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NOAA Technical Report NMFS Circular 438

Marine Flora and Fauna of The Northeastern United States. Scleractinia

Stephen D. Cairns

July 1981

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no.438

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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QL377.C7C35 1981 no. 438

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
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National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator for Fisheries

FOREWORD

This NMFS Circular is part of the subseries "Marine Flora and Fauna of the Northeastern United States," which consists of original, illustrated, modern manuals on the identification, classification, and general biology of the estuarine and coastal marine plants and animals of the Northeastern United States. The manuals are published at irregular intervals on as many taxa of the region as there are specialists available to collaborate in their preparation.

Geographic coverage of the "Marine Flora and Fauna of the Northeastern United States" is planned to include organisms from the headwaters of estuaries seaward to approximately the 200 m depth on the continental shelf from Maine to Virginia, but may vary somewhat with each major taxon and the interests of collaborators. Whenever possible representative specimens dealt with in the manuals are deposited in the reference collections of major museums of the region.

The "Marine Flora and Fauna of the Northeastern United States" is being prepared in collaboration with systematic specialists in the United States and abroad. Each manual is based primarily on recent and ongoing revisionary systematic research and a fresh examination of the plants and animals. Each major taxon, treated in a separate manual, includes an introduction, illustrated glossary, uniform originally illustrated keys, annotated checklist with information when available on distribution, habitat, life history, and related biology, references to the major literature of the group, and a systematic index.

These manuals are intended for use by biology students, biologists, biological oceanographers, informed laymen, and others wishing to identify coastal organisms for this region. Often they can serve as guides to additional information about species or groups.

The manuals are an outgrowth of the widely used "Keys to Marine Invertebrates of the Woods Hole Region," edited by R. I. Smith in 1964, and produced under the auspices of the Systematics Ecology Program, Marine Biological Laboratory, Woods Hole, Mass. After a sufficient number of manuals of related taxonomic groups have been published, the manuals will be revised, grouped, and issued as special volumes, which will consist of compilations for phyla or groups of phyla.

CONTENTS

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Marine Flora and Fauna of the Northeastern United States. Scleractinia

STEPHEN D. CAIