston. *Eontia variabilis clewistonensis* MacNeil<sup>bb</sup> was picked up in the same area. MacNeil concludes that this variety came from an upper stratum in this area. *Morum floridanum* Tucker and Wilson, the holotype from Prairie Creek, was found at Ortona Lock, Caloosahatchee River. *Fusinus watermani* Maxwell Smith, the holotype from Belle Glade, a town on the Hillsborough Canal, was dredged from St. Lucie canal, 9 miles from Lake Okeechobee.

#### AREA ALONG WEST PALM BEACH CANAL

Fossils from the spoil bank have been collected on the West Palm Beach Canal as far east as Loxahatchee. *Turritella subannulata* Heilprin, *Ostrea sculpturata* Say, *Phacoides caloosaënsis* Dall, as well as other species, indicate that the Pliocene stratum was penetrated in digging the canal.

#### AREA ALONG ST. LUCIE CANAL

The St. Lucie canal cuts into the Pliocene from its entrance at Port Mayaca to a few miles east of the Seaboard Air Line Railway bridge at Indiantown. The holotype of *Arca aequalitas* Tucker and Wilson came from Port Mayaca (probably from the spoil bank). This species has been collected in place near Bermont and from the spoil bank

along the West Palm Beach Canal, 2 to 3 miles above Loxahatchee Post Office (station 11152) and two miles west of the railway bridge on the St. Lucie canal. Two to three miles west of St. Lucie Lock a small collection was obtained from a bed at water level (station 11145). The bed in which the fossils occur may be a little younger than or about the same age as that which yielded the shells dredged from the Pliocene at Port Mayaca. The fossils indicate a close relationship to those in the Caloosahatchee marl at DeLand and to the Waccamaw formation of the Carolinas. The following species were collected: *Arca* near *A. plicatura* Conrad; *Eontia* cf. *E. tillensis* MacNeil, a species from the Pliocene from Tilly's Lake, South Carolina; *Arca subsinuata* Conrad; *Ostrea virginica* Gmelin; *Ostrea sculpturata* Conrad?; *Cardium robustum* Solander; *Mulinia lateralis* Say (heavy form); and *Mulinia contracta* (Conrad).

## UPPER TERTIARY FAUNAS ON THE EAST SIDE OF FLORIDA

*Caloosahatchee marl* of Volusia County.—For the Pliocene deposits of Volusia County the name Nashua marl was proposed by Matson and Clapp, who described the characteristics of the formation and listed the contained species.<sup>10c</sup> Later, Mansfield<sup>1a</sup> studied the faunas. These deposits are now included in the Caloosahatchee marl.<sup>2a</sup>

The fauna of the Caloosahatchee marl in Volusia County may be separated into two zones, as follows:

1. Fauna near Nashua (basal) and fauna around Orange City and DeLand (lower part), Volusia County.
2. Fauna at DeLeon Springs (upper part), Volusia County.

The more characteristic forms of the two horizons are:

1. *Conus waccamawensis* B. Smith, *Arca delandensis* Mansfield (very abundant), *Pecten eboreus solaroides* Heilprin (common), *Arca rustica* Tuomey and Holmes. *Chione cancellata* Linnaeus is probably absent.

2. *Aurinia obtusa* Emmons (present), *Arca plicatura* Conrad (common), *Pecten eboreus solaroides* Heilprin (very rare), *Chione cancellata* Linnaeus, (common), *Corbula* n. sp. (common). The last occurs also in the Shell Creek fauna, but the bed in which it occurs is unknown.

The following species not formerly reported from DeLeon Springs

were collected half a mile southwest of the Golf Club there by the writer and F. S. MacNeil:

- Terebra dislocata* (Say)  
*Marginella limatula* Conrad  
*Aurinia obtusa* Emmons  
*Busycon canaliculatum* Linnaeus  
*Busycon caricum* Linnaeus  
*Ilyanassa irrorata* (Conrad)  
*Nucula proxima* Say  
*Nuculana acuta* Conrad  
*Glycymeris americana* DeFrance  
*Arca (Fossularca) adamsi* Dall  
*Ostrea virginica* Gmelin?  
*Pecten eboreus solaroides* Heilprin (1 valve)  
*Modiolus demissus* Dillwyn  
*Phacoides nassulus caloosanus* Dall  
*Phacoides trisulcatus multistriatus* Conrad  
*Phacoides anodonta* Say  
*Diwaricella quadrisulcata* (D'Orbigny)  
*Sportella constricta* Conrad  
*Tellma sayi* Dall  
*Corbula* n. sp., also at Shell Creek and at Neills Eddy Landing

The above species appear to be rather characteristic of the uppermost part of the Caloosahatchee marl of Volusia County.

## DISTRIBUTION OF THE ARCINAE OF THE PLIOCENE OF FLORIDA

Table 2 shows the distribution of most of the species of Arcinae of Florida. The presence of certain species, especially when represented by many individuals, has been helpful in correlating the deposits.

The specimens, from DeLeon Springs which I have placed under *Fontia platyura* show a gradation toward *E. variabilis* MacNeil. It has been pointed out by me in a previous study of the Caloosahatchee marl of eastern Florida that its faunal affinities are as close if not closer to the Waccamaw formation of the Carolinas than to the typical Caloosahatchee marl. The specimen which Dall figured<sup>3b</sup> under the name "*Arca (Noetia) limula* Conrad" was obtained at some horizon, perhaps the *Turritella*-bearing bed, along the Caloosahatchee River. This specimen probably should be referred to another species or subspecies. A similar form occurs in the lower part of the exposures in Volusia County.

TABLE 2—DISTRIBUTION OF THE *ARCINAE* OF THE PLOCIENE OF FLORIDA

	CALOOSAHATCHEE RIVER			DREDGED							VOLUSIA COUNTY			
	<i>Turritella</i> -bearing bed	Former Collection	¾ mi. above Fort Denaud	Shell Creek, beds not differentiated	Alligator Creek, upper beds	Myakka River	Near Bermont	St. Lucie Canal, 2 mi. west A.C.L. Ry. bridge Station 11148	Western side Lake Okeechobee Station 11159	Caloosahatchee River Coffee Mill Hammock Station 11160	Caloosahatchee Canal at Ortona Lock, Station 14161	2 to 3 mi. above Loxahatchee Station 11152	DeLand	DeLeon Springs
<i>Barbatia caloosahatchiensis</i> Sheldon .....		X		A	X									
<i>Navicula wagneriana</i> (Dall) .....	A	A	OI	A		F				X	A			
<i>Navicula aquila</i> Heilprin .....		X		G										
<i>Arca campyla</i> Dall (b) .....	A	X	U	X	X	F	X				X			
<i>Arca rustica</i> Tuomey and Holmes .....	X	A	U	A	G	R					A		X	
<i>Arca catararca</i> Dall .....				?	AT				X	X	A	?		
<i>Arca aequalitas</i> Tucker and Wilson (c) .....							X	X				X		
<i>Arca scalarina</i> Heilprin .....	X	A		A						X	X			
<i>Arca lienosa</i> Say .....		X		X			A			X	X			
<i>Arca alcina</i> Dall .....					T									
<i>Calloarca millifila</i> Dall .....				T										
<i>Calloarca taeniata</i> Dall .....		X	L	X							X			
<i>Eontia platyura</i> (Dall) .....		X	L	X	T		G							X
<i>Eontia "limula (Conrad)" fide Dall</i> .....	?	X												
<i>Eontia variabilis</i> cf. <i>E. v. quadrata</i> MacNeil .....			UO											
<i>Eontia</i> cf. <i>E. variabilis</i> MacNeil .....			O											

(A) abundant

(T) type locality

(B) also dredged 3 miles west of Clewiston

(C) type from Port Mayaca

(R) reported here but not found by writer

(E) one small specimen

 (F) reported here = *A. transversa* Say

(G) one specimen

(X) occurrence

(L) lower bed

(O) collected in this area

(U) upper bed

(I) 3 specimens



The occurrence of *Navicula wagneriana* (Dall), which appears to be more abundant in the early part of the Caloosahatchee marl, was reported by Mansfield and MacNeil<sup>22</sup> to occur among fossils from the spoil bank 3 miles west-southwest of Little River, South Carolina.

## TENTATIVE CORRELATION OF THE UPPER TERTIARY DEPOSITS OF PENINSULAR FLORIDA

Table 3 shows a tentative correlation of the upper Tertiary deposits of southern and eastern Florida. The correlation of some of the deposits is not yet fully determined, and it will no doubt be necessary at some future time to make adjustments. It seems to the writer desirable, however, to present the views that are best justified by present data.

### PLEISTOCENE DEPOSITS

It is not the purpose in this paper to include all the localities in Florida at which Pleistocene faunas occur nor to discuss fully their significance and distribution in time. However, in the study of the deposits along the Caloosahatchee River and elsewhere, it was necessary to examine the fauna from each fossiliferous deposit in order to determine the epoch to which it belongs, and a record of the information obtained is offered here. In the study of the Pleistocene faunas more information is still needed to interpret fully their significance as to origin, distribution, and correlation. This may perhaps be accomplished eventually by careful differentiation of the beds along the individual rivers and canals, by following these beds as closely as is possible over their horizontal extent, and by comparing the contained faunas with the living fauna in order to interpret their ecological significance and probable origin.

*Pleistocene deposits along Caloosahatchee River between Fort Denaud and Alva.*—The species of mollusks from the Pleistocene deposits along the Caloosahatchee River between Fort Denaud and Alva have not been reported previously. During the writer's work three collections were made, of which a record is given below.

About 3 miles below Fort Denaud (station 14081), in place on the left bank of the river in a rather coarse-grained sand, occurs the fauna listed below. The river bank here is 6 to 8 feet high.

*Helisoma duryi* (Wetherby)

*Helisoma duryi intercalare* Pilsbry

*Physa* sp.

