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PLIOCENE FOSSILS
FROM LIMESTONE IN SOUTHERN FLORIDA

BY
WENDELL C. MANSFIELD

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PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA

By WENDELL C. MANSFIELD

ABSTRACT

This paper describes the mollusks and echinoids found in limestone dredged from ditches along the Tamiami Trail in southern Florida, in the area mapped as "Lostmans River limestone (Quaternary)" by Sanford but included in the Pliocene Caloosahatchee formation by Cooke and Mossom on the evidence of these fossils as identified by Mansfield. The matrix of the fossils is unlike the typical Caloosahatchee formation, which is sandy, but the fauna is closely related to that of the upper part of the Caloosahatchee formation and is regarded as a facies of the Caloosahatchee. The fauna shows considerable resemblance to that of the Imperial formation of California but may not be contemporaneous with it.

INTRODUCTION

The fossils upon which this paper is based were collected in February, 1927, by C. Wythe Cooke, geologist, of the United States Geological Survey, Stuart Mossom, then assistant on the Florida Geological Survey, and W. C. Mansfield. The five collections here reported upon were obtained along the Tamiami Trail within a northwest-southeast distance of about 34 miles, in Collier and Monroe Counties, Fla. The fossils were embedded in white or gray limestone, here referred to the Caloosahatchee marl, which had been dredged from shallow ditches to form the roadbed of the Tamiami Trail and which was not observed in place. Cooke and Mossom¹ give a brief account of these collections, referring them to the Pliocene. These collections are of considerable interest because they extend the range of Pliocene faunas much farther south than they had been known before.

I wish to express my sincere thanks to L. W. Stephenson and C. Wythe Cooke, of the United States Geological Survey, and to Austin H. Clark, of the United States National Museum, for helpful assistance.

The photographs for the illustrations of this paper were made in the laboratory of the United States Geological Survey by W. O. Hazard, and the prints were retouched by Miss Frances Wieser.

FORMER WORK IN THE AREA

The fossils described in this report were collected in the area formerly mapped under the name "Lostmans River limestone," proposed by Sanford² for a dark to light crystalline to brittle limestone that is

sandy in places. The type locality of the "Lostmans River limestone" is on the Lostmans River, Collier County, about 15 miles south of station 1/1179, one of the localities at which the fossils described in the present paper were collected. Sanford referred the "Lostmans River limestone" to the Pleistocene. Cooke and Mossom,³ however, did not adopt this name but mapped the area formerly outlined by Sanford for this limestone in part as Miami oolite (Pleistocene) and in part as Caloosahatchee marl (Pliocene). The area in which the fossils here described were collected is mapped by Cooke and Mossom as the Caloosahatchee marl, and the area at the type locality of the "Lostmans River limestone" as the Miami oolite. Cooke and Mossom evidently considered the "Lostmans River limestone" equivalent in age to the Miami oolite.

Dall and Harris⁴ described the rock at the Lostmans River as being very hard and compact and consisting of large masses of Polyzoa more or less completely changed into crystalline limestone, the cavities filled with crystals of calc spar. The only mollusk reported from this limestone was a single valve of *Chione cancellata* (Linnaeus), a species ranging in age from the Pliocene to the Recent. This species was found only at one locality (station 1/1177) among the collections described in the present paper.

As I have not seen samples of limestone or organic remains from the type locality of the "Lostmans River limestone," I do not know whether the rock in which the fossils here described were found is the same as the "Lostmans River limestone" or a different limestone, but I am of the opinion that it is different.

GEOGRAPHIC OCCURRENCE, MATRIX, AND FAUNAL COMPOSITION

The following is a brief description of the material in which the fossils were embedded, based on the matrix attached to the fossils, and a brief account of the kinds of organisms found at each locality.

Station 1/1176. Tamiami Trail, about 11 miles east by north of Marco, Collier County. Dirty-white to gray, rather hard, porous, nonoolitic limestone with inclusions of clear angular quartz grains. The cavities were originally occupied by the tests of organisms, mainly mollusks. Some of these cavities are now partly filled with small, rounded, attached

¹ Cooke, C. W., and Mossom, Stuart, *Geology of Florida: Florida Geol. Survey Twentieth Ann. Rept.*, p. 156, 1929.

² Sanford, Samuel, *The topography and geology of southern Florida: Florida Geol. Survey Second Ann. Rept.*, p. 222, 1909.

³ Cooke, C. W., and Mossom, Stuart, *Geology of Florida: Florida Geol. Survey Twentieth Ann. Rept.*, p. 207, 1929.

⁴ Dall, W. H., and Harris, G. D., *The Neocene of North America: U. S. Geol. Survey Bull.* 84, p. 100, 1892.

limy bodies. The fauna consists of small and large mollusks, bryozoans, and barnacles. To judge from the nature of the matrix, all the organisms came from the same bed.

Station 1/1178. Tamiami Trail, about 6 miles west of the crossroads leading to Everglades, Collier County. The matrix is similar to that at station 1/1176. The fauna consists of large mollusks, bryozoans, foraminifers, and echinoids. The nature of the matrix indicates that all the fossils came from the same bed.

Station 1/1180. Tamiami Trail at Carnestown, 4 miles north of Everglades, Collier County. The matrix is similar to that at stations 1/1176 and 1/1178. The fauna consists of large mollusks, echinoids, bryozoans, and many small foraminifers. The nature of the matrix indicates that all the fossils came from the same bed.

Station 1/1177. Tamiami Trail, 5 miles east of Carnestown and about 7 miles northeast of Everglades, Collier County. The matrix is similar to that at the localities above described. The fauna consists of large mollusks, bryozoans, foraminifers, and echinoderms. The presence of the species *Chione cancellata* (Linnaeus) in this collection may indicate that it came from a stratigraphically higher limestone, as this species was not recognized with certainty in the other collections.

Station 1/1179. Tamiami Trail, 9 miles west of Pinecrest, in sec. 13, T. 54 S., R. 32 E., Monroe County. The matrix is mainly similar to that at station 1/1177 but slightly more compact and harder. The fauna consists of large mollusks, one species of echinoid, bryozoans, and barnacles. To judge from the nature of the matrix, probably most if not all the fossils came from the same bed.

GEOLOGIC OCCURRENCE

Although the conditions at the localities at which the fossils were collected did not afford data for determining the thickness of the limestone, Sanford⁵ reports that a well drilled at Everglades, 4 miles south of station 1/1180 of this paper, passed through 30 feet of limestone (presumably the same as the fossil-bearing limestone farther north) and 40 feet or more of fine gray sand beneath it.

Fossils, either of upper Miocene or Pliocene age, have been collected by members of the Florida Geological Survey along the Tamiami Trail 42 miles west of Miami (about 13 miles east of station 1/1179) in a beachlike sand, which is overlain by a 3-foot bed of hard yellow limestone containing *Chione cancellata*. The limestone may be a little younger than the fossil-bearing limestone treated in this paper, and the sandy bed may represent the sandy bed beneath 30 feet of limestone at Everglades. If these sands are contemporaneous, the overlying limestone bed or beds thicken westward. Sufficient information has not been obtained to determine definitely whether there is one limestone or more in this area.

⁵ Sanford, Samuel, The topography and geology of southern Florida: Florida Geol. Survey Second Ann. Rept., pp. 208, 223, 1909.

