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Cenozoic Irregular Echinoids of Eastern United States

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## CENOZOIC IRREGULAR ECHINOIDS OF EASTERN UNITED STATES

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**ABSTRACT**—This paper treats of 115 species referred to 46 genera or subgenera representing 11 families. Twenty-one species are described as new. One new generic name, *Echanthus*, replaces *Echinanthus* of authors, not Leske, 1778. Two new family names, Echinocyamidae and Echinocardiidae, are proposed. The nomenclature is thoroughly revised, and genotypes are designated for all genera. Transfers involve many genera.

The Paleocene epoch is represented by 3 species, the early Eocene by 7, the middle Eocene by 6, the late Eocene by 52, the Oligocene by 12, the Miocene by 8, the Pliocene by 11 (3 still living), the Pleistocene by 5 (all living), and the Recent by 13.

**T**HIS PAPER, a companion to the one on regular echinoids published in volume 15 of this Journal (pp. 1–20, pls. 1–4, January 1941), completes the study of the Cenozoic echinoids of the Atlantic and Gulf Coastal Plain of the United States. Like the other, it is based primarily on collections in the United States National Museum, though collections of the Florida Geological Survey, the Geological Survey of Alabama, and the Johns Hopkins University have been studied. Most of the extinct species not figured here are illustrated in W. B. Clark and M. W. Twitchell's (1915) "Mesozoic and Cenozoic Echinodermata of the United States" (U. S. Geol. Survey Mon. 54), which can still be purchased from the Superintendent of Documents, Washington, D. C. Excellent figures of most of the Recent species will be found in Alexander

Agassiz's (1872–1874) "Revision of the Echini."

The use of Cenozoic echinoids for correlation has been greatly hampered by the lack of accurate published data on their stratigraphic ranges. Since the manuscript of Clark and Twitchell's monograph was completed, the stratigraphic column as known to them has undergone drastic revision. The Vincentown sand of New Jersey, then supposed to be Upper Cretaceous, has proved to be early Eocene. The Ocala limestone, from which many of their supposed Oligocene species were derived, has been transferred to the late Eocene. These and other changes make the references to geologic horizons in that monograph utterly unreliable and misleading. The supposed age of every species treated herein is brought up to date in the following list.

### STRATIGRAPHIC RANGE OF CENOZOIC IRREGULAR ECHINOIDS

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Echinidae (regular)		
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*Paleocene*.—Only three species are listed from the Paleocene (Midway)—*Echanthus georgiensis*, *Schizaster* (*Linthia*) *alabamensis*, and *Eupatagus?* (*Brissopatagus?*) *primus*. None of the genera suggest an age older than Tertiary. No regular echinoids are known from this unit in the eastern United States.

*Early Eocene*.—The formations of early Eocene age that contain echinoids are the Vincentown sand of New Jersey (supposed by W. B. Clark to be Upper Cretaceous), the Salt Mountain limestone of Alabama (supposed by Clark to be late Oligocene), and the Bashi formation of Alabama, from which last only *Eurhodia?* *elbana* has been obtained. Species of *Trematopygus*, *Hemiaster*, *Echinocorys*, and *Holaster* in the Vincentown sand are reminiscent of the Cretaceous, but the presence of a *Psammechinus* and a *Schizaster* is indicative of the Cenozoic. Seven species of irregular echinoids (six genera) are listed from the early Eocene, and there are also eight regular echinoids. Besides these, *Cassidulus* (*Galerolampas*) *fontis*, found in a deep well, may have come from this horizon or from the Paleocene.

*Middle Eocene*.—Six species from the Lisbon, Cook Mountain, or Mount Selman formations include a *Fibularia*, two Proto-scutellas, a *Porpitella*, a *Schizaster*, and a *Hemipatagus*. Only one regular echinoid, a *Psammechinus*, has been reported from this horizon.

*Late Eocene*.—Echinoids were much more abundant in the North American region during late Eocene (Jackson) time than at any other part of the Cenozoic era. The list includes 52 species of irregular echinoids. Eight or nine regular echinoids have also been described. These 60 or 61 species include two different but closely related successive faunas. The older occupies the Castle Hayne marl of North Carolina, the Santee limestone of South Carolina, the lower part of the Ocala limestone of Georgia and Alabama, and the Moodys marl (including the beds formerly called "Gosport" or "Clairborne sand") of Alabama and Mississippi. The most common and widespread species

of this older zone is *Periarchus lyelli*, which, with its several varieties, extends from North Carolina to Louisiana. It is the so-called *Scutella* from which the "Scutella bed" is named. This species occurs rarely in the succeeding zone, but it has not been found in beds older than basal Jackson.

The other late Eocene fauna is that of the Ocala limestone, which contains a profusion of *Oligopygus*, Laganidae, and *Eupatagus* and includes several West Indian species. Among the more common species are *Oligopygus haldemani*, *Peronella crustuloides*, *P. cubae*, *Cassidulus* (*Paralampas*) *conradi*, and *Schizaster armiger*.

These late Eocene faunas, though presumably less completely known than the Recent, contain three times as many species as are living today off the Atlantic and Gulf coasts of the United States. The faunas are remarkable in that many of the genera that disappeared completely from the Atlantic at the end of the Eocene are still flourishing in the Indo-Pacific region.

*Oligocene*.—Only 12 irregular echinoid species are listed from the Oligocene. *Cyclaster druryensis* is the only species reported from the early Oligocene (Red Bluff), to which it is restricted. Four or five occur in the middle Oligocene (Marianna, Glendon, and Byram, in succession), of which two or three persisted into late Oligocene time (Flint River, Suwannee, and Chickasawhay, contemporaneous). *Clypeaster rogersi* is the commonest species. The late Oligocene contains 5 regular and 10 irregular echinoids, of which *Cassidulus gouldii* is the most abundant in the Suwannee limestone and *Echinolampas aldrichi* in the Chickasawhay.

*Miocene*.—Four regular and eight irregular Miocene echinoids are known. True *Scutella* appears in the early Miocene Hawthorn formation and middle Miocene Choptank formation. Other genera represented are *Clypeaster*, *Encope*, *Echinocyamus*, *Cassidulus*, *Echinocardium*, and *Lovenia*. Regular echinoids are represented by species of *Arbacia*, *Stirechinus*, and *Psammechinus*.

*Pliocene*.—The Pliocene has yielded 3 regular and 11 irregular species, representing *Clypeaster*, *Encope*, *Leodia*, *Cassidulus*, *Agassizia*, *Brissus*, *Eupatagus* (*Plagiobrius*), *Echinocardium*, *Arbacia*, and *Psammechinus*. At least three species are not extinct.

*Quaternary*.—The Recent fauna off the coast of the eastern United States includes 8 or more regular and 13 irregular species, of which 1 regular and 5 irregular species have been found in the late Pleistocene Pamlico or Anastasia formations or in the contemporaneous Miami oolite.

DIAGNOSTIC FEATURES

The irregular echinoids are those in which the periproct (the opening in the test through which the anus protrudes) lies outside of the apical system (a group of plates containing the ocular and genital pores and the madreporite, and from which the ambulacral and interambulacral areas radiate). They are conspicuously bilaterally sym-

metrical in form and surface structure, thus contrasting with the regular echinoids, most of which are nearly circular in form and radially symmetrical in surface structure. The peristome (the aperture containing the mouth), though always on the lower surface, may be either central, as in the regular echinoids, or farther forward. The groups of ambulacral pores near the mouth may form conspicuous phylloides separated by swollen bourrelets, both together constituting a floscelle, or they may be very inconspicuous. In many genera the periproct is on the lower surface behind the peristome, but in others it is marginal or supramarginal. In some species its location is variable. It may be flush or sunken or, if supramarginal, sheltered by a rostrate extension of the test. The ambulacral areas may be distinctly petaloid or not. In some families the anterior, or odd, ambulacral area differs markedly from the paired areas in the arrangement of its pores. This feature is the first basis of division in the key to the families and genera.

KEY TO THE FAMILIES AND GENERA OF CENOZOIC IRREGULAR ECHINOIDS OF EASTERN UNITED STATES

1. Odd ambulacrum like the others.
  2. Peristome not surrounded by a floscelle.
    3. Test swollen or globular, margin conspicuously rounded..... ECHINONEIDAE.
      4. Adult less than 10 mm. long; peristome and periproct round..... *Fibularia*.
      4. Adult more than 10 mm. long.
        5. Periproct basal.
          6. Periproct small, round; peristome deeply sunken..... *Oligopygus*.
          6. Periproct large, pyriform; peristome asymmetrical.
            7. Ambulacra petaloid or subpetaloid..... *Amblypygus*.
            7. Ambulacra not petaloid..... *Echinoneus*.
        5. Periproct terminal or above the margin, in a flattened area..... *Trematopygus*.
    3. Test shield-shaped, base flat, or concave.
      4. Having ambulacral grooves leading to peristome.
        5. Without buccal tubes; grooves generally straight; five genital pores..... CLYPEASTRIDAE, *Clypeaster*.
      5. Having buccal tubes; grooves generally forked..... SCUTELLIDAE.
        6. Without lunules or ambulacral notches; with or without posterior notch.
          7. Outline circular or faintly fluted.
            8. Five genital pores; poriferous zones wider than interporiferous zones; periproct not near the margin..... *Periarchus*.
            8. Four genital pores; poriferous zones narrower than interporiferous zones, expanding distally; periproct marginal or supramarginal... *Echinarachnius*.
          7. Outline not circular, generally notched posteriorly; periproct near the margin.
            8. Five genital pores; posterior notch weak..... *Protoscutella*.
            8. Four genital pores; posterior notch stronger..... *Scutella*.
        6. Having lunules or ambulacral notches.
          7. Five genital pores; outline sagittate or not..... *Encope*.
          7. Four genital pores; outline not sagittate.
            8. Without lunule in anterior ambulacral area..... *Mellita*.
            8. Having lunule in anterior ambulacral area..... *Leodia*.
    4. Without ambulacral grooves or buccal tubes.
      5. Ambulacral areas plainly petaloid; petals closed..... LAGANIDAE.
        6. Five genital pores..... *Laganum*.
        6. Four genital pores.



7. Lower surface flat . . . . . *Rumphia*.  
 7. Lower surface concave . . . . . *Peronella*.
5. Ambulacral areas not plainly petaloid; poriferous zones not closed . . . ECHINOCYAMIDAE.  
 6. Periproct below . . . . . *Echinocyamus*.  
 6. Periproct above . . . . . *Porpiella*.
2. Peristome surrounded by a floscelle.  
 3. Periproct above the margin . . . . . CASSIDULIDAE.  
 4. Periproct wider than high; opening into a sulcus.  
 5. Periproct flush . . . . . *Cassidulus* s. l.  
 6. Periproct not terminal . . . . . *Cassidulus* (*Cassidulus*).  
 6. Periproct terminal.  
 7. Upper surface inflated; under surface not concave except near the peristome . . . . . *Cassidulus* (*Paralampus*).  
 7. Upper surface depressed; under surface more or less concave . . . . . *Cassidulus* (*Galerolampus*).  
 5. Periproct sunken . . . . . *Eurhodia*.
4. Periproct not wider than high.  
 5. Periproct higher than wide, terminal, slightly sunken in an emargination . . . *Echanthus*.  
 5. Periproct nearly circular, not terminal, in a conical tube opening into a sulcus (Upper Cretaceous) . . . . . *Hardouinia*.
3. Periproct below the margin, nearly terminal, flush, obliquely truncated.  
 4. Apical system not longer than wide; madreporite central. ECHINOLAMPADIDAE. *Echinolampus*.  
 4. Apical system longer than wide; madreporite not central. ECHINOCORYTHIDAE. *Echinocorys*.
1. Odd ambulacrum unlike the others.  
 2. Peripetalous fasciole present, lateral fasciole present or not, no subanal or apical fascioles; apical system posterior or median; test generally high . . . . . HEMIASTERIDAE.  
 3. Petals deeply sunken; lateral fascioles present.  
 4. Four or two genital pores; anterior petals not roofed over . . . . . *Schizaster*.  
 5. Apical system posterior; petals less widely spreading . . . . . *Schizaster* (*Schizaster*).  
 5. Apical system central; petals more widely spreading . . . . . *Schizaster* (*Linthia*).  
 4. Two genital pores; anterior petals partly roofed over . . . . . *Moiria*.
3. Petals less deeply sunken. Four genital pores.  
 4. Odd ambulacrum depressed, subpetaloid; no lateral fasciole; poriferous zones not obsolete . . . . . *Hemiasster*.  
 4. Odd ambulacrum very little depressed, not at all petaloid; lateral fasciole present; anterior poriferous zones of anterior petals more or less obsolete . . . *Agassizia*.  
 5. Anterior poriferous zones almost completely atrophied . . . . . *Agassizia* (*Agassizia*).  
 5. Anterior poriferous zones only partly atrophied . . . . . *Agassizia* (*Anisaster*).
2. Subanal fasciole generally present; apical system anterior or medial.  
 3. No apical fasciole . . . . . SPATANGIDAE.  
 4. Escutcheon, if present, not resembling spread wings; larger tubercles not confined within a peripetalous fasciole.  
 5. Peripetalous fasciole deeply indented.  
 6. Peripetalous fasciole complete; periproct large.  
 7. Poriferous zones not atrophied near apex.  
 8. Subanal fasciole complete; petals not deeply depressed . . . . . *Brissus*.  
 8. Subanal fasciole incomplete; petals deeply depressed . . . . . *Meoma*.  
 7. Poriferous zones generally atrophied and posterior petals close together near apex . . . . . *Brissopsis*.
6. Peripetalous fasciole incomplete, not crossing the odd ambulacrum; periproct small . . . . . *Cyclaster*.
5. Peripetalous fasciole not deeply indented, sometimes marginal, incomplete, or wanting.  
 6. Odd ambulacrum not deeply depressed; test high . . . . . *Macropneustes*.  
 6. Odd ambulacrum deeply depressed.  
 7. No large tubercles on upper surface; test high . . . . . *Holaster*.  
 7. Large tubercles on upper surface; test low . . . . . *Hemipatagus*.
4. Escutcheon resembling spread wings; large tubercles confined within a peripetalous fasciole . . . . . *Eupatagus*.  
 5. Plates on upper surface plainly swollen; tubercles arranged in concentric ranks along sutures . . . . . *Eupatagus* (*Gymnopatagus*).  
 5. Plates on upper surface not swollen; tubercles generally not in concentric ranks.  
 6. Apical system far forward; anterior end steeply sloping . . . *Eupatagus* (*Brissopatagus*).  
 6. Apical system not far forward; anterior end less steeply sloping . . . . . *Eupatagus* (*Plagiobrissus*).
3. Apical fasciole present; apical system nearly medial . . . . . ECHINOCARDIIDAE.  
 4. Large spines on upper surface.

- 5. Large spines supported by internal processes . . . . . *Lovenia*.
- 5. Large spines not supported by internal processes . . . . . *Vasconaster*.
- 4. No large spines on upper surface . . . . . *Echinocardium*.

SYSTEMATIC DESCRIPTIONS

Family ECHINONEIDAE A. Agassiz, 1881  
 Genus FIBULARIA Lamarck, 1816

- Fibularia* (part) LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 16.
- Fibularia* DESOR, 1858, Synopsis des échinides fossiles, p. 220.
- Fibularia* A. AGASSIZ, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 506.
- Fibularia* POMEL, 1883, Classification méthodique et genera des échinides, p. 73.
- Echinocyamus* LAMBERT, 1891, Soc. géol. France, sér. 3, t. 19, pp. 749-752.
- Fibularia* COTTEAU, 1892, Paléontologie française, Echinides éocènes, t. 2, p. 390.
- Fibularia* H. L. CLARK, 1911, Annals and Mag. Nat. History, ser. 8, vol. 7, p. 605.
- Fibularia* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 56.
- Echinocyamus* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 287.

Genotype, *Fibularia trigona* Lamarck = *Echinocyamus craniolaris* Leske, living in the Indian Ocean and around the Philippines, designated by H. L. Clark (1911, pp. 598, 605). Lamarck assigned three species to *Fibularia*—*F. trigona*, *F. ovulum*, and *F. tarentina*. The first two, apparently synonyms of *Echinocyamus craniolaris* Leske, represent the usual conception of *Fibularia*—small tumid, egg-shaped species without internal partitions. The third is an *Echinocyamus*.

FIBULARIA VAUGHANI (Twitchell)

- Echinocyamus vaughani* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 160, pl. 74, figs. 1a-d.
- Echinocyamus vaughani* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 576.
- Echinocyamus vaughani* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, figs. 4a-b. (After Twitchell.)

**Occurrence.**—GEORGIA: Little Horseshoe Bend on Flint River 4 miles below Bainbridge (station 3380, type, T. W. Vaughan, collector).  
 FLORIDA: Well near Cedar Keys (station 13143, depths 115-288 feet); well at Leesburg (station 2076, L. C. Johnson, collector); 1 mile northwest of Newberry (station 6810, C. W. Cooke, collector); Suwannee River at Dowling Springs (station 7338, C. W. Cooke, collector); Oakhurst Lime Co. 2½ miles southeast of Ocala (station 11749, C. W. Cooke and Stuart Mossom, col-

lectors); 2 miles northeast of Sumterville (station 12751, W. C. Mansfield and C. W. Mumm, collectors).

ALABAMA: Choctawhatchee River at railway bridge, Geneva (station 6757, C. W. Cooke, collector); stream on line between secs. 20 and 29, T. 4 N., R. 15 E., 6 miles west of Andalusia, Covington County (station 10014, C. W. Cooke and Julia Gardner, collectors).

**Geologic horizon.**—Late Eocene, Ocala limestone.

**Type.**—U. S. Nat. Mus. 166486.

**Remarks.**—*Fibularia vaughani* is very variable in shape, ranging from forms even more elongated than the type to nearly spherical. The location of the periproct seems to be constant. The petals are obliterated in many individuals but vary little in those on which they are visible.

FIBULARIA TEXANA (Twitchell)

- Echinocyamus texanus* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 120, pl. 57, figs. 2a-d, 1915.
- Echinocyamus texanus* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, p. 576.

**Occurrence.**—TEXAS: Lee County (T. H. Aldrich, collector); San Augustine—Nacogdoches road 6.7 miles east of Attoyac Bayou, San Augustine County (station 15093, Julia Gardner and Alex Osanik, collectors).

**Geologic horizon.**—Middle Eocene, Mount Selman formation, Weches greensand member.

**Type.**—Johns Hopkins University, Baltimore, Md., 2002.

Genus OLIGOPYGUS de Loriol, 1887

- Oligopygus* DE LORIOL, 1887, Recueil zool. suisse, t. 4, no. 3, p. 394.
- Oligopygus* DUNCAN, 1889, Linnean Soc. London Jour., Zoology, vol. 23, p. 174.
- Oligopygus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 166.
- Oligopygus* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 387.
- Oligopygus* LAMBERT, 1931, Soc. géol. France Bull., sér. 5, t. 1, p. 290.

Genotype, *Oligopygus wetherbyi* de Loriol, from the Eocene of Florida, by monotypy.



## OLIGOPYGUS WETHERBYI de Loriol

*Oligopygus wetherbyi* DE LORIOI, 1887, Recueil zool. suisse, ser. 1, t. 4, no. 3, p. 396, pl. 17, figs. 7-7d.

*Oligopygus wetherbyi* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 166, pl. 78, figs. 2a-d, 3a-b.

*Oligopygus wetherbyi* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, figs 2a-b. (After Clark and Twitchell.)

*Occurrence.*—FLORIDA: Near Gainesville (type, A. G. Wetherby collector, fide de Loriol); 6 miles southwest of Gainesville (U. S. Nat. Mus. 164662, A. G. Wetherby collector); 5½ miles southwest of Gainesville (W. C. Mansfield and C. W. Mumm, collectors); Nixons, Levy County (station 355, U. S. Nat. Mus. 137878, L. C. Johnson, collector); Johnsons lime sink, Levy County (station 365, U. S. Nat. Mus. 137881, L. C. Johnson collector); Martin station, 9 miles north of Ocala (station 6808, C. W. Cooke, collector); Zuber (station 6807, C. W. Cooke, collector); Perry road 5.2 miles west of Mayo (station 14537, C. W. Cooke, collector); Suwannee River at Dowling Park (station 14538, C. W. Cooke and W. D. Havens, collectors); Kendrick, 4.8 miles north of Ocala (station 14125, W. C. Mansfield and C. W. Mumm, collectors); Ocala (station 4180, U. S. Nat. Mus. 165685, W. H. Merrill, collector); Suwannee River 2¼ miles above Branford (station 7345, C. W. Cooke, collector); quarry 6 miles southeast of Crystal River (station 14141, W. C. Mansfield and C. W. Mumm, collectors); quarry on Steinhatchee River opposite Clara (station 14541, C. W. Cooke and W. D. Havens, collectors).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—Location unknown.

*Remarks.*—The shape of the peristome, which is described by de Loriol and by Clark and Twitchell as pentagonal, is generally somewhat irregular but is much more nearly oval than pentagonal. Full-grown individuals are subpentagonal in outline. A specimen from Kendrick (station 14125) measures 55 by 45.5 by 25 mm.

## OLIGOPYGUS FLORIDANUS Twitchell

*Oligopygus floridanus* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 169, pl. 79, figs. 1a-f.

*Occurrence.*—FLORIDA: Nigger Sink, 2 miles south of Gainesville (station 378b, L. C. Johnson, collector).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—U. S. Nat. Mus. 164660.

*Remarks.*—The type of this species is corroded in such a way as to reveal the ambu-

lacral pores very plainly. The sides of the petals are nearly straight, and there is no constriction at the distal ends. The poriferous zones are narrower than those of *O. wetherbyi*, which occurs at the same locality. The type is the only individual referred to this species. It may be merely an aberrant variety of *O. wetherbyi*.

## OLIGOPYGUS HALDEMANI (Conrad)

*Discoidea haldemani* CONRAD, 1850, Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 40, pl. 1, fig. 12.

*Oligopygus haldemani* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon., 54, p. 167, pl. 78, figs. 4a-d, 5a-d.

*Oligopygus haldemani* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, fig. 3a-b. (After Clark and Twitchell.)

*Oligopygus colsoni* LAMBERT, 1931, Soc. géol. France Bull., sér. 5, t. 1, p. 290, pl. 17, figs. 1-4.

*Occurrence.*—GEORGIA: Bainbridge (well, depth 70 feet, type, fide Conrad); station 3293, A. H. Brooks, collector; station 3390, T. W. Vaughan, collector; station 6171, L. W. Stephenson, collector; station 7097, C. W. Cooke and W. C. Mansfield, collectors); Blue Spring, 4 miles below Bainbridge (station 3380, T. W. Vaughan, collector); Red Bluff, Flint River, 6 miles above Bainbridge (station 3387, T. W. Vaughan, collector); station 6159, L. W. Stephenson, collector); half a mile above Red Bluff (station 7099, C. W. Cooke, collector); 7¾ miles from Bainbridge (station 3770, S. W. McCallie, collector); Dry Bread Shoals, Flint River, 8½ miles below Newton (station 7126, C. W. Cooke, collector); Normans Ferry, Flint River, 21½ miles below Newton (station, 7127, C. W. Cooke, collector); Chatahoochee River at Saffold (station 8241, H. K. Shearer, collector); 4 miles below Saffold (station 6761, C. W. Cooke, collector).

FLORIDA: Ocala (U. S. Nat. Mus. 112506, 164661, Clark and Twitchell's figured specimens, Joseph Willcox, collector; station 6804, C. W. Cooke, collector); Oakhurst Lime Co., 2 miles southeast of Ocala (station 6805, C. W. Cooke, collector); Zuber, 6½ miles north of Ocala (station 6807, C. W. Cooke collector); 1¼ miles south of Newberry (station 6812, C. W. Cooke, collector); 1½ miles northwest of Newberry (station 6814, C. W. Cooke, collector); old French phosphate mine east of Anthony (station 7366, C. W. Cooke, collector); Johnson's lime sink, Levy County (station 365, L. C. Johnson, collector); Willow Sink, Levy County (station 7367, C. W. Cooke, collector); 2 miles northeast of Sumterville (station 12751, W. C. Mansfield and C. W. Mumm, collectors); Kendrick, 4.8 miles north of Ocala (station 14125, W. C. Mansfield and C. W. Mumm, collectors); 3½ miles southeast of Floral City (station 14133, W. C. Mansfield and C. W. Mumm, collectors); 2½ miles southeast of Ocala (station 14137, W. C. Mansfield and C. W.

Mumm, collectors); 5 miles south of Ocala (station 14181, W. C. Mansfield and C. W. Mumm, collectors); north of Marianna (type of *colsoni*, Colson collector, fide Lambert); 12 miles north of Marianna (stations 14152, 14182, W. C. Mansfield and C. W. Mumm, collectors); 3 miles northeast of Newberry (station 14177, W. C. Mansfield and C. W. Mumm, collectors); station 13843, W. C. Mansfield and F. S. MacNeil, collectors);  $3\frac{1}{2}$  miles northeast of Newberry (station 14178, W. C. Mansfield and C. W. Mumm, collectors); 1 mile east of Newberry (station 14180, W. C. Mansfield and C. W. Mumm, collectors).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Remarks.*—This, the most common species of *Oligopygus*, is distinguished from other species of the genus by the location of its periproct, which is near the posterior end. Attention should be called to Clark and Twitchell's misspelling of the specific name—a mistake that has been copied by subsequent writers.

OLIGOPYGUS ROTUNDUS Cooke, n. sp.

Plate 2, figures 1–3

Ambitus nearly circular; upper surface inflated; lower surface flatter. Apical system central, tumid, with four genital pores. Petals nearly straight, tumid, open at the distal ends, extending about three-fourths the distance to the ambitus; interporiferous zones about twice as wide as poriferous zones; pores circular; pores of a pair connected by a groove. Peristome nearly circular, deeply sunken in a tubular depression. Peristomial depression transversely elliptical, about twice as long as wide, plainly delimited from the rest of the lower surface; anterior wall slightly overhanging, posterior wall nearly vertical, lateral walls steeply sloping upward towards the peristome. Periproct small, round, flush, about one-third the distance from the ambitus to the peristome.

Length, 22.2 mm.; width, 20.3 mm.; height, 13.3 mm.

*Occurrence.*—Koons Mill on Cripple Creek, Geneva County, Alabama (Alabama Geol. Survey, T. H. Aldrich, collector).

*Geologic horizon.*—Late Eocene, probably Moodys marl.

*Type.*—U. S. Nat. Mus. 498991, deposited by Alabama Geol. Survey.

*Remarks.*—This species is represented by three slightly corroded but otherwise well preserved individuals. The matrix is light-gray glauconitic, sandy, calcareous marl containing "Nummulites."

*Oligopygus rotundus* resembles *O. haldemani* (Conrad), but its upper surface and petals are more tumid, its periproct is farther from the ambitus, and its peristomial depression is more sharply delimited, steeper, and narrower. The species apparently did not grow so large as *O. wetherbyi* and *O. floridanus*, its periproct is nearer the ambitus, and its outline is more nearly circular. Its proportions are similar to *O. colignoni* Lambert (1931, p. 291, pl. 17, figs. 5–7), but its lower surface appears to be flatter, and its peristomial depression is shorter and wider.

Genus AMBLYPYGUS Agassiz, 1840

- Amblypygus* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, pp. 5, 17.  
*Amblypygus* AGASSIZ, and DESOR, 1847, Catalogue raisonné des échinides, p. 108.  
*Amblypygus* D'ORBIGNY 1855, Paléontologie française, Terrain crétacé, Échinides irréguliers, p. 373.  
*Amblypygus* DESOR, 1858, Synopsis des échinides fossiles, p. 255.  
*Amblypygus* COTTEAU, 1865, Échinides fossiles des Pyrénées, p. 109.  
*Amblypygus* DE LORIOU, 1875, Schweizer. paleont. Gesell. Verh., Band 2, p. 43.  
*Amblypygus* DUNCAN and SLADEN, 1883, Palaeontologia Indica, ser. 14, vol. 1, pt. 4, p. 12.  
*Amblypygus* POMEL, 1883, Classification méthodique et genera des échinides, p. 59.  
*Amblypygus* COTTEAU, 1887, Paléontologie française, Échinides éocènes, t. 1, p. 487.  
*Amblypygus* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 341.

Genotype, *Amblypygus dilatatus* Agassiz and Desor (1847, p. 109; Cotteau, 1887, p. 488, pls. 130, 131), from the Eocene of France, designated by Duncan and Sladen (1883, p. 15).

*Amblypygus* is very closely related to *Echinoneus*, the most conspicuous difference being in the outer row of ambulacral pores, which are circular throughout in *Echinoneus* but elongate and slotlike above the ambitus in *Amblypygus*. Both genera have four genital pores, but in *Echinoneus* the anterior and posterior pairs are farther apart than in *Amblypygus*.

## AMBLYPYGUS AMERICANUS Desor

- Amblypygus americanus* DESOR, 1858, Synopsis des échinides fossiles, p. 256.  
*Amblypygus merrilli* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 165, pl. 76, figs. 1a-d; pl. 57, figs. 1a-b, 2a-b; pl. 78, figs. 1a-b.  
*Amblypygus americanus* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 55.  
*Amblypygus americanus* ARNOLD and CLARK, 1927, Harvard College Mus. Comp. Zoology Mem., vol. 50, no. 1, p. 25, pl. 3, figs. 1-3.

*Occurrence.*—FLORIDA: Kendrick lime quarry near Ocala (station 4246, U. S. Nat. Mus. 164934, type of *merrilli*, G. P. Merrill, collector); Clark, Alachua County (station 2825, U. S. Nat. Mus. 137870, L. M. Everett, collector); Newberry (station 6812, C. W. Cooke, collector).

GEORGIA: Chattahoochee River above US 84 near Saffold (station 12100, C. W. Cooke and W. H. Monroe, collectors); near Albany (Florida Geol. Survey I-1382, G. Winthrop, collector).

JAMAICA: Type; Mt. Sinai region of the Yallahs River district, St. Thomas Parish (Mus. Comp. Zoology, B. W. Arnold, collector).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—Mus. Comp. Zoology 724 (a plaster cast of the original, No. Y 5).

*Remarks.*—The specimens from the United States are higher than those from Jamaica, which also show more variation in shape, some being plainly elongated (fide Arnold and Clark). This difference in height probably is merely individual variation. The nearest related living species, *Echinoneus cyclostomus*, also is variable in shape.

## Genus ECHINONEUS Leske, 1778

- Echinoneus* LESKE, 1778, Naturalis dispositio echinodermatum, p. 173.  
*Echinonëus* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 117, 332.  
*Echinoneus* POMEL, 1883, Classification méthodique et genera des échinides, p. 54.  
*Echinonëus* A. AGASSIZ, 1909, Am. Jour. Sci., ser. 4, vol. 28, pp. 490-492.  
*Echinonëus* WESTERGREN, 1911, Harvard College Mus. Comp. Zoology Mem., vol. 39, no. 2, pp. 41-44.  
*Echinoneus* H. L. CLARK, 1917, idem, vol. 46, no. 2, p. 101.  
*Echinoneus* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 330.  
*Echinoneus* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. in Math. and Phys. Sci., vol. 2, p. 103.

*Genotype*, *Echinoneus cyclostomus* Leske, living in warm oceanic waters, designated by H. L. Clark, 1917.

## ECHINONEUS CYCLOSTOMUS Leske

- Echinoneus cyclostomus* LESKE, 1778, Naturalis dispositio echinodermatum, p. 173, pl. 37, figs. 4, 5.  
*Echinonëus cyclostomus* A. AGASSIZ, 1872, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 117, 550, pl. 14, figs. 6-8; pl. 14a, figs. 5-10.  
*Echinonëus cyclostomus* WESTERGREN, 1911, idem, vol. 39, no. 2, p. 44, pls. 1-28.  
*Echinoneus cyclostomus* H. L. CLARK, 1917, idem, vol. 46, no. 2, p. 192.  
*?Echinoneus cyclostomus* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 54, pl. 9, figs. 4, 5.

*Occurrence.*—Widely distributed in shallow warm waters.

*Geologic horizon.*—Recent. Jackson (1922, p. 54) reports this species from the Anguilla limestone (early Miocene), but the identification seems open to question.

## Genus TREMATOPYGUS d'Orbigny, 1885

- Trematopygus* D'ORBIGNY, 1855, Paléontologie française, sér 1, t. 6, p. 374.  
*Nucleolites* Lamarck (part). DESOR, 1858, Synopsis des échinides fossiles, p. 262.  
*Trematopygus* POMEL, 1883, Classification méthodique et genera des échinides, p. 57.  
*Plagiochlasma* POMEL, 1883, idem, p. 59.  
*Dochmostoma* DUNCAN, 1891, Linnean Soc. London Jour., Zoology, vol. 23, p. 176.  
*Trematopygus* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 338.

*Genotype*, *Nucleolites olfersi* Agassiz (d'Orbigny, 1855, p. 376, pl. 949), from the Neocomian of Europe, designated by Lambert and Thiéry, 1921.

## TREMATOPYGUS CRUCIFER (Morton)

- Ananchytes cruciferus* MORTON, 1830, Am. Jour. Sci., ser. 1, vol. 18, p. 245, pl. 3, fig. 8.  
*Nucleolites crucifer* MORTON, 1833, Am. Jour. Sci., ser. 1, vol. 23, p. 294.  
*Trematopygus crucifer* D'ORBIGNY, 1855, Paléontologie française, Terrain crétacé, t. 6, p. 387, pl. 953, figs. 10, 11; pl. 963, figs. 1-5.  
*Trematopygus crucifer* CLARK, 1893, U. S. Geol. Survey Bull. 97, p. 63, pl. 27, figs. 1a-i.  
*Trematopygus cruciferus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 71, pl. 28, figs. 3a-c; pl. 29, figs. 1a-f.  
*Lichnidius crucifer* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 341.

*Occurrence.*—NEW JERSEY: Rancocas Creek, Vincentown (U. S. Nat. Mus. 29470).

*Geologic horizon.*—Early Eocene, Vincentown sand.

*Type*.—Acad. Nat. Sci. Philadelphia 1464.

*Remarks*.—The original spelling *cruciferus*, corrected by Morton to *crucifer*, should be regarded as a *lapsus calami* and the correction permitted to stand.

Family CLYPEASTRIDAE A. Agassiz, 1873

Genus CLYPEASTER Lamarck, 1801

*Clypeaster* LAMARCK, 1801, *Système des animaux sans vertèbres*, p. 349.

*Clypeaster* DESOR, 1858, *Synopsis des échinides fossiles*, p. 239.

*Clypeaster* MICHELIN, 1861, *Soc. géol. France Mém., sér. 2, t. 7, no. 2*, p. 101.

*Stolonoclypeus* A. AGASSIZ, 1863, *Harvard College Mus. Comp. Zoology Bull.*, vol. 1 p. 25. (Genotype, *Clypeaster prostratus* Ravenel = *Echinanthus subdepressus* Gray, designated by H. L. Clark, 1911, p. 595).

*Clypeaster* POMEL, 1883, *Classification méthodique et genera des échinides*, p. 68.

*Echinorodum* POMEL, 1883, *idem*, p. 68. (Genotype *Echinus rosaceus* Linnaeus, here designated. Proposed as subgenus of *Clypeaster*.)

*Diplotheicanthus* DUNCAN, 1891, *Linnean Soc. London Jour., Zoology*, vol. 23, p. 153. (Genotype, *Echinus reticulatus* Linnaeus = *E. rosaceus* Linnaeus.)

*Clypeaster* H. L. CLARK, 1911, *Annals and Mag. Nat. History*, ser. 8, vol. 7, p. 604.

*Clypeaster* H. L. CLARK, 1914, *Harvard College Mus. Comp. Zoology Mem.*, vol. 46, p. 20.

*Clypeaster* LAMBERT and THIÉRY, 1914, *Nomenclature raisonnée des échinides*, fasc. 7, p. 298.

Genotype, *Echinus rosaceus* Linnaeus, living in the West Indian region, fixed by elimination by Lamarck (1816, p. 13; see H. L. Clark, 1911, p. 594).

#### CLYPEASTER ROSACEUS (Linnaeus)

*Echinus rosaceus* LINNAEUS, 1758, *Systema naturae*, ed. 10, p. 665.

*Clypeaster rosaceus* LAMARCK, 1801, *Système des animaux sans vertèbres*, p. 349.

*Clypeaster rosaceus* H. L. CLARK, 1914, *Harvard College Mus. Comp. Zoology Mem.*, vol. 46, p. 25, pl. 123, fig. 1.

*Diplotheicanthus rosaceus* CLARK and TWITCHELL, 1915, *U. S. Geol. Survey Mon.* 54, p. 219, pl. 102, figs. 1a-b; pl. 103, figs. 1a-b.

*Diplotheicanthus dalli* TWITCHELL, 1915, *idem*, p. 218, pl. 99, figs. 2a-b; pl. 100, figs. 1a-b.

*Clypeaster rosaceus* JACKSON, 1922, *Carnegie Inst. Washington Pub.* 306, p. 33.

*Clypeaster dalli* JACKSON, 1922, *idem*, p. 37, pl. 4, fig. 1.

*Occurrence*.—South Carolina to West Indies (living).

FLORIDA: Caloosahatchee River 2½ miles below LaBelle (station 4955, F. G. Clapp, collector); Four-mile Hammock, between Ft. Thompson and Denaud (station 2094, W. H. Dall, collector, type

of *Diplotheicanthus dalli*); about 1 mile below LaBelle (Florida Geol. Survey station I-209).