TABLE 3  
TENTATIVE CORRELATION OF THE UPPER TERTIARY DEPOSITS OF PENINSULAR FLORIDA

		WESTERN FLORIDA	OKEECHOBEE LAKE AREA AND SOUTH OF	EASTERN FLORIDA	
PLIOCENE	CALOOSAHATCHEE MARL	Beds on Myakka River (in part)			
		Bed at Bermont	Material dredged in northern area at Port Mayaca and St. Lucie Canal		
		<i>Planorbis</i> rock and probably marine sand below it	Material dredged at Ortona Lock	Upper part	Beds with DeLeon Springs fauna
		<i>Turiteella</i> -bearing bed Clayey marl (a)	and in Clewiston area	Lower part	Deposits near Nashua, at DeLand, and around Orange City
		Tamiami limestone	Tamiami limestone		
MIOCENE	UPPER	Buckingham limestone	Sand in Dade County		

(a) Reported here by Matson

*Acteocina canaliculata* (Say)  
*Marginella* sp.  
*Melongena corona* Gmelin  
*Cerithium muscarum* Say  
*Annicola?* sp.  
*Nucula* sp.  
*Pecten gibbus gibbus* Linnaeus  
*Anomia simplex* D'Orbigny  
*Laevicardium mortoni* Conrad  
*Transennella conradiana* Dall  
*Macrocallista* sp. (young specimen)  
*Parastarte triquetra* Conrad  
*Anomalocardia hendriana* Mansfield, n. sp.  
*Chione cancellata* Linnaeus  
*Cumingia tellinoides* Conrad  
*Tellina sayi* (Deshayes)

On the left bank of the River at Turkey farm, Hendry County, 2.7 miles above Floweree Grove (station 14198), a small fauna occurs. The Pleistocene sediments at this place consist mainly of sand, in all about 5 feet thick, the upper 2 feet containing more shells than the lower 3 feet. A 2-foot bed below the Pleistocene deposit is referred to the Buckingham limestone. The species found are:

*Melongena corona* Gmelin  
*Cerithium muscarium* Say  
*Parastarte triquetra* Conrad  
*Chione cancellata* Linnaeus

On the right bank of the River at Floweree Grove, Lee County, about 3 miles above Alva (station 14197), a few species of mollusks are found in a sandy matrix that rests unconformably on 4 feet of material referred to the Buckingham limestone (Miocene). The upper surface of the Buckingham has been eroded, as indicated by pockets of the Pleistocene material within the lower bed. The species found are:

*Helisoma scalare* (Jay)  
*Helisoma duryi* (Wetherby)  
*Vivipara georgiana* Lea  
*Bythinella?* sp.  
*Annicola floridana convexa* Pilsbry  
*Rissoa?* sp.  
*Cyrenoida* aff. *C. floridana* Dall  
*Chione cancellata* Linnaeus

The *Vivipara* was obtained directly above the contact, whereas the *Helisoma* came from one foot above.

No fossiliferous Pleistocene deposits were noted below Floweree

Grove, but they may be present. If the Caloosahatchee Pliocene was formerly present, it has been removed by erosion. It may be noted on figure 1 that the river takes a southwestern course a mile or more below Fort Denaud, a change that may have been caused by the former presence of shoreline deposits of the Caloosahatchee Pliocene sea.

The three localities above probably should be referred to the Fort Thompson formation.

*Pleistocene fossils of the southwestern and eastern sides of the Peninsula of Florida.*—Table 4 shows the species from a number of localities on the western and eastern sides of the Peninsula of Florida; also the extent of occurrence of the same species at two localities in South Carolina.

*Localities in southwestern Florida.*—Fossils were noted at five localities in southwestern Florida. These are:

North Creek near Osprey, Little Sarasota Bay, Manatee County. Collected by Joseph Willcox and W. H. Dall.

Station 14202, dump from a shallow ditch along highway, Naples to Fort Myers, 6 miles from Fort Myers, Lee County. Collected by W. C. Mansfield and F. S. MacNeil. Probably the same as H. G. Richards' locality no. 35.<sup>15a</sup>

Station 14160, marl pits at Charlotte County stockade, 2 miles northeast of Punta Gorda, Charlotte County. Collected by W. C. Mansfield and F. S. MacNeil.

Sections 11169, 14082, highest fossiliferous bed in bank of Caloosahatchee River one-fourth mile below the bridge at Labelle, Hendry County. Collected by W. C. Mansfield and C. W. Mumm.

Station 11166, left bank of Caloosahatchee River, about one-third mile above Labelle, Hendry County, highest bed in the exposure carrying a mixed fauna. Collected by C. W. Cooke, Stuart Mossom, and W. C. Mansfield.

A brief discussion of the fauna from each of the above localities follows.

A list of species from North Creek is given by Dall,<sup>36</sup> of which species five are said to be extinct, so far as known. Some of these species were not found by the writer and are indicated in Table 4 by "R". This fauna appears to be of late Pleistocene age.

Seventeen species were collected at station 14202, 6 miles south of Fort Myers, and others likely could be obtained. Of these, 10 or more occur at North Creek. This fauna is also of late Pleistocene age.

Around 50 species were collected from the material thrown out in digging pits near Punta Gorda (stations 14160, 14191). About 30

of these species occur, or have been reported to occur, at North Creek. However, the fauna as a whole indicates the presence during its epoch of water a little warmer than that at North Creek, and thus suggests that it probably lived at a somewhat earlier time. The horizon in the Pleistocene may be about the same or a little higher than that of the bed at Sanford discussed later in this paper.

Approximately 50 species of mollusks have been collected at station 11169, one-fourth of a mile below Labelle, and about 15 species at station 11166, one-third of a mile above Labelle. Both exposures are illustrated on plate 22, A and B, of Cooke and Mossom.<sup>20</sup> The description of illustration "B," however, is wrong, as it illustrates a Pleistocene locality instead of Pliocene. The fauna at the upper locality is definitely referred to the Fort Thompson formation by Cooke and Mossom.<sup>20</sup> The fauna at this place, where the containing bed rests unconformably upon the Pliocene is similar to that at the locality below Labelle, except that it contains many more individuals of *Helisoma scalare* (Jay) and the species *Rangia cuneata* Gray. I have not seen the latter species at the lower locality. The fauna at the locality below Labelle is probably a little younger than that of the locality above Labelle, but probably should be referred to the Fort Thompson formation.

*Localities on the eastern side of Florida.*—Four localities on the eastern side of Florida were examined. These are:

Station 14201, about 8 miles southwest of Melbourne, Brevard County. The fossiliferous bed was reported to lie below the bone bed in this area. The writer did not confirm this report. Collected by W. C. Mansfield and F. S. MacNeil.

Station 14192, Buffalo Bluff, right bank of the St. Johns River, one-half mile, more or less, above Atlantic Coast Line Railway bridge, Putnam County. Collected by W. C. Mansfield and F. S. MacNeil.

Station 14196, walls of a dredge cut on the north shore of Lake Monroe, about one-fourth of a mile east of highway bridge across the west end of the lake at the outlet of St. Johns River, Volusia County. Collected by W. C. Mansfield and F. S. MacNeil.

Station 11138, from dump of West Palm Beach Canal at 7-Mile Post out of West Palm Beach, Palm Beach County. The uppermost fossiliferous stratum is exposed 4 or 5 feet above water level. Collected by C. W. Cooke and W. C. Mansfield.

Thirty species of mollusks were collected at station 14201, 8 miles southwest of Melbourne. Nearly all of the species occur in the Fort Thompson formation.

The faunas at station 14196, Lake Monroe, and station 14192, Buffalo Bluff, will be considered together, as they are believed to represent nearly the same zone. The fauna at Buffalo Bluff suggests, however, that it might have lived at a little earlier time. About 31 species of mollusks have been collected from these two localities. On the basis of the fossils, the writer previously<sup>7</sup> referred them to the late Pliocene or early Pleistocene. The fauna is now referred to the Pleistocene and for convenience is designated the "bed at Sanford." The fauna at station 14196 is regarded as typical. The same fauna as that at station 14196 occurs in the left bank of the St. Johns River, about 5 miles northwest of Sanford. It may be noted in table 4 that the fauna is represented by a few species with many individuals. No species of *Turritella*, so far noted, is present, though the Pliocene usually has them. The following species indicate a Pleistocene age rather than Pliocene: *Anachis obesa* C. B. Adams, *Eontia ponderosa* (Say) and var., *Atrina rigida* Dillwyn, *Cardita floridana* Conrad, *Cardium muricatum* Linnaeus, *Semele proficua* Poulteney (probably only Pleistocene and Recent). This fauna appears to be early Pleistocene age and lived about the same time as that on the west side of Florida at Charlotte County stockade (station 14160). A similar fauna was obtained from material dredged in digging the canal 2 miles south of Okeechobee City.

The species from station 11138, West Palm Beach Canal are recorded in table 4. The fauna is similar to that of the Fort Thompson formation, except that some of the species indicate the presence of slightly warmer water during its deposition, which condition may be accounted for by its more southern latitude.

*Pleistocene deposits near Myrtle Beach and Little River, South Carolina.*—The occurrences of Florida Pleistocene species at two localities in South Carolina, station 13858, 2½ miles northwest of Myrtle Beach, and station 13424, 3 miles west-southwest of Little River, are recorded in table 4.

The South Carolina fauna has been referred to the Pleistocene Pamlico formation. It contains the following species not reported at Florida Pleistocene localities: *Olivella nitudula* Dillwyn, *Ilyanassa obsoleta* (Say), *Busycon caricum* Gmelin, *Argina pexata* (Say), *Donax variabilis* Say. On the other hand, the following species were not found at station 13858 nor station 13424: *Alectrion vibex* (Say), *Melongena corona* Gmelin, *Cerithium muscarum* Say, *Modulus floridanus* Conrad, *Cardium isocardia* Linnaeus, *Laevicardium mortoni* Conrad.

*Observations on a few species occurring in the Pleistocene.*—*Helisoma scalare* (Jay) probably appeared in the Pleistocene. I have not found it associated with known Pliocene faunas. *Bulla striata* Bruguière is present, at some localities abundantly. *Olivella mutica* Say is a common species in Florida. *Marginella apicina* Menke is present at most localities as are also *Fasciolaria distans* Lamarck, *Busycon pyrum* Dillwyn, and *B. perversum* Linnaeus. The following species probably appeared in the Pleistocene:—*Melongena corona* Gmelin, *Cerithium muscarum* Say, *Atrina rigida* Dillwyn, *Cardita floridana* Conrad, *Cardium muricatum* Linnaeus, and *Semele proficua* Poulteney. *Diodora alternata* (Say) occurs at a few localities. *Arca transversa* is usually present, and *Lucina floridana* is a common species. *Anomalocardia caloosana* Dall is much smaller than the form in the Pliocene. *Macrocallista nimbose* Solander, the elongate form, is much more common than *M. maculata* Linnaeus, the shorter form.

*List of Pleistocene species.*—A list of Pleistocene species from a few localities on the eastern and western sides of Peninsular Florida and also from near Myrtle Beach and Little River, South Carolina, is given on table 4.

*Tentative correlation of Pleistocene deposits.*—A tentative correlation of the Pleistocene deposits discussed in this paper is presented in table 5. The relations of some of the beds are not certainly known. For instance, the fauna near Punta Gorda (station 14160) may be younger than indicated. However, the correlations are offered as the best now available.