Species and geologic range

	1/1176	1/1178	1/1180	1/1177	1/1179	Miocene	Pliocene	Recent
GASTROPODS								
<i>Terebra dislocata</i> Say		×				×	×	×
<i>Fasciolaria</i> sp.	?	×						
<i>Strombus</i> sp.		×						
<i>Turritella</i> , n. sp.? aff. <i>T. perattenuata</i> Heilprin			×					
<i>Calyptrea</i> sp.		×						
<i>Crucibulum</i> sp.			×					
PELECYPODS								
<i>Glycymeris americana</i> (Defrance)			×			×	×	×
<i>Glycymeris pectinata</i> (Gmelin)?			×					
<i>Arca</i> (<i>Anadara</i>) sp.		×						
<i>Arca occidentalis</i> Philippi?					×			
<i>Pinna</i> sp.		×		×				
<i>Ostrea sculpturata</i> Conrad	×					×	×	
<i>Ostrea</i> sp., group of <i>O. trigonalis</i> Conrad *	×		?					
<i>Ostrea tamiamiensis</i> Mansfield, n. sp.	×		×	×	×			
<i>Ostrea tamiamiensis monroensis</i> Mansfield, n. subsp.					×			
<i>Pecten</i> (<i>Plagiectenium</i>) <i>evergladensis</i> Mansfield, n. sp.	×	×	×	×	×		×	
<i>Pecten</i> (<i>Nodipecten</i>) <i>pittieri collierensis</i> Mansfield, n. subsp.	×	×	×					
<i>Pecten</i> (<i>Lyropecten</i>) <i>tamiamiensis</i> Mansfield, n. sp.		×			×			
<i>Pecten</i> (<i>Pecten</i>) sp.	×		×					
<i>Spondylus</i> sp.		×			×			
<i>Plicatula marginata</i> Say	×	×	×			×	×	
<i>Anomia simplex</i> D'Orbigny			×	×		×	×	×
<i>Thracia</i> (<i>Cyathodonta</i>) <i>tristana</i> Olsson?		×						
<i>Cardita</i> (<i>Carditamera</i>) sp.			×	×				
<i>Divaricella</i> sp.				×				
<i>Cardium</i> sp.					×			
<i>Chione intapurpurea</i> Conrad?	×	×	×	?				
<i>Chione cancellata</i> (Linnaeus)				×	?		×	×
<i>Venus?</i> sp.					×			
<i>Metis magnoliana</i> Dall?		×						
<i>Spisula</i> sp.		×						
<i>Gastrochaena</i> sp.				×				
ECHINOIDS								
<i>Encope macrophora tamiamiensis</i> Mansfield, n. subsp.*		×	×	×				
<i>Cassidulus</i> (<i>Rhynchopygus?</i>) <i>evergladensis</i> Mansfield, n. sp.				×	×			

* Same form as in the Pliocene at Alligator Creek, Fla.

NATURE OF THE FAUNAS

The faunas 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, n. subsp., was found at three localities, and the new species *Cassidulus evergladensis* at two localities.

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

AGE OF THE FAUNAS

Although fossils collected from spoil banks may come from more than one bed, nevertheless most of the fossils obtained at these five localities appear to have come from the same bed. However, the occurrence of *Chione cancellata* at station 1/1177 may indicate that it came from a higher bed at that place; and the occurrence of the new subspecies *Ostrea tamiamiensis monroensis* at station 1/1179 may indicate that it came from the higher of two beds at that place. The ditches were partly filled with water at the time the fossils were collected, and a full section of the cut was not revealed.

The age of the faunas is believed to be Pliocene. Although the collections include some forms that were not found elsewhere and consequently are of little aid in correlation, a few are like or closely allied to Pliocene forms, such as *Ostrea*, group of *O. trigonalis*, *Pecten evergladensis*, and *Encope macrophora tamiamiensis*. On the other hand, one form, *Cassidulus evergladensis*, apparently shows some relationship to a species occurring in the Oligocene. Nevertheless, one specimen, borrowed for comparison from the Florida Geological Survey, collected at Moore Haven, Glades County, Fla., and probably dredged from the canal, agrees in detail with *C. evergladensis*. No fossils older than Pliocene have been dredged from the canal in the vicinity of Moore Haven. However, the faunal facies and the apparent stratigraphic relation of the fossiliferous bed to other formations in southern Florida suggest strongly a Pliocene rather than an earlier age.

Some poorly preserved specimens of Foraminifera from stations 1/1177 and 1/1180 were submitted to Dr. Joseph A. Cushman for identification. Those from station 1/1177 were unidentifiable, but in the lot from station 1/1180 were found *Amphistegina lessonii* D'Orbigny, *Eponoides* sp.? (probably the same as one of our living species off the coast), and some internal casts of *Quinqueloculina* and *Triloculina*. Doctor Cushman states that "these are not sufficient to place the material with any degree of accuracy, but it is apparently Pliocene or Pleistocene."

RELATIONSHIP TO OTHER FAUNAS

The faunas from the Tamiami Trail compare most closely with those at Alligator Creek, Charlotte County, Fla., which Dall⁶ regarded as younger than the fauna occurring at Shell Creek, a tributary of Prairie Creek, Charlotte County, Fla., and assigned to the Pliocene Caloosahatchee marl.

The faunas of southern Florida appear to be related to those occurring in the Imperial formation—the marine deposits bordering Carrizo Mountain (sometimes called Coyote Mountain), Imperial County, Calif.; in fact, they appear more closely related to the Imperial faunas than to any other remote fossil faunas I have seen.

The Imperial formation, proposed by Hanna in 1926, was redefined by Woodring⁷ and made to embrace the entire series of marine deposits bordering Carrizo Mountain, and to exclude the overlying non-marine beds. In referring to this formation I have followed Woodring's definition of it.

The marine beds of the Imperial formation have been called "doubtfully Cretaceous," Miocene, and Pliocene.

Vaughan,⁸ relying upon two species of coral, originally referred them doubtfully to the Cretaceous.

Arnold⁹ first called them lower Miocene, or simply Miocene, but later¹⁰ referred them to the upper Miocene and correlated them with the Etchegoin formation of California. The Etchegoin formation is now considered of Pliocene age.

Vaughan, in a later paper,¹¹ concluded that "the systematic affinities of the fauna of Carrizo Creek are with the Caloosahatchee Pliocene of Florida and the Pleistocene and living faunas of the Antilles."

Dickerson¹² states: "Several species appear to be identical with forms which are characteristic of the Gatun formation, of Miocene age."

Kew,¹³ in his studies of the echinoids, referred the beds to the Pliocene.

⁶ Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1604, 1903.

⁷ Woodring, W. P., Distribution and age of the marine Tertiary deposits of the Colorado Desert: Carnegie Inst. Washington Pub. 418, p. 7, 1931.

⁸ Vaughan, T. W., The Eocene and lower Oligocene coral faunas of the United States: U. S. Geol. Survey Mon. 39, p. 19, 1900.

⁹ Arnold, Ralph, The faunal relations of the Carrizo Creek beds of California [abstract]: Science, new ser., vol. 19, p. 503, 1904; The Tertiary and Quaternary pectens of California: U. S. Geol. Survey Prof. Paper 47, p. 21, 1906.