DOMINICAN REPUBLIC: Gato (Rodolfo Cambarso, collector).

*Geologic range*.—Pliocene, Caloosahatchee marl, to Recent.

*Remarks*.—The Recent *Clypeaster rosaceus* is very variable in height, degree of inflation of the petals, and in other features. Two of the three specimens in the United States National Museum from the Caloosahatchee marl, named *dalli* by Twitchell, have somewhat more inflated petals than the other, which Twitchell identified as *rosaceus*. The specimen from the Dominican Republic figured as *dalli* by Jackson also is more inflated than most living *rosaceus*. A larger suite of fossils might reveal constant differences between the Recent and the fossil forms, but the differences in the material at hand seem to be merely individual variations.

#### CLYPEASTER SUBDEPRESSUS (Gray)

Plate 4, figure 5

*Echinanthus subdepressa* GRAY, 1825, *Annals of Philosophy*, ser. 2, vol. 10, p. 427.

*Clypeaster subdepressus* A. AGASSIZ, 1874, *Harvard College Mus. Comp. Zoology Mem.*, vol. 3, p. 306, pl. 11b; pl. 11e, figs. 1, 2; pl. 12d, fig. 4; pl. 13, figs. 10-18.

*Clypeaster subdepressus* H. L. CLARK, 1914, *idem*, vol. 46, p. 38, pl. 123, figs. 11, 12.

*Occurrence*.—South Carolina to Brazil (living). SOUTH CAROLINA: Intracoastal Waterway Canal about 3 miles southwest of Little River, (Charleston Museum, G. Robert Lunz, collector; S. F. Blake, collector; station 13377, C. W. Cooke, collector).

*Geologic range*.—Pliocene, Waccamaw formation, to Recent.

*Figured specimen*.—U. S. Nat. Mus. 499007, S. F. Blake, collector.

*Remarks*.—The odd petal of the fossils is slightly shorter, broader, and more closely rounded at the distal end than that of Recent specimens; and the margin of the larger fossils is somewhat thicker than is customary today. But these differences are so slight and the Recent specimens are so variable that it seems hardly worth while to apply a new name to the fossils, which probably are the ancestors of specimens living in the same region. The largest specimen collected by Mr. Lunz is about 155 mm. long and 140



mm. wide. The figured specimen is 70 mm. long.

CLYPEASTER ROGERSI (Morton)

*Scutella rogersi* MORTON, 1834, Synopsis organic remains Cretaceous, p. 77, pl. 13, fig. 3.

*Lagana rogersi* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, p. 6.

*Scutella jonesii* FORBES in LYELL, 1845, Geol. Soc. London Proc., vol. 4, p. 574, text fig.; idem, Quart. Jour., vol. 1, p. 440, text fig.

*Clypeaster rogersi* CONRAD, 1866, Smithsonian Misc. Coll., vol. 7 (200), p. 22.

*Scutella (Mortonia) rogersi* (part) DE GREGORIO, 1890, Mon. faune éocénique de l'Alabama, p. 250, pl. 43, fig. 16. (After Morton. Not description nor figs. 17-20).

*Clypeaster dowvillei* STEFANINI, 1911, Soc. geol. italiana Boll. 30, p. 682, p. 22, figs. 1a-c.

*Clypeaster rogersi* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 136, pl. 64, figs. 2a-d, 3a-d.

*Clypeaster rogersi* COOKE, 1926, Alabama Geol. Survey Special Rept. 14, pl. 97, fig. 7.

*Clypeaster rogersi* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 7, fig. 7. (After Cooke.)

Not *Scutella rogersi* Morton. AGASSIZ, 1841, Mon. échinodermes vivans et fossiles, Mon. 2, p. 85, pl. 19a, figs. 1-4 (= *Periarchus quinquefarius* (Say)).

Not *Mortonia rogersi* (Morton). DESOR, 1858, Synopsis des échinides fossiles, p. 231.

*Occurrence.*—ALABAMA: Monroe County (type); 2 miles east of Howard's Landing, 7 miles southwest of Claiborne, Monroe County (station 2329, Frank Burns, collector); road from Claiborne to Perdue Hill (station 6729, C. W. Cooke, collector); Clarksville, Clarke County, (Alexander Winchell, collector); 2 miles southwest of Whatley, Clarke County (station 7157, C. W. Cooke, collector); 5 miles south of Jackson Clarke County (station 3296, north side of Salt Mountain, T. W. Vaughan collector); St. Stephens Bluff, Tombigbee River, Washington County (station 12167, C. W. Cooke, R. B. Stewart, and W. H. Monroe, collectors); 2½ miles north of Millry, Washington County (station 6702, C. W. Cooke, collector) Whitsett's quarry 3 miles south of Collomburg, in Washington County (station 7208, figured by Cooke, 1926, C. W. Cooke, collector); Leck's place near Rescueville, Choctaw County (station 2894, Charles Schuchert, collector); Rock House Bluff, Conecuh River (stations 6750, 6752, C. W. Cooke, collector); Murder Creek 2 miles above Castleberry (station 7210, C. W. Cooke, collector); Feagin, Conecuh River, Covington County (station 306, L. C. Johnson, collector).

FLORIDA: Marianna (stations 6767, C. W. Cooke, collector; 14330, W. C. Mansfield, and F. S. MacNeil, collectors); Suwannee River opposite Dowling Park (station 12313, W. C. Mansfield and G. M. Ponton, collectors); Suwannee River opposite Ellaville (stations 6824, C. W.

Cooke, collector; 12310, lower bed, W. C. Mansfield and G. M. Ponton, collectors); 6 miles below Ellaville (station 12740, W. C. Mansfield, Herman Gunter, and G. M. Ponton, collectors); Miley rock pit in sec. 36, T. 20, R. 18 E., Citrus County (station 14554, C. W. Cooke and W. D. Havens, collectors); Duncan Church, sec. 36, T. 4 N., R. 14 W., Washington County (W. C. Mansfield and C. W. Mumm, collectors).

GEORGIA: Flint River 8 miles below Bainbridge (station 3766, S. W. McCallie, collector); near Hawkinsville (stations 2309, 2311, Frank Burns, collector; R. M. Harper, collector; station 7387, Ocmulgee River about 2 miles below Hawkinsville, C. W. Cooke, collector; station 3967, right bank of river just below wagon bridge, S. W. McCallie, collector; station 2314, south of Big Creek, 5 miles southwest of Hawkinsville, Frank Burns, collector); fork of Brier and Beaverdam Creeks, Screven County, (type of *jonesii*); Brier Creek at Thompson's Bridge, 9 miles east of Waynesboro (station 3663, T. W. Vaughan, collector).

MISSISSIPPI: Hilltop south of Eucutta Creek 5 miles west of Shubuta (station 334, Frank Burns, collector, figured by Clark and Twitchell); Tiger Hill on East Tallahala Creek, sec. 7, T. 1 N, R. 12 E., 10 miles southeast of Bay Springs (station 7735, C. W. Cooke, collector); Bay Springs-Silvarena road (station 7374, 4½ miles west of Bay Springs, C. W. Cooke and E. N. Lowe, collectors; station 7680, 3½ or 4 miles west of Bay Springs, C. W. Cooke, collector; station 7375 east of Tallahala Creek, C. W. Cooke, collector); Chickasawhay River 1½ miles northwest of the mouth of Limestone Creek, Wayne County (station 13384, C. W. Cooke, collector); Horton Mill Creek 12 miles southeast of Boyce (station 14922, C. W. Cooke, collector); railroad cut 7½ miles south of Jackson, (station 7373, C. W. Cooke, collector); station 14864, F. S. MacNeil, collector); Byram (stations 6455, C. W. Cooke, collector; 9966, A. F. Crider, collector; 12174, C. W. Cooke, R. B. Stewart, and W. H. Monroe, collectors); Vicksburg (station 6451, waterfall in Mint Spring Bayou, C. W. Cooke, collector; U. S. Nat. Mus. 480021, T. L. Casey, collector).

*Geologic horizon.*—Middle and late Oligocene; Marianna limestone, Byram formation and its Glendon limestone member, and Flint River formation.

*Type.*—Probably Acad. Nat. Sci. Philadelphia.

*Remarks.*—*Clypeaster rogersi* is very common in middle and late Oligocene deposits. The species is subject to considerable variation in outline, thickness of margin, and degree of tumidity; but the several varieties usually occur together. Specimens from the Byram near Ellaville (stations 12310, 12740, 12744), Dowling Park (station 12313), and from the Marianna limestone at Marianna, Fla., have thinner margins and are more

tumid centrally than customary, but these features can be matched in selected individuals from Alabama and Mississippi.

CLYPEASTER OXYBAPHON Jackson  
Plate 8, figure 7

*Clypeaster oxybaphon* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 44, pl. 7, figs. 3, 4; pl. 8, figs. 1-3.

*Occurrence*.—WEST INDIES: Antigua, north side of Willoughby Bay (type, station 6881, T. W. Vaughan, collector); Puerto Rico, several localities (Am. Mus. Nat. History, C. A. Reeds, collector).

FLORIDA: NW  $\frac{1}{4}$  sec. 36, T. 4. N., R. 13 W., Washington County (station 15068, F. S. MacNeil, collector).

*Geologic horizon*.—Late Oligocene; Antigua formation, Suwannee limestone.

*Type*.—Holotype, U. S. Nat. Mus. 328241; paratypes, 328242, 328243. Figured specimen, station 15068, U. S. Nat. Mus. 499006.

*Remarks*.—This species differs from *Clypeaster rogersi* chiefly in that its margin is thicker than its submargin. It is more depressed above and less deeply concave below than the specimens from the United States referred to *Clypeaster cotteauui*. It bears considerable resemblance to *Laganum elongatum* Egozcue (1897, pl. 4), which appears to be a *Clypeaster*.

CLYPEASTER COTTEAUI Egozcue

*Clypeaster cotteauui* EGOZCUE, 1897, Com. Mapa Geol. España Bol., vol. 22, p. 40, pl. 10, figs. 1-4.

*Clypeaster cotteauui* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 41, p. 6, figs. 6-8.

*Occurrence*.—WEST INDIES: Cuba (type); Jamaica; Antigua.

GEORGIA: Worth County on road from Isabella to Albany, 6.4 miles west of Isabella and about 12 miles east of Albany (station 7995, C. W. Cooke, collector).

ALABAMA: Quarry  $\frac{1}{4}$  mile northwest of Adams Crossroads on lower Hacoda-Floralá road 8 miles east of Floralá (stations 14511, 14604a, F. S. MacNeil, collector; identification doubtful, may be *C. rogersi*).

FLORIDA: Duncan Church, SE  $\frac{1}{4}$  sec. 36, T. 4 N., R. 14 W., 6 miles southwest of Chipley (station 12724, W. C. Mansfield and F. S. MacNeil collectors); Cedar Grove, 2 miles south of Chipley (station 14278, too poor for certain identification); Westville-Geneva road  $\frac{1}{2}$  miles south of State line in Holmes County (station 10104, C. W. Cooke and Julia Gardner, collectors). All specimens from Florida may be *C. rogersi*.

*Geologic horizon*.—Late Oligocene, Suwannee limestone and Flint River formation.

*Type*.—Comisión del Mapa Geológico de España.

*Remarks*.—The petals of *Clypeaster cotteauui*, as identified by Jackson (1922), are like those of *C. rogersi*, but the margin is thicker, and the oral surface is more deeply concave and lacks conspicuous ambulacral grooves.

CLYPEASTER GATUNI Jackson  
Plate 1, figure 15

*Clypeaster gatuni* JACKSON, 1917, U. S. Nat. Mus. Proc., vol. 53, no. 2218, p. 491, pl. 63, fig. 1; pl. 64, fig. 1, 1917.

*Clypeaster gatuni* JACKSON, 1919, U. S. Nat. Mus., Bull. 103, p. 105, pls. 47, 48.

*Occurrence*.—CANAL ZONE: Near Gatun Dam, (station 5662, type, D. F., MacDonald, collector); swamp north of Ancon Hill and  $\frac{1}{4}$  mile south of Diablo Ridge (station 6237, D. F. MacDonald, collector).

FLORIDA: One mile below Bailey's Ferry, Chipola River, Calhoun County (station 2213, Frank Burns, collector U. S. Nat. Mus. 164671, figured).

*Geologic horizon*.—Early Miocene; Gatun formation (type) and Emperador limestone in Canal Zone; Chipola formation in Florida.

*Type*.—U. S. Nat. Mus. 324453.

*Remarks*.—Only one specimen, about half as large as the type, has been found in Florida.

Family SCUTELLIDAE Agassiz, 1841

Genus PERIARCHUS Conrad, 1866

*Mortonia* DESOR, 1858, Synopsis des échinides fossiles, p. 231. (Not *Mortonia* Gray, 1851)

*Mortonia* (*Periarchus*) CONRAD, 1866, Smithsonian Misc. Coll. vol. 7 (200), p. 21.

*Mortonella* POMEL, 1883, Classification méthodique et généra des échinides, p. 70.

*Periarchus* GRABAU and SHIMER, 1910, North American index fossils, vol. 2, p. 591.

*Mortonella* STEFANINI, 1911, Soc. geol. italiana Boll., vol. 30, p. 684.

*Periarchus* STEFANINI, 1911, idem., p. 687.

*Mortonella* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 316.

*Periarchus* LAMBERT and THIÉRY, 1914, idem., p. 316.

*Mortonella* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 128.

*Periarchus* CLARK and TWITCHELL, 1915, idem., p. 130.

Genotype, *Sismondia alta* Conrad, 1865, a variant of *Scutella lyelli* Conrad, 1834,



from the late Eocene Castle Hayne marl of North Carolina, designated by Stefanini (1911, p. 687).

*Periarchus* has five genital pores; open, slender, rather short petals, in which one or two pairs of pores extend beyond the rounded tip; twice-branching ambulacral furrows on the lower surface carrying buccal tubes; and many internal stalactitic pillars and partitions around the margin. *Mortonia* (genotype *Scutella quinquefaria* Say) differs from *Periarchus* only in its generally thicker margin and somewhat less distal periproct, both variable features.

#### PERIARCHUS LYELLI (Conrad)

- Scutella lyelli* CONRAD, 1834, Acad. Nat. Sci. Philadelphia Jour., ser. 1, vol. 7, p. 152.  
*Scutella pileus-sinensis* RAVENEL, 1844, Acad. Nat. Sci. Philadelphia Proc., vol. 2, p. 97.  
*Scutella* sp. EMMONS, 1858, Agriculture of the eastern counties, p. 308, figs. 247, 248.  
*Sismondia alta* CONRAD, 1865, Acad. Nat. Sci. Philadelphia Proc., ser. 2, vol. 9, p. 74.  
*Periarchus pileus-sinensis* STEFANINI, 1911, Soc. geol. italiana Boll., vol. 30, p. 688, pl. 22, figs. 4a-b, 5a-b.  
*Periarchus altus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 130, pl. 58, figs. 1a-e.  
*Periarchus lyelli* CLARK and TWITCHELL, 1915, idem, p. 131, pl. 61, figs. 2a-f; pl. 62, figs. 1a-c, 2a-d.  
*Periarchus pileus-sinensis* CLARK and TWITCHELL, 1915, idem., p. 135, pl. 63, figs. 1a-e, 2a-d.

*Occurrence*.—NORTH CAROLINA: Craven County (type of *Sismondia alta*); Castle Hayne phosphate works, New Hanover County (station 4286, L. W. Stephenson, collector); Northeast Cape Fear River 3½ miles above Castle Hayne (L. W. Stephenson, collector; station 10616, L. B. Kellum, collector); city quarry, near Wilmington (station 3602, Frank Burns, collector; station 3609, T. W. Vaughan, collector; station 4285, L. W. Stephenson, collector; station 7302, B. L. Miller, collector; station 10613, L. B. Kellum, collector); Rocky Point, Pender County (station 779, T. W. Stanton, collector); Moores Creek 2 miles west of Angola and 3 miles northeast of Maple Hill, Pender County, on farm of J. L. Fisher (station 10619, L. B. Kellum, collector); 2 to 2½ miles southwest of Charity, Duplin County (station 11816, W. C. Mansfield collector); 2 miles south of Magnolia, Duplin County, on farm of B. D. Johnson (station 10622, L. B. Kellum, collector); Trent River ¼ mile southwest of Comfort, Jones County (station 10630, L. B. Kellum, collector); 10 miles northwest of Jacksonville, Onslow County, on J. J. Thomas' farm (station 10636, L. B. Kellum, collector); 1 mile west of Maple Cypress, Craven County, on farm of Douglas Green (station 12007, W. C. Mansfield,

collector); Cove Creek, Craven County (type of *Sismondia alta*).

SOUTH CAROLINA: About 6 miles south of Black Oak Lock of Santee Canal, Berkeley County, on estate of Dr. Philip G. Prioleau (type of *Scutella pileus-sinensis*); Santee Canal (U. S. Nat. Mus. 5133, Col. Totten, collector).

GEORGIA: Ring Jaw Landing on Oconee River 2 miles west of Kittrell's, Johnson County (station 3961, S. W. McCallie, collector) 2½ miles southeast of Stony Creek Church, Twiggs County, (station 7432, J. E. Brantly, collector); 3 miles north of Adams Park, Twiggs County, on land of Col. Minter (station 7437, C. W. Cooke, collector); Marion road 0.4 mile southwest of Bond's store, Bibb County, 9 miles south of Macon (station 7695, C. W. Cooke, collector); Blue Ruin plantation, Houston County, 10 miles east-northeast of Montezuma (station 7690, C. W. Cooke, collector); Georgia Southern and Florida Railway ½ mile south of Tivola, Houston County (station 3760, S. W. McCallie, collector); quarry at Clinchfield, 1 mile south of Tivola (stations 7689, 12098, C. W. Cooke, collector; 13183, J. W. Rhodes, collector; 10499, C. W. Cooke and T. M. Prettyman, collectors); Elko road 2 miles south of Perry (station 3966, S. W. McCallie, collector) Ross Hill, Elko road 3½ miles south of Perry (stations 5535 and 5536, T. W. Vaughan, collector; 5540, Otto Veatch, collector; 7683, 7684, C. W. Cooke, collector); Elko road 4½ miles south of Perry (station 5588, Otto Veatch, collector); railway ¼ mile north of Bonaire, Houston County (station 3970, S. W. McCallie, collector); Boughton place, 2 miles northwest of Westlake, Houston County (station 8270, J. E. Brantly, collector); Small's place 4 miles east of Kathleen, Houston County (station 8272, J. E. Brantly, collector); Pennahatchee Creek about 1 mile above its mouth, Dooly County (station 12022, C. W. Cooke and W. H. Monroe, collectors); Flint River ¼ mile below the mouth of Spring Creek, Sumter County (station 7107, C. W. Cooke and J. E. Brantly, collectors); Big Shellstone Creek on Deese plantation, 5 miles north-northeast of Coley, Bleckley County (stations 2310, S. W. McCallie, collector; 7433, J. E. Brantly, collector); Ainslie, Bleckley County (station 7434, J. E. Brantly, collector); the Brooks farm, 12 miles southeast of Marshallville, Macon County (station 3993, S. W. McCallie, collector); 3 miles southeast of Marshallville (station 3975, S. W. McCallie, collector); 4 miles south of Marshallville (station 3786, S. W. McCallie, collector); Rich Hill, Crawford County 5½ miles east-southeast of Knoxville (stations 3604, T. W. Vaughan, collector; 4004, S. W. McCallie, collector; 4959, L. W. Stephenson, collector); Chattahoochee River below Lower Gordon Landing, Early County, 1½ miles above Alaga, Ala. (station 8253, C. W. Cooke and O. B. Hopkins, collectors); Chattahoochee River ½ mile above Alaga (station 8255, C. W. Cooke and O. B. Hopkins, collectors); Chattahoochee River at railway bridge near Saffold, Early County (station 8249, H. K. Shearer, collector); Chattahoochee River above highway bridge at Saffold

(station 12100, C. W. Cooke and W. H. Monroe, collectors).

FLORIDA: Pit between Inglis and Yankeetown, Levy County (station 14544, C. W. Cooke and W. D. Havens, collectors); drainage ditch in Citrus County on Florida 15, 5.2 miles northwest of Crystal River.

ALABAMA: Chattahoochee River 1 mile below Lower Gordon's Landing (station 7265, L. C. Johnson, collector); Choctawhatchee River at railway bridge at Geneva (station 6757, C. W. Cooke, collector); 100 yards above the mouth of Pea River (station 10039, C. W. Cooke and Julia Gardner, collectors); Pea River  $1\frac{1}{2}$  miles southwest of Geneva (station 8864, F. G. Clapp, collector); falls of Double Bridges Creek 5 miles east of Samson, Geneva County (stations 8859, 8861, F. G. Clapp, collector); Conecuh County (station 393, L. C. Johnson, collector); Sepulga River opposite Ward's sawmill, sec. 8., T. 3 N., R. 13 E. (station 6745, C. W. Cooke, collector); railway  $\frac{1}{2}$  mile south of Drewry, Monroe County (station 6720, C. W. Cooke, collector); Claiborne (type of *Scutella lyelli*, stations 2393, Frank Burns, collector; 5556, 5565, T. W. Vaughan, collector); Alabama River below Marshallville (station 295, L. C. Johnson, collector); east of Jones Field Branch, in sec. 35, T. 8 N., R. 3 E., 5 miles southeast of Whatley, Clarke County (station 7161, C. W. Cooke, collector); 1 mile southwest of Rockville, Clarke County (station 6158, G. C. Matson, collector); Gopher Hill, Tombigbee River, Washington County (stations 5605, T. W. Vaughan, collector; 6087, George Little, collector); 4 miles west of Silas, Choctaw County (station 7878, O. B. Hopkins, collector); Fail road south of Willow Branch, 4 miles southwest of Silas (station 7215, C. W. Cooke, collector); 1 mile west of old Cocoa Postoffice, Choctaw County (station 2896, L. C. Johnson, collector).

MISSISSIPPI: Shubuta Creek  $2\frac{1}{2}$  miles north of Shubuta, Clarke County (station 331, Frank Burns, collector); Chickasawhay River near Shubuta (station 332, Frank Burns, collector); prairies 2 miles southwest of Shubuta (station 335, Frank Burns, collector); railroad cut southwest of the pumping station at Jackson (station 12172, C. W. Cooke, R. B. Stewart, and W. H. Monroe, collectors); NE corner sec. 32, T. 10 N., R. 13 E.,  $\frac{1}{2}$  mile west of Frost Bridge, Wayne County (station 14280, W. C. Mansfield and F. S. MacNeil, collectors).

LOUISIANA: Below the ferry landing at Montgomery, Grant Parish (station 2638, T. W. Vaughan, collector, fragments presumably of this species).

*Geologic horizon.*—Late Eocene, Castle Hayne marl (North Carolina), Santee limestone (South Carolina). Lower part of the Ocala limestone (Georgia and Alabama), Moodys marl (Alabama, Mississippi and Louisiana).

*Type.*—Probably Acad. Nat. Sci. Philadelphia; type of *Sismondia alta*, U. S. Nat.

Mus. 498960, deposited by Williams College.

*Remarks.*—*Periarachus lyelli* is very abundant and variable. The variety occurring at Claiborne, Ala., near which the type is reported to have been found, is gently convexly tumid. All gradations exist between this typical form and the conical variety with slightly concave slopes to which Ravelin applied the name *pileus-sinensis*. As these variations occur in the same bed and at many different places, there seems to be no reason for retaining both names, unless one wishes to distinguish as varieties the end members of the series, which are widely different in appearance. The holotype of *Sismondia alta* has wider interporiferous zones and narrower poriferous zones than is customary in *Periarachus lyelli*, which normally shows some variation in these features. I regard it as an aberrant form of *P. lyelli*. Other specimens from North Carolina are conspicuously subtriangular but in other respects resemble typical *P. lyelli*. This subtriangular variety occurs also at several places near Geneva, Ala. The specimens from Florida have rounded petals very like those of var. *alta*.

#### PERIARCHUS PROTUBERANS Twitchell

*Periarachus protuberans* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 133, pl. 62, figs. 3a-f.

*Occurrence.*—MISSISSIPPI: Shubuta Creek  $2\frac{1}{2}$  miles north of Shubuta, Clarke County (station 331, type, Frank Burns, collector); Chickasawhay River near Shubuta (station 332, Frank Burns, collector).

*Geologic horizon.*—Late Eocene, Jackson group.

*Type.*—U. S. Nat. Mus. 164685.

#### PERIARCHUS QUINQUEFARIUS (Say)

*Scutella 5-faria* SAY, 1825, Acad. Nat. Sci. Philadelphia Jour., ser. 1, vol. 5, p. 228.

*Scutella rogersi* Morton. AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 85, pl. 19a, figs. 1-4.

*Mortonia rogersi* (Morton). DESOR, 1858, Synopsis des échinides fossiles, p. 231.

*Mortonia quinquefaria* CONRAD, 1866, Smithsonian Misc. Coll., vol. 7 (200), p. 32.

*Mortonella rogersi* (Morton). POMEL, 1883, Classification méthodique et généra des échinides, p. 70.

*Scutella (Mortonia) rogersi* Morton. DE GREGORIO, 1890, Mon. faune éocénique de l'Alabama, p. 250, pl. 43, figs. 17-20 (not fig. 16).

*Mortonella rogersi* (Agassiz, not Morton). STEF-

ANINI, 1911, Soc. geol. italiana Boll., vol. 30, p. 685, pl. 22, figs. 2, 3.  
*Mortonella quinquefaria* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 128, pl. 60, figs. 2a-f; pl. 61, figs. 1a-b.

*Occurrence*.—GEORGIA: Near Milledgeville, (types); spring and lime sink 1 mile southwest of the court house at Sandersville, Washington County (stations 3955, S. W. McCallie, collector; 10489, C. W. Cooke and T. M. Prettyman, collectors; 5250, T. W. Vaughan, collector; 7705, C. W. Cooke, collector); quarry of Atlantic Lime Rock Co. 1½ miles south of Sandersville (station 12099, C. W. Cooke and W. H. Monroe, collectors); cut on Central of Georgia Railway between mileposts 138 and 139, Washington County (station 3959, S. W. McCallie, collector); Dublin road 4.6 miles southwest of Tennesse, Washington County, at crossing of Central of Georgia Railway (station 10500, C. W. Cooke and T. M. Prettyman, collectors); 1½ miles northwest of Tennesse (station 3761, S. W. McCallie, collector); T. W. Smith's farm 2¼ miles south of Warthen, Washington County (station 3953, S. W. McCallie, collector); 1 mile south of Waynesboro, Burke County (station 10504, C. W. Cooke and T. M. Prettyman, collectors).

*Geologic horizon*.—Late Eocene, Sandersville limestone member of the Barnwell formation.

*Types*.—Acad. Nat. Sci. Philadelphia.

*Remarks*.—*Periarachus quinquefarius* seems to be restricted to the vicinity of Washington and Burke counties, Georgia. Say's types could not have come from very near Milledgeville, for that town is situated on ancient igneous and metamorphic rocks. Old labels referring this species to Alabama can not be trusted; the error is due to a regrettable confusion with *Clypeaster rogersi* (Morton), whose type came from Alabama.

PERIARCHUS KEWI Cooke, n. sp.

Plate 1, figures 12–14

Test circular, margin weakly fluted, thin, covered with small tubercles. Apical region tumid; five genital pores at the same distance from the center as the apical ends of the petals. Petals nearly closed at the apical ends; wider open at the outer ends; interporiferous zones somewhat narrower than poriferous zones, nearly straight, widening slightly distally; inner pores round, connected by grooves with the slot-shaped outer pores; petals extending three-fifths the way to the margin. Petals encircled by a tumid ring, which gives the submarginal area a bevelled appearance. Base flat; ambulacral

furrows branching about halfway to the margin; buccal tubes extending to the bifurcation. Peristome nearly circular, sunken, about twice as large as the periproct. Periproct small; midway between the peristome and the margin.

Length, 49 mm.; width, 51 mm.; height, 10 mm.; diameter of peristome, 2.5 mm.

*Occurrence*.—GEORGIA: Highway 341 4.2 miles southeast of Clinchfield, Houston County (U. S. Nat. Mus. 499000, W. S. W. Kew and C. W. Cooke, collectors).

*Geologic horizon*.—Late Eocene, Cooper marl.

*Type*.—U. S. Nat. Mus. 499000.

*Remarks*.—*Periarachus kewi* is closely related to *P. quinquefarius* but differs from that species in its bevelled margin and tumid submarginal band.

Genus ECHINARACHNIUS Gray, 1825

*Echinarachnius* (part) GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 428.

*Echinarachnius* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, pp. 88, 148.

*Echinarachnius* DESOR, 1858, Synopsis des échinides fossiles, p. 230.

*Scutella* (*Echinarachnius*) A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 315.

*Phelsumia* POMEL, 1883, Classification méthodique et genera des échinides fossiles, p. 70. Genotype, *Scutella parma* Lamarck, 1816, here designated.

*Echinarachnius* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 66.

*Phelsumaster* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 316. Genotype, *Scutella parma* Lamarck.

*Echinarachnius* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 56.

Genotype, *Scutella parma* Lamarck, fixed by elimination by Agassiz, 1841. The reason for crediting this genus to Gray rather than to Leske is stated by H. L. Clark (1911, p. 598).

ECHINARACHNIUS PARMA (Lamarck)

*Scutella parma* LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 11.

*Echinarachnius parma* GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 428.

*Echinarachnius parma* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 89, pl. 20, figs. 9–18.

*Echinarachnius parma* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pt. 2, p. 316, pl. 11d, figs. 4, 5; pl. 11e, figs. 4, 5; pl. 12, figs. 1–13.

*Echinarachnius parma* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 62, pl. 9, figs. 1, 2; pl. 19, fig. 2; pl. 30, fig. 8.

*Occurrence*.—Atlantic coast of North America from New Jersey northward and Pacific coast northward from Puget Sound.

*Geologic horizon*.—Recent.

*Remarks*.—This species, the common sand dollar of the northern Atlantic coast, has not been reported fossil in North America.

Genus PROTOSCUTELLA Stefanini, 1924

*Protoscutella* STEFANINI, 1924, Geol. Soc. America Bull., vol. 35, p. 843.

Genotype, *Scutella mississippiensis* Twitchell.

Stefanini defines this genus as follows:

*Scutella mississippiensis* Twitch., provided with five genital pores and bifurcated actinal furrows, is very different from the true Miocene Scutellas, which have by definition four genital pores and branching actinal furrows. On the other hand, it differs from *Periarchus* (to which it is, however, more allied), by its more important characters, not so much by the shape, more low and flat, as especially by its periproct on the edge of the test. I apply to this species the name *Protoscutella*. As to *S. tuomeyi* Twitch., it is in some ways intermediate between *Protoscutella* and *Periarchus*; but, notwithstanding its flattened shape, I would include them in the second of these genera, to which it corresponds by the position of the anus. In any case it is not a *Scutella*.

Twitchell and Stefanini (whose knowledge of the species was based entirely on Monograph 54) were mistaken in crediting *Protoscutella mississippiensis* with bifurcated actinal furrows. Each furrow is straight and unbranched, like those of *Clypeaster* but less conspicuous and having one raised thread (buccal tube) near the peristome. The genus may be described thus:

Test low, generally broader than long. Upper surface usually somewhat swollen medially. Lower surface nearly flat, commonly somewhat concave around the margin, having five straight ambulacral furrows and buccal tubes. Margin thin, usually truncated and slightly notched posteriorly, the notch in some individuals extending to the periproct. Apical disk with five genital pores situated (in all the known species) in such a manner that a straight line drawn through two adjacent genital pores passes through an ocular pore. Petals of nearly

equal length, extending about halfway to the margin; open at the distal ends and having a few detached pores there. Peristome small, subcircular, flush. Periproct closer to the margin than to the peristome, sometimes marginal, the closeness to the margin depending upon the depth of the posterior notch.

PROTOSCUTELLA MISSISSIPPIENSIS  
(Twitchell)

*Scutella mississippiensis* TWITCHELL, 1915, U. S.

Geol. Survey Mon. 54, p. 124, pl. 59, figs. 1a-f. *Protoscutella mississippiensis* STEFANINI, 1924, Geol. Soc. Am. Bull., vol. 35, p. 843.

*Monostychia mississippiensis* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 583.

*Occurrence*.—MISSISSIPPI: Cemetery Creek west of Enterprise, Clarke County (station 115, 116, 129, type, L. C. Johnson, collector); Chickasawhay River at Enterprise (stations 346, 2629, Frank Burns, collector); McCanns Creek bluff on Chickasawhay River 4 miles southwest of Enterprise (station 345, Frank Burns, collector).

TEXAS: Mt. Enterprise, in the southeast part of Rusk County (station 2056, L. C. Johnson, collector); San Augustine (stations 512, T. W. Vaughan, collector; 13144, Julia Gardner, collector); 6 miles west of San Augustine on the Nacogdoches road (station 13267, Julia Gardner and W. P. Popenoe, collectors).

*Geologic horizon*.—Middle Eocene, Winona sand member of the Lisbon formation in Mississippi; Mount Selman formation in Texas.

*Type*.—U. S. Nat. Mus. 137655.

PROTOSCUTELLA CONRADI (Cotteau)

*Sismondia marginalis* CONRAD, 1865, Acad. Nat. Sci. Philadelphia Proc. p. 75. (Not Des Moulins, 1837).

*Sismondia conradi* COTTEAU, 1891, Paléontologie française, Échinides éocènes, t. 2, p. 300.

*Scutella conradi* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 126, pl. 64, figs. 1a-d.

*Occurrence*.—SOUTH CAROLINA: Locality not specified (type).

NORTH CAROLINA: Farm of J. A. Stokes 2 miles north of creek near Maple Cypress, Craven County (station 8165, J. A. Cushman, collector); farm of A. R. Bland 1½ miles northeast of Rose Hill, Duplin County (station 10621, L. B. Kellum, collector), farm of T. J. Falkner 3 miles east of Quinerly and 2 miles north of Neuse River, Craven County (station 10627, L. B. Kellum, collector).

*Geologic horizon*.—Late Eocene, probably Santee limestone in South Carolina, Castle Hayne marl in North Carolina.



## PROTOSCUTELLA TUOMEYI (Twitchell)

*Scutella tuomeyi* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 125, pl. 60, figs. 1a-d.

*Periarachus tuomeyi* STEFANINI, 1924, Geol. Soc. America Bull., vol. 35, p. 843.

*Occurrence.*—SOUTH CAROLINA: Cave Hall, Orangeburg County, 14 miles south of Ft. Motte (station 2017, Frank Burns, collector).

*Geologic horizon.*—Eocene, probably Santee limestone or possibly McBean formation.

*Type.*—U. S. Nat. Mus. 137970.

*Remarks.*—*Protoscutella tuomeyi*, known only from the type, may prove to be a synonym of *P. conradi*. The most conspicuous difference is in the location of the periproct, which is farther from the margin in *P. tuomeyi*. The posterior margin of *P. tuomeyi* is less strongly notched than that of *P. conradi*. The type is twice as large as that of *P. conradi*.

## PROTOSCUTELLA PENTAGONIUM

Cooke, n. sp.

Plate 2, figures 4-6

Test subpentagonal, tumid medially, margin thin, slightly bent down; covered with small tubercles. Apical system central; five genital pores. Petals equal in length, lanceolate, open at the ends, extending half-way to the margin; interporiferous zones about equal in width to the poriferous zones; anterior petal swollen at the apical end, somewhat wider than the others. Lower surface flat except for the turning down of the margin; ambulacral furrows straight, extending almost to the margin. Peristome small, central, round. Periproct round, one-fourth the way from the margin to the peristome; connected with the margin by a shallow furrow.

Length, 30 mm.; width, 30 mm.; height, 6 mm.

*Occurrence.*—FLORIDA: Well of the Chipley Oil Co. at Falling Water, 4 miles south of Chipley, Washington County (depth unknown probably about 600 feet; embedded in white sand; station 13145, type, C. W. Cooke collector).

TEXAS: Nacogdoches County (station 7951, Mr. Bruyere, collector); 12 to 13 mile west of San Augustine on Nacogdoches road (station 13269, Julia Gardner, collector); 5 miles west of San Augustine on Nacogdoches road (U. S. Nat. Mus. 499111, Julia Gardner, collector).

*Geologic horizon.*—Middle Eocene; prob-

ably Lisbon formation in Florida, Mount Selman formation in Texas.

*Type.*—U. S. Nat. Mus. 498992.

*Remarks.*—The specimens from Texas, which are rounder and smaller than the type, are somewhat doubtfully identified as this species.

## PROTOSCUTELLA PLANA (Conrad)

*Scutella crustuloides* MORTON. MORTON, 1833, Am. Jour. Sci., vol. 24, pl. 10, fig. 8. (Not description, p. 131.)

*Scutella lyelli* CONRAD. MORTON, 1834, Synopsis organic remains Cretaceous, p. 77, pl. 10, fig. 8. (Figure same as preceding.)

*Sismondia plana* CONRAD, 1865, Acad. Nat. Sci. Philadelphia Proc., p. 75.

*Mortonia (Periarachus) planus* CONRAD, 1866, Smithsonian Misc. Coll., vol. 7 (200), p. 21.

*Sismondia plana* COTTEAU, 1891, Paléontologie française, Échinides éocènes, t. 2, p. 299.

*Monostychia plana* GREGORY, 1891, Geol. Soc. America Bull., vol. 3, p. 108.

*Periarachus? planus* STEFANINI, 1891, Soc. geol. italiana Boll., vol. 30, p. 699.

*Sismondia? plana* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 121, pl. 57, figs. 4a-d.

