TWO NEW BALANID BARNACLES (CIRRIPEDIA) FROM THE PINECREST SAND OF SARASOTA, FLORIDA

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INTRODUCTION

Two species of barnacles — *Balanus sarasotensis* Weisbord, 1971, and *Balanus newburnensis*, n. sp. — were collected by Harbans Puri in 1970 in what are locally known as the Warren Brothers Pits. These are situated 4.8 miles due east of Washington Boulevard, Sarasota in Sect. 13, T36S, R18E, Sarasota County, Florida. The approximate co-ordinates of the Pits are 27°22′27″N, 82°27′20″W.

The section exposed within the pits was measured and described by Harbans Puri and that section (see Weisbord, 1972, p. 60), with the fossil identifications determined by Puri, is reproduced below.

WARREN BROTHERS PITS —
Sarasota, Fla.

4.5 miles east off U. S. 301, 17th Street, dead end, turn left on paved road [Newburn Rd.], go 0.4 miles, pits on right.

BED	DESCRIPTION	THICKNESS [Ft.]
4	Pleistocene Sand Pinecrest Formation	+15
3	Oyster biostrome, as bed 1 (delicate) *Pecten* sp., *Ostrea haitensis* (Sowerby) mostly articulated valves, *Conus* sp.	4
2	Shell hash, sandy with few complete mollusks; top of the bed marked with *Mytiloconcha* sp. oriented as in life. Can be traced laterally around the pits.	1
1	Oyster biostrome Light gray to green shell hash, quartz sand with *Ostrea haitensis* (Sowerby), *Pecten eboreus darlingtonensis* Dall, *Cancellaria propevenusta* Mansfield, *Murex globosus* Emmons, *Conus adversarius* Conrad.	3

Also in 1970 a detailed study of the Warren Brothers Pits was made by Muriel Hunter of Coastal Petroleum Company, and there is presented below, with Hunter's permission, her composite section, which overlaps that of Puri and continues deeper to the base of the Pinecrest Sand.

COMPOSITE SECTION,
WARREN BROS. NEW PIT
December 15, 1970
M. E. Hunter

Surface beds, north wall, west of pump

BED	DESCRIPTION	THICKNESS [Ft.]
15	Soil, brown	+4
14	Sand, white, loose	+1-2
13	Sand, buff, loose; top wavy and irregular	+4

Maximum total sand and soil about 9 to 10 feet.
Age uncertain.

TAMIAMI FORMATION
(Pinecrest Sand Member)

On south side of pump excavation, in ditch overlain by about 4′ of buff sand and spoil pile:

12 White shell hash, includes many small shells of ½ to 1 inch in size; sandy . . . ½
11 *Pecten* hash, with many *Anadonta alba* or *A. schrammi*; pectens mostly of *P. eborius* type, with a few other specimens of different species 1
10 *Ostrea haitensis* biostrome: Light gray, single and articulate valves; a few other species. Micro-shell-hash at base, and in some places all through bed 3

On north side of pump excavation, beneath pump walk:

10 *Ostrea haitensis* biostrome as on south side, also 3 feet in thickness
9 Mixed shell in light gray sand. Zone of *Pecten* fragments in spots around pit not usually over 6 inches thick at bottom 3
8 *Ostrea haitensis* biostrome, dark grey 2

There is an irregular contact between beds 7 and 8.

7. *Vermicularia woodringi* zone. Upright tubes of this species in clusters. Iron seepage starts in this bed. Shapes and occurrence of clusters of *Vermicularia* added to the habit of this genus of living in sponges suggests that this may be a sponge bed. ½-1
6 *Strombus alatus* biostrome. Abundant *Strombus* with a few other species 1
5 Mixed shell in sand 1
4 Mixed shell in sand. Similar to above but contains *Chione ulocyma* and *Sconsia hodgei*. *Vermicularia* (new species?) at base, also horizontal tubes of *Petaloconchus* (not *sculpturatus*). Large black bone fragments at base of bed. The tubes are oriented parallel with bedding and apparently lived that way . . . . . ½

[There is a possibility of a small hiatus between beds 4 and 3.]