<i>Busycon pyrüm</i> Dillwyn	R			X		X	X	X	X	
<i>Busycon perversum</i> (Linnaeus)	R	X	X	X		X	X	X	?	
<i>Melöngena corona</i> Gmelin	X		X	X	X	X				
<i>Alectrion acuta</i> Say			X					X		X
<i>Alectrion vibex</i> (Say)	X		X	X		X			X	
<i>Columbella rusticoides</i> Heilprin				X						
<i>Anachis avara</i> Say	X									X
<i>Anachis obesa</i> C. B. Adams							X			X
<i>Mitrella lunata</i> (Say)	X			X						X
<i>Muricidea ostrearum</i> Conrad		X	X	X		X	X		?	
<i>Urosalpinx perrugatus</i> Conrad	R									
<i>Urosalpinx iampaensis</i> Conrad	R									
<i>Eupleura caudata</i> Say			X							
<i>Cymatium aquatilis</i> Reeve									X	
<i>Cerithiopsis subulata</i> Montagu							X			
<i>Pyramidella</i> , 1 or more sp.	X		X	X		X			X	
<i>Turbonilla</i> , 1 or more sp.	X		X	X		X			X	X
<i>Odostomia</i> , 1 or more sp.	X		X							X
<i>Strombus pugilis</i> Linnaeus	R								X	
<i>Scala frielei</i> Dall	X									
<i>Cerithium muscarum</i> Say	X	X		X	X	X			A	
<i>Cerithium algicolum</i> C. B. Adams									X	
<i>Modulus floridanus</i> Conrad				X		X			X	
<i>Caecum regulare</i> Carpenter									X	
<i>Rissoina chesnelii</i> Michaud			X	X					X	
<i>Rissoina laevigata</i> (C. B. Adams)									X	
<i>Rissoa</i> ( <i>Onoba</i> ) <i>callistrophia</i> Dall var.	X									
<i>Crepidula convexa</i> Say	X			X			X	X	X	
<i>Crepidula plana</i> Say	X			X			X			
<i>Polinices duplicatus</i> Say	X		X							X
<i>Natica canrena</i> (Linnaeus)									X	
<i>Diodora alternata</i> (Say)			X				X	X	X	
<i>Tectonatica pusilla</i> (Say)	X									?
<i>Teinostoma crytospira</i> Verrill	X									
<i>Nucula proxima</i> Say			X							
<i>Nuculana acuta</i> (Conrad)			X							

TABLE 4—LIST OF PLEISTOCENE SPECIES—(Continued)

	FLORIDA									SOUTH CAROLINA
	WESTERN SIDE					EASTERN SIDE				
	North Creek	14202, 6 miles south of Fort Myers	14160, 14191, 2 miles northeast of Punta Gorda	11169, 14082, ¼ mile below Labelle	11166, 1/3 mile above Labelle	14201, 8 miles southwest of Melbourne	14192, Buffalo Bluff	14196, Lake Monroe	11138, West Palm Beach Canal	
<i>Glycymeris pectinata</i> Gmelin		X								
<i>Arca secticostata</i> Reeve	R									
<i>Arca transversa</i> Say	X	X	X	X		X	X	X	1 spec.	X
<i>Eontia ponderosa</i> (Say)			X							X
<i>Eontia ponderosa</i> (Say) var.							X			
<i>Atrina rigida</i> Dillwyn							X	X		
<i>Ostrea virginica</i> Gmelin	X						X			X
<i>Ostrea</i> gr. <i>O. equestris</i> Say							X	X		
<i>Pecten</i> ( <i>Chlamys</i> ) <i>gibbus</i> Linnaeus	X	X	X				X		X	X
<i>Anomia simplex</i> D'Orbigny			X	X		X	X	X		X
<i>Modiolaria lateralis</i> Say			X							
<i>Mytilus exustus</i> Lamarck				?		X			X	
<i>Modiolus demissus</i> Dillwyn	R									
<i>Polymesoda</i> sp.				X						
<i>Plicatula gibbosa</i> Lamarck			X							
<i>Cardita floridana</i> Conrad	X	X	X	X	X	X	X		X	
<i>Cardita dominguensis</i> D'Orbigny	R									
<i>Phacoides multilineatus</i> Tuomey and Holmes	X		X	X				X		X
<i>Phacoides amiantus</i> Dall			X						X	
<i>Phacoides nassulus</i> Conrad	X		X							
<i>Phacoides pennsylvanicus</i> Linnaeus									X	
<i>Phacoides pectinatus</i> Gmelin	R									
<i>Phacoides muricatus</i> Spengler	R									
<i>Phacoides radians</i> Conrad				X						X

<i>Lucina chrysostoma</i> (Meuschen)									X	
<i>Lucina floridana</i> Conrad	X	A	X	X	X	A			A	
<i>Codakia orbicularis</i> Conrad				?					X	
<i>Sportella constricta</i> Conrad	R									
<i>Sportella protexta</i> Conrad				X						
<i>Diplodonta</i> aff. <i>D. caloosaensis</i> Dall									X	
<i>Divaricella quadrisulcata</i> D'Orbigny									X	X
<i>Cardium muricatum</i> Linnaeus							X	X		X
<i>Cardium robustum</i> Solander	X	X	X	X		X	X			X
<i>Cardium isocardia</i> Linnaeus	X	X	X	X		X		X	A	
<i>Laevicardium mortoni</i> Conrad	X	X		X		X		X	X	
<i>Dosinia elegans</i> Conrad	X			X				X	X	
<i>Dosinia discus</i> Reeve	X		X			X				X
<i>Anomalocardia caloosana</i> Dall	X		X	X	X	X				
<i>Anomalocardia cuneimeris</i> Conrad									X	
<i>Transennella conradiana</i> Dall	X	X	X	X	X	X			X	
<i>Callocardia</i> cf. <i>C. sayana</i> Dall		X	X	X				X	X	
<i>Parastarte triquetra</i> Conrad	X		A	X	X	X			A	
<i>Gemma gemma purpurea</i> Lea	X									?
<i>Macrocallista nimbosa</i> Solander	X	X	X	X		A			X	
<i>Chione cancellata</i> Linnaeus	X	X	X	X	X	X	X	X	X	X
<i>Venus campechiensis</i> Gmelin	R		X	X			X	X		1 spec.
<i>Tellina alternata</i> Say			X	X	X					
<i>Tellina sayi</i> (Deshayes)			X	X		X	X		X	?
<i>Angulus versicolor</i> Cozzens	X									
<i>Tellina similis</i> Sowerby									X	
<i>Tellina mera</i> Say									X	
<i>Tellina suberis</i> Dall									X	
<i>Angulus sybariticus</i> Dall	R									
<i>Semele proficua</i> Poulteney			X				X	X		X
<i>Tellidora cristata</i> Recluz			X							
<i>Tagelus divisus</i> Spengler	X		X	X		X	X	X	X	X
<i>Spisula fragilis</i> Gmelin						X		X		
<i>Mulinia lateralis</i> Say								X		X

TABLE 4—LIST OF PLEISTOCENE SPECIES—(Continued)

	FLORIDA									SOUTH CAROLINA
	WESTERN SIDE					EASTERN SIDE				
	North Creek	14202, 6 miles south of Fort Myers	14160, 14191, 2 miles northeast of Punta Gorda	11169, 14082, ¼ mile below Labelle	11166, 1/3 mile above Labelle	14201, 8 miles southwest of Melbourne	14192, Buffalo Bluff	14196, Lake Monroe	11138, West Beach Canal	
<i>Mulinia lateralis corbuloides</i> Reeve .....	X		X							
<i>Ervilia concentrica</i> Gould .....	X									X
<i>Corbula barrattiana</i> C. B. Adams .....			X			X	X			
<i>Rangia cuneata</i> Gray .....					X					
<i>Barnea (Scobina) costata</i> (Linnaeus) .....			X							X
<i>Anatina canaliculata</i> Say .....	X		X							X
<i>Dentalium</i> sp. ....			X							
<i>Acanthochites spiculosus</i> Reeve .....	R									

A. Abundant

X. Occurrence

R. Not seen, cited fide Dall

TABLE 5.—TENTATIVE CORRELATION OF THE PLEISTOCENE DEPOSITS

FLORIDA			SOUTH CAROLINA
	WEST SIDE	EAST SIDE	
Pamlico formation and equivalent beds	Beds on North Creek; Beds exposed 6 miles south of Fort Myers (station 14202); probably contemporaneous.		Myrtle Beach (station 13858) and Little River (station 13424).
Fort Thompson formation	Beds exposed below and above Labelle and between Fort Denaud and Alva; beds exposed below Labelle may be younger than those above.	Beds exposed 8 miles southwest of Melbourne (station 14201) and along West Palm Beach Canal (station 11138).	
Bed at Sanford	Exposures 2 miles northeast of Punta Gorda (station 14160).	Beds exposed near Lake Monroe typical bed of Sanford (station 14196); Buffalo Bluff (station 14192); probably nearly contemporaneous.	

## DESCRIPTIONS AND DISCUSSIONS OF UPPER TERTIARY SPECIES, ESPECIALLY OF THE BUCKINGHAM LIMESTONE, AND OF PLEISTOCENE SPECIES OF FLORIDA

### **CANCELLARIA (CANCELLARIA) of. C. TABULATA Gardner and Aldrich**

Plate 1, figure 11

The material consists of an incomplete external mold showing only the upper part of the original shell.

*Horizon and occurrence.*—Buckingham limestone, station 14184, lower bed, right bank of the Caloosahatchee River, about 3 miles above Alva.

*Cancellaria tabulata* is restricted to the upper Miocene.

### **CANCELLARIA (CANCELLARIA?) aff. C. VENUSTA Tuomey and Holmes**

The material consists of an internal mold and an incomplete external mold. The external mold is larger than that of *Cancellaria venusta*, a Pliocene species, and in that feature may indicate a closer relationship to *C. propevenusta* Mansfield, an upper Miocene species.

*Occurrence.*—Buckingham limestone, station 14184, lower bed in right bank of Caloosahatchee River, about 3 miles above Alva.

### **DORSANUM? of. D. ? PLICATILUM (Böse)**

Plate 1, figure 4

*Dorsanum? plicatillum* (Böse) is believed to occur in beds not younger than upper Miocene. The material consists of an incomplete external mold.

*Horizon and occurrence.*—Buckingham limestone, station 13927, Buckingham.

### **TURRITELLA aff. T. CARTAGENENSIS Pilsbry and Brown**

Plate 1, figures 2, 12

*Turritella cartagenensis* Pilsbry and Brown<sup>11a</sup> came from the neighborhood of Cartagena, Colombia, South America. The specimens at hand may have coarser sculpture than *T. cartagenensis*, but evidently they show some relationship to it. The spiral sculpture consists of fine lines alternating with secondary threads.

