

Revision of the Atlantic Brisingida
(Echinodermata: Asteroidea), with
Description of a New Genus and Family

MAUREEN E. DOWNEY

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 435

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ABSTRACT

Downey, Maureen E. Revision of the Atlantic Brisingida (Echinodermata: Asteroidea), with Description of a New Genus and Family. *Smithsonian Contributions to Zoology*, number 435, 57 pages, 24 figures, 1986.—The Brisingida, a mainly deep-sea order of Asteroidea, is represented in the Atlantic by 23 species belonging to 9 genera and 2 families. The following changes in classification are suggested:

Freyellidae, new family, with Atlantic genera *Colpaster*, *Freyastera*, and *Freyella*, and non-Atlantic genera *Belgicella* and *Freyellaster*.

Freyastera, new genus, with the species *benthophila*, *mexicana*, *sexradiata*, and *tuberculata*, all formerly assigned to the genus *Freyella* Perrier, 1885c.

Craterobrisinga Fisher, 1916b, synonymized with *Brisinga* Asbjørnsen, 1856.

Freyella edwardsi (Perrier, 1882) transferred to the genus *Colpaster* Sladen, 1889.

Astrocles Fisher, 1917 (non-Atlantic), synonymized with *Freyella*.

Freyella spinosa, *bracteata*, *aspera*, *abyssicola*, and *laubieri* synonymized with *Freyella elegans* (Verrill, 1884).

Freyella trispinosa H.L. Clark, 1941, synonymized with *Freyella microspina* Verrill, 1894.

Brisinga americana Verrill, 1880, transferred to the genus *Novodinia* Dartnall, Pawson, Pope, and Smith, 1969.

Novodinia elegans (Perrier, 1885a), an invalid homonym of *Brisinga elegans* (Perrier, 1885c), is renamed *Novodinia homonyma*, new name.

Novodinia robusta (Perrier, 1885a), synonymized with *Novodinia semicoronata* (Perrier, 1885a).

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Contents

	<i>Page</i>
Introduction	1
Historical Background	1
Range Extensions	2
Biology	2
Diagnostic Method	2
Acknowledgments	4
Order BRISINGIDA Fisher, 1928, new status	4
Family BRISINGIDAE G.O. Sars, 1875	4
Genus <i>Brisinga</i> Asbjørnsen, 1856	4
<i>Brisinga costata</i> Verrill, 1884	5
<i>Brisinga cricophora</i> Sladen, 1889	7
<i>Brisinga endecacnemos</i> Asbjørnsen, 1856	9
<i>Brisinga hirsuta</i> Perrier, 1894	11
Genus <i>Brisingella</i> Fisher, 1917	13
<i>Brisingella coronata</i> (G.O. Sars, 1871)	13
<i>Brisingella verticellata</i> (Sladen, 1889)	15
Genus <i>Brisingenes</i> Fisher, 1917	16
<i>Brisingenes multcostata</i> (Verrill, 1894)	17
Genus <i>Midgardia</i> Downey, 1972	18
<i>Midgardia xandaros</i> Downey, 1972	19
Genus <i>Novodinia</i> Dartnell, Pawson, Pope, and Smith, 1969	21
<i>Novodinia americana</i> (Verrill, 1880)	21
<i>Novodinia antillensis</i> (A.H. Clark, 1934)	23
<i>Novodinia homonyma</i> , new name	25
<i>Novodinia pandina</i> (Sladen, 1889)	27
<i>Novodinia semicoronata</i> (Perrier, 1885)	29
Genus <i>Stegnobrisinga</i> Fisher, 1916	29
<i>Stegnobrisinga splendens</i> H.L. Clark, 1926	31
Family FREYELLIDAE, new family	33
Genus <i>Colpaster</i> Sladen, 1889	33
<i>Colpaster edwardsi</i> (Perrier, 1882)	33
<i>Colpaster scutigerula</i> Sladen, 1889	34
Genus <i>Freyastera</i> , new genus	36
<i>Freyastera benthophila</i> (Sladen, 1889), new combination	36
<i>Freyastera mexicana</i> (A.H. Clark, 1939), new combination	38
<i>Freyastera sexradiata</i> (Perrier, 1885), new combination	40
<i>Freyastera tuberculata</i> (Sladen, 1889), new combination	41

Genus <i>Freyella</i> Perrier, 1885	43
<i>Freyella elegans</i> (Verrill, 1884)	43
<i>Freyella microspina</i> Verrill, 1894	46
<i>Freyella recta</i> Koehler, 1907	48
Appendix: Characters of the Brisingida	50
Literature Cited	53
Index	57

Revision of the Atlantic Brisingida (Echinodermata: Asteroidea), with Description of a New Genus and Family

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Introduction

The Brisingida are almost exclusively abyssal, with some Antarctic species occurring more in shallow waters. Hitherto, all brisingidans were considered to belong to one family, the Brisingidae, but careful comparison of all genera clearly shows two well-defined families: the Brisingidae, containing the genera *Astrostephane* Fisher (1917), *Brisinga* Asbjørnsen (1856), *Brisingaster* de Loriol (1883), *Brisingella* Fisher (1917), *Brisingenes* Fisher (1917), *Midgardia* Downey (1972), *Novodinia* Dartnall et al. (1969), *Parabrisinga* Hayashi (1943), and *Stegnobrisinga* Fisher (1916b); and the Freyellidae, with the genera *Belgicella* Ludwig (1903), *Colpaster* Sladen (1889), *Freyella* Perrier (1885c), *Freyellaster* Fisher (1918), and *Freyastera*, new genus. These families can be separated both morphologically and ecologically, as discussed below under the family headings.

The Brisingida are related most closely to the Forcipulatida, but are obviously distinctive because of their small, circular disc and long, attenuate arms. Their general appearance is superficially like that of a large, multiarmed ophiuroid. The fused ring of disc plates, spool-like ambula-

cral column, reduced abactinal plates, single series of marginals, lack of actinal plates, and crossed pedicellariae only are characteristic of the order.

HISTORICAL BACKGROUND.—The first known representative of this order, *Brisinga endecacemos*, was described by Asbjørnsen in 1856 from Hardangerfjord, Norway. A second species, *Brisinga coronata* (= *Brisingella coronata*) was described by G.O. Sars in 1871 from Lofoten, Norway, and in 1875 Sars recognized the uniqueness of these starfish by erecting a new family, Brisingidae, to accommodate them. Increased deep-sea dredging activity led to further additions to the family by Sladen, Perrier, Verrill, Fisher, and others. Perrier (1885c) based a second genus, *Freyella*, largely on the presence of bare interradial plates and a consequent gradually curved interradial arc (as opposed to the acute arc in *Brisinga*). The only major taxonomic and biogeographic survey of the group was that of Fisher (1917, 1919). In 1928 he raised the family to a suborder, Brisingina. In 1958, Tortonese separated the family Brisingidae from the order Forcipulatida and placed it in a new order, Euclasteroidea. I agree fully with this placement, and the content of the order is unchanged. The consensus among current asteroid specialists, however, seems to be that the name Euclasteroidea is of awkward construction and conveys no

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indication of the content of the order. Accordingly, I have dropped the name Euclasteroidea in favor of the simpler name Brisingida, which, being based on the family name established by G.O. Sars in 1875, is familiar and instantly defines the content of the order.

RANGE EXTENSIONS.—The following range extensions are noted:

Brisinga costata Verrill, 1884, hitherto known only from north of Cape Hatteras in the Western Atlantic, has now been identified from the Gulf of Mexico, Haiti, and Venezuela. The bathymetric distribution is extended to 2377 m.

Brisinga cricophora Sladen, 1889, known only from off the Virgin Islands, has now been identified from Florida, the Bahamas, the Sargasso Sea, and western South Africa. The bathymetric range is extended to 1340 m.

Brisinga hirsuta Perrier, 1894, from the Iberian Basin, has also been collected in the Gulf of Guinea.

Brisingella verticellata (Sladen, 1889), known only from north of Cape Hatteras, has now been collected in the Gulf of Mexico.

Brisingenes multicostata (Verrill, 1894), known only from off New England in depths of over 2000 m, has been identified from the Straits of Florida in 805 m.

Novodinia americana (Verrill, 1880), from Banquereau Bank, has been collected from off Colombia.

Novodinia antillensis (A.H. Clark, 1934), from off Puerto Rico, has been collected in the Gulf of Mexico.

Novodinia pandina (Sladen, 1889), heretofore known only from Faerøe Channel, has been identified from off North Carolina.

Stegnobrisinga splendens H.L. Clark, 1926, from South Africa (~1000 m), has been identified from the Straits of Florida and from off Venezuela (to 4000 m).

Colpaster scutigera Sladen, 1889, known only from the type collected by the *Challenger* southwest of the Canary Islands in 2789 m, has now been collected from the Gulf of Guinea (2525 m) and from off Honduras (933 m).

Freyastera benthophila (Sladen, 1889), previously known from the South Pacific, the Bay of Bengal, and the Bay of Biscay, is now reported from the Eastern Pacific off California.

Freyella elegans (Verrill, 1884), known from Cape Hatteras north to George's Bank, has been collected from the Gulf of Guinea and from off Greenland.

Freyella microspina Verrill, 1894, from off Nantucket and (as *Freyella trispinosa*) south of Cuba, has also been identified from off Surinam. The bathymetric range is extended to 2734 m.

BIOLOGY.—Little is known about feeding among the Brisingida, but small crustacean exoskeletons are sometimes found within the actinostome. Recent bottom photographs by Pawson and Miller (pers. comm.) and others (e.g., Pawson, 1976) show brisingids with their arms upraised, apparently suspension feeding (Figure 1*a,b*), whereas the Freyellidae are always photographed lying flat on the bottom (Figure 1*d*) or with only the distal portion of the arms raised (Figure 1*c*) and are probably not suspension feeders (see "Discussion" under Brisingidae and Freyellidae).

DIAGNOSTIC METHOD.—In this paper I have used a different approach to the taxon diagnosis, using a master list of characters and character states compiled from the major literature on the Brisingida ("Appendix"). This compilation represents a first step in the development of a comprehensive character list for the entire Asteroidea. The numbers (for characters) and letters (for character states) in square brackets in the diagnoses are described in the appendix. The advantages of having a number and letter system are: (1) it becomes immediately apparent which characters belong at which taxonomic level; (2) characters and character states can be compared in numerous ways to investigate possible relationships; and (3) some evolutionary trends can be detected; less specialized characters are shared at higher taxonomic levels, whereas the greatest degree of specialization appears at the species level or below.

Characters are considered in the following or-

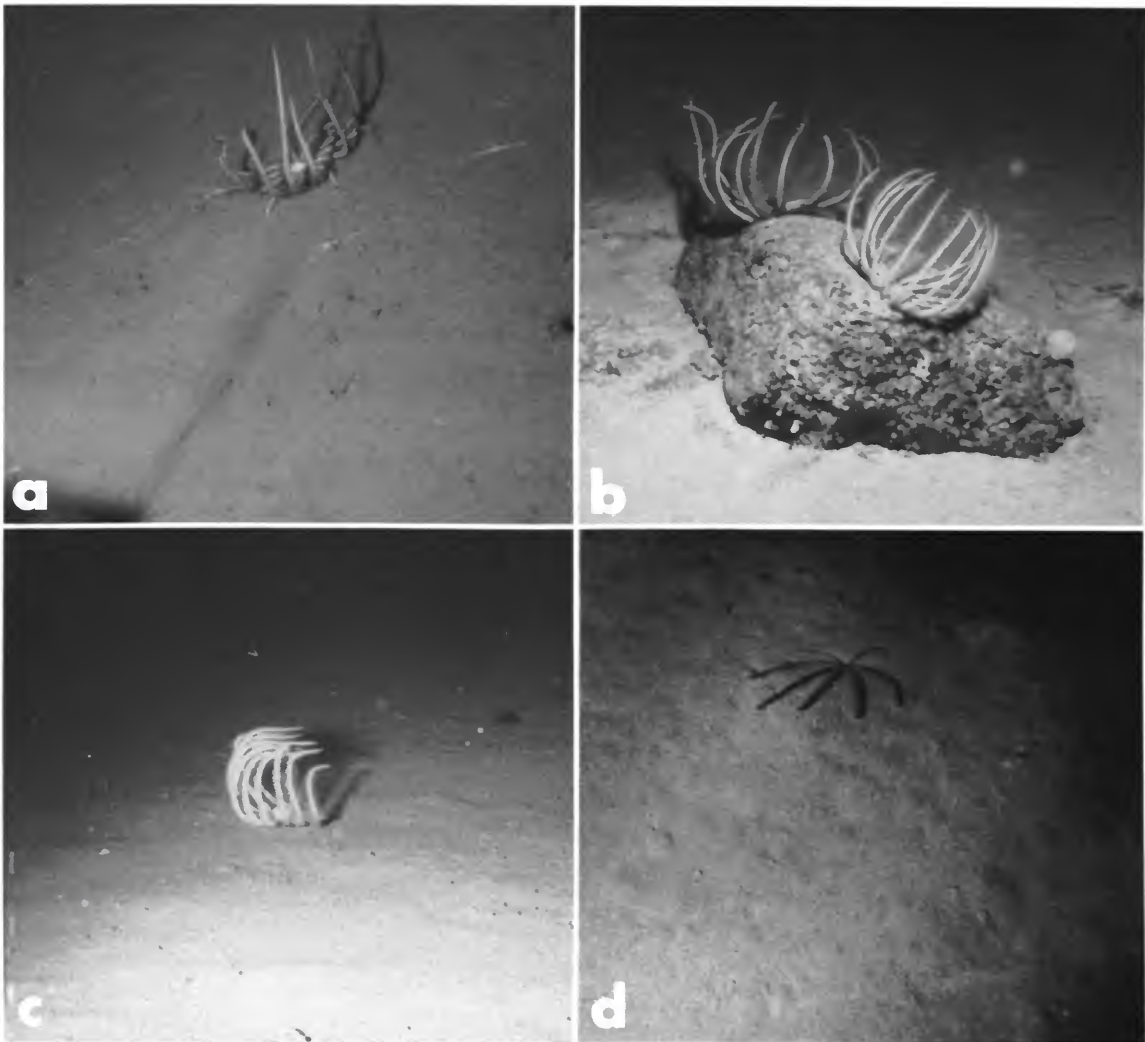


FIGURE 1.—Bottom photographs of various brisingidans showing normal position: a, *Novodinia* sp.; b, *Brisinga* sp.; c, *Freyastera elegans*; d, *Freyastera* sp. (normally with only six arms).

der: general form, disc, arms, terminal plates, inferomarginal plates, adambulacrals, ambulacrals, mouth plates, gonads, pedicellariae. The numbering system for characters is by tens to allow for addition of further characters. Some features are repeated in other forms for ease of evaluation (for example, disc shape and interradial arc frequently offer the same information)

and thus tend to weight certain features. Characters were taken en masse from existing literature and in that way reflect a minimal personal bias.

The Brisingida was selected to test this method primarily because the order was in need of revision and secondarily because it is a relatively small order, with distinctive characters. Revision

of another order (or family or genus) would require analyses of a different suite of characters and character states.

Note that the scale on all figures represents one centimeter.

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Order BRISINGIDA Fisher, 1928, new status

BRISINGINA Fisher, 1928:4 [suborder].
EUCLASTEROIDEA Tortonese, 1958:1–3.

DIAGNOSIS.—[10.a] Form ophiuroid-like; [20.a] disc size small (~10–40/1 R/r) [40.a] disc shape circular, frame an inflexible ring of plates fused or united by syzygy; [90.a] position of madreporite more or less lateral, on outer edge of disc (except *Freyastera mexicana*); [170] arms always more than 5; [180.a] shape of arms long, attenuate, R/r more than 6/1; [200.a] gonadal region of arms differing from rest of arm; [230.a] size of abactinal arm plates relative to marginals small; [300.a,b] marginals not corresponding one to one with adambulacrals (except *Brisinga hirsuta*); [310.a] marginals armed with spines; [330.a] adambulacrals plates more or less cylindrical; [410.a] ambulacral groove broad, open;

[440.a] ambulacral plates not crowded (except *Novodinia americana*), heads abutting end to end; [450] tube feet in 2 rows; [460.a] tube feet suckered; [610.a] pedicellariae crossed.

Family BRISINGIDAE G.O. Sars, 1875

BRISINGIDAE G.O. Sars, 1875:1.—Verrill, 1880:139.—Perrier, 1885c:3.—Sladen, 1889:603.—Perrier, 1891c:198.—Verrill, 1895:199.—Ludwig, 1897b:418; 1900:488.—Fisher, 1906:1108.—Koehler, 1907:3; 1906 [1907]:141; 1908:578.—Fisher, 1916b:31; 1917:419; 1918:104; 1919:516.—H.L. Clark, 1920:107.—Fisher, 1928:7.—Hayashi, 1943:136.—Tortonese, 1958:1.—A.M. Clark, 1962:68.—Bernasconi, 1964:248.—Spencer and Wright, 1966:U76.—McKnight, 1975:17.—A.M. Clark and Courtman-Stock, 1976:97.

DIAGNOSIS.—[50.a] Interradial arcs acute; [80.a,b] madreporite large to moderate; [140.b] no bare interradian plates on disc; [190.a] arms deciduous, constricted where they join the disc; [220.a] abactinal arm plates forming costae; [400.a] proximal adambulacrals united interradianly.

DISCUSSION.—The Brisingidae, with arms sharply demarcated from the disc by a constriction at their base, and with abactinal arm plates in costae across the arms with either bare membrane or thin imbricate fenestrate plates between the costae, raised arms above the disc are admirably adapted to suspension feeding. Only the species of *Novodinia* are slightly limited in their ability to raise the arms completely over the disc because of the plating between the costae on the proximal part of the arms, but even they are less limited in this regard than are the Freyellidae. The Brisingidae live on hard substrates, and in bottom photographs are easy to mistake for comatulid crinoids because of their feeding position.

Genus *Brisinga* Asbjørnsen, 1856

Brisinga Asbjørnsen, 1856:95.—G.O. Sars, 1875:1.—Sladen, 1889:604.—Wood-Mason and Alcock, 1891:12.—Alcock, 1893b:170.—Bell, 1893:104.—Perrier,

1894:61.—Verrill, 1894:280; 1895:211.—Fisher, 1916b:31; 1917:427; 1918:103; 1919:516.—Döderlein, 1927:292.—Fisher, 1928:7.—A.M. Clark and Courtman-Stock, 1976:97.

DIAGNOSIS.—[30.a] Disc thick, raised well above plane of arms; [50.a] interradial arcs acute; [60.a] skin thick, dense, opaque; [70.a,b] anal opening barely visible (microscopic) or absent; [140.b] no bare interradial plates; [160.a] no papulae; [170] number of arms 7–13; [190.a] arms deciduous, constricted at base; [220.a] abactinal arm plates imbricating across arms in costae; [400.a] proximal adambulacral plates united interradially; [590.a] gonads numerous; [600.a] gonads serial.

TYPE-SPECIES.—*Brisinga endecacnemos* Asbjørnsen, 1856, by original designation.

DISCUSSION.—*Brisinga* formerly contained many species that have since been assigned to other genera within the family, mainly by Fisher (1917, 1919). The type species was monographed and illustrated in detail by G.O. Sars (1875), to whose thorough explication we owe much of our knowledge of this deep-sea genus.

The characters Fisher (1917, 1919) used to separate *Craterobrisinga* from *Brisinga* are not reliable. Fisher distinguished *Craterobrisinga* on the basis of capitate or truncate subambulacral spines in the proximal region of the arms, presence of a second subambulacral spine, and adambulacral plates higher than long. *Brisinga costata* has 1–3 capitate spines on the proximal adambulacral, and the adambulacral plates are longer than high. *Brisinga cricophora* (which Fisher assigned to *Craterobrisinga*) has adambulacral plates higher than long proximally, longer than high distally, and only one subambulacral spine. *Brisinga endecacnemos* has adambulacral plates higher than long, and one acicular subambulacral spine. *Brisinga hirsuta* has adambulacral plates longer than high, and one large and one small acicular subambulacral spine. Thus characters Fisher used to distinguish *Craterobrisinga* are specific, not generic.

The species of *Brisinga* have large eggs and direct development. Post-larval development is

discussed by G.O. Sars (1875).

CHARACTERS.—Those peculiar to the genus *Brisinga*: None.

Characters shared with other genera of *Brisingidae*:

Brisingella: 60.a, 70.a,b, 160.a.

Brisingenes: 70.a,b, 600.a.

Midgardia: 30.a, 60.a.

Novodinia: 30.a, 60.a.

Stegnobrisinga: 30.a, 70.a,b, 160.a.

Characters in which *Brisinga* differs from other genera of *Brisingidae*:

Brisingella: 30, 590, 600.

Brisingenes: 30, 60, 160.

Midgardia: 70, 160, 590, 600.

Novodinia: 70, 160, 590, 600.

Stegnobrisinga: 60, 590, 600.

***Brisinga costata* Verrill, 1884**

FIGURE 2

Brisinga costata Verrill, 1884:382; 1885:529; 1894:280; 1895:211.

MERISTICS.—Arms = 12–13, R = 161–381 mm, r = 16–22 mm, R/r = 10–17/1, length of gonadal region = 61–95 mm, length of longest arm spine = 9–15 mm.

DIAGNOSIS.—[80.a] Madreporite large, raised; [100.a] madreporite irregular, coarsely channeled; [110.a,b] abactinal disc plates metapaxillar, tumid, irregular; [120.a] abactinal disc plates widely scattered in membrane; [130.a] abactinal disc plates bearing 1–3 very small sharp spinelets; [170] number of arms 12 or 13; [210.a] abactinal arm plates rod-like; [220.a] abactinal arm plates imbricate across arms in raised ridges (costae), costae well spaced, no plates between or beyond costae; [240.a] abactinal arm plates bearing 0–8 small sharp spinelets in a line on ridge of plate; [280.a] marginal plates very small relative to adambulacral; [290.a] shape of marginals irregular; [300.b] marginals occurring about every 2–3 adambulacral; [310.a] marginals bearing one moderately long acicular spine; [320.a] adambulacral plates large relative to marginals, higher

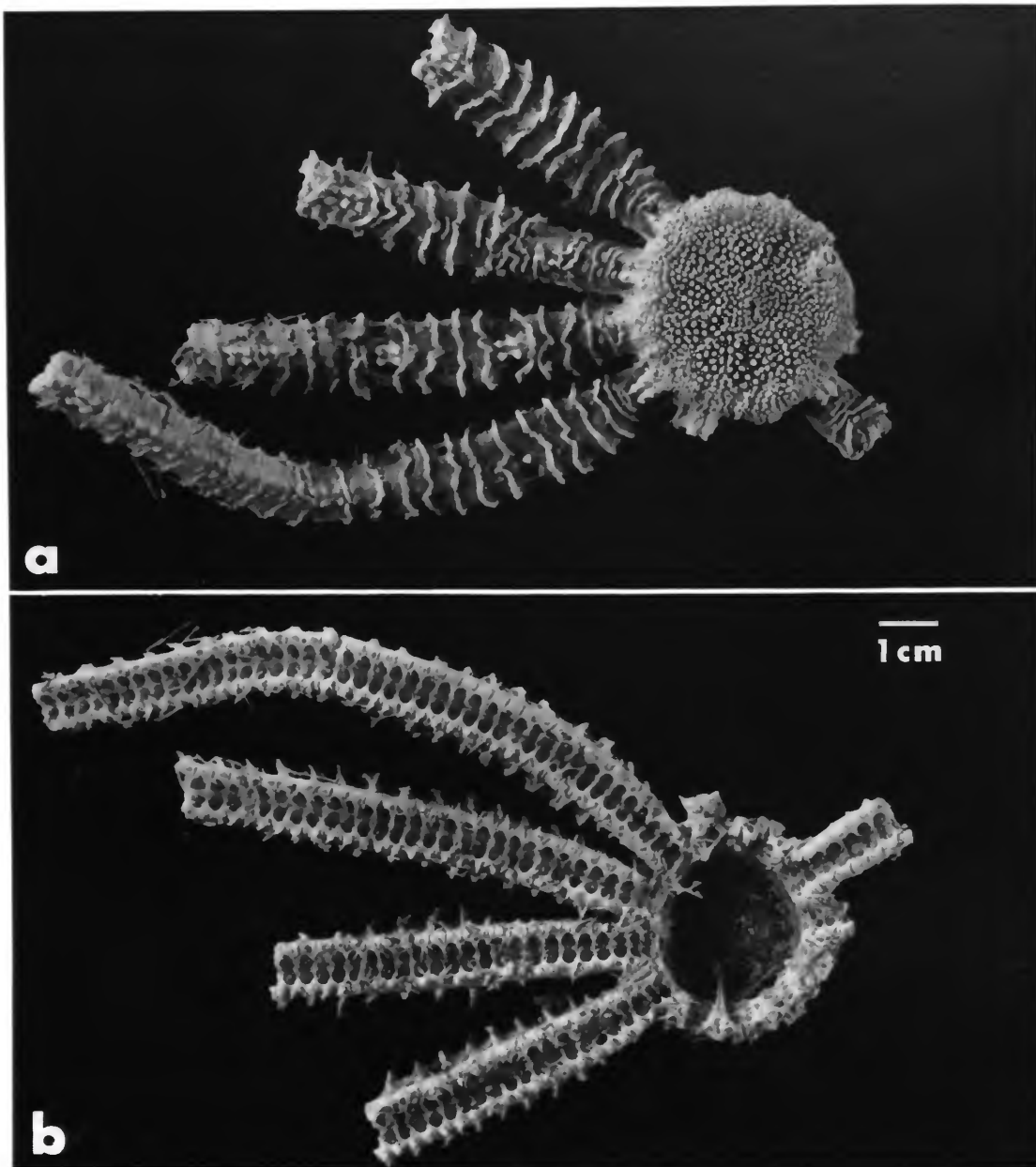


FIGURE 2.—*Brisinga costata*: a, abactinal view; b, actinal view.

than long; [330.b] adambulacrals spool-shaped, higher than long, with sharp inner distal prolongation; [340.a] furrow margin straight; [350] number of furrow spines 1–3; [360.a] furrow

spines quite small, slender, acute; [370.a] furrow spines on proximal end of adambulacral; [380] number of subambulacral spines 1(2–3); [390.a,b] subambulacral spines moderately large,

acicular, sometimes proximal ones slightly capitate; [420.a] ambulacral plates high, forming distinct ridge along arm; [430.a] head of ambulacrals saddle-shaped; [470.a] structure of tubefeet delicate, thin, translucent; [480.a] mouth plates rather small relative to adambulacrals; [490.a] mouth plates T-shaped; [500] number of preoral spines per mouth plate 1; [510.a] preoral spines very long, fine, acicular; [520.a] position of preoral spines adoral; [530] number of lateral oral spines 2 per mouth plate; [540.a] lateral oral spines small, slender, slightly curved, acicular; [550.a] lateral oral spines on oral edge of mouth plates, beneath preoral spines; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines large, acicular; [580.a] position of suboral spines just behind preorals; [620.a,b,c] pedicellariae tiny, abundant on membranous part of disc and in irregular bands on membranous part of arms beyond costae, all spines enclosed in fleshy sacs completely covered with pedicellariae; [630.a] all pedicellariae microscopic.