3 Gray clayey sand with weathered crumbly shells, mainly small *Mercenaria* species 2

Bed 3 is probably *Ecphora* Zone equivalent.

2 Phosphatic clayey sand, no fossils seen 3

Beds 2 through 12 equivalent to the Jackson Bluff Formation.

UNCONFORMITY TAMIAMI FORMATION
(Murdock Station Member)

1 Clay, phosphatic, semi-consolidated, with abundant *Pecten jeffersonius* and fragments of Murdock barnacles (Looks like Murdock Station Unit. *Arca* Zone equivalent) 2

The two new barnacles of this report were collected in the oyster biostrome of Puri's Bed 1, one foot below the *Mytiloconcha* sp. horizon of Bed 2. Puri's Bed 1 corresponds in all likelihood with Hunter's *Ostrea haitensis* biostrome of her Bed 10 so that the stratigraphic position of *Balanus sarasotaensis* and *B. newburnensis* in the Warren Brothers Pits, at least, is firmly established. Beds 3 to 1 of Puri and Beds 12 to 2 of Hunter in the Pinecrest Sand are correlated with the Jackson Bluff Formation in Leon County, Florida, the type locality of which is approximately 250 air miles northwest of the pits. The barnacles of the Jackson Bluff Formation have been described by Weisbord (1966) and by Spivey (1977), Spivey noting the occurrence therein of the barnacle *Balanus concavus proteus* Conrad, a form also known from the Tamiami Formation of Florida and the Yorktown Formation of Virginia. These formations (see Hunter, 1968) formerly were considered upper Miocene. However, the Jackson Bluff Formation and the Pinecrest Sand, based on the zonation of planktonic Foraminiferida and on the flora of calcareous nannoplankton (Akers 1972, 1974) are currently considered to be early to middle Pliocene in age and are referred to Zones 19 and 20 of Blow (1969). The age change seems to agree with the reduction in time from about 10 million years duration of the American Pliocene to about 3 million years duration of the European Pliocene, according to the Geologic Time Table compiled by Van Eysinga (1975). Van Eysinga's dating is based on radiometry and geomagnetic events. In any event the Pliocene age of the Pinecrest Sand is accepted by Hunter (personal communication), and there is some supporting evidence in the nature of the corals of the Jackson Bluff Formation (Weisbord, 1971a) and of the barnacle *Creusia neogenica* Weisbord (1972), which was recovered in the same Pinecrest Sand bed as the barnacles *Balanus sarasotaensis* and *Balanus newburnensis* of the present paper.

Since the ages variously assigned to the Pinecrest Formation in the Warren Brothers Pits have been late Miocene, Pliocene, and Pleistocene, Shaak and Nicol (1974) refrained from making a precise placement and age determination of their new bivalve *Plicatula hunterae*, the type locality of which is the Pinecrest Formation in the Warren Brothers Pits. Although the exact bed is not known, it is, according to Hunter, within the Pinecrest Sand interval and is therefore presumed to be Pliocene.

Thus far I have seen no barnacles from the Pinecrest Formation at Sarasota which I have been able to identify in the Jackson Bluff Formation of north Florida. However, I believe some *bleached white* specimens of *Balanus newburnensis* do occur on the Caloosahatchee River, 2-5 miles west of La Belle, Hendry County in what may be the Ayers Landing Member of the Caloosahatchee Formation, as well as a single specimen therein of *Balanus talquinensis* Weisbord, first described from the Jackson Bluff Formation. Hence there is little reason to doubt that of the many hundreds of species yet to be identified in the Pliocene Pinecrest Sand some will have ranged upward from the Miocene, some will be found ranging into the Pleistocene, and that about a third of all Pinecrest molluscan fossils will have survived to Recent time.

ACKNOWLEDGMENTS

I wish to thank Harbans S. Puri and Muriel E. Hunter for their important stratigraphic tables and Emily H. Vokes of Tulane University for her careful review and editorial supervision of this paper. The photographic work was done by Gerritt Mulders of Tallahassee and Alan Brown, Florida State University.