*Horizon and occurrence.*—Buckingham limestone, station 14078, in place, one-half mile above Alva; station 14184, in place, right bank of Caloosahatchee River across from Floweree Grove, about three miles above Alva; station 14194, dredged from the Caloosahatchee River 200 yards, more or less, above Olga bridge; station 14075, dredgings from Caloosahatchee River, one mile below Olga.

**TURRITELLA** cf. **T. PONTONI** Mansfield

Plate 1, figures 3, 8

*Turritella pontoni* Mansfield<sup>na</sup> was described from a sand of upper Miocene age at a locality 42 miles west of Miami, Florida. The material consists of rather poorly preserved large specimens. A carina is present on the lower third of each whorl and the whorl is less depressed medially than the specimen referred to *T. aff. T. cartagenensis* Pilsbry and Brown.

*Horizon and occurrence.*—Buckingham limestone; quite common at Buckingham; station 14075, dredged from the Caloosahatchee River, one mile below Olga.

**TURRITELLA BUCKINGHAMENSIS** Mansfield, n. sp.

Plate 1, figure 1

Shell large, moderately slender, and strongly sculptured spirally. The sculpture consists of 5 primary nodulated spirals. The upper two spirals and the one above the basal spiral are of about equal strength and stronger than the others; the medial one, which lies at the constriction of the whorl, and the basal one are also of about the same strength. A secondary spiral lies between the posterior two and the medial one. The species is described from a silicified anterior end of a shell.

Holotype (U. S. Nat. Mus. No. 497966) measures: length of fragment, 40 millimeters; diameter, 17 millimeters.

*Type locality.*—Station 11175, Buckingham, Lee County, Florida.

*Horizon and occurrence.*—Buckingham limestone, upper Miocene; fairly common at type locality; station 11742, Alva, Caloosahatchee River, in place in the river bank; poorly preserved molds but probably belong to this species; station 14075, dredged from Caloosahatchee River, one mile below Olga; station 14184, lower bed across from Floweree Grove, about three miles above Alva; station 14190, dredged from Caloosahatchee River, about half a mile above Olga bridge.

The new species is related to *Turritella burdeni* Tuomey and Holmes from the Duplin marl and to *T. apicalis tensa* Dall, reported as a Pliocene Caloosahatchee species. In size it more closely resembles the upper Miocene species. The figured holotype of *Turritella apicalis tensa*, (Cat. No. 113461) is unlike other specimens in the Pliocene Caloosahatchee marl and may have come from a somewhat lower horizon. It is reported to occur on Caloosahatchee River, but no place on the river is given. The specimens from station 14184, across the river from Floweree Grove, are more closely related to *T. apicalis tensa*, but in the new species the medial constriction is deeper.

**TURRITELLA APICALIS** Heilprin

Plate 1, figures 9, 10

*Turritella apicalis* Heilprin occurs abundantly in the Pliocene along Caloosahatchee River and at Shell Creek.

A number of specimens of *Turritella apicalis* Heilprin were dredged from the Caloosahatchee River a quarter to a half mile (stations 14194 and 14190) above Olga. The matrix in which the external molds occur consists of a dark gray, porous limestone having a few molds of *Chione ulocyma*.

The occurrence of this *Turritella* strongly indicates a Pliocene fauna associated with reworked upper Miocene species.

**NUCULANA, sp. indeterminate**

The material consists of internal molds. The molds represent larger shells than species referred to *Nuculana acuta* Conrad from the Pliocene Caloosahatchee. The preservation of the material does not warrant specific determination, but apparently only one species is represented.

*Horizon and occurrence.*—Buckingham limestone, station 11792, exposed at low tide at Alva, Caloosahatchee River; station 13927, Buckingham; station 14184, across the Caloosahatchee River from Floweree Grove; station 14078, in place in bank of Caloosahatchee River half a mile above Alva.

**NAVICULA OCCIDENTALIS** Philippi?

The material consists of one poorly preserved internal mold whose specific determination is questionable.

*Horizon and occurrence.*—Buckingham limestone; station 13927, Buckingham.

**NAVICULA UMBONATA** Lamarck?

The material consists of four internal molds of soft argillaceous limestone with phosphatic grains.

*Horizon and occurrence.*—Buckingham limestone; station 11742, exposed at low tide in bank of Caloosahatchee River at Alva.

**ARCA LIENOSA** Say

*Arca lienosa* Say ranges in time from upper Miocene to the Pliocene.

*Horizon and occurrence.*—Buckingham limestone; station 13927, Buckingham; station 14184, lower bed in the section on Caloosahatchee River across from Floweree Grove; station 14190, dredged from Caloosahatchee River half a mile above bridge at Alva.



**ARCA (CUNEARCA) SCALARIS** Conrad, variety?

Plate 3, figure 6

*Arca (Cunearca) scalaris* Conrad is believed to occur in beds not younger than upper Miocene.

The material consists of internal and external molds. All the molds represent a much smaller shell than *Arca (Cunearca) scalarina* Heilprin, a Pliocene species. The form appears to be the same as that occurring in an upper Miocene sand along the Tamiami Trail at a locality 42 miles west of Miami, listed by Mansfield.<sup>9b</sup>

*Horizon and occurrence.*—Buckingham limestone; station 13927, Buckingham; station 14184, lowest bed exposed in right bank of Caloosahatchee River across from Floweree Grove; station 14078, right bank of Caloosahatchee River half a mile above Alva; station 11742, exposed at low tide at Alva; station 14075, dredged from the Caloosahatchee River one mile below Olga.

**ARCA DELANDENSIS** Mansfield, n. sp.

Plate 4, figures 4, 8

Shell thin, elongate, rather low, nearly equivalve, inequilateral; posterior end slightly more expanded than anterior end. Beaks low, medially depressed, and situated at about the anterior third of hinge line. Ribs 35 to 37, including 2 finer ribs adjacent to the anterior margin, slightly wider than interspaces, nearly flat on right valve and slightly rounded on left valve, and weakly crenulated on anterior side. Cardinal area narrow, marked by 2 angular grooves which meet under the beak. Hinge line nearly straight. Base widely rounded.

Cotypes (U. S. Nat. Mus. No. 352281) measure: Right valve, length 31 millimeters; height, 20 millimeters; diameter, 8 millimeters. Left valve, length 27 millimeters; height, 18 millimeters; diameter, 8 millimeters.

*Type locality.*—DeLand, Volusia County, Florida.

*Horizon.*—Pliocene, Caloosahatchee marl.

*Other occurrences.*—Florida: Sta. 5010, DeLeon Springs (1 valve); ?Sta. 5019, Orange City, North Carolina: Sta. 3931, Cronley; Sta. 13156, Walkers Bluff, Cape Fear River (this form appears closer to the new species than to *A. plicatura* Conrad).

*Arca delandensis* has been referred previously to *A. transversa* Say, a Pleistocene and Recent species. It differs from the latter, however, in having a thinner and lighter shell, a less expanded posterior end, a more rounded base line, a longer hinge line, and a less anterior beak. The thinness of the shell of the new species

approaches that of specimens from Simmons Bluff, S. C., a Pleistocene species referred to *A. transversa*.

*A. "subsinnata"* Conrad, *A. plicatura* Conrad, and *A. delandensis* n. sp., all from the Pliocene, are closely related. A comparison of these species indicates that *A. subsinnata* is usually larger and more elongate; *A. plicatura* shorter and more rounded with a rather high beak; and *A. delandensis* thinner with a rather low beak. However, at some localities, the forms appear to intergrade and it is uncertain where to place them.

#### **OSTREA MERIDIONALIS Heilprin**

*Ostrea meridionalis* Heilprin, Trans. Wagner Free Inst. Sci., Philadelphia, vol. 1, pp. 100, 101, figs. 35, 35a, 1887.

The type locality of *Ostrea meridionalis* Heilprin is believed to be in the "marl" banks below Thorpe's, probably somewhere above or below Alva. Dall<sup>30</sup> considered *O. meridionalis* a synonym of *O. sculpturata* Conrad. I am unable to decide to which of these species some of the small specimens should be assigned. *Ostrea meridionalis* is a very large and heavy shell and resembles *O. haitensis* Sowerby, and for that reason has been, in some instances, mistaken for it.

*Horizon and occurrence.*—Buckingham limestone; station 13927, Buckingham; also along the Caloosahatchee River at the following places:—station 4997, in place about 1 mile above Caloosa; station 11742, exposed at low tide at Alva; station 11173, in place about 2.8 miles east of Alva; station 13928, dredged half a mile below Alva.

#### **OSTREA DISPARILIS Conrad**

*Ostrea disparilis* Conrad, in localities outside of Florida, is believed not to occur above the upper Miocene.

*Horizon and occurrence.*—Buckingham limestone; station 13927, Buckingham. The following localities are along the Caloosahatchee River: station 14076, one mile above Olga (dredged); station 14077, two miles above Olga (dredged); station 14075 (dredged), one mile below Olga; station 13928, a half mile below Alva (dredged); station 14078, half a mile above Alva (in place).

#### **PECTEN (PECTEN) OCHLOKOMBËNSIS LEËNSIS Mansfield, n. subsp.**

Plate 2, figures 3; Plate 4, figure 9.

Left concave valve rather deeply concave throughout except for the lateral margins, which are bevelled. Ears large, equal, bent backward in harmony with the convexity of the disk; marked by one incised radial, and crossed by closely spaced lamellae. Submargins

rounded and without radials. Ribs 13 to 16 (15 on the cotype) in number, all lying in the concavity, nearly flat over the early and middle part of the disk and very gently concave distally, with flat interspaces twice as wide as the ribs. Whole surface marked by very closely spaced concentric lamellae.

Right convex valve not entire, evenly rounded. Ears bent downward, marked only by growth structures. Disk with about 19 nearly flat, smooth ribs, (the three on the lateral side being weaker), distally widening, separated by narrower spaces.

Cotypes (U. S. Nat. Mus. No. 497982) measure: Left valve, length 63 millimeters; height, 56 millimeters. Right valve, height 44 millimeters; convexity about 12 millimeters.

*Type locality*.—Station 13927, Buckingham, Lee County, Florida.

The new subspecies is closely related to *Pecten (Pecten) ochlockoneënsis* Mansfield from the upper Miocene of Florida. The left valve of the new subspecies has a deeper convexity than the species, and the right valve has wider ribs, which show a little less tendency to bifurcation. The concentric lamellae on the new subspecies are also finer.

*Horizon and occurrence*.—Buckingham limestone, upper Miocene. Abundant at type locality; Station 14075, dredged from Caloosahatchee River one mile below Olga. The specimen from the following stations are related but may not be the same. Station 13409, 16 to 18 miles south of Immokalee, Collier County (2 left valves, less concave); Station 12923, 18 miles south of Immokalee (1 left valve less compressed); Station 11180, Tamiami Trail at Carnestown, Collier County (fragment); Station 11176, about 11 miles east by north of Marco, Collier County (fragment).

**PECTEN (PECTEN?) WENDELLI OLGENSIS** Mansfield, n. subsp.

Plate 2, figures 1, 2, 4

Shell small, low, nearly equivalve and equilateral. Ears large, the right being deeply sinuate. Right valve with 15 rounded, roughened ribs of nearly uniform size; left valve slightly higher in the umbonal area than right valve, with 14 rounded ribs; two weaker ribs alternate with a single stronger rib.

Holotype with attached valves (U. S. Nat. Mus. No. 497970) measures: length, 22 millimeters; height, 22 millimeters; diameter, 7.4 millimeters.

*Type locality*.—Station 14077, dredged from the Caloosahatchee River, 2 miles above Olga.

*Horizon and occurrence.*—Pliocene?; station 14076, dredged one mile above Olga and station 14194 a quarter of a mile above Olga.

The new subspecies is closely allied to *Pecten wendelli* Tucker from the Pliocene Caloosahatchee marl at Fort Denaud and at Shell Creek, but is larger than the latter species and has more rounded ribs. The right valve of *P. wendelli* has sharper primary ribs, which are usually intercalated with a finer rib, whereas the left valve usually has three instead of two weaker ribs between a stronger rib on either side.

Both *Pecten wendelli* and the new subspecies differ from *P. leonensis* Mansfield, a known Miocene species, in having a less inflated right valve and a higher left valve and in the character of the radials. The new subspecies appears to intergrade the known Miocene and Pliocene species.

The original of figure 8, plate 4 of "Tucker" probably should be referred to *Pecten wendelli* and not to *P. leonensis*, and her figure 9, plate 4 appears to be incorrectly identified. The illustration of this form indicates that it may be closely related to the new subspecies *P. wendelli olgensis*.

One small right valve collected at Walkers Bluff,\* Cape Fear River (station 13156) appears also to be more closely related to the new subspecies *olgensis* than to *Pecten leonensis*. The matrix adhering to the new subspecies consists of a limy clay and phosphatic grains. This group may be nearer the subgenus *Chlamys* than the subgenus *Pecten*.

**PECTEN (CHLAMYS) CALOSENSIS** Mansfield, n. sp.

Plate 3, figures 1, 3

*Chlamys (Plagiocentrum) comparilis* (Tuomey and Holmes) [part], Tucker-Rowland, Mus. royale historie nat. Belgique Mém., Deuxième série, fasc. 13, p. 43, pl. 4, fig. 14 [not pl. 3, fig. 11]. 1938.

Shell rather small, suborbicular, nearly equivalve and slightly inequilateral; posterior region more produced. Both valves with about 20 high, narrow, flat-topped, squarish ribs, separated by spaces a little wider than the ribs. Ears rather large, marked by 4 to 5 faint radials. Submargins without radials. Concentric sculpture of fine, closely spaced lamellae.

Cotypes (U. S. Nat. Mus. No. 479979) measure: Right valve, length 48 millimeters; height, 49 millimeters; diameter, 15 millimeters. Left valve, length 47 millimeters; height, 47 millimeters; diameter, 14 millimeters.

*Type locality.*—Station 14075, dredged from Caloosahatchee River, 1 mile below Olga.

*Horizon and occurrence.*—Buckingham limestone, upper Miocene.

Section 13927, Buckingham, Lee County; station 13928, dredged from Caloosahatchee River a half mile below Alva; station 14077, 2 miles above Olga; station 14076, 1 mile above Olga; station 4997, in place 1 mile above Caloosa.

This species is related to *Pecten comparilis* Tuomey and Holmes, a known Miocene species, differing from the latter in having 2 or 3 fewer ribs and sculptured with finer concentric lamellae. It differs from *P. evergladensis* Mansfield in having a less expanded shell and narrower and higher ribs.

The new species from the Buckingham limestone at Buckingham and elsewhere, as noted above, is somewhat similar to but not identical with specimens from South Carolina that I consider typical of "*Chlamys (Plagiocentrum) comparilis* (Tuomey and Holmes)."

Tucker-Rowland<sup>10</sup> designated a left valve from Buckingham, Fla., as the neoholotype of "*Chlamys (Plagiocentrum) comparilis* (Tuomey and Holmes)."

The present practice is to select a neoholotype from the original locality of the species, and it would conform more nearly with the rules of zoological nomenclature to select a specimen from South Carolina rather than from Florida. Therefore, I designate a right valve in the U. S. National Museum under the Catalogue No. 11447 from South Carolina identified by R. P. Whitfield as "*Pecten comparilis* Tuomey and Holmes." The matrix on this specimen is the same as on other fossils from "Smiths Goose Creek," Berkeley County, S. Car. Although no specific locality is recorded for the specimen by Tuomey and Holmes it probably came from the Goose Creek locality. It agrees in detail with the original illustration of a right valve of Tuomey and Holmes species.

**PECTEN (CHLAMYS) EBOREUS BUCKINGHAMENSIS** Mansfield, n. subsp.

Plate 3, figures 4, 5, 8

Shell rather large, moderately inflated, nearly equivalve and nearly equilateral. Left valve weakly depressed in its posterior area. Ribs about 18 in number on each valve, nearly flat or very slightly rounded, smooth except for moderately coarse concentric growth lines, rather wide—about as wide as interspaces. Ears with faint radials crossed by fine, closely spaced lamellae.

Holotype, attached valves, (U. S. Nat. Mus. no. 497972) measures: Length, 90 millimeters; height, 84 millimeters; diameter, 25 millimeters.

*Type locality*.—Station 13927, Buckingham, Lee County, Florida. Some topotypes are larger than the holotype. This subspecies

differs from *Pecten (Chlamys) eboreus solaroides* Heilprin in lacking interradials, which are present especially on the left valve of the Pliocene species.

*Horizon and occurrence.*—Buckingham limestone, upper Miocene; type locality (abundant); station 11742, Alva, in place; station 4996, 2 miles above Caloosa, in place; station 13928, dredged half a mile below Alva; station 14078, half a mile above Alva, in place; station 14077, dredged 2 miles above Olga; station 14075, dredged 1 mile below Olga; station 14184, right bank of Caloosahatchee River, lower bed, across from Floweree Grove, about 3 miles above Alva.

**PECTEN (NODIPECTEN) NODOSUS FLORIDENSIS Tucker and Wilson**

*Pecten (Lyropecten) pittieri floridensis* Tucker and Wilson, Bull. Am. Paleontology, vol. 18, p. 43, pl. 8, fig. 6, 1932.

*Type locality.*—Buckingham, Florida.

A number of specimens were collected by the writer and F. S. MacNeil from the type locality. The subspecies *floridensis* appears to be more closely related to *Pecten (Nodipecten) nodosus* Linnaeus than to *Pecten pittieri* Dall. The ribs are wider, more quadrate in section, and usually less nodose than on *P. nodosus*, but some left valves show quite strong nodes on the ribs.

*Pecten (Nodipecten) pittieri collierensis* Mansfield from the Tamiami limestone is more closely related to *P. pittieri* than to *P. nodosus*.

*Horizon and occurrence.*—Buckingham limestone; Buckingham station 14075, dredged from the Caloosahatchee River, one mile below Olga, fragment which may be the subspecies *floridensis*.

**LIMA (MANTELLUM) CAROLINENSIS Dall**

Plate 2, figure 6

*Lima (Mantellum) carolinensis* Dall occurs in the Duplin marl of the Carolinas and in the *Cancellaria* zone of Florida, both of upper Miocene age.

*Horizon and occurrence.*—Buckingham limestone, station 13927, Buckingham, Florida (two valves).

**ANOMIA SIMPLEX D'Orbigny**

*Anomia simplex* D'Orbigny occurs in deposits ranging from the upper Miocene to the Recent.

*Horizon and occurrence.*—Buckingham limestone, Buckingham, Florida, and at a number of localities along the Caloosahatchee River referred to the Buckingham limestone.

**PLACUNANOMIA PLICATA** Tuomey and Holmes

Plate 3, figure 9, 10

*Placunanomia plicata* Tuomey and Holmes occurs in the upper Miocene in the Carolinas and in Florida.

*Horizon and occurrence.*—Buckingham limestone, station 14194, dredgings from Caloosahatchee River, 200 yards more or less above Olga bridge, Lee County, Florida. Only one specimen with attached valves was collected. The matrix consists of a light-colored limestone containing impressions of *Chione ulocyma* Dall.

Tucker and Wilson<sup>19n</sup> described a new species of *Placunanomia*, *P. acclinica*, from Acline, Florida. As there are at least two different horizons of fossiliferous deposits in the vicinity of Acline, the exact horizon of their species is unknown. The plications on the figured valve of Tucker and Wilson indicate that it is closely related to *P. plicata* Tuomey and Holmes.

**PODODESMUS BURNSI** Mansfield, n. sp.

Plate 4, figures 1, 3, 5, 6

Shell large, thick, elongate-ovate, subequilateral and equivalve. The right valve being weakly inflated and the left weakly concave medially. Exterior of valves not plicated but marked by faint radials on the middle part of the valves, these radials becoming very obscure distally. The left valve has stronger radials than the right. Byssal scar on right valve large; byssal area on left valve nearly flat and marked with faint radials which are bounded below by a strong knob. Auricular crura on right valve large, elongate, weakly curved, and medially sulcated; byssal and adductor scars large.

Holotype (U. S. Nat. Mus. no. 164569) measures: right valve, length, 69 millimeters (lower margin broken); height, 94 millimeters; left valve, length 69 millimeters; height 73 millimeters.

*Type locality.*—Station 3300, Shell Creek, Florida.

*Horizon.*—Probably Pliocene.

I have not seen this species outside of its type locality. *Pododesmus decipiens* Philippi, a living species, is much smaller and has finer radial sculpture. The species is named after the collector, Frank Burns.

**THRACIA (CYATHODONTA) sp.**

Two incomplete impressions of the interior of the original shells were collected from dumps dredged from the Caloosahatchee River, one from a small island half a mile above the bridge at Olga (station 14190), and the other one mile below Olga (station 14075). The

matrices of both are the same and contain exterior molds of *Chione ulocyma* Dall. The unnamed form may be related to *Thracia* (*Cyathodonta*) *gatumensis* Toula, from the Gatun formation of the Panama Canal zone, but it had a much larger shell than Toula's species. This may be an undescribed form.

*Horizon*.—Buckingham limestone.