*Occurrence.*—SOUTH CAROLINA: Not specified (type); Eutaw Springs, Orangeburg County (stations 7968 and 13391, C. W. Cooke, collector).

NORTH CAROLINA: Farm of J. C. Teachey, Duplin County 3 miles northeast of Teachey depot (station 10620, L. B. Kellum, collector); marl pit 2½ miles southwest of Charity, Duplin County (station 11816, W. C. Mansfield, collector).

*Geologic horizon.*—Late Eocene, Santee limestone in South Carolina; Castle Hayne marl in North Carolina.

*Type.*—Acad. Nat. Sci. Philadelphia 1080.

*Remarks.*—Clark and Twitchell's figure shows that this species is not congeneric with *Sismondia occitana* (the genotype of *Sismondia*) as figured by Cotteau (1891, p. 272, pls. 271, 272, 273, figs. 1-6). The specimens in the National Museum, which have not been compared with the type, have five genital pores, which remove the species from *Sismondia* and *Peronella*, both of which have only four. The unbranched ambulacral furrows remove it from *Periarachus*. The periproct is not marginal, as in *Protoscutella mississippiensis*, but it is not farther from the margin than that of *P. tuomeyi*.

## Genus SCUTELLA Lamarck, 1816

*Scutella* (part) LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, p. 7.

*Scutella* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, pp. 75, 147.

*Scutella* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes, p. 76.

*Scutella* DESOR, 1858, Synopsis des échinides fossiles, p. 231.

*Scutella* POMEL, 1883, Classification méthodique et genera des échinides, p. 70.

*Scutella* COTTEAU, 1891, Paléontologie française, Échinides éocènes, t. 2, p. 239.

*Scutella* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 317.

*Scutella* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 53.

Genotype, *Echinodiscus subrotundus* Leske (1778, p. 206, pl. 47, fig. 7; Agassiz, 1841, p. 76, pl. 17), Miocene of Bordeaux, by elimination by Agassiz.

#### SCUTELLA ABERTI Conrad

*Scutella aberti* CONRAD, 1842, Nat. Inst. Promotion Sci. Proc., vol. 2, p. 194.

*Scutella aberti* MEEK, 1864, Smithsonian Misc. Coll., vol. 7 (183), p. 2.

*Scutella aberti* CLARK, 1904, Maryland Geol. Survey, Miocene, p. 432, pl. 129, figs. 2, 2a; pl. 120, figs. 1a, b, 2a, b.

*Scutella aberti* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 187, pl. 86, figs. 1a, b; pl. 87, figs. 1a-d.

*Occurrence*.—MARYLAND: Jones Wharf, St. Marys County (station 2451, Frank Burns, collector; W. R. Maxon, collector); Governor Run, Calvert County (Maryland Geological Survey); Scientists' Cliffs, Chesapeake Bay 1½ miles north of Governor Run (A. H. Clark, collector; W. F. Foshag, collector); Dover Bridge, Dorchester County (Maryland Geological Survey).

*Geologic horizon*.—Miocene, Choptank formation.

*Remarks*.—Clark and Twitchell were mistaken in crediting *Scutella aberti* with five genital pores; it has only four. The species differs from *S. subrotunda* in its ambulacral furrows, which branch much nearer the peristome. The outer ends of its petals are more evenly rounded, its periproct is smaller and farther from the margin, and its posterior notch is much deeper. The depth and shape of the notch, however, are variable in the Maryland species, most individuals being more deeply notched than the one figured by Clark. The individual plates in *Scutella aberti* are very loosely connected and fall apart very easily.

SCUTELLA FLORIDANA Cooke, n. sp.

Plate 4, figures 9, 10

Test large, flat, broader than long; margin thin, sinuous, with a deep, narrow posterior notch. Upper surface gently tumid medially, slightly concave around the margin. Apical system central; madreporite large, star-shaped, with four genital pores at the tips; petals wide, slightly open and broadly rounded or truncate at the tips, extending more than halfway to the margin; poriferous zones widening distally; interporiferous zones narrower at each end than in the middle, where they equal the poriferous zones. Lower surface flat; grooves bifurcating near the peristome. Peristome central, subcircular, with protruding buccal tubes. Periproct round or oval, smaller than the peristome, near the margin.

Length, 106 mm.; width, more than 122 mm.; height, 12.5 mm.

*Occurrence*.—FLORIDA: Sopchoppy, Wakulla County (station 7468, type, G. C. Matson, collector; station 10972, W. C. Mansfield, collector); Rouse's place, 3 miles west of Sopchoppy (station 4977, F. G. Clapp, collector).

*Geologic horizon*.—Miocene, Hawthorn formation.

*Type*.—U. S. Nat. Mus. 498980.

*Remarks*.—The petals of *Scutella floridana* appear to be blunter at the ends than those of *S. aberti*, its posterior notch is narrower, its periproct is nearer the margin, and its plates are more firmly joined and have less conspicuous sutures. *S. floridana* is closely related to *S. cazonensis* Kew from the State of Vera Cruz, Mexico, but its interporiferous zones appear to be narrower, its notch is much deeper than that of the type of *S. cazonensis*, and its periproct is nearer the margin. However, the closeness of the periproct to the margin may depend upon the depth of the notch, which is variable.

#### Genus ENCOPE Agassiz, 1840

*Encope*, AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, pp. 6, 17.

*Encope* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 45.

*Encope* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes, p. 79.

*Encope* DESOR, 1858, Synopsis des échinides fossiles, p. 237.

*Encope* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 324.



*Encope* POMEL, 1883, Classification méthodique et genera des échinides p. 71.

*Encope* H. L. CLARK, 1911, Ann. and Mag. Nat. History, ser. 8, vol. 7, p. 599 (*Encope* by misprint).

*Encope*, H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem. vol. 46, p. 72.

*Encope* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 325, 1921.

Genotype, *Encope grandis* Agassiz, living off the Pacific Coast of the Americas, by monotypy. The description of the genus must serve as the original description of this species, which was later described and figured by Agassiz (1841, p. 57, pl. 6).

#### ENCOPE EMARGINATA (Leske)

Plate 3, figures 14, 15

*Echinodiscus emarginatus* LESKE, 1778, Naturalis dispositio echinodermatum, p. 200, pl. 50, figs. 5, 6.

*Encope emarginata* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 47, pl. 10.

*Encope emarginata* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 325, pl. 12, figs. 14–24; pl. 12b, figs. 1–3; pl. 12d, figs. 2, 3.

*Encope emarginata* H. L. CLARK, 1914, idem., vol. 46, p. 74, pl. 125, fig. 25.

*Occurrence*.—NORTH CAROLINA: Farm of James Dawson 3 miles north of Grifton, Pitt County (figured, U. S. Nat. Mus. 166525, Harvey Bassler, collector); North shore of Lake Waccamaw, Columbia County (station 13379, base of upper bed, F. S. MacNeil, collector); Wilmington (station 3610, fragments, T. W. Vaughan, collector).

SOUTH CAROLINA: Intracoastal Waterway Canal 3 to 5 miles southwest of Little River, Horry County (station 13377, C. W. Cooke, collector; station 13427, W. C. Mansfield and F. S. MacNeil, collectors; S. F. Blake, collector; Charleston Museum, G. Robert Lunz, collector).

LIVING: Uruguay northward to Yucatan, perhaps to South Carolina.

*Geologic horizon*.—Miocene, Duplin marl, or Pliocene, Waccamaw formation, in North

Carolina; Pliocene, Waccamaw formation, in South Carolina; Recent.

#### ENCOPE MACROPHORA (Ravenel)

*Scutella macrophora* RAVENEL, 1842, Acad. Nat. Sci. Philadelphia Jour. ser. 1, vol. 8, pt. 2, p. 334, text fig.

*Encope macrophora* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 3.

*Encope macrophora* TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 2, pl. 1, fig. 3.

*Macrophora raveneli* CONRAD, 1865, Acad. Nat. Sci. Philadelphia Proc., p. 74.

*Encope macrophora* (part) CLARK and TWITCHELL 1915, U. S. Geol. Survey Mon. 54, p. 206, pl. 93, figs. 2a–e; pl. 94, fig. 2; not pl. 94, figs. 1a–f.

*Occurrence*.—SOUTH CAROLINA: The Grove, on Cooper River, Berkeley County (Edmund Ravenel, collector; W. Stimpson, collector).

*Geologic horizon*.—Pliocene, Waccamaw formation.

#### ENCOPE TAMIAMIENSIS Mansfield

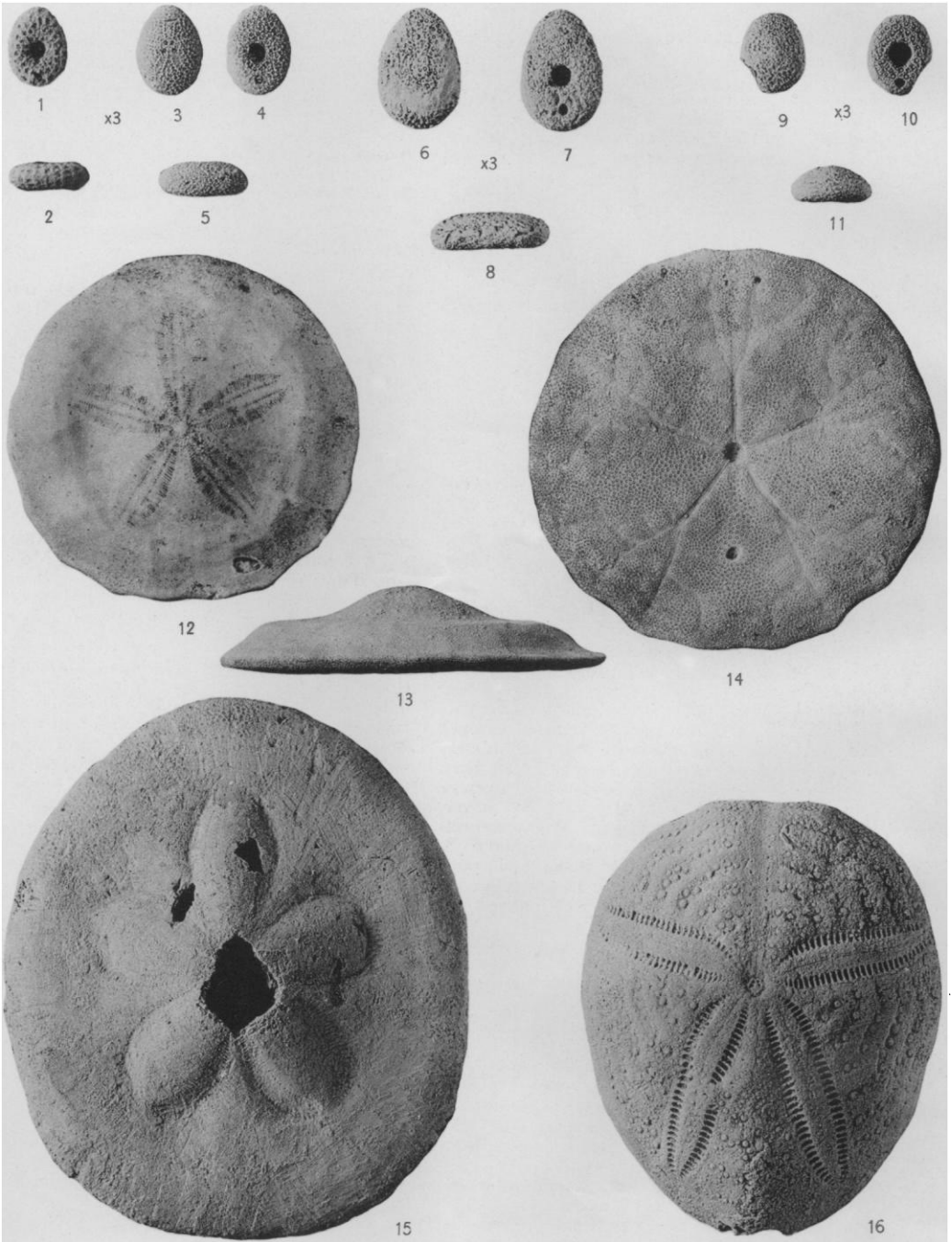
*Encope macrophora* (Ravenel) (part). CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 206, pl. 94, figs. 1a–f.

*Encope macrophora tamiamiensis* MANSFIELD, 1932, U. S. Geol. Survey Prof. Paper 170, p. 48, pl. 17, fig. 8.

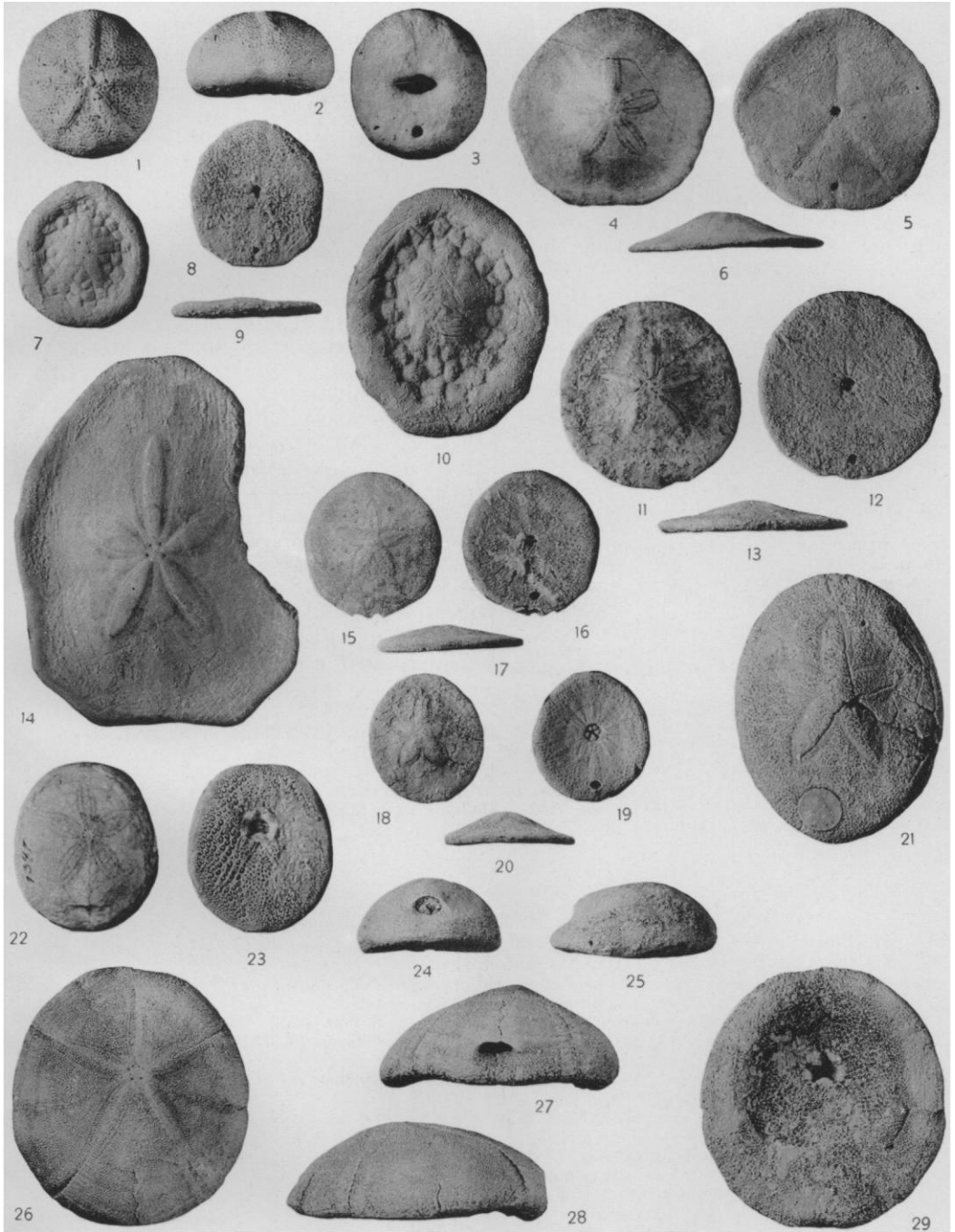
*Occurrence*.—FLORIDA: Tamiami Trail, Collier County 5 miles east of Carnestown and about 7 miles northeast of Everglades (station 11177, type, C. W. Cooke, W. C. Mansfield, and Stuart Mossom, collectors); Tamiami Trail about 6 miles west of the crossroads leading to Everglades (station 11178, C. W. Cooke, W. C. Mansfield, and Stuart Mossom, collectors); Alligator Creek, Monroe County (Joseph Willcox, collector, figured by Clark and Twitchell); 16 to 22 miles south of Immokalee, Collier County (station 13409, G. M. Ponton, collector); Tamiami Trail 56 miles west of Miami (station 13410, G. M. Ponton, collector; Carnestown, Collier County, 4 miles north of Everglades (station 11180, C. W. Cooke, W. C. Mansfield, and Stuart Mossom, collectors)).

#### EXPLANATION OF PLATE 1

- FIGS. 1–5—*Echinocyamus huxleyanus* Meyer. 1, 2, U. S. Nat. Mus. 166503, Claiborne, Ala.; 3–5, U. S. Nat. Mus. 499001, Geneva, Ala.; all  $\times 3$ . Late Eocene. (p. 29)
- 6–8—*Echinocyamus parvus* Emmons. U. S. Nat. Mus. 499002, 10 miles north of Jacksonville, N. C.,  $\times 3$ . Late Eocene. (p. 28)
- 9–11—*Echinocyamus chipolanus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 499003, Alum Bluff, Fla.,  $\times 3$ . Early Miocene. (p. 29)
- 12–14—*Periarachus kewi* Cooke, n. sp. 12, Paratype; 13, 14, holotype, both U. S. Nat. Mus. 499000, 4.2 miles southeast of Clinchfield, Ga.,  $\times 1$ . Late Eocene. (p. 16)
- 15—*Clypeaster gatuni* Jackson. U. S. Nat. Mus. 164671, Baileys Ferry, Fla.,  $\times 1$  (p. 13)
- 16—*Eupatagus (Gymnopatagus) mooreanus* Pilsbry. U. S. Nat. Mus. 372879,  $\times 1$ . Late Eocene. (p. 54)



Cooke, Cenozoic Echinoids



Cooke, Cenozoic Echinoids



*Geologic horizon*.—Pliocene, Caloosahatchee marl.

*Type*.—U. S. Nat. Mus. 371328.

*Remarks*.—*Encope tamiamiensis* differs from *E. macrophora* as follows: its lunule is smaller; it is proportionately wider; its margin is thinner; its apical center is farther back; its anterior pair of petals do not lie nearly in a straight line, like those of *E. macrophora*, but form an angle of about 150°; the interporiferous zones of the anterior pair of petals are not nearly straight-sided, like those of *E. macrophora*, but are narrower at the ends than in the middle. These differences appear to be constant.

ENCOPE MICHELINI Agassiz  
Plate 4, figure 6

*Encope michelini* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 58, pl. 6a, figs. 9, 10.

*Encope michelini* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 329, pl. 12b, fig. 4; pl. 12c, figs. 3, 4; pl. 12d, fig. 1.

*Encope michelini* H. L. CLARK, 1914, idem. vol. 46, p. 75.

*Encope michelini* BERRY, 1941, U. S. Nat. Mus. Proc., vol. 90, no. 3113, p. 444, pl. 63.

*Occurrence*.—NORTH CAROLINA: Neills Eddy Landing, Cape Fear River, 28 miles above Wilmington (station 4275, L. W. Stephenson and B. L. Johnson, collectors).

SOUTH CAROLINA: Intracoastal Waterway canal about 3 miles southwest of Little River, Horry County (station 13427, W. C. Mansfield and S. F. MacNeil, collectors; S. F. Blake, collector); railroad bridge over Intracoastal Waterway canal 2 miles west of Myrtle Beach, Horry County (S. F. Blake, collector).

FLORIDA: St. Lucie Canal, 1 mile from Lake Okeechobee, Palm Beach County (station 10593, C. W. Cooke, Herman Gunter, and Stuart Mossom, collectors); Biscayne Bay at 13th Street, Miami, about 25 feet below sea level (station 13401, G. M. Ponton, collector); Biscayne Bay at foot of Northeast 39th Street, Miami, depth not over 20 feet (station 13400, G. M. Ponton, collector); Big Pine Key, Monroe County (station 4954, Samuel Sanford, collector).

RECENT: Gulf of Mexico, Florida to Yucatan.

*Geologic horizon*.—Pliocene to Recent; Waccamaw formation, in North Carolina and South Carolina (station 13427), Caloosahatchee marl in Florida (stations 10593), Pamlico formation in South Carolina (West of Myrtle Beach), and Miami oolite in Florida.

*Figured specimen*.—U. S. Nat. Mus. 499011, station 13427.

*Remarks*.—All of the specimens referred to the Pliocene have broad, shallow anterior and anterolateral notches. Some of them are very tumid at the back, and in some of them the lunule is rudimentary. The lunule of the figured specimen has a raised rim and is shaped like that of *E. macrophora*.

Each of the posterior pair of petals is straight, as in *michelini*, not curved around the lunule, as in *macrophora*.

Genus MELLITA Agassiz, 1841

*Mellita* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 34.

*Mellita* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes, p. 80.

*Mellita* GRAY, 1851, Zool. Soc. London Proc., vol. 19, p. 36.

EXPLANATION OF PLATE 2

All figures X1

- FIGS. 1-3—*Oligopygus rotundus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498991, Koon's mill on Cripple Creek, Geneva County, Ala. Late Eocene. (p. 9)  
 4-6—*Protoscutella pentagonium* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498992, deep well at Falling Water, Washington County, Fla. Middle Eocene. (p. 18)  
 7-10—*Laganum ocalanum* Cooke, n. sp. 7-9, Holotype, U. S. Nat. Mus. 372873, 2 miles nrth of Sumterville, Fla.; 10, paratype, U. S. Nat. Mus. 498993, Ocala, Fla. Late Eocene. (p. 23)  
 11-13—*Rumphia archerensis* (Twitchell). U. S. Nat. Mus. 498994, deep well in Polk County, Fla. Late Eocene. (p. 27)  
 14—*Rumphia eldridgei* (Twitchell). U. S. Nat. Mus. 498999, Steinhatcree River near Clara, Fla. Late Eocene. (p. 27)  
 15-21—*Peronella cubae* Weisbord. 15-17, Variety with several large tubercles, U. S. Nat. Mus. 499115, 6 miles southeast of Crystal River, Fla.; 18-20, variety with few large tubercles, U. S. Nat. Mus. 499114, Branford, Fla.; 21, variety with no large tubercles, U. S. Nat. Mus. 498995, Oakfield, Ga. Late Eocene. (p. 25)  
 22-25—*Cassidulus* (*Cassidulus*) *trojanus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498996, Troy Spring, Lafayette County, Fla. Late Eocene. (p. 32)  
 26-29—*Cassidulus* (*Galerolampas*) *fontis* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498997, deep well at Falling Water, Washington County, Fla. Early Tertiary. (p. 35)

- Mellita* DESOR, 1858, Synopsis des échinides fossiles, p. 236.  
*Mellita* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 319.  
*Mellita* POMEL, 1883, Classification méthodique et genera des échinides, p. 71.  
*Mellita* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 76.  
*Mellita* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 324.  
*Mellita* H. L. CLARK, 1940, U. S. Nat. Mus. Proc., vol. 89, no. 3099, p. 436.  
*Mellita* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., p. 101.

Genotype, *Echinodiscus quinquesperforatus* Leske, living in the western Atlantic, designated (under the name *Mellita testudinata* Klein) by Pomel (1883, p. 71).

MELLITA QUINQUESPERFORATA (Leske)  
 Plate 3, figures 12, 13

- Echinodiscus quinquesperforatus* LESKE, 1778, Naturalis dispositio echinodermatum, p. 197, pl. 21, figs. c, d.  
*Scutella quinquefora* LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 9.  
*Mellita quinquefora* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 36, pl. 3.  
*Mellita testudinata* AGASSIZ, 1841, idem. p. 40, pl. 4a, figs. 7-9.  
*Mellita ampla* MICHELIN, 1858, Rev. et Mag. Zoologie, no. 8, p. 5 of reprint, pl. 9.  
*Mellita quinquefora* var. *ampla* HOLMES, 1860, Post-Pleocene fossils of South-Carolina, p. 3, pl. 1, figs. 6, 6a-b.  
*Mellita testudinata* A. AGASSIZ, 1872, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 141, 538, pl. 11, figs. 13-22; pl. 12a, pl. 12c, figs. 1, 2; pl. 37, figs. 1, 2. Gives additional synonymy.  
*Mellita quinquesperforata* H. L. CLARK, 1914, idem, vol. 46, p. 76, pl. 125, figs. 16-21.  
*Mellita pentapora* (Gmelin) CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 225, pl. 106, fig. 1; pl. 107, figs 1a-c.

*Occurrence*.—LIVING: Massachusetts to Brazil. SOUTH CAROLINA: Wando River (station 7320, Edmund Ravenel, collector); Simmons Bluff, Yorges Island, on Wadmalaw Sound (station 2023, Frank Burns, collector); "Nordmalan" (probably misprint for Wadmalaw, type of *M. ampla* Michelin).

GEORGIA: Brunswick canal (U. S. N. M. 146633, J. M. Couper, collector).

*Geologic horizon*.—Pleistocene, Pamlico formation; and Recent.

*Figured specimen*.—U. S. Nat. Mus. 499012.

*Remarks*.—The fossil form for which Michelin adopted Holmes' manuscript name of *ampla* is much larger than the Recent

form living in the same region, and its petals are somewhat wider open at the ends.

MELLITA QUINQUESPERFORATA TENUIS  
 H. L. Clark

*Mellita quinquesperforata tenuis* H. L. CLARK, 1940, U. S. Nat. Mus. Proc., vol. 89, no. 3099, p. 442, pl. 60, fig. 2; pl. 61, fig. 2.

*Occurrence*.—FLORIDA: Two miles off Sanibel Island (W. J. Clench, collector); Tarpon Springs (E. J. Shadle, collector); Charlotte Harbor (W. H. Dall, collector).

*Geologic horizon*.—Recent.

*Type*.—U. S. Nat. Mus. E 5656.

Genus LEODIA Gray, 1852

*Leodia* GRAY, 1852, Zool. Soc. London Proc. for 1851, vol. 19, p. 36.

*Mellita* AUCTORES (part).

*Leodia* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 324.

*Leodia* H. L. CLARK, 1940, U. S. Nat. Mus. Proc., vol. 89, no. 3099, p. 435.

Genotype, *Leodia richardsonii* Gray, 1852, = *Echinodiscus sexies perforatus* Leske, 1778, by monotypy.

This genus differs from *Mellita* in having a lunule in each of the five ambulacral areas instead of in only four. Moreover, the lunules are formed by the enlargement of pits instead of by the closing of marginal notches.

LEODIA SEXIESPERFORATA (Leske)

*Echinodiscus sexies perforatus* LESKE, 1778, Naturalis dispositio echinodermatum, p. 199, pl. 50, figs. 3, 4.

*Scutella sexforis* LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 9.

*Mellita hexapora* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 41, pl. 4, figs. 4-7; pl. 4a, figs. 11, 12.

*Mellita similis* AGASSIZ, 1841, idem, p. 45, pl. 4, figs. 1-3.

*Leodia richardsonii* GRAY, 1852, Zool. Soc. London Proc. for 1851, vol. 19, p. 36.

*Mellita sexforis* A. AGASSIZ, 1872, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 141, 536, pl. 11, figs. 1-12; pl. 11d, fig. 3. Gives additional synonymy.

*Mellita sexiesperforata* H. L. CLARK, 1914, idem, vol. 46, p. 77, pl. 125, figs. 22, 23.

*Occurrence*.—LIVING: South Carolina to Uruguay.

FLORIDA: Miami (station 4867, John McGonigle, collector).

SOUTH CAROLINA: Wadmalaw River (fide Tuomey and Holmes).

*Geologic horizon*.—Pleistocene to Recent, Miami oolite and Pamlico formation.

LEODIA CAROLINIANA (Ravenel)

*Scutella caroliniana* RAVENEL, 1841, Acad. Nat. Sci. Philadelphia Jour., ser. 1, vol. 8, p. 333, text figure.

*Mellita caroliniana* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4.

? *Mellita caroliniana* TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 3, pl. 1, figs. 4, 4a-b.

*Mellita caroliniana* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 204, pl. 91, figs. 1a-b; pl. 92, figs. 1a-b.

*Occurrence*.—SOUTH CAROLINA: The Grove, Cooper River, Berkeley County (type); Davis Landing, Pee Dee River, Florence County (sta-

tion 7804, L. W. Stephenson, collector, fragment).

*Geologic horizon*.—Pliocene, Waccamaw formation; or Miocene, Duplin marl.

*Remarks*.—Tuomey and Holmes record this species also from Goose Creek and Wadmalaw River. The latter place may have been Simmons Bluff, which is Pleistocene. *Leodia caroliniana* evidently is very closely related to *L. sexiesperforata* and may prove to be identical with it. As figured by Tuomey and Holmes, however, *L. caroliniana* has proportionately longer and blunter petals and a smaller star-shaped apical plate.

Family LAGANIDAE Gregory, 1900

KEY TO THE LAGANIDAE OF EASTERN UNITED STATES

1. Five genital pores . . . . . *Laganum*.
2. Individual plates of submargin tumid . . . . . *Laganum ocalanum*.
2. Individual plates of submargin not tumid . . . . . *Laganum floridanum*.
1. Four genital pores.
2. Lower surface flat . . . . . *Rumphia*.
3. Test much longer than wide . . . . . *Rumphia eldridgei*.
3. Test not much longer than wide . . . . . *Rumphia archerensis*.
2. Lower surface concave . . . . . *Peronella*.
3. Poriferous zones as wide as interporiferous zones . . . . . *Peronella dalli*.
3. Poriferous zones not as wide as interporiferous zones.
4. Petals narrow at apex . . . . . *Peronella crustuloides*.
4. Petals wide at apex . . . . . *Peronella cubae*.

Genus LAGANUM Link, 1807

*Laganum* LINK, 1807, Beschr. Natural.-Samm- lung Rostock, no. 3, p. 161.

*Lagana* GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 427.

*Laganum* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 105.

*Laganum* DESOR, 1858, Synopsis des échinides fossiles, p. 227.

*Laganum* A. AGASSIZ, 1874, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 516.

*Laganum* POMEL, 1883, Classification méthodique et genera des échinides, p. 69.

*Laganum* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 1, p. 44.

*Laganum* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 313.

Genotype, *Laganum petalodes* Link (1807) = *Echinodiscus laganum* Leske (1778, p. 204, pl. 22, figs. a-c) = *Laganum bonani* Agassiz (1841, p. 108, pl. 23, figs. 8-12; pl. 22, figs. 25-29; A. Agassiz, 1874, p. 517, pl. 13e, figs. 6, 7), by tautonomy, living from the Philippines to the Carolines and Tasmania. The Eocene species here tentatively referred to *Laganum* differ from the genotype in that their lower surfaces are much flatter and lack conspicuous ambulacral grooves and grooves behind the periproct.

LAGANUM FLORIDANUM Twitchell

*Laganum floridanum* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 163, pl. 75, figs. 3a-d. *Echinodiscus floridanus* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 581.

*Laganum floridanum* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, figs. 5a-b. (After Twitchell.)

*Occurrence*.—FLORIDA: Johnson's sink, Levy County (station 365, type, L. C. Johnson, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. National Museum 137884.

LAGANUM OCALANUM Cooke, n. sp.

Plate 2, figures 7-10

Outline subpentagonal to oval; margin thick; submargin depressed; petaloidal region tumid; lower surface flat. Individual plates in the area between the thick rim and the petals tumid. Apical system slightly eccentric anteriorly; five genital pores. Petals short, extending about halfway to the margin; nearly closed; poriferous zones much



narrower than interporiferous zones, widely separated at the proximal ends. Peristome very small, pentagonal, central. Periproct about one-quarter way from the margin to the peristome. Tubercles fairly large, of uniform size; more widely scattered on the lower than on the upper surface.

Length of holotype, 22 mm.; width, 19.5 mm.; height, 3.5 mm. Length of paratype, 25.5 mm.; width, 22 mm.; height, 4 mm. A specimen from Ocala is 37 mm. long by 30.7 mm. wide.

*Occurrence.*—FLORIDA: Pit 2 miles northeast of Sumterville (station 12751, type, W. C. Mansfield and G. M. Ponton, collectors; Florida Geol. Survey station 2317; drainage ditch at Great Wall sink near Sumterville (Florida Geol. Survey station 2318, paratype); old MacDonald quarry one mile north of Istachatta (station 11112, C. W. Cooke and Stuart Mossom, collectors); Ocala (station 6804, C. W. Cooke, collector); Zuber, 6 miles north of Ocala (station 6807, C. W. Cooke, collector); 1½ miles northwest of Newberry (station 6814, C. W. Cooke, collector); 1½ miles south of Newberry (Stuart Mossom, collector); old French phosphate mine east of Anthony (station 7366, C. W. Cooke, collector); near Citra (station 7266, L. C. Johnson, collector); Johnson's sink, Levy County (station 365, L. C. Johnson, collector); 1½ miles west of Croom, Hernando County (station 7364, C. W. Cooke, collector); Suwannee River at Branford (station 7341, C. W. Cooke collector); well at Leesburg (station 2076, L. C. Johnson, collector); 1 mile south of Williston (Florida Geol. Survey station 2319); 6 miles southeast of Crystal River (station 14141, W. C. Mansfield and C. W. Mumm, collectors).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—Holotype, U. S. Nat. Mus. 372873; paratype, 498993.

*Remarks.*—This species appears to be closely related to *Laganum floridanum* Twitchell, from which it differs in its strongly tumid submarginal plates, which form conspicuous bumps in the sunken region between the petals and the thickened rim. The apical ends of the poriferous zones of *L. ocalanum* are less incurved than those of *L. floridanum*. The buccal tubes can not be seen in most specimens of *L. ocalanum* but are visible in some from the type locality.

#### Genus PERONELLA Gray, 1855

*Laganum (Peronella)* GRAY, 1855, Catalogue of the Recent Echinida or sea eggs in the collection of the British Museum, p. 13.  
*Laganum (Peronella)* A. AGASSIZ, 1872, Harvard

College Mus. Comp. Zoology Mem., vol. 3, pp. 148, 520.

*Peronella* POMEL, 1883, Classification méthodique et genera des échinides, p. 69.

*Peronella* H. L. CLARK, 1911, Annals and Mag. Nat. History, ser. 8, vol. 7, pp. 599, 605.

*Peronella* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 312.

*Echinodiscus* LAMBERT and THIÉRY, 1914, idem, p. 311; 1925, idem, fasc. 9, p. 580.

*Peronella* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 50.

*Peronella* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 47.

Genotype, *Laganum peronii* Agassiz (1841, p. 124, pl. 22, figs. 21–24; A. Agassiz, 1872, p. 522, pl. 13e, figs. 4, 5; H. L. Clark, 1914, p. 54, pl. 124, figs. 21, 22), by monotypy, living around Australia and Tasmania. The genotype is unique in that its four genital pores lie well outside the apical region, whereas those of all other known species referred to the genus, recent as well as fossil, lie within or contiguous to the apical region. The location of the genital pores has not generally been regarded as of generic importance, though Lambert and Thiéry base their distinction between *Peronella* and *Echinodiscus* on that feature. Their use of *Echinodiscus* is not valid, for its genotype (*E. bisperforatus* Leske, designated by H. L. Clark, 1911, p. 597) is quite different.

Though the genotype is Recent, all the known American species are late Eocene. Three species from the Ocala limestone are treated herein. Jackson (1922) describes one species (*P. mirabilis*) from the San Fernando formation of Trinidad.

#### PERONELLA CRUSTULOIDES (Morton)

*Scutella crustuloides* MORTON, 1833, Am. Jour. Sci., ser. 1, vol. 24, p. 131 (not pl. 10, fig. 8).

*Scutella crustuloides* MORTON, 1834, Synopsis organic remains Cretaceous, p. 77, pl. 15, fig. 10.

*Sismondia crustuloides* DESOR, 1858, Synopsis des échinides fossiles, p. 227.

*Mortonia (Periarthus) crustuloides* CONRAD, 1866, Smithsonian Misc. Coll., vol. 7 (200), p. 21.

*Scutella crustuloides* DE GREGORIO, 1890, Mon. faune éocénique de l'Alabama, p. 251, pl. 43, figs. 24, 25. (After Morton, 1834).

*Sismondia crustuloides* COTTEAU, 1891, Paléontologie française, Échinides éocènes, t. 2, p. 300.

*Periarthus? crustuloides* STEFANINI, 1911, Soc. geol. italiana Boll., vol. 30, p. 699.

*Laganum? crustuloides* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 122, pl. 57, figs. 5a–d, 6a–d.

*Laganum johnsoni* TWITCHELL, 1915, idem, p. 162 pl. 75, figs. 2a-d.

*Echinodiscus crustuloides* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 581.

*Echinodiscus johnsoni* LAMBERT and THIÉRY, 1925, idem, p. 581.

*Laganum johnsoni* COOKE, 1926, Alabama Geol. Survey Special Rept. 14, pl. 96, fig. 2.

*Occurrence*.—Morton's type was collected by T. A. Conrad in the Southern States, probably in Alabama, where the species is abundant.