¹⁰ Arnold, Ralph, Paleontology of the Coalinga district, Calif.: U. S. Geol. Survey Bull. 396, p. 44, 1909. Arnold, Ralph, and Anderson, Robert, Geology and oil resources of the Coalinga district, Calif.: U. S. Geol. Survey Bull. 398, p. 139, 1910.

¹¹ Vaughan, T. W., The reef-coral fauna of Carrizo Creek, Imperial County, Calif., and its significance: U. S. Geol. Survey Prof. Paper 98, p. 367, 1917.

¹² Dickerson, R. E., Mollusca of the Carrizo Creek beds and their Caribbean affinities [abstract]: Geol. Soc. America Bull., vol. 29, p. 148, 1918.

¹³ Kew, W. S. W., Cretaceous and Cenozoic Echinoidea of the Pacific coast of North America: California Univ. Dept. Geology Bull., vol. 12, No. 2, pp. 32, 33, 56, 60, 61, 137, 1920

Hanna¹⁴ has more recently published a paper in which he gives formational names to the series of deposits about Coyote Mountain, records the faunas, and describes eight new species of mollusks. He concludes that the age is not greater than lower Pliocene and is inclined to believe that the greater portion of the series is middle and upper Pliocene. The illustrations in Hanna's paper were found very helpful for comparison with the faunas of southern Florida.

The latest contribution to the paleontology of the Imperial formation has been made by Woodring,¹⁵ who says:

The paleontological evidence points to the conclusion that the marine beds of the Colorado Desert are of Miocene age, and the other two lines of evidence passively support this conclusion. There is little on which to base a conclusion as to what part of the coastal Miocene section is represented, but the evidence that is now apparent indicates late Vaqueros age—that is, late lower Miocene.

I have not studied the faunas of the Imperial formation sufficiently to express a definite opinion as to their age or the relative stratigraphic position of these beds with respect to those lying along the Tamiami Trail in Florida. However, I have observed certain species in the Florida faunas that appear to be related to species occurring in the Imperial formation and also to species now living in the Gulf of California. This apparent relationship may be a facies similarity rather than a genetic similarity.

Species collected from the Pliocene along the Tamiami Trail that are apparently related to those in the Imperial formation and to those now living in the Gulf of California are listed below. The species named in the middle column were either originally described as from the Imperial formation or have been reported to occur there.

Pliocene, southern Florida	Imperial formation, California	Recent, Gulf of California
<i>Ostrea tamiamiensis</i> Mansfield, n. sp.-----	<i>Ostrea heermanni</i> Conrad-----	<i>Ostrea jacobaea</i> Rochebrune.
<i>Pecten tamiamiensis</i> Mansfield, n. sp.-----	<i>Pecten mediocostatus</i> Hanna-----	
<i>Pecten pittieri collierensis</i> Mansfield, n. subsp.-----	<i>Pecten subnodosus</i> Sowerby-----	<i>Pecten subnodosus</i> Sowerby.
<i>Pecten evergladensis</i> Mansfield, n. sp.-----	<i>Pecten deserti</i> Conrad-----	<i>Pecten circularis</i> Sowerby.
<i>Thracia (Cyathodonta) tristana</i> Olsson?-----	<i>Cyathodonta undulata</i> Conrad-----	
<i>Encope macrophora tamiamiensis</i> Mansfield, n. subsp.	<i>Encope tenuis</i> Kew-----	<i>Encope grandis</i> (L. Agassiz).

DESCRIPTIONS OF NEW SPECIES

Ostrea tamiamiensis Mansfield, n. sp.

Plate 14, Figures 1, 3

Shell large, rather thin, nearly flat, orbicular, with fluted margins. Exterior surface of holotype partly concealed by matrix but reveals about six rather strong undulating radials. Hinge area rather narrow and furrowed with a rather narrow and shallow channel. Submargins with elongate corrugations. Muscle scar orbicular and situated slightly to the left of the center of left valve.

Dimensions: Holotype, left valve (catalogue No. 371320, U. S. Nat. Mus.), length, 139 millimeters; height, 131 millimeters.

Type locality: Station 1/1177, Tamiami Trail, 5 miles east of Carnestown and 7 miles northeast of Everglades, Collier County, Fla.

The closest related Recent species appears to be *Ostrea jacobaea* Rochebrune,¹⁶ a species occurring in the Gulf of California.

¹⁴ Hanna, G. D., Paleontology of Coyote Mountain, Imperial County, Calif.: California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, pp. 427-502, 1926.

¹⁵ Woodring, W. P., Distribution and age of the marine Tertiary deposits of the Colorado Desert: Carnegie Inst. Washington Pub. 418, pp. 1-25 (especially p. 25), 1931.

¹⁶ Rochebrune, A. T. de, Mus. hist. nat. Paris Bull., vol. 1, p. 241, 1895.

Occurrence: Pliocene. Station 1/1177 (type locality, 1 valve); station 1/1180 (1 valve); station 1/1176 (1 valve); station 1/1179 (2 valves).

The specimens collected at stations 1/1179 and 1/1176 are much smaller than those collected at stations 1/1177 and 1/1180 but have the same general outline and appear to belong to the same species.

Ostrea tamiamiensis monroensis Mansfield, n. subsp.

Plate 14, Figure 2; Plate 15, Figures 1-4

Shell rather thick and heavy, ovate, moderately convex, with fluted ventral margins in adult specimens. Exterior marked with rather sharp, subspinose ribs separated by deep and narrow valleys. Hinge area moderately wide and furrowed with a rather wide channel. Submargins with weak elongated crenulations. Muscle scar prominent and rounded in outline.

Dimensions: Cotypes (catalogue No. 371321, U. S. Nat. Mus.): Left valve, length, 89 millimeters; height, 102 millimeters. Right valve, length, 76 millimeters; height, 96 millimeters.

Type locality: Station 1/1179, Tamiami Trail, 9 miles west of Pinecrest, in sec. 13, T. 54 S., R. 32 E., Monroe County, Fla.

This new subspecies differs from *O. tamiamiensis* in having a heavier, more inflated, and less rounded shell.

Ostrea sculpturata Conrad has more prominent crenulations on the submargins and lower and more rounded ribs than the new subspecies.

Occurrence: Pliocene. Found only at the type locality.

***Pecten (Nodipecten) pittieri collierensis* Mansfield, n. subsp.**

Plate 16, Figures 3, 5

Shell large, orbicular, moderately ventricose, equi-valve, and nearly equilateral, the posterior region being slightly more produced. Sculptured with broad, nearly flat, weakly undulating ribs (seven on the left valve and eight on the right) separated by little wider interspaces. The ribs are broader over the middle of the disk and narrower on each side. Top of ribs sculptured with five to eight coarse, raised threads separated by narrower interspaces. Spaces between major ribs marked with three to five coarse, weakly undulating threads and occasionally with a finer thread. Submargins sculptured with six to eight radial threads, which are equal in strength to the intercostal threads. Ears ornamented with rather coarse radiating riblets.

Dimensions: Holotype (catalogue No. 371326, U. S. Nat. Mus.), left valve, length, 142 millimeters; height, 125 millimeters. Paratype, right valve (catalogue No. 371327, U. S. Nat. Mus.), length, 100 millimeters; height, 104 millimeters.

Type locality: Station 1/1176, Tamiami Trail, about 11 miles east by north of Marco, Collier County, Fla.