**VENERICARDIA OLGA** Mansfield, n. sp.

Plate 2, figure 5; Plate 3, figures 2, 7

Shell solid, robust, obliquely oblong, of moderate size, equivalve and inequilateral. Beaks full, high and strongly prosogyrate. Ribs on right valve of cotype 17 in number, strong, elevated, weakly undercut, a little wider than the interspaces and strongly transversely nodulated; the fourth rib counting from the dorsal margin on the posterior side is weaker than the others and lies close to the posterior one. Left valve of cotype immature, ornamented with 18 ribs; the third and fourth, counting from the dorsal margin, are closely spaced, and the rib in front of it is a little weaker than the others; the other ribs over the disk are of the same strength.

Dimensions of cotypes (U. S. Nat. Mus. no. 497976).—Right valve, length 43 millimeters; height, 39 millimeters; diameter 24 millimeters; left valve, posterior margin broken away; height, 28 millimeters; diameter, 15 millimeters.

*Type locality*.—Station 14075, dredged from Caloosahatchee River, one mile below Olga, Florida.

*Horizon*.—Probably Pliocene.

Altogether six valves were collected, of which five indicate that they were taken from a sand and the other from an indurated limestone similar to that on another piece from this place having a *Chione cancellata* on it.

*Venericardia olga* n. sp. is related both to *Venericardia hadra* Dall, a species from the Chipola formation, and *V. himerta* Dall, a species from the Oak Grove sand, but differs from both of these species in having wider and stronger ribs, especially over the earlier part of the shell. The new species somewhat resembles a varietal form of *V. laticostata* Sowerby, a living species from Panama, but the posterior side is less truncate and the ribs are higher than those of the varietal form of *laticostata*.



**PHACOIDES CHRYSOSTOMA (Meuschen) Philippi**

*Phacoides chrysostoma* (Meuschen) ranges in time from Miocene to the Recent.

*Horizon and occurrence.*—Buckingham limestone; station 11175, Buckingham. There are a few distorted internal molds from Buckingham which are more elongate than others, but probably represent the same species.

**ANOMALOCARDIA HENDRIANA Mansfield, n. sp.**

Plate 1, figures 5, 6, 7

Shell small, thin, low elongate, equivalve and very inequilateral. Anterior margin broadly rounded, posterior margin short and narrowly rounded. Disk gently depressed radially in front of the posterior shoulder, being more so distally. Umbo smooth, followed by closely spaced, thin, nearly erect concentric lamellae. Distally these lamellae are less closely but rather uniformly spaced. These lamellae are subdued in the depressed area in front of the rounded posterior shoulder and intercalated by fine concentric threads over this shoulder. Inner margin finely crenulate:

Holotype, left valve (U. S. Nat. Mus. No. 497980) measures: Length, 15 millimeters; height, 10 millimeters; diameter, 2 millimeters.

*Type locality.*—Station 14081, left bank of Caloosahatchee River, about 3 miles below Fort Denaud, Hendry County, Florida.

*Horizon.*—Pleistocene, Fort Thompson(?) formation.

The sculpture on *Anomalocardia hendriana*, n. sp. somewhat resembles that on *A. leptalea* Dall, a species inhabiting salt lagoons in the Bahamas, but in Dall's species the concentric sculpture is less closely spaced, and the posterior end has a different shape.

The new species has a thinner shell, finer sculpture, and a lower shell than the species occurring in place in the Pleistocene (Fort Thompson formation) one-third mile above Labelle (station 11166) or one-eighth of a mile below Labelle (station 11169).

Other occurrence: Station 11028, from bank of the canal one-fourth mile above Goodno's Landing at Fort Thompson.

**CHIONE CANCELLATA Linnaeus**

*Chione cancellata* Linnaeus ranges from the Pliocene to the Recent.

Four valves of *Chione cancellata* were collected at Buckingham, Florida, but the matrix adhering to these specimens consists of a coarse sand, a matrix unlike that with other specimens from the main

part of the quarry. Consequently, these *Chione* came from the Pliocene or a later epoch. No specimens of *Chione cancellata* were collected (only *C. ulocyma* Dall) at station 14184, in place, on the right bank of the Caloosahatchee River, across from Floweree Grove, a fauna referred to the Buckingham limestone. *Chione cancellata* and *C. ulocyma* Dall were dredged from the Caloosahatchee River about half a mile above Olga (station 14190), the former probably from the Pliocene and the latter from Buckingham limestone.

**CHIONE ULOCYMA Dall**

Plate 4, figures 2, 7

*Chione ulocyma* Dall occurs in deposits not younger than the upper Miocene.

*Horizon and occurrence.*—Buckingham limestone, station 13927, Buckingham; quite common; station 14184, in place, in bank of Caloosahatchee River across from Floweree Grove, quite common; station 11742, exposed at low tide at Alva; station 14190, dredged from Caloosahatchee River half a mile above Olga (station 14190), and one mile below Olga (station 14075).

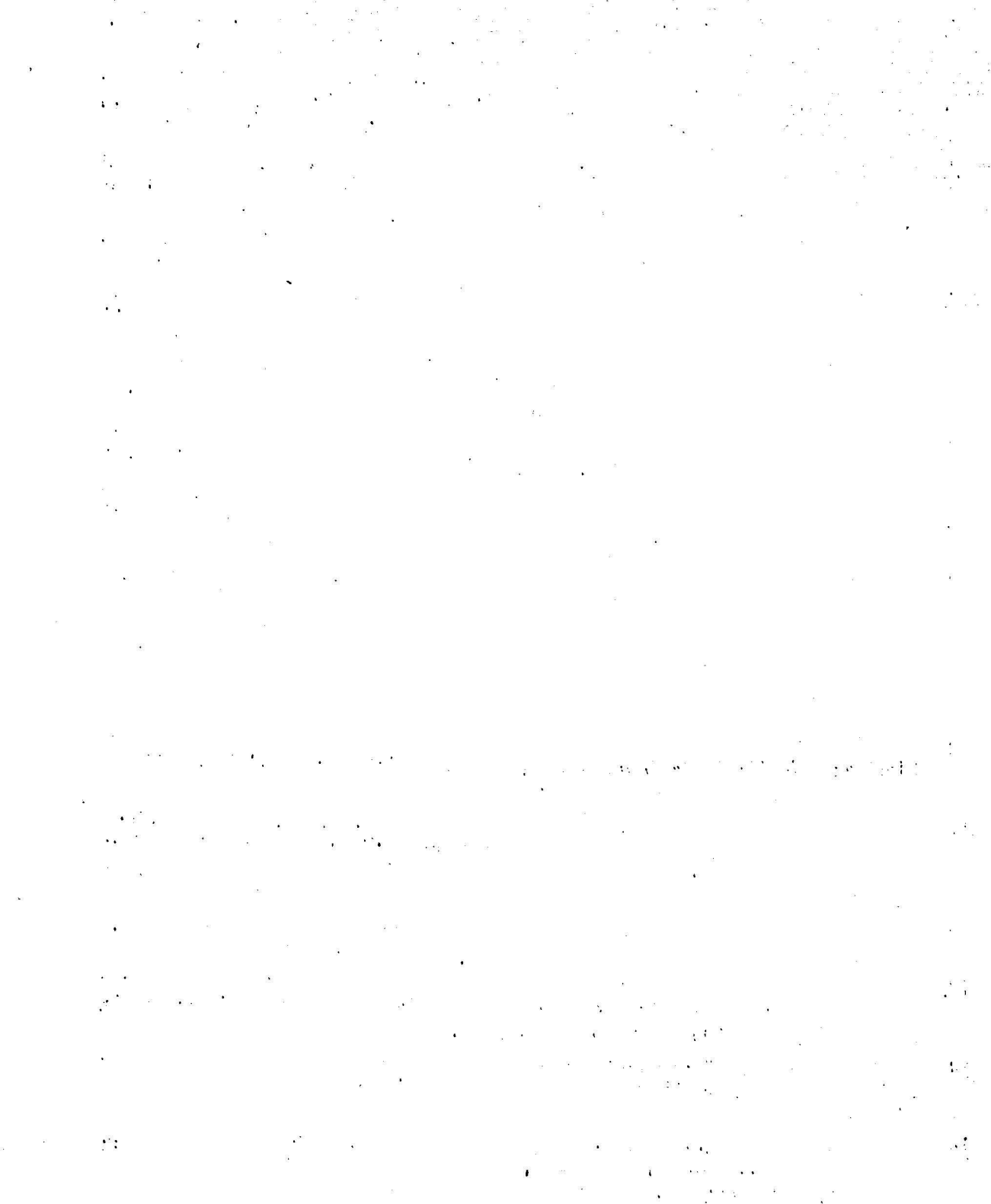
**CHIONE LATILIRATA ATHLETA Conrad**

*Chione latilirata athleta* Conrad ranges from the upper Miocene to the Recent.

*Horizon and occurrence.*—Buckingham limestone, station 14184, Caloosahatchee River, across from Floweree Grove (1 fragment); Buckingham limestone?, station 14194, dredged from Caloosahatchee River, 200 yards more or less above Olga.