ALABAMA: Turk's Cave in sec. 19, T. 4 N., R. 13 E., Conecuh County (station 305, type of *Laganum johnsoni* Twitchell, L. C. Johnson, collector; station 10030, C. W. Cooke and Julia Gardner, collectors); Rock Bluff, Conecuh River, in SW.  $\frac{1}{4}$  sec. 28, T. 3 N., R. 14 E. (station 6750, C. W. Cooke, collector; station 10025, figured by Cooke, C. W. Cooke and Julia Gardner, collectors);  $\frac{3}{4}$  mile northwest of Monroeville (station 6722, C. W. Cooke, collector); railroad cut  $\frac{1}{2}$  mile north of Drewry, Monroe County (station 6720, C. W. Cooke, collector).

FLORIDA: Florida Basic Rock Co., 12 miles north of Marianna (station 12058, W. C. Mansfield and G. M. Ponton, collectors); Florida Geol. Survey, G. M. Ponton, collector; Willow Sink,  $1\frac{1}{2}$  or 2 miles west of Chiefland, Levy County (station 7367, C. W. Cooke, collector); old French phosphate mine east of Anthony, Marion County (station 7366, C. W. Cooke, collector); Florida (station 3696, J. L. Oliver, collector).

GEORGIA: Bainbridge (station 3390, T. W. Vaughan, collector; station 13611, A. F. Foerste, collector); Red Bluff on Flint River 7 miles above Bainbridge (station 6159, L. W. Stephenson, collector; station 7098, C. W. Cooke, collector); from well on Newton road  $7\frac{1}{2}$  miles north of Bainbridge and  $\frac{1}{2}$  mile from Flint River (station 3770, S. W. McCallie, collector, figured by Clark and Twitchell as *Laganum crustuloides*); Flint River at Dry Bread Shoals 9 miles below Newton (station 7126, C. W. Cooke, collector); Flint River at spring 2 miles below Norman's Ferry, Mitchell County (station 7128, C. W. Cooke, collector); power plant 2 miles north of Albany (station 5054, T. W. Vaughan, collector; station 12040, C. W. Cooke and W. H. Monroe, collectors); well at Cordele, depth 225 feet (station 3814, S. W. McCallie, collector).

*Geologic horizon*.—Late Eocene; Ocala limestone.

*Type*.—Probably Acad. Nat. Sci. Philadelphia. Type of *Laganum johnsoni*, U. S. Nat. Mus. 137202.

*Figured specimens*.—By Clark and Twitchell, U. S. Nat. Mus. 164744; Boston Soc. Nat. History 8802a, deposited in Mus. Comp. Zoology. By Cooke, 1926, as *Laganum johnsoni*, U. S. Nat. Mus. 372896.

*Remarks*.—As Twitchell suspected, the type of *Laganum johnsoni* proves to be

merely an unusually tumid specimen of the species identified by Clark and Twitchell as *Laganum? crustuloides* (Morton). Whether that identification was made from type is not stated, but as they mention no specimens at Philadelphia it is probable that they did not see it; however, as their specimen represents such a common species and agrees so well with Morton's (1834) figure, there is no reason to doubt its correctness.

Morton's (1833, pl. 10, fig. 8) original figure evidently does not represent his *Scutella crustuloides*, which is described as having a thick margin, whereas the figure apparently represents a thin-margined creature, probably *Protoscutella plana* (Conrad). He used the same figure to illustrate *Scutella lyelli* Conrad in 1834 (p. 77, pl. 10, fig. 8).

*Peronella crustuloides* is very variable in size and shape. The largest specimen in the United States National Museum (from station 10025) measures 55 mm. in length and 45 mm. in width.

#### PERONELLA CUBAE Weisbord

##### Plate 2, figures 15-21

*Peronella cubae* WEISBORD, 1934, Bull. Am.

Paleontology, vol. 20, p. 217, pl. 24, figs. 4-6.

*Peronella quinquenodulata* WEISBORD, 1934, idem, p. 214, pl. 24, figs. 1-3.

*Peronella caribbeana* WEISBORD, 1934, idem, p. 216, pl. 24, figs. 7-9.

Test oval; upper surface more or less convex; lower surface slightly concave. Apical system central; four small genital pores, very obscure, moderately far apart. Petals wide, short, pointed, extending little more than halfway to the margin, nearly closed at the tips; poriferous zones narrow, slightly incurved at the apical end but wide apart there and almost touching the adjacent petals. Peristome small, central, pentagonal, usually retaining the teeth. Periproct transversely oval, about one-fourth of the distance from the margin to the peristome. Tubercles on the upper surface rather widely spaced, small except a central cluster of larger ones between the genital pores; a few large adventitious tubercles on the interambulacral areas present or not; tubercles on the lower surface larger than the ordinary ones on the upper surface.

The species attained a length of at least 40 mm.

*Occurrence.*—FLORIDA: Pit of the Crystal River Rock Company about 6 miles southeast of Crystal River, Citrus County (station 14141, W. C. Mansfield and C. W. Mumm, collectors; pl. 2, figs. 15–17, Frank Westendick, collector); Suwannee River at Dowling Springs, (station 7338, C. W. Cooke, collector); east of Steinhatchee River in Dixie County, opposite Clara (station-12747, W. C. Mansfield and G. M. Ponton, collectors; station 14541, C. W. Cooke and W. D. Havens, collectors); Zuber, 6½ miles north of Ocala (station 6807, C. W. Cooke, collector); Alachua Sink, 3½ miles east of Gainesville (station 6799, T. W. Vaughan and C. W. Cooke, collectors; C. W. Cooke and Stuart Mossom, collectors); 2 miles southeast of the cemetery at Alachua (station 13656, Stuart Mossom, collector); 2 miles north of High Springs (station 6787, T. W. Vaughan and C. W. Cooke, collectors); south of Irvings Ferry near Luraville (station 2613, G. H. Eldridge, collector); old MacDonald quarry 1 mile north of Istachatta, Hernando County (station 11112, C. W. Cooke and Stuart Mossom, collectors); Johnson's sink, Levy County (station 365, L. C. Johnson, collector); old French phosphate mine east of Anthony, Marion County (station 7366, C. W. Cooke, collector); 5½ miles southwest of Gainesville (station 14135, W. C. Mansfield and C. W. Mumm, collectors); Kendrick (station 14125, W. C. Mansfield and C. W. Mumm, collectors); pit west of Florida 19, 5 miles south of Salem, Taylor County (station 14539, C. W. Cooke and W. D. Havens, collectors).

GEORGIA: Flint River at mouth of creek in the northeast corner of Dougherty County (station 7235, C. W. Cooke, collector); Flint River about 1¼ miles above the Georgia, Southwestern, and Gulf Railway near Oakfield, Lee County (pl. 2, fig. 21, station 7116, C. W. Cooke, collector).

CUBA: Province of Camagüey, between Nuevitas and Pastellillo; Loma Calisto (Weisbord).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—Paleont. Research Inst., Ithaca, N. Y.

*Figured specimens.*—U. S. Nat. Mus. 498995, 499114, 499115.

*Remarks.*—The number of large tubercles on *Peronella cubae* is variable; some individuals have more than the figured specimens, many have none. The presence of large adventitious tubercles allies it to *P. mirabilis* Jackson (1922, p. 47, pl. 9, fig. 3), from Trinidad, which, however, has much narrower petals like those of *P. crustuloides*, of which it may prove to be a variant. The greater width of the apical end of the petals distinguishes *P. cubae* from *P. crustuloides*, which usually has a less regularly oval outline but resembles *P. cubae* in its variability in convexity. Many individuals of *P. cubae*

are much more tumid than the figured specimens. Several specimens from Florida show the swollen spots within the petals from which *P. quinquenodulata* derived its name.

PERONELLA DALLI (Twitchell)

*Laganum dalli* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 164, pl. 75, figs. 4a–d.

*Echinodiscus dalli* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 581.

*Laganum dalli* COLE and PONTON, 1932, Am. Jour. Sci., ser. 5, vol. 24, p. 23, fig. 1.

*Occurrence.*—FLORIDA: Archer (type, W. H. Dall, collector); deep well at Leesburg (station 2076, L. C. Johnson, collector); well at Bradenton depth 985–1000 feet (Stuart Mossom, collector); city well at Davenport (found in cleaning the well at a depth of 365 feet, Florida Geol. Survey, collector); well of Palmetto Phosphate Co. near Tiger Bay (I-1600, depth 550 to 620 feet; I-1601, depth 580 feet; I-1602, depth 600 feet, Florida Geol. Survey); well 50 miles west of Miami, depth 1250 feet (E. F. P. Brigham, collector).

GEORGIA: Clinchfield, Houston County (station 14566, C. W. Cooke, collector, imperfect specimen, doubtfully identified).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—U. S. Nat. Mus. 164667b.

*Remarks.*—This species is evidently not a *Laganum*, for it has only four genital pores. Its subpentagonal peristome, its buccal tubes, and its punctate extrapetalous ambulacral regions resemble those of *P. peronii*. In general aspect it resembles *Sismondia occitana* (Defrance), the genotype of *Sismondia*, as figured by Cotteau (1891, p. 272, pl. 271, figs. 1–6) but its petals are nearly closed and rounded at the distal ends and wide open at the apical ends, the opposite of those of *S. occitana*. It is very similar to and perhaps identical with *Sismondia antillarum* Cotteau from the Eocene limestone of St. Bartholomew, but its petals appear to be a little wider and its tubercles a little larger and less numerous than those of the West Indian species. As pointed out by Cole and Ponton, the position of the periproct is variable.

Genus RUMPHIA Desor, 1857

*Rumphia* DESOR, 1857, Synopsis des échinides fossiles, fasc. 4, p. 229.

*Polyaster* MICHELIN, 1859, Rev. et mag. zoologie, sér. 2, vol. 11, p. 397. Not *Polyaster* Gray, 1840.

*Rumphia* POMEL, 1883, Classification méthodique et genera des échinides, p. 69.

*Hupea* POMEL, 1883, idem, p. 69. (Genotype, *Scutella decagonalis* Lesson).

*Rumphia* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 312.

Genotype, *Laganum rostratum* Agassiz (1841, p. 118, pl. 25), living in New Zealand, by original designation.

RUMPHIA ELDRIDGEI (Twitchell)

Plate 2, figure 14

*Laganum eldridgei* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 160, pl. 74, figs. 2a-d.

*Rumphia eldridgei* STEFANINI, 1924, Geol. Soc. America Bull., vol. 35, pp. 831, 843.

*Rumphia eldridgei* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, fig. 7. (After Twitchell.)

*Occurrence*.—FLORIDA: Suwannee River below a sulphur spring 17 miles below Ellaville (station 2612, type, G. H. Eldridge, collector); Suwannee River at Dowling Springs, Suwannee County (station 7338, C. W. Cooke, collector; stations 12311 and 12312, W. C. Mansfield and G. M. Ponton collectors; station 14538, C. W. Cooke, collector); Suwannee River above the railway bridge near Wilmarth, Suwannee County (station 7337, C. W. Cooke, collector); Suwannee River 4 to 4½ miles below Ellaville (station 12743, W. C. Mansfield, Herman Gunter, and G. M. Ponton, collectors); 5 miles northwest of Mayo, Lafayette County, on road to Dowling Park (station 11114, C. W. Cooke and Stuart Mossom, collectors); 5.2 miles west of Mayo on road to Perry (station 14537, C. W. Cooke and W. D. Havens, collectors); 1 mile north of Mayo (station I-2413, Florida Geol. Survey, G. M. Ponton, collector); Suwannee River below Troy Springs, Lafayette County (station 7347, C. W. Cooke, collector); Florida 19 east of Steinhatchee River opposite Clara, Dixie County (station 12747, W. C. Mansfield and G. M. Ponton, collectors; station 14158, W. C. Mansfield and C. W. Mumm, collectors); Miley rock pit, sec. 36, T. 20 S., R. 18 E., Citrus County (station 14536, C. W. Cooke, collector); 6 miles southeast of Crystal River (station 14141, W. C. Mansfield and C. W. Mumm, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 164683.

*Figured specimen*.—U. S. Nat. Mus. 498999, station 12747.

*Remarks*.—The type is the largest individual of this species yet collected. Smaller individuals have proportionately wider and rounder petals, and their anterior pair of petals is less spreading. The ambulacral furrows on the base of *R. eldridgei* are generally very indistinct.

RUMPHIA ARCHERENSIS (Twitchell)

Plate 2, figures 11-13

*Laganum archerensis* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 161, pl. 75, figs. 1a-d.

*Echinodiscus archerensis* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 581.

*Laganum archerensis* COOKE and MOSSOM, 1929, Florida Geol. Survey Ann. Rept. 20, pl. 3, figs. 6a-b. (After Twitchell.)

?*Scutella camagueyana* WEISBORD, 1934, Bull. Am. Paleontology, vol. 20, p. 220, pl. 24, figs. 13, 14.

*Occurrence*.—FLORIDA: Archer (type, W. H. Dall, collector); Bennett's bone bed, Nixon, Levy County (station 355, L. C. Johnson, collector); Suwannee River near the bridge on Florida 19 east of Oldtown (Florida Geol. Survey I-2329); Cummer Lumber Company phosphate mine near Newberry (Florida Geol. Survey I-1582, G. M. Ponton, collector); 3 miles northeast of Newberry (station 14177, W. C. Mansfield and C. W. Mumm, collectors); 3½ miles northeast of Newberry (station 14178, W. C. Mansfield and C. W. Mumm, collectors); 3 miles north of Newberry (station 13843, W. C. Mansfield and F. S. MacNeil, collectors); pit north of Florida 15-A between Inglis and Yankeetown, Levy County (station 14544, C. W. Cooke and W. D. Havens, collectors); Polk County oil-prospecting well, depth unknown (Florida Geol. Survey I-1580).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 164667a.

*Figured specimen*.—U. S. Nat. Mus. 498994, deposited by Florida Geol. Survey, I-1580.

*Remarks*.—This species, described from a single small specimen, is now well represented in collections. A specimen from station 14544 measures 37.5 mm. in diameter—more than twice as large as the type. The species is referred to *Rumphia* because of its four genital pores and flat base with ambulacral grooves.

Family ECHINOCYAMIDAE Cooke, n. fam.

Test small, depressed, with rudimentary, wide-open, few-pored petals. Interambulacra bordered within by low vertical partitions, which radiate toward the peristome.

Genus ECHINOCYAMUS Leske, 1778

*Echinocyamus* VAN PHELSUM, 1774, Brief aan Cornelius Nozeman, over de Gewelvslekken of Zee-egelen.

*Echinocyamus* (part) LESKE, 1778, Naturalis dispositio echinodermatum, p. 215.

- Fibularia* (part) LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 16.  
*Echinocyamus* AGASSIZ, 1841, Mon. d'échinodermes, Mon. 2, p. 125.  
*Echinocyamus* DESOR, 1858, Synopsis des échinides fossiles, p. 217.  
*Echinocyamus* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 304.  
*Echinocyamus* POMEL, 1883, Classification méthodique et genera des échinides, p. 73.  
*Fibularia* LAMBERT, 1891, Soc. géol. France Bull., sér. 3, t. 19, pp. 749-752.  
*Echinocyamus* COTTEAU, 1892, Paléontologie française, Échinides éocènes, t. 2, p. 348.  
*Echinocyamus* H. L. CLARK, 1911, Ann. and Mag. Nat. History, ser. 8, vol. 7, pp. 598, 605.  
*Echinocyamus* H. L. CLARK, 1914, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 59.  
*Fibularia* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 289.

Genotype, *Echinocyamus angulosus* Leske, 1778, = *Spatagus pusillus* Müller, 1776, = *Echinus minutus* Pallas, 1774, living in the Atlantic Ocean and the Mediterranean Sea, designated, according to Agassiz (1841, p. 125), by de Blainville, 1834. This species is figured under the name *Echinocyamus pusillus* by A. Agassiz (1873, p. 505, pl. 11e, fig. 3; pl. 13, figs. 1-8).

Most authors credit *Echinocyamus* to Van Phelsum, 1774, but H. L. Clark (1911, p. 596) refers it to Leske, regarding Van Phelsum's use of it as not binomial. Lambert is of the opinion that all of Van Phelsum's figures, some of which were copied by Leske, represent a swollen, globular species without internal partitions, like the usual interpretation of *Fibularia* Lamarck. Cotteau, however, points out that the figures of Van Phelsum leave much to be desired, and that his specimens are said to have come from America and the Adriatic Sea—regions in which the globular form without partitions is unknown, but in which the flatter form with partitions abounds.

#### ECHINOCYAMUS PUSILLUS (Müller)

- Echinus minutus* PALLAS, 1774, Spicilegia Zoologica, fasc. 10, p. 34 (fide H. L. Clark).  
*Echinocyamus pusillus* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 111, 304, pls. 11e, fig. 3; pl. 13, figs. 1-8 (gives synonymy).  
*Echinocyamus minutus* H. L. CLARK, 1914, idem, vol. 46, no. 1, p. 61.  
*Fibularia pusilla* LAMBERT and THIÉRY, 1914, Nomenclature raisonnée des échinides, fasc. 4, p. 289.

*Occurrence*.—Moderately deep water off Florida and elsewhere.

*Geologic horizon*.—Recent.

*Remarks*.—According to Opinion 107 of the Commission on Zoological Nomenclature, *pusillus* 1776 should not be displaced by *minutus* 1774.

#### ECHINOCYAMUS PARVUS Emmons

Plate 1, figures 6-8

- Echinocyamus parvus* EMMONS, 1858, Agriculture of the eastern counties, p. 307, fig. 244.  
*Echinocyamus parvus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 119.  
*Fibularia parva* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 577.  
*Echinocyamus parvus* KELLUM, 1926, U. S. Geol. Survey Prof. Paper 143, p. 14.

*Occurrence*.—NORTH CAROLINA: Craven County (type); farm of J. M. Thomas 10 miles north of Jacksonville, Onslow County (figured specimen, station 10636, L. B. Kellum, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—Misaid or lost. Possibly at Williams College, Williamstown, Mass.

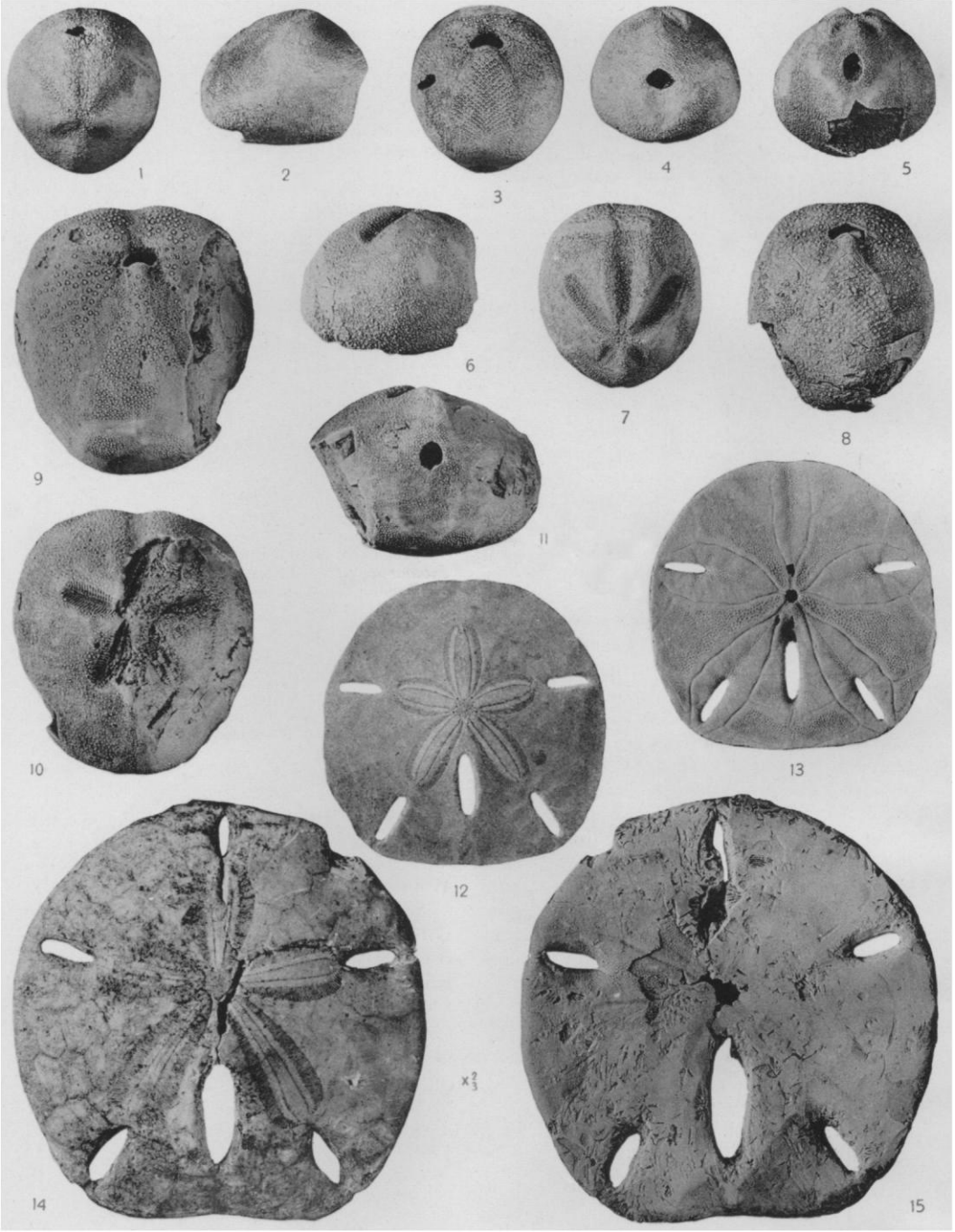
*Figured specimen*.—U. S. Nat. Mus. 499002.

*Remarks*.—The specimen here figured has not been compared with the type, which could not be found at Williams College, where other of Emmons' types were origi-

#### EXPLANATION OF PLATE 3

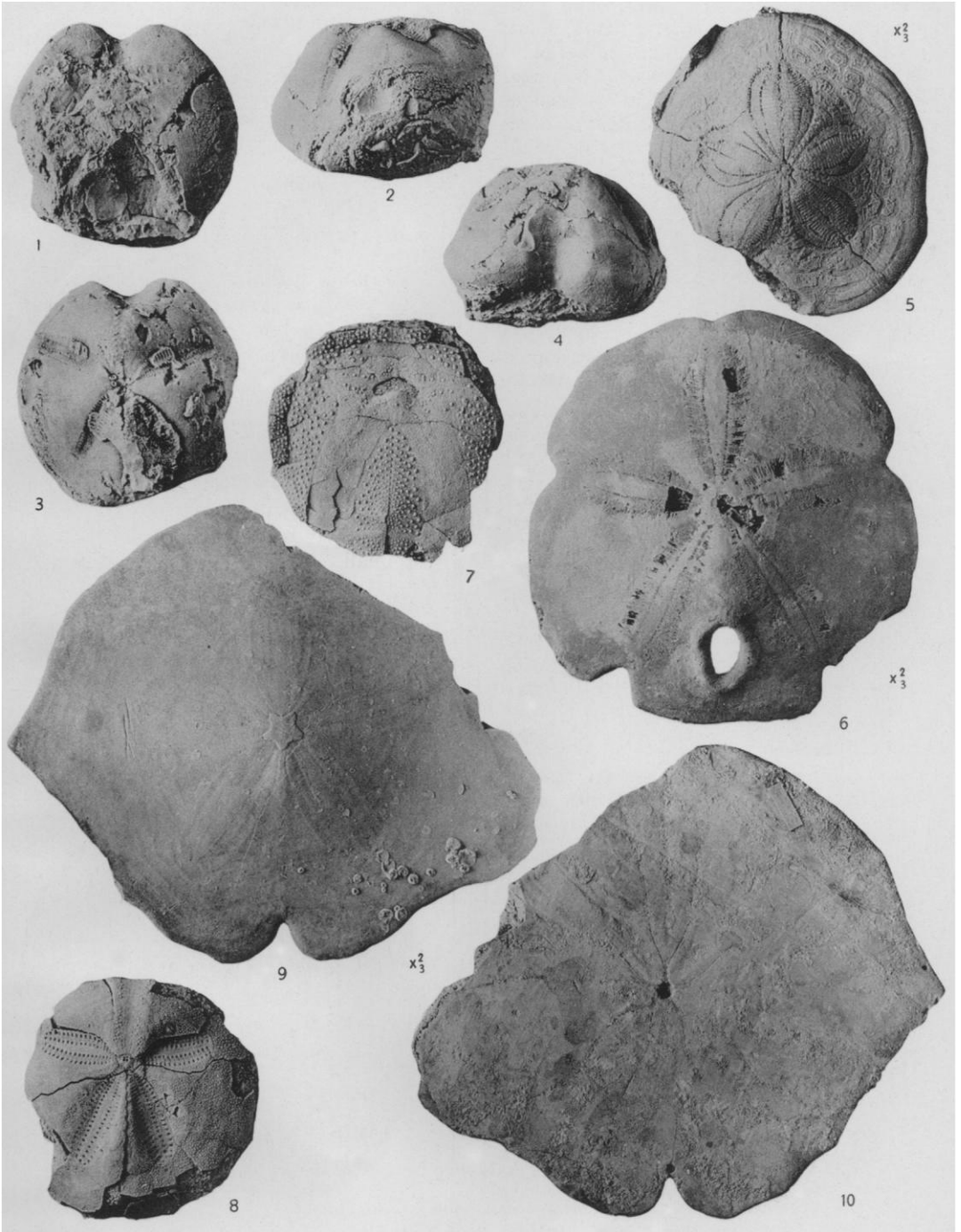
- FIGS. 1-4—*Agassizia floridana* de Loriol. U. S. Nat. Mus. 499010, Steinhatchee River near Clara, Fla., ×1. Late Eocene. (p. 44)  
 5-8—*Schizaster beckeri* Cooke, n. sp. 5-7, Holotype, U. S. Nat. Mus. 499008, Arredondo, Fla.; 8, paratype, U. S. Nat. Mus. 499009, Dowling Park, Fla.; all ×1. Late Eocene. (p. 40)  
 9-11—*Cyclaster drewryensis* Cooke, n. sp. Holotype, U. S. Nat. Mus. 372880, Drewry, Ala., ×1. Early Oligocene. (p. 50)  
 12, 13—*Mellita quinquiesperforata* (Leske). U. S. Nat. Mus. 499012, Folly Beach, S. C., × $\frac{2}{3}$ . Recent. (p. 22)  
 14, 15—*Encope emarginata* (Leske). U. S. Nat. Mus. 166525, 3 miles north of Grifton, N. C., × $\frac{2}{3}$ . Late Miocene? (p. 20)





Cooke, Cenozoic Echinoids





Cooke, Cenozoic Echinoids

nally deposited. It is wider behind and narrower in front than Emmon's figure, which is elliptical, but the peristome and periproct are very similar. All of the five specimens from station 10636 have very inconspicuous ambulacral pores. Their four genital pores are much farther apart than those of *E. huxleyanus* Meyer.

ECHINOCYAMUS HUXLEYANUS Meyer

Plate 1, figures 1-5

*Echinocyamus huxleyanus* MEYER, 1886, Alabama Geol. Survey Bull. 1, p. 85, pl. 3, fig. 23.

*Echinocyamus huxleyanus* DE GREGORIO, 1890, Faune éocénique de l'Alabama, p. 251, pl. 43, fig. 15 (after Meyer).

*Echinocyamus huxleyanus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 119, pl. 57, figs. 1a-d.

*Fibularia huxleyi* (Meyer) LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 577. (Slip of the pen.)

*Occurrence.*—ALABAMA: Claiborne (type; U. S. Nat. Mus. 166503, T. H. Aldrich, collector); railway bridge at Geneva, Ala. (figured specimen, station 6757, C. W. Cooke, collector).

*Geologic horizon.*—Late Eocene, Moodys marl (formerly called Gosport sand at Claiborne).

*Type.*—Johns Hopkins University T 2002.

*Figured specimens.*—U. S. Nat. Mus. 499001, from Geneva, Ala.; 166503, Claiborne, Ala.

ECHINOCYAMUS MERIDIONALIS Meyer

*Echinocyamus meridionalis* MEYER, 1887 Senkenberg. naturf. Gesell. Ber. 1887, Vorträge, p. 12, pl. 2, figs. 21, 21a.

*Echinocyamus meridionalis* DE GREGORIO, 1890, Faune éocénique de l'Alabama, p. 251, pl. 43, figs. 13, 14. (After Meyer.)

*Fibularia meridionalis* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 121, pl. 57, figs. 3a-d.

*Fibularia meridionalis* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 9, p. 577.

*Original description.*—Elliptisch, fast kreisförmig, abgeplattet. After ziemlich nah dem Rande.

Claiborne, Ala.; Jackson, Miss.

Runder und abgeplatteter als *Echinocyamus Huxleyanus* Mr. von Claiborne, auch ist der After kleiner und weiter vom Rand. Das Original ist von Claiborne. Ein Exemplar von Jackson, welches ich zu derselben Art stelle, ist elliptischer.

*Occurrence.*—Claiborne, Ala. (type); Jackson, Miss.

*Geologic horizon.*—Late Eocene, Moodys marl.

*Type.*—Johns Hopkins University T 2005.

*Remarks.*—This species is represented in the National Museum by a fragment from Claiborne. Its outline is rounder, it is flatter, its periproct is nearer the margin, and its internal marginal partitions are closer together and more numerous than those of *E. huxleyanus*.

ECHINOCYAMUS CHIPOLANUS

Cooke, n. sp.

Plate 1, figures 9-11

Test small, outline broadly oval, gently arched above, flatter below; with surface covered with proportionately large tubercles; strengthened by internal marginal partitions. Genital pores four in number, widely spaced. Ambulacral areas obscure; poriferous zones of each area apparently widely diverging. Peristome about one-third the total width, nearly circular. Periproct very slightly closer to the margin than to the peristome, rather large, slightly pointed posteriorly.

Length, 4 mm.; width, 3.3 mm.; height, 1.3 mm.

*Occurrence.*—FLORIDA: Lower bed at Alum Bluff, Apalachicola River, Liberty County (station 2211, Frank Burns, collector).

*Geologic horizon.*—Miocene, Chipola formation.

EXPLANATION OF PLATE 4

- FIGS. 1-4—*Eupatagus?* (*Brissopatagus?*) *primus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498978, 5 miles south of Ellaville, Ga.,  $\times 1$ . Paleocene. (p. 59)  
 5—*Clypeaster subdepressus* (Gray). U. S. Nat. Mus. 499007, Intracoastal Waterway Canal 3 miles southwest of Little River, S. C.,  $\times \frac{2}{3}$ . Pliocene. (p. 11)  
 6—*Encope michelini* Agassiz. U. S. Nat. Mus. 499011, 3 miles southwest of Little River, S. C.,  $\times \frac{2}{3}$ . Pliocene. (p. 21)  
 7, 8—*Eupatagus* (*Brissopatagus*) *alabamensis* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498979, St. Stephens, Ala.,  $\times 1$ . Late Eocene. (p. 58)  
 9, 10—*Scutella floridana* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498980, Sopchoppy, Fla.,  $\times \frac{2}{3}$ . Early Miocene. (p. 19)

*Type*.—U. S. Nat. Mus. 499003.

*Remarks*.—This species is based on a single individual, in which a hole in the left side gives a view of the interior. Its genital pores are much smaller and farther apart than those of *E. huxleyanus*, and its poriferous zones appear to be more widely diverging. It is proportionately shorter and wider than *E. parvus*, and its periproct and peristome are larger.

#### Genus PORPITELLA Pomel

*Porpitella* POMEL, 1883, Classification méthodique et genera des échinides, p. 72.

Genotype, *Scutellina supera* Agassiz (1841, p. 103, pl. 21, figs. 15–19), from the Eocene of France.

Pomel cites two species, *Scutellina hayesianana* Agassiz and *S. porpita* Desor. The first is a synonym of *Scutellina supera*, which Agassiz regarded as perhaps the same as *Cassidulus hayesianus* Desmoulins, 1835, a nude name. *C. hayesianus* Desmoulins is cited by Lambert and Thiéry as the "type unique" of *Porpitella*.

#### PORPITELLA MICRA H. L. Clark

*Porpitella micra* H. L. CLARK, 1937, Jour. Paleontology, vol. 11, no. 3, p. 248, text figs. 1–8.

*Occurrence*.—ALABAMA: Cuttings from a well (Oakley Estate no. 2) sec. 9, T. 3 N., R. 29 E., Houston County, depth 3800–4000 feet.

*Geologic horizon*.—Eocene, Lisbon formation or older.

*Types*.—Holotype, Alabama Mus. Nat. History no. 85, Tuscaloosa, Alabama. Paratypes in Alabama Mus. Nat. History, Mus. Comp. Zoology, and U. S. Nat. Mus.

#### Family CASSIDULIDAE Agassiz and Desor, 1847

#### Genus CASSIDULUS Lamarck, 1801

*Cassidulus* LAMARCK, 1801, Système des animaux sans vertèbres, p. 348.

*Rhyncholampas* A. AGASSIZ, 1869, Harvard College Mus. Comp. Zoology Bull., vol. 1, p. 270. *Rhyncholampas* H. L. CLARK, 1917, idem, Mem., vol. 46, p. 105.

Genotype, *Cassidulus caribæarum* Lamarck (1801, p. 349), living in the Caribbean Sea. As pointed out by Grant and Hertlein, this species is the only possible type of *Cassidulus* because the two other names mentioned in the original description were nude. H. L. Clark (1917, p. 105) design-

nated this same species as the genotype of *Rhyncholampas* A. Agassiz, 1869, and proposed to abandon *Cassidulus* because he deemed it to be preoccupied, but *Cassidulus* is valid under the International Rules, and *Rhyncholampas* becomes a synonym.

No one seems to have questioned the reference of *Cassidulus caribæarum* and *Pygorhynchus pacificus* A. Agassiz to the same genus, yet the two species as figured show marked differences, particularly in the region of the peristome. Agassiz's figures of *caribæarum* are enlarged photographs of a small, presumably immature individual, and Lütken's figures of the same species may be inaccurate. Should these differences prove to be real and important, *Cassidulus*, s.s., may have to be restricted to the genotype. The fossil species here referred to it resemble *C. pacificus* rather than the figures of the genotype.

#### CASSIDULUS (CASSIDULUS) CARIBÆARUM Lamarck

*Cassidulus caribæarum* LAMARCK, 1801, Système des animaux sans vertèbres, p. 349.

*Cassidulus caribæarum* LÜTKEN, 1864, Naturh. Forening i Kjøbenhavn vidensk. Meddelelser, p. 126, pl. 2, fig. 6.

*Rhynchopygus caribæarum* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pt. 2, p. 343, pl. 15, figs. 1–4.

*Rhyncholampas caribæarum* H. L. CLARK, 1917, idem, vol. 46, p. 106, pl. 144, figs. 6, 7.

*Occurrence*.—Caribbean sea.

*Geologic horizon*.—Recent.

#### CASSIDULUS (CASSIDULUS) EVERGLADENSIS Mansfield Plate 8, figures 5, 6

*Cassidulus (Rhynchopygus?) evergladensis* MANSFIELD, 1932, U. S. Geol. Survey Prof. Paper 170, p. 48, pl. 18, figs. 1–10.

*Occurrence*.—FLORIDA: Tamiami Trail 5 miles east of Carnestown and about 7 miles northeast of Everglades, Collier County (station 11177, type, C. W. Cooke, W. C. Mansfield, and Stuart Mossom, collectors); Tamiami Trail 9 miles west of Pinecrest in sec. 13, T. 54 S., R. 32 E. (station 11179, C. W. Cooke, W. C. Mansfield, and Stuart Mossom, collectors); 18 miles south of Immokalee Collier County (Florida Geol. Survey station I-3148, Clarence Simpson, collector; this station was reported as "near Moorehaven" by Mansfield, who was misinformed as to its location).

SOUTH CAROLINA: Intracoastal Waterway canal about 5 miles southwest of Little River and about 15 miles northeast of Myrtle Beach

(station 13377, C. W. Cooke, collector; Charleston Museum, G. Robert Lunz, collector).

*Geologic horizon*.—Pliocene, Tamiami limestone (Florida) and Waccamaw formation (South Carolina).

*Types*.—Syntypes, U. S. Nat. Mus. 371329; paratype, U. S. Nat. Mus. 371330.

*Figured specimen*.—U. S. Nat. Mus. 499005, station 13377.

#### CASSIDULUS (CASSIDULUS)

##### SABISTONENSIS Kellum

Plate 8, figure 4

*Cassidulus (Pygorhynchus) berryi* KELLUM, 1926, U. S. Geol. Survey Prof. Paper 143, p. 15, pl. 1, figs. 4-7. Not *Cassidulus berryi* Twitchell, 1915.

*Cassidulus (Pygorhynchus) sabistonensis* KELLUM, 1931, Washington Acad. Sci. Jour., vol. 21, p. 51.

*Occurrence*.—NORTH CAROLINA: E. W. Sabiston's farm, 2 miles north of Jacksonville, Onslow County (station 10637, type, L. B. Kellum, collector).

*Geologic horizon*.—Early Miocene?, Trent marl? Kellum reports this species from the Eocene Castle Hayne marl, but the hard sandy matrix resembles the Trent marl. A badly worn individual of *Eurhodia raveneli* (Twitchell) in the same lot probably was reworked from the Eocene.

*Remarks*.—The petals of *C. sabistonensis* are more like those of *C. evergladensis* Mansfield than those of any other American species, being rounder and less spatulate than other species.

#### CASSIDULUS (CASSIDULUS)

##### GOULDII (Bouvé)

*Pygorhynchus gouldii* BOUVÉ, 1846, Boston Soc. Nat. History Proc., vol. 2, p. 192.