DESCRIPTION OF SPECIES

Class CIRRIPEDIA Burmeister 1834
Suborder BALANOMORPHA Pilsbry 1916
Family BALANIDAE Leach 1817

BALANUS SARASOTAENSIS Weisbord
Plate 1, figs. 1-11

Balanus sarasotaensis Weisbord, 1971, Florida Acad. Sci., Quart. Jour., v. 34, no. 2, p. 101-106, figs. 1-8.

The original description of *B. sarasotaensis* in 1971 was based on individual compartments and a single well preserved shell (SP-2a1, the holotype) within which no opercular valves were recovered. Since then a few more wholly articulated shells as well as separated compartments have been obtained from samples of the Pinecrest Sand from the same Sarasota locality and bed as the holotype. One of the later-recovered shells (SP-2a2) is here figured (pl. 1, figs. 4-7). Additionally a few discrete opercular valves were found in some of the shells as well as loose in the washed sand. With this additional material at hand the original description of *B. sarasotaensis* may be supplemented as follows:

Shell. The largest shell in the collection is 19.5 mm in height at the rostrum, 14.5 mm in rostro-carinal diameter at the base, and 13.5 mm in width at the base between the lateral compartments. With increase in size, the compartments, particularly the rostra, appear humpbacked by virtue of added layers of carbonate.

The new shell (SP-2a2) is 9 mm in height at the carinal end, 11.6 mm at the rostral end; the diameters of the basis are 11.7 mm × 10.2 mm; and the diameters of the orifices are about 5.5 mm × 3.5 mm.

The color of the shells is a light tan, and the outer surface is gnarly and concentrically lineated. Many of the shells are misshapen due to crowded growth conditions.

Opercular valves. The tergum as exemplified in part by SP-2a4 is thin, moderately embayed at the base of the carinal side, and has a long gently concave scutal margin, an evenly convex carinal margin, a sharp apex, and a relatively short spur truncated (by breakage?) at its base. The length from the apex to the base of the spur is 4.5 mm, the width across the base 4.0 mm.

The outer surface of the tergal valve is nearly flat except along the scutal side where there is a narrow convexity of rise extending from the apex to base, there measuring some 0.5 mm in width. This scutal wedge is separated from the carinal surface by a faintly incised spur furrow, and is sculptured by an estimated 25 chevron-like or sinuous folds. The rest of the exterior and much broader side is marked by faint concentric fillets following the contour of the basal margin of the tergum.

In the interior of the tergum, the apical region consists of about seven sharp, elevated, caret-like ridges. The articular furrow (which is the under side of the scutal wedge) is moderately deep, the widest part just below the abrupt bend of the articular ridge. The outer rim of the furrow is slightly curved, and in the lower half, is inclined a litle toward the furrow. The articular ridge is acute and runs obliquely from the apex about a third of the distance to the base where it turns abruptly to parallel the scutal margin, then diminishes to play out before reaching the base of the spur. The crests for the depressor muscle, of which there are six, are laminar and lean toward the interior. The crests project slightly below the basal margin. The spur is short and there may be a small re-entrant between it and the base of the articular furrow.

The scutum of *B. sarasotaensis* is thin, inequilaterally triangular, acute at the basioccludent angle, gently rounded at the basitergal angle, and nearly straight at the base. The scutum of SP-2a6 is 5.7 mm in length from the apex to the basioccludent angle, 4.0 mm in width across the base, and 3.5 mm in length along the tergal margin. The exterior of the scutal valve is flattish except for a general barely perceptible apico-basal depression and a very narrow slope along the tergal margin. The exterior of the scutal valve is sculptured by longitudinal rays or striae and by flattish concentric riblets separated by incised interspaces, the riblets tending to be shingle-like toward the base. The longitudinal radii cover most of the surface but are absent near the occludent margin; where they intercept the concentric riblets, minute longitudinal nodulations are formed. On specimen SP-2a6 there are approximately 26 concentric riblets and these merge to form about 13 teeth in a length of 5.5 mm along the occludent margin. On the narrow slope of the tergal margin the concentric riblets narrow considerably to form the same number of oblique compressed striae.