The subspecies differs from *Pecten (Nodipecten) pittieri* Dall,¹⁷ a species collected from Moin Hill, near Port Limon, Costa Rica, horizon *a*, in having a more ventricose shell which is ornamented with wider and fewer (by two) ribs. The surface of the ribs on the subspecies, although slightly corroded, does not distinctly indicate the vaulted scales, which are strongly developed on the left valve of *P. pittieri*. Dall, in his original description of *P. pittieri*, placed it in the section *Lyropecten*, but it appears to be more closely related to the section *Nodipecten* than to *Lyropecten*.

Pecten pittieri Dall and the new subspecies appear to be more closely related to *Pecten (Nodipecten) nodosus* Linnaeus, of the east coast, than to *Pecten (Nodipecten) subnodosus* Sowerby, of the west coast.

The new subspecies appears to be an intermediate form between *Pecten pittieri* and *Pecten nodosus*.

Pecten (Nodipecten) veatchii Gabb, a Pliocene species from Cerros Island, off Lower California, appears from the illustration to be closely related to my new subspecies.

Occurrence: Pliocene. Station 1/1176 (type locality, 2 valves), station 1/1180 (paratype locality, 1 valve), and station 1/1178 (2 valves).

***Pecten (Lyropecten) tamiamiensis* Mansfield, n. sp.**

Plate 16, Figures 4, 6

Shell rather small, ovate, moderately ventricose, equi-valve, and nearly equilateral. Both valves similarly sculptured. Right valve sculptured with 23 major ribs, which are stronger over the middle of the disk and weaker on the lateral areas. The two marginal posterior ribs are paired and much weaker than the others. Interspaces occupied by a single strong, rounded riblet. Surface of shell ornamented with fine concentric, beakward-reflected imbrications. Anterior ear with a rather deep byssal notch and externally marked with six rather coarse radials; posterior ear with finer radials than anterior.

Dimensions: Holotype (catalogue No. 371325, U. S. Nat. Mus.), length, 69 millimeters; height, 74 millimeters. One right valve with the margins broken off and occurring at the type locality is a little larger than the holotype, its length being 82 millimeters and height 83 millimeters.

Type locality: Station 1/1178, Tamiami Trail, 6 miles west of crossroads leading to Everglades, Collier County, Fla.

Pecten mediacostatus Hanna,¹⁸ collected from "Alverson Canyon, on the south side of Coyote Mountain, Imperial County, Calif., in the Pliocene coral reef about midway up the canyon," apparently is the nearest related fossil species, but by a comparison made from the illustration, it appears to have a narrower shell with smaller ears than the new species.

Occurrence: Pliocene. Station 1/1178, type locality (3 valves), station 1/1179 (6 valves).

***Pecten (Plagiectenium) evergladensis* Mansfield, n. sp.**

Plate 17, Figures 1, 2, 4, 5

Shell small, broadly orbicular, probably nearly equi-valve, inequilateral, the posterior region being more produced. Right valve of holotype inflated and swollen behind the umbo; posterior region more gently sloping to submargins than anterior; base broadly rounded. Sculptured with 22 nearly flat laterally sloping ribs separated by much narrower interspaces. Sides of ribs and submargins of shell marked with moderately coarse, nearly erect, concentric lamellæ. Submargins without any distinct radials. Right ear with a shallow byssal notch and ornamented with six radials; left ear bearing weak radials on the lower

¹⁷ Dall, W. H., New species of fossil shells from Panama and Costa Rica: Smithsonian Misc. Coll., vol. 59, No. 2, p. 10, 1912.

¹⁸ Hanna, G. D., Paleontology of Coyote Mountain, Imperial County, Calif.: California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, p. 472, pl. 22, fig. 6, pl. 24, fig. 2, 1926.

half. Left valve of immature and slightly corroded paratype sculptured with 20 ribs, which are a little lower than those on right valve; submargins without distinct radials.

Dimensions: Holotype, right valve (catalogue No. 371323, U. S. Nat. Mus.), length, 58 millimeters; height, 52 millimeters. Paratype, left valve (catalogue No. 371324, U. S. Nat. Mus.), length, 29 millimeters; height, 28 millimeters.

Type locality: Station 1/1178, Tamiami Trail, 6 miles west of crossroad leading to Everglades, Collier County.

The new species differs from *Pecten gibbus gibbus* Linnaeus in the absence of any distinct radials on the submargins and in having a much more inequilateral shell. In the latter feature it more closely resembles *Pecten circularis* Sowerby, a Recent species geographically ranging on the west coast from Monterey, Calif., to the Gulf of California and Paíta, Peru. *Pecten (Plagiectenium) comparilis* Tuomey and Holmes, an upper Miocene species, appears to be the ancestral form of the new species. *Pecten mendenhalli* Arnold, a Pliocene species collected at Santa Rosalia, Lower California, and also occurring at Alverson Canyon, San Diego County, Calif., is nearly related to the new species.

Occurrence: Pliocene. Station 1/1178 (type locality, 2 valves), station 1/1177 (paratype locality, 3 valves), station 1/1180 (5 valves), station 1/1176 (2 valves), 1/1179 (4 valves).

Specimens occurring in the Caloosahatchee marl, Florida, have the same characteristics as the new species and appear to belong to it. The Caloosahatchee specimens appear to have been referred to *P. gibbus gibbus* Linnaeus by Dall,¹⁹ but they are unlike the Recent species referred to that variety.

***Cassidulus (Rhynchopygus?) evergladensis* Mansfield, n. sp.**

Plate 18, Figures 1-10

Test large, suborbicular, and moderately high; upper surface convex and broadly rounded, the posterior surface more gently inclined than the anterior; lower surface nearly flat except in the area surrounding the peristome, where it is shallowly concave. Apical system, situated opposite the peristome, is rather large, granular, and slightly elevated; so far as revealed, a genital pore is at the juncture of the petals and a smaller radial pore is opposite each petal. Ambulacral areas petaloid at dorsal portions. Petals rather long, extending nearly to the ambitus, expanding to about one-third their length from the apical system, then gradually contracting distally, and nearly closing at their extremities; poriferous zones rather wide,

shallowly depressed; pores nearly equal in size and rounded in outline; pairs of pores conjugate. Interporiferous areas weakly tumid. Posterior interambulacrum weakly medially arched. Periproct rather large, longest transversely; supramarginal, the lower margin being about 4 millimeters above the ambitus; the upper arched margin slightly overhangs the aperture. Peristome excentric anteriorly, pentagonal, transversely elongate, and surrounded by a large well-defined floscelle with prominent bourrelets. The outer pores of the floscelle are more direct and more regularly placed; the inner ones are more irregularly placed and some of them are arranged in two rows. The surface of the test is closely set with scrobiculate tubercles.

Dimensions: Cotypes (catalogue No. 371329, U. S. Nat. Mus.): Larger slightly crushed cotype with preserved periproct, length, 73 millimeters; width, 74 millimeters; height, 29 millimeters. Smaller cotype (posterior end broken off), width, 57 millimeters; height, 32 millimeters. Paratype (catalogue No. 371330, U. S. Nat. Mus.), length, 75 millimeters (posterior end broken); width, 64 millimeters; height, 35 millimeters.