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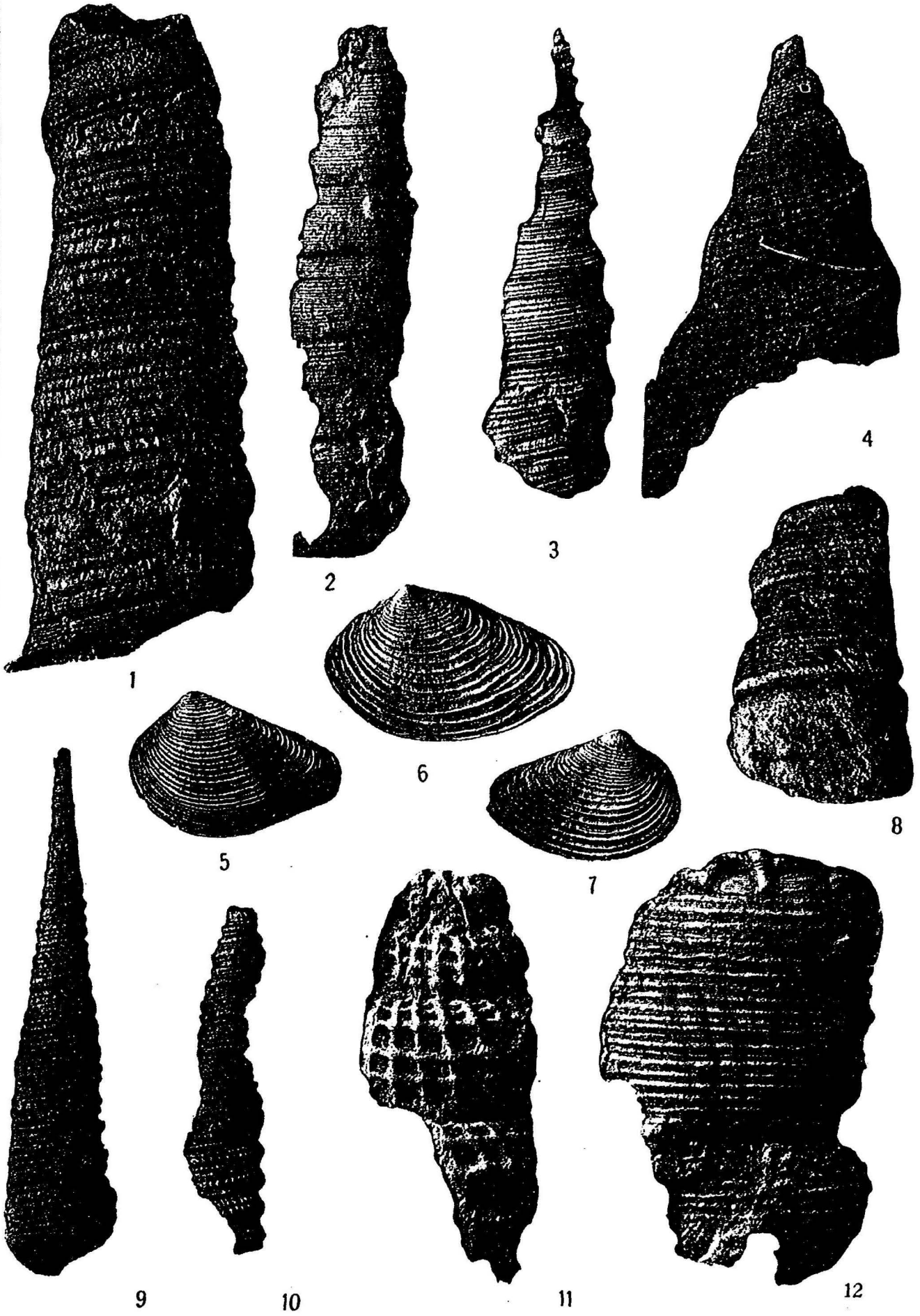
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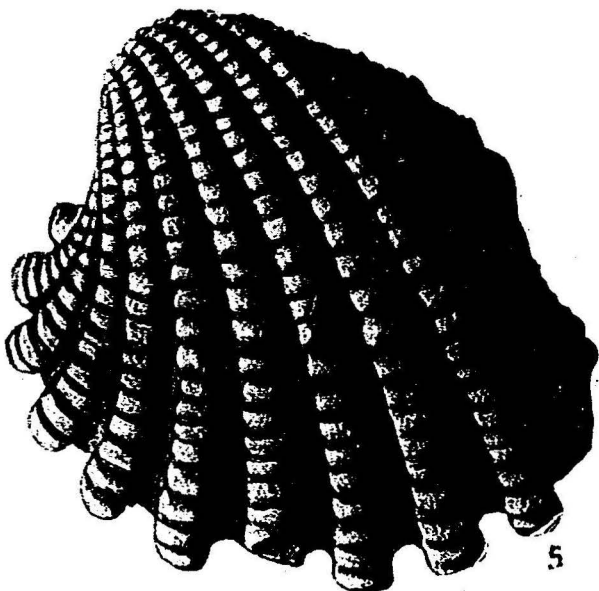
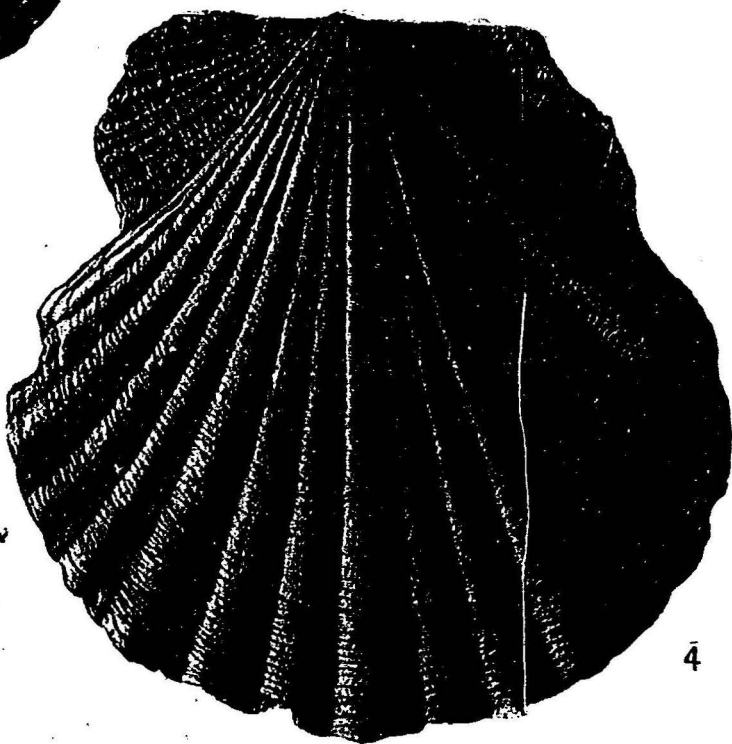
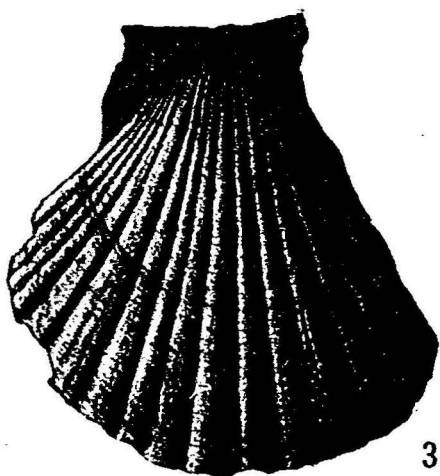
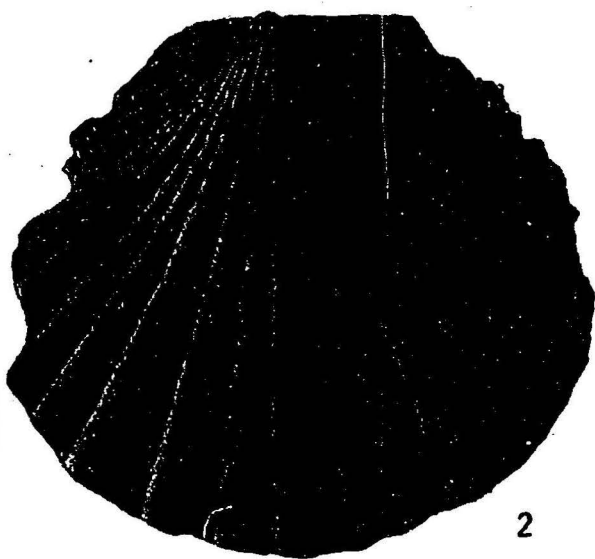
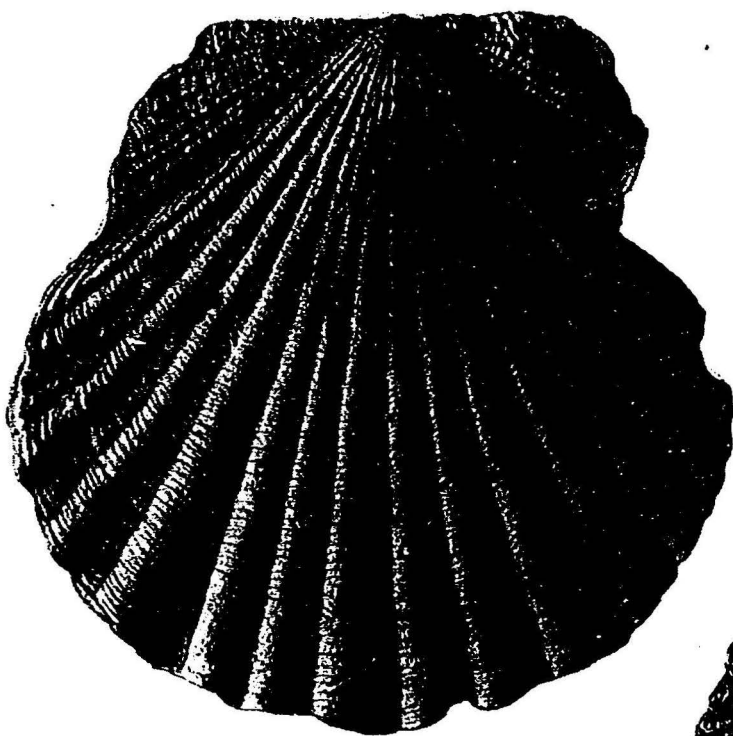
**Notes on the Upper Tertiary and Pleistocene  
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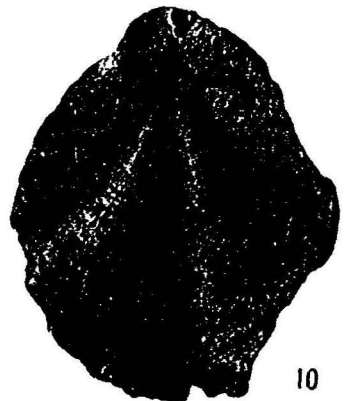
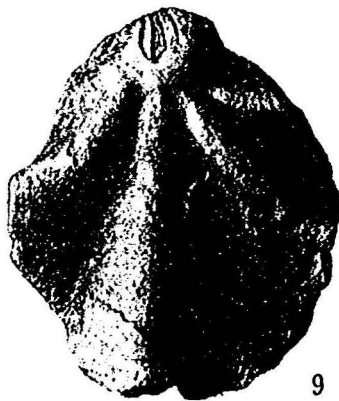
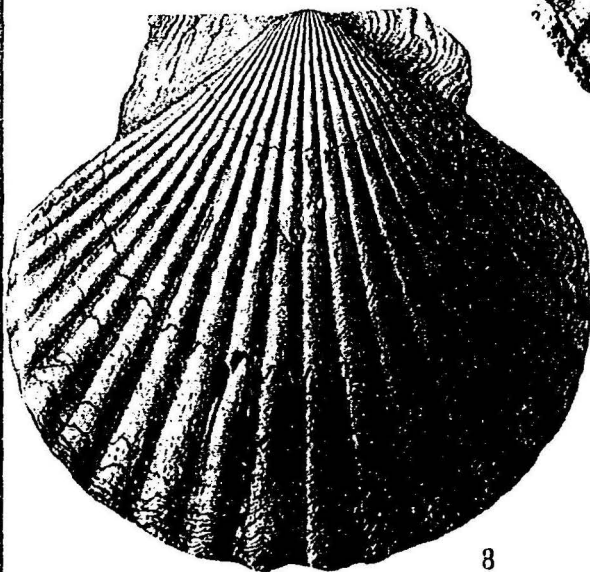
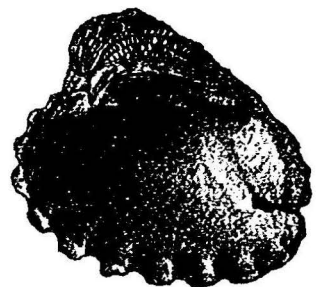
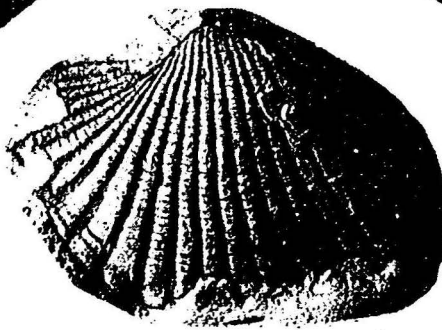
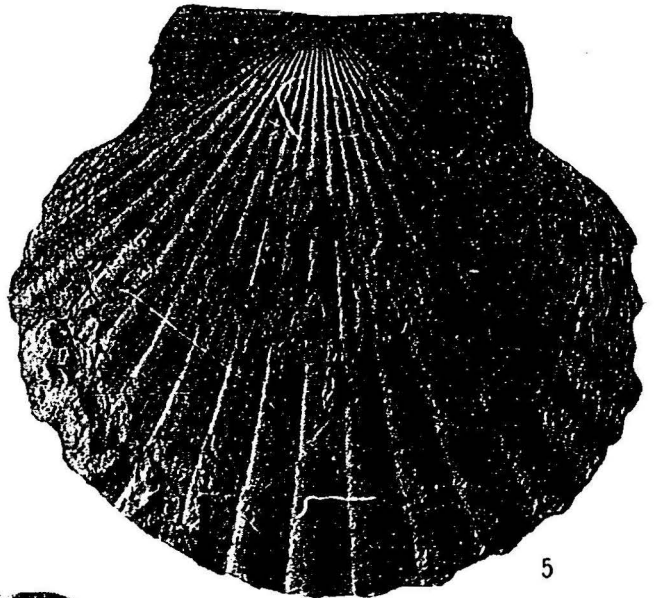
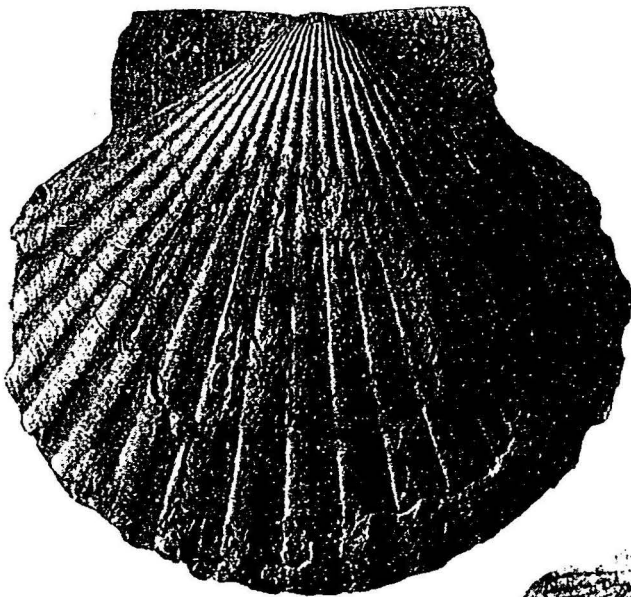
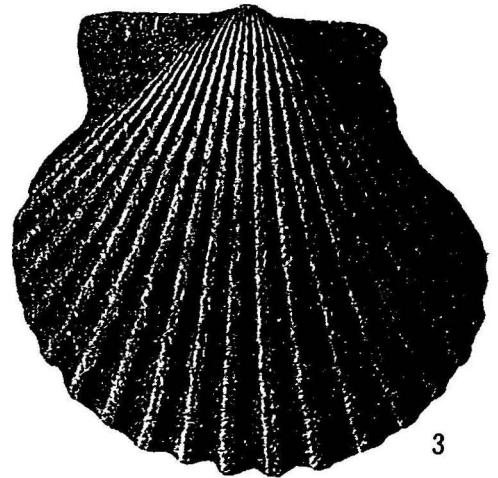
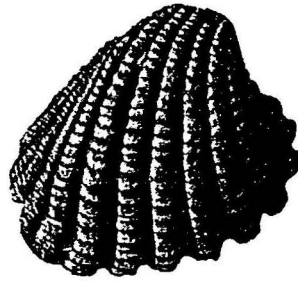
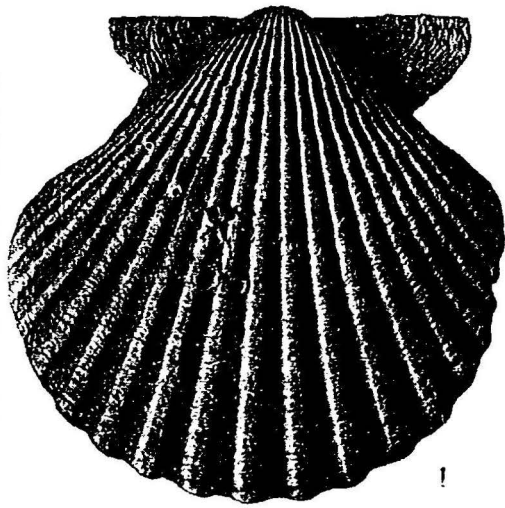