In the interior of the scutum of SP-2a6 the lateral depressor pit is subquadrate in outline and deeply sunken. The adductor ridge is prominent and straight above; at about the middle of its course it forms an elbow with the lower part of the ridge, which plays out before the base and slants into the adductor furrow; the adductor furrow is about 1.0 mm in width and is moderately shallow. Adjacent to the elbow of the adductor ridge is a triangular depression separated from the lateral depressor pit. Between the upper part of the adductor ridge and the articular ridge is a furrow terminating at the upper end of the lateral depressor pit. The upper part of the articular ridge is ear-like and erect but is flattened below the middle, the flattened segment ornamented with nine or ten oblique plications.

Comparison. Quite unlike the shell, which is distinct, the opercular valves of *Balanus sarasotaensis* invite comparison with those of *Balanus eburneus* Gould. The exterior of the scutum is similar in both species, but in the interior of the scutum the lateral depressor pit of *B. sarasotaensis* is sub-

quadrate and much more deeply sunken than in *B. eburneus*. Further differences are noted in the tergum of *B. sarasotaensis*, which has a narrower and shorter prolongation of the spur and a considerably less embayed basal margin on both sides of the spur than in *B. eburneus*, "which when fully developed has a three-pronged outline" (Pilsbry, 1916, p. 81). I have compared the fossil *B. sarasotaensis* with scores of Recent specimens of *B. eburneus* from Alligator Point, Franklin County, Florida, and without exception the shells of *B. eburneus* are white and smooth contrasted with the gnarled, concentrically lineated surface of the shells of *B. sarasotaensis*.

In my original comments on *B. sarasotaensis* I stated that the "type and only specimen was recovered from loose sand adherent to some large corals." The particular coral was the holotype of *Oculina sarasotana* Weisbord (1971a, pp. 55-57, pl. 13, figs. 2-4), collected by Puri one foot below the *Mytiloconcha* layer in the oyster biostrome of Bed 1. *Oculina sarasotana* has also been identified in the Jackson Bluff Formation at Jackson Bluff, Leon County, Florida and is another of a number of species occurring in both the Pinecrest and Jackson Bluff Formations.

BALANUS NEWBURNENSIS Weisbord, n.sp.
Plate 2, figs. 1-14

This species is characterized by color in the sense that the shell, numerous disarticulated plates, and the opercula are blackish to gray-black in color. The specimens were found loose in the sand of the same bed in the Warren Brothers Pits that contains *Balanus sarasotaensis* Weisbord.

Shell. The shell of *Balanus newburnensis* is relatively short, tubulo-conic, and a little longer than wide, with the broad rostrum convex in profile, and the carina slightly concave in profile. The apex of the rostrum is arched over the orifice whereas that of the angulate carina is erect and leans slightly outward. The orifice is subtrigonal in outline, with the rostral end truncate, and the carinal end attenuated. The length of the orifice is a little over half the width. The peritreme, by virtue of the acute apices and sloping summits of the radii and alae, is saw-toothed. The parietes are sharply triangular, and on the exterior are unctuous and marked by thin faint rugae which are oblique, transverse, or concentric. The radii are triangular, narrowing acutely at the basis; the summits are faintly denticulate and inclined about 45° with respect to the horizontal. The radii are marked by faint narrow horizontal fillets, each terminating at the summit and along the sutural edge in a denticle. The alae are thin and their summits also inclined. The basis is thin and calcareous, the surface marked by concentric lineations, perhaps 25 to 30, becoming more closely spaced toward the off-centered locus of attachment. The larger lineations are interspaced by finer concentric striae. The holotype (SP-3a1) is 11 mm × 10 mm in diameter at the base, 11.8 mm × 4.0 mm at the orifice, and is 9.7 mm in height at the carina and 12 mm at the rostrum.