COLOR.—Unknown.

TYPES.—USNM 7820 (holotype), *Albatross* Sta 2210, collected 1884 south of Block Island, Rhode Island, 1812 m; USNM 11256 (paratype), *Albatross* Sta 2533, SE of George's Bank, 1514 m.

MATERIAL EXAMINED.—Holotype and paratype; 1 specimen, USNM 6739, *Albatross* Sta 2116, off Hatteras, North Carolina, 1624 m; arm fragments, *Albatross* Sta 2706, off George's Bank, 2173 m; 1 specimen, USNM 18503, *Albatross* Sta 2116, off Cape Hatteras, North Carolina, 1624 m; arm fragment, R/V *Knorr* Sta 325, Hudson Canyon, 39°13.3'N, 71°53.4'W, 1974 m; arm fragment, USNM E20942, *Oregon* Sta 2571, Gulf of Mexico, 26°34'N, 90°31'W, 2377 m; 2 specimens, *Pillsbury* Sta 1178, Haiti, 19°14'N, 73°14'W, 1903 m; 17 specimens, *Pillsbury* Sta 748, off Venezuela, 11°24.8'N, 67°10.1'W, 1865 m.

DISTRIBUTION.—Western Atlantic, George's Bank to Venezuela, 1514–2377 m.

DISCUSSION.—Within the gonadal inflation, numerous oval sacs contain one to four very large

yolky eggs (up to 3 mm) and a number of smaller eggs. Development is therefore likely direct and probably demersal.

CHARACTERS.—Those peculiar to *B. costata*: 430.a.

Characters shared with other species of *Brisinga*:

B. cricophora: 80.a, 100.b, 110.b, 130.a, 210.a, 220.a, 240.a, 280.a, 290.a, 300.b, 310.a, 320.a, 330.b, 360.a, 370.a, 390.a,b, 470.a, 480.a, 500.1, 510.a, 540.a, 570.a, 580.a, 620.a,b,c, 630.a.

B. endecacnemos: 100.a, 110.a, 130.a, 210.a, 220.a, 240.a, 280.a, 300.b, 310.a, 320.a, 330.b, 360.a, 370.a, 390.a, 420.a, 480.a, 500.1, 510.a, 520.a, 540.a, 560.1, 570.a, 580.a, 620.a,b, 630.a.

B. hirsuta: 110.b, 120.a, 210.a, 220.a, 240.a, 280.a, 310.a, 330.b, 360.a, 390.a, 420.a, 470.a, 500.1, 510.a, 570.a, 620.a,b,c.

Characters in which *B. costata* differs from other species of *Brisinga*:

B. cricophora: 100, 110, 120, 320, 340, 370, 420, 430, 490, 520, 550.

B. endecacnemos: 80, 100, 110, 120, 290, 310, 340, 370, 390, 430, 470, 490, 530, 550, 620.

B. hirsuta: 80, 100, 110, 130, 290, 300, 320, 340, 370, 430, 480, 490, 520, 530, 550, 580, 630.

Brisinga cricophora Sladen, 1889

FIGURE 3

Brisinga cricophora Sladen, 1889:606–608, pl. 59: figs 6–8.
Craterobrisinga cricophora.—Fisher, 1917:426; 1919:513.

MERISTICS.—Arms = 11, R = 130 mm (estimated), r = 7–13 mm, R/r = 10–19/1, length of gonadal region = 60 mm, length of longest arm spine = 17 mm.

DIAGNOSIS.—[80.a] Madreporite large, raised; [100.b] madreporite irregular; [110.b] abactinal disc plates tumid; [120.b] abactinal disc plates dense in membrane; [130.a] abactinal disc plates sometimes bearing one or more tiny hyaline spinelets or one moderately long hyaline spinelet;

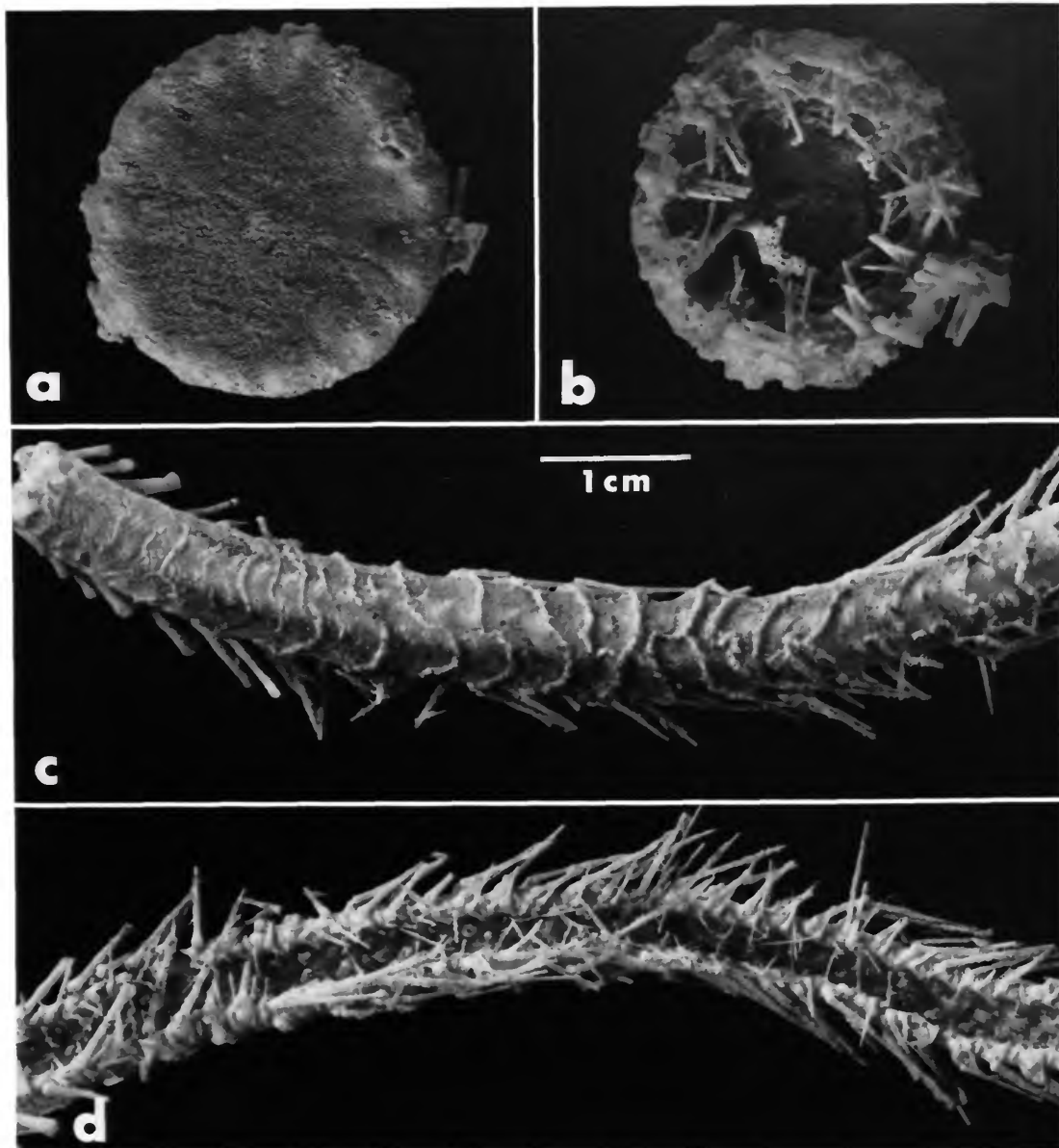


FIGURE 3.—*Brisinga cricophora*: a, abactinal view of disc; b, actinal view of disc; c, abactinal view of arm section; d, actinal view of arm section.

[170] number of arms 11; [205.a] gonadal region of arms 60 mm, moderately inflated; [210.a] abactinal arm plates elongate, rod-like; [220.a] abactinal arm plates imbricate, costae delicate, frequently incomplete, bare membrane between

and beyond costae; [240.a] abactinal arm plates bearing 1 or 2 tiny thorn-like spinelets; [280.a] marginal plates very small relative to adambulacrals; [290.a] shape of marginals irregular; [300.b] marginals occurring about every other

adambulacral; [310.a] first 5–7 marginals without spines, rest with 1 or 2 moderately long acicular spines; [320.a,b] adambulacral plates higher than long proximally, longer than high distally; [330.b] adambulacrals spool-shaped; [340.b] furrow margin slightly indented; [350] number of furrow spines 2; [360.a] furrow spines small, tapering; [370.a,b] one furrow spine at either end of adambulacral; [380] number of subambulacral spines 1; [390.a,b] subambulacral spines extremely long, length increasing distad, first 10–15 stout, capitate, rest slender, aciculate; [420.b] ambulacral plates rather small, delicate; [430.b] head of ambulacral plates quite small, hourglass-shaped; [470.a] tubefeet delicate, slender, translucent; [480.a] mouth plates very small relative to adambulacrals; [490.b] mouth plates trapezoidal, with outer side and distal end concave; [500] number of preoral spines per mouth plate 1; [510.a] preoral spines small, acicular; [520.b] preoral spines directed laterally, across groove; [530] number of lateral oral spines 1–3; [540.a] lateral oral spines small, acicular; [550.b] lateral oral spines on face of mouth plates, near outer side; [560] number of suboral spines per mouth plate 1 or 2; [570.a] suboral spines moderately large, acicular; [580.a] suboral spines behind preoral spines; [620.a,b,c] pedicellariae abundant, all spines enclosed in fleshy sac completely covered with pedicellariae, membrane between and beyond costae with transverse bands of tiny pedicellariae; [630.a] all pedicellariae microscopic.

COLOR.—Orange.

TYPE.—BM(NH) 90.5.7.1043 (holotype), *Challenger* Sta 24, NW of St. Thomas, Virgin Islands, 18°38.3'N, 65°5.3'W, 713 m.

MATERIAL EXAMINED.—Holotype; USNM E20952, 15 specimens, *Gerda* Sta 190, Bahamas, 25°57'N, 78°07'W, 733–897 m; USNM E20947, arm fragments, *Gerda* Sta 403, off Florida, 27°49'N, 78°50'W, 824 m; USNM E20946, arm fragments, *Gerda* Sta 672, off Florida, 27°53'N, 79°03'W, 796 m.

DISTRIBUTION.—Florida, the Bahamas, the Virgin Islands, Sargasso Sea, western South Africa; 713–1340 m.

CHARACTERS.—Those peculiar to *B. cricophora*: None.

Characters shared with other species of *Brisinga*:

B. endecacnemos: 120.b, 130.a, 170.11, 205.a, 210.a, 220.a, 240.a, 280.a, 300.b, 310.a, 330.b, 340.b, 360.a, 380.1, 480.a, 500.1, 510.a, 540.a, 550.b, 570.a, 580.a, 630.a.

B. hirsuta: 110.b, 210.a, 220.a, 240.a, 280.a, 310.a, 330.b, 340.b, 360.a, 470.a, 500.1, 510.a, 520.b, 560.1–2, 570.a, 620.a,b,c.

Characters in which *B. cricophora* differs from other species of *Brisinga*:

B. endecacnemos: 80, 100, 110, 290, 320, 390, 420, 430, 470, 490, 520, 620.

B. hirsuta: 80, 100, 120, 130, 170, 205, 290, 300, 380, 420, 480, 490, 550, 580, 630.

Brisinga endecacnemos Asbjørnsen, 1856

FIGURE 4

Brisinga endecacnemos Asbjørnsen, 1856:95, pl. 9.—G.O. Sars, 1875:1–112, pl. 4: fig. 41, pl. 7.—Bell, 1892 [1893]:520; 1893:104.—Perrier, 1894:62.—Farran, 1913:27–28.—Gage et al., 1983:284–285.

MERISTICS.—Arms = 11, R = 342 mm, r = 12 mm, R/r = 28.5/1, length of gonadal region = 130 mm, length of longest arm spine = 18 mm.

DIAGNOSIS.—[80.b] Madreporite of moderate size, raised; [100.a] madreporite coarsely channeled; [110.a] abactinal disc plates metapaxillar; [120.b] abactinal disc plates dense, embedded in membrane; [130.a] abactinal disc plates armed with a tiny echinulate spinelet; [170] number of arms 11; [205.a] gonadal region nearly half arm length, moderately inflated; [210.a] abactinal arm plates rod-like; [220.a] abactinal arm plates imbricate, costae meandering, some incomplete, some anastomosing, not widely spaced, membrane between and beyond costae with minute spinelets; [240.a] abactinal arm plates bearing row of fine spinelets; [250.a] terminal plates rather small relative to marginals; [260.a] terminals catsclaw-shaped; [270.a] terminals bearing about 5 slender spines; [280.a] marginal plates very small relative to adambulacrals; [290.b] marginals irregularly oval; [300.b] marginals occur-

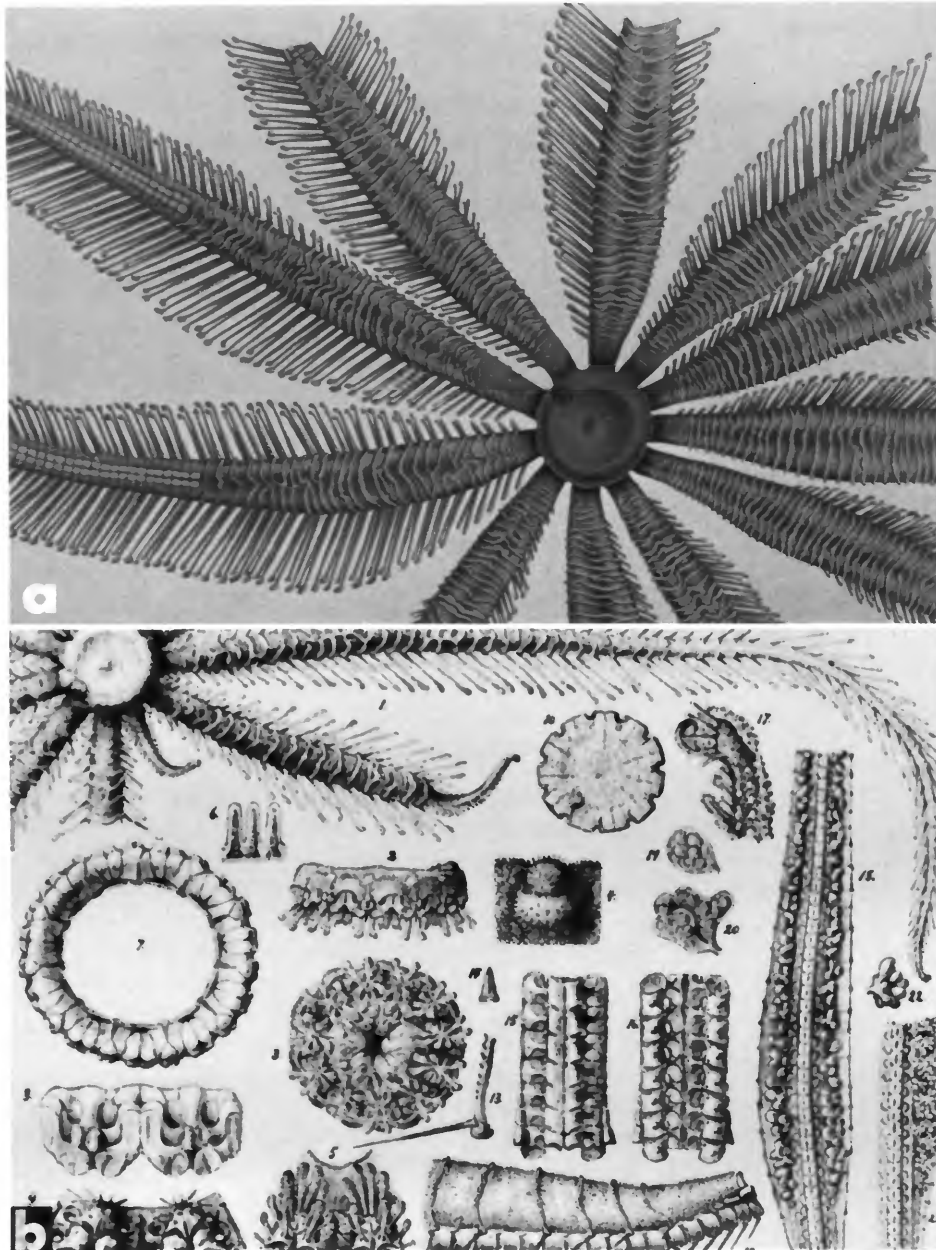


FIGURE 4.—*Brisinga endecacnemos*: a, abactinal view (from Koehler, 1909c); b, Details (from G.O.Sars, 1875).

ring about every other adambulacral; [310.a] marginals bearing each one very long acicular spine; [320.a] adambulacral plates higher than long; [330.b,c] adambulacrals nearly discoid, spool-shaped; [340.b] furrow margin slightly indented; [350] number of furrow spines 1 or 2; [360.a] furrow spines small, acicular; [370.a(a,b)] furrow spines at proximal end of adambulacral if single, one at each end if double; [380] number of subambulacral spines 1; [390.a] subambulacral spines long, acicular; [420.a] ambulacral plates fairly high, heavy; [430.c] head of ambulacrals Y-shaped, larger than base, cylindrical, with inner proximal projection; [470.b] tubefeet rather heavy; [480.a] mouth plates rather small relative to adambulacrals; [490.c] mouth plates longer than broad, subtriangular, truncate; [500] number of preoral spines per mouth plate 1; [510.a] preoral spines acicular, moderately long; [520.a] preoral spines projecting into actinostome; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines small, acicular; [550.b] lateral oral spines at sides of mouth plates; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines moderately long, acicular; [580.a] suboral spines below preoral spines; [620.a,b(f)] pedicellariae on both abactinal and actinal surfaces, on disc confined to mouth spines, on arms mostly confined to adambulacral spines, very few on membranous areas of arms, in bands; [630.a] all pedicellariae microscopic.

COLOR.—Bright yellow-orange.

TYPE.—Bergens Museum; Hardangerfjord, Norway, 183–366 m.

MATERIAL EXAMINED.—2 lots, 3 specimens in BM(NH).

DISTRIBUTION.—Norway to Portugal; 183–2000 m.

CHARACTERS.—Those peculiar to *B. endecacnemos*: None.

Characters shared with other species of *Brisinga*:

B. hirsuta: 80.b, 210.a, 220.a, 240.a, 280.a, 330.b, 340.b, 360.a, 390.a, 420.a, 500.1, 510.a, 530.1, 570.a.

Characters in which *B. endecacnemos* differs from other species of *Brisinga*:

B. hirsuta: 100, 110, 120, 130, 170, 205, 290, 300, 320, 380, 430, 470, 480, 490, 520, 550, 580, 620, 630.

Brisinga hirsuta Perrier, 1894

FIGURE 5

Brisinga hirsuta Perrier, 1894:66.

MERISTICS.—Arms = 13, R = 148 mm (estimated), r = 8.5 mm, R/r = 17.4/1, length of gonadal region = 45 mm, length of longest arm spine = 5 mm.

DIAGNOSIS.—[80.b] Madreporite of moderate size; [100.c] madreporite subtubercular; [110.b] abactinal disc plates tumid, close but not crowded; [120.a] abactinal disc plates scattered in membrane; [130.b] abactinal disc plates each bearing a moderately long setose spine; [170] number of arms 13; [205.b] gonadal region of arms 45 mm long, not inflated; [210.a] abactinal arm plates rod-like; [220.a] abactinal arm plates imbricate, in costae rather closely and evenly spaced, membrane between and beyond costae usually bare but sometimes with isolated minute platelets; [240.a] costal plates bearing transverse row of small, acute spinelets; [280.a] marginal plates small relative to adambulacrals; [290.c] marginals tubercular; [300.a] marginals corresponding to every adambulacral; [310.a] every other marginal bearing a long, ridged, hyaline spine; [320.b] adambulacrals longer than high; [330.b] adambulacrals spool-shaped, with definite ridge at each end; [340.b] furrow margin slightly indented; [350] number of furrow spines 2 proximally (in gonadal region), 1 distally; [360.a] distal furrow spine small, proximal one very fine, setose; [370.b(b,a)] one furrow spine at distal end of adambulacral and, in gonadal region, one at proximal end also; [380] number of subambulacral spines 2; [390.a] subambulacral spines quite long, acicular, ridged, hyaline, 1 on proximal end of actinal face of adambulacral, one in center of actinal face; [420.a] ambulacral plates large, heavy; [430.b,d] ambulacral plates T-shaped, head hourglass-shaped, with definite

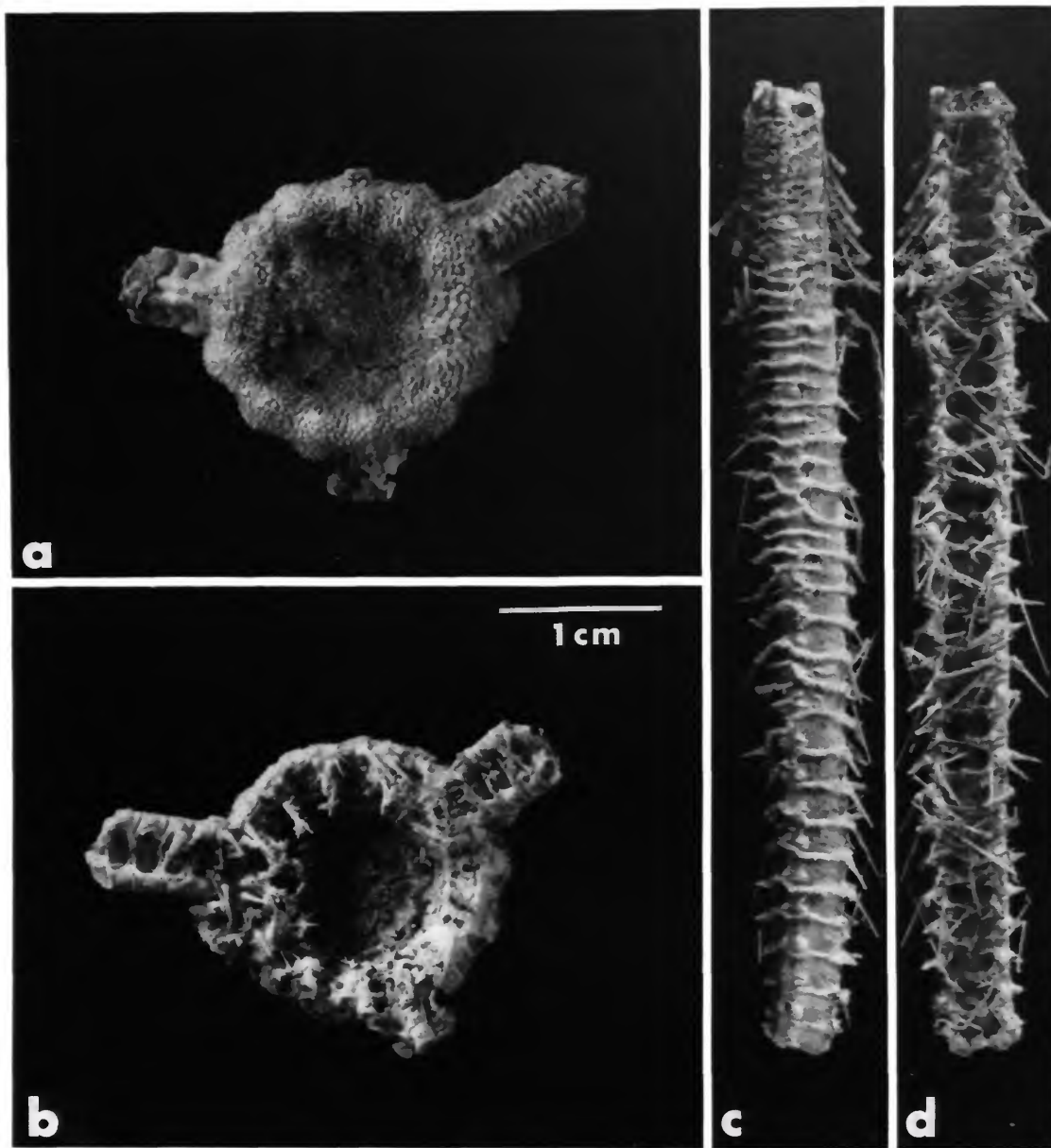


FIGURE 5.—*Brisinga hirsuta*: a, abactinal view of disc; b, actinal view of disc; c, abactinal view of arm section; d, actinal view of arm section.

ridge at each end; [470.a] tubefeet quite delicate; [480.b] mouth plates of moderate size; [490.d] mouth plates cylindrical, with outer side and distal end indented, broader at base than at apex,

somewhat flared at each end; [500] number of preoral spines per mouth plate 1; [510.a] preoral spines small, delicate, acicular; [520.b] preoral spines laterally directed; [530] number of lateral

oral spines per mouth plate 1; [540.a] lateral oral spines small, delicate, acicular; [550.c] lateral oral spines placed distad on mouth plates; [560] number of suboral spines per mouth plate 1 or 2; [570.a] suboral spines very long, hyaline, acicular; [580.b] suboral spines distad to preorals; [620.a,b,c] pedicellariae on both surfaces of disc and arms, in bands on membranous part of arms; [630.a,b] pedicellariae on costae, mouth plate spines and furrow spine huge, smaller, abundant on other spines.

COLOR.—Unknown.

TYPE.—Paris Museum 4594 (holotype consisting of one arm fragment); *Travilleur* Sta 13, between Portugal and the Azores, 2030 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, *Pillsbury* Sta 266, Gulf of Guinea, 1° 13' N, 7° 46' E, 2525 m.

DISTRIBUTION.—Iberian Basin, Gulf of Guinea; 2030–2525 m.