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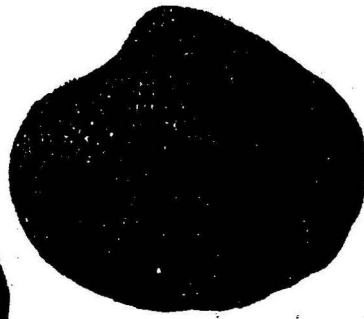
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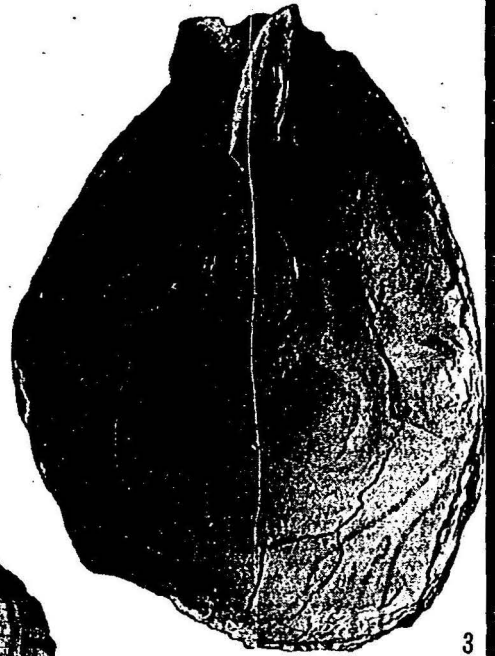




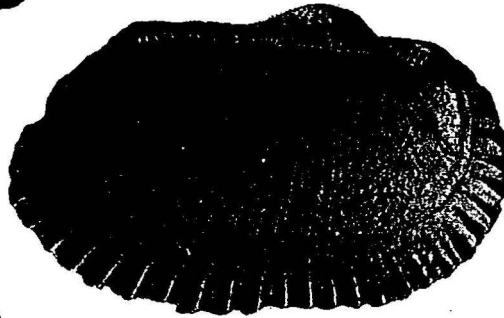
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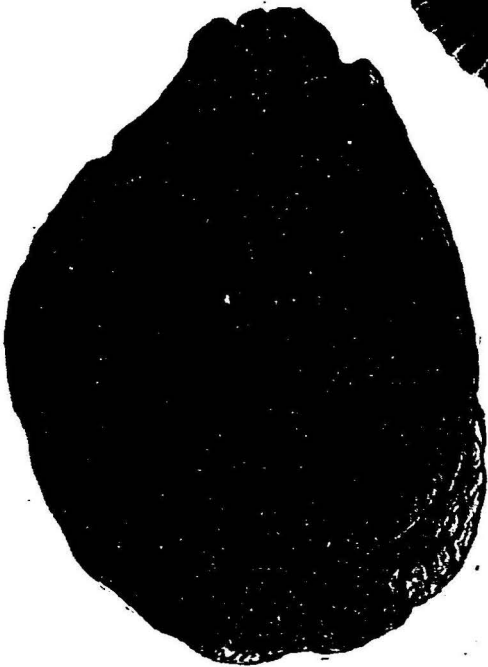
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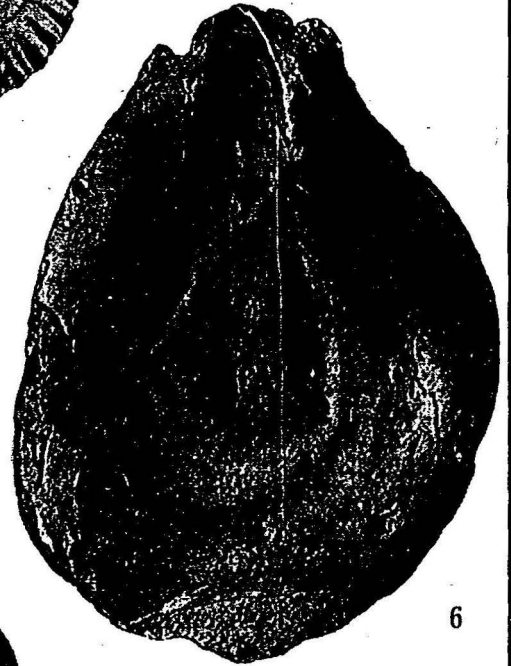
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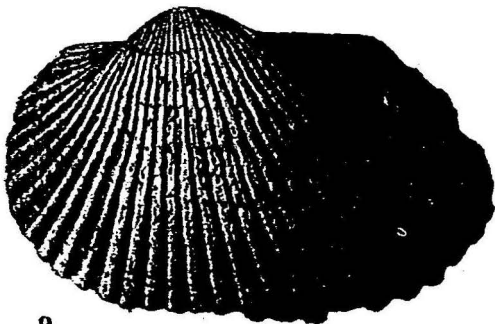
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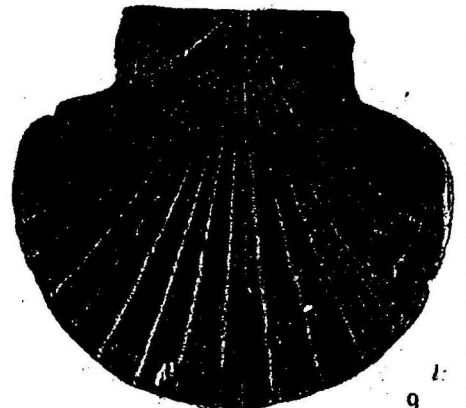
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