The sheath occupies one-third to about three-fifths of the interior of the compartments and is generally adherent except at the lower margin, which is smooth and excavated underneath. The upper part of the sheath is sculptured by thin concentric laminae. On the acutely angulated carina the sheath is flexuous, and unlike in other compartments is attached at its lower margin but non-adherent on the lower sides. The lower fifth of the carinal sheath is smooth, the upper four-fifths marked by sharp individual laminae of which there are 20 or so on specimen SP-3a5. The laminae are close together at the apex of the sheath but become successively farther apart toward the smooth area below. The basis attached to the carina on SP-3a5 is thin and calcareous and there are eleven quadrate pores or openings of the longitudinal tubes at the basis junction with

PLATE 1
Balanus sarasotaensis Weisbord

Figure

1-3. Holotype. Exterior of shell, SP-2a1. Measurements: height at carina 9 mm, at rostrum 6.5 mm; diameters at basis 8.5 mm × 7.6 mm.

4-7. Exterior of shell, SP-2a2. Measurements: height at carina 9 mm, at rostrum 11.6 mm; diameters at basis 11.2 mm × 10.4 mm; diameters of orifice 5.5 mm × 4.5 mm. Fig. 4, lateral view, carina to left. Fig. 5, lateral view, carina to right. Fig. 6, carinal view. Fig. 7, rostral view.

8-11. Opercula. Figs. 8, 9, exterior and interior of tergum (SP-2a4). Measurements: length from apex to base of spur 4.7 mm, width from basiscutal to basicarinal angle 3 mm. Figs. 10, 11, exterior and interior of scutum (SP-2a6). Measurements: length along occludent margin from apex to basioccludent angle 6.3 mm, width across basal margin 4.2 mm.

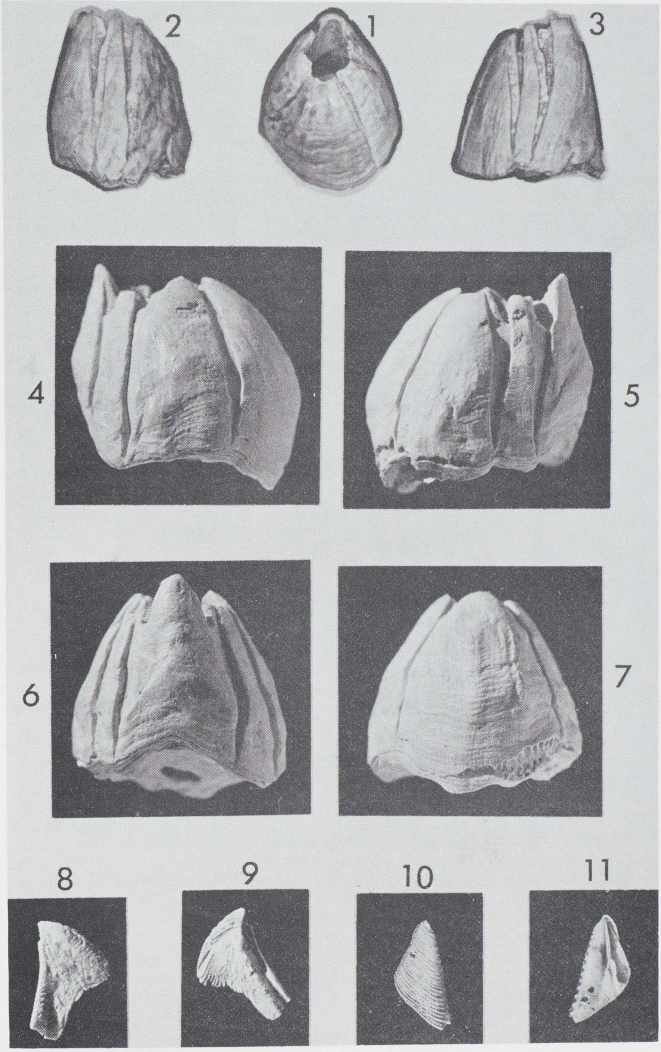

PLATE 1

that of the carinolateral plate. The parietal or longitudinal tubes of the compartment are a little higher than wide near the sheath but broaden below where they become slanted and are marked with auxiliary longitudinal striae at the base. The primary longitudinal septa are sturdy and laminar, each one crested by a longitudinal rib, these ribs most fully developed at the base of the parietes and continuing upward therefrom in diminishing strength to the base of the sheath. Between the primary septa there may be up to four secondary longitudinal septa, these confined to the basal edge of the parietes.