Occurrence: Station 1/1177, Tamiami Trail, 5 miles east of Carnestown and about 7 miles northeast of Everglades, Collier County, Fla. (type locality); station 1/1179, Tamiami Trail, 9 miles west of Pinecrest (sec. 13, T. 54 S., R. 32 E.), Monroe County, Fla. (paratype locality). Near Moore Haven, Glades County, Fla.; probably dredged from the canal. Only one fairly well preserved specimen, which was embedded in limestone, has been collected near Moore Haven; it is in the collection of the Florida Geological Survey.

Cassidulus evergladensis resembles, in a general way, the figured type of *Cassidulus (Pygorhynchus) alabamensis* Twitchell,²⁰ a species collected at the Natural Bridge, St. Stephens, Washington County, Ala., but the lower surface of the test of that species is more concave longitudinally, and the periproct is at a greater distance above the ambitus. The same authors²¹ refer the "St. Stephens limestone" (upper part) to the lower Oligocene.

***Encope macrophora tamiamiensis* Mansfield, n. subsp.**

Plate 17, Figure 8

In the report by Cooke and Mossom²² I referred this form to *Encope macrophora* Ravenel, but I now believe, after more study, that it represents a new subspecies of *E. macrophora*.

²⁰ Clark, W. B., and Twitchell, M. W., The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 172, pl. 80, figs. 3a-d, 1915.

²¹ Idem, p. 173.

²² Cooke, C. W., and Mossom, Stuart, Geology of Florida: Florida Geol. Survey Twentieth Ann. Rept., p. 156, 1929.

¹⁹ Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 745, 1898.

E. macrophora tamiamiensis appears to be an intermediate form between *E. macrophora* and *E. grandis* (L. Agassiz). It differs from *E. macrophora* in having a proportionately wider and thinner test, a concave instead of convex posterior margin, and a much smaller interambulacral lunule. It differs from *E. grandis*, a Recent species reported by A. Agassiz²³ to occur in the Gulf of California, in having in general a shallower anterior marginal notch and less incised lateral marginal notches. The posterior margin on both forms is very similar in the degree of convexity, indicating a close relationship.

The test of the new subspecies is usually wider than long, rather thin, but not having sharp edges. The

region directly in front of the lunule is the thickest part of the test. The lunule is elliptical and is surrounded on its upper surface by a raised border.

Dimensions: Holotype (catalogue No. 371328, U. S. Nat. Mus.), length, 84 millimeters; width, 87 millimeters; height, 11 millimeters; thickness of margins, about 6 millimeters.

Type locality: Station 1/1177, Tamiami Trail, 5 miles east of Carnestown and about 7 miles northeast of Everglades, Collier County.

Occurrence: Pliocene. Type locality (abundant), station 1/1180 (abundant), station 1/1178 (rare?). Small specimens that have been referred to *Encope macrophora* from the Pliocene Caloosahatchee marl at Alligator Creek, Monroe County, Fla., appear to be more closely related to the new subspecies than to *E. macrophora*.

²³ Agassiz, Alexander, Revision of the Echini: Harvard Coll. Mus. Comp. Zoology Illus. Catalog, No. 7, pt. 3, p. 545, pl. 13d, figs. 5, 6, 1873.

PLATES 14–18

PLATE 14

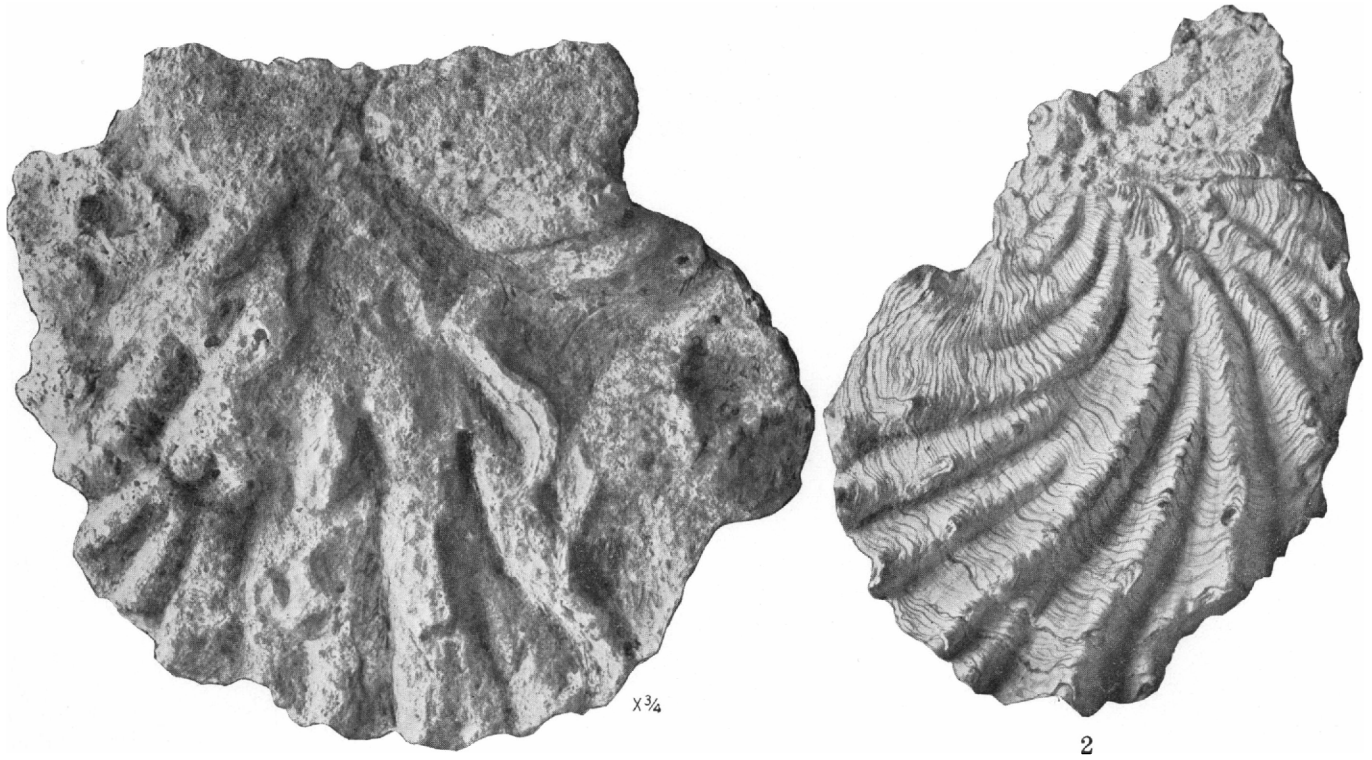
FIGURES 1, 3. *Ostrea tamiamiensis* Mansfield, n. sp., holotype (p. 46).

1. Exterior of left valve.

3. Interior of same valve.

FIGURE 2. *Ostrea tamiamiensis monroensis* Mansfield, n. subsp., paratype, left valve, catalogue No. 371322, U. S. Nat. Mus. (p. 46).