*Nucleolites mortoni* CONRAD, 1850, Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 40, pl. 1, fig. 11.

*Ravenelia gouldii* MCCRADY, 1859, Elliot Soc. Nat. History Charleston Proc., vol. 1, p. 283.

*Cassidulus (Pygorhynchus) gouldii* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 171, pl. 79, figs. 3a-d; pl. 80, figs. 1a-f, 2a-d.

*Proccassidulus (Hardouinia) gouldii* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 363.

*Occurrence*.—GEORGIA: Baker County (type); 2½ miles north of Cuthbert (station 4058, S. W. McCallie, collector); A. E. Belcher's well in lot 180, 16th District, Decatur County (station 3755, S. W. McCallie, collector); Leesburg (station 7421, Pierce, collector); Flint River, half a mile

below Newton (station 6106, L. W. Stephenson, collector); Georgia Southern and Florida Railway 32 miles south of Macon (station 3783, S. W. McCallie, collector); 2 miles south of Perry (station 3966, S. W. McCallie, collector); Hawkinsville (station 2311, Frank Burns, collector); Abbeville road 3½ miles south of Hawkinsville (station 6194, L. W. Stephenson, collector); 9 miles southwest of Abbeville and half a mile northeast of Center School, Wilcox County (station 10324, C. W. Cooke and T. M. Prettyman, collectors); Albany road 9 miles north of Camilla (station 14921, C. W. Cooke, collector).

FLORIDA: Many places in Alachua, Columbia, Gadsden, Hamilton, Hernando, Hillsborough, Jefferson, Pasco, and Suwannee Counties.

MISSISSIPPI: Heidelberg (U. S. Nat. Mus. 156464, L. C. Johnson, collector); bed of creek in sec. 22 (?), T. 4 N., R. 1 E., about 3¼ miles east of Byram (stations 14071a, 14605, F. S. MacNeil, collector, doubtfully identified).

*Geologic horizon*.—Oligocene, Flint River formation (Georgia) and Suwannee limestone (Florida), Mint Spring marl member of Marianna limestone (?) (Mississippi).

*Type*.—Boston Soc. Nat. History 1756A (lectotype, a cast of the interior) deposited in Mus. Comp. Zoology, Cambridge, Mass. A plaster cast of this specimen is in the United States National Museum.

*Remarks*.—*Cassidulus gouldii* is a very abundant and variable species. The type, a silicious cast of the interior from the late Oligocene Flint River formation in Baker County, Ga., is somewhat larger than the average. Its longitudinal profile is tumid anteriorly but nearly straight between the apex and the periproct. Other specimens from Georgia are somewhat tumid posteriorly as well as anteriorly. Individuals from the late Oligocene Suwannee limestone, in which it is very abundant, tend to be more conical, with the highest point anterior to the apical system, like the two specimens from Florida figured by Clark and Twitchell. Most of them are not tumid posteriorly. The specimens from the middle Oligocene Marianna limestone and its Mint Spring marl member of Mississippi have sharper margins than customary.

#### CASSIDULUS (CASSIDULUS)

##### ALABAMENSIS Twitchell

*Cassidulus (Pygorhynchus) alabamensis* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 172, pl. 80, figs. 3a-d.

*Cassidulus (Hardouinia) alabamensis* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 362.



*Occurrence*.—FLORIDA: Natural Bridge, Walton County in SE.  $\frac{1}{4}$  sec. 26, T. 6 N., R. 20 W. (type, T. H. Aldrich, collector); Suwannee River opposite Ellaville, lowest bed (station 6824, C. W. Cooke, collector); station 11111, C. W. Cooke and Stuart Mossom, collectors; station 12310, W. C. Mansfield and G. M. Ponton, collectors); lowest bed near mouth of Withlacoochee River (station 12744, W. C. Mansfield and others, collectors).

*Geologic horizon*.—Middle Oligocene, Byram formation.

*Type*.—Holotype, Johns Hopkins University (two plaster casts in U. S. Nat. Mus.).

*Remarks*.—*Cassidulus alabamensis* is very closely related to *C. gouldii* and may prove to be indistinguishable from it. The type is much larger than most specimens referred to either species but is almost equalled in size by a cast of the interior from A. E. Belcher's well in Decatur County, Ga., which was listed by Twitchell as one of the two original localities for *C. alabamensis*. This cast is here referred to *C. gouldii*. The available specimens indicate *C. alabamensis* is more nearly quadrate in outline than *C. gouldii* and more inflated posteriorly. *C. alabamensis* comes from slightly older beds than *C. gouldii*.

The label accompanying the type gives Alabama as the location of Natural Bridge, which, however, is in Florida nearly three-quarters of a mile south of the Alabama line.

CASSIDULUS (CASSIDULUS) TROJANUS  
Cooke, n. sp.

Plate 2, figures 22–25

Outline subquadrate, wider behind than in front. Upper surface moderately inflated except behind the periproct, where there is a broad, shallow sulcus; rostrate above the periproct. Lower surface flat. Margin acute. Apical system slightly excentric anteriorly; four genital pores, five ocular pores, madreporite central. Petals lanceolate, of nearly equal length, extending somewhat more than halfway to the margin, open at the distal ends; pores round or oval; interporiferous zones wider than poriferous zones; outer poriferous zones of posterior paired petals longer than the inner. Peristome farther forward than the apical system, pentagonal, slightly wider than long. Oral lobes swollen. Phyllodes about as long as the diameter of the peristomial opening.

Periproct supramarginal, transversely elliptical, flush, about one-third the way from the margin to the apex. Upper surface finely granulated between small tubercles; tubercles on lower surface much larger than on upper, deeply sunken in large scrobiculae except near the margin, where they are much smaller. Longitudinal median band on base moderately wide and deeply pitted.

Length, 25.4 mm.; width, 22 mm.; height, 11.3 mm.

*Occurrence*.—FLORIDA: Suwannee River below Troy Springs, Lafayette County (station 7347, type, C. W. Cooke, collector); Suwannee River at Dowling Springs, Suwannee County (station 7338, C. W. Cooke, collector); 5 miles northwest of Mayo on road to Dowling Park (station 11114, C. W. Cooke and Stuart Mossom, collectors); Perry road 5.2 miles west of Mayo (station 14537, C. W. Cooke, collector); east side of Steinhatchee River in Dixie County opposite Clara (station 12747, W. C. Mansfield and G. M. Ponton, collectors); station 14158, W. C. Mansfield and C. W. Mumm, collectors); 12 miles north of Marianna (station 14182, W. C. Mansfield and C. W. Mumm, collectors).

GEORGIA: Miller County about 1 mile southeast of Joe Shingler's and about 5 miles west of Colquitt (station 8247, cast of interior, C. W. Cooke, collector); Spring Creek at Colquitt (station 10168, cast of interior, C. W. Cooke and T. M. Prettyman, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—Holotype, U. S. Nat. Mus. 498996.

*Remarks*.—*Cassidulus trojanus* is narrower than *C. alabamensis*, and its periproct is farther forward. The longitudinal profile of its upper surface is more evenly rounded than that of *C. gouldii*, which is commonly conical. Its oral lobes and phyllodes are less conspicuous than those of *C. evergladensis*, whose periproct is terminal. The specimen from station 14182 is narrower behind than others referred to this species. The available specimens indicate that *C. trojanus* did not grow as large as any of the other species mentioned.

Subgenus PARALAMPAS Duncan  
and Sladen, 1882

*Pygorhynchus* Agassiz. DESOR, 1858, Synopsis des échinides fossiles, p. 297.  
*Paralampas* DUNCAN and SLADEN, 1882, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, p. 72.  
*Plagiopygus* LAMBERT, 1897, Soc. belge géologie Bull. (Mém.), t. 11, p. 162.

*Pleuropygus* LAMBERT and THIÉRY in LAMBERT, 1913, Schweizer. palaeont. Gesell. Abh., Band 39, p. 126.

*Paralampas* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 371.  
*Anisopetalus* H. L. CLARK in ARNOLD and CLARK, 1927, Harvard College Mus. Comp. Zoology Mem., vol. 50, no. 1, p. 44.

Genotype, *Paralampas pileus* Duncan and Sladen (1882, p. 73, pl. 15, figs. 11–14), from the Eocene (Ranikot) of Sind, designated by Lambert and Thiéry (1921). Desor (1858, pl. 31, figs. 1–3) figured as representative of *Pygorhynchus* Agassiz, 1839 (genotype, *Catopygus obovatus* Agassiz, designated by Lambert and Thiéry, 1921), a specimen of *Nucleolites grignonensis* DeFrance, which species later became the genotype of *Plagiopygus* and *Pleuropygus*. The genotype of *Anisopetalus* is *A. ellipticus* H. L. Clark, from Jamaica (presumably Eocene), by monotypy.

The American species here referred to *Paralampas* are Eocene. They resemble more closely the published figures of *Nucleolites grignonensis* than of *Paralampas pileus*, which species, according to Duncan and Sladen, lacks the median actinal band visible on *grignonensis* and the American species. But this lack may be merely apparent, for Duncan and Sladen's specimen appears to be rather poorly preserved. If this or other differences should eliminate *grignonensis* and the American species from *Paralampas*, they may take the name *Plagiopygus*, which is not preoccupied under the International Rules.

CASSIDULUS (PARALAMPAS)  
CONRADI (Conrad)

*Catopygus conradi* CONRAD, 1850, Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 39, pl. 1, fig. 9.

*Cassidulus conradi* CONRAD, 1865, idem, Proc., p. 75.

*Cassidulus (Pygorhynchus) conradi* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 145, pl. 67, figs. 1a–f.

*Rhyncholampas conradi* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 370.

*Occurrence*.—GEORGIA: Palmyra, Lee County (type, fide Conrad); Kinchafoonee Creek, 2 miles north of Albany (station 5054, T. W. Vaughan, collector; station 7121, C. W. Cooke and J. E. Brantly, collectors; station 10507, C. W. Cooke and T. M. Prettyman, collectors). Casts of the interior, probably representing this species, from

Ichawaynochaway Creek about 4 miles west of Newton (station 10919, Stuart Mossom, collector); about 1 mile southeast of Joe Shingler's and 5 miles west of Colquitt (station 8247, C. W. Cooke, collector).

ALABAMA: Conecuh River 1 mile east of Harts Bridge, Covington County, in the SW.  $\frac{1}{4}$  sec. 28, T. 3 N., R. 14 E. (station 10025, C. W. Cooke and Julia Gardner, collectors).

FLORIDA: Alachua (cast of the interior, station 6790, C. W. Cooke and Herman Gunter, collectors); Florida Basic Rock Company, 12 miles north of Marianna (station 12058, W. C. Mansfield and G. M. Ponton, collectors; station 14182, W. C. Mansfield and C. W. Mumm, collectors); Florida 2, 6 miles north of High Springs (Florida Geol. Survey, G. M. Ponton, collector); 1 mile north of Mayo (Florida Geol. Survey, G. M. Ponton, collector); excavation for bridge at Caryville, depth 40 feet (Florida Geol. Survey).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—Acad. Nat. Sci. Philadelphia.

CASSIDULUS (PARALAMPAS)  
LYELLI (Conrad)

*Nucleolites lyelli* CONRAD, 1850, Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 40, pl. 1, fig. 14.

*Cassidulus lyelli* CONRAD, 1865, idem, Proc., p. 75.  
*Pygorhynchus lyelli* COTTEAU, 1888, Paléontologie française, Echinides éocènes, t. 1, p. 550.

*Cassidulus (Rhynchopygus) lyelli* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 141, pl. 65, figs. 4a–d.

*Cassidulus (Pygorhynchus) georgiensis* TWITCHELL 1915, idem, p. 170, pl. 79, figs. 2a–d.

*Rhyncholampas lyelli* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 370.

*Rhyncholampas georgiensis* LAMBERT and THIÉRY, 1921, idem, p. 370.

*Occurrence*.—GEORGIA: Baker County (type, J. H. Couper, collector); Bainbridge (station 3293, type of *C. georgiensis*, A. H. Brooks, collector; station 7097, C. W. Cooke and W. C. Mansfield, collectors; station 13611, A. F. Foerste, collector Red Bluff, 6 miles above Bainbridge (station 6159 L. W. Stephenson, collector); Chattahoochee River at Saffold (station 8249, H. K. Shearer, collector; station 12100, C. W. Cooke and W. H. Monroe, collectors).

FLORIDA: Chattahoochee River 5 miles below Neals Landing (station 6763, C. W. Cooke, collector); Chattahoochee River one-fourth mile below Bartons Landing (station 6765, C. W. Cooke, collector); Holder mine, 5 miles southwest of Inverness (station 7382, C. W. Cooke, collector); between Inglis and Yankeetown, Levy County (station 14544, C. W. Cooke and W. D. Havens, collectors); quarry  $1\frac{1}{2}$  miles west of Springfield Church, about 12 miles north of Marianna (station 14152, W. C. Mansfield and C. W. Mumm, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—A cast of the interior, probably Acad. Nat. Sci. Philadelphia. Holotype of *C. georgiensis*, U. S. Nat. Mus. 164747.

*Remarks*.—The specimens from Florida are higher in front than behind, thus differing from those from Bainbridge, Ga., which are uniformly inflated. This difference is probably not of specific importance, for other species show considerable variation in tumidity.

CASSIDULUS (PARALAMPAS)  
CAROLINENSIS (Twitchell)

*Cassidulus (Pygorhynchus) carolinensis* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 146, pl. 67, figs. 2a-g.

*Occurrence*.—NORTH CAROLINA: Smith Creek (type); Rocky Point, Pender County (station 779, T. W. Stanton, collector); city rock quarry, Wilmington (station 3602, Frank Burns, collector); station 4285, L. W. Stephenson, collector); Castle Hayne (L. W. Stephenson, collector); 1 mile northwest of Lanes Ferry, Northeast Cape Fear River (L. W. Stephenson, collector).

FLORIDA: Quarry in Dixie County north of US 19 east of Steinhatchee River opposite Clara, (station 14541, C. W. Cooke and W. D. Havens, collectors).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—Johns Hopkins University.

*Remarks*.—Lambert and Thiéry (1921, p. 370) say that this species appears to be a synonym of *C. conradi*, but comparison of specimens show that they are amply distinct. The most conspicuous difference is the protracted shape of the posterior end of *conradi*. The apical system of *carolinensis* is a little nearer the center than that of *conradi*, and the periferous zones are much wider. The specimens from Florida tend to be less concave about the peristome than the typical form.

CASSIDULUS (PARALAMPAS?)  
GREGORYI (Twitchell)

*Breyneella gregoryi* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 148, pl. 68, figs. 1a-f.

*Echinanthus gregoryi* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 367.

*Occurrence*.—SOUTH CAROLINA: Santee Canal.

*Geologic horizon*.—Late Eocene, probably Santee limestone.

*Type*.—Am. Mus. Nat. History.

*Remarks*.—The figures of this species resemble *Cassidulus carolinensis* from the same horizon in North Carolina except that the periproct appears to be a little higher than wide, whereas that of *carolinensis* is wider than high. This difference may be the result of erosion of the area above the periproct. If the shape is accidental, *gregoryi* is probably a synonym of *carolinensis*.

CASSIDULUS? OVIFORMIS (Conrad)

*Catopygus oviformis* CONRAD, 1850, Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 39, pl. 1, fig. 15.

*Nucleolites oviformis* CONRAD in COOK, 1868, Geology of New Jersey, p. 722.

*Catopygus oviformis* CLARK, 1893, U. S. Geol. Bull. 97, p. 64, pl. 27, figs. 2a-f.

*Catopygus oviformis* CLARK, 1915, idem, Mon. 54, p. 72, pl. 29, figs. 2a-f.

*Occurrence*.—NEW JERSEY: Timber Creek.

*Geologic horizon*.—Early Eocene, Vincetown sand.

*Type*.—Acad. Nat. Sci. Philadelphia 1477.

This species, which I have not seen, is of uncertain generic position. It is removed from *Catopygus* by the shape of its peristome and by its lack of a conspicuous floscelle. In size and shape it resembles *Cassidulus*, but its peristome appears to be somewhat more nearly oval than late Eocene species, and its periproct is higher than wide.

Subgenus GALEROLAMPAS Cotteau, 1889

*Galerolampas* COTTEAU 1889, Paléontologie française, Échinides éocènes, t. 2, p. 1.

*Rhyncholampas (Galerolampas)* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, p. 371.

Genotype, *Galerolampas sorigneti* Cotteau (1889, p. 3, pl. 201, figs. 1-6), from the middle Eocene of France, by monotypy.

The differences between *Galerolampas* and the fossil species here referred to *Cassidulus*, s.s., are rather intangible. In general, *Galerolampas* appears to be a little more depressed above and more concave below, its periproct is more nearly terminal, and the sides of its petals are straighter. As none of these differences are of much importance, the fossil species of *Cassidulus*, s.s., might very well be transferred to *Galerolampas* if *Cassidulus caribæarum* proves to be generically distinct.

CASSIDULUS (GALEROLAMPAS) FONTIS

Cooke, n. sp.

Plate 2, figures 26-29

Test oval, upper surface moderately low, under surface slightly concave; apex eccentric anteriorly; four genital pores, five ocular pores; ambulacral areas narrow; petals narrow, nearly straight, open at the ends; anterior petal the shortest, other petals nearly equal, all extending more than halfway to the ambitus; ambulacral pores small; inner pores round, outer pores oval; pore pairs conjugate, oblique; widest part of the interporiferous areas more than twice as wide as one poriferous area; periproct terminal, at the top of a sulcus, transversely oval; peristome eccentric anteriorly, pentagonal, broader than long, with a floscelle; tubercles on under side much larger than those above.

Length, 38.7 mm.; width, 35.8 mm.; height, 16 mm.

*Occurrence.*—FLORIDA: Well near Falling Water 4 miles south of Chipley, depth less than 1600 feet (station 8872g, E. C. Butler, collector).

*Geologic horizon.*—Early Tertiary, formation unknown; probably early Eocene or Paleocene.

*Type.*—U. S. Nat. Mus. 498997.

*Remarks.*—This species, known from only one slightly crushed specimen, is similar to Cotteau's figures of *Galerolampas sorigneti*, which, however, do not show the periproct.

Genus EURHODIA d'Archiac  
and Haime, 1853

*Eurhodia* D'ARCHIAC and HAIME, 1853, Animaux fossiles du groupe nummulitique de l'Inde, p. 214.

*Eurhodia* DESOR, 1858, Synopsis des échinides fossiles, p. 300.

*Ravenelia* McCRADY, 1859, Elliot Soc. Nat. History Charleston Proc., vol. 1, p. 283.

*Eurhodia* DUNCAN and SLADEN, 1882, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, pp. 69, 70.

*Eurhodia* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 364.

Genotype, *Pygorhynchus morrisii* d'Archiac, from the late Eocene (Ranikot) of Sind, by monotypy.

*Eurhodia* differs from other Eocene Cassidulidae in its deeply sunken periproct, which is wider than high, and in its longitudinally elongated pentagonal peristome.

EURHODIA RAVENELI (Twitchell)

*Pygorhynchus crucifer* (Morton). RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4, figs. 9, 10.

*Ravenelia crucifer* (Morton). McCRADY, 1859, Elliot Soc. Nat. History Charleston Proc., vol. 1, p. 283.

*Cassidulus (Rhynchopygus) raveneli* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 142, pl. 65, figs. 5a-d; pl. 66, figs. 1a-c, 2a-b.

*Eurhodia rugosa* (Ravenel). LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 365.

*Occurrence.*—SOUTH CAROLINA: Santee River (fide Ravenel); Santee Canal (type).

NORTH CAROLINA: Wilmington (station 3602, Frank Burns, collector; U. S. Nat. Mus. 166494, L. W. Stephenson collector; station 10340, C. W. Cooke, collector, station 10613, L. B. Kellum, collector); Sabiston's farm, 2 miles north of Jacksonville (station 10637, L. B. Kellum, collector); 1 mile northwest of Lanes Ferry, Northeast Cape Fear River (U. S. Nat. Mus. 166493, L. W. Stephenson, collector).

*Geologic horizon.*—Late Eocene, Santee limestone (South Carolina); Castle Hayne marl (North Carolina).

*Type.*—Am. Mus. Nat. History.

*Remarks.*—Lambert and Thiéry regard this species as the adult form of the species figured by Ravenel (1848, p. 4, figs. 7, 8) under the name *Pygorhynchus rugosus*. This may be true, but the type of *rugosus* is lost, and the figure differs notably from specimens of comparable size. It seems better to accept Twitchell's species and to discard *Pygorhynchus rugosus* as unrecognizable.

EURHODIA PATELLIFORMIS (Bouvé)

Plate 5, figures 1-4

*Catopygus patelliformis* BOUVÉ, 1851, Boston Soc. Nat. History Proc., vol. 4, p. 2, 2 text figs.

*Cassidulus patelliformis* DESOR, 1858, Synopsis des échinides fossiles, p. 290.

*Cassidulus (Rhynchopygus?) patelliformis* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 143, pl. 66, figs. 3a-d.

*Cassidulus (Rhynchopygus) depressus* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 144, pl. 66, figs. 4a-e, 5a-b. Not *Gisopygus depressus* Fourtau, 1908, p. 136, pl. 8, figs. 15, 16.

*Procassidulus patelliformis* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 362.

*Procassidulus depressus* LAMBERT and THIÉRY, 1921, idem, p. 362.

*Occurrence.*—GEORGIA: Baker County (type of *C. depressus*); Albany (station 5054, figured, T. W. Vaughan, collector; station 7121, C. W. Cooke, collector).



ALABAMA: Conecuh River 1 mile east of Harts Bridge (station 10025, C. W. Cooke and Julia Gardner, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—Holotype, Boston Soc. Nat. History 1558. Holotype of *Cassidulus depressus* Twitchell, Boston Soc. Nat. History 1557a. Deposited in Mus. Comp. Zoology, Cambridge, Mass.

*Remarks*.—This species is characterized by its unusually flat bottom and by its small, deeply sunken periproct. Though the holotype is much higher than other specimens referred to this species, there is little doubt that *Cassidulus depressus* Twitchell is a synonym, for such variation in shape is common among the Cassidulidae. The figured specimen is intermediate in size between Bouvé's and Twitchell's types. Twitchell's specific name appears to be preoccupied by *Eurhodia depressa* (Fourtau).

#### EURHODIA HOLMESI (Twitchell)

*Cassidulus (Rhynchopygus?) holmesi* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 140, pl. 65, figs. 3a-d.

*Rhyncholampas holmesi* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 370.

*Cassidulus (Pygorhynchus) carolinensis* var *cravenensis* KELLUM, 1926, U. S. Geol. Survey Prof. Paper 143, p. 15, pl. 1, figs. 1-3.

*Occurrence*.—SOUTH CAROLINA: Santee River (?) (type); Cave Hall, Santee River scarp 6 miles northeast of Elloreë (station 4856, Earle Sloan and T. W. Vaughan, collectors).

NORTH CAROLINA: Pitt County 3 miles east of Quinerly and 2 miles north of the Neuse River (station 10627, type of *cravenensis*, L. B. Kellum, collector); J. A. Stokes' farm, Craven County 2 miles north of Maple Cypress (station 8165, J. A. Cushman, collector); Biddle Landing, Neuse

River, north of Ft. Barnwell, Craven County (station 10626, L. B. Kellum, collector); Douglas Green's farm 1 mile west of Maple Cypress (station 12007, W. C. Mansfield, collector).

*Geologic horizon*.—Late Eocene, Santee limestone (South Carolina) and Castle Hayne marl (North Carolina).

*Type*.—Holotype, F. S. Holmes collection, Am. Mus. Nat. History. Type of *cravenensis*, U. S. Nat. Mus. 353256.

*Remarks*.—The three specimens from Cave Hall agree well with figures of the holotype, which is without specific locality. Those from North Carolina, of which there is a large suite, are somewhat less rostrate behind and have smaller peristomes. Perhaps Kellum's name *cravenensis* should be retained to designate the variety. One of the specimens from Cave Hall has an abnormal, apparently twisted peristome.

#### EURHODIA? ELBANA Cooke, n. sp.

Plate 5, figures 5-8

Test small, subquadrate; upper surface moderately tumid, lower surface slightly concave; margin rounded; tubercles larger on lower than on upper surface. Apical system eccentric anteriorly. Paired petals open at the distal ends; anterior pairs widely divergent; pore pairs oblique; pores conjugate. Peristome pentagonal, equilateral, anteriorly eccentric; oral lobes rounded. Periproct small, transversely oval, nearly round, supramarginal, within a short tube that merges into a posterior sulcus.

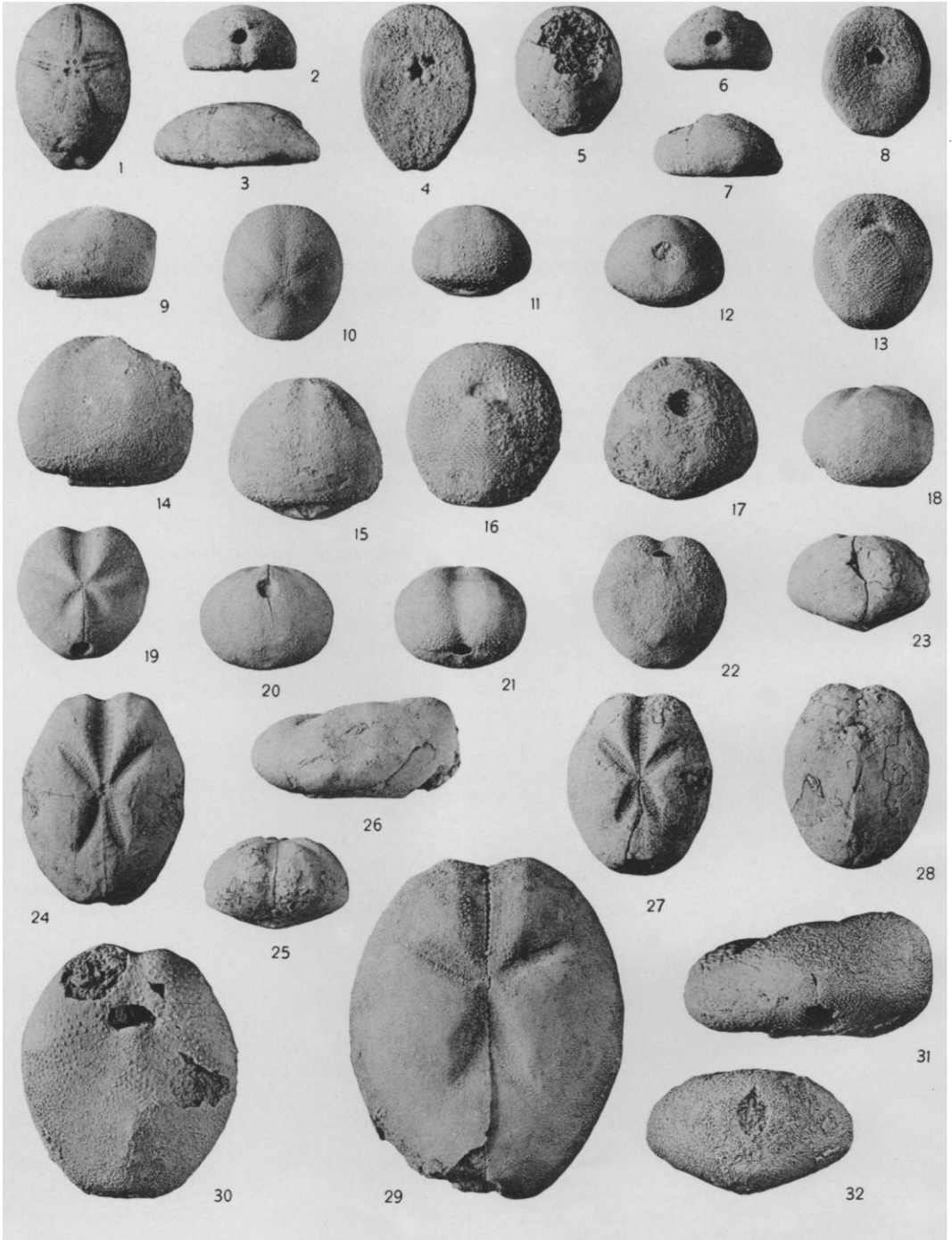
Length, 20 mm.; width, 16 mm.; height, 9.5 mm.

*Occurrence*.—ALABAMA: Pea River at power plant 4 miles below Elba (station 10013, C. W. Cooke and Julia Gardner, collectors).

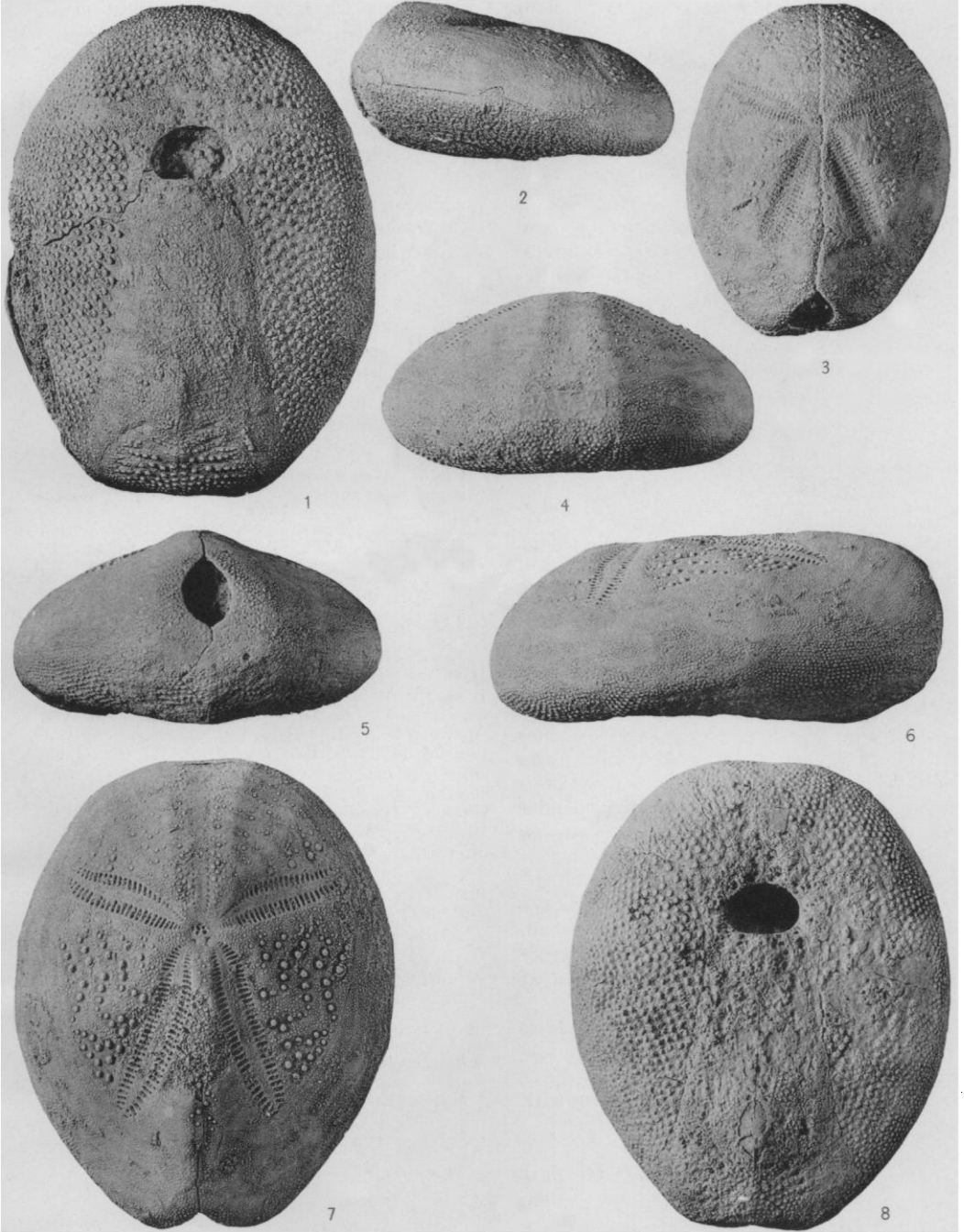
#### EXPLANATION OF PLATE 5

All figures  $\times 1$

- FIGS. 1-4—*Eurhodia patelliformis* (Bouvé). U. S. Nat. Mus. 498988, Albany, Ga. Late Eocene. (p. 35)  
 5-8—*Eurhodia? elbana* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498981, power plant on Pea River below Elba, Ala. Early Eocene. (p. 36)  
 9-13—*Agassizia (Anisaster) wilmingtonica* Cooke, n. sp. Holotype, U. S. Nat. Mus. 499004, Wilmington, N. C. Late Eocene. (p. 46)  
 14-17—*Agassizia (Anisaster) mossomi* Cooke, n. sp. 14, 15, Holotype; 16, 17, paratype; U. S. Nat. Mus. 498989; Brooksville, Fla. Late Oligocene. (p. 46)  
 18-22—*Schizaster (Linthia) ocalanus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498990, Kendrick, Fla. Late Eocene. (p. 42)  
 23-28—*Brissoopsis blanpiedi* Grant and Hertlein. Two topotypes, U. S. Nat. Mus. 498998, Lemon, Smith County, Miss. Middle Oligocene. (p. 49)  
 29-32—*Brissoopsis steinhatchee* Cooke, n. sp. 29, Holotype; 30-32, a paratype; U. S. Nat. Mus. 498987, Steinhatchee River near Clara, Fla. Late Eocene. (p. 49)



Cooke, Cenozoic Echinoids



Cooke, Cenozoic Echinoids



*Geologic horizon.*—Early Eocene, Wilcox group, Bashi formation.

*Type.*—U. S. Nat. Mus. 498981.

*Remarks.*—This species is represented by a single individual, from which the apex and part of the petals are missing. It does not closely resemble any other known American species. Its periproct suggests that of *Eurhodia patelliformis* (Bouvé), but its test is broader, its peristome is not elongated, and its margin is not so sharp. Its equilateral peristome distinguishes it from other species of *Eurhodia*. In general appearance it resembles *Cassidulus (Paralampas) carolinensis* Twitchell, but its periproct is farther forward and more deeply sunken, and its margin is less broadly rounded.

Genus ECHANTHUS Cooke, n. gen.

*Echinanthus* DESOR, 1858, Synopsis des échinides fossiles, p. 291. Not Leske, 1778.

*Echinanthus* DUNCAN and SLADEN, 1882, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, p. 12.

*Echinanthus* POMEL, 1883, Classification méthodique et genera des échinides, p. 61.

*Echinanthus* COTTEAU, 1888, Paléontologie française, Échinides éocènes, t. 1, p. 553.

Test subpentagonal. Apex eccentric anteriorly, with a large central madreporite, four genital pores, and five ocular pores. Petals spatulate, open at the ends, posterior pair longer than the others, poriferous zones of each petal of equal length, pore pairs oblique, pores nearly equal; extrapetalous pores single; floscelle well developed. Under surface slightly concave, with a narrow longitudinal granulated band not raised or callous and lacking large scrobiculae. Peristome eccentric anteriorly, beneath the apex, pentagonal; phyllodes short, broad, conspicuous; oral lobes inflated. Periproct terminal, higher than wide, oval, sunken, at the top of a marginal furrow.

Genotype, *Echinanthus georgiensis* Twitchell, from the Paleocene Clayton formation of Georgia and Alabama.

*Echanthus* appears to be synonymous with

*Echinanthus* Desor (not Leske), whose genotype is *Clypeaster cuvieri* Münster (Desor, 1858, p. 292, pl. 34, figs. 17, 18) which is quite different from any of the species referred by Leske to *Echinanthus*. Desor attributed the genus to Breynius, 1732, who was pre-Linnean. Gregory (1892, p. 600) proposed *Breynella* to include species commonly known as *Echinanthus*, but the only two species cited appear to represent *Echinolampas*, which has an oblique, flush periproct in contrast to the vertical, sunken periproct of *Echanthus*. *Echanthus* differs from *Parapygus* Pomel (1883, p. 61), genotype *Botriopygus toucasanus* d'Orbigny (1855, p. 340, pl. 931), in its sunken periproct and in its outer ambulacral pores, which are nearly round, not slotlike.

ECHANTHUS GEORGIENSIS (Twitchell)

Plate 8, figures 1–3

*Echinanthus georgiensis* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 139, pl. 65, figs. 1a–d.

*Occurrence.*—GEORGIA: Dr. A. J. Parker's farm, Ellaville-Americus road 5 miles south of Ellaville (station 4033, S. W. McCallie, collector, type).

ALABAMA: Luverne road 4.6 miles south of Highland Home, Crenshaw County (station 10497, L. W. Stephenson, collector, casts of the interior); 5 miles south of Highland Home on Alabama 9 in SE.  $\frac{1}{4}$  sec. 25, T. 11 N., R. 17 E., (station 14920, C. W. Cooke and A. C. Munyan, collectors, casts of the interior); chert blocks near road in sec. 21, T. 10 N., R. 28 E., Barbour County,  $2\frac{1}{4}$  miles east of Cotton Hill (station 10910, C. W. Cooke, collector, casts of the interior).

*Geologic horizon.*—Paleocene, Clayton formation.

*Type.*—U. S. Nat. Mus. 165683b.

Family ECHINOLAMPADIDAE

Bernard, 1895

Genus ECHINOLAMPAS Gray, 1825

*Echinolampas* GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 429.