DISCUSSION.—A single specimen of *Brisinga hirsuta* collected by the *Pillsbury* off Sao Tome in the Gulf of Guinea allows this first description of the disc and the number of arms; Perrier based the species on a single arm fragment, which was, however, distinctive enough to allow identification of the *Pillsbury* specimen. This species is clearly distinguished from the other species of *Brisinga* by the relatively large and numerous marginal plates, the unusual size and distribution of the pedicellariae, and the number and distribution of the adambulacral spines, as well as the well-defined, narrow ridges of spines on the costae.

CHARACTERS.—Those peculiar to *B. hirsuta*: 300.a, 480.b.

Genus *Brisingella* Fisher, 1917

Brisingella Fisher, 1917:419; 1918:104; 1919:515.—H.L. Clark, 1920:107.—Fisher, 1928:13; 1940:206.—Hayashi, 1943:152.—Djakanov, 1950:103.—John and A.M. Clark, 1954:151.—McKnight, 1975:235.

DIAGNOSIS.—[30.b] Disc raised slightly above plane of arms; [50.a] interradial arcs acute; [60.b] flesh thin, opaque; [70.a,b] anal opening micro-

scopic or absent; [140.b] bare interradial plates absent; [160.a] no papulae; [170] number of arms 8–12; [190.a] arms deciduous, constricted at base; [220.a] abactinal arm plates imbricate, costae widely spaced, spaces between and beyond costae covered with membrane; [400.a] proximal adambulacrals united interradially; [590.b] 2 pairs of gonads per arm; [600.b] gonads in pairs at base of arm.

TYPE-SPECIES.—*Brisinga fragilis* Fisher (1906: 1115), by original designation.

CHARACTERS.—Those peculiar to the genus *Brisingella*: None.

Characters *Brisingella* shares with other genera of Brisingidae:

Brisingenes: 70.a,b, 400.a.

Midgardia: 60.a, 400.a, 590.b, 600.b.

Novodinia: 60.a, 400.a, 600.b.

Stegnobrisinga: 70.a,b, 160.a, 400.a, 600.b.

Characters in which *Brisingella* differs from other genera of Brisingidae:

Brisingenes: 30, 60, 160, 590, 600.

Midgardia: 30, 70, 160.

Novodinia: 30, 70, 160, 590.

Stegnobrisinga: 30, 60, 590.

Brisingella coronata (G.O. Sars, 1871)

FIGURE 6

Brisinga coronata G.O. Sars, 1871:5.—Thomson, 1873:66 (part).—G.O. Sars, 1875:1–112, pls. 1–6.—Ludwig, 1878:216–234, pl. 15.—Perrier, 1882:61.—Danielssen and Koren, 1884:104.—Carus, 1885:91.—Perrier, 1885d:442–444; 1885b:4–5.—Sladen, 1889:598, 601–604, 832.—Bell, 1889:433.—Sladen, 1891:698.—Bell, 1892[1893]:105.—Norman, 1893:347.—von Marenzeller, 1893a:66–70; 1893b:65–67.—Perrier, 1894:50, 51, 54, 68–70, pl. 1: figs 1, 2, 4–6.—von Marenzeller, 1895a:189–191.—Koehler, 1896a:440; 1896b:38–40.—Perrier, 1896:20.—Ludwig, 1897a:308; 1897b:418–438; 1900:488.

Brisinga sp.—Marion, 1883:129–136.

Brisinga mediterranea Perrier, 1885d:442, 444; 1885b:3–4.—Sladen, 1889:602, 603, 834.—Perrier, 1894:51, 70–71, pl. 1: fig. 3, pl. 3: fig. 1.—von Marenzeller, 1895b:137.—Boone, 1933:93.

Brisingella coronata.—Mortensen, 1927:127.—Grieg, 1927b: 127; 1928:1.—John and A.M. Clark, 1954:151.—Gage et al, 1983:285.

MERISTICS.—Arms = 9–12, R = 310 mm (estimated), r = 7–15 mm, R/r = 20.7/1, length of gonadal region = 75 mm, length of longest arm spine = 20 mm.

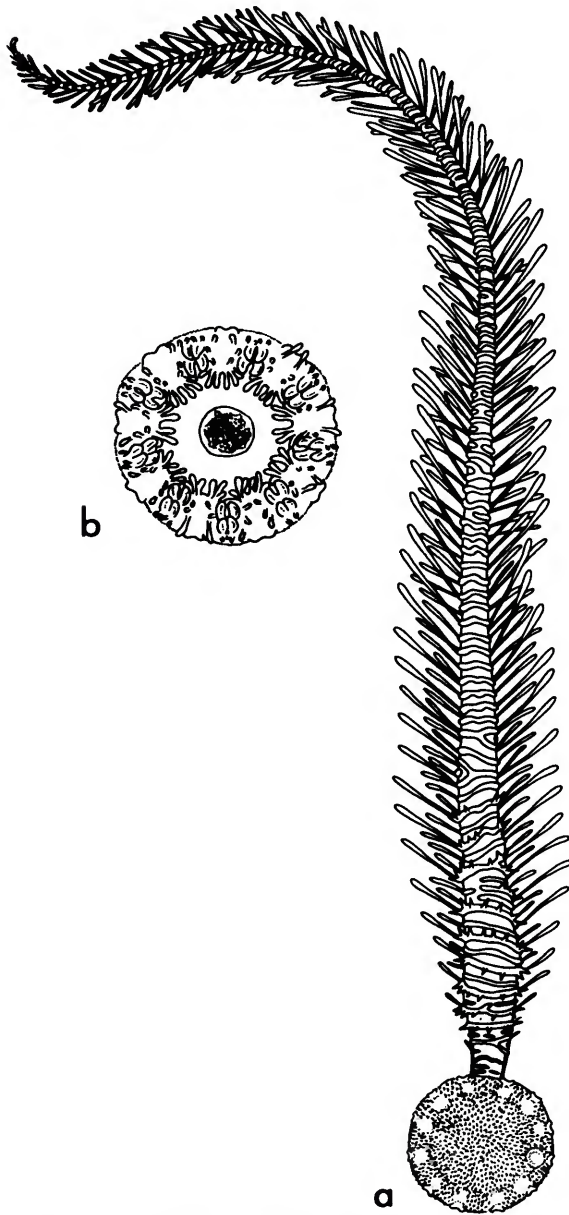


FIGURE 6.—*Brisingella coronata*: a, abactinal view of disc and one arm; b, actinal view of disc. (Adapted from G.O. Sars, 1875, by Molly Griffin.)

DIAGNOSIS.—[80.a] Madreporite large; [100.a] madreporite channeled; [110.c] abactinal disc plates small, tubercular; [120.a,d] abactinal disc plates few, in irregular radiating rows, not dense; [130.b] abactinal disc plates bearing 1 moderately long, mobile, denticulate spine; [170] number of arms 9–12; [205.a,c] gonadal region of arms 75 mm long, slightly to highly inflated; [210.a] abactinal arm plates rod-like; [240.b] costal plates each bearing a long, glassy spine; [250.a] terminal plates small relative to marginals; [260.b] terminal plates shield-shaped; [270.a] terminal plates armed with 8 or 9 outwardly directed webbed spines, central 3 longest; [280.a] marginal plates small; [290.a] marginals irregular; [300.b] marginals occurring about every other adambulacral; [310.b] marginals bearing 1 spinelet; [320.a] adambulacrals higher than long; [330.d] adambulacral plates hourglass-shaped; [340.b] furrow margin slightly indented; [350] number of furrow spines 2–4; [360.a] furrow spines tiny, acicular; [370.c] furrow spines medial; [380] number of subambulacral spines 1 or 2; [390.a] subambulacral spines moderately long, acicular; [420.a] ambulacral plates moderately high; [430.c] ambulacrals broadly Y-shaped; [470.b] tubefeet rather heavy; [480.a] mouth plates rather small relative to adambulacrals; [490.e] mouth plates short, broad; [500] number of preoral spines per mouth plate 2; [510.a] preoral spines acute; [520.a] preoral spines adoral; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines acute; [550.b] lateral oral spines lateral; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines acute; [580.c] suboral spines in center of mouth plate; [620.a,b,c] pedicellariae on both surfaces of disc and arms, in bands or rows on arms; [630.a] all pedicellariae microscopic.

COLOR.—Orange to red.

TYPE.—Bergens Museum; Lofoten, Norway, 549 m.

MATERIAL EXAMINED.—1 specimen, BM(NH), from off Ireland; 1 specimen, USNM 18288, HMS *Pola*, off Samothraki, Turkey, 40° 17' N, 25° 13' E, 588 m.

DISTRIBUTION.—Norway to Azores and Cape Verde Islands; Mediterranean; 100–2600 m.

DISCUSSION.—Thanks to G.O. Sars (1875), this species is the best known of the brisingidans. Sars had abundant material, including some young specimens (smallest had disc diameter of 2.5 mm), so some idea of growth changes and variation could be given. An even smaller specimen (~1 mm), with only eight arms, was collected by the *Atlantis II* off Libya, and my SEM micrographs (unpublished) show the abundant pedicellariae and the early plate development.

CHARACTERS.—Those peculiar to *Brisingella coronata*: 110.c, 370.c, 490.e.

Characters *B. coronata* shares with other species of *Brisingella*:

B. verticellata: 100.a, 130.b, 210.a, 280.a, 330.d, 340.b, 360.a, 390.a, 510.a, 520.a, 570.a, 620.a,b,c, 630.a.

Characters in which *B. coronata* differs from other species of *Brisingella*:

B. verticellata: 80, 110, 120, 170, 240, 290, 320, 370, 420, 430, 470, 480, 490, 530, 540, 550, 580.

Brisingella verticellata (Sladen, 1889)

FIGURE 7

Brisingella verticellata Sladen, 1889:604–606, pl. 59: figs. 9–11.—Verrill, 1894:283; 1895:211.—H.L. Clark, 1941: 64–65.

Brisingella verticellata.—Fisher, 1917:427; 1919:524.

MERISTICS.—Arms = 8, R = 150–180 mm (estimated), r = 5–7.5 mm, R/r = 24–30/1, length of gonadal region = 30–40 mm, length of longest arm spine = 8 mm.

DIAGNOSIS.—[80.b] Madreporite of moderate size, not much raised; [100.a] madreporite flat, channeled; [110.d] abactinal disc plates of numerous small papilliform spinelets embedded in membrane; [120.c] abactinal disc plates imbricate, membrane very thin, easily torn; [130.b] abactinal disc plates armed with spines; [170] number of arms 8; [205.a] gonadal region of arm 30–40 mm long, only slightly inflated; [210.a] abactinal arm plates rod-like; [240.a] abactinal

arm plates bearing small, robust, conical spinelets; [280.a] marginal plates small; [290.c] marginals tubercular; [320.b] adambulacral plates longer than high; [330.d] adambulacrals hour-glass-shaped; [340.b] furrow margin slightly indented; [350] number of furrow spines 2; [360.a] furrow spines acute, glassy; [370.a,b] one furrow spine proximal, one distal; [380] number of subambulacral spines 1; [390.a] subambulacral spines short, robust, conical; [420.b] ambulacral plates small, delicate; [430.d] ambulacral plates T-shaped, head elongate, much larger than base, imbricating distad, but beneath upper distal projection separated by muscle; [470.a] tubefeet delicate; [480.c] mouth plates moderately large; [490.f] mouth plates slightly longer than broad, with prominent median keel; [500] number of preoral spines per mouth plate 1 or 2; [510.a] preoral spines acute; [520.a] preoral spines adoral; [530] number of lateral oral spines 2; [540.b] lateral oral spines blunt; [550.c] lateral oral spines distal; [560] number of suboral spines per mouth plate 0–2; [570.a] suboral spines acute; [580.a,b] one suboral spine immediately behind preoral spine, one near distal end of mouth plate; [620.a,b,c] pedicellariae on both surfaces of disc and arms, on arms in rows or bands; [630.a] all pedicellariae microscopic.

COLOR.—Ashy gray (in alcohol).

TYPE.—BM(NH) 90.5.7.1041 (holotype): *Challenger* Sta 46, off New Jersey, 40° 17' N, 66° 48' W, 2469 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, USNM 6619, *Albatross* Sta 2102, off Delaware Bay, 2211 m; 1 disc, USNM 7818, *Albatross* Sta 2205, S of Block Island, Rhode Island, 1962 m; 1 specimen, USNM 9016, *Albatross* Sta 2076, off Martha's Vineyard, 1657 m; 6 discs, 15 arm fragments, USNM 9064, *Albatross* Sta 2077, off Georges Bank, 2295 m; arm fragments, USNM 15543, *Albatross* Sta 2734, off Chesapeake Bay, 1538 m; arm fragments, USNM 15548, *Albatross* Sta 2732, off Chesapeake Bay, 2107 m; arm fragment, USNM 21486, *Albatross* Sta 2210, S of Block Island, Rhode Island, 1812 m; 3 arms, USNM 21487, *Albatross* Sta 2229, off Maryland, 2602 m; 5 arm fragments, USNM 21488, off

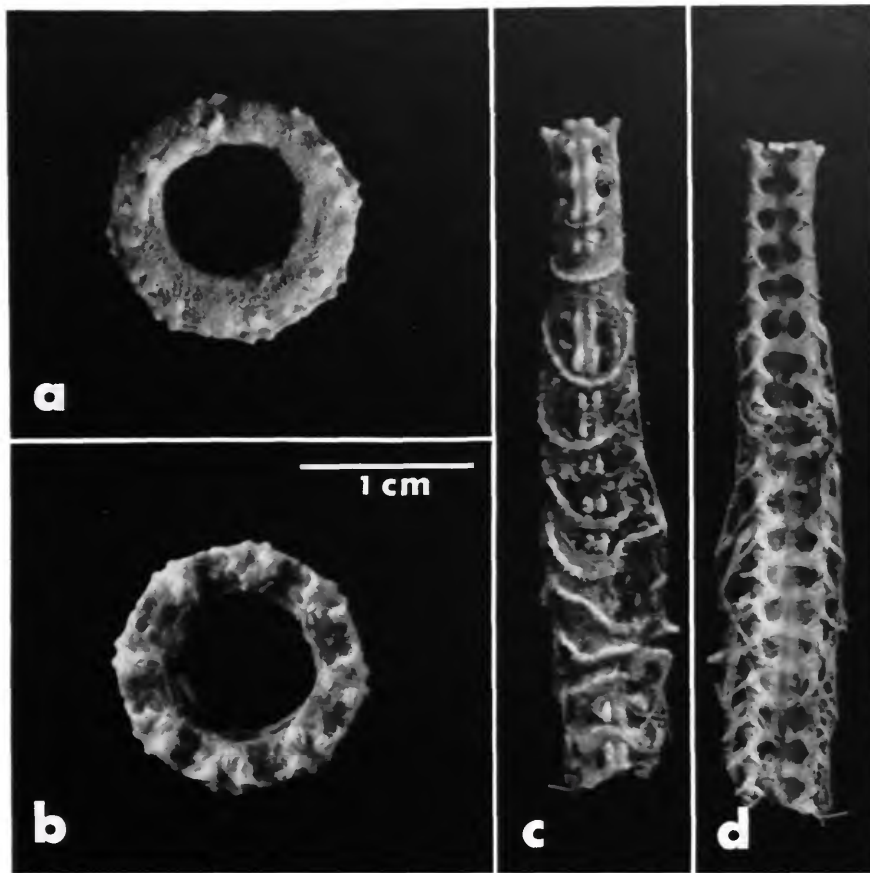


FIGURE 7.—*Brisingella verticellata*: a, abactinal view of disc; b, actinal view of disc; c, abactinal view of arm section; d, actinal view of arm section.

Delaware, 2136 m; 4 arm fragments, USNM 21989, *Albatross* Sta 2725, off Chesapeake Bay, 2513 m; 3 specimens, USNM 21910, *Albatross* Sta 2076, off Georges Bank, 1657 m; 1 specimen, USNM E20949, *Alaminos* Cr. 68A13-8, Gulf of Mexico, 26°18'N, 96°08'W, 732 m; 1 specimen, USNM E20950, no data.

DISTRIBUTION.—Georges Bank to the Gulf of Mexico, 640–2570 m.

DISCUSSION.—This small, delicate brisingid is chiefly distinguished from *B. coronata* by its widely spaced costae. The disc is remarkably small, flat, and delicate, with very thin membrane, and no plates, and the arms are unusually

slender. The subambulacral spines are short, stout, and conical, rather than long and slender as in *Brisingella coronata*.

CHARACTERS.—Those peculiar to *Brisingella verticellata*: None.

Genus *Brisingenes* Fisher, 1917

Brisingenes Fisher, 1917:419,427; 1919:517.

DIAGNOSIS.—[30.c] Disc flat, in same plane as arms; [50.a] interradial arcs acute; [60.b] rather fleshy, skin thin but conspicuous, opaque, many areas plateless; [70.a,b] anal opening microscopic

or absent; [140.b] no bare interradial plates; [160.c] one pair of papulae to each radial area of disc; [170] number of arms 13–15; [190.a] arms deciduous, constricted at base; [220.a] abactinal arm plates imbricate; [400.a] proximal adambulacrals united interradially; [590.a] many gonads; [600.a] gonads serial.

TYPE-SPECIES.—*Brisinga mimica* Fisher, 1917, by original designation.

CHARACTERS.—Those peculiar to *Brisingen*: None.

Characters *Brisingen* shares with other genera of Brisingidae:

Midgardia: 160.c, 400.a.

Novodinia: 400.a.

Stegnobrisinga: 60.b, 70.a,b, 400.a.

Characters in which *Brisingen* differs from other genera of Brisingidae:

Midgardia: 30, 60, 70, 590, 600.

Novodinia: 30, 60, 70, 160, 590, 600.

Stegnobrisinga: 30, 160, 590, 600.

***Brisingen multicostata* (Verrill, 1894)**

FIGURE 8

Brisinga multicostata Verrill, 1894:280.

Brisingen multicostata.—Fisher, 1917:426; 1919:513.

MERISTICS.—Arms = 13–15, R = ~170–400 mm, r = 13–16 mm, R/r = 13–25/1, length of gonadal region = 52–80 mm, length of longest arm spine = 5–13 mm.

DIAGNOSIS.—[80.a] Madreporite large, raised well above plane of arms; [100.b] madreporite warty, irregular; [110.a] abactinal disc plates round, metapaxillar; [120.b] abactinal disc plates dense in membrane; [130.a] abactinal disc plates bearing 1 or 2 small glassy acicular spinelets; [170] number of arms 13–15; [205.a] gonadal region of arms 52–80 mm long, inflated; [210.a] abactinal arm plates rod-like; [240.a] costal plates bearing transverse ridge of small sharp spinelets; [250.a] terminal plates small, about size of last pair of adambulacrals; [260.b] terminals irregularly shield-shaped; [280.a] marginals small;

[290.c] marginals tubercular, more or less fused to adambulacrals; [310.a] marginals unarmed proximally, beyond midgonadal region bearing 1 stout, fluted, bulbous-based acicular spine; [320.a] adambulacrals higher than long; [330.c] adambulacrals discoidal; [340.b] furrow margin slightly indented, with distal projection; [350] number of furrow spines 2; [360.a] furrow spines short, sharp; [370.a] furrow spines near proximal end of adambulacrals; [380] number of subambulacrals spines 2; [390.a] subambulacrals spines long, stout, fluted, acicular; [420.a] ambulacrals plates large, heavy; [430.e] ambulacrals dumbbell-shaped; [470.b] tubefeet moderately heavy; [480.a] mouth plates small, narrow; [490.g] mouth plates hourglass-shaped; [500] number of preoral spines 1; [510.a] preoral spines small, acicular; [520.b] preoral spines lateral; [530] number of lateral oral spines 0; [560] number of suboral spines 2; [570.a] suboral spines long, acicular; [580.b,c] one suboral spine near center of mouth plate, one distal; [620.a,b,c] pedicellariae on both surfaces of disc and arms, in rows or bands on arms; [630.b] pedicellariae fairly large.

COLOR.—Unknown.

TYPES.—USNM 12074 and 14858 (syntypes), *Albatross* Sta 2573, SE of Georges Bank, 3186 m, Sta 2685, S of Martha's Vineyard, 2079 m.

MATERIAL EXAMINED.—Syntypes; 4 arm fragments, USNM 12075, Fishing Vessel *Grampus*, no other data; 1 specimen, USNM E20951, *Gerda* Sta 226, Straits of Florida, 24°28'N, 80°16'W, 805 m.

DISTRIBUTION.—Georges Bank to the Straits of Florida; 805–3186 m.

DISCUSSION.—Fisher (1917, 1919) placed this species in his new genus, *Craterobrisinga*; he evidently did not examine specimens of Verrill's species, and Verrill did not mention in his description the presence of papulae on the disc. These papulae, coupled with the serial gonads and the interradially joined first adambulacrals and marginals, clearly place this species in the genus *Brisingen*. It is notable for the very large, slender-valved pedicellariae on the spines.

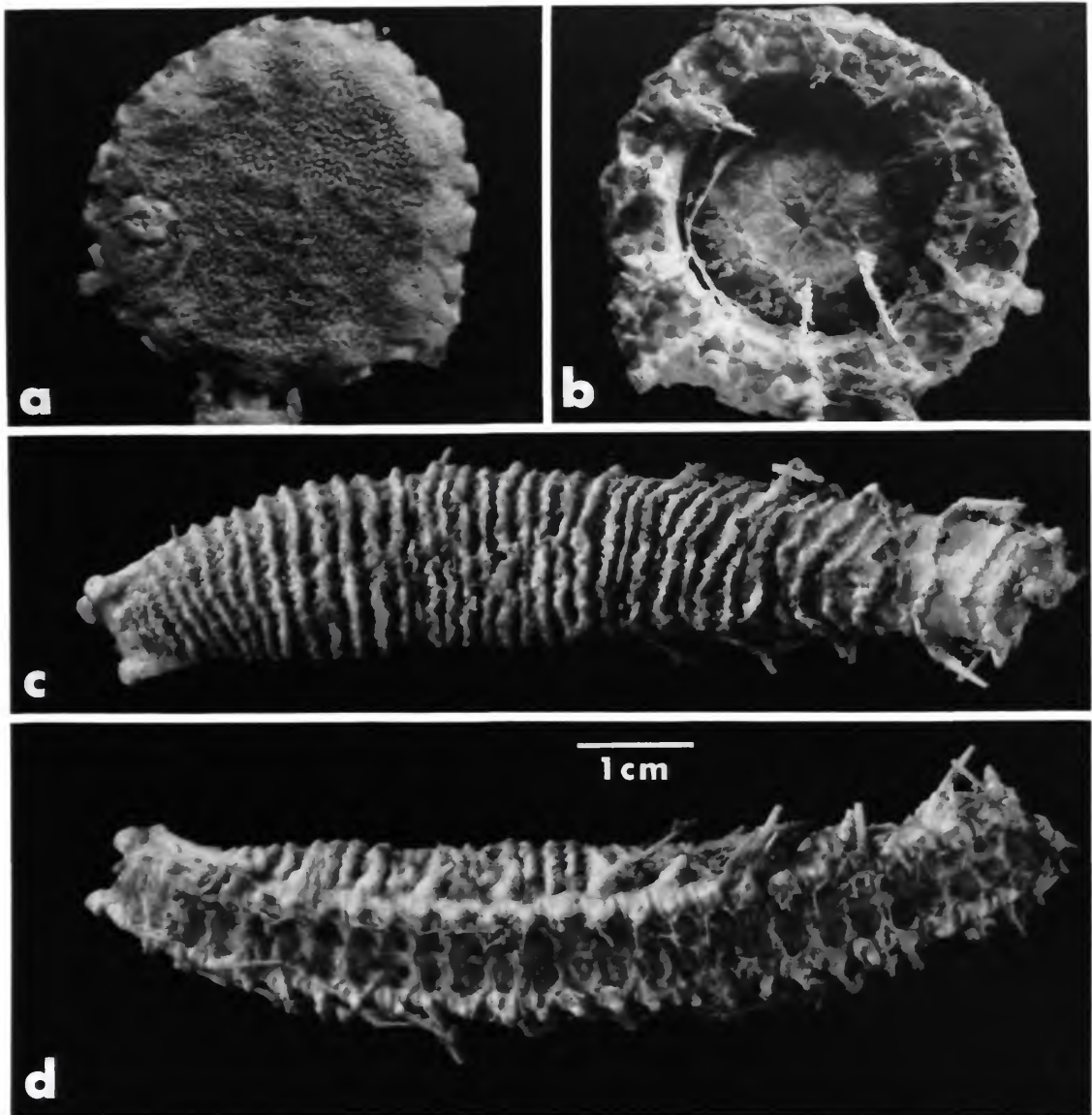


FIGURE 8.—*Brisingenes multicostata*: a, abactinal view of disc; b, actinal view of disc; c, abactinal view of arm section; d, actinal view of arm section.

Genus *Midgardia* Downey, 1972

Midgardia Downey, 1972:421; 1973:99.

DIAGNOSIS.—[30.a] Disc thick, raised well above plane of arms; [50.a] interradial arcs acute; [60.a] flesh dense, opaque; [70.c] anal opening

conspicuous, surrounded by spinelets; [140.b] no bare interradial plates; [160.c] 2 papulae per radial area of disc; [170] number of arms 11-13; [190.a] arms deciduous, constricted at base; [220.a] abactinal arm plates imbricate, in numerous costae; [400.a] proximal adambulacral plates

united interradially; [590.b] 2 pairs of gonads to each arm; [600.b] a pair of gonads on either side of arm.

TYPE-SPECIES.—*Midgardia xandaros* Downey, 1972, by monotypy.

CHARACTERS.—Those peculiar to *Midgardia*: None.

Characters *Midgardia* shares with other genera of Brisingidae:

Novodinia: 30.a, 60.a, 70.c, 400.a, 600.b.

Stegnobrisinga: 30.a, 400.a, 600.b.

Characters in which *Midgardia* differs from other genera of Brisingidae:

Novodinia: 160, 590.

Stegnobrisinga: 60, 70, 160, 590.

Midgardia xandaros Downey, 1972

FIGURE 9

Midgardia xandaros Downey, 1972:421–426, fig. 1; 1973:99–100, pl. 48A,B,C.

MERISTICS.—Arms = 11–13, R = 600 mm, r = 14.5 mm, R/r = 41.4/1, length of gonadal region = 40–60 mm, length of longest arm spine = 10 mm.