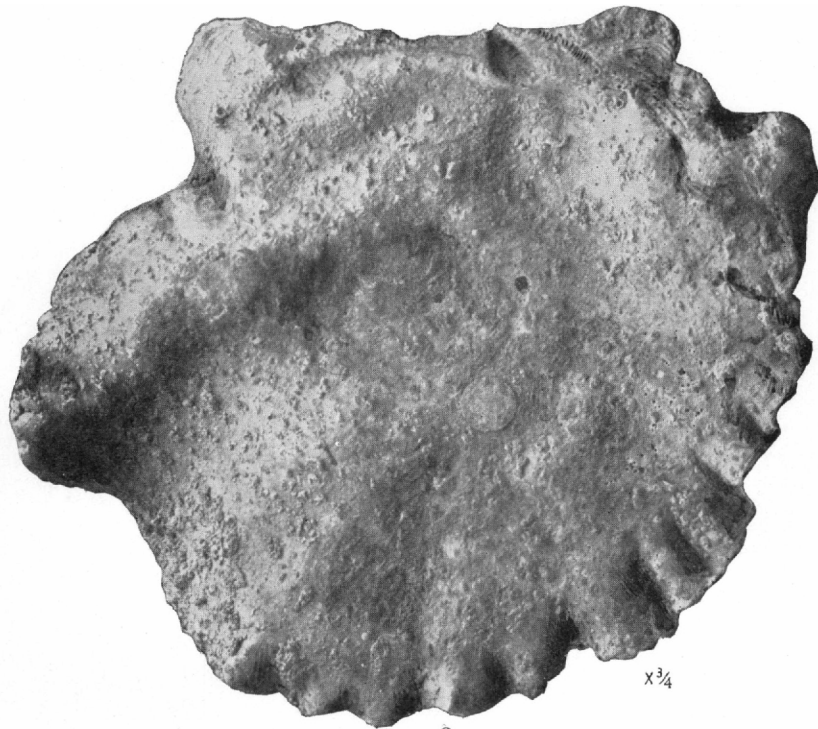
FIGURE 4. *Turritella* sp. aff. *Turritella perattenuata* Heilprin, catalogue No. 371319, U. S. Nat. Mus., figured specimen. Collected at station 1/1180, Tamiami Trail, Carnestown, 4 miles north of Everglades, Collier County, Fla.



x 3/4

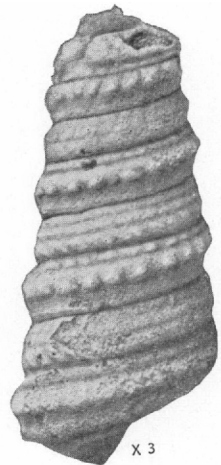
2

1



x 3/4

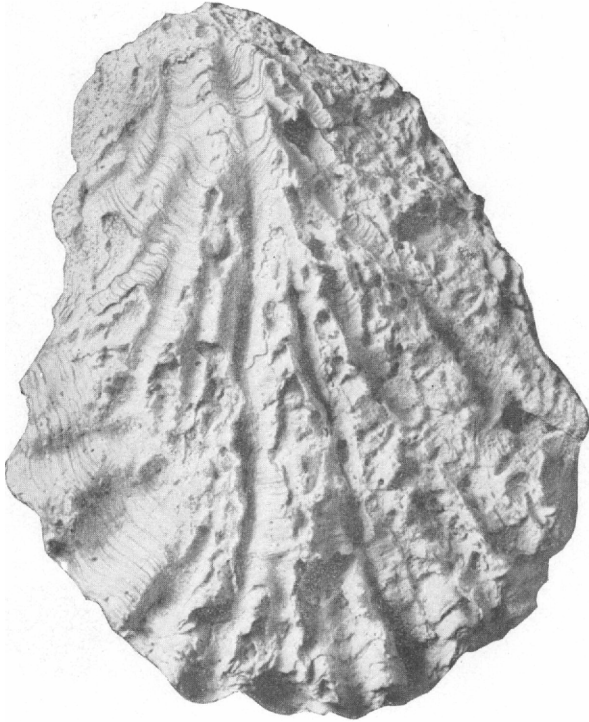
3



x 3

4

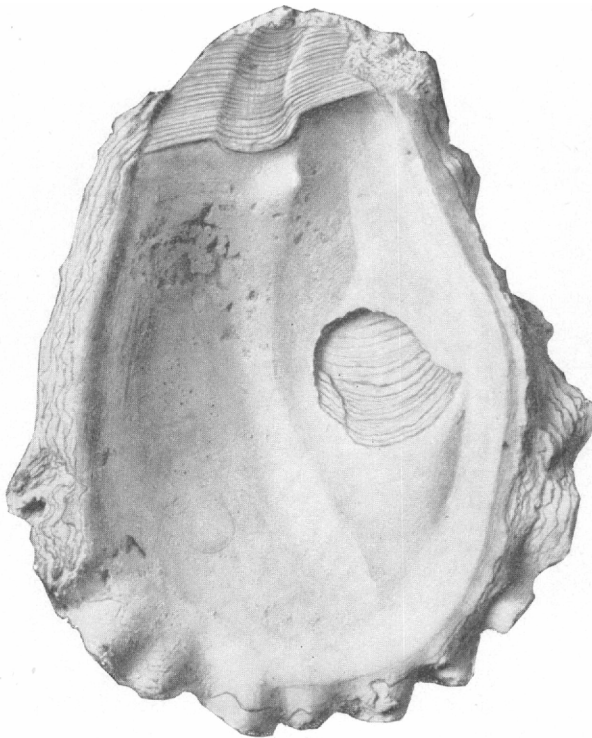
PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA



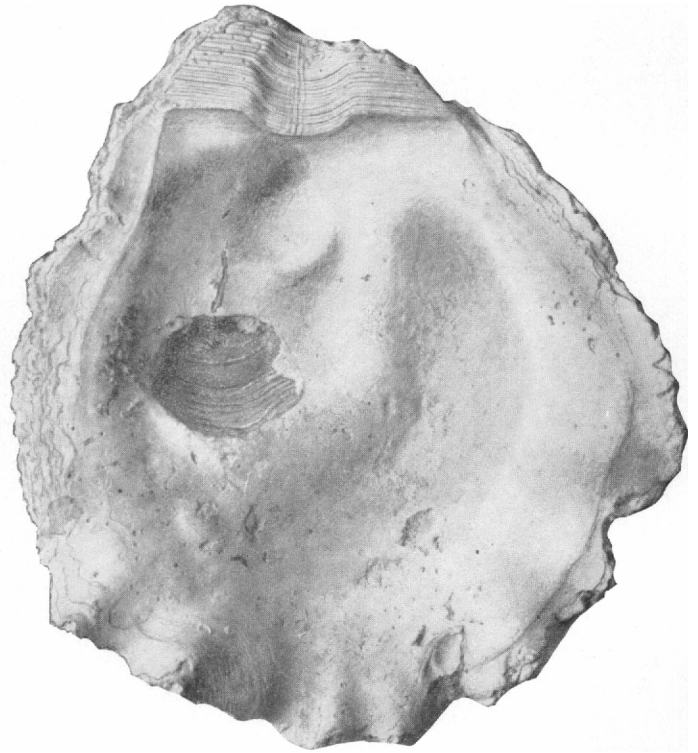
1



2



3



4

PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA

PLATE 15

FIGURES 1-4. *Ostrea tamiamiensis monroensis* Mansfield, n. subsp., cotypes (p. 46).

1, 3. Exterior and interior of right valve.

2, 4. Exterior and interior of left valve.

PLATE 16

FIGURE 1. *Pecten subnodosus* Sowerby. (After Hanna, California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, pl. 25, fig. 6, 1926.)