*Echinolampas* d'ARCHIAC and HAIME, 1853, Ani-

#### EXPLANATION OF PLATE 6

All figures  $\times 1$

FIGS. 1–3—*Eupatagus (Plagiobrissus) dixie* Cooke, n. sp. 1, Paratype, U. S. Nat. Mus. 498986, Steinhatchee River near Clara, Fla.; 2, 3, holotype, U. S. Nat. Mus. 498985, 1 mile north of Mayo, Fla. Late Eocene. (p. 55)

4–8—*Eupatagus (Plagiobrissus) ocalanus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 372984, 1 mile north of Mayo, Fla. Late Eocene. (p. 57)



maux fossiles du groupe nummultique de l'Inde, p. 209.

*Echinolampas* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 335.

*Echinolampas* POMEL, 1883, Classification méthodique et genera des échinides, p. 62.

*Echinolampas* COTTEAU, 1889, Paléontologie française, Échinides éocènes, t. 2, p. 5.

*Breyrella* GREGORY, 1892, Roy. Soc. Edinburgh Trans., vol. 36, p. 600.

*Echinolampas* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 111.

*Echinolampas* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, p. 377.

Genotype, *Echinus oviformis* Gmelin, 1788, = *Echinanthus ovatus* Leske (1778, p. 191, pl. 20, figs. c, d), living in the Indian Ocean, designated by Pomel, 1883. The genotype of *Breyrella* is *Pygorhynchus vasalli* Wright, 1855, from the Miocene of Malta, here designated. Gregory intended *Breyrella* as a substitute for *Echinanthus* of authors (*Echanthus* Cooke, n. gen.), but the only two species named appear to represent *Echinolampas*.

#### ECHINOLAMPAS APPENDICULATA Emmons

*Echinolampas appendiculatus* EMMONS, 1858, Agriculture of the eastern counties, p. 307, figs. 240, 241.

*Echinolampas appendiculatus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 149, pl. 68, figs. 2a-h.

*Echinolampas (Isolampas) appendiculatus* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 380, 1921.

*Echinolampas (Miolampas) appendiculata* LAMBERT and THIÉRY, 1921, idem, p. 382.

*Occurrence*.—NORTH CAROLINA: Newbern; Rocky Point (station 779, T. W. Stanton, collector); Wilmington (station 782, Smith Creek, T. W. Stanton, collector; stations 4285, 4287, L. W. Stephenson, collector; 3602, Frank Burns, collector; L. W. Stephenson, E. W. Berry, and B. L. Miller, collectors); Castle Hayne (station 4286, L. W. Stephenson, collector); Lane's Ferry on Northeast Cape Fear River 3 miles east of Rocky Point (L. W. Stephenson, collector); 1 mile northwest of Lane's Ferry (L. W. Stephenson, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—U. S. Nat. Mus. 499113, deposited by Williams College.

#### ECHINOLAMPAS ALDRICHI Twitchell

*Echinolampas aldrichi* TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 173, pl. 81, figs. 1a-d, 2.

*Echinolampas (Miolampas) aldrichi* LAMBERT and THIÉRY, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 383.

*Occurrence*.—ALABAMA: Bluff east of Jacksonville road 200 yards north of Salt Creek, Clark County, NW.  $\frac{1}{4}$  sec. 34, T. 6 N., R. 2 E. (station 7165, C. W. Cooke, collector); 1 mile north of Glendon, Clarke County, NW.  $\frac{1}{4}$  sec. 31, T. 7 N., R. 3 E. (station 7163, C. W. Cooke, collector);  $\frac{1}{2}$  mile northwest of Glendon (station 14514, F. S. MacNeil, collector); Perdue Hill, Monroe County (station 2398, Frank Burns, collector); road to Lambard's Landing, 1.7 miles southeast of Gainestown, Clarke County (station 10050, C. W. Cooke and Julia Gardner, collectors); Gainestown Ferry, Clarke County (station 10052, C. W. Cooke and Julia Gardner, collectors); Choctaw Bluff, Alabama River (Univ. Alabama); 1.3 miles north of Millry, Washington County (station 14291, W. C. Mansfield, collector).

MISSISSIPPI: Four miles north of Waynesboro on road to Shubuta, near middle of sec. 24, T. 9 N., R. 7 W. (station 10053, C. W. Cooke and Julia Gardner, collectors); Taylor Mill Creek  $1\frac{1}{2}$  miles north of Waynesboro (stations 14281a, W. C. Mansfield and F. S. MacNeil, collectors; 14347, Julia Gardner, collector); Sandy Creek, Wayne County (station 14345, Julia Gardner, collector); west bank Chickasawhay River downstream from the Waynesboro-Laurel road (stations 14348, bed 2 of section; 14362, bed 4; 14350, bed 7, Julia Gardner, collector; station 14517, W. C. Mansfield and F. S. MacNeil, collectors).

*Geologic horizon*.—Late Oligocene, Chickasawhay marl.

*Type*.—Johns Hopkins University T 1099 A.

#### Family ECHINOCORYTHIDAE

Gregory, 1900

#### Genus ECHINOCORYS Leske, 1778

*Echinocorys* LESKE, 1778, Naturalis dispositio echinodermatum, p. 175.

*Anachytes* LAMARCK, 1801, Animaux sans vertèbres, p. 347.

*Echinocorys* D'ORBIGNY, 1853, Paléontologie française, Terrain crétacé, t. 6, p. 58.

*Anachytes* DESOR, 1858, Synopsis des échinides fossiles, p. 329.

*Anachytes* JACKSON in ZITTEL, 1913, Text-book of paleontology, p. 292.

*Echinocorys* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 417.

Genotype, *Echinocorys scutatus* Leske (1778, p. 175, pl. 15, figs. A, B), by monotypy. This species is described and figured by Desor (1858, p. 330, pl. 38, fig. 6) under the name *Anachytes ovata* Lamarck and by d'Orbigny (1853, p. 62, pls. 804-806; 808, figs. 1-3) under the name *Echinocorys vulgaris* Breynius.

## ECHINOCORYS OVALIS (Clark)

*Ananchytes ovalis* CLARK, 1893, Johns Hopkins Univ. Circ., vol. 12, no. 103, p. 52.

*Ananchytes ovalis* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 81, pl. 35, figs. 1a-h. Includes additional synonymy.

*Occurrence*.—NEW JERSEY: Vincentown.

*Geologic horizon*.—Early Eocene, Vincentown sand.

*Type*.—Johns Hopkins Univ. T 3011.

## Family HEMIASTERIDAE

H. L. Clark, 1917

## Genus SCHIZASTER Agassiz, 1836

*Schizaster* (part) AGASSIZ, 1836, Soc. sci. nat. Neuchatel Mem., t. 1, p. 185.

*Schizaster* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, p. 15.

*Schizaster* SISMONDA, 1843, Memoria geo-zoologica sugli echinidi fossili del contado di Nizza, p. 30.

*Schizaster* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes (reprint), p. 126.

*Schizaster* DESOR, 1858, Synopsis des échinides fossiles, p. 389.

*Paraster* POMEL, 1869, Revue des échinodermes, p. 14.

*Schizaster* COTTEAU, 1875, K. svenska vetensk. akad. Handl., Bandet 13, no. 6, p. 28.

*Paraster* POMEL, 1883, Classification méthodique et genera des échinides, p. 36.

*Schizaster* COTTEAU, 1886, Paléontologie française Echinides éocènes, p. 270.

*Schizaster* (*Paraster*) MORTENSEN, 1907, Danish Ingolf-Expedition, vol. 4, pt. 2. Echinoidea, p. 123.

*Schizaster* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 192.

*Paraster* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 74.

*Schizaster* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Mat. and Phys. Sci., vol. 2, p. 119.

Genotype, *Schizaster studeri* Agassiz (1836, p. 185), from the late Eocene of Italy, by elimination. Agassiz named only two species, *Spatangus atropos* Lamarck, which became the genotype of *Moera* Michelin, 1855, = *Moira* A. Agassiz, 1872, and *Schizaster studeri*, for which the generic diagnosis should be accepted as the specific description (see H. L. Clark, 1917, p. 192, and Mortensen, 1932, p. 360). *Schizaster studeri* has been figured by Sismonda (1843, p. 32, pl. 2, fig. 4) and by Cotteau (1886, p. 344, pls. 103-105), whose plate 104, figures 4, 5, represent a plastotype. According to Cotteau this species apparently has four

genital pores, whereas *Moira atropos* has two.

Pomel, supposing that *Schizaster* normally has only two genital pores, erected the genus *Paraster* (genotype *Schizaster gibberula* Agassiz and Desor, a living Red Sea species) for species having four genital pores. *Paraster* therefore becomes a synonym of *Schizaster* unless *Schizaster gibberula* has other generic differences from *S. studeri*.

Of the American species, *S. armiger* Clark and *S. americana* Clark have four genital pores, the anterior pair being so near the posterior pair that they might be mistaken for oculars; but *S. beckeri* Cooke, n. sp., has only two, the anterior pair being wanting. The same difference occurs in the subgenus *Linthia*, *L. alabamensis* Clark, *L. hanoverensis* Kellum, and *L. wilmingtonensis* Clark having four pores, whereas *L. ocalana* Cooke, n. sp., has two. All of the species named have the same complement of fascioles—a peripetalous fasciole connected with lateral fascioles that join beneath the periproct. It seems, therefore, that the number of genital pores in *Schizaster* is a specific rather than a generic feature.

## SCHIZASTER ARMIGER Clark

—HARRIS, 1894, Arkansas Geol. Survey Ann. Rept. for 1892, vol. 2, p. 172, pl. 6, fig. 11.

*Schizaster armiger* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 152, pl. 70, figs. 1a-d.

*Schizaster floridanus* CLARK, 1915, idem, p. 175, pl. 82, figs. 1a-c.

*Schizaster armiger* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 524.

*Occurrence*.—ALABAMA: Near old Cocoa post office, Choctaw County, in SW.  $\frac{1}{4}$  sec. 13, T. 11 N., R. 5 W. (station 2637, type, Charles Schuchert, collector; station 7219, C. W. Cooke and W. C. Mansfield, collectors); near Fail, Choctaw County (station 2869, Charles Schuchert, collector); railroad 2 to 3 miles southeast of Whatley, Clarke County (station 2957, Frank Burns, collector); E.  $\frac{1}{2}$  sec. 34, T. 8 N., R. 3 E., 5 miles southeast of Whatley (station 7159, C. W. Cooke, collector); sec. 35, T. 8 N., R. 3 E., 500 feet east of Jones' Field Branch, 5 miles southeast of Whatley (station 7161, C. W. Cooke, collector);  $2\frac{1}{2}$  miles northeast of Jackson (station 3642, T. W. Vaughan, collector); Claiborne (station 5567, bed 8, T. W. Vaughan, collector; station 10023, 8 feet above the "Scutella" bed, C. W. Cooke, collector; station 12166, C. W. Cooke and R. B. Stewart, collectors; Alabama Geol. Survey, W. McGlamery, collector); Claiborne road west of Double Branches,  $2\frac{1}{2}$  miles southwest of Monroe-

ville (station 6730, C. W. Cooke, collector); 1½ miles southwest of Perdue Hill (station 10043, C. W. Cooke and Julia Gardner, collectors); Tombigbee River ¼ mile above St. Stephens Bluff, 10 feet above the Moodys marl (station 7392, C. W. Cooke, collector).

MISSISSIPPI: Railroad cut southwest of the pumping station at Jackson (station 12172, C. W. Cooke, R. B. Stewart, and W. H. Monroe, collectors).

GEORGIA: Power plant on Kinchafoonee Creek 2 miles north of Albany (station 7121, C. W. Cooke and J. E. Brantly, collectors); Flint River in the northeast corner of Dougherty County (station 7235, C. W. Cooke, collector).

FLORIDA: Johnson's Sink, Levy County (station 365, type of *Schizaster floridanus*, L. C. Johnson, collector); Suwannee River 17 miles south of Ellaville (station 2612, G. H. Eldridge, collector); Suwannee River 100 yards below Troy Springs, 6 miles northwest of Branford (station 7347, C. W. Cooke, collector); lowest bed at mouth of Withlacoochee River at Ellaville (station 11111, C. W. Cooke and Stuart Mossom, collectors); 5 miles northwest of Mayo on road to Dowling Park (station 11114, C. W. Cooke and Stuart Mossom, collectors); Steinhatchee River opposite Clara, Dixie County (station 12747, W. C. Mansfield and G. M. Ponton, collectors); station 14541, C. W. Cooke and W. D. Havens, collectors); 1 mile north of Mayo (Florida Geological Survey, G. M. Ponton, collector); Daysville, between Gainesville and Archer (R. B. Becker, collector); Crystal River Rock Company, 6 miles southeast of Crystal River (station 14336, C. W. Cooke and F. S. MacNeil, collectors).

ARKANSAS: East bank Sabine River at Cornish Ferry (Caveness Landing) about 5 miles east-northeast of Warren, Bradley County (station 2412, G. D. Harris, collector).

*Geologic horizon*.—Late Eocene, Jackson formation and Ocala limestone.

*Type*.—U. S. Nat. Mus. 141104.

*Remarks*.—*Schizaster armiger* is very difficult to distinguish from *S. americanus*; but its posterior petals are proportionately longer than those of *P. americanus*, its peripetalous fasciole is angular, not rounded, between the lateral petals and crosses the interambulacral area nearer the center.

#### SCHIZASTER BECKERI Cooke, n. sp.

Plate 3, figures 5–8

Test tumid above and below, margin rounded, highest behind the center, sloping steeply forward, vertically truncated behind. Apical system behind the center, with two posterior genital pores. Anterior ambulacral area deeply depressed halfway to the margin, thence becoming shallower, but depression still perceptible at the peristome.

Petals deeply depressed; anterior pair long, with nearly straight margins, slightly curved outwards at the tip; posterior pair depressed, much shorter; interporiferous zones about as wide as poriferous zones; pores elongate-oval, conjugate. Peristome fairly large, curved, with a strongly rostrate posterior lip; near the anterior end. Periproct oval, higher than wide, high up on the posterior end. Peripetalous fasciole deeply indented between the lateral petals.

Length, 28 mm.; width, 25 mm.; height, 22 mm.

*Occurrence*.—FLORIDA: Gainesville rock pit southeast of Arredondo, Alachua County (type, R. B. Becker, collector); Suwannee River at bridge near Dowling Park, in Lafayette County (paratype, station 14553, C. W. Cooke, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 499008; paratype, 499009.

*Remarks*.—*Schizaster beckeri* is higher and more rotund than other species of *Schizaster* s.s. from the United States. Moreover, it has only two genital pores rather than four.

#### SCHIZASTER AMERICANUS Clark

*Schizaster americana* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 176, pl. 82, figs. 2a–d.

*Schizaster americanus* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 526.

*Occurrence*.—MISSISSIPPI: Yost's lime kiln near Brandon (type, station 3951, A. F. Crider, collector); Vicksburg (A. H. Worthen, collector); station 6450, from ledges forming waterfall at Mint Spring Bayou, C. W. Cooke and E. N. Lowe, collectors); Sylvarena road about 4½ miles west of Bay Springs (station 7374, E. N. Lowe and C. W. Cooke, collectors); Panther Creek, 7 miles north of Youngton, Warren County, in sec. 22 (station 7447, O. B. Hopkins, collector).

ALABAMA: A fragment, probably this species, at Jay Branch, sec. 15, T. 5 N., R. 5 E., Monroe County (station 14368, C. W. Cooke, Julia Gardner, and Edgar Bowles, collectors).

GEORGIA: Ocmulgee River at mill ¼ mile below Hawkinsville (station 10482, H. S. Cave, collector).

*Geologic horizon*.—Middle and late Oligocene: Byram formation (Mississippi); Bucatunna clay member of Byram (Alabama); Suwanne limestone (Georgia).

*Type*.—U. S. Nat. Mus. 165695.

*Remarks*.—*Schizaster americanus* closely resembles *S. armiger*, but its posterior

petals are proportionately shorter, and its peripetalous fasciole is less deeply reentrant between the lateral petals and crosses the anterior ambulacral area nearer the margin.

SCHIZASTER sp. a

Internal casts from the Lisbon formation of Mississippi resemble *Schizaster armiger* Clark except that they are considerably lower than undistorted individuals of that species.

*Occurrence*.—MISSISSIPPI: Wautubbee Hills, railroad cut 4 miles south of Enterprise, between mile posts 20 and 21 south of Meridian (station 2616, Frank Burns, collector; station 6479, E. N. Lowe and C. W. Cooke, collectors); bridge over Falling Creek on road to Langsdale, 6 miles south of Quitman (station 6482, C. W. Cooke, collector).

*Geologic horizon*.—Middle Eocene, Lisbon formation (Wautubbee marl of Lowe).

SCHIZASTER sp. b

Casts from three widely separated places but probably from the same horizon appear to represent an undescribed species of *Schizaster*. Its apical system is farther back than that of *S. americana*, its anterior paired petals are less diverging, its posterior petals are somewhat shorter, and it is more sharply pointed behind.

*Occurrence*.—ALABAMA: Old Weaver Chute, 2 or 3 miles below McGowans Bridge, Escambia County (station 6753, C. W. Cooke, collector, cast made from a mold of the exterior); clay squeezes made from a siliceous mold owned by a country potter, reported to have been found near Baker Hill, Barbour County (station 10778, C. W. Cooke and W. S. Hoffmeister, collectors).

FLORIDA: West side S.  $\frac{1}{2}$  sec. 25, T. 7 N., R. 17 W.,  $\frac{3}{4}$  mile south of the Alabama State line in Holmes County (station 15101, C. W. Cooke, collector, natural cast of the interior).

*Geologic horizon*.—Late Oligocene, Chickasawhay marl and Flint River formation.

Subgenus LINTHIA Desor, 1853

*Linthia* DESOR, 1853, Soc. helvetique sci. nat. Actes (Porrentruy) (Schweitzer. naturf. Gesell. Verh.), p. 278.

*Linthia* DESOR, 1858, Synopsis des échinides fossiles, p. 395.

*Linthia* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 604.

*Linthia* DUNCAN and SLADEN, 1882, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, p. 17.

*Linthia* POMEL, 1883, Classification méthodique et genera des échinides, p. 36.

*Linthia* COTTEAU, 1886, Paléontologie française, Echinides éocènes, p. 206.

*Linthia* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 518.

*Linthia* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 124.

Genotype, *Escheria insignis* Merian, 1853, from the middle Eocene of Switzerland, designated by Desor (1858, p. 395). This species has been figured by Desor (1858, pl. 43, fig. 9) and by Cotteau (1886, p. 232, pl. 70). Its apical system is farther forward than that of typical *Schizaster*, its petals are straighter and less deeply impressed, the posterior pair are longer, and the posterior end is less strongly rostrate. The genotypes of *Linthia* and *Schizaster* are so different in appearance that one might be justified in deeming them different genera if they alone were to be considered; but several species seem to be intermediate between the two end forms.

SCHIZASTER (LINTHIA) TUMIDULUS (Clark)

*Linthia tumidula* CLARK, 1891, Johns Hopkins Univ. Circ., vol. 10, no. 87, p. 77.

*Linthia tumidula* CLARK, 1893, idem, vol. 12, no. 103, p. 52.

*Linthia tumidula* CLARK, 1893, U. S. Geol. Survey Bull. 97, p. 91, pl. 1, figs. 1a-i.

*Linthia tumidula* WELLER, 1907, New Jersey Geol. Survey, Paleontology, vol. 4, p. 304, pl. 18, figs. 1-9.

*Linthia tumidula* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 99, pl. 53, figs. 1a-i.

*Occurrence*.—NEW JERSEY: Timber Creek and Vincentown (Clark).

*Geologic horizon*.—Early Eocene, Vincentown sand.

*Type*.—Am. Mus. Nat. History.

*Remarks*.—There are no identified specimens of this species in the United States National Museum. Clark's drawings indicate that the fasciole is not at all U-shaped below the periproct in contrast with typical *Schizaster*. The petals appear to resemble those of typical *Linthia*.

SCHIZASTER (LINTHIA) WILMINGTONENSIS (Clark)

*Linthia wilmingttonensis* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 152, pl. 70, figs. 3a-c.

*Linthia wilmingttonensis* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 519.

*Occurrence*.—NORTH CAROLINA: Wilmington



(type); Rocky Point (station 779, T. W. Stanton, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—U. S. Nat. Mus. 166482.

*Remarks*.—The petals of this species seem to be more deeply sunken than those of typical *Linthia*, and the posterior pair show a tendency to curve backward and are shorter. The nearly central apical system and the widely spreading, nearly straight anterior pair of petals separate it from typical *Schizaster*.

SCHIZASTER (LINTHIA) HANOVERENSIS  
(Kellum)

*Linthia hanoverensis* KELLUM, 1926, U. S. Geol. Survey Prof. Paper 143, p. 15, pl. 1, figs. 8-9, 1926.

*Occurrence*.—NORTH CAROLINA: Wilmington (type, station 782, T. W. Stanton, collector; L. B. Kellum, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—U. S. Nat. Mus. 164664.

*Remarks*.—The anterior ambulacral area of this species is less deeply depressed than is usual for *Linthia*, but the species has peripetalous and lateral fascioles. *Linthia wilmingtonensis* superficially resembles *Macropneustes carolinensis* Clark, which occupies the same geologic horizon at Wilmington, but its front and back pairs of genital pores are closer together, its anterior end is less rounded, and its peristome is farther forward than that of *Macropneustes carolinensis*, which species appears to have only a nearly straight marginal fasciole.

SCHIZASTER (LINTHIA) ALABAMENSIS  
(Clark)

*Linthia alabamensis* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 153, pl. 71, figs. 1a-d, 2a-d. *Linthia maverickensis* GARDNER, 1935, Texas Univ. Bull. 3301, p. 110, pl. 4, figs. 13, 14.

*Occurrence*.—ALABAMA: Prairie Creek, Wilcox County (type, station 264, L. C. Johnson, collector); Brundidge, Pike County (Johns Hopkins Univ., T. H. Aldrich, collector).

ARKANSAS: Railroad cut  $\frac{1}{2}$  mile southwest of Grand Glaise, Jackson County (U. S. Nat. Mus. 166483, L. W. Stephenson, collector).

TEXAS: Indio Ranch, 6 miles below the McFarland sheep pens on the Windmill (Jacal) ranch road (station 11754, Julia Gardner, collector).

*Geologic horizon*.—Paleocene; Clayton for-

mation in Alabama, Midway formation in Arkansas, and Wills Point (?) formation in Texas.

*Types*.—Holotype, U. S. Nat. Mus. 137371; paratype, 166483. Holotype of *maverickensis*, U. S. Nat. Mus. 370904.

*Remarks*.—This species is represented in the United States National Museum only by the three types specified. The type of *Linthia maverickensis* is a small internal cast that can not be certainly identified. *Linthia alabamensis* is similar to *L. variabilis* Slocum from the Upper Cretaceous Ripley formation of Mississippi, but its apical system is more nearly central, its test is not so high, and its posterior truncation is not quite so steep.

SCHIZASTER (LINTHIA) OCALANUS Cooke,  
n. sp.

Plate 5, figures 18-22

Test subglobular, cordate, the anterior depression extending from the apical system to the peristome, the upper surface more inflated than the lower. Apical system nearly central, with two large genital pores, one between the ends of each lateral pair of petals, and the madreporite extending behind them. Anterior ambulacral area moderately sunken; pores of each pair separated by a high granule. Petals nearly straight, sunken; anterior pair diverging at an angle of approximately 120°, the posterior at an angle of approximately 60°; anterior pair about twice as long as posterior; open at the distal ends; poriferous zones about as wide as interporiferous zones; pores conjugate. Peripetalous fasciole concave between the lateral petals, convex elsewhere. Peristome far forward, sub-trigonal to subpentagonal, strongly lipped posteriorly, weakly lobate anterolaterally. Periproct about as large as the peristome, elliptical, higher than wide, high up on the flattened, sloping posterior end. Surface covered with small tubercles.

Length of holotype, 21 mm.; width, 21 mm.; height, 16 mm. Length of a paratype from station 14539, 33mm.; width, 32 mm.; height, 27 mm.

*Occurrence*.—FLORIDA: Pit of the Ocala Lime-rock Company near Kendrick (holotype, station 13429, T. H. Hubbell, collector); pit of Cummer Lumber Company near Kendrick, 4.8 miles north

of Ocala (station 12754a, C. W. Cooke and T. P. Kirby, collectors); old MacDonald quarry 1 mile north of Istachatta (figured paratype, station 11112, C. W. Cooke and Stuart Mossom, collectors); Oakhurst Lime Company, 2½ miles southeast of Ocala (station 11749, C. W. Cooke and Stuart Mossom, collectors); spoil bank of drainage canal on U. S. 19, 5 miles south of Salem, Taylor County (station 14539, C. W. Cooke and W. D. Havens, collectors); quarry 6 miles southeast of Crystal River (station 14141, W. C. Mansfield and C. W. Mumm, collectors); Florida Geol. Survey, Frank Westendick, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 498990.

*Remarks*.—*Schizaster (Linthia) ocalanus* is more globular than most American Linthias, and its periproct is visible from above. Moreover, it has two instead of four genital pores.

#### Genus MOIRA A. Agassiz, 1872

*Moira* MICHELIN, 1855, *Revue et magasin de zoologie*, ser. 2, t. 7, p. 246. Not Huebner, 1819.

*Moira* A. AGASSIZ, 1872, 1874, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 146, 365.

*Moira* POMEL, 1883, *Classification méthodique et genera des échinides*, p. 37.

*Moira* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 195.

*Moira* LAMBERT and THIÉRY, 1925, *Nomenclature raisonnée des échinides*, fasc. 8, p. 532.

Genotype, *Spatangus atropos* Lamarck, living off the coast of the United States from North Carolina to Texas, by monotypy. Strict application of the rules might make this species the type of *Schizaster*, but a large group of echinologists have recommended (Mortensen, 1932, p. 360) that the present classification be retained.

#### MOIRA ATROPOS (Lamarck)

*Spatangus atropos* LAMARCK, 1816, *Histoire naturelle des animaux sans vertèbres*, vol. 3, p. 32.

*Moira atropos* A. AGASSIZ, 1874, Harvard College Mus. Comp. Zoology Mem., vol. 3, pt. 2, p. 365, pl. 23.

*Moira atropos* H. L. CLARK, 1917, *idem*, vol. 46, no. 2, p. 196.

*Occurrence*.—Coast of the southeastern States from North Carolina to Texas; rare in the West Indies (H. L. Clark).

*Geologic horizon*.—Recent.

*Remarks*.—This species is characterized by the roofing over of part of the ambulacral

depressions by expansions of the interambulacra.

#### Genus HEMIASTER Desor, 1847

*Hemiaster* DESOR in AGASSIZ and DESOR, 1847, *Annales sci. nat. (zoologie)*, t. 8, p. 16 (reprint, p. 122).

*Hemiaster* D'ORBIGNY, 1853, *Paléontologie française, Terrain crétacé*, t. 6, p. 220.

*Hemiaster* DESOR, 1858, *Synopsis des échinides fossiles*, p. 367.

*Hemiaster* AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem. 3, p. 585.

*Hemiaster* DUNCAN and SLADEN, 1882, *Palaeontologia Indica*, ser. 14, vol. 1, pt. 3, p. 78.

*Hemiaster* POMEL, 1883, *Classification méthodique et genera des échinides*, p. 42.

*Hemiaster*, H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem. vol. 46, no. 2, p. 165.

*Hemiaster* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 73.

*Hemiaster* LAMBERT and THIÉRY, 1924, *Nomenclature raisonnée des échinides*, fasc. 7, p. 498.

*Hemiaster* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. Phys. Sci., vol. 2, p. 117.

Genotype, *Spatangus bufo* Al. Brongniart, 1822, from the Cenomanian of France, designated by Pomel (1883). This species has been figured by Agassiz and Desor (1847, pl. 6, fig. 7) and by d'Orbigny (1853, pl. 873).

#### HEMIASTER PARASTATUS (Morton)

*Spatangus cor marinum?* Parkinson. MORTON, 1830, *Am. Jour. Sci.*, ser. 1, vol. 18, p. 250, pl. 3, fig. 10.

*Spatangus parastatus* MORTON, 1830, *idem*, vol. 23, p. 294.

*Spatangus parastatus* MORTON, 1834, *Synopsis organic remains Cretaceous*, p. 77, pl. 3, fig. 21.

*Hemiaster parastatus* DESOR in AGASSIZ and DESOR, 1847, *Catalogue raisonné des échinodermes* (reprint), p. 141.

*Holaster parastatus* GABB, 1859, *Cat. invert. fossils Cretaceous*, p. 19.

*Hemiaster parastatus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 92, pl. 48, figs. 1a-n.

*Hemiaster (Leymeriaster) parastatus* LAMBERT and THIÉRY, 1924, *Nomenclature raisonnée des échinides*, fasc. 7, p. 501.

*Occurrence*.—NEW JERSEY: Gloucester County (type); Rancocas Creek, Vincentown (U. S. Nat. Mus. 29472, figured by Clark, F. B. Meek, collector); Timber Creek (fide Clark).

*Geologic horizon*.—Early Eocene, Vincentown sand.

*Type*.—Acad. Nat. Sci. Philadelphia 1487.

## HEMIASTER STELLA (Morton)

- Spatangus stella* MORTON, 1830, Am. Jour. Sci., ser. 1, vol. 18, p. 245, pl. 3, fig. 11.
- Spatangus parastatus* (part) MORTON, 1834, Synopsis organic remains Cretaceous, p. 78, pl. 3, fig. 18(?).
- Hemiasler stella* DESOR in AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes (reprint), p. 141.
- Hemiasler stella* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 93, pl. 48, figs. 2a-d. Gives additional synonymy.
- Hemiasler (Integraster) stella* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 504.

*Occurrence*.—NEW JERSEY: Timber Creek (type); near Blackwoodstown (U. S. Nat. Mus. 2208, figured by Clark, F. B. Meek, collector); Rancocas Creek, Vincenttown, U. S. Nat. Mus. 29473, F. B. Meek, collector).

*Geologic horizon*.—Early Eocene, Vincenttown sand.

*Type*.—Acad. Nat. Sci. Philadelphia?

## Genus AGASSIZIA Valenciennes, 1846

- Agassizia* VALENCIENNES, 1846, Voyage sur *La Venus*, Zoophytes, pl. 1, figs. 2-2f.
- Agassizia* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes (reprint), p. 126.
- Agassizia* DESOR, 1858, Synopsis des échinides fossiles, p. 394.
- Agassizia* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 88, 353.
- Agassizia* COTTEAU, 1875, K. svenska vetensk. akad. Handl., Bandet 13, no. 6, p. 82.
- Agassizia* POMEL, 1883, Classification méthodique et genera des échinides, p. 35.
- Agassizia* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 163.
- Agassizia* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 70.
- Agassizia* LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 516.
- Agassizia* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 113.

Genotype, *Agassizia scrobiculata* Valenciennes, 1846, by monotypy, living off the west coast of tropical and subtropical America (Clark). This species has been

figured by A. Agassiz (1872, pl. 19a, figs. 1-3; pl. 19b, figs. 1-3) and by Grant and Hertlein (1938, pl. 29, figs. 2, 3; pl. 30, fig. 12; text fig. 10), who copy Valenciennes original figure. The anterior poriferous zones of the anterior paired petals are absent or obsolete. The genus is further characterized by having a peripetalous fasciole and a lateral fasciole. Its periproct is transverse.

## AGASSIZIA FLORIDANA de Loriol

Plate 3, figures 1-4

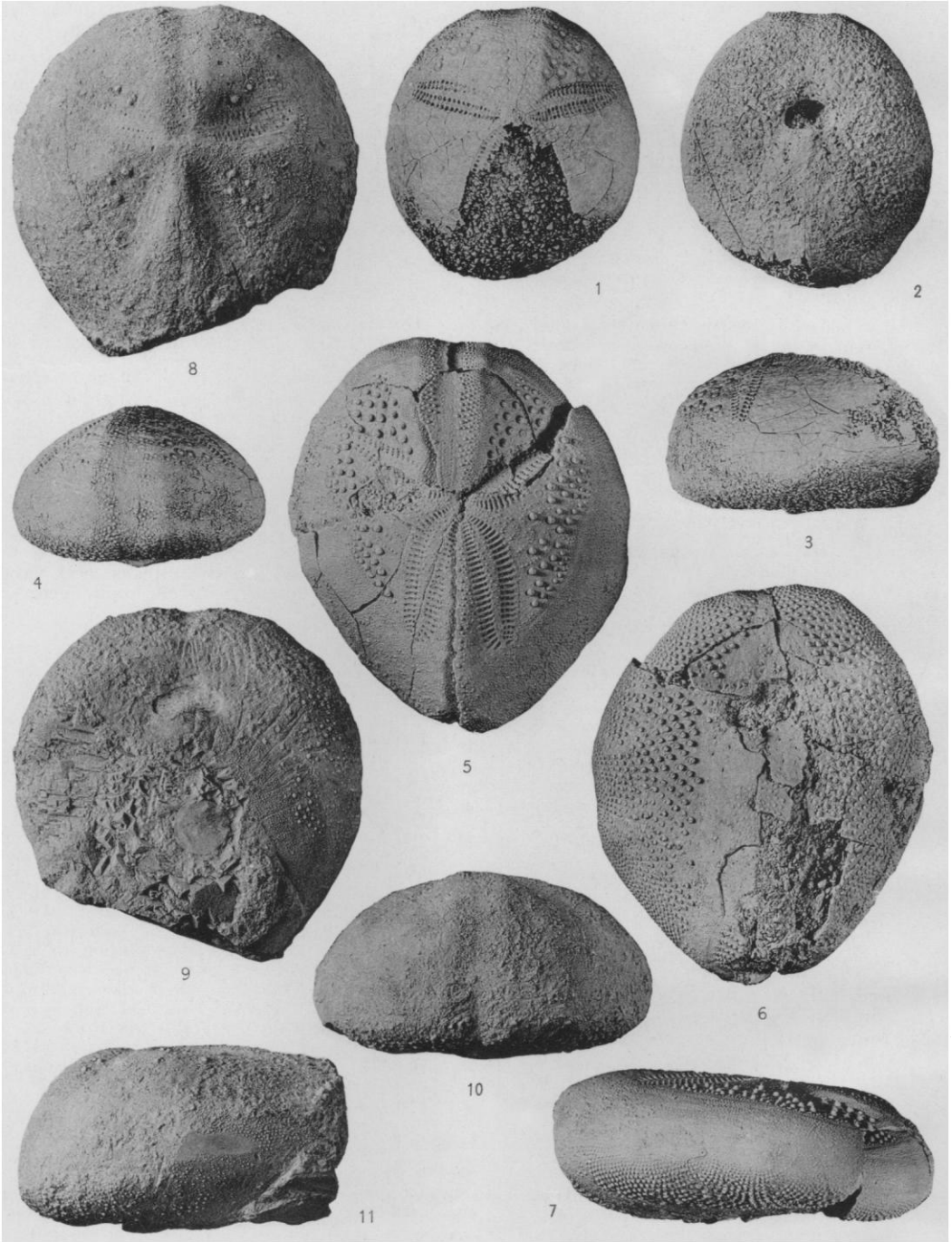
- Agassizia floridiana* DE LORIO, 1887, Recueil zool. suisse, ser. 1, t. 4, no. 3, p. 398, pl. 17, figs. 9-9f.
- Agassizia conradi* (Bouvé). CLARK and TWITCH-ELL, 1915, U. S. Geol. Survey Mon. 54, p. 174, pl. 81, figs. 3a-d.
- Agassizia inflata* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 70, pl. 12, figs. 2-4.
- Agassizia egozcuei* LAMBERT, 1922, Annals and Mag. Nat. History, ser. 9, vol. 9, p. 596.
- Agassizia inflata* ARNOLD and CLARK, 1927, Harvard College Mus. Comp. Zoology Mem., vol. 50, p. 56.
- Agassizia conradi* (Bouvé). PIJPER, 1933, Geog. geol. Mededeel. (Utrecht Rijksuniv. geog. en mineral-geol. Inst.) Phys.-geol. Reeks no. 8, p. 92.
- Agassizia caribbeana* WEISBORD, 1934, Bull. Am. Paleontology, vol. 20, no. 700, p. 74, pl. 8, figs. 1-6.

*Occurrence*.—FLORIDA: Near Gainesville (type, Prof. Wetherby, collector, fide de Loriol); about 12 miles north of Marianna (station 12058, Florida Basic Rock Co., W. C. Mansfield and G. M. Ponton, collectors; station 14152, 1½ miles west of Springfield Church, W. C. Mansfield and C. W. Mumm, collectors); Ocala (station 7383, C. W. Cooke, collector); Zuber (station 6807, C. W. Cooke, collector); Newberry (station 6812, C. W. Cooke, collector); 2 miles northeast of Sumterville (station 12751, W. C. Mansfield and C. W. Mumm, collectors); 1½ miles southwest of Inverness (station 7378, C. W. Cooke, collector); Steinhatchee River near Clara (station 14541, C. W. Cooke, collector; station 12747, W. C. Mansfield and G. M. Ponton, collectors); Crystal River Rock Co., 6 miles southeast of Crystal River (station 14141, W. C. Mansfield and C. W. Mumm, collectors);

## EXPLANATION OF PLATE 7

All figures  $\times 1$

- FIGS. 1-4—*Eupatagus (Plagiobrissus) gardnerae* Cooke, n. sp. Holotype U. S. Nat. Mus. 498983, 6 miles west of Andalusia, Ala. Late Eocene. (p. 56)
- 5-7—*Eupatagus (Plagiobrissus) curvus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498984, Marianna, Fla. Late Eocene. (p. 56)
- 8-11—*Eupatagus (Brissopatagus) georgianus* Cooke, n. sp. Holotype, U. S. Nat. Mus. 498982, Albany, Ga. Late Eocene. (p. 58)



Cooke, Cenozoic Echinoids





Cooke, Cenozoic Echinoids

Johnson's lime sink (U. S. Nat. Mus. 137881, L. C. Johnson, collector); between Inglis and Yankeetown, Levy County (station 14544, C. W. Cooke, collector); Archer, Sumter, and Williston (Florida Geol. Survey).

GEORGIA: Near Bainbridge (station 3770, U. S. Nat. Mus. 164744, figured by Clark and Twitchell, S. W. McCallie, collector); stations 6159, 6171, L. W. Stephenson, collector; station 7097, C. W. Cooke and W. C. Mansfield, collectors).

WEST INDIES: St. Bartholomew (types of *inflata* and *egozcui*); Bonaire (*conradi*, fide Pijpers); Jamaica (*inflata*, fide Arnold and Clark); Cuba (type of *caribbeana*).

*Geologic horizon*.—Late Eocene, Ocala limestone and equivalents in the West Indies.

*Figured specimens*.—Station 1454, U. S. Nat. Mus. 499010, Steinhatchee River near Clara, Fla.; U. S. Nat. Mus. 325610, St. Bartholomew, figured by Jackson as type of *inflata*; U. S. Nat. Mus. 164744a, near Bainbridge, Ga., figured by Clark and Twitchell as *conradi* (Bouvé); Paleont. Research Inst., Camagüey Province, Cuba, figured by Weisbord as type and paratype of *caribbeana*.

*Remarks*.—This species was placed in the synonymy of *Hemiasler conradi* Bouvé (1851, p. 3, 2 text figs.) by Clark and Twitchell, but Bouvé's type, which is in the Museum of Comparative Zoology at Cambridge, Mass., is "absolutely unidentifiable even to the family, let alone genus or species," according to Prof. H. L. Clark, who kindly examined it for me. De Loriol's careful description and excellent figures leave no doubt that the specimen here figured represents the same species as his, though his type is not available.

*Agassizia inflata* Jackson, placed by Pijpers in the synonymy of *conradi* as identified by Clark and Twitchell, closely resembles *A. floridana* and probably is identical with it. It appears to differ in

that its base is a little flatter, its peristome a little smaller, and its periproct a little lower; but these features, particularly the location of the periproct, are obscure in the type of *inflata*. Both *inflata* and *egozcui* are based on part of *A. clevei* Cotteau (1875, p. 33, pl. 6, figs. 9, 10, not figs. 2–8), from which they differ in their more widely diverging anterior petals and in other features.

The largest individual in the collections of the National Museum is from Steinhatchee River, station 14541. It measures 36 by 34 by 28 mm.

#### AGASSIZIA RIMULATA (Ravenel)

*Brissopsis rimulatus* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4, figs. 3, 4.

*Agassizia rimulata* McCrady in TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 5.

*Brissopsis rimulatus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 154.

*Occurrence*.—SOUTH CAROLINA; Exact locality not recorded, possibly Santee Canal.

*Geologic horizon*.—Eocene (Ravenel).

*Type*.—Unknown; originally in the Ravenel collection at Charleston, S. C.

*Remarks*.—This species, which McCrady describes as conical, is known only from Ravenel's figure. It is probably not recognizable.

#### AGASSIZIA PORIFERA (Ravenel)

*Brissopsis poriferus* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4, figs. 5, 6.

*Agassizia porifera* McCrady in TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 5, pl. 1, figs. 5–5b; pl. 2, figs. 4, 4a.

*Agassizia porifera* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 212, pl. 97, figs. 1a–d.

*Occurrence*.—SOUTH CAROLINA: The Grove.

#### EXPLANATION OF PLATE 8

All figures  $\times 1$

- FIGS. 1–3—*Echanthus georgiensis* (Twitchell). Holotype, U. S. Nat. Mus. 165683b, 5 miles south of Ellaville, Ga. Paleocene. (p. 37)  
 4—*Cassidulus (Cassidulus) sabistonensis* Kellum. Holotype, U. S. Nat. Mus. 353233, 2 miles north of Jacksonville, N. C. Early Miocene? (p. 31)  
 5, 6—*Cassidulus (Cassidulus) evergladensis* Mansfield. U. S. Nat. Mus. 499005, station 13377, Intracoastal Waterway canal 5 miles southwest of Little River, S. C. Two individuals. Pliocene. (p. 30)  
 7—*Clypeaster oxybaphon* Jackson. U. S. Nat. Mus. 499006, station 15067A, NW $\frac{1}{4}$  sec. 36, T. 4 N., R. 13 W., Washington County, Fla. Late Oligocene. (p. 13)

Cooper River 5 miles northwest of Wando, Berkeley County (type); near Oakley Inlet.

*Geologic horizon*.—Pliocene, Waccamaw formation.

*Type*.—Unknown; originally in the Ravenel collection at Charleston, S. C.

*Remarks*.—There are no identified specimens of this species in the United States National Museum.

Subgenus ANISASTER Pomel, 1886

*Anisaster* POMEL, 1886, Soc. géol. France Bull., sér. 3, t. 14, pp. 610, 612.

*Anisaster* COTTEAU, 1887, Paléontologie française, Échinides éocènes, t. 1, p. 374.

*Prenaster* (*Anisaster*) LAMBERT and THIÉRY, 1925, Nomenclature raisonnée des échinides, fasc. 8, p. 515.

Genotype, *Agassizia gibberula* Cotteau (1876), from the Eocene of Egypt, designated by Cotteau (1887, p. 381). This species has been figured by Cotteau and by de Loriol (1880, pl. 8, figs. 1-7).

*Anisaster* differs from typical *Agassizia* in that some of the pores of the anterior zones of its anterior paired ambulacra are not obsolete.

AGASSIZIA (ANISASTER) WILMINGTONICA

Cooke, n. sp.

Plate 5, figures 9-13

Test ovoid, truncated behind: upper surface sloping gently from the apex to the posterior truncation, more steeply rounded at the front; rostrate behind; margin rounded; lower surface moderately inflated. Apical system back of the center; four genital pores separated by an elongated madreporite, which extends behind them. Anterior ambulacral area slightly depressed near the apex and peristome, flush at the margin; pores inconspicuous. Anterior paired petals slightly depressed; pore pairs of front zone small, diagonal distally, obsolete near the apex; pores of rear zone normal. Posterior petals about half as long as anterior pair; slightly depressed; interporiferous zones about as wide as poriferous zones; pores oval. Peristome transverse, crescent-shaped, labiate behind. Periproct transverse, oval, flush, terminal, at the top of the truncation. Hemipetalous fasciole curving downward to the marginal fasciole. Marginal fasciole curving downward to a V at the bottom of the truncation. Escutch-

eon ovate, extending from the peristome to the posterior end, reticulated with scales and tubercles. Remainder of surface covered with small tubercles, which are coarsest along the edges of the interambulacral areas.

Length, 21 mm.; width, 18.5 mm.; height, 14.2 mm.

*Occurrence*.—NORTH CAROLINA: City rock quarry near Wilmington (L. W. Stephenson, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—U. S. Nat. Mus. 499004.

*Remarks*.—The unique type of this species is less inflated than *A. floridana*, its front and back paired petals do not diverge at the same angle (the anterior pair are wider apart than the posterior), and the front posterior poriferous zones of the anterior pair are not obsolete distally. It was found in a bed slightly older than the zone occupied by *A. floridana*.

AGASSIZIA (ANISASTER) MOSSOMI

Cooke, n. sp.

Plate 5, figures 14-17

Test nearly spherical, less tumid beneath, truncated behind. Apical system nearly central, with four genital pores, the posterior pair separated by an elongated madreporite, which extends behind them. Petals forming a nearly right angled X; more deeply sunken than customary for the genus; front pair half again as long as the back pair; pores of anterior zone of front pair small and oblique distally, very minute near the apex; interporiferous zones of back pair narrower than the poriferous zones. Anterior ambulacral area slightly sunken near the apex, flush at the margin. Peristome semilunate, with a posterior lip, located at the anterior third. Periproct large, transversely oval, terminal, at the top of the truncation. Marginal fasciole forming a V below the periproct, joined by the hemipetalous fasciole behind the anterior pair of petals. Interambulacral areas covered with close-set tubercles.

Length of holotype, 27 mm.; width, 24.5 mm.; height, 23.4 mm. Length of figured paratype, 25.2 mm.; width, 24 mm.; height, 22.3 mm.

*Occurrence.*—FLORIDA: Florida Rock Products quarry  $\frac{1}{2}$  mile southwest of Brooksville (types, station 11113, C. W. Cooke and Stuart Mossom, collectors); Consolidated Rock Products quarry 3 miles northeast of Brooksville (station 12321, W. C. Mansfield and Herman Gunter, collectors).

GEORGIA: Dawson-Albany road 3 $\frac{1}{2}$  miles south of Sasser (station 4059, U. S. Nat. Mus. 165681, S. W. McCallie, collector, cast of interior); 1 $\frac{1}{2}$  miles west of Muckalee Creek on road from Americus to Plains (station 12090, C. W. Cooke and W. H. Monroe, collectors, cast of interior).

MISSISSIPPI: Rocky Branch, S.W.  $\frac{1}{4}$  sec. 8, T. 8 N., R. 5 W., 1 mile north-northeast of Denham, Wayne County (station 14288a, W. C. Mansfield and F. S. MacNeil, collectors).

*Geologic horizon.*—Late Oligocene; Suwannee limestone (Florida), Flint River formation (Georgia), Chickasawhay marl (Mississippi).

*Type.*—U. S. Nat. Mus. 498989.

*Remarks.*—*Agassizia mossomi* is higher and more nearly spherical, its apex is farther forward, its petals are more deeply sunken, and the anterior pores of the front pair are more nearly complete than in *A. floridana* or *A. wilmingtunica*. The single distorted specimen from Mississippi (station 14288a) may represent a different species.

#### Family SPATANGIDAE Gray, 1825

##### Genus BRISSUS Gray, 1825

*Brissus* GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 431.

*Brissus* DESOR, 1858, Synopsis des échinides fossiles, p. 403.

*Brissus* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pt. 2, p. 356.

*Brissus* POMEL, 1883, Classification méthodique et genera des échinides, p. 34.

*Brissus* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 217.

Genotype, *Spatangus brissus* var. *unicolor* Leske, 1778, living in the tropical Atlantic, designated by H. L. Clark (1917, p. 217).

*Brissus* should not be credited to Leske because he did not accept it himself as of either generic or subgeneric rank but merely referred to it (1778, p. 245) as "Brissi Kleinii." His use of the word "Brissi" in the synoptic index (p. XX) was in the same sense. Nor can the use of *Brissus* on page 29 of his "Naturalis dispositio echinodermatum" be accepted, according to opinion 5 of the International Committee on Zoological Nomenclature.

##### BRISSUS UNICOLOR (Leske)

*Spatangus brissus* var. *unicolor* LESKE, 1778, Naturalis dispositio echinodermatum, p. 248, pl. 26, figs. B, C.

*Brissus unicolor* GRAY, 1825, Annals of Philosophy, ser. 2, vol. 10, p. 431.

*Brissus unicolor* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 97, 357, pl. 22, figs. 1, 2, pl. 37, fig. 19.

*Brissus brissus* H. L. CLARK, 1917, idem, vol. 46, no. 2, p. 218.

*Occurrence.*—Southern Florida, tropical Atlantic, and Mediterranean Sea (Clark).

*Geologic horizon.*—Recent.

*Remarks.*—This species, as identified by Agassiz, has a peripetalous fasciole with reentrant angles, a subanal fasciole, wide-spreading anterior petals, which form almost a straight line and which are almost as long as the posterior petals.

##### BRISSUS? SPATIOSUS McCrady

*Pericosmus spatiosus* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4 (nomen nudum).

*Brissus spatiosus* McCrady in TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 8, pl. 3, figs. 1–1c.

*Meoma ventricosa* (part) A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, p. 143.

*Brissus spatiosus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 215.

*Occurrence.*—SOUTH CAROLINA: The Grove, Cooper River.

*Geologic horizon.*—Pliocene, Waccamaw formation; or late Miocene.

*Remarks.*—This species, known only from drawings of an imperfect cast, appears to be neither a *Brissus* nor a *Meoma*. It is probably unrecognizable. *Plagionotus ravenelianus* McCrady (1857, p. 10, pl. 3, figs. 3, 3a) and *Plagionotus holmesii* McCrady (1857, p. 9 pl. 3, figs. 2, 2a), described from fragments from the same formation, are unrecognizable. They may represent the same species.

##### Genus MEOMA Gray, 1851

*Meoma* GRAY, 1851, Annals and Mag. Nat. History, ser. 2, vol. 7, p. 131.

*Meoma* DESOR, 1858, Synopsis des échinides fossiles, p. 423.

*Rhyssobrissus* A. AGASSIZ, 1863, Harvard College Mus. Comp. Zoology Bull., vol. 1, p. 27.

*Hemibrissus* POMEL, 1869, Revue des échinodermes, p. 13. (Genotype, *Spatangus ventricosus* Lamarck.)

*Brissus (Meoma)* A. AGASSIZ, 1872, Harvard Col-



- lege Mus. Comp. Zoology Mem., vol. 3, pp. 142, 358.
- Meoma* POMEL, 1883, Classification méthodique et genera des échinides, p. 35.
- Meoma* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 220.
- Meoma* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 495.
- Meoma* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. Phys. Sci., vol. 2, p. 130.
- Genotype, *Meoma grandis* Gray (1851, p. 132), living in the Gulf of California and along the Pacific coast of Mexico, by monotypy. Lambert and Thiéry identify this species as *Echinus grandis* Gmelin, but there is no evidence in Gray's paper that the correspondence in specific names is not accidental. Gray cites Australia as the habitat, but this is regarded by A. Agassiz and subsequent writers as probably an error.

#### MEOMA VENTRICOSA (Lamarck)

- Spatangus ventricosus* LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 29.
- Meoma ventricosa* LÜTKEN, 1864, Naturh. Forening Kjöbenhavn, vidensk. Meddelelser, 1863, ser. 2, vol. 5, p. 120.
- Brissus* (*Meoma*) *ventricosa* A. AGASSIZ, 1872-1874, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 143, 358, 603, pl. 20, fig. 8; pl. 22, figs. 3, 4; pl. 26, figs. 31-34; pl. 38, figs. 24, 25.
- Meoma ventricosa* H. L. CLARK, 1917, idem, vol. 46, no. 2, p. 221.
- Meoma ventricosa* H. L. CLARK, 1933, New York Acad. Sci., Sci. Survey Porto Rico Virgin Islands, vol. 16, pt. 1, p. 92.

*Occurrence*.—Bahamas, southern Florida, Jamaica, and the Virgin Islands (Clark).

*Geologic horizon*.—Recent.

*Remarks*.—According to Clark this species attains a length of 188 mm., a width of 158 mm., and a height of 100 mm. A specimen in the collection of the Florida Geological Survey measures 156 mm. in length, 135 mm. in width, and 75 mm. in height.

#### Genus BRISSOPSIS Agassiz, 1840

- Brissopsis* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, pp. 3, 16.
- Brissopsis* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinides (reprint), p. 120.
- Brissopsis* WRIGHT, 1855, Annals and Mag. Nat. History, ser. 2, vol. 15, p. 187.
- Brissopsis* DESOR, 1858, Synopsis des échinides fossiles, p. 378.
- Toxobrissus* DESOR, 1858, idem, p. 399.

- Brissopsis* A. AGASSIZ, 1872-74, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 95, 354, 593.
- Brissopsis* COTTEAU, 1875, K. svenska vetensk. akad. Handl., Bandet 13, no. 6, p. 36.
- Brissopsis* POMEL, 1883, Classification méthodique et genera des échinides, p. 34.
- Toxobrissus* POMEL, 1883, idem, p. 34.
- Brissopsis* DUNCAN and SLADEN, 1884, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, p. 202.
- Brissopsis* COTTEAU, 1886, Paléontologie française, Échinides éocènes, pp. 130, 182.
- Brissopsis* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem. 46, no. 2, p. 199.
- Brissopsis* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 81.
- Brissopsis* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 489.
- Brissopsis* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. in Math. and Phys. Sci., vol. 2, p. 126.

Genotype, *Brissopsis elegans* Agassiz, 1840, from the upper Eocene of France, by monotypy. This species has been described and figured by Cotteau (1886, p. 184, pls. 52, 53). The genotype of *Toxobrissus* is *Brissopsis crescenticus* Wright (1855, p. 187, pl. 6, figs. 2a-c), from Malta, having been designated by Pomel (1883, p. 34).

In regarding *Brissopsis* Agassiz, 1840, as a nomen nudum, H. L. Clark (1917, p. 199) seems to have overlooked the description on page 16, which must also be regarded as the description of *B. elegans*, cited on page 3 as the only species of the genus. Agassiz and Desor (1847, p. 121) list *B. elegans* as the first of seven fossil species and *Brissus lyrifer* Forbes as the first of three living species. They figure *B. lyrifer* (pl. 16, figs. 12, 12a), which is designated by Desor (1858, p. 378) as the type of *Brissopsis*.

As figured by Cotteau, the posterior petals of *Brissopsis elegans* are plainly separate throughout, and the inner poriferous zones are complete to the apical end—not atrophied near the apex as in *Brissopsis crescentica*, in which the apical parts of the posterior petals are nearly contiguous. Moreover, the madreporite is represented as attaining its maximum width between the posterior genital pores and not extending far behind them, whereas in *B. lyrifer* the madreporite is narrower between the genital pores and extends far behind them. These and other possible differences may be important enough to justify the revival of *Toxobrissus* as a

subgenus of *Brissopsis* if not its restoration to generic rank.

**BRISSOPSIS ATLANTICA** Mortensen

*Brissopsis atlantica* MORTENSEN, 1907, Danish Ingolf-Expedition, pt. 2, Echinoidea, p. 160.  
*Brissopsis atlantica* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, pp. 200, 203.

*Occurrence*.—Southeastern coast of the United States.

*Geologic horizon*.—Recent.

*Remarks*.—This species, which I have not studied, was separated from *Brissopsis lyrifer* of authors. H. L. Clark regarded it as of somewhat doubtful validity.

**BRISSOPSIS STEINHATCHEE** Cooke, n. sp.  
Plate 5, figures 29–32

Test cordate, half as high as wide; upper surface sloping gently forward from the posterior end; lower surface slightly convex; ambitus rounded. Apical system in front of the center; four genital pores, the front pair close together, the back pair separated by the attenuated end of the madreporite, which extends behind them. Anterior ambulacral area not petaloid, depressed throughout but nearly flush near the peristome; pores small, pore pairs divided by a granule. Anterior petals extending more than halfway to the ambitus, diverging at an angle of 130°, depressed, anterior poriferous zones nearly obsolete near the apex. Posterior petals somewhat longer, close together near the apex, diverging behind at an angle of about 40°, both sunken in a single depression; inner poriferous zones narrowing and becoming obsolete near the apex. Peristome curved, with rounded ends and a posterior lip. Periproct large, terminal, pear-shaped, about half as high as the test, near the top. Upper surface nearly smooth, probably granulated; lower surface covered with larger tubercles. Obscure traces of a peripetalous fasciole; subanal fasciole not apparent.

Length of holotype, 51 mm.; width, 42 mm.; height, about 21 mm. Another specimen is about 68 mm. long, 53 mm. wide, and about 25 mm. high.

*Occurrence*.—FLORIDA: Pit on Steinhatchee River north of U. S. Highway 19 near Clara, in Dixie County (station 14541, C. W. Cooke and W. D. Havens, collectors; station 12747, W. C.

Mansfield and G. M. Ponton, collectors; station 14158, W. C. Mansfield and C. W. Mumm, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—Station 14541, U. S. Nat. Mus. 498987.

*Remarks*.—The larger specimen measured is tentatively regarded as a senile variant. Its apical system appears to be much farther back, its anterior petals are curved forward, and its anterior ambulacral area is no more deeply sunken in spite of its larger size. It may represent an undescribed species.

**BRISSOPSIS BLANPIEDI** Grant and Hertlein  
Plate 5, figures 23–28

*Brissopsis blanpiedi* GRANT and HERTLEIN, 1938, Am. Midland Naturalist, vol. 19, no. 2, p. 482.

Test cordate, higher behind than in front. Upper surface inflated; lower surface slightly convex, arched posteriorly. Apical system slightly in front of the center; four close-set genital pores; madreporite between and behind the posterior pair of pores. Petals sunken, slightly curved outward; anterior pair diverging at an angle of 85°, extending about two-thirds the distance to the ambitus, a little longer than the posterior pair, which extend about halfway to the ambitus and diverge at an angle of 37°. Pores of paired petals large, oval, conjugate, those nearest the longitudinal axis obsolescent near the apical center; poriferous zones wider than the interporiferous zones. Anterior ambulacral area in a deep furrow, which deeply indents the margin but becomes obsolete near the peristome; pores small. Peristome large, oval, with a posterior lip; midway between the center and the anterior end. Periproct large, round, at the top of a truncation, which slopes steeply backward.

Length of largest topotype, 33 mm.; width, 25.5 mm.; height, 16 mm.

*Occurrence*.—MISSISSIPPI: Gully about 200 yards east of Highway 35 on Glaze farm  $\frac{1}{4}$  mile west of Lemon and about 9 miles north of Raleigh, Smith County (station 13435, L. W. Stephenson and C. W. Cooke, collectors).

*Geologic horizon*.—Middle Oligocene, Byram formation.

*Types*.—California Acad. Sci. 7171–7173; figured topotype, U. S. Nat. Mus. 498998.

*Remarks*.—This species is known only from casts of the interior composed of bentonite and a few fragmentary molds. As the shell of *Brissoopsis* is very thin, these casts show the shape very well.

Genus CYCLASTER Cotteau and  
Leymerie, 1856

*Cyclaster* COTTEAU and LEYMERIE, 1856, Soc. géol. France Bull., sér. 2, t. 13, p. 345.

*Cyclaster* POMEL, 1883, Classification méthodique et genera des échinides, p. 34.

*Cyclaster* COTTEAU, 1886, 1887, Paléontologie française, Échinides éocènes, t 1, pp. 133, 442.

*Cyclaster* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 485.

Genotype, *Cyclaster declivus* Cotteau, 1856, from the upper Eocene of France, by monotypy. This species is figured by Cotteau (1887, p. 444, pl. 121, fig. 4; pl. 122). *Cyclaster* was regarded by Desor (1858, p. 378) as a synonym of *Brissoopsis*, from which it differs in having three genital pores instead of four, an incomplete instead of a complete peripetalous fasciole, in the shape of its petals, and in other features.

CYCLASTER DREWRYENSIS Cooke, n. sp.  
Plate 9, figures 9–11

Test cordate, truncated behind. Upper surface inflated; arched and rostrate between the apex and the periproct. Lower surface slightly swollen. Margin rounded. Apical system slightly in front of the center; three genital pores; madreporite confined to the right quadrant. Petals short, broad, straight, open at the ends, nearly equally long; anterior pair diverging at an angle of approximately 130°, posterior at approximately 60°; interporiferous zones nearly as wide as poriferous zones; pores oval, conjugate. Anterior ambulacral area not petaloid, slightly furrowed, deepest near the apex and peristome but broad and shallow at the ambitus; pores small, pairs oblique, pores of a pair separated by a granule. Peristome small, oval, with a posterior lip, located near the front. Periproct small, broadly oval, longitudinal, at the top of the truncated posterior end. Surface granulated. Tubercles small and scattered on upper surface, set in scrobiculae on lower surface. Partial peripetalous fasciole nearly straight

between the ends of the posterior petals, deeply incurved between the lateral petals, and vanishing in front of the anterior paired petals. Subanal fasciole short, wide, elliptical.

Length, 41 mm.; width, 36 mm. (originally wider); height, 26 mm.

*Occurrence*.—ALABAMA: Lowest bed at Drewry, Monroe County, in sec. 15, T. 6 N., R. 8 E. (holotype, station 10026, C. W. Cooke, collector); 2 or 3 miles southeast of Whatley, Clarke County (paratype, station 2957, Frank Burns, collector); St. Stephens Bluff, Washington County, bed 3 of section (station 6712, C. W. Cooke, collector; Florida Geol. Survey I-1386).

*Geologic horizon*.—Early Oligocene, limestone facies of the Red Bluff.

*Types*.—Holotype, U. S. Nat. Mus. 372880; paratype, U. S. Nat. Mus. 154148.

*Remarks*.—The specimen from St. Stephens Bluff is merely a partly corroded fragment, but there appears to be little doubt of its identity.

Genus MACROPNEUSTES Agassiz, 1847

*Macropneustes* AGASSIZ in AGASSIZ and DESOR, 1847, Annales sci. nat. (zoologie), ser. 3, vol. 8, p. 9. (Reprint, p. 114.)

*Macropneustes* DESOR, 1858, Synopsis des échinides fossiles, p. 409.

?*Schizobrissus* POMEL, 1869, Revue des échinodermes, p. 13.

*Peripneustes* COTTEAU, 1875, K. svenska ventens.-akad. Handl., Bandet 13, no. 6, p. 38.

*Macropneustes* POMEL, 1883, Classification méthodique et genera des échinides, p. 32.

?*Schizobrissus* POMEL, 1883, idem, p. 35.

?*Macropneustes* DUNCAN and SLADEN, 1884, Palaeontologia Indica, ser. 14, vol. 1, pt. 3, p. 229.

?*Mauritanaster* LAMBERT, 1920, Soc. acad. de l'Aube Mem., t. 84, p. 22.

*Macropneustes* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 84.

*Macropneustes* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 493.

*Macropneustes* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 127.

Genotype, *Micraster deshayesii* Agassiz, designated by Jackson (1922, p. 84), from the Eocene of the Paris Basin. This species has been figured by Desor (1858, pl. 44, figs. 2, 3) and by Cotteau (1886, p. 141, pls. 31–33). It has a nearly circular peripetalous fasciole and a bilobed subanal fasciole.

There seems to be a good deal of variation

in the shape and location of the fascioles in *Macropneustes*, and in some individuals one or both of the fascioles may be incomplete or missing. *Mauritanaster*, whose chief difference from *Macropneustes* is the apparent lack of fascioles, probably is a synonym.

MACROPNEUSTES MORTONI (Conrad)

- Holaster mortoni* CONRAD, 1850. Acad. Nat. Sci. Philadelphia Jour., ser. 2, vol. 2, p. 40, pl. 1, fig. 10.  
*Macropneustes cubensis* COTTEAU, 1875, K. svenska vetensk.-akad. Handl., vol. 13, no. 6, p. 6.  
*Macropneustes cubensis* COTTEAU, 1876, Soc. géol. France Bull., ser. 3, t. 5, p. 130.  
*Macropneustes cubensis* COTTEAU, 1881, Soc. géol. Belgique Annales, t. 9, p. 48, pl. 4, fig. 7.  
*Macropneustes cubensis* EGOZCUE, 1897, Com. mapa geol. España Bol., vol. 22, p. 91, pl. 23, figs. 1-4; pl. 25, fig. 7.  
*Macropneustes mortoni* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 155, pl. 72, figs. 1a-d.  
*Mauritanaster cubensis* LAMBERT, 1923, Soc. cubana historia nat. "Felipe Poey" Mem., vol. 5, no. 1, p. 44. (1924, Reprint, p. 42.)  
*Antillaster castroi* LAMBERT, 1923, idem, p. 44. (1924, Reprint, p. 42.)  
*Trachypatagus castroi* LAMBERT, 1923, idem, p. 48. (1924, Reprint, p. 46.)  
*Antillaster castroi* SANCHEZ ROIG, 1923, idem, 35. (1924, Reprint, p. 33.)  
*Mauritanaster cubensis* SANCHEZ ROIG, 1923, idem, p. 38. (1924, Reprint, p. 36.)  
*Macropneustes mortoni* COOKE, 1926, Alabama Geol. Survey Special Rept. 14, pl. 96, figs. 1a-b.

*Occurrence*.—GEORGIA: Palmyra, Lee County (type); power plant on Kinchafoonee Creek north of Albany (station 7121, C. W. Cooke and J. E. Brantly, collectors; station 10507, C. W. Cooke and T. M. Prettyman, collectors); just above bridge of Albany Northern Railway over Muckafoonee Creek near Albany (station 3617, T. W. Vaughan, collector); east side Flint River at power plant above Albany (station 12021, C. W. Cooke and W. H. Monroe, collectors); east bank Flint River at mouth of creek in the northeastern corner of Dougherty County (station 7235, C. W. Cooke, collector).

ALABAMA: Claiborne road west of Double Branches, 2½ miles west of Monroeville (station 6730, C. W. Cooke, collector); creek at road in SW. ¼ sec. 7, T. 6 N., R. 6 E., 1½ miles southwest of Perdue Hill, Monroe County (station 10043, C. W. Cooke and Julia Gardner, collectors); near middle of E. ¼ sec. 34, T. 8 N., R. 3 E., 5 miles southeast of Whatley, Clarke County, bed 2 of section (station 7159, C. W. Cooke, collector, figured by Cooke, 1926); Fall Post Office, Choctaw County (station 2864, Charles Schuchert, collector, figured by Clark and Twitchell,

1915); Little Stave Creek, secs. 20, 21, T. 7 N., R. 2 E., Clarke County (Alabama Geol. Survey, Winnie McGlamery, collector); St. Stephens Bluff, Tombigbee River (Alabama Geol. Survey); Frankville, Washington County (Alabama Geol. Survey).

FLORIDA: State park near Marianna (Florida Geol. Survey I-3957, Herman Gunter and Clarence Simpson, collectors).

CUBA: San Martin, Matanzas (type of *M. cubensis*); Finca Cervantes, San Jose de las Lajas, Habana (Mario Sanchez Roig, collector).

*Geologic horizon*.—Late Eocene; Ocala limestone (Georgia, Florida, and central Alabama). Jackson group (western Alabama).

*Type*.—Probably Acad. Nat. Sci. Philadelphia.

*Figured specimens*.—Clark and Twitchell, 1915, U. S. Nat. Mus. 146468; Cooke, 1926, U. S. Nat. Mus.

*Remarks*.—*Macropneustes mortoni* has a fasciole that crosses the ends of the petals and which is somewhat reentrant between the lateral paired petals. It has also a bilobed subanal fasciole. The petals are normally flush but may become sunken. Specimens from Cuba identified by Dr. Sanchez Roig as *Antillaster castroi* and *Mauritanaster cubensis* have somewhat sunken petals. These specimens are too badly corroded to show fascioles, but even well-preserved Cuban specimens are said to lack them. Nevertheless there seems little doubt that these corroded specimens are congeneric with *Macropneustes mortoni*, even though one might question their specific identity.

MACROPNEUSTES CAROLINENSIS Clark

- Macropneustes carolinensis* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 154, pl. 71, figs. 5a-d.  
*Mauritanaster carolinensis* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 493.

*Occurrence*.—NORTH CAROLINA: Wilmington (type, station 3602, Frank Burns, collector); J. A. Stokes farm 2 miles north of creek near Maple Cypress, Craven County (station 8165, J. A. Cushman collector); Southern Drainage Canal about 9 miles northwest of Vanceboro, Pitt County (station 11810, W. C. Mansfield, collector).

*Geologic horizon*.—Late Eocene, Castle Hayne marl.

*Type*.—U. S. Nat. Mus. 164651.

*Remarks*.—A well-preserved specimen of



this species shows distinctly a marginal fasciole, which passes above the periproct, but no subanal fasciole. The lack of a subanal fasciole throws doubt on the reference of this species to *Macropneustes*, but the presence of a marginal fasciole apparently removes it from *Mauritanaster* if that genus is valid.

#### Genus HOLASTER Agassiz, 1836

- Holaster* AGASSIZ, 1836, Soc. sci. nat. Neuchatel, t. 1, p. 183.  
*Holaster* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, p. 1.  
*Holaster* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes, p. 132.  
*Holaster* D'ORBIGNY, 1853, Paléontologie française, Terrain crétacé, t. 6, p. 71.  
*Holaster* DESOR, 1858, Synopsis des échinides fossiles, p. 336.  
*Holaster* POMEL, 1883, Classification méthodique et genera des échinides, p. 45.  
*Holaster* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 401.

Genotype, *Spatangus nodulosus* Goldfuss, 1829, from the Cenomanian of Europe, designated by Lambert and Thiéry, 1924. This species was figured by d'Orbigny (1853, p. 104, pl. 818) under the name *Holaster carinatus* (Lamarck), which name is not valid (International Rules, Art. 31) because Lamarck misidentified the species (*Ananchytes carinata*) with *Spatangites carinatus* Leske. (D'Orbigny, 1853, p. 106.)

#### HOLASTER CINCTUS (Morton)

- Ananchytes cinctus* MORTON, 1830, Acad. Nat. Sci. Philadelphia Jour., ser. 1, vol. 6, p. 200.  
*Ananchytes fimbriatus* MORTON, 1830, idem, p. 200.  
*Ananchytes cinctus* MORTON, 1830, Am. Jour. Sci., ser. 1, vol. 18, p. 246, pl. 3, fig. 7.  
*Ananchytes fimbriatus* MORTON, 1830, idem, p. 245, pl. 3, fig. 9.  
*Ananchytes cinctus* MORTON, 1834, Synopsis Organic Remains Cretaceous, p. 78, pl. 3, fig. 19.  
*Ananchytes fimbriatus* MORTON, 1834, idem, p. 78, pl. 3, fig. 20.  
*Holaster cinctus* AGASSIZ, 1840, Catalogus systematicus ectyporum echinodermatum, p. 1.  
*Cardiaster cinctus* BRONN, 1853-56, Lethaea geognostica, vol. 2, pt. 5, p. 205.  
*Cardiaster cinctus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 83, pl. 36, figs. 2a-h. Contains additional synonymy.

*Occurrence*.—NEW JERSEY: Rancocas Creek, Vincentown (U. S. Nat. Mus. 29467, F. B. Meek, collector).

*Geologic horizon*.—Early Eocene, Vincentown sand.

*Type*.—Acad. Nat. Sci. Philadelphia, (Figured by Clark.)

*Remarks*.—This species is represented in the United States National Museum by three imperfect individuals, which show the sculpture clearly. Lack of a fasciole removes it from *Cardiaster*. The anterior and posterior pairs of genital pores are widely separated. The decoration may be coarser, and the anterior sulcus is much deeper than in *Holaster nodulosus*, but in generic features the species seems to agree with typical *Holaster*.

#### Genus HEMIPATAGUS Desor, 1858

- Hemipatagus* DESOR, 1858, Synopsis des échinides fossiles, p. 416.  
*Hemipatagus* POMEL, 1883, Classification méthodique et genera des échinides, p. 29.  
*Maretia* Gray. COTTEAU, 1885, Paléontologie française, Échinides éocènes, t. 1, p. 24.  
*Chuniola* GAGEL, 1903, K. preuss. geol. Landesanstalt Jahrb. 1902, Band 23, Heft 3, p. 531.  
*Hemipatagus* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 456.

Genotype, *Spatangus hoffmanni* Goldfuss, from the Tertiary of Germany, by original designation. *Hemipatagus* differs from *Eupatagus* in the elongation of its periproct, which is transverse, not longitudinal. It apparently lacks a peripetalous fasciole but has a subanal fasciole. Desor's (1858, pl. 44, fig. 5) figure of the genotype shows a subanal fasciole, though his description of the genus specifies "point de fascioles." The shape of *Hemipatagus* is strongly cordate—a feature that distinguishes it from most species of *Eupatagus*, though species of *Eupatagus* (*Brissopatagus*) are somewhat cordate.

#### HEMIPATAGUS ARGUTUS Clark

- Hemipatagus argutus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 150, pl. 69, figs. 1a-d.

*Occurrence*.—MISSISSIPPI: Chickasawhay River at Enterprise (type, station 2629, Frank Burns, collector); Rose Hill road 8 miles west of Enterprise (station 2621, Frank Burns, collector); north of mile post 20, New Orleans & Northeastern Railway, 1 mile north of Wautubbee, Clarke County (station 6479, E. N. Lowe and C. W. Cooke, collectors).

*Geologic horizon*.—Middle Eocene, Lisbon formation.

*Type*.—U. S. Nat. Mus. 141107.

HEMIPATAGUS SUBROSTRATUS Clark

*Hemipatagus subrostratus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 151, pl. 69, figs. 2a-b.

*Occurrence.*—NORTH CAROLINA: Wilmington (type, station 3602, Frank Burns, collector; city rock quarry, U. S. Nat. Mus. 166516, L. W. Stephenson, collector).

*Geologic horizon.*—Late Eocene, Castle Hayne marl.

*Type.*—U. S. Nat. Mus. 164652.

*Remarks.*—This species is represented in the United States National Museum by three individuals, all imperfect. The one numbered 166516 retains part of a subanal fasciole, but there is no peripetalous fasciole.

Genus EUPATAGUS Agassiz, 1847

*Eupatagus* AGASSIZ in AGASSIZ and DESOR, 1847,

Ann. Sci. nat., ser. 3, t. 8, p. 9 (reprint, p. 115).  
*Eupatagus* DESOR, 1858, Synopsis des échinides fossiles, p. 413.