DIAGNOSIS.—[80.a] Madreporite large; [100.b,c] madreporite warty and irregular, tumid, almost conical; [110.d] abactinal disc plates papilliform; [120.a] abactinal disc plates scattered in membrane; [130.a] abactinal disc plates armed with 1 small prickle-like spinelet; [170] number of arms 11–13; [205.c] gonadal region of arm 40–60 mm long, greatly inflated; [210.a,f] thin flat irregular plates embedded in membrane between costae of rod-like plates, bare membrane beyond gonadal region; [220.a] abactinal arm plates imbricate, in close irregular costae; [240.a] costal plates bearing 1 small prickle-like spinelet; [250.a] terminal plates tiny; [270.b] terminals armed with catsclaw-like spinelets; [280.a] marginals small; [290.c,d] marginals broadly triangular proximally, becoming reduced to tubercles distally; [310.a] marginals bearing very long (up to 25 mm) acicular spine; [320.a,b] adambulacral plates about as high as

long; [330.c] adambulacrals vertebra-shaped; [340.b] furrow margin slightly indented; [350] number of furrow spines 3 or 4; [360.a] furrow spines setose, small; [370.a,b] furrow spines at either end of adambulacral plate; [380] number of subambulacral spines 1; [390.a] subambulacral spines large, robust (up to 10 mm), acicular; [420.b] ambulacral plates rather small, delicate; [430.d] ambulacrals T-shaped, with very narrow waist, short stout cylindrical head; [470.b] tube-feet very long, heavy, stiffened at base by calcareous collar, probably with limited ability to contract; [480.a] mouth plates small; [490.d] mouth plates slightly longer than broad; [500] number of preoral spines per mouth plate 2 or 3; [510.a] preoral spines slender, delicate, small, acicular; [520.a] preoral spines adoral; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines slender, delicate, small, acicular; [550.c] lateral oral spines distal; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines very large, acicular; [580.c] suboral spines in center of mouth plate; [620.a,b] pedicellariae very numerous, none on abactinal surface of disc, a few in ambulacral groove enlarged, subambulacral and marginal spines bearing a flap of tissue at tip covered with pedicellariae, all spines bearing numerous pedicellariae; [630.a] all pedicellariae small.

COLOR.—Bright red.

TYPES.—USNM E11420 (holotype), E11421 (paratype); *Alaminos* Sta 69–A–11, Gulf of Mexico, 19°02.6'N, 95°27.5'W, 457 m.

MATERIAL EXAMINED.—Holotype and paratype; 1 specimen, USNM E20984, *Explorer* Sta BC–I, Gulf of Mexico, ~16°40'N, 82°50'W, 366 m.

DISTRIBUTION.—Gulf of Mexico, 366–457 m.

DISCUSSION.—The two very large specimens of this species taken in a single dredge haul by the Texas A&M vessel *Alaminos* were mature and shedding gametes when collected. The eggs were large, yolky, and orange; the male gametes were bright red.

CHARACTERS.—Those peculiar to *M. xandaros*: None.

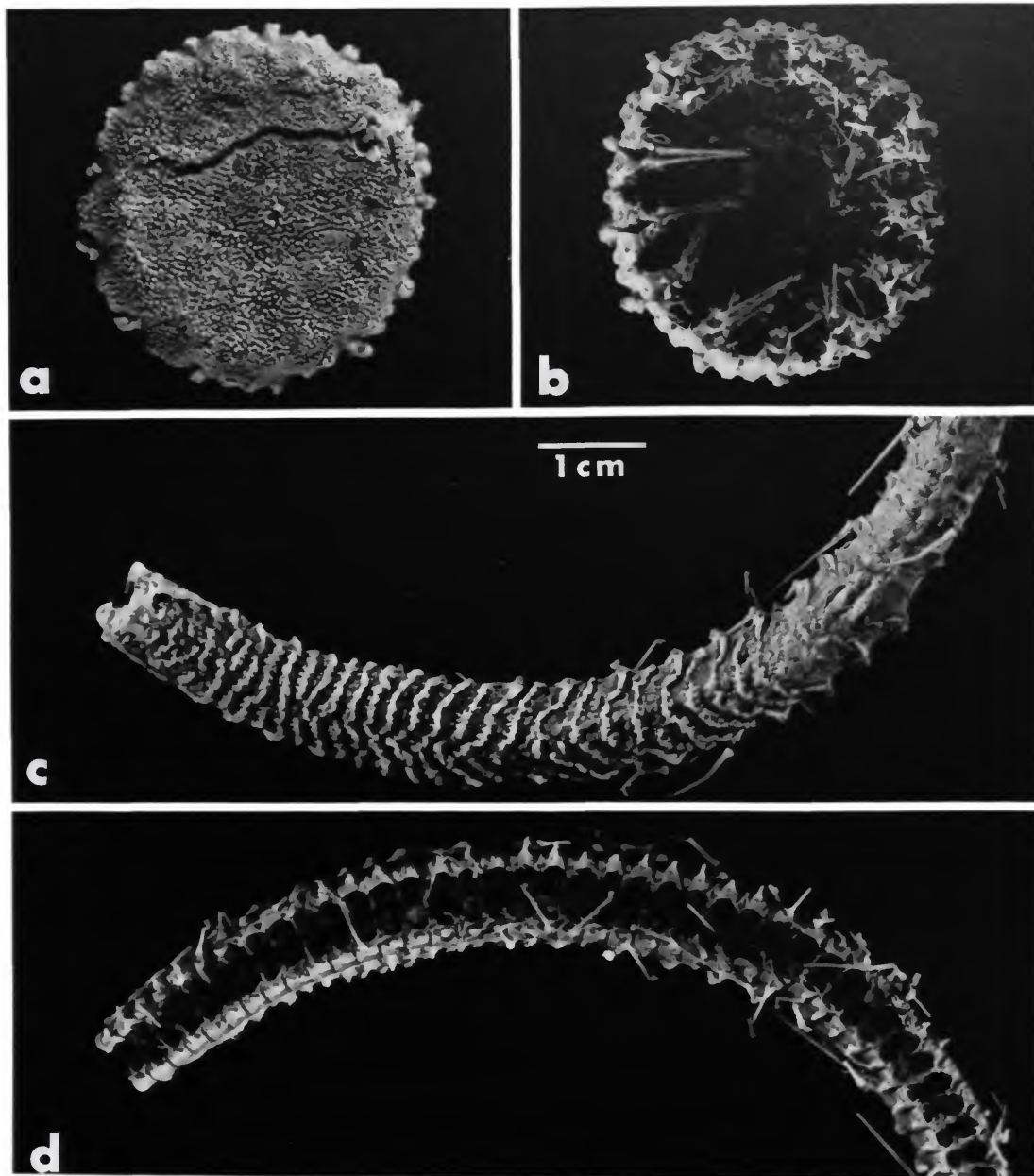


FIGURE 9.—*Midgardia xandaros*: *a*, abactinal view of disc; *b*, actinal view of disc; *c*, abactinal view of arm section; *d*, actinal view of arm section.

**Genus *Novodinia* Dartnell, Pawson,
Pope, and Smith, 1969**

Odinia Perrier, 1885c:9.—Sladen, 1889:598.—Bell, 1982 [1893]:105.—Perrier, 1894:71.—Verrill, 1894:279; 1895:211.—Koehler, 1895b:420.—Fisher, 1906:1108; 1916b:31; 1917:419.—A.H. Clark, 1916:57.—Fisher, 1918:105; 1919:505.—A.H. Clark, 1934:1.—Hayashi, 1943:136.

Novodinia Dartnell et al., 1969:211 [replacement name].

TYPE-SPECIES.—*Odinia semicoronata* Perrier, 1885c, by subsequent designation (Fisher, 1917).

DIAGNOSIS.—[30.a] Disc thick, raised well above plane of arms; [50.a] interradial arcs acute; [60.a] flesh dense, opaque, with some plateless areas; [70.c] anal opening usually visible; [140.b] no bare interradial plates; [150.b] papulae numerous, scattered on disc and proximal (gonadal) portion of arms; [160.b] papulae single, long, vermiform; [170] number of arms 13–20; [190.a] arms deciduous, constricted at base; [220.a] abactinal arm plates imbricate; [400.a] first 3–5 pairs of adambulacrals united interradially; [590.c] one pair of gonads to each arm; [600.b] gonads paired.

DISCUSSION.—Unlike most brisingidans, *Novodinia* is a genus of only moderately deep waters (~250–1500 m). The feeding posture, arms held up into the current over the disc, has been observed and filmed by Pawson et al. (in prep.).

CHARACTERS.—Those peculiar to *Novodinia*: 160.b.

Characters *Novodinia* shares with other genera of Brisingidae:

Stegnobrisinga: 30.a, 400.a, 590.c, 600.b.

Characters in which *Novodinia* differs from other genera of Brisingidae:

Stegnobrisinga: 60, 70, 160.

***Novodinia americana* (Verrill, 1880)**

FIGURE 10

Brisinga americana Verrill, 1880:139; 1894:279; 1895:211.

MERISTICS.—Arms = 15–20, R = 350 mm, r = 12–16 mm, R/r = 22–29/1, length of go-

nadal region = 45–50 mm, length of longest arm spine = 10 mm.

DIAGNOSIS.—[80.b] Madreporite of moderate size, raised well above plane of arms; [100.a] madreporite button-like, channeled; [110.b] abactinal disc plates tumid, irregularly rounded; [130.a] abactinal disc plates bearing 2–4 small acute spinelets; [170] number of arms 15–20; [205.c] gonadal region of arms 45–50 mm long, high, inflated, laterally compressed, rest of arm depressed and tapering gradually to slender tip; [210.g] costal plates of gonadal region of arm cruciform, between costae membrane embedded with flat, heavy, bizarrely shaped imbricating plates; [220.a] abactinal arm plates imbricate, beyond gonadal region, which ends abruptly, arms covered with plateless membrane; [240.b] most costal plates bearing single short acicular spine; [280.b] marginal plates large relative to adambulacrals; [290.g] marginals cruciform; [300.b] one marginal to each adambulacrals on short portion of arm before gonadal inflation, beyond occurring only about every fifth adambulacrals; [310.a] marginals unarmed proximally, just beyond highest part of gonadal inflation marginals bear single stout acicular spine, beyond gonadal region marginals bear a transverse series of about 5 long acicular spines; [330.c] adambulacrals plates discoidal; [350] number of furrow spines 0; [390.c] form of subambulacrals spines long, stout, truncate; [400.a] first 2–4 adambulacrals united interradially; [420.b] ambulacrals plates small, delicate; [430.f] head of ambulacrals not much enlarged, discoidal; [440.b] ambulacrals rather crowded; [470.b] tubefeet very heavy; [480.c] mouth plates large; [490.a,c] mouth plates triangular, pair forming broadly rounded T-shape, oral margin broad, in contact across ambulacrals groove; [500] number of preoral spines per mouth plate 3; [510.a] preoral spines small, acicular; [520.b] preoral spines lateral; [530] number of lateral oral spines per mouth plate 1–3; [540.a] lateral oral spines small, similar to preoral spines, acicular; [550.b] lateral oral spines lateral; [560] suboral spines absent; [620.a,b] pedicellariae on both surfaces of disc

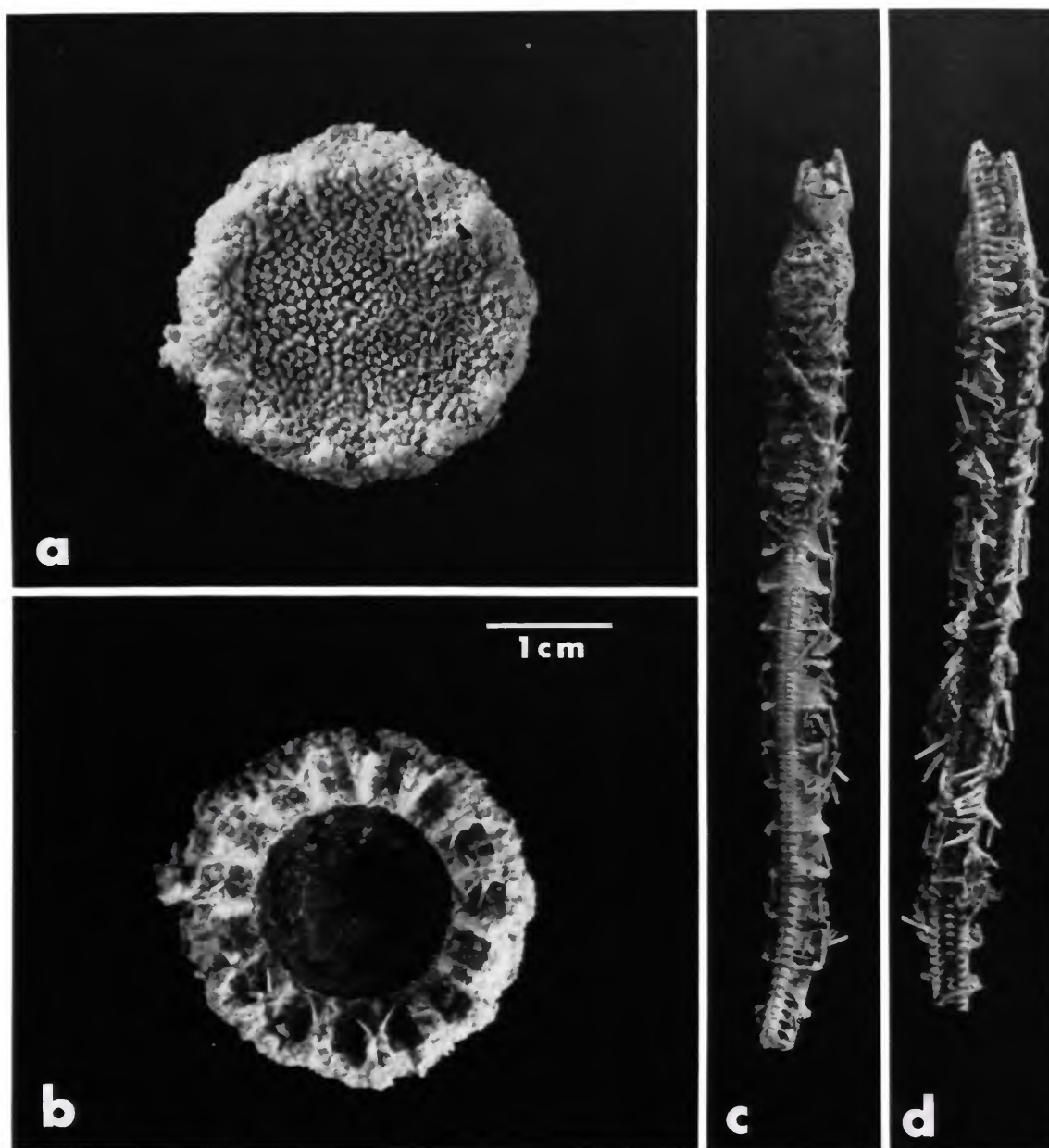


FIGURE 10.—*Novodinia americana*: *a*, abactinal view of disc; *b*, actinal view of disc; *c*, abactinal view of arm section; *d*, actinal view of arm section.

and arms; [630.a] all pedicellariae small.

COLOR.—"Pale orange-red in alcohol when received, soon fading to whitish . . . living, probably bright red." (Verrill, 1880:139).

TYPE.—USNM 33038 (holotype), Gloucester Fisheries Donation, Banquereau Bank, 320 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, Gloucester Fisheries Donation, Banquereau Bank, 732 m; 3 specimens, *Pillsbury* Sta 776, off Colombia, 12° 13.3'N, 72° 50'W, 408–576 m.

DISTRIBUTION.—Nova Scotia to Colombia, 320–732 m.

DISCUSSION.—Examination of Verrill's type and additional material in the NMNH shows that this species clearly belongs in the genus *Novodinia*. The disc was unknown, as Verrill described *N. americana* solely on the basis of the arms. The three specimens collected by the *Pillsbury*, although considerably smaller than the type (e.g., height of gonadal inflation 12 mm, vs 32 mm in the type), undoubtedly belong to this species, and allow the first description of the disc. They also represent a considerable extension of geographic range.

CHARACTERS.—Those peculiar to *N. americana*: 440.b.

Characters *N. americana* shares with other species of *Novodinia*:

N. antillensis: 110.b, 220.a, 300.b, 330.c, 390.c, 420.b, 430.f, 480.c, 510.a, 520.b, 540.a, 550.b, 560.0, 620.a,b, 630.a.

N. homonyma: 100.a, 220.a, 300.b, 330.c, 420.b, 430.f, 470.b, 480.c, 520.b, 540.a, 620.a,b, 630.a.

N. pandina: 130.a, 205.c, 220.a, 280b, 300.b, 330.c, 420.b, 430.f, 530.1–3, 630.a.

N. semicoronata: 130.a, 210.g, 240.b, 300.b, 330.c, 420.b, 480.c, 520.b, 540.a, 550.b, 620.a,b, 630.a.

Characters in which *N. americana* differs from other species of *Novodinia*:

N. antillensis: 80, 100, 130, 280, 290, 470.

N. homonyma: 80, 110, 205, 210, 240, 290, 390, 490, 500, 510, 560.

N. pandina: 80, 100, 110, 210, 240, 290, 470,

480, 490, 510, 520, 540, 560, 620.

N. semicoronata: 80, 100, 110, 290, 510.

Novodinia antillensis (A.H. Clark, 1934)

FIGURE 11

Odinia antillensis A.H. Clark, 1934:1–3, pl. 1.—Downey, 1973:99, pl. 47c,d.

MERISTICS.—Arms = 13–17, R = 80–250 mm, r = 4–18 mm, R/r = 14–20/1, length of gonadal region = 20–40 mm, length of longest arm spine = 9 mm.

DIAGNOSIS.—[80.c] Madreporite rather small, raised; [100.e] madreporite with meandering gyri like a brain coral, surrounded by enlarged spine-bearing plates; [110.b] abactinal disc plates close, irregular, tumid, interradially a double row of flat, irregular, more or less bare plates extending from abactinal margin down beveled lateral side of disc and out a short distance on base of arms, which are basally fused; these are the more or less rectangular marginals of the first 4–6 adambulacrals, fused interradially; [130.b] abactinal disc plates bearing 4–10(2–16) small blunt spines; [170] number of arms 13–17; [205.c] gonadal region of arm 20–40 mm long, greatly inflated, arms tapering distally; [210.a,d,g] abactinal arm plates cruciform or rod-like, costae of gonadal region irregular, membrane between costae filled with flat, irregularly shaped plates, bare membrane beyond gonadal region; [220.a] abactinal arm plates imbricating in transverse bands; [240.b,c] many plates of costae bearing a long, slender acicular spine mounted on a tubercle; [280.a] marginal plates small; [290.d,e,h] about first 10 marginal plates flat, rectangular, rest subtriangular; [300.b] about first 10 marginals occurring on every adambulacrals plate, on gonadal region proper, on every other adambulacrals, and on rest of arm, about every 3–4 adambulacrals; [310.a] first 10 marginals unarmed, rest bearing transverse group of 3 long slender acicular spines mounted on large, knob-like tubercles; [320.a] adambulacrals higher than long; [330.c] adambulacrals plates discoidal; [350] num-

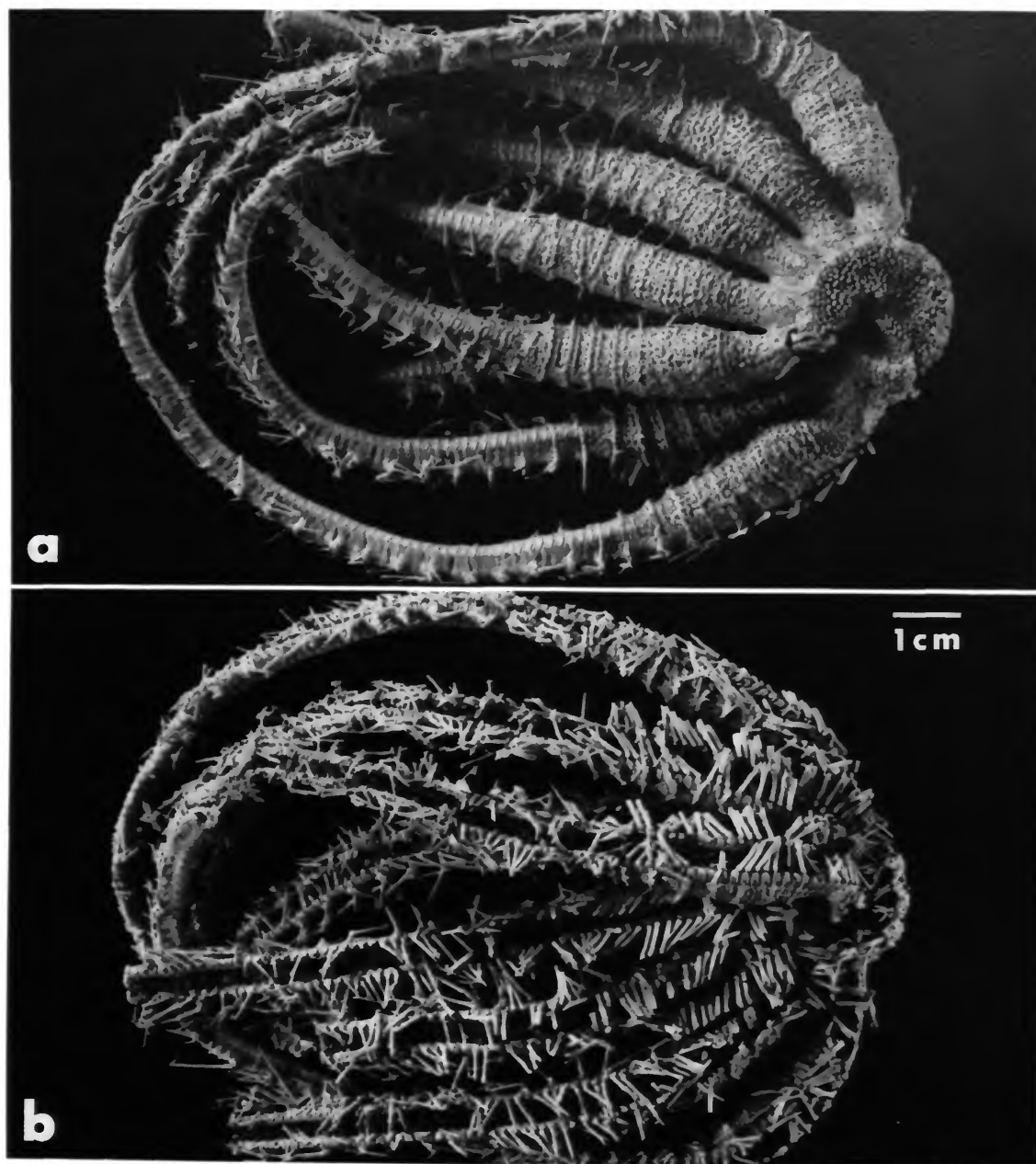


FIGURE 11.—*Novodinia antillensis*: *a*, abactinal view; *b*, actinal view.

ber of furrow spines 1; [360.a] furrow spines tiny, acute; [370.b] furrow spines on distal prolongation of adambulacral; [390.c] subambulacral spines long, thick, truncate, mounted on tubercle; [400.a] about first 2–6 adambulacral plates united interradially by symphysis to those of adjoining arm, as are the corresponding marginals; [420.b] ambulacral plates small, delicate; [430.f] ambulacrals discoidal; [470.a] tubefeet moderately delicate; [480.c] mouth plates large; [490.a] mouth plate pear-shaped like a broadly rounded T, with lateral prolongation meeting adjoining mouth plates; [500] number of preoral spines per mouth plate 3–4; [510.a] preoral spines small, acicular; [520.b] preoral spines lateral; [530] number of lateral oral spines per mouth plate 1 or 2; [540.a] lateral oral spines small, acicular; [550.b] lateral oral spines lateral; [560] number of suboral spines per mouth plate 0; [620.a,b] pedicellariae on both surfaces of disc and arms; [630.a] all pedicellariae small.

COLOR.—Unknown.

TYPE.—USNM E3266 (holotype), *Caroline* Sta 47, W of Puerto Rico, 18°17.2'N, 67°25'W, 512–622 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, USNM E12621, *Oregon* Sta 4574, 23°13'N, 87°50'W, 384 m; 1 specimen, USNM E12622, *Oregon* Sta 4480, 11°10'N, 65°07'W, 402 m; 1 specimen, USNM E12913, *Oregon* Sta 1408, 28°02'N, 90°15'W, 366 m.

DISTRIBUTION.—West Indies, Gulf of Mexico, 366–622 m.

DISCUSSION.—A quite small specimen (USNM E12621) has only incipient costae and only 1–3 marginal spines. The adambulacral spines are proportionally larger and decidedly capitate.

CHARACTERS.—Those peculiar to *N. antillensis*: None.

Characters *N. antillensis* shares with other species of *Novodinia*:

N. homonyma: 80.c, 220.a, 300.b, 330.c, 420.b, 430.f, 480.c, 520.b, 540.a, 620.a,b, 630.a.

N. pandina: 100.e, 205.c, 220.a, 300.b, 330.c, 420.b, 430.f, 470.a, 630.a.

N. semicoronata: 80.c, 100.e, 300.b, 320.a,

330.c, 420.b, 480.c, 490.a, 520.b, 540.a, 620.a,b, 630.a.

Characters in which *N. antillensis* differs from other species of *Novodinia*:

N. homonyma: 100, 110, 130, 205, 210, 290, 390, 470, 490, 500, 510, 560.

N. pandina: 80, 110, 130, 210, 240, 280, 290, 480, 490, 510, 520, 540, 560, 620.

N. semicoronata: 110, 130, 205, 290, 350, 500, 510.

Novodinia homonyma, new name

FIGURE 12

Brisinga elegans Perrier, 1885c:9 [non *Brisinga elegans* Verri1, 1884:382.]

Odinia elegans.—Perrier, 1894:71–74, pl. 4: fig. 4.

MERISTICS.—Arms = 19, R = 40–79 mm, r = 4–10 mm, R/r = 6.6–10/1, length of gonadal region = 8–16 mm (estimated), length of longest arm spine = 4 mm (estimated).

DIAGNOSIS.—[80.c] Madreporite small, inconspicuous; [100.a] madreporite channeled; [110.f] abactinal disc plates polygonal, thin, flat; [120.c] abactinal disc plates imbricate; [130.a,c] abactinal disc plates bearing 1–3 tubercles with short, capitate spinelets; [170] number of arms 19; [205.a] gonadal region of arms 8–16 mm long, moderately inflated; [210.e,f] abactinal arm plates polygonal, thin, beyond gonadal region arms covered with smooth skin with occasional bands of thin, transparent plates; [220.a] abactinal arm plates imbricate, only a few rudimentary costae on distal portion of gonadal region; [240.a,c] plates of gonadal region of arm with tubercle bearing single moderately long acicular spine; [280.a,b] first 6 marginals rather large, rest quite small; [290.f] marginals squarish; [300.b] first 6 marginals above every adambulacral, closely appressed to those of adjoining arms, their upper edges forming a bare sulcus interradially on disc, other marginals about every third adambulacral; [310.a] first 6 marginals unarmed, others bearing 2 extremely long acicular spines; [320.a,b] adambulacral plates higher than long proximally,

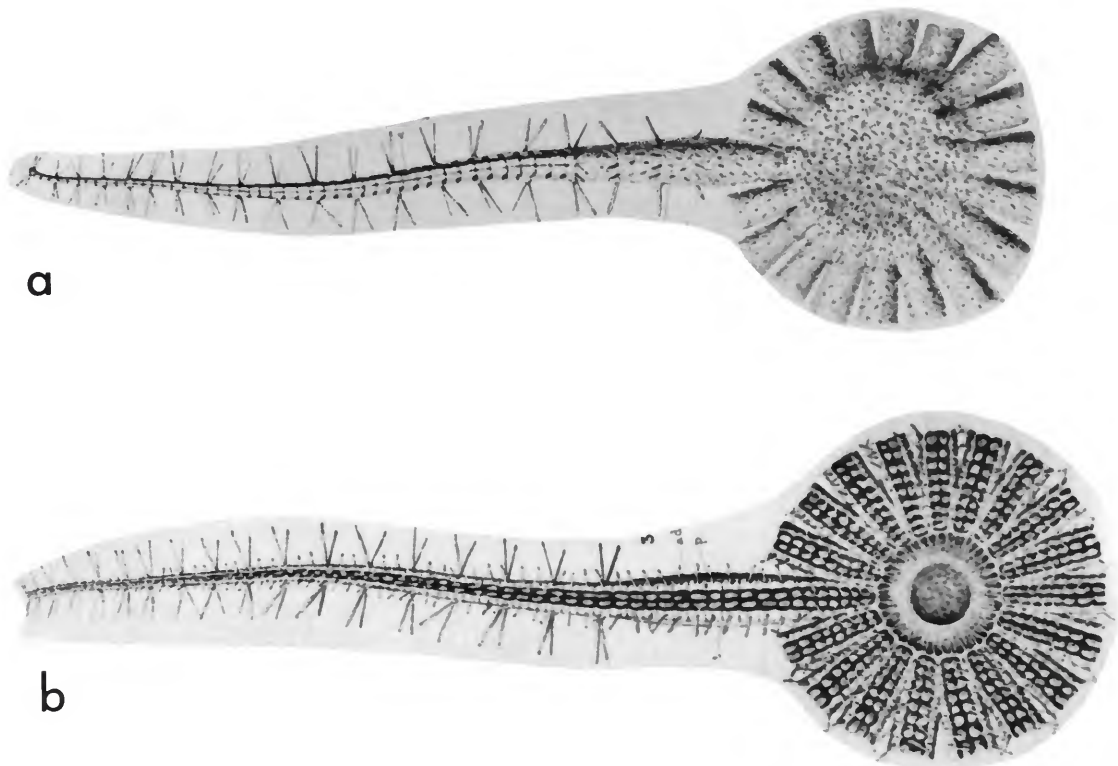


FIGURE 12.—*Novodinia homonyma*: a, abactinal view; b, actinal view. (From Perrier, 1894.)

longer than high distally; [330.c] adambulacral plates discoidal; [350] furrow spines absent; [390.a] subambulacral spines moderately long, acicular; [420.b] ambulacral plates small, delicate; [430.f] ambulacrals discoidal; [470.b] tube-feet moderately heavy; [480.c] mouth plates large; [490.g] mouth plates long, narrow, hour-glass-shaped; [500] number of preoral spines per mouth plate 2; [510.b] preoral spines short, conical; [520.b] preoral spines lateral; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines small, acicular; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines acute; [580.b] suboral spines below center of mouth plate; [620.a,b] pedicellariae on both surfaces of disc and arms; [630.a] all pedicellariae small.

COLOR.—Unknown.

TYPE.—Paris Museum 4623 (holotype), *Tal-*

isman Sta 73, S of Canary Islands, 1056–1435 m.

MATERIAL EXAMINED.—Holotype.

DISTRIBUTION.—Known only from type-locality.

DISCUSSION.—Perrier's *Brisinga elegans* (1885c) (= his *Odinia elegans* (1894)) is an invalid homonym of Verrill's *Brisinga elegans* (1884) (= *Freyella elegans*) and must therefore be replaced. The name *homonyma* seems both appropriate and euphonic.

The disc in this species is very flat, and the papulae on the disc occur in regular radiating rows.

CHARACTERS.—Those peculiar to *N. homonyma*: None.

Characters *N. homonyma* shares with other species of *Novodinia*:

N. pandina: 120.c, 220.a, 300.b, 330.c, 350.0,

420.b, 430.f, 490.g, 510.b, 560.1, 570.a, 630.a.

N. semicoronata: 80.c, 120.c, 205.a, 280.a,b, 300.b, 330.c, 350.0, 420.b, 480.c, 510.b, 520.b, 530.1, 540.a, 570.a, 620.a,b, 630.a.

Characters in which *N. homonyma* differs from other species of *Novodinia*:

N. pandina: 80, 100, 110, 205, 470, 480, 520, 540, 620.

N. semicoronata: 100, 110, 210, 240, 290, 390, 490, 500.

Novodinia pandina (Sladen, 1889)

FIGURE 13

Odinia pandina Sladen, 1889:598-601, pl. 59: figs 1-5.—Bell, 1893a:105.

MERISTICS.—Arms = 13-18, R = 150-215 mm, r = 9-15 mm, R/r = 14.3-16.7/1, length of gonadal region = 40-48 mm, length of longest arm spine = 7 mm.

DIAGNOSIS.—[80.a] Madreporite convex, prominent; [100.e] madreporite covered with fine striations; [110.g] abactinal disc plates sturdy, lobed; [120.c] abactinal disc plates imbricate; [130.a] abactinal disc plates bearing 1-14 small, stout, rough-tipped spinelets; [170] number of arms 13-18; [180.a,b] arms robust, rounded in cross-section; [205.c] gonadal region of arms 40-48 mm long, highly inflated; [210.f] abactinal arm plates flat; [220.a] gonadal region of arms covered with thick coriaceous skin, underlaid with small imbricating plates, outer half of gonadal region transversely by 5-7 costae of small prominent imbricating plates, membrane between costae smooth and without pedicellariae or spinelets, beyond gonadal region arms covered with thin membrane bearing small roundish patches of tiny pedicellariae; [240.a] costal plates bearing isolated, robust, conical or clavate spinelets; [280.b] marginal plates large; [290.c,f] beyond first few, marginals transversely elongate, forming a ridge of 2-6 stout, knobby tubercles (the appearance is of a few ankylosed plates, rather than a single plate), first 8-10

marginals rectangular, unarmed, appressed to those of adjoining arm; [300.b] marginals occurring about every fourth adambulacral; [310.a] marginals armed with 2-6 (usually 3) extremely long, acicular spines; [320.b] adambulacrals small, longer than high; [330.c] adambulacrals discoidal; [350] number of furrow spines 0; [390.a,c] subambulacral spines long, stout, chisel-shaped proximally, acicular distally; [400.a] first two adambulacrals joined interradially by a symphysis; [420.b] ambulacral plates small, delicate; [430.f] ambulacral plates discoidal; [470.a] tube-feet rather delicate; [480.a] mouth plates small; [490.g] mouth plates somewhat hourglass-shaped; [500] number of preoral spines per mouth plate 1-3; [510.b] preoral spines short, conical, dogtooth-shaped; [520.a] preoral spines adoral; [530] number of lateral oral spines per mouth plate 1-3; [540.b] lateral oral spines short, conical, touching or overlapping adjacent mouth plate spines, more or less closing ambulacral groove; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines acute; [620.a,g] no pedicellariae on disc, pedicellariae on membranous sheath covering spines and spinelets on arms, tiny pedicellariae in sacculi on bare membrane of distal arms; [630.a] all pedicellariae small.

COLOR.—Yellowish white to pinkish (in alcohol).

TYPE.—BM(NH) 90.5.7.1035 (holotype), *Lightning* Sta 7, Faerøe Channel, 60°07'N, 5°21'W, 914 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, USNM E15535, off North Carolina, 32°46.7'N, 77°42.3'W, 278 m.

DISTRIBUTION.—Faerøe Channel; North Carolina; 278-914 m.

DISCUSSION.—The recent discovery of a specimen of this species from off North Carolina considerably extends the range of the species.

CHARACTERS.—Those peculiar to *N. pandina*: 620.g.

Characters *N. pandina* shares with other species of *Novodinia*:

N. semicoronata: 100.e, 110.g, 120.c, 130.a,

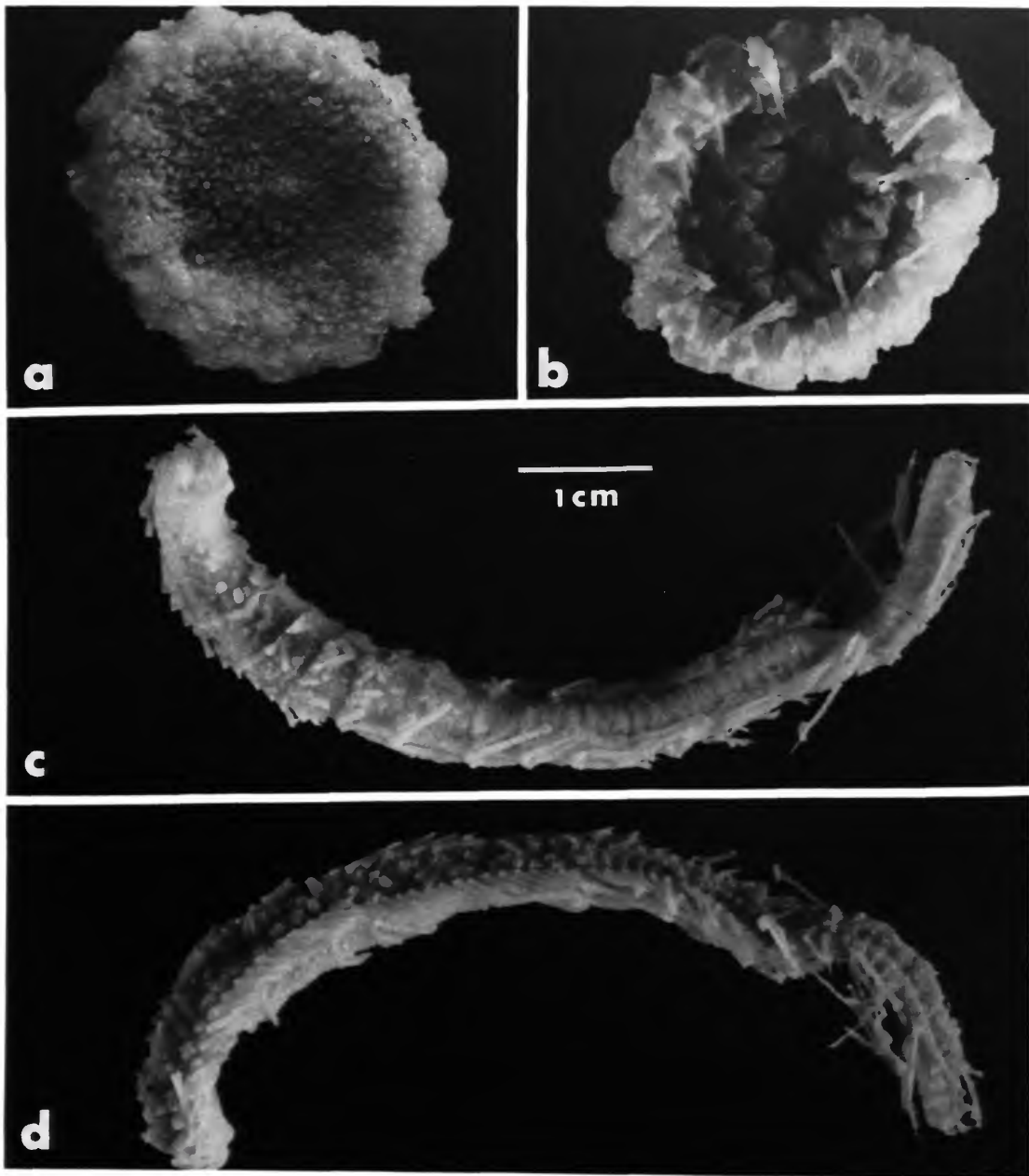


FIGURE 13.—*Novodinia pandina*: *a*, abactinal view of disc; *b*, actinal view of disc; *c*, abactinal view of arm section; *d*, actinal view of arm section.

300.b, 330.c, 350.0, 420.b, 510.b, 570.a, 630.a.

Characters in which *N. pandina* differs from other species of *Novodinia*:

N. semicoronata: 80, 180, 205, 210, 240, 290, 320, 480, 490, 520, 540, 620.

***Novodinia semicoronata* (Perrier, 1885)**

FIGURE 14

Brisinga semicoronata Perrier, 1885c:9.

Brisinga robusta Perrier, 1885:11.

Odinia semicoronata.—Perrier, 1894:75–78, pl. 5.

Odinia robusta.—Perrier, 1894:78–81, pl. 6.—Koehler, 1895b:420.

MERISTICS.—Arms = 15–17, R = 275 mm, r = 15 mm, R/r = 18.3/1, length of gonadal region = 40 mm, length of longest arm spine = 5 mm.

DIAGNOSIS.—[80.c] Madreporite small; [100.e] madreporite with deep gyri; [110.g] abactinal disc plates lobed; [120.c] abactinal disc plates imbricate; [130.a] abactinal disc plates bearing 3(1–4) moderately long acute or bifurcate spinelets; [170] number of arms 15–17; [180.b] arms long, robust; [205.a] gonadal region of arms 40 mm long, moderately inflated; [210.g] abactinal arm plates lobed, in usually incomplete costae extending beyond gonadal region for a short distance, between costae thick skin concealing lobed plates, thick skin beyond costae plateless; [240.b] plates of costae bearing acute spines; [250.b] terminal plates large; [260.a] terminals round, convex; [270.a] terminals bearing about 6 long, slender, acute spines; [280.a,b] first few marginals large, others small; [290.b] marginals elongate; [300.b] marginals occurring about every 2–4 adambulacrals; [310.a] marginals bearing 1(2) rather short acute spine(s); [320.a] adambulacrals higher than long; [330.c] adambulacrals discoidal; [350] furrow spines absent; [390.b,c,d] subambulacrals long, stout, capitate, truncate or bifurcate; [400.a] first 3 or 4 adambulacrals united interradially; [420.b] ambulacrals small, delicate; [480.c] mouth plates large; [490.a] mouth plates

more or less T-shaped, longer than broad, with lateral extension meeting adjoining mouth plate across ambulacrals groove; [500] number of preoral spines per mouth plate 1; [510.b] preoral spines small, conical; [520.b] preoral spines lateral; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines small, acute; [550.b] lateral oral spines lateral; [560] number of suboral spines per mouth plate 1 (not always present); [570.a] suboral spines long, thick, acicular; [620.a,b] pedicellariae on both surfaces of arms and disc; [630.a] all pedicellariae small.

COLOR.—Unknown.

TYPES.—Paris Museum 4630–4631 (2 syntypes), *Talisman* Sta 73, off Senegal, 25°39'N, 18°26'W, 1056–1435 m.

MATERIAL EXAMINED.—Syntypes; holotype of *Brisinga robusta*, Paris Museum, *Talisman* Sta 72, off Senegal, 25°39'N, 18°22'W, 882 m.

DISTRIBUTION.—Known only from off Senegal, 882–1435 m.

DISCUSSION.—Despite the paucity of available material, there can be little doubt that the specimens described by Perrier as *Brisinga semicoronata* are conspecific with the two specimens described by him as *B. robusta* from approximately the same locality. Differences (size, length of abactinal spines, one vs one or two adambulacrals spines) can be accounted for by ontogeny. The particularly thick skin with embedded lobed plates between the costae is characteristic. The name *semicoronata* has been chosen over *robusta* because it has page priority.

The papulae on the gonadal regions of the arms are arranged in irregular transverse rows.

CHARACTERS.—Those peculiar to *N. semicoronata*: None.

Genus *Stegnobrisinga* Fisher, 1916

Stegnobrisinga Fisher, 1916b:34; 1917:428.—H.L. Clark, 1926:31.—A.M. Clark and Courtman-Stock, 1976:98.

DIAGNOSIS.—[30.a] Disc thick, raised well above plane of arms; [50.a] interradial arcs acute; [60.b] skin thin, opaque, some areas plateless;

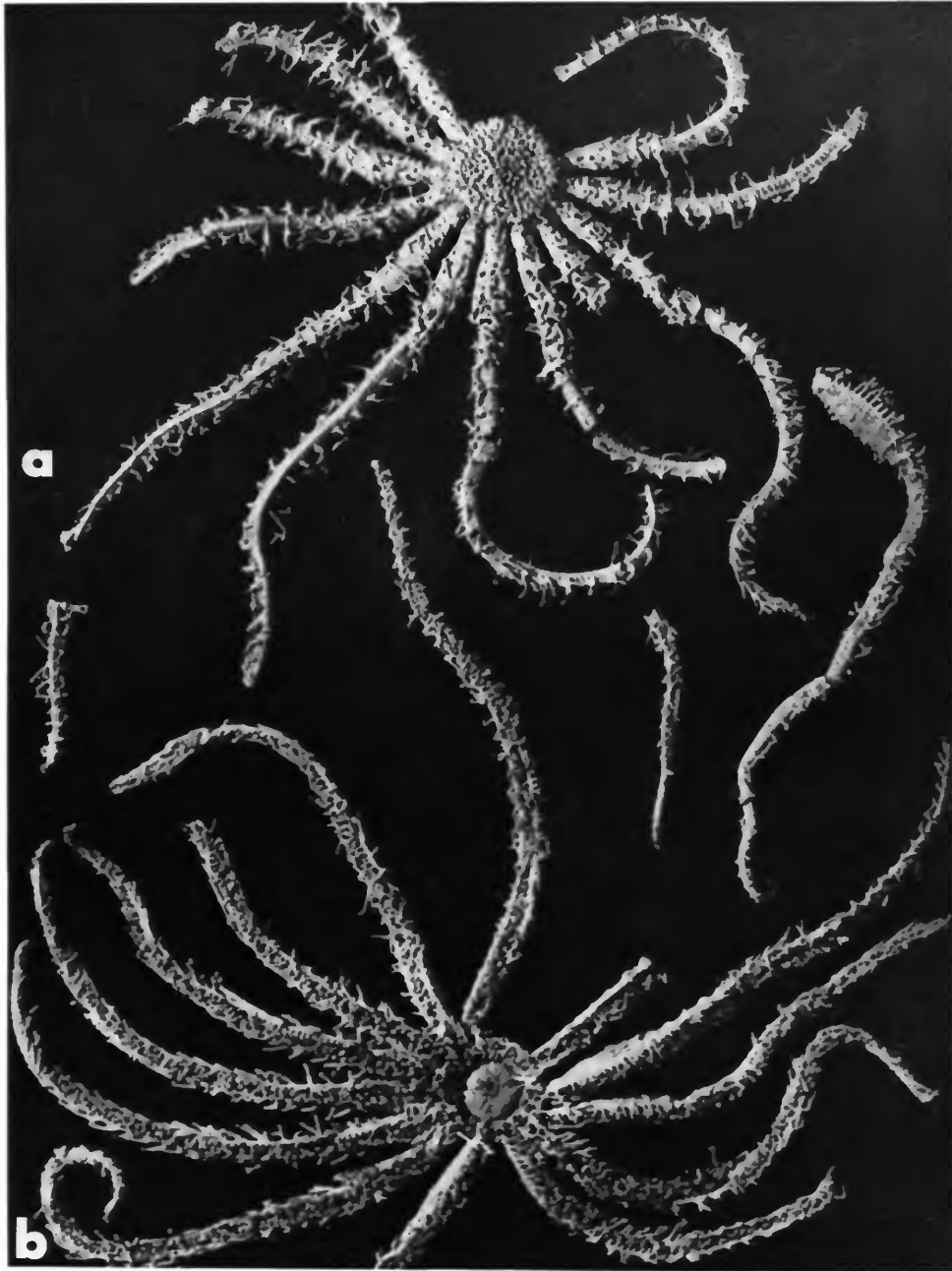


FIGURE 14.—*Novodinia semicoronata*: a, abactinal view; b, actinal view (from Perrier, 1894).

[70.a,b] anal opening microscopic or absent; [140.b] no bare interradiial plates; [160.a] no papulae; [170] number of arms 11-14; [190.a] arms deciduous, constricted at base; [205.b] gonadal region of arms broad, flat; [220.a] abactinal arm plates imbricate; [400.a] proximal adambulacral united interradiially; [590.c] 2 pairs of gonads per arm; [600.b] gonads paired.

TYPE-SPECIES.—*Stegnobrisinga placoderma* Fisher, 1916b, by original designation.

CHARACTERS.—Those peculiar to the genus *Stegnobrisinga*: None.

Stegnobrisinga splendens H.L. Clark, 1926

FIGURE 15

Stegnobrisinga splendens H.L. Clark, 1926:31-33, pl. 7: figs. 3-4.—A.M. Clark and Courtman-Stock, 1976:98.

MERISTICS.—Arms = 11-14, R = 145-500 mm, r = 9-19 mm, R/r = 16-26/1, length of gonadal region = 22-65 mm, length of longest arm spine = 16 mm.

DIAGNOSIS.—[80.a] Madreporite large, raised, conical; [100.a] madreporite coarsely channeled; [110.a] disc membrane set with small roundish plates; [120.b] abactinal disc plates dense in membrane; [130.a] abactinal disc plates bearing tiny spinelet; [170] number of arms 11-14; [205.a] gonadal region of arms 22-65 mm long, broad, somewhat flat; [210.b,d,f] abactinal arm plates somewhat tumid, irregular, costae low, close, between costae flat irregular plates, beyond gonadal region a few incomplete costae, thin irregular plates, then bare membrane; [240.a] many costal plates bearing single short sharp spinelet, other abactinal arm plates unarmed; [250.a] terminal plates minute; [270.c] terminal plates possibly unarmed; [280.a] marginal plates small; [290.c,g] marginals lobate, with central tubercle; [320.a,b] adambulacral plates about as long as high; [330.f] adambulacral dumbbell-shaped; [340.c] furrow margin deeply indented; [350] number of furrow spines 4; [360.a] furrow spines fairly long, fine, setose; [370.a,b] 2 furrow spines on distal end of adambulacral, 2 on proximal

end; [380] number of subambulacral spines 1; [390.a] subambulacral spines long, acicular; [420.a] ambulacral plates large, sturdy; [430.g] ambulacral plates l-shaped; [470.a] tubefeet rather delicate; [480.a] mouth plates small; [490.b] mouth plates nearly rectangular, with only slight curved indentation on outside lateral edge; [500] 2 preoral spines per mouth plate; [510.a] preoral spines small, acicular, delicate; [520.a] preoral spines adoral; [530] number of lateral oral spines per mouth plate 1; [540.a] lateral oral spines small, acicular; [550.b] lateral oral spines lateral; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines huge, acicular, ridged; [580.b] suboral spines below center of mouth plate; [620.a,b,c] pedicellariae on disc plates, in bands on arms, and on membranous spine covering; [630.b] all pedicellariae large.

COLOR.—Vermilion.

TYPE.—South African Museum (holotype), *Pickle* Sta 405, Natal, ESE from Durban, 860 m.

MATERIAL EXAMINED.—1 specimen, USNM E20798, *Pillsbury* Sta 675, off Surinam, 08°26'N, 54°17'W, 1234-1271 m; 1 specimen, USNM E20954, *Pillsbury* Sta 636, Straits of Florida, 23°54'N, 81°27'W, 3400 m; 1 specimen, USNM E20955, *Pillsbury* Sta 892, West Indies, 14°17'N, 60°45'W, 4000 m; arm fragment, USNM E20953, *Gerda* Sta 1112, Straits of Florida, 23°44'N, 81°14'W, 2275-2359 m; 2 specimens, *Atlantis II* Sta 42-192, Walvis Bay, Angola, 23°02'S, 12°19'E, 2117-2154 m; 1 specimen, uncatalogued, USNM, *Pillsbury* Sta 747, 11°46'N, 67°05.7'W, 1174 m.

DISTRIBUTION.—South Africa to Angola, Straits of Florida to Venezuela; 860-4000 m.

DISCUSSION.—This species, hitherto known only from South Africa, was collected by the *Atlantis II* off Angola and in the Straits of Florida, the West Indies, and off Venezuela by the *Pillsbury* and *Gerda*. The principal (and only significant) difference between this species and Fisher's (1916b:33) *Stegnobrisinga placoderma* from the China Sea is in the distribution of the marginal plates; also, Fisher's specimens were smaller.

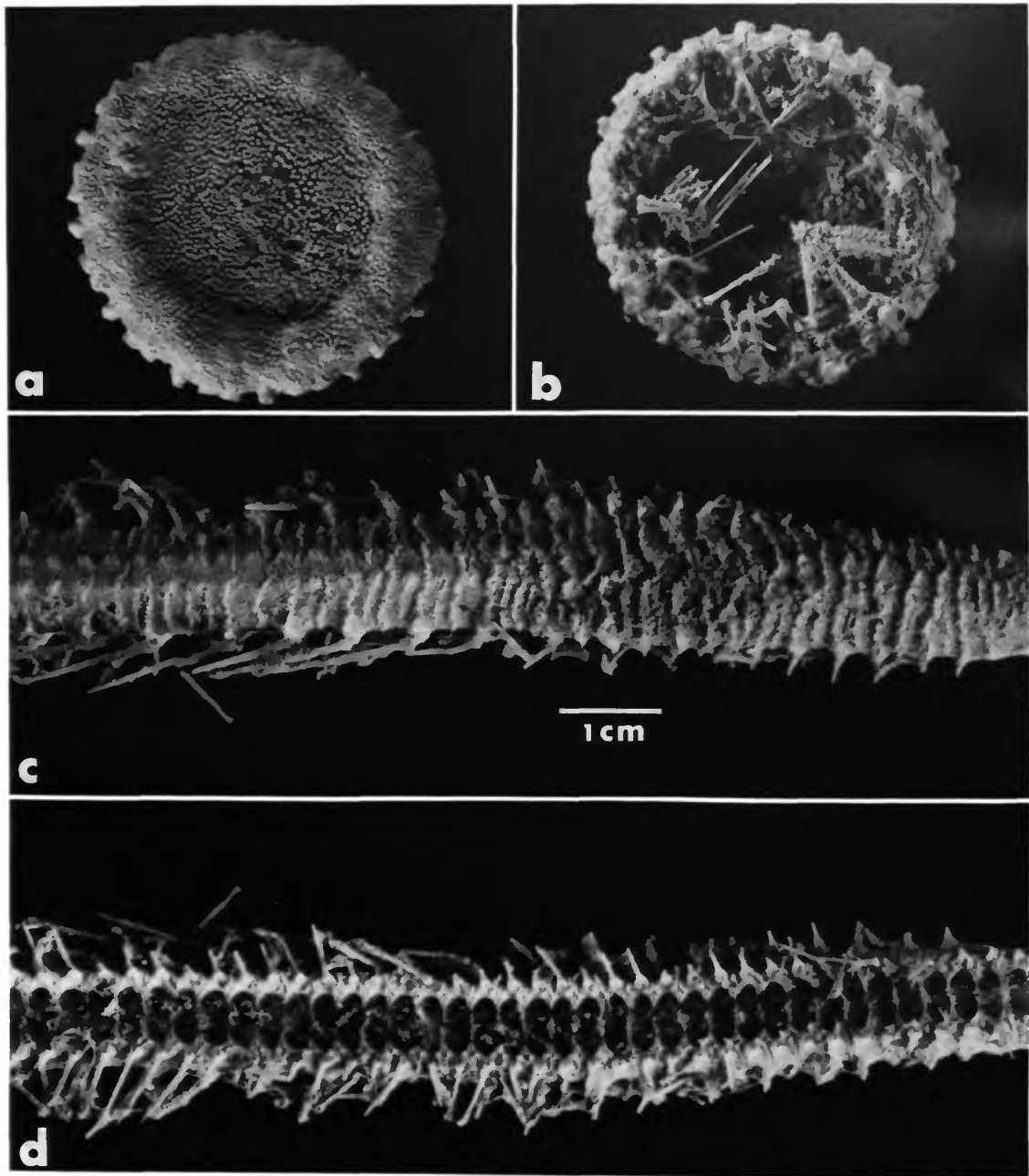


FIGURE 15.—*Stegnobrisinga splendens*: *a*, abactinal view of disc; *b*, actinal view of disc; *c*, abactinal view of arm section; *d*, actinal view of arm section.

CHARACTERS.—Those peculiar to *S. splendens*: 430.g.

Family FREYELLIDAE, new family

DIAGNOSIS.—[50.b] Interradial arcs gradually curved; [80.c] madreporite small; [140.a] bare interradial plates present on disc; [190.b] abactinal surface of proximal arms continuous with that of disc; [220.b] abactinal arms plates not forming costae on proximal part, but a mosaic of abutting plates; [400.b] proximal adambulacrals not united interradially.

DISCUSSION.—The preceding characters separate the Freyellidae from the Brisingidae. In addition, because of the bare interradial plates and the plating on the proximal part of the arms, the Freyellidae have a more limited ability to raise the arms above the disc. They are usually found on soft substrates, and in deeper water (950–5618 m), in contrast to the Brisingidae, which seem to prefer hard substrates and frequently occur in shallower water (100–4500 m). Some of the Freyellidae (e.g., *Freyastera*) are probably not suspension feeders, as they lack the ability to raise their arms above the disc, while others can raise the arms from a point beyond the gonadal region, but not directly from the juncture with the disc as can members of the Brisingidae.

Genus *Colpaster* Sladen, 1889

Colpaster Sladen, 1889:647.

DIAGNOSIS.—[30.b] Disc raised slightly above plane of arms; [50.b] interradial arcs gently curved; [60.b] skin thin, opaque; [70.c] anal opening conspicuous; [140.a] conspicuous bare plate interradially, on vertical margin of disc; [160.c] 2 papulae in each radial area of disc; [170] number of arms 7–12; [190.b] abactinal surface of gonadal region of arms continuous with that of disc, arms not constricted at base; [220.a] abactinal arm plates imbricate; [400.b] proximal adambulacrals not united interradially;

[590.b] 1 pair of gonads per arm; [600.b] gonads paired.

TYPE-SPECIES.—*Colpaster scutigerula* Sladen, 1889, by monotypy.

DISCUSSION.—Although I was unable to locate any specimens of *Freyella edwardsi* Perrier there is little doubt that this species belongs to *Colpaster*. Based on the descriptions and illustrations of Perrier (1882, 1894) and Koehler (1909a), *C. edwardsi* possesses the bare, smooth interradial plates on the margin of the disc, two small papulae over each arm (not described, but inferred from the illustrations), the small madreporite, moderately inflated gonadal region of the arms, similar plating on disc and gonadal region of arms, two very small furrow spines, and a similar distribution of pedicellariae.

CHARACTERS.—Those peculiar to the genus *Colpaster*: None.

Characters *Colpaster* shares with other genera of *Freyellidae*:

Freyastera: 70.c, 400.b.

Freyella: 30.b, 60.b, 590.b, 600.b.

Characters in which *Colpaster* differs from other genera of *Freyellidae*:

Freyastera: 30, 60, 160, 170, 590, 600.

Freyella: 70, 160, 220, 400.

Colpaster edwardsi (Perrier, 1882)

FIGURE 16

Brisinga edwardsi Perrier, 1882:61.

Freyella edwardsi.—Perrier, 1885d:441; 1894:82–84, pl. 1: fig. 7.—Sladen, 1889:616,617.—Koehler, 1907:6; 1909c: 124–127, pl. 23: figs 1, 2.—Mortensen, 1921:128, fig. 74.

MERISTICS.—Arms = 12, R = 60–80 mm (estimated), r = 11 mm, R/r = 6.4/1, length of gonadal region = 25–40 mm, length of longest arm spine = 4–5 mm.

DIAGNOSIS.—[80.c] Madreporite small but raised and conspicuous; [100.b] madreporite irregular; [110.a] abactinal disc plates small, metapaxillar; [120.b] abactinal disc plates dense in membrane; [130.a] abactinal disc plates bearing

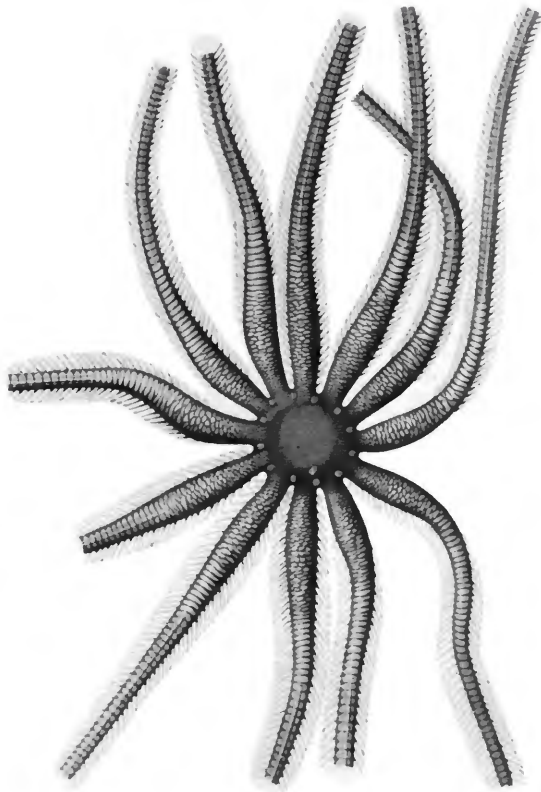


FIGURE 16.—*Colpaster edwardsi* (from Koehler, 1909c).

tiny, almost granulose, blunt, rough spinelets; [170] number of arms 12; [205.a] gonadal region of arms 25–40 mm long, moderately inflated; [210.c,d] abactinal arm plates metapaxillar, like disc plates, from midgonadal region on, abactinal arm plates tend to form costae or arcs across arm, with irregular plates between costae; [240.a] abactinal arm plates bearing 1–10 spinelets, larger, stouter and more numerous than those of disc plates; [280.a] marginal plates small; [290.a,h] marginal plates irregular, tumid; [310.a] marginals bearing a short, acute spine beyond gonadal region; [320.a] adambulacral plates higher than long; [330.a] adambulacral plates cylindrical; [380] number of subambulacral spines 1; [390.a,c] about first 10 adambulacral bearing long, stout, truncate subambulacral

spine, rest with long, aciculate spine; [530] lateral oral spines absent; [560] number of suboral spines per mouth plate 1; [620.a,b,c] pedicellariae on both surfaces of disc and arms, in rows or bands on arms.

COLOR.—Unknown.

TYPE.—Not found; Golfe de Gascogne, 2300 m.

MATERIAL EXAMINED.—None.

DISTRIBUTION.—Golfe de Gascogne, Canary Islands, 1700–2300 m.

DISCUSSION.—I could find no existing material of this species, and neither Perrier nor Koehler discussed several important characters; furthermore they did not figure the mouth plates or pedicellariae. However, despite the lack of specimens, there is little doubt that the species is indeed a *Colpaster*.

CHARACTERS.—Those peculiar to *Colpaster edwardsi*: None.

Characters which *C. edwardsi* shares with other species of *Colpaster*:

C. scutigera: 110.a, 130.a, 240.a, 280.a, 320.a, 330.a, 620.a,b,c.

Characters in which *C. edwardsi* differs from other species of *Colpaster*:

C. scutigera: 80, 100, 120, 170, 205, 210, 380, 390.

Colpaster scutigera Sladen, 1889

FIGURE 17

Colpaster scutigera Sladen, 1889:648–650, pl. 47: figs. 4–7.

MERISTICS.—Arms = 7–10, R = 135+ mm (estimated), r = 6–10 mm, R/r = 13.5–22.5/1, length of gonadal region = 18–31 mm, length of longest arm spine = 4–7 mm.

DIAGNOSIS.—[80.a] Madreporite large; [100.a] madreporite with a few coarse irregular channels; [110.a] abactinal disc plates small, round, metapaxillar; [120.c] abactinal disc plates imbricate; [130.a] abactinal disc plates bearing 3–6 short, capitate spinelets; [170] number of arms 7–10, robust in proportion to disc; [205.b]

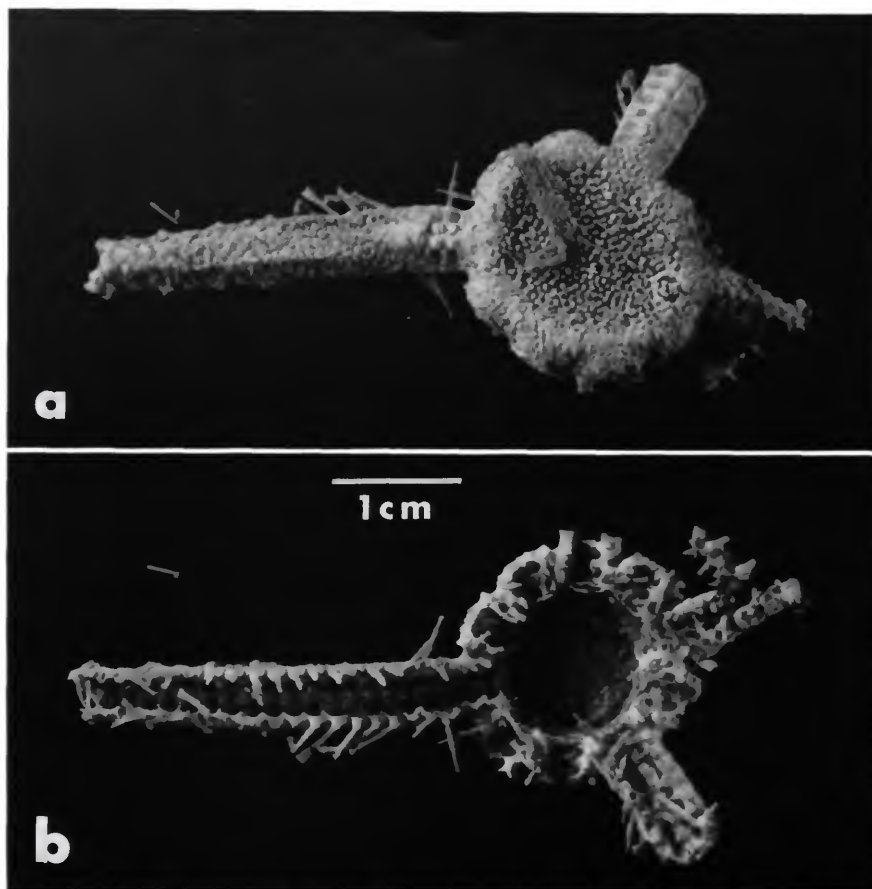


FIGURE 17.—*Colpaster scutigerula*: a, abactinal view; b, actinal view.

gonadal region of arms 18–31 mm long, not inflated; [210.b] abactinal arm plates tumid; [240.a] abactinal arm plates bearing 3–6 short capitate spinelets; [280.a] marginal plates small; [290.d] marginals triangular; [310.a] marginals bearing one long, very robust, frequently capitate spine; [320.a,b] adambulacral plates about as long as high; [330.a] adambulacral plates cylindrical; [340.a] furrow margin straight; [350] number of furrow spines 2, small; [360.a] furrow spines acute; [370.a,b] one furrow spine proximal, one distal; [380] number of subambulacral spines 2; [390.b] subambulacral spines large, robust, frequently capitate; [420.b] ambulacral plates rather small, delicate; [430.d] head of am-

bulacrals cylindrical, much larger than base; [470.b] tubefeet rather heavy; [480.a] mouth plates small, strong; [490.c,f] mouth plates broader distally than proximally, with pronounced keel distally; [500] number of preoral spines per mouth plate 2; [510.b] preoral spine small, blunt, almost club-shaped; [520.b] preoral spines laterally placed, nearly closing ambulacral groove; [530] number of lateral oral spines per mouth plate 1 (not always present); [540.b] lateral oral spines blunt, similar to preoral spines; [550.a] lateral oral spines proximal on mouth plate; [560] number of suboral spines per mouth plate 1–3; [570.a] suboral spines acute; [580.a] suboral spines above center of mouth plate;

[620.a,b,c] pedicellariae on both surfaces of disc and arms, in bands or rows on arms; [630.a] all pedicellariae quite small.

COLOR.—Ashy gray with traces of violet (in alcohol).

TYPE.—BM(NH) 1890.5.7.1081 (holotype); *Challenger* Sta 3, SW of Canary Islands, 25°45'N, 20°14'W, 2789 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, USNM E20796, *Pillsbury* Sta 266, Gulf of Guinea, 1°13'N, 46°E, 2525 m; 1 disc, *Oregon II* Sta 11217, off Honduras, 26°26'N, 83°31'W, 933 m.

DISTRIBUTION.—S of Canary Islands; Gulf of Guinea; off Honduras; 933–2789 m.

DISCUSSION.—This species is distinguished mainly by the conspicuous shield-shaped interradial plates and the unusually long and numerous spines of the mouth plates. The specimen from the Gulf of Guinea differs slightly from the type (number of arms, more curved and blunt preoral spines, frequent absence of furrow spines), but I believe that it belongs to this species. Similarly, the specimen from off Honduras (disc only) obviously belongs to this species. It is gratifying to have two more specimens of this peculiar seastar, which has not been seen since the *Challenger* specimen was collected.

CHARACTERS.—Those peculiar to *Colpaster scutigerula*: None.

Genus *Freyastera*, new genus

Freyella.—Korovchinsky and Galkin, 1984:1205–1215 [part].

DIAGNOSIS.—[30.c] Disc flat, in same plane as arms; [50.b] interradial arcs broadly curved; [60.c] flesh thin, delicate, slimy; [70.c] anal opening conspicuous; [140.a] bare interradial plates present; [160.a] no papulae; [170] number of arms normally 6; [190.b] abactinal surface of proximal arms continuous with that of disc, arms not constricted at base; [220.a] abactinal arm plates imbricate; [400.b] proximal adambulacrals not united interradially; [590.c] 1 pair of gonads per arm; [600.a] gonads serial.

TYPE-SPECIES.—*Freyella sexradiata* Perrier, 1885c.

DISCUSSION.—In addition to the characters listed above, the genus *Freyastera* is characterized by a very flat disc (on the same plane as the arms), plates of the disc frame are massive, and disc size is small. The adambulacrals have a peculiar twisted look, and ambulacrals plates are quite broad and solid. There is a conspicuous bare smooth plate in each interradius.

CHARACTERS.—Those peculiar to the genus *Freyastera*: 60.c, 170.6.

Characters *Freyastera* shares with *Freyella*: 160.a. Characters in which *Freyastera* differs from *Freyella*: 30, 60, 70, 170, 400, 590, 600.

Freyastera benthophila (Sladen, 1889), new combination

FIGURE 18

Freyella benthophila Sladen, 1889:641–643, pl. 111: figs. 5–8.—Wood-Mason and Alcock, 1891:430.—Alcock, 1893a:121.—Fisher, 1919:538.—Madsen, 1950:184.—Cherbonnier and Sibuet, 1972:1356.—Sibuet, 1975:292.—Korovchinsky and Galkin, 1984:1215 [key].
Freyellidea benthophila.—Fisher, 1917:429.

MERISTICS.—Arms = 6, R = 82–132 mm, r = 3–5.5 mm, R/r = 14.7–28.3/1, length of gonadal region = 10–29 mm, length of longest arm spine = 2 mm.

DIAGNOSIS.—[80.c] Madreporite small, nearly concealed by scale-like plates; [100.d] madreporite seemingly of two shell-like valves with a suture between; [110.e] abactinal disc plates scale-like, thin, delicate, fenestrate, irregular; [120.c] abactinal disc plates imbricate; [130.c] abactinal disc plates bearing 1–5 minute low tubercles overlaid with thin skin; [180.a] arms long, delicate, very attenuate, almost string-like; [205.b] gonadal inflation slight, length 10–29 mm, less than 1/8 length of arm; [210.e] abactinal arm plates scale-like; [240.c] abactinal arm plates bearing 1–3 minute tubercles, arms beyond gonadal region covered with delicate bare membrane; [250.a] terminal plates small relative to marginals; [260.a] terminal plates bifurcate; [270.a] termi-



FIGURE 18.—*Freyastera benthophila*: *a*, abactinal view; *b*, actinal view.

nals armed with 1 stout glassy spine on each half; [280.a] marginal plates small; [290.a] marginals irregular; [310.a] marginals bearing 1 long, glassy, acicular spine; [320.b] adambulacral

plates very elongate; [330.b] adambulacrals spool-shaped; [340.c] furrow margin deeply indented; [390.a(b)] subambulacral spines moderately long, ridged, glassy, usually acicular but

some with slightly expanded rough tip; [420.b] ambulacral plates very elongate; [430.d] head of ambulacral plates large, very elongate; [470.b] tubefeet moderately heavy; [480.c] mouth plates large; [490.b] paired mouth plates subhexagonal; [500] number of preoral spines per mouth plate 1 or 2; [530] number of lateral oral spines per mouth plate 0; [560] number of suboral spines per mouth plate 1; [570.a] suboral spines long, partly sheathed in membrane, acicular, stout, glassy; [580.b] suboral spines below center of mouth plate; [620.a,b,e] all spines except the small preoral spines covered with pedicellariae, which are also numerous on disc but none on gonadal portion of arms except on marginal and adambulacral spines, scattered pedicellariae on arms beyond gonadal region; [630.a] all pedicellariae small.

COLOR.—Whitish, with pink tinge (in alcohol).

TYPE.—BM(NH) 90.5.7.1078 (holotype), *Challenger* Sta 289, mid-South Pacific, 39°41'S, 131°23'W, 4663 m.

MATERIAL EXAMINED.—Holotype; 4 specimens, USNM E29172, *Golden Fleece* Sta WS-N, off California, 39°31'N, 127°26'W, 4250 m.

DISTRIBUTION.—South Pacific, eastern Pacific off California, Bay of Bengal, mid-Atlantic (between Azores and Spain), Bay of Biscay; 4250–5000 m.

DISCUSSION.—This delicate and attractive species has a cosmopolitan deep-sea distribution. It is notable for the extremely long ambulacral plates and the partial membranous sheath clothing the spines.

CHARACTERS.—Those peculiar to *F. benthophila*: None.

Characters *F. benthophila* shares with other species of *Freyastera*:

F. mexicana: 100.d, 110.e, 180.a, 280.a, 470.b.

F. sexradiata: 100.d, 110.e, 210.e, 280.a, 430.d, 480.c, 560.1, 630.a.

F. tuberculata: 120.c, 280.a, 290.a, 320.b, 420.b, 430.d, 470.b, 480.c, 530.0, 560.1.

Characters in which *F. benthophila* differs from other species of *Freyastera*:

F. mexicana: 80, 90, 130, 205, 210, 290, 330,

340, 430, 490, 500, 530, 560, 570, 580, 620.

F. sexradiata: 80, 130, 205, 240, 290, 330, 420, 470, 490, 500, 530, 620.

F. tuberculata: 80, 100, 110, 130, 205, 210, 330, 490, 580, 620.

***Freyastera mexicana* (A.H. Clark, 1939),
new combination**

FIGURE 19

Freyella mexicana A.H. Clark, 1939a:442.—Korovchinsky and Galkin, 1984:1213 [key].

MERISTICS.—Arms = 6, R = 110 mm (estimated), r = 5.5 mm, R/r = 20/1, length of gonadal region = 24 mm, length of longest arm spine = 1 mm.

DIAGNOSIS.—[80.a] Madreporite large; [90.b] madreporite lying in smooth, conical pit surrounded by many long spinelets; [100.d] madreporite with single S-shaped pore; [110.e] abactinal disc plates scale-like; [120.b,c] abactinal disc plates dense, slightly imbricate; [130.a] each abactinal disc plate bearing usually 1, sometimes 2 or 3 rough, glassy spinelets; [180.a] arms long, very attenuate; [205.a] gonadal portion of arms slightly inflated, set off abruptly from rest of arm; [210.f] abactinal arm plates flat, squarish, ending abruptly beyond gonadal region, distal portion of arms covered only by thin membrane; [240.a,c] abactinal arm plates bearing about 5 tubercles, each with a rough, glassy spinelet, membrane beyond gonadal region bearing scattered tiny pedicellariae; [280.a] marginal plates small; [290.b,e] marginal plates oval, flat, inconspicuous; [320.b] adambulacral plates longer than high; [330.a] adambulacrals cylindrical; [340.b] furrow margin slightly indented; [350] number of furrow spines 1; [380] number of subambulacral spines 1; [390.a] subambulacral spines large, glassy, mounted on conspicuous tubercle, 2 or 3 very delicate, setose small spines in diagonal line with larger spine, on inner distal edge of adambulacral; [420.a,b] ambulacral plates rather low proximally, quite high distally;

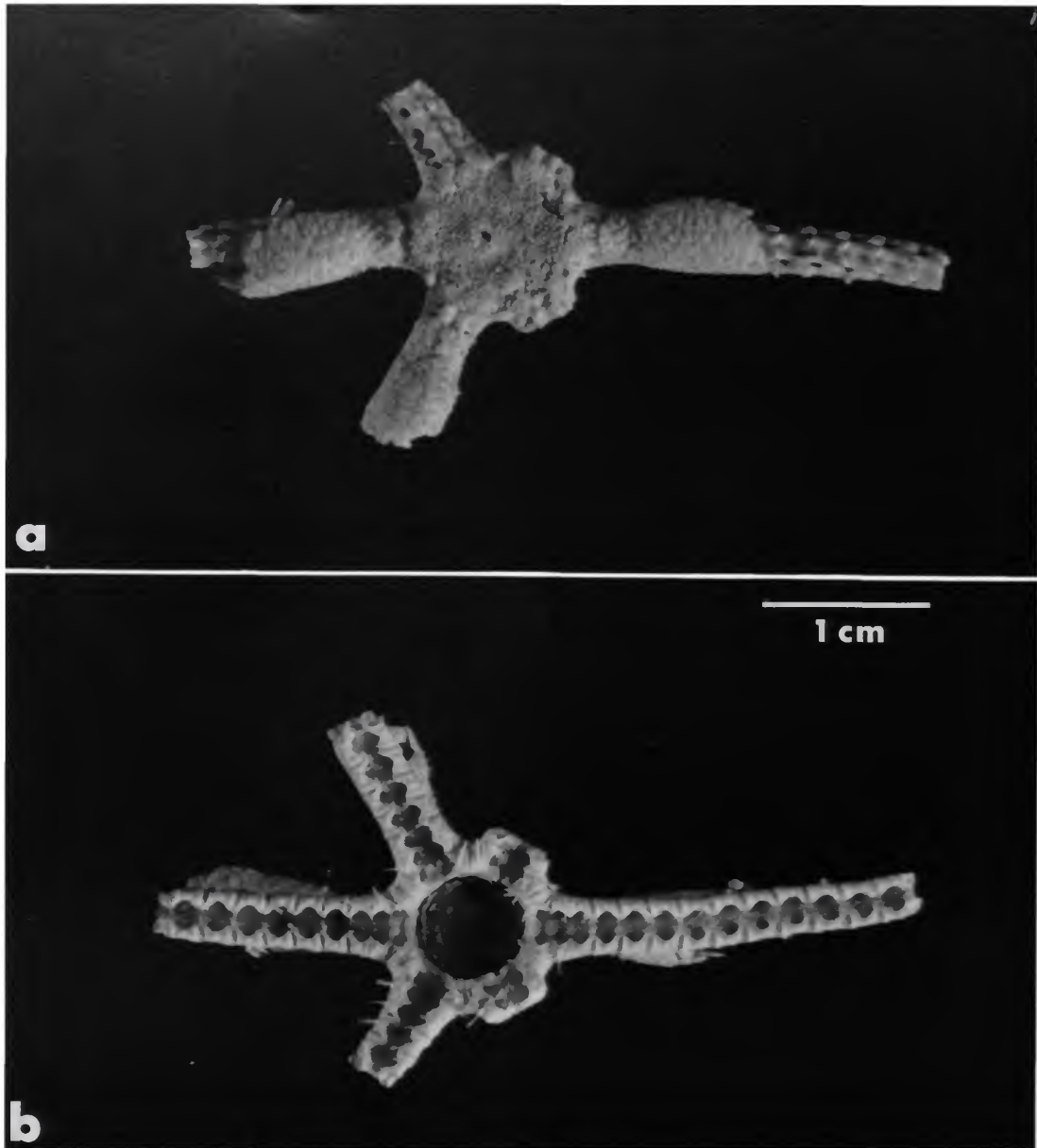


FIGURE 19.—*Freyastera mexicana*: *a*, abactinal view; *b*, actinal view.