Hanna's figured specimen was collected in a branch of Alverson Canyon, at the base of Coyote Mountain, Imperial County, Calif. The photograph is used here for comparison with Figures 3 and 5 of this plate.

FIGURE 2. *Pecten mediacostatus* Hanna. (After Hanna, California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, pl. 24, fig. 2, 1926.)

The photograph, taken from the original, is that of the holotype, which was collected from "Alverson Canyon, on the south side of Coyote Mountain, Imperial County, Calif., in the Pliocene coral reef about midway up the canyon." The illustration is used here for comparison with Figures 4 and 6 on this plate.

FIGURES 3, 5. *Pecten (Nodipecten) pittieri collierensis* Mansfield, n. subsp. (p. 47).

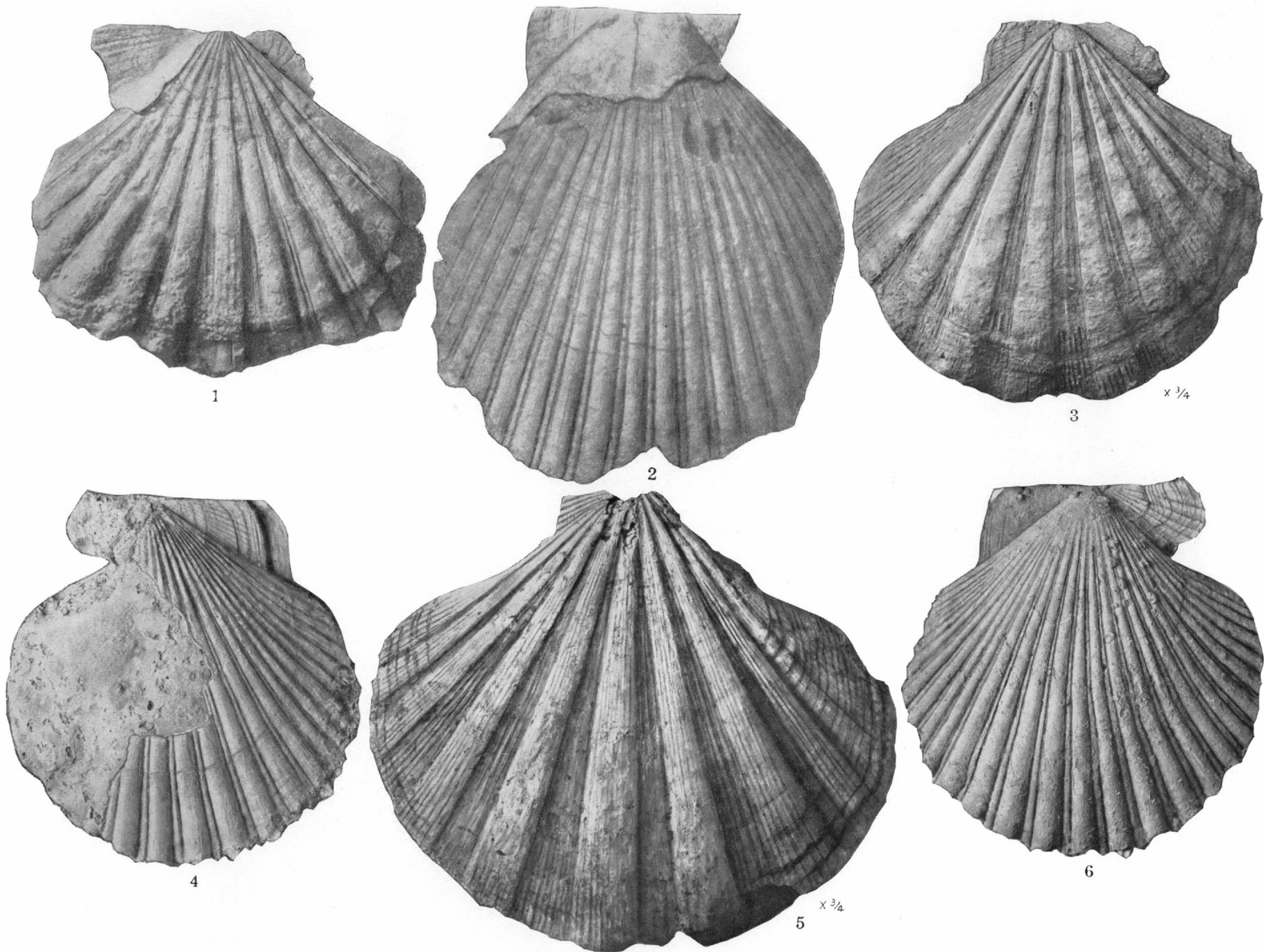
3. Paratype, right valve.

5. Holotype, left valve.

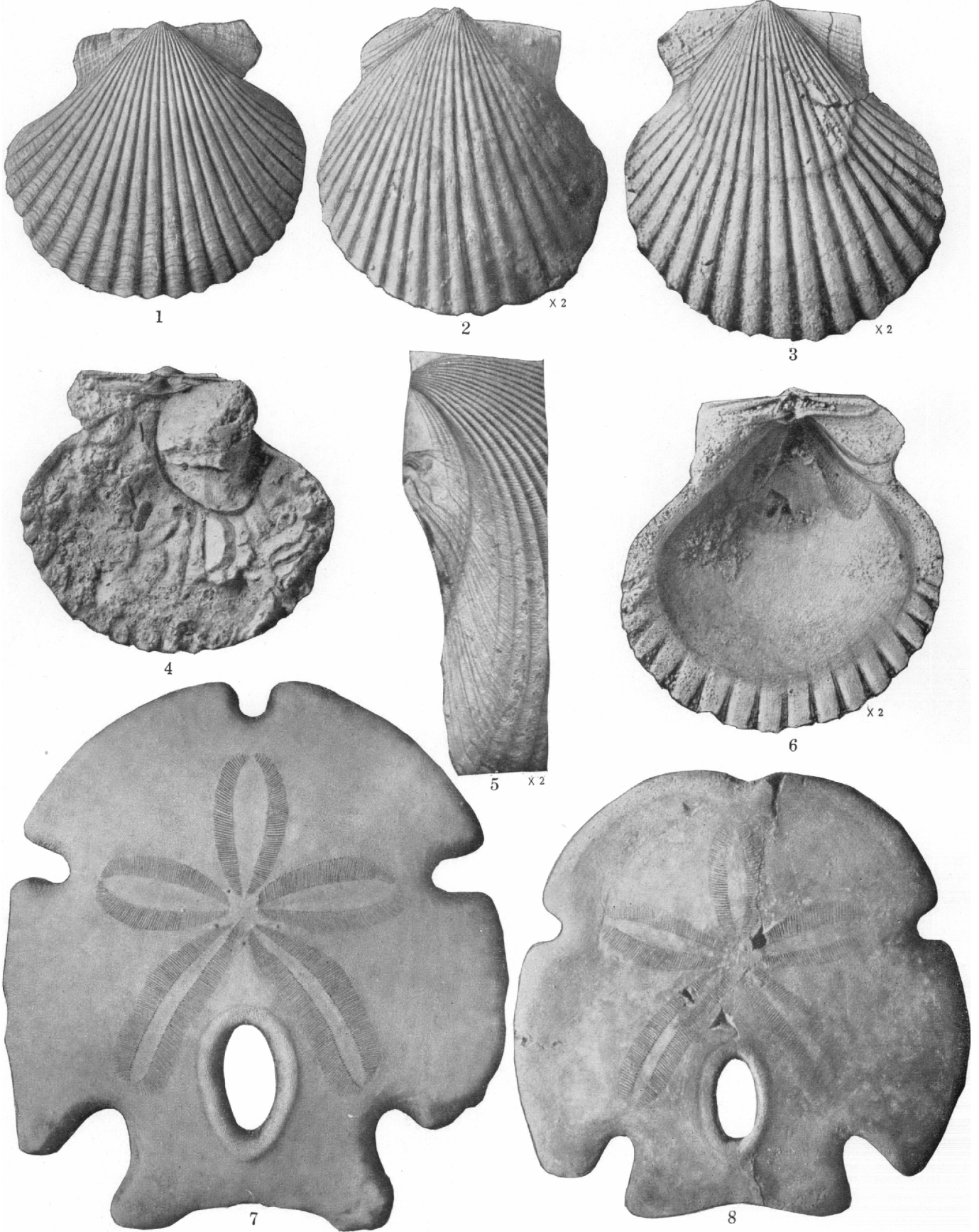
FIGURES 4, 6. *Pecten (Lyropecten) tamiamiensis* Mansfield, n. sp., holotype (p. 47).