The radii are robust, the upper edge thick and slanting, the sutural edge broad, the later with prominent denticulae. On the sutural edge of specimen SP-3a8, a lateral compartment, there are about 46 primary denticulae in a length of 6.5 mm and about 9 secondary denticulae across the broadest part of the sutural edge (0.7 mm). The alae are thin, small and marked by concentric lineations.

Opercular valves. The scutum, as exemplified by specimen SP-3a3, is 5.8 mm in length along the occludent margin from the apex to the basioccludent angle, and approximately 4.0 mm in width across the basal margin. It is triangular in outline, the sides diverging from the sharp apex at an angle of about 38°. The basioccludent and basitergal angles are narrowly rounded. The basal margin is embayed slightly between the angles, and there is a faint radial depression along the central part of the exterior extending from near the apex to the base. The external surface is sculptured by strong concentric costae, which are smaller and subequal on the apical area, larger and alternating on the basal area. Each costa is thickest at its lower margin and slopes gently toward the costa immediately above it. Throughout, the course of the costae conforms with the contour of the basal margin. All of the costae are raised at the occludent margin at which they bend abruptly upward to produce short oblique ridgelets or denticles on the under side.

In the interior of adult scuta there is a broad apical platform sloping steeply down toward the occludent margin. Below the apex proper there are two diverging prongs, one merging into the adductor ridge, the other into the articular ridge. The occludent side of the prongs is marked by a few vermicular corrugations, and continuing around the apex there are several raised laminae extending down the occludent margin on one side and into the articular furrow of the other. The adductor ridge is slightly curved and forms the crest of a slope on which the large adductor muscle seems to have been located. The upper part of the articular ridge overhangs the narrow articular furrow, on the margins of which are the termini of the concentric costa of the exterior. The pit for the lateral depressor muscle is small and may be shallow or deep.

The tergum of *B. newburnensis* as exemplified by SP-3a4 is dull gray in color, decidedly oblique in outline, and measures 5.3 mm from the apex to the base of the spur and 4.5 mm across the base between the terminal angles. The external surface is flat and tripartite in structure, rendered so by a faint demarcation line from the apex to the carinal side of the spur and a narrowly channeled spur furrow on the scutal side of the spur. On the carinal side of the spur the base is gently embayed and reflects a very gentle depression of the exterior of the surface from near the apex to the basal margin. The markings of the carinal side consist of faint concentric fillets following the contour of the embayed basal margin. The surface markings of the spur consist of reduced concentric riblets concave upward. The scutal portion of the valve is a slightly raised ridge and is marked by flexuous ribs pointing upward in the open spur furrow and downward on the crest of scutal ridge.

PLATE 2

Balanus newburnensis Weisbord, n. sp.

Figure

1-6. Holotype. Exterior of shell, SP-3a1. Measurements: height at carina 9.7 mm, at rostrum 12 mm; diameters at basis 11 mm × 10 mm; diameters of orifice 11.8 mm × 4 mm. Fig. 1, lateral view showing part of basis, carina to left. Fig. 2, lateral view, carina to right. Fig. 3, view of orifice from above. Fig. 4, basis, upper margin toward carina. Fig. 5, frontal (carinal) view. Fig. 6, rostral view.

7-10. Compartments. Interior views of disarticulated specimens. Fig. 7 (SP-3a7), carinolateral compartment, height 5.6 mm, width at wings 2.9 mm. Fig. 8 (SP-3a8), lateral compartment, height 9 mm, width at base 7.6 mm. Fig. 9 (SP-3a5), carina, height 5.9 mm, width at base 3.7 mm. Fig. 10 (SP-3a6), rostrum, maximum height 13 mm, minimum 5.4 mm, width approximately 4 mm.

11-14. Opercula. Figs. 11, 12, exterior and interior of tergum (SP-3a4), length from apex to base of spur 5.3 mm, width across base 4.5 mm. Figs. 13, 14, exterior and interior of scutum (SP-3a3), length along occludent margin from apex to basioccludent angle 5.8 mm, width across basal margin 4.0 mm.