[430.a] head of ambulacral plates more or less cylindrical, but not larger than base, waist of plates quite broad, the whole plate looking like a stout anvil; [470.b] tubefeet rather heavy; [490.c]

mouth plates triangular, well separated from adjoining mouth plates, about as broad as long, with proximal lateral boss or extension; [500] number of preoral spines per mouth plate 3 or

4, moderately long; [510.b] preoral spines blunt; [520.a] preoral spines behind adoral margin; [530] number of lateral oral spines per mouth plate 2 or 3; [540.a] lateral oral spines small, very delicate, setose; [550.a,c] one lateral oral spine proximal, one or two distal; [560] number of suboral spines per mouth plate 2, large, stout; [570.c] suboral spines blunt; [580.a] suboral spines above center of mouth plate; [620.a,b] pedicellariae abundant on disc, arms, and all spines, those on spines quite large; [630.a,b] both large and small pedicellariae present.

COLOR.—Unknown.

TYPE.—USNM E5602 (holotype); *Albatross* Sta 2379, Gulf of Mexico, 28°N, 87°42'W, 2683 m.

MATERIAL EXAMINED.—Holotype.

DISTRIBUTION.—Known only from type-locality.

DISCUSSION.—The very small, setose spines on the inner distal edge of the adambulacral plates might be thought to be furrow spines, but they sit not on the furrow face of the plate, but on the outer face, in a diagonal line with the large subambulacral spine and so should be considered subambulacral spines.

CHARACTERS.—Those peculiar to *F. mexicana*: 90.b, 570.c.

Characters *F. mexicana* shares with other species of *Freyastera*:

F. sexradiata: 100.d, 110.e, 130.a, 205.a, 280.a, 330.a, 500.3–4, 540.a.

F. tuberculata: 80.a, 130.a, 205.a, 210.f, 240.a,c, 280.a, 340.b, 380.1, 390.a, 470.b, 580.a, 620.a,b, 630.a,b.

Characters in which *F. mexicana* differs from other species of *Freyastera*:

F. sexradiata: 80, 90, 210, 290, 390, 430, 470, 490, 560, 580, 620, 630.

F. tuberculata: 90, 100, 110, 290, 330, 350, 430, 500, 530, 560.

***Freyastera sexradiata* (Perrier, 1885),
new combination**

FIGURE 20

Freyella sexradiata Perrier, 1885c:6; 1894:89–90, pl. 3: fig. 2.—Koehler, 1906[1907]:145; 1909a:129–130, pl. 23: fig. 9; 1921:2.—Grieg, 1927a:20, fig. 10.—Mortensen, 1927:129.—Gage et al., 1983:285.—Korovchinsky and Galkin, 1984:1213 [key].

MERISTICS.—Arms = 6(5), R = 100+ mm (estimated), r = 5–8 mm, R/r = 12.5–17/1,

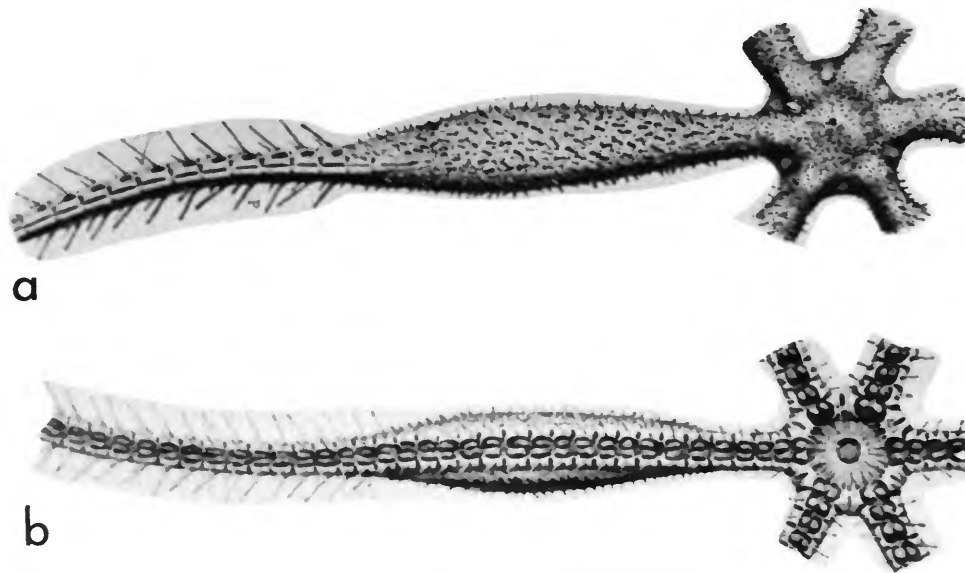


FIGURE 20.—*Freyastera sexradiata*: a, abactinal view; b, actinal view (from Perrier, 1894).

length of gonadal region = 30 mm, length of longest arm spine = 3 mm.

DIAGNOSIS.—[80.b] Size of madreporite moderate; [100.d] madreporite oval, with single S-shaped pore; [110.e] abactinal disc plates scale-like; [130.a] abactinal disc plates each bearing 1(2) glassy aciculate spinelet; [205.a] gonadal region of arm slightly inflated; [210.e] abactinal arm plates scale-like; [240.a] abactinal arm plates bearing single glassy spinelet; [280.a] marginal plates small; [290.c] form of marginals a small tubercle; [300.b] marginals occurring about every third adambulacral; [310.a] marginals each bearing a moderate-sized spine; [330.a] adambulacral plates cylindrical; [390.b] subambulacral spines moderately long, frequently capitate, spine on actinal face of adambulacral, plus a tiny secondary spine near distal prolongation of adambulacral; [420.a] ambulacral plates large, heavy; [430.d] head of ambulacral plates elongate; [470.a] tubefeet rather delicate; [480.c] mouth plates large; [490.d] mouth plates slightly longer than broad; [500] number of preoral spines per mouth plate 3 or 4; [530] number of lateral oral spines per mouth plate 1 or 2, tiny; [540.a] lateral oral spines acute; [550.c] one lateral oral spine on distal lateral prolongation of mouth plate; [560] number of suboral spines per mouth plate 1, moderately large; [580.b] suboral spines below center of mouth plate; [620.f] pedicellariae occurring only on spines, fewer than normal in most Brisingida; [630.a] all pedicellariae small.

COLOR.—Unknown.

TYPE.—Paris Museum 4598 (holotype); *Talisman* Sta 134, 42° 19' N, 23° 36' W, 4060 m.

MATERIAL EXAMINED.—Holotype.

DISTRIBUTION.—Azores, Portugal, Bay of Biscaia, 38° to 45° N, 9° to 23° W; 4020–4700 m.

DISCUSSION.—This extremely delicate species has never been collected intact, making it impossible to accurately estimate the length of the arms; obviously, they must have been longer than 100 mm.

CHARACTERS.—Those peculiar to *F. sexradiata*: 620.f.

Characters *F. sexradiata* shares with other species of *Freyastera*:

F. tuberculata: 130.a, 205.a, 280.a, 430.d, 480.c, 560.1.

Characters in which *F. sexradiata* differs from other species of *Freyastera*:

F. tuberculata: 80, 100, 110, 210, 290, 330, 390, 420, 470, 490, 500, 530, 580, 620, 630.

***Freyastera tuberculata* (Sladen, 1889),
new combination**

FIGURE 21

Freyella tuberculata Sladen, 1889:638–640, pl. 117: figs. 1–3.—Alcock, 1893a:121.—Korovchinsky and Galkin, 1984:1214 [key].

Freyellidea tuberculata.—Fisher, 1917:429.—H.L. Clark, 1920:113.

MERISTICS.—Arms = 6, R = 240 mm, r = 6 mm, R/r = 40/1, length of gonadal region = 30 mm, length of longest arm spine = 7 mm.

DIAGNOSIS.—[80.a] Madreporite huge; [100.c] madreporite subtubercular; [110.f] abactinal disc plates flat, hexagonal; [120.c] abactinal disc plates imbricate; [130.a] abactinal disc plates each armed with a short, sharp spinelet sheathed in membrane bearing many small pedicellariae; numerous larger pedicellariae on disc; [205.a] gonadal region of arms not highly inflated; [210.f] gonadal region of arms covered abactinally with very regular mosaic of squarish, thin plates, larger than those of disc, beyond gonadal region, plates scattered, fewer and thinner, but occurring all the way out the arm; [240.a,c] abactinal arm plates bearing a single tubercle with a glassy spinelet; [280.a] marginal plates small; [290.a] marginals thin, round, reduced; [310.a] marginals bearing single delicate acicular spine; [320.b] adambulacral plates longer than high; [330.f] adambulacral plates dumbbell-shaped, well separated from adjoining plates by muscle tissue in which is sometimes embedded a few small irregular plates or calcite deposits; [340.b] furrow margin slightly indented; [350] furrow

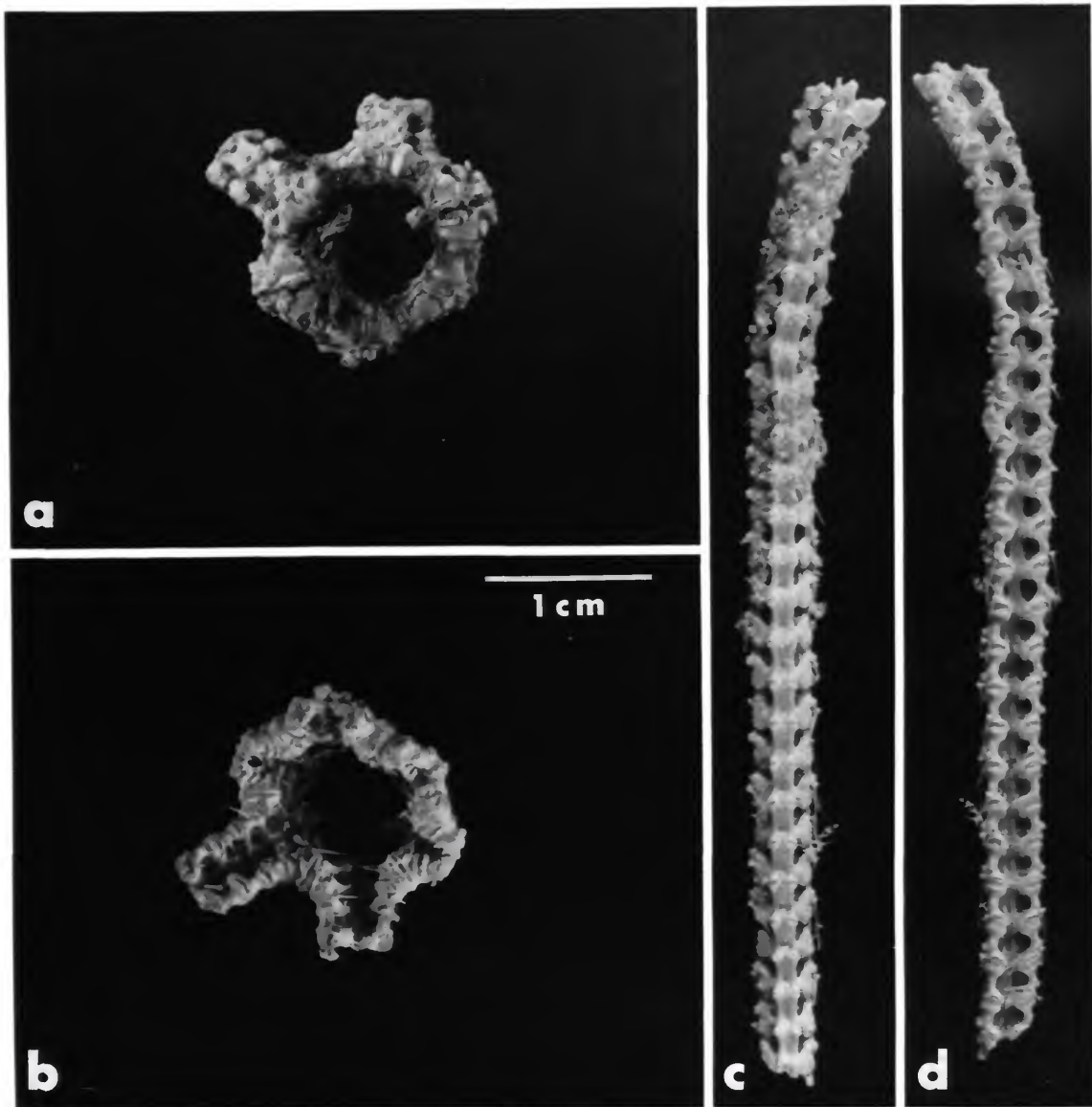


FIGURE 21.—*Freyastera tuberculata*: *a*, abactinal view of disc; *b*, actinal view of disc; *c*, abactinal view of arm section; *d*, actinal view of arm section.

spines absent; [380] number of subambulacral spines 1; [390.a] subambulacral spines long, delicate, glassy, borne on tubercle on actinal face of plate; [420.b] ambulacral plates rather small, elongate; [430.d] head of ambulacrals long, cylindrical; [470.b] tubefeet rather heavy; [480.c]

mouth plates large; [490.c,f] mouth plates wedge-shaped, with median keel; [500] number of preoral spines per mouth plate 1; [530] lateral oral spines absent [560] number of suboral spines per mouth plate 1; [580.a] suboral spines above center of mouth plate; [620.a,b] all spines cov-

ered with delicate membrane bearing many pedicellariae, disc and arm plates bearing larger scattered pedicellariae; [630.a,b] both large and small pedicellariae present.

COLOR.—Grayish white, with light pink tinge to gonadal region (in alcohol).

TYPES.—BM(NH) 90.5.7.1–76–1077 (2 syntypes); *Challenger* Sta 89, between Canary Islands and Cape Verde Islands, 22° 18' N, 22° 02' W, 4389 m; Sta 346, between W coast of Africa and Ascension Island, 2° 42' S, 14° 41' W, 4298 m.

MATERIAL EXAMINED.—Syntypes; 1 specimen, USNM E931, *Albatross* Sta 4742, Eastern Tropical Pacific, 0° 03' N, 117° 15' W, 4243 m; 1 specimen, USNM E20797, *Pillsbury* Sta 1372, mid-Atlantic, 23° 14' N, 64° 49' W, 5618 m.

DISTRIBUTION.—Apparently cosmopolitan; Alcock (1893a) also reported it from the Indian Ocean.

DISCUSSION.—This species is quite close to *Freyastera sexradiata*, but differs in having fewer mouth spines and more pedicellariae.

CHARACTERS.—Those peculiar to *F. tuberculata*: None.

Genus *Freyella* Perrier, 1885

Freyella Perrier, 1885c:5.—Sladen, 1889:618.—Alcock, 1893a:121.—Verrill, 1894:283.—Perrier, 1894:81.—Verrill, 1895:212.—Ludwig, 1905a:267.—Fisher, 1905:319.—Koehler, 1907:3; 1909d:626.—Fisher, 1916b:35.—A.H. Clark, 1916:51.—Fisher, 1918:104.—1919:538; 1928:24.—Grieg, 1932:30.—A.H. Clark, 1939a:442.—H.L. Clark, 1941:65.—Hayashi, 1943:169.—Madsen, 1956:29.—Cherbonnier and Sibuet, 1972:1353.—Sibuet, 1975:281.—Korovchinsky, 1976:1188.—Korovchinsky and Galkin, 1984:1205–1215.
Freyellidea Fisher, 1917:424; 1919:538.—H.L. Clark, 1920:108.—Döderlein, 1927:293.
Astrocles Fisher, 1917:426, 430; 1919:504; 1928:29.

DIAGNOSIS.—[30.b] Disc slightly raised above plane of arms; [50.b] interradial arcs gently curved; [60.b] flesh thin, opaque; [70.a,b] anal opening microscopic or absent; [140.a] a large, bare, smooth interradial plate at each interradial angle; [160.a] papulae absent; [170] number of arms 8–14; [190.b] abactinal surface of proximal

arms more or less a continuation with that of disc, arms not constricted at base; [220.b] abactinal arm plates tessellate; [400.a] proximal adambulacrals united interradially; [590.b] 2 pairs of gonads per arm; [600.b] gonads paired.

TYPE-SPECIES.—*Freyella spinosa* Perrier (1885c:5), by original designation (= *Freyella elegans* (Verrill, 1884)).

DISCUSSION.—Fisher (1917) attempted to divide the genus *Freyella* into two groups, *Freyella* and *Freyellidea*, but later (1919) decided, quite rightly, that the basis for division was of less than generic importance. The genus *Astrocles* (Fisher, 1917) differs from *Freyella* only in having the abactinal arm plates arranged in bands across the arms. As Fisher himself pointed out (1928:29), these plates are more like *Freyella* plates than the plates that form the costae in *Brisinga* and related genera. As most of the species of *Freyella* have the abactinal arm plates beyond the center of the gonadal region also arranged in bands, at least in larger specimens, this can hardly be considered a generic character, and *Astrocles* is thus a junior synonym of *Freyella*, and the type and only known species, *Astrocles actinodetus*, from off British Columbia, is closely related to *Freyella microspina*.

CHARACTERS.—Those peculiar to *Freyella*: None.

Freyella elegans (Verrill, 1884)

FIGURE 22

Brisinga elegans Verrill, 1884:382 [non *Brisinga elegans* Perrier, 1885 (= *Novodina homonyma* Downey, new name).]
Freyella spinosa Perrier, 1885c:5; 1894:85–89, pl. 7.—Koehler, 1907:6.—Mortensen, 1927:129.—Sibuet, 1975:281.—Gage et al., 1983:285.—Korovchinsky and Galkin, 1984:1213 [key].
Freyella bracteata Sladen, 1889:629–632, pl. 114: figs 1–4.
Freyella elegans.—Verrill, 1894:283; 1895:212.
Freyella spinosa Perrier, 1885c:5; 1894:85–89, pl. 7.—Koehler, 1907:6.—Mortensen, 1927:129.—Sibuet, 1975:281.—Gage et al., 1983:285.—Korovchinsky and Galkin, 1984:1213 [key].
Freyella abyssicola.—A.H. Clark, 1949:375.
Freyella laubieri Cherbonnier and Sibuet, 1972:1353, unnumbered figure.

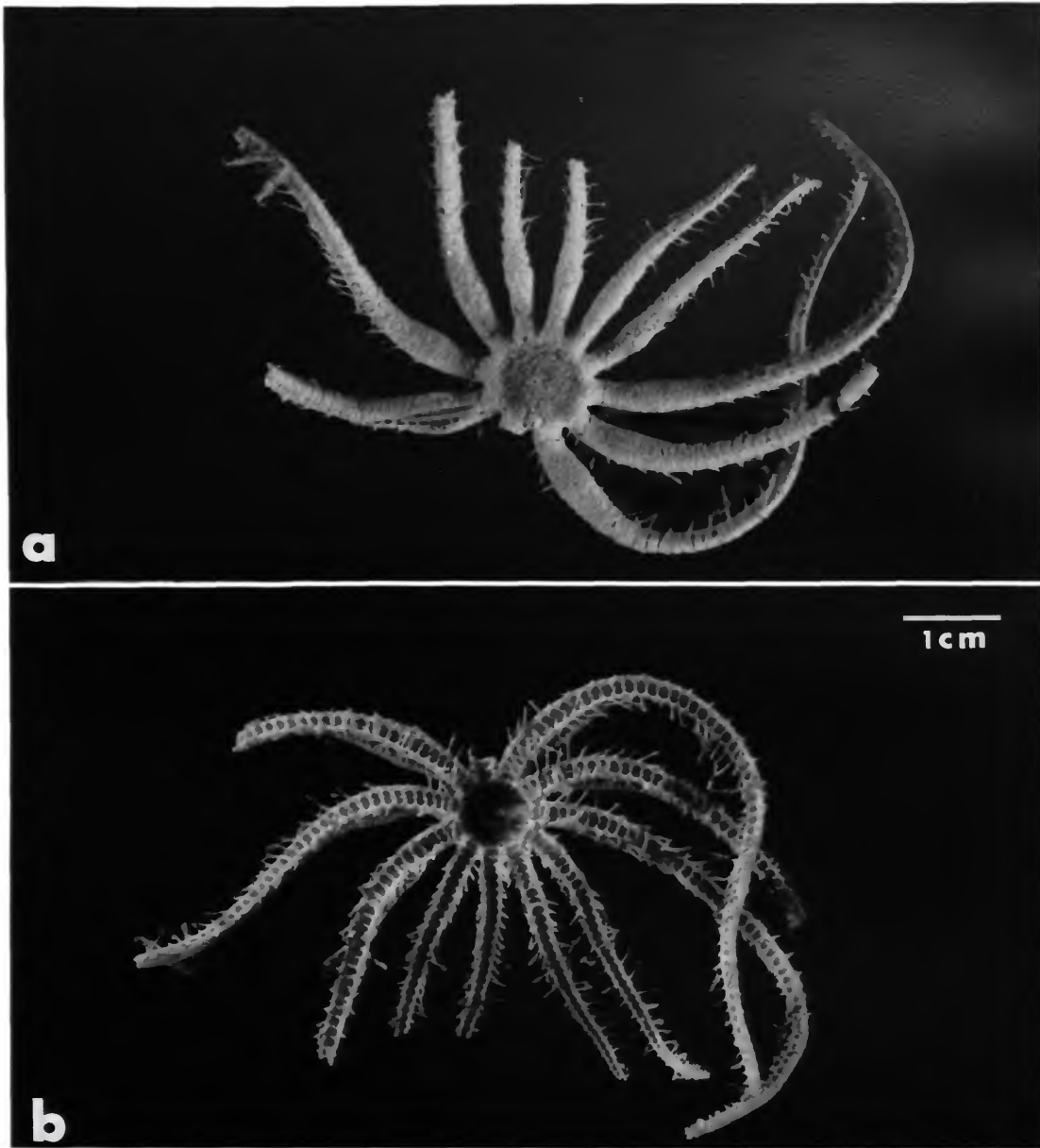


FIGURE 22.—*Freyella elegans*: a, abactinal view; b, actinal view.

MERISTICS.—Arms = 9–14, R = 135–191 mm, r = 5–15 mm, R/r = 12–27/1, length of gonadal region = 21–44 mm, length of longest arm spine = 7–9 mm.

DIAGNOSIS.—[80.a,b,c] Madreporite inconspicuous to moderately large; [100.a] madreporite

channeled; [110.e,f] abactinal disc plates thin, flat; scale-like; [120.c] abactinal disc plates imbricate; [130.a] abactinal disc plates bearing 2–5 short, sharp, usually divergent spinelets; [170] number of arms 9–14; [205.a,c] gonadal region of arms 21–44 mm long, slightly to highly in-

flated; [210.f] abactinal arm plates flat, diamond-shaped; [220.b] abactinal arm plates tessellate, closely abutting adjoining plates; [240.a] abactinal arm costae bearing single irregular transverse row of short, sharp spinelets; [250.a] terminal plates tiny; [260.a] terminal plates bifurcate; [270.a] terminal plates armed with 1 or 2 acute spines; [280.a] marginals small; [290.c] marginals tuberculate; [310.a] marginals bearing 1 long stout acicular spine; [320.a] adambulacrals higher than long, with inner distal prolongation; [330.a] adambulacral plates cylindrical; [340.a] furrow margin straight; [350] number of furrow spines 0–2; [360.a] furrow spines short, sharp; [370.b] furrow spines distal; [380] number of subambulacral spines 1; [390.a,b,c] subambulacral spines large, stout, aciculate, capitate, or truncate (usually capitate or truncate in gonadal region, aciculate beyond); [420.a] ambulacral plates rather high; [430.e] ambulacral plates dumbbell-shaped, head large, elongate, spool-shaped; [470.c] tubefeet neither particularly delicate or particularly heavy; [480.a] mouth plates rather small; [490.c] mouth plates slightly longer than broad; [500] number of preoral spines per mouth plate 2 or 3; [510.a,b] preoral spines short, blunt or acicular, divergent; [520.a,b] preoral spines adoral or lateral; [540.a] lateral oral spines short, acicular; [550.c] lateral oral spines at distal angle of mouth plates; [560] number of suboral spines per mouth plate 1–3; [570.a] suboral spines long, stout, acicular; [580.a] suboral spines above center of mouth plate; [620.a,b,e] pedicellariae scattered on both surfaces of disc and arms; [630.a] all pedicellariae small.

COLOR.—Unknown.

TYPES.—Syntypes: USNM 6740, 11 specimens, *Albatross* Sta 2105, off Virginia, 2551 m; USNM 8076, 5 specimens, *Albatross* Sta 2229, off Maryland, 2602 m; USNM 9015, 10 specimens, *Albatross* Sta 2084, off George's Bank, 2359 m; USNM 9016, *Albatross* Sta 2076, off George's Bank, 1657 m; USNM 9065, 2 specimens, *Albatross* Sta 2035, off Nantucket Shoals, 2491 m; USNM 18305, 3 arm fragments, *Albatross* Sta 2077, off Martha's Vineyard, 2295 m;

USNM 18455, 14 specimens, *Albatross* Sta 2105, off Virginia, 2551 m.