4. Left valve of specimen.

6. Right valve of specimen.



PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA
Shows also, for comparison, specimens obtained elsewhere



PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA
Shows also, for comparison, specimens obtained elsewhere

PLATE 17

FIGURES 1, 2, 4, 5. *Pecten (Plagioctenium) evergladensis* Mansfield, n. subsp. (p. 47).

1, 4, 5. Holotype, right valve: 1, 4, Exterior and interior of same valve; 5, posterior submargin, showing the nearly smooth area.

2. Paratype, left valve. Collected at station 1/1177, Tamiami Trail, 5 miles east of Carnestown and about 7 miles north-east of Everglades, Collier County, Fla.

FIGURES 3, 6. *Pecten (Lyropecten) deserti* Conrad, left valve, catalogue No. 324564, U. S. Nat. Mus. Collected at station 3919 east end of Coyote Mountain, Imperial County, Calif., by Stephen Bowers, 1904. Illustrated for comparison with Figures 1, 2, 4, 5 on this plate.

FIGURE 7. *Encope grandis* (L. Agassiz), upper surface of test, catalogue No. 10013, U. S. Nat. Mus. Photograph of a specimen collected at La Paz, Gulf of California. Illustrated for comparison with Figure 8 on this plate.

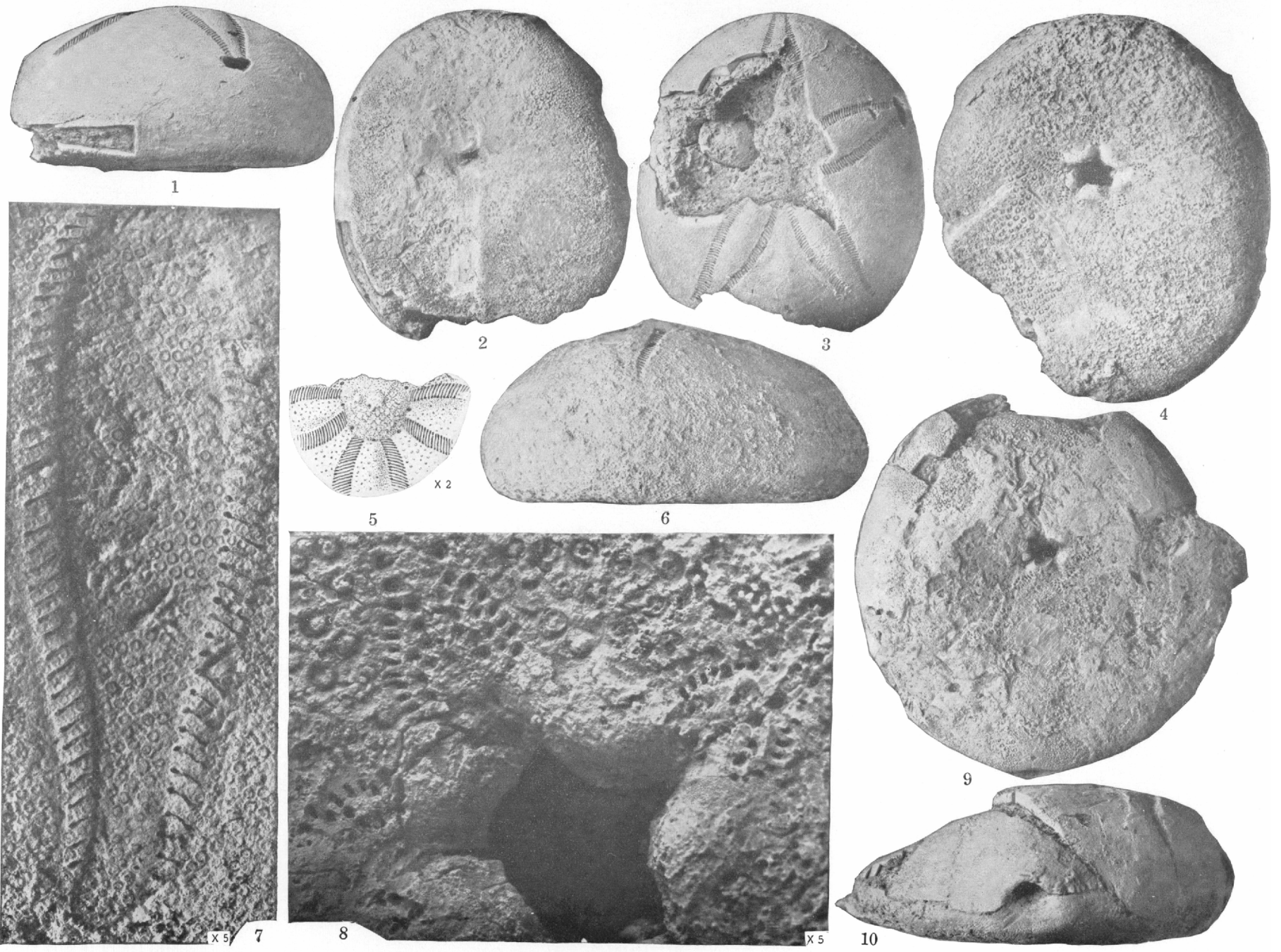
FIGURE 8. *Encope macrophora tamiamiensis* Mansfield, n. subsp., holotype, upper surface of test (p. 48).

PLATE 18

FIGURES 1-10. *Cassidulus (Rhynchopygus?) evergladensis* Mansfield, n. sp. (p. 48).

1. Right lateral surface of test of smaller cotype.
2. Lower surface of test of smaller cotype.
3. Upper surface of test of smaller cotype.
4. Lower surface of test of paratype, catalogue No. 371330, U. S. Nat. Mus.
5. Diagrammatic view of the preserved part of the apical system, based on the paratype.
6. Left lateral surface of test of paratype.
7. Portion of the anterior ambulacrum on upper surface of paratype.
8. Part of the ambulacral pores around the peristome of paratype.
9. Lower surface of test of larger cotype.
10. Posterior surface of test of larger cotype.





PLIOCENE FOSSILS FROM LIMESTONE IN SOUTHERN FLORIDA