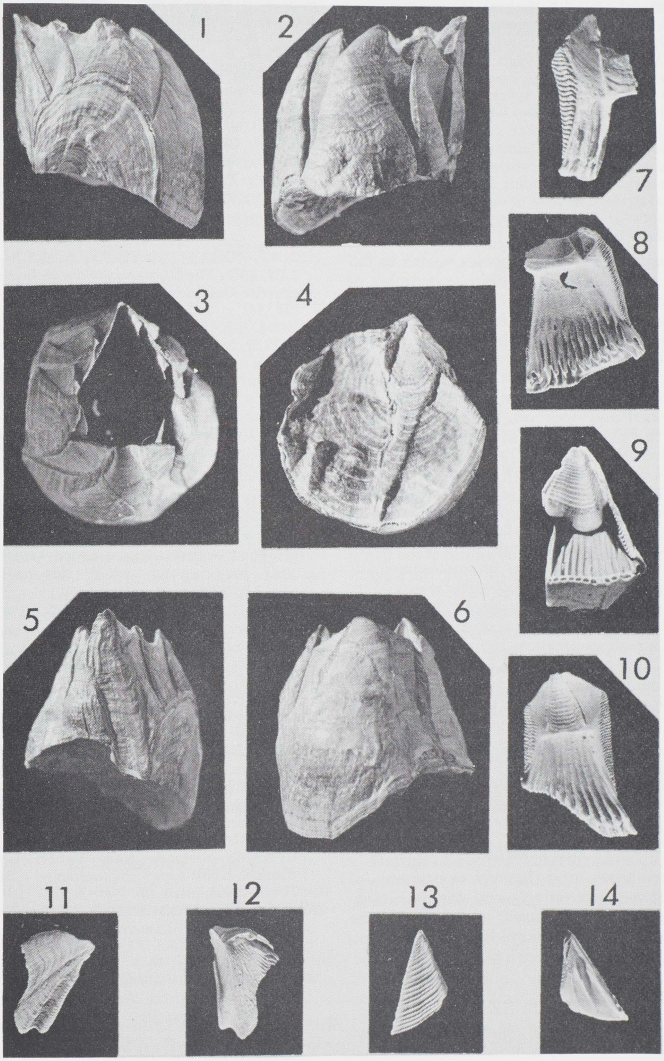

PLATE 2

In the interior of the tergum of *B. newburnensis* the scutal furrow is relatively deep near the apex but shallows and gradually broadens to the base. The articular ridge is high at the apex but becomes less pronounced below. The apex is ornamented on mature specimens by about five acrcuate ridges between which are fine striae. There are six depressor muscle crests represented by six laminae leaning toward the center of the valve, and this central area is roughened by somewhat vermicular, longitudinally interrupted striae. The base of the spur is subangular and between it and the base of the articular furrow there is a re-entrant.

Comparisons. This species seems to fall within the *Balanus amphitrite* complex of Henry and McLaughlin (1975) and is not dissimilar to the Recent *Balanus amphitrite venustus* Darwin which occurs along the coasts of Florida. However, as shown on Henry and McLaughlin's plate 21, figures a-f, there are sufficient minor differences of the shell and opercula between our fossil and the living *B. venustus* that I am persuaded to propose the new species name of *Balanus newburnensis* for the fossil.

It is interesting to note that Darwin's *B. amphitrite obscurus* has been synoymized with *B. a. venustus* by Henry and McLaughlin (p. 8), and that the coloration of the living *B. a. obscurus* was slaty or with "dark slate-colored stripes" (Darwin, 1854, p. 241). It is thus likely that the blackish to gray-black color of our *B. newburnensis* is much the same as it was during its life in the Pliocene. Nevertheless, black shells can become bleached under fossilization as witnessed by the whitish specimens of what I think must be *B. newburnensis* in the Caloosahatchee Formation 2-5 miles west of La Belle, Hendry County, Florida.

Newman and Ross (1976, p. 65) refer to *Balanus venustus* as *Balanus venustus venustus* Darwin.

REPOSITORY

The types and figured specimens of *Balanus newburnensis* and *Balanus sarasotaensis* are conserved at present in the Department of Geology, Florida State University, Tallahassee, Florida 32306, U.S.A.

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