*Spatangus (Eupatagus)* A. AGASSIZ, 1872, 1873,

assiz, living around Bass Strait, Australia (Clark), designated by Pomel (1883). This species is figured by A. Agassiz (1873, pl. 15a, figs. 3, 4). It has broad, rounded, nearly closed, flush paired petals, with narrow poriferous zones. Its peripetalous fasciole is without indentations. Its subanal fasciole is described as closed, heart-shaped, broad, and with an indistinct anal branch. A few large tubercles lie within the peripetalous fasciole in the four lateral interambulacral areas. Its anterior ambulacral area is not petaloid nor depressed.

Students of fossil echinoids interpret *Eupatagus* much more broadly than either Alexander Agassiz or H. L. Clark, who restrict the genus to the genotype. In the present paper *Gymnopatagus*, *Plagiobrissus*, and *Brissopatagus* are interpreted as subgenera of *Eupatagus*, with which they agree in the structure of such vital parts as are revealed by the test alone.

KEY TO THE EARLY TERTIARY SPECIES OF EUPATAGUS OF THE EASTERN UNITED STATES

1. Region in front of the apical system lower than that behind it.
  2. Interporiferous zones much wider than poriferous zones; upper surface rugose; spines in lines . . . . . *mooreanus*.
  2. Interporiferous zones not wider than poriferous zones.
    3. Highest point at posterior end . . . . . *dixie*.
    3. Highest point at apical system . . . . . *gardnerae*.
1. Region in front of the apical system not lower than that behind it.
  2. Anterior ambulacral area flattened, not conspicuously furrowed.
    3. Petals straight; no large tubercles in anterior interambulacral areas . . . . . *carolinensis*.
    3. Petals not straight; large tubercles in anterior interambulacral areas.
      4. Posterior petals curved backward . . . . . *curvus*.
      4. Posterior petals curved forward . . . . . *ocalanus*.
  2. Anterior ambulacral areas furrowed; petals in broad depressions; anterior end humpbacked.
    3. Apical system far forward.
      4. Interporiferous zones wider than poriferous zones . . . . . *georgianus*.
      4. Interporiferous zones not wider than poriferous zones . . . . . *alabamensis*.
    3. Apical system not far forward (Paleocene) . . . . . *primus*.

Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 128, 572.  
*Eupatagus* POMEL, 1883, Classification méthodique et genera des échinides, p. 28.  
*Euspatangus* COTTEAU, 1885, Paléontologie française, Échinides éocènes, t. 1, p. 44.  
*Eupatagus* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 226.  
*Brissoides (Brissoides)* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 450.  
*Eupatagus* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 88.  
*Eupatagus* GRANT and HERTLEIN, 1938, Univ. California (Los Angeles) Pub. in Math. and Phys. Sci., vol. 2, p. 134.

Genotype, *Eupatagus valenciennesii* Ag-

Subgenus GYMNOPATAGUS Döderlein, 1901  
*Gymnopatagus* DÖDERLEIN, 1901, Zool. Anzeiger, vol. 24, p. 22.  
*Gymnopatagus* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, p. 226.  
*Gymnopatagus* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 453.

Genotype, *Gymnopatagus valdiviae* Döderlein (1901, p. 23), living off the coast of East Africa, by monotypy. This species is described as having a very thin heart-shaped test, with the forward ambulacrum sunken in a rather broad and deep furrow; lateral ambulacra petaloid, small, closed;

subanal and peripetalous fascioles present; a few very large primary spines confined within the peripetalous fasciole. As I have not seen this species, I am basing my interpretation of *Gymnopatagus* on H. L. Clark's (1917, pl. 159, figs. 2-6) figures of *Gymnopatagus pulchellus* A. Agassiz and Clark, which apparently differs considerably from *G. valdiviae*. The linear arrangement of its tubercles suggest *Maretia* Gray, 1855 (genotype *Spatangus planulatus* Lamarck = *Spatangus ovatus* Leske), which, however, is said to lack a peripetalous fasciole.

#### EUPATAGUS (GYMNOBATAGUS)

MOOREANUS Pilsbry

Plate 1, figure 16

- Eupatagus mooreanus* PILSBRY, 1914, Acad. Nat. Sci. Philadelphia Proc., vol. 66, p. 206, pl. 8.  
*Eupatagus floridanus* (part) CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 176, pl. 83, figs. 1a-2b (not pl. 82, figs. 2a-d).  
*Maretia twitchelli* LAMBERT in SANCHEZ ROIG, 1926, Bol. minas (Cuba), vol. 10, p. 112.  
*Maretia clarki* LAMBERT in SANCHEZ ROIG, 1926, idem, p. 112.

*Occurrence*.—FLORIDA: Withlacoochee River (type, C. M. Moore, collector); Levy County between Inglis and Yankeetown (station 14544, C. W. Cooke and W. D. Havens, collectors); Inglis (station 11118, Herman Gunter and Stuart Mossom, collectors); phosphate pit 1½ miles southwest of Inverness (station 7378, C. W. Cooke, collector); 5 miles southwest of Inverness (station 7382, C. W. Cooke, collector); phosphate mine north of Dunnellon (station 7381, C. W. Cooke, collector); Silver Springs, Marion County (station 14572, Mr. Ray, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—Acad. Nat. Sci. Philadelphia, 1147.

*Remarks*.—This striking robust species has a spread-wings-shaped escutcheon enclosed in the subanal fasciole and perforated by at least seven ambulacral pores on each side. An arrowhead-shaped plastron with tubercles on each side adjoins it anteriorly and extends halfway to the peristome. The ambulacral areas on the base are thick and smooth, like a deposit of callus. A peripetalous fasciole without indentations can be detected on well-preserved individuals.

Two of the three individuals on which *Eupatagus floridanus* Clark was based are conspecific with *Eupatagus mooreanus* Pilsbry, which was described while Clark and

Twitchell's monograph was in course of publication. In 1926 Lambert chose them as types of his *Maretia clarki* and *Maretia twitchelli*, which therefore fall into the synonymy of *E. mooreanus*. Both specimens are from Florida, but the exact locality is unknown.

#### Subgenus PLAGIOBRISUS Pomel, 1883

- Brissus* (*Plagionotus*) AGASSIZ in AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes (reprint), p. 119, not *Plagionotus* Mulsant, 1842.  
*Plagiostomus* D'ORBIGNY, 1853, Paléontologie française, Terrain crétacé, t. 6, p. 151, not *Plagiostomus* Sowerby, 1812.  
*Plagiobrissus* POMEL, 1883, Classification méthodique et genera des échinides, p. 29.  
*Plagiobrissus* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 207.  
*Plagiobrissus* LAMBERT and THIÉRY, 1924, Nomenclature raisonné des échinides, fasc. 7, p. 495.  
*Plagiobrissus* JACKSON, 1922, Carnegie Inst. Washington Pub. 306, p. 83.

Genotype, *Spatangus pectoralis* Lamarck, 1816, = *Echinus grandis* Gmelin, 1788, living off Florida, Bahamas, and Brazil.

#### EUPATAGUS (PLAGIOBRISUS) GRANDIS (Gmelin)

- Echinus grandis* GMELIN, 1791, Linné, Systema naturae, t. 1, pt. 6, p. 3200.  
*Spatangus pectoralis* LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, t. 3, p. 29.  
*Brissus pectoralis* AGASSIZ, 1836, Soc. sci. nat. Neuchatel Mém., t. 1, p. 185.  
*Plagionotus pectoralis* AGASSIZ and DESOR, 1847, Catalogue raisonné des échinodermes (reprint), p. 119, pl. 16, fig. 15.  
*Metalia pectoralis* A. AGASSIZ, 1872, 1874, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 144, 361, 600, pl. 21, figs. 4, 5.  
*Plagiobrissus pectoralis* POMEL, 1883, Classification méthodique et genera des échinides, p. 30.  
*Plagiobrissus grandis* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 46, no. 2, p. 207, pl. 146, figs. 21, 22.  
*Plagiobrissus grandis* H. L. CLARK, 1933, New York Acad. Sci., Sci. Survey Porto Rico Virgin Islands, vol. 16, pt. 1, p. 90.  
*Occurrence*.—Off Tampa, Fla., Nassau, Bahamas, and Bahia, Brazil (Clark).

*Geologic horizon*.—Recent.

#### EUPATAGUS (PLAGIOBRISUS) HOLMESII (McCrary)

- Plagionotus holmesii* MCCRARY in TUOMEY and HOLMES, 1857, Pleiocene fossils of South Carolina, p. 9, pl. 3, figs. 2, 2a.

*Plagionotus ravenelianus* McCrady, 1857, idem, p. 10, pl. 3, figs. 3, 3a.

*Plagiobrissus holmesi* Stefanini, 1911, Soc. geol. italiana Boll., vol. 30, p. 707.

*Plagiobrissus ravenelianus* Stefanini, 1911, idem, p. 707.

*Metalia raveneliana* Clark and Twitchell, 1915, U. S. Geol. Survey Mon. 54, p. 215.

*Metalia holmesi* Clark and Twitchell, 1915, idem, p. 215.

*Occurrence.*—SOUTH CAROLINA: Smith's, Goose Creek (Yeamans Hall); The Grove, Cooper River.

*Geologic horizon.*—Pliocene, Waccamaw formation.

*Remarks.*—These two nominal species of McCrady, which were based on fragments, were placed in the synonymy of *Metalia pectoralis* (= *Plagiobrissus grandis*) by A. Agassiz (1872, p. 145), though later (1874, p. 751) he appears to have regarded them as two valid species. Judgment as to their true relationships had better be reserved until better representatives of them have been obtained.

EUPATAGUS (PLAGIOBRISSEUS) DIXIE  
Cooke, n. sp.

Plate 6, figures 1-3

?*Eupatagus floridanus* (part) Clark, 1915, U. S. Geol. Survey Mon. 54, p. 176, pl. 82, figs. 2a-d (not pl. 83, figs. 1a-c, 2a-d).

?*Brissoides* (*Koilospatangus*) *floridanus* Lambert and Thiéry, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 454.

Test oval, depressed, truncate behind, margin rounded, upper surface little more inflated than the lower, rostrate above the periproct. Apical system in front of the center; four genital pores close together, the posterior pair separated by the elongated madreporite. Anterior ambulacral area not at all petaloid nor depressed. Petals somewhat sunken; anterior pair curved slightly forward, diverging at an angle of about 145°, extending about three-fourths of the way to the margin, shorter than the posterior pair; posterior petals straight, diverging at an angle of nearly 50°, extending nearly two-thirds of the way to the margin; poriferous zones wider than interporiferous zones; pores conjugate. Peristome large, wider than long, evenly curved in front, labiate behind. Periproct about as large as the peristome, pear-shaped, above the margin, on the steeply truncated end. Peripetalous fasciole

without marked indentations. Subanal fasciole, heart-shaped, enclosing a spread-wings-shaped escutcheon covered with large tubercles; remainder of lower posterior interambulacral area covered by closer, smaller tubercles. Ambulacral areas on lower surface bare. Paired interambulacral areas on lower surface covered by lines of large tubercles. Upper surface well covered by small tubercles; large tubercles confined within the peripetalous fasciole, most abundant between and adjacent to the paired petals.

Length, 47 mm.; width, 38 mm.; height, 20 mm. One specimen (fig. 1) measures 70 mm. in length.

*Occurrence.*—FLORIDA: Taylor County rock pit 1 mile north of Mayo, Lafayette County (type, G. M. Ponton, collector); 5.2 miles west of Mayo (station 14537, C. W. Cooke, collector); Dixie County north of U. S. 19 east of Steinhatchee River, opposite Clara (station 14541, figured paratype, C. W. Cooke and W. D. Havens, collectors). Casts of the interior, probably this species: Alachua (station 6791, T. W. Vaughan and C. W. Cooke, collectors); Arredonda (station 380, L. C. Johnson, collector); Johnson's lime sink, Levy County (type of *Eupatagus floridanus* Clark as restricted by Lambert, station 365, L. C. Johnson, collector).

GEORGIA: Dam on Flint River at Kinchafoonee Creek north of Albany (station 7121, C. W. Cooke, collector; station 10507, C. W. Cooke and T. M. Prettyman, collectors).

*Geologic horizon.*—Late Eocene, Ocala limestone.

*Type.*—U. S. Nat. Mus. 498985; figured paratype, 498986, station 14541.

*Remarks.*—*Eupatagus dixie* has narrower interporiferous zones than either *E. carolinensis* or *E. ocalanus*, its anterior ambulacral area is not at all depressed, its anterior paired petals are not so widely diverging, and the arrangement and distribution of its tubercles are different.

W. B. Clark figured as *Eupatagus floridanus* three individuals from different places and in different museums. Two of these represent *Eupatagus* (*Gymnopatagus*) *mooreanus* Pilsbry, which was described while Clark and Twitchell's monograph was in course of publication. Clark's description was based on these two specimens, which are well preserved. The third figured specimen, an internal cast, shows few specific characters, and the exact location from which it came is unknown. This cast was chosen as the type of *E. floridanus* by Lam-



bert (in Sanchez Roig, 1926, p. 112). Though this cast agrees in recognizable characters with *Eupatagus dixie*, there must always remain some doubt as to its true identity. To apply the name *E. floridanus* to this species would inevitably result in confusion.

EUPATAGUS (PLAGIOBRISSUS) GARDNERAE

Cooke, n. sp.

Plate 7, figures 1-4

Test oval, upper surface inflated, lower surface gently rounded, margin rounded; anterior ambulacral area flattened but not depressed. Apical system anteriorly eccentric; four genital pores close together. Petals flush, nearly the same length; anterior pair widely diverging; interporiferous zones of anterior pair narrow, very narrow at the ends; pores round, equal except at the inner end of the anterior zones of the anterior petals, where they are much smaller; 25 pairs in each zone. Pores of anterior ambulacral area very small; pore pairs oblique. Peristome large, oval, labiate, somewhat farther forward than the apical center. Traces of a peripetalous fasciole can be detected, but the unbroken part of the posterior end is so deeply corroded that the subanal fasciole is obliterated. At least a dozen large perforated tubercles within the peripetalous fasciole in the anterior interambulacral areas; tubercles in the other interambulacral areas obliterated.

Length, 40 mm.; width, 37.4 mm.; height, 24.3 mm.

*Occurrence*.—ALABAMA: Stream 6 miles west of Andalusia, on line between secs. 20 and 29, T. 4 N., R. 15 E. (station 10014, C. W. Cooke and Julia Gardner, collectors).

*Geologic horizon*.—Late Eocene, Ocala limestone, just above *Periarchus lyelli* bed at base of formation.

*Type*.—U. S. Nat. Mus. 498983.

*Remarks*.—This species, based on one imperfect specimen, appears to be more closely related to *Eupatagus (Plagionotus) ocalanus* than to any other species. *E. gardnerae* is proportionately shorter, higher, and more evenly tumid than *ocalanus*; its petals are flush, and the tubercles in the anterior interambulacral areas are larger.

EUPATAGUS (PLAGIOBRISSUS) CAROLINENSIS  
Clark

*Eupatagus carolinensis* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 153, pl. 71, figs. 3a-d, 4.  
*Brissoides carolinensis* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, p. 450.

*Occurrence*.—NORTH CAROLINA: Wilmington (type, L. W. Stephenson, collector; figured specimen, Frank Burns, collector; station 10340, C. W. Cooke, collector); Northeast Cape Fear River 3½ miles above Castle Hayne (U. S. Nat. Mus. 164495, L. W. Stephenson, collector).

ALABAMA: Rock House Bluff, Conecuh River, sec. 28 or 29, T. 3 N., R. 14 E., Conecuh County (station 6750, C. W. Cooke, collector, identification doubtful).

*Geologic horizon*.—Late Eocene; Castle Hayne marl (North Carolina), Ocala limestone (Alabama).

*Type*.—U. S. Nat. Mus. 166484.

*Remarks*.—This species has a peripetalous fasciole without conspicuous indentations and a heart-shaped subanal fasciole, from which apparently arise a short, incomplete fasciole on each side of the periproct, though these lateral fascioles are very obscure.

EUPATAGUS (PLAGIOBRISSUS) CURVUS

Cooke, n. sp.

Plate 7, figures 5-7

Test ovate, low, margin rounded. Anterior ambulacral area not at all petaloid, slightly depressed. Anterior pair of petals nearly as long as the posterior pair, widely diverging, extending more than two-thirds the way to the margin, constricted near the tips; interporiferous zones as wide as poriferous zones at the tips, twice as wide elsewhere; poriferous zones convex near the apex, straighter near the tip. Posterior petals curved slightly backward, diverging at an angle of 30°, extending less than two-thirds the way to the margin; outer poriferous zones convex, inner nearly straight; interporiferous zones little wider than poriferous zones in medial part, equal near the ends. Pores conjugate. Peristome oval, labiate behind, farther forward than the apical system. Periproct terminal, above the margin, pear-shaped. Peripetalous fasciole without lateral sinuations, slightly bent backward at the anterior end and more strongly bent backward at the posterior end. Subanal fasciole heart-shaped, enclosing a spread-wings-shaped escutcheon, which is

studded with large tubercles arranged in transverse lines and perforated by at least six pores on each side. All four paired interambulacral areas studded with large tubercles within the peripetalous fasciole; nearly bare elsewhere on the upper surface; studded with large, evenly spaced tubercles on the lower surface. Plastron resembling fish scales.

Length, about 56 mm.; width, 50 mm.; height, about 22 mm.

*Occurrence*.—FLORIDA: Chipola River  $\frac{1}{4}$  mile above bridge at Marianna (holotype, C. W. Cooke, collector).

GEORGIA: Flint River at mouth of Kinchafoonee Creek above Albany (station 7121, C. W. Cooke, collector; station 5054, L. W. Stephenson and Otto Veatch, collectors); Flint River at Bainbridge (station 7097, C. W. Cooke, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 498984.

*Remarks*.—*Eupatagus curvus* differs from *E. ocalanus* in its incurving posterior petals, the shape of its peripetalous fasciole, and the distribution of its large tubercles.

EUPATAGUS (PLAGIOBRISUS) OCALANUS  
Cooke, n. sp.

Plate 6, figures 4–8

Test large, oval, truncated behind; upper surface rostrate above the periproct, sloping to the rounded margin; lower surface nearly flat but projecting downward where the subanal fasciole crosses the median line. Apical system slightly in front of the center; four genital pores, close together; madreporite extending behind the posterior pair of ocular pores. Anterior ambulacral area not at all petaloid, flattened. Petals slightly depressed; anterior pair extending four-fifths the way to the margin, diverging at an angle of 135°; posterior pair longer, extending three-fourths the way to the margin, diverging at an angle of 47°. Poriferous zones about as wide as interporiferous zones; pores elliptical, conjugate. Peristome large, elliptical, labiate behind, slightly farther forward than the apical system. Periproct large, terminal, supramarginal, pear-shaped. Peripetalous fasciole without indentations but having a V-shaped projection above the periproct. Subanal fasciole heart-shaped, enclosing a spread-wings-shaped escutcheon studded

with large tubercles arranged in transverse lines. Sternum covered with somewhat smaller tubercles. Posterior ambulacral areas almost smooth on lower surface. Paired interambulacral areas on lower surface covered with a coarse reticulation of large tubercles. Large tubercles on upper surface confined within the peripetalous fasciole, arranged in zigzag rows in the posterior paired interambulacral areas, fewer and more scattered in the other interambulacral areas.

Length, 67 mm.; width, 56 mm.; height, 28 mm.

*Occurrence*.—FLORIDA: Taylor County rock pit, 1 mile north of Mayo, Lafayette County (type, Florida Geol. Survey I-2406, G. M. Ponton, collector).

GEORGIA: Bainbridge (station 13611, A. F. Foerste, collector).

ALABAMA: Railway cut  $\frac{3}{4}$  mile north of Drewry, Monroe County, upper bed (station 6719, C. W. Cooke, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 372884.

*Remarks*.—*Eupatagus ocalanus* differs from *E. dixie* in its much wider poriferous zones, its flattened anterior ambulacral area, and in the more plainly zigzag arrangement of its tubercles. Its petals are proportionately longer and narrower than those of *E. carolinensis*, which appears not to have attained so great a size. Its petals are of more even width than those of *E. curvus*, and it lacks the group of large tubercles in the anterior interambulacral areas.

Subgenus BRISSOPATAGUS Cotteau, 1863

*Brissopatagus* COTTEAU, 1863, Congrès sci. France, sess. de Bordeaux, p. 143.

*Brissopatagus* DUNCAN and SLADEN, 1884, Palaeontologia Indica, ser. 14, vol. 3, pt. 3, fasc. 3, p. 226.

*Brissopatagus* POMEL, 1833, Classification méthodique et genera des échinides, p. 32.

*Brissopatagus* COTTEAU, 1886, Paléontologie française, Échinides éocènes, t. 1, pp. 128, 135.

*Brissopatagus* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 491.

Genotype, *Brissopatagus caumonti* Cotteau, 1863, from the late Eocene of Biarritz, France, designated by Cotteau (1886, p. 135, footnote). This species has been figured by Cotteau (1886, pl. 30).

*Brissopatagus*, as here interpreted, is characterized by four genital pores close together

with the madreporite behind them; anterior ambulacral area more or less depressed, with inconspicuous pores; anterior petals widely spreading, curved forward, in broad shallow depressions extending into the anterior interambulacral areas; posterior petals nearly straight, diverging at an angle of about 45°, in broad shallow depressions extending into the posterior paired interambulacral areas; peripetalous fasciole little indented, enclosing large tubercles; subanal fasciole enclosing an escutcheon; peristome semilunate, with a posterior lip; periproct large, pear-shaped. So many of these features are identical with those of *Plagiobrissus* that, like it, *Brissopatagus* should be regarded as a subgenus of *Eupatagus*, with which it agrees in apical system, fascioles, peristome, periproct, general character of the ambulacral areas, and in the presence of large tubercles within the peripetalous fasciole. The interporiferous zones of both *Plagiobrissus* and *Brissopatagus* are much narrower than those of *Eupatagus valenciennesii*, the type of the genus. *Brissopatagus* is further distinguishable by its anterior depression, a tendency to be truncated anteriorly, which brings the highest part of the test in front of the apical system, and by the broad depressions on the petals.

EUPATAGUS (BRISSOPATAGUS) GEORGIANUS  
Cooke, n. sp.

Plate 7, figures 8–11

Test large, ovate (posterior end wanting); upper surface tumid, highest in front of the apical system, thence descending steeply to the rounded margin; lower surface nearly flat. Apical system in front of the center; four genital pores, the madreporite extending behind them. Petals medium-sized, about equally long, in shallow, broad depressions that extend into the adjacent ambulacral areas; anterior pair widely diverging; interporiferous zones somewhat wider than poriferous zones; front poriferous zones of anterior pair narrower near the apex. Anterior ambulacral area depressed from near the apical system to the peristome; pores inconspicuous. Peristome large, strongly labiate, farther forward than the apical system. Large perforated tubercles in the depressed parts of the paired interambulacral areas, seven or more adjacent to the posterior

petals and two or more in front of the anterior petals. Fascioles obliterated.

Original length, about 54 mm.; width, 52 mm.; height, 27.5 mm.

*Occurrence*.—GEORGIA: Power plant on Kinchafoonee Creek north of Albany (station 10507, C. W. Cooke and T. M. Prettyman, collectors); Flint River below mouth of Cedar Creek, Crisp County (station 7113, C. W. Cooke, collector).

*Geologic horizon*.—Late Eocene, Ocala limestone.

*Type*.—U. S. Nat. Mus. 498982.

*Remarks*.—This species is represented by only two specimens, from both of which the posterior end is broken. Besides the much larger size, which may not be diagnostic, this species is distinguishable from *E. alabamensis* by its wider interporiferous zones.

EUPATAGUS (BRISSOPATAGUS) ALABAMENSIS  
Cooke, n. sp.

Plate 4, figures 7, 8

Test small, cordate, highest point in front of the apical system, thence sloping steeply forward. Apical system in front of the center; four genital pores, very close together; madreporite behind the pores. Paired ambulacral areas petaloid; petals and adjacent parts of the interambulacral areas sunken in broad oval depressions; petals extending more than halfway to the ambitus, nearly straight, the posterior pair a little longer than the anterior pair; anterior pair widely diverging; pores large, nearly equal, conjugate; interporiferous zones nearly as wide as the poriferous zones; front poriferous zones of anterior pair narrow near the apical system. Anterior ambulacral area slightly depressed; pore pairs oblique, very small, obsolete distally. Peripetalous fasciole slightly arched toward the apex between the petals; subanal fasciole present. Peristome semilunate, with an anterior lip; located at the anterior third. Periproct high up on the truncated end. Two large crenulated tubercles beside each posterior petal and one in front of each of the anterior pair. These latter single tubercles do not occur on another specimen from the same place. Secondary perforated tubercles border the anterior ambulacral area and decorate the anterior marginal part of the lower surface and the sternal and episternal plates. Elsewhere the

surface is covered with close-set miliary tubercles.

Length of crushed holotype with margin broken, 38 mm.; width, 38 mm.; height, 9 mm. A less distorted specimen from station 10043 measures: length, 35 mm.; width, 32.5 mm.; height, 11 mm.

*Occurrence.*—ALABAMA: Base of St. Stephens Bluff on Tombigbee River, Washington County (type, station 12168, C. W. Cooke, W. H. Monroe, and R. B. Stewart, collectors); 1½ miles southwest of Perdue Hill, Monroe County (station 10043, C. W. Cooke and Julia Gardner, collectors; station 15064, F. S. MacNeil, collector); 3½ miles southeast of Cullomburg (station 7203, bed 4 of section in U. S. Geol. Survey Prof. Paper 95, p. 116, C. W. Cooke and W. C. Mansfield, collectors); 2 or 3 miles southeast of Whatley, Clark County (station 2957, Frank Burns, collector).

*Geologic horizon.*—Late Eocene; Ocala limestone and Jackson group (contemporaneous).

*Type.*—U. S. Nat. Mus. 498979.

*Remarks.*—This species differs from *B. caumonti* as figured by Cotteau (1886, pl. 30) in that its anterior furrow is shallower and more even; its paired petals are longer and straighter; and its posterior petals, as well as the anterior pair, lie in broad depressions. *Brissopatulus alabamensis* appears to have fewer and larger tubercles than are shown on Cotteau's figure, but Cotteau says (1886, p. 137) that the tubercles and fascioles are not visible on his specimen. Presumably his figure is to some extent synthetic.

EUPATAGUS? (BRISSOPATAGUS?) PRIMUS  
Cooke, n. sp.

Plate 4, figures 1-4

Test cordate; upper surface high, highest point in front of the apical system; anterior margin deeply cut by a rounded sulcus, which slopes steeply from a point in front of the apical system to the peristome. Apical system nearly central, with four genital pores. Petals in broad depressions; anterior pair longer than the posterior, extending nearly to the margin; straight, widely diverging, nearly closed; pores round, conjugate; zones equally wide distally, but interporiferous zones and front poriferous zones narrowing more rapidly than the back poriferous zone near the apical system. Posterior petals straight, extending about two-thirds the way to the margin; outer poriferous

zones longer than the inner. Pore pairs of the anterior ambulacral area oblique, narrow, crossing the tumid part of the test and becoming much wider apart and replaced by single pores alternating in position in the sulcus. Posterior interambulacral area arched, apparently covered with tubercles and granules. Peristome far forward.

Length (broken), 34.5 mm.; width, 35 mm.; height, about 24 mm.

*Occurrence.*—GEORGIA: Dr. A. J. Parke's farm on the Americus road 5 miles south of Ellaville, Schley County (station 4033, S. W. McCallie, collector).

*Geologic horizon.*—Paleocene, Clayton formation.

*Type.*—U. S. Nat. Mus. 498978.

*Remarks.*—This species is represented by only one cast of the interior, to which a few fragments of the silicified test are clinging. It was associated with *Echanthus georgiensis* (Twitchell).

Family ECHINOCARDIIDAE Cooke, n. fam.

Test cordate. Odd ambulacral area unlike the others. Poriferous zones of petals composed of wide plates, which are depressed medially along the sutures. Petals terminated apically or crossed by a fasciole.

The fasciole surrounding the apex, which is known only in this family, is commonly called the *internal fasciole*. It is herein referred to as the *apical fasciole* because the adjective internal is misleading.

Genus ECHINOCARDIUM Gray, 1825

*Echinocardium* GRAY 1825, Annals of Philosophy, ser. 2, vol. 10, p. 430.

*Amphidetus* AGASSIZ, 1836, Soc. sci. nat. Neuchâtel Mém., t. 1, p. 184.

*Amphidetus* AGASSIZ and DESOR, 1847, Annales sci. nat. (zoologie), ser. 3, t. 7, reprint p. 117.

*Echinocardium* DESOR, 1858, Synopsis des échinides fossiles, p. 406.

*Echinocardium* A. AGASSIZ, 1872, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 109, 349.

*Echinospatagus (Echinocardium)* POMEL, 1883, Classification méthodique et genera des échinides, p. 28.

*Echinospatagus (Amphidetus)* POMEL, 1883, idem, p. 28.

*Echinocardium* H. L. CLARK, 1917, Harvard College Mus. Comp. Zoology Mem., vol. 36, no. 2, p. 261.

*Echinocardium* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 468.



*Amphidetus* LAMBERT and THIÉRY, 1924, idem, p. 469.

Genotype, *Spatangus pusillus* Leske, 1778, = *Echinus cordatus* Pennant, 1777, designated by H. L. Clark (1917, p. 261), a wide-ranging species living in water not deeper than 85 fathoms (H. L. Clark, 1917, p. 263). Lambert and Thiéry (1924, pp. 469, 470) unintentionally designated this same species as the genotype of *Amphidetus*, for Agassiz himself identifies *Amphidetus pusillus* Agassiz with *Spatangus pusillus* Leske.

#### ECHINOCARDIUM CORDATUM (Pennant)

*Echinus cordatus* PENNANT, 1777, British Zoology, vol. 4, p. 58, pl. 34, fig. 2; pl. 36, fig. 2 (fide A. Agassiz).

*Echinocardium cordatum* A. AGASSIZ, 1872, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 109, 349, 580, pl. 19, figs. 10-17; pl. 20, figs. 5-7; pl. 25, figs. 27, 28; pl. 33, fig. 6. (Gives additional synonymy.)

*Echinocardium cordatum* H. L. CLARK, 1917, idem, vol. 46, no. 2, p. 262.

*Occurrence*.—Nearly world wide in moderately deep water.

*Geologic horizon*.—Recent.

#### ECHINOCARDIUM ORTHONOTUM (Conrad)

*Spatangus orthonotus* CONRAD, 1843, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 327.

*Amphidetus virginianus* FORBES, 1845, Geol. Soc. London Quart. Jour., vol. 1, p. 425, 3 figs.

*Amphidetus orthonotus* TUOMEY and HOLMES, 1855, Pleiocene fossils of South Carolina, pl. 2, figs. 1-1c.

*Echinocardium orthonotum* CLARK, 1904, Maryland Geol. Survey Miocene, p. 430, pl. 119, figs. 1a-c.

*Echinocardium orthonotum* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 213, pl. 97, figs. 2a-c; pl. 98, figs. 1a-c, 2a-c. Contains additional synonymy.

*Echinocardium orthonotum* SCHOONOVER, 1941, Jour. Paleontology, vol. 15, p. 92.

*Occurrence*.—VIRGINIA: Near Coggins Point, James River (type, Michael Tuomey, collector); Chuckatuck, just below mill dam north of village (U. S. Nat. Mus. 116517, M. W. Twitchell, collector); Prince George (U. S. Nat. Mus. 1688, J. L. Bridges, collector).

MARYLAND: Jones Wharf, Patuxent River (Maryland Geol. Survey); Scientists Cliffs, Chesapeake Bay, Calvert County (U. S. Nat. Mus. 153265, W. F. Foshag and James Benn, collectors).

*Geologic horizon*.—Miocene; Choptank?

formation (Maryland), Yorktown? formation (Virginia).

*Type*.—Probably Acad. Nat. Sci. Philadelphia.

*Remarks*.—Schoonover (1941, pp. 92, 93) describes a colony of well-preserved individuals of this species at Scientists Cliffs.

#### ECHINOCARDIUM GOTHICUM (Ravenel)

*Amphidetus gothicus* RAVENEL, 1848, Echinidae, Recent and fossil, of South Carolina, p. 4, figs. 1, 2.

*Amphidetus ampliflorus* MCCRADY in TUOMEY and HOLMES, 1855, Pleiocene fossils of South Carolina, p. 6, pl. 3, figs. 2, 2a.

*Amphidetus gothicus* MCCRADY, 1855, idem, p. 7, pl. 3, figs. 3, 3a-f.

*Echinocardium gothicus* CLARK and TWITCHELL, 1915, U. S. Geol. Survey Mon. 54, p. 214.

*Amphidetus gothicus* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 470.

*Occurrence*.—SOUTH CAROLINA: The Grove, Cooper River.

*Geologic horizon*.—Pliocene?, Waccamaw formation?; possibly upper Miocene.

*Type*.—Unknown.

*Remarks*.—There are no identified specimens of this species in the United States National Museum. McCrady's figures very closely resemble *Echinocardium orthonotum*.

#### Genus LOVENIA Desor, 1847

*Lovenia* DESOR in AGASSIZ and DESOR, 1847, Annales sci. nat. (zoologie), ser. 3, t. 8, p. 11 (reprint, p. 116).

*Lovenia* A. AGASSIZ, 1872, 1873, Harvard College Mus. Comp. Zoology Mem., vol. 3, pp. 139, 574.

*Lovenia* POMEL, 1883, Classification méthodique et genera des échinides, p. 28.

*Lovenia* GRANT and HERTLEIN, 1938, California Univ. (Los Angeles) Pub. Math. and Phys. Sci., vol. 2, p. 135. (Gives additional synonymy.)

Genotype, *Lovenia hystrix* Desor, 1847, = *Spatangus elongatus* Gray, 1845, living from Zanzibar and the Red Sea to northern Australia and Japan (H. L. Clark, 1917, p. 252), by monotypy. This species has been figured by Agassiz and Desor (1847, pp. 1, 16, fig. 16) and by A. Agassiz (1874, p. 575, pl. 19c, figs. 1-4, etc.).

#### LOVENIA CLARKI (Lambert)

*Echinocardium depressum* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 214, pl. 98, figs. 3a-c. Not *Amphidetus depressus* Agassiz, 1847.

*Amphidetus clarki* LAMBERT, in LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 470.

*Occurrence*.—FLORIDA: Chatahoochee, Gadsden County, 78 feet above sea level (type, W. H. Dall and Joseph Stanley-Brown, collectors; station 4836, F. G. Clapp, collector; station 3405, T. W. Vaughan, collector; station 7168, G. C. Matson, collector; station 6185, L. W. Stephenson, collector; station 12282, W. C. Mansfield and G. M. Ponton, collectors).

*Geologic horizon*.—Early Miocene, base of Tampa limestone.

*Type*.—U. S. Nat. Mus. 164654.

*Remarks*.—This species is known only from casts of the interior that lack many specific characters. Some of the casts retain circular grooves that appear to mark the location of large tubercles. The occurrence of tubercles removes the species from *Echinocardium* and seems to place it in or near *Lovenia*, which it resembles in shape. The species is much flatter than *Amphidetus orthonotus*, and its petals are not depressed.

#### LOVENIA? sp.

*Hemipatagus* sp. COOKE, 1926, Alabama Geol. Survey Special Rept. 14, p. 292 (list).

*Occurrence*.—ALABAMA: Conecuh River at Weaver Chute, 2 miles south of McGowans Bridge, Escambia County (station 6753, C. W. Cooke, collector).

*Geologic horizon*.—Late Oligocene, Chickasaw marl.

*Remarks*.—The cast of the interior of an echinoid shows marks of tubercles like those of *Lovenia*. If recognizable specimens are found, they should be compared with *Lovenia dumblei* Kew (1917, p. 136, pl. 17, figs. 2a-c), from Mexico.

#### Genus VASCONASTER Lambert, 1915

*Sarsella* POMEL, 1883, Classification méthodique et genera des échinides, p. 28. Not Haecckel, 1879.

*Sarsella* COTTEAU, 1886, Paléontologie française, Echinides éocènes, t. 1, p. 101.

*Vasconaster* LAMBERT, 1915, Schweizer. palaeont. Gesell. Abh., vol. 41, p. 191 (note), for *Sarsella* Pomel.

*Vasconaster* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 466.

Genotype, *Breynia sulcata* Haime, 1853, from the late Eocene of France, designated by Pomel. This species has been described and figured by Cotteau (1886) p. 103, pls. 22, 23, 24, figs. 1-3). It lacks the internal

processes (ampullae) that support the large spines in *Lovenia elongata*.

#### VASCONASTER GREGORYI (Clark)

*Sarsella gregoryi* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 155, pl. 72, figs. 2a-d.

*Vasconaster gregoryi* LAMBERT and THIÉRY, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 466.

*Occurrence*.—SOUTH CAROLINA: Santee Canal.

*Geologic horizon*.—Probably late Eocene, Santee limestone.

*Type*.—Am. Mus. Nat. History.

*Remarks*.—There are no identified specimens of this species in the United States National Museum.

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## ADDENDUM

The following species was omitted from my paper (Cooke, 1941) on the Cenozoic regular echinoids.

## PSAMMECHINUS CINGULATUS Clark

*Psammechinus cingulatus* CLARK 1891, Johns Hopkins Univ. Circular, vol. 10, no. 87, p. 76.  
*Psammechinus cingulatus* CLARK, 1915, U. S. Geol. Survey Mon. 54, p. 63, pl. 22, figs. 2a-i. Includes additional synonymy.

*Occurrence*.—New Jersey: Timber Creek.

*Geologic horizon*.—Early Eocene, Vincetown sand.

*Type*.—Acad. Nat. Sci. Philadelphia 1467.

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