MATERIAL EXAMINED.—Syntypes; 1 specimen, USNM 7819, *Albatross* Sta 2209, S of Block Island, 1829 m; 1 specimen, USNM 7854, *Albatross* Sta 2211, Cape Hatteras to Nantucket, 1946 m; 1 specimen, USNM 8135, *Albatross* Sta 2230, off Delaware, 2136 m; 1 specimen, USNM 11257, *Albatross* Sta 2534, SE of George's Bank, 2257 m; 4 specimens, USNM 11258, *Albatross* Sta 2564, SW of Martha's Vineyard, 2542 m; 6 specimens, USNM 11259, *Albatross* Sta 2562, SW of Martha's Vineyard, 2622 m; 8 specimens, USNM 15560, *Albatross* Sta 2725, off Chesapeake Bay, 2513 m; 1 specimen, USNM 15561, *Albatross* Sta 2727, off Chesapeake Bay, 2266 m; 1 arm fragment, USNM 18306, *Albatross* Sta 2192, S of Nantucket, 1939 m; 2 specimens, USNM 38452, *Albatross* Sta 2229, Cape Hatteras to Nantucket, 2602 m; 32 specimens, USNM 38862, *Albatross* Sta 2105, between Cape Hatteras and Nantucket, 2551 m; 3 specimens, USNM 38926, *Albatross* Sta 2229, Cape Hatteras to Nantucket, 2602 m; 4 specimens, USNM E12438, 34°45'N, 75°11'W, 2450 m; 1 arm fragment, USNM E15979, "Knorr" Sta 326, Hudson Canyon; 5 specimens, USNM E15982, "Knorr" Sta 325, Hudson Canyon, 39°13'N, 71°53'W, 1919 m; 2 specimens, USNM E20944, *Pillsbury* Sta 292, Gulf of Guinea, 0°12'N, 5°11'E, 3587 m; 1 specimen, USNM E20945, *Pillsbury* Sta 34, Gulf of Guinea, 3°53'N, 2°33'W, 1986 m; 1 specimen, USNM E13828, *Chain* Sta 249; 2 specimens, USNM 6740, *Albatross* Sta 2105, off Virginia, 2551 m; 5 specimens, USNM 12068, *Albatross* Sta 2571, SE of George's Bank, 2480 m (the last two lots were originally labelled "*Brisinga spinulosa*" but this name was never published; Verrill evidently meant it for a replacement name); type of *Freyella spinosa* Perrier, Paris Museum, about 19°N, 20°W, 2320–4060 m; type of *Freyella aspera* Verrill, USNM 6301, *Albatross* Sta 2097, off Martha's Vineyard, 3506 m; type of *Freyella bracteata* Sladen, *Challenger* Sta 46, E of New Jersey, 40°17'N, 66°48'W, 2469 m; type of *Freyella laubieri* Cherbonnier and Sibuet, *Jean Charcot*

Sta 17, 52°45'N, 41°12'W, 4340 m.

DISTRIBUTION.—Greenland to Angola (east) and North Carolina (west); 1600–4500 m.

DISCUSSION.—This variable species may have a worldwide distribution in deep water. The size of the gonadal inflation on the arms is dependent on the state of development of the gonads. The most variable features are the preoral mouth spines, the proximal adambulacral spines, and the distribution and abundance of pedicellariae. The oral mouth spines and the proximal adambulacral furrow spines may be straight and acicular, or broad, truncate, and more or less distorted; this seems to be related to distribution, not growth, as is the shape of the adambulacral spines. Possibly *Freyella mutabilis* Korovchinsky from the Sub-Antarctic (4664–6070 m), *F. dimorpha* Sladen from Torres Strait (2560 m), *F. pennata* Sladen from Japan (3429 m), and others also belong to this species. Certainly all the Atlantic species heretofore described that have two or three short preoral spines, one short furrow spine, one long, stout subambulacral spine, and abactinal disc and arm plates as described above belong to the same species, for which Verrill's name *elegans* has priority.

CHARACTERS.—Those peculiar to *F. elegans*: 470.c.

Characters *F. elegans* shares with other species of *Freyella*:

F. microspina: 130.a, 240.a, 280.a, 290.c, 340.a, 390.a,b,c, 430.e, 490.c, 620.a,b,e.

F. recta: 100.a, 130.a, 220.b, 240.a, 280.a, 320.a, 330.a, 380.1, 480.a, 540.a, 570.a.

Characters in which *F. elegans* differs from other species of *Freyella*:

F. microspina: 100, 110, 120, 210, 320, 330, 470, 480, 540, 550, 570, 580, 630.

F. recta: 110, 120, 170, 210, 290, 340, 470, 550, 580, 620.

Freyella microspina Verrill, 1894

FIGURE 23

Freyella microspina Verrill, 1894:285.—Korovchinsky and Galkin, 1984:1214 [key].

Freyella trispinosa H.L. Clark, 1941:65–66.—Korovchinsky and Galkin, 1984:1214 [key].

MERISTICS.—Arms = 10–13, R = 95–140 mm (estimated), r = 5–11.5 mm, R/r = 12–19/1, length of gonadal region = 20–33 mm, length of longest arm spine = 7 mm.

DIAGNOSIS.—[80.a] Madreporite large; [100.b] madreporite rough, irregular; [110.b] abactinal disc plates small, tumid, roundish; [120.a] abactinal disc plates scattered in membrane; [130.a] abactinal disc plates bearing central group of 1–5 short, sharp spinelets; [170] number of arms 10–13; [205.a] gonadal region of arms 20–33 mm long, rather sturdy; [210.b] abactinal arm plates tumid; [220.b,c] abactinal arm plates in irregular mosaic; [240.a] abactinal arm plates bearing roughly 2 rows of short, sharp spinelets; [280.a] marginals small; [290.c] marginals conical; [310.a] marginals bearing one large acicular spine; [320.b] adambulacral plates slightly longer than high, with long truncate prolongation at inner distal edge; [330.e] adambulacral plates knobbed; [340.a] furrow margin straight; [350] furrow spines usually absent, sometimes one short spinelet on distal prolongation; [360.a,b] furrow spines acute or clavate; [370.a,b] one furrow spine proximal, one distal; [380] number of subambulacral spines 1 or 2; [390.a,b,c] subambulacral spines large, stout, truncate or capitate in gonadal region, aciculate beyond; [420.b] ambulacral plates small, delicate; [430.e] ambulacral plates dumbbell-shaped; [470.a] tubefeet rather delicate; [480.c] mouth plates moderately large; [490.c] mouth plates longer than wide, wider at distal than at proximal end; [500] number of preoral spines per mouth plate 3; [510.a] preoral spines moderately long, acicular; [520.b] preoral spines directed laterally, meeting across ambulacral groove, so appearance is of 3 more or less continuous rings of calcite around the actinostome; [530] number of lateral oral spines per mouth plate 1; [540.c,d] lateral oral spines short, flat, truncate, broadly expanded at tip; [550.b] lateral oral spines lying beneath preoral spines and meeting the lateral orals of adjoining mouth plates; [570.b] suboral

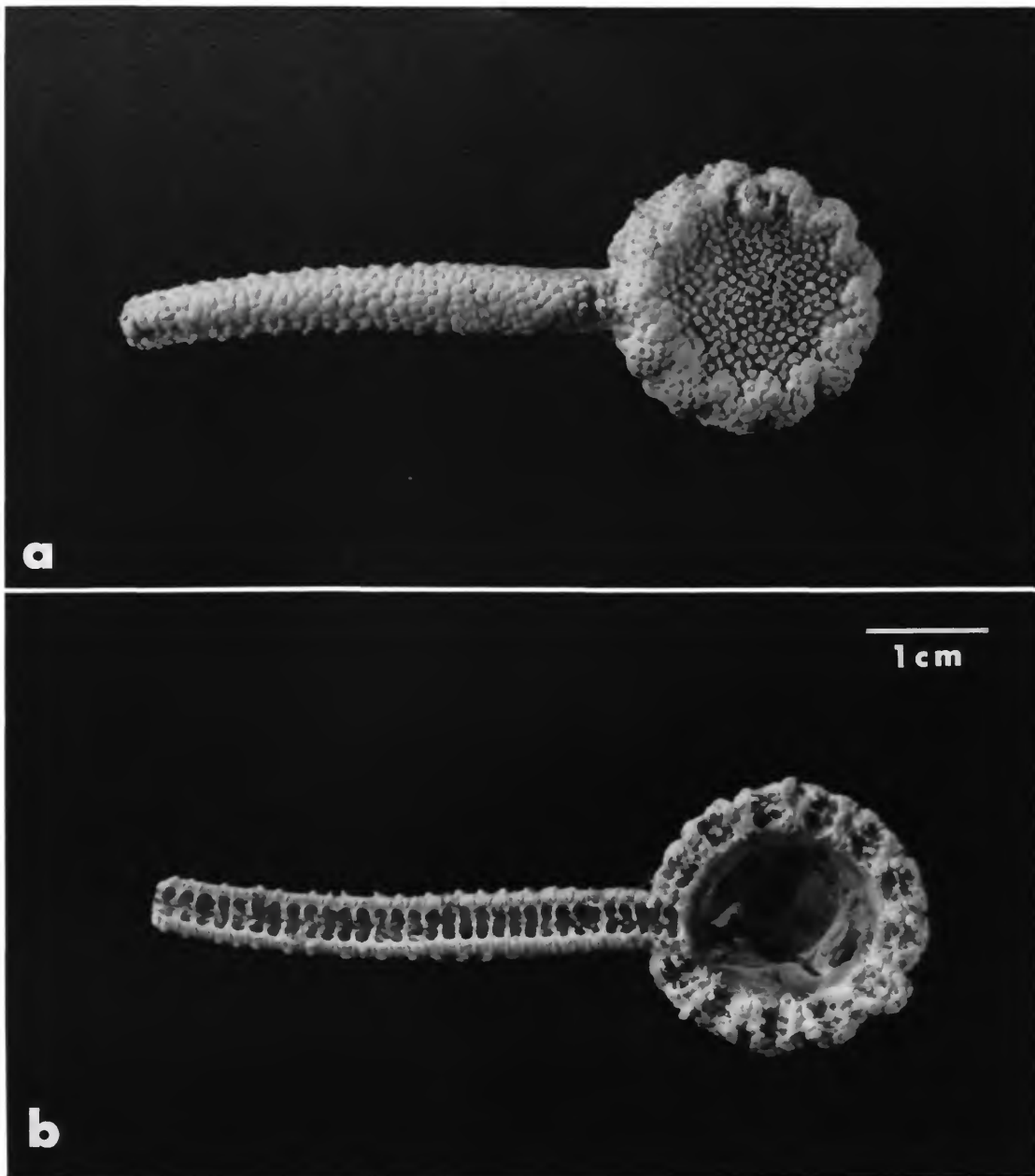


FIGURE 23.—*Freyella microspina*: a, abactinal view; b, actinal view.

spines large, usually capitate; [580.b] suboral spines below center of mouth plate; [620.a,b,e] pedicellariae on both surfaces of disc and arms; [630.b] pedicellariae rather large.

COLOR.—Unknown.

TYPE.—USNM 7821 (arm fragments) (holotype), *Albatross* Sta 2220, off Nantucket, 39°43'N, 69°23'W, 1928 m.

MATERIAL EXAMINED.—Holotype; 1 specimen, USNM 7805, *Albatross* Sta 2192, S of Nantucket, 1939 m; 1 specimen, USNM E20799, *Pillsbury* Sta 681, off Surinam, 8°11.5'N, 56°12'W, 2734 m; type of *Freyella trispinosa*, MCZ 3825, *Atlantis* Sta 2969A, off Bahia de Guantanamo, Cuba, 1847 m.

DISTRIBUTION.—Off Nantucket; southern coast of Cuba; Surinam; 1847–2734 m.

DISCUSSION.—Although closely related to *Freyella elegans*, the disc and arm plates of this species are generally thicker and more tumid, the preoral spines are entirely lateral in position, and the small, single furrow spine is sometimes lacking entirely. *Freyella trispinosa* differs only in the shape of the preoral spines (thinner and more truncate), but this can scarcely be considered a specific difference.

CHARACTERS.—Those peculiar to *F. microspina*: 330.e, 540.c,d.

Characters *F. microspina* shares with other species of *Freyella*:

F. recta: 120.a, 130.a, 205.a, 240.a, 280.a, 360.a,b, 510.a, 580.b.

Characters in which *F. microspina* differs from other species of *Freyella*:

F. recta: 80, 100, 110, 170, 210, 290, 320, 330, 340, 470, 480, 500, 520, 540, 550, 570, 620.

***Freyella recta* Koehler, 1907**

FIGURE 24

Freyella recta Koehler, 1907a:3; 1909:127–129, pl. 21: fig. 7, pl. 22: fig. 4, pl. 23: figs. 3–5.—Korovchinsky and Galkin, 1984:1214 [key].

MERISTICS.—Arms = 8, R = 150+ mm, r = 9 mm, R/r = 17/1, length of gonadal region = 35 mm, length of longest arm spine = 3 mm.

DIAGNOSIS.—[80.c] Madreporite very small, raised; [100.a] madreporite channeled; [110.a] abactinal disc plates metapaxillar, irregularly polygonal; [120.a] abactinal disc plates small, embedded in membrane; [130.a] abactinal disc

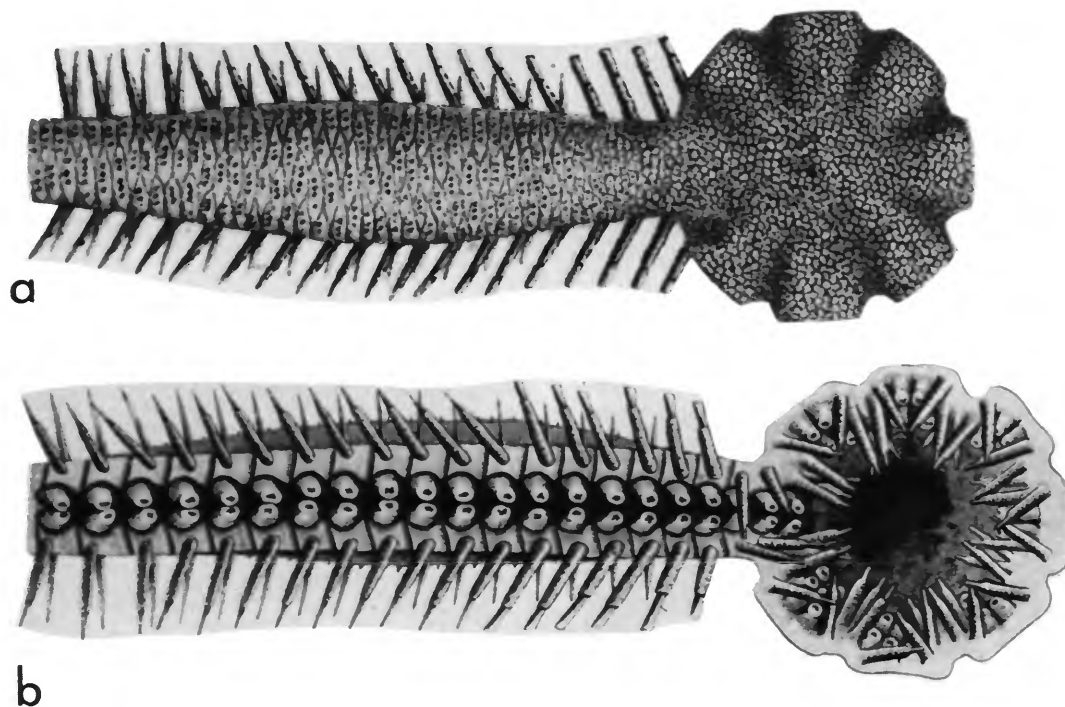


FIGURE 24.—*Freyella recta*: a, abactinal view; b, actinal view. (From Koehler, 1909a.)

plates bearing 1–3 short, blunt, rough spinelets; [170] number of arms 8; [205.a] gonadal region of arms 35 mm long, moderately inflated; [210.c,f] abactinal arm plates irregularly polygonal, metapaxillar, larger than those of disc on proximal part of arm, bare membrane beyond gonadal region; [220.b] abactinal arm plates tessellate, forming irregular mosaic; [240.a] abactinal arm plates bearing 4 or 5 short, fine, conical spinelets; [280.a] marginal plates small; [290.b] marginals more or less oval; [310.a] marginals bearing one short acicular spine; [320.a] adambulacral plates higher than long; [330.a] adambulacral plates cylindrical; [340.b] furrow margin slightly indented; [350] number of furrow spines 1; [360.a,b] furrow spines acute or clavate; [380] number of subambulacral spines 1; [390.a,b] subambulacral spines large, first 6 or 7 capitate, rest aciculate; [470.b] tubefeet rather heavy; [480.a] mouth plates rather small; [500] number of preoral spines per mouth plate 2, one tiny, delicate, the other large, stout; [510.a] preoral spines short, sharp, straight; [520.a] preoral

spines adoral; [540.a] lateral oral spines acute; [550.a] lateral oral spines proximal; [570.a] suboral spines large, acicular; [580.b] suboral spines below center of mouth plate; [620.a,b,d] pedicellariae in patches on distal membranous area of arms, all spine with membranous sheath covered with pedicellariae (tips of spines exposed).

COLOR.—Unknown.

TYPE.—Musée Oceanographique de Monaco (holotype); *Princesse Alice* Sta 2111, mid-Atlantic ridge, between Azores and Virgin Islands, 31°45'N, 42°42'W, 3465 m.

MATERIAL EXAMINED.—None.

DISTRIBUTION.—Known only from type-locality.

DISCUSSION.—As I was unable to examine the type, I cannot say with certainty that this species may be another variety of *Freyella elegans*. Without further material or access to the type, I consider the validity of this species in doubt.

CHARACTERS.—Those unique to *Freyella recta*: 620.a,b,d.

Appendix

CHARACTERS OF THE BRISINGIDA

10. Form:
 - a. Ophiuroid-like
 - d. Papilliform
20. Disc size:
 - a. Small
 - e. Scale-like
30. Disc thickness:
 - a. Thick, raised well above plane of arms
 - b. Intermediate, raised slightly above plane of arms
 - c. Flat, in same plane as arms
 - f. Flat
 - g. Lobed or cruciform
40. Disc shape:
 - a. Circular
50. Interradial arcs:
 - a. Acute
 - b. Curved
60. Fleshiness:
 - a. Thick, dense, opaque
 - b. Moderate, thin, opaque
 - c. Slight, transparent, usually slimy
70. Anal opening:
 - a. Barely visible (microscopic)
 - b. Absent
 - c. Plainly visible
80. Size of madreporite:
 - a. Large
 - b. Moderate
 - c. Small
90. Position of madreporite:
 - a. Lateral (on edge of disc)
 - b. Near edge of disc
100. Type of madreporite:
 - a. Channeled
 - b. Irregular
 - c. Subtubercular
 - d. Single pore
 - e. Meandering gyri
110. Type of abactinal disc plates:
 - a. Metapaxillar
 - b. Tumid
 - c. Tuberculate
120. Arrangement of abactinal disc plates:
 - a. Scattered in membrane
 - b. Dense in membrane
 - c. Imbricate
 - d. Few or none
130. Armament of abactinal disc plates:
 - a. Spinelets
 - b. Spines
 - c. Tubercles
140. Bare interradianal plates:
 - a. Present
 - b. Absent
150. Distribution of papulae:
 - a. On disc only
 - b. On disc and arms
160. Number of papulae:
 - a. None
 - b. Scattered (single)
 - c. Exact number
170. Number and/or length of arms
180. Shape of arms:
 - a. Long, attenuate, R/r more than 6/1
 - b. Long, robust
190. Attachment of arms to disc:
 - a. Arms deciduous, constricted at base
 - b. Abactinal surface of arms continuous with that of disc, not constricted at base
200. Gonadal region differing from rest of arm:
 - a. Yes
205. Size of gonadal region of arms:
 - a. Moderately inflated
 - b. Not inflated
 - c. Greatly inflated

210. Type of abactinal arm plates:
- Rod-like
 - Tumid
 - Metapaxillar
 - Irregular
 - Scale-like
 - Flat
 - Lobed or cruciform
220. Arrangement of abactinal arm plates:
- Imbricate
 - Abutting (tessellate)
 - Scattered
230. Size of abactinal arm plates relative to marginals:
- Small
240. Armament of abactinal arm plates:
- Spinelets
 - Spines
 - Tubercles
250. Size of terminal plates relative to marginals:
- Small
 - Large
260. Shape of terminal plates:
- Irregular or bifurcate or catsclaw
 - Squarish or shield-shaped
270. Armament of terminal plates:
- Spines
 - Spinelets
 - Bare
280. Size of marginal plates relative to adambulacrals:
- Small
 - Large
290. Shape of marginals:
- Irregular
 - Elongate
 - Tuberculate
 - Angular
 - Flat
 - Squarish or rectangular
 - Cruciform or lobate
 - Tumid
300. Position of marginals relative to adambulacrals:
- Corresponding
 - Not corresponding
310. Armament of marginals:
- Spines
 - Spinelets
320. Size of adambulacrals relative to marginals:
- Large (higher than long)
 - Small (longer than high)
330. Shape of adambulacrals:
- Cylindrical
 - Spool-shaped
 - Discoidal
 - Hourglass-shaped
 - Knobbed
 - Dumbbell-shaped
340. Furrow margin:
- Straight
 - Slightly indented
 - Deeply indented
350. Number of furrow spines
360. Form of furrow spines:
- Acute
 - Clavate
370. Position of furrow spines:
- Proximal
 - Distal
 - Medial
380. Number of subambulacral spines
390. Form of subambulacral spines:
- Acute
 - Capitate
 - Truncate
 - Furcate
400. Proximal adambulacrals united interradi-ally:
- Yes
 - No
410. Ambulacral groove:
- Wide (broad, open, often petaloid)
420. Size of ambulacral plates:
- Large, heavy
 - Small, delicate
430. Shape of ambulacral plates:
- Saddle-shaped
 - Hourglass-shaped
 - Y-shaped
 - T-shaped
 - Dumbbell-shaped

- f. Discoidal
- g. l-shaped
- 440. Spacing of ambulacral plates:
 - a. With heads abutting end to end
 - b. Crowded
- 450. Number of rows of tubefeet 2
- 460. Type of tubefeet:
 - a. Suckered
- 470. Structure of tubefeet:
 - a. Delicate, slender, thin, translucent
 - b. Heavy, thick, opaque
 - c. Neither of the above
- 480. Size of mouth plates relative to adambulacrals:
 - a. Small
 - b. Moderate
 - c. Large
- 490. Shape of mouth plates:
 - a. T-shaped
 - b. Trapezoidal
 - c. Triangular
 - d. Cylindrical
 - e. Short, broad
 - f. Keeled
 - g. Hourglass-shaped
- 500. Number of preoral spines
- 510. Shape of preoral spines:
 - a. Acute
 - b. Blunt
- 520. Position of preoral spines:
 - a. Adoral
 - b. Lateral
- 530. Number of lateral oral spines
- 540. Shape of lateral oral spines:
 - a. Acute
 - b. Blunt
 - c. Truncate
 - d. Flattened
- 550. Position of lateral oral spines:
 - a. Proximal
 - b. Lateral
 - c. Distal
- 560. Number of suboral spines
- 570. Shape of suboral spines:
 - a. Acute
 - b. Capitate
 - c. Blunt
- 580. Position of suboral spines relative to mouth plate:
 - a. Above center
 - b. Below center
 - c. Center
- 590. Number of pairs of gonads per arm:
 - a. Many
 - b. 2
 - c. 1
- 600. Position of gonads:
 - a. Serial
 - b. Paired
- 610. Type of pedicellariae:
 - a. Crossed
- 620. Distribution of pedicellariae:
 - a. Actinal and abactinal
 - b. Disc and arms
 - c. In rows or bands
 - d. In patches
 - e. Scattered
 - f. Only on spines
 - g. Arms only
- 630. Size of pedicellariae:
 - a. Microscopic
 - b. Plainly visible

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Index

(Synonyms and page numbers of principal entries are in italics.)

- abyssicola*, *Freyella*, 43
actinodetus, *Astrocles*, 43
americana, Novodinia, 2, 4, *21*, 22
antillensis, Novodinia, 2, *23*, 25
aspera, *Freyella*, 43, 45
Astrocles, 43
Astrostephane, 1
Belgicella, 1
benthophila, Freyastera, 2, *36*, 38
bracteata, *Freyella*, 43, 45
Brisinga, 1, 4, 5, 7, 9, 11, 13, 15, 17, 21, 25, 26, 29, 33, 43, 45
Brisingaster, 1
Brisingella, 1, 2, 4, 5, *13*, 15, 16
Brisingenes, 1, 2, 5, 13, *16*, 17
Brisingida, 1, 2, 3, 4, 41, 50
Brisingidae, 1, 2, 4, 5, 33
Colpaster, 1, 2, *33*, 34, 36
coronata, Brisingella, 1, 4, *13*, 15, 16
costata, Brisinga, 2, 5, 7
Craterobrisinga, 5, 7, 17
cricophora, Brisinga, 2, 5, 7, 9
dimorpha, *Freyella*, 46
edwardsi, Colpaster, *33*, 34
elegans, *Freyella*, 2, *43*, 46, 48, 49
elegans, *Odinia*, 25, 26
endecacnemos, Brisinga, 1, 5, 9, 11
Euclasteroidea, 1, 2, 4
Freyastera, 1, 2, 4, 33, *36*, 38, 40, 41, 43
Freyella, 1, 2, 25, 26, 33, 36, 38, 40, 41, *43*, 45, 46, 48, 49
Freyellaster, 1
Freyellidae, 33
Freyellidea, 43
 benthophila, 36
 tuberculata, 41
hirsuta, Brisinga, 2, 4, 5, 7, 9, *11*, 13
homonyma, Novodinia, 25, 26, 27, 43
laubieri, *Freyella*, 43, 45
mediterranea, *Brisinga*, 13
mexicana, Freyastera, 4, *38*, 40
microspina, *Freyella*, 2, 43, *46*, 48
Midgardia, 1, 5, 13, 17, *18*, 19
multicostata, Brisingenes, 2, *17*
mutabilis, *Freyella*, 46
Novodinia, 1, 2, 4, 5, 13, 17, 19, *21*, 23, 25, 27, 29
Odinia, 21
 antillensis, 23
 elegans, 25, 26
 pandina, 27
 robusta, 29
 semicoronata, 29
pandina, Novodinia, 2, 23, 25, 26, 27, 29
Parabrisinga, 1
pennata, *Freyella*, 46
placoderma, Stegnobrisinga, 31
recta, *Freyella*, 46, *48*, 49
robusta, *Odinia*, 29
scutigerula, Colpaster, 2, 33, *34*, 36
semicoronata, Novodinia, 21, 23, 25, 27, 29
sexradiata, Freyastera, 36, 38, 40, 41, 43
spinosa, *Freyella*, 43, 45
spinulosa, *Freyella*, 45
splendens, Stegnobrisinga, 2, *31*, 33
Stegnobrisinga, 1, 2, 5, 13, 17, 19, 21, 29, 31
trispinosa, *Freyella*, 2, 46, 48
tuberculata, Freyastera, 38, 40, *41*, 43
verticellata, Brisingella, 2, *15*, 16
xandaros, Midgardia, 18, *19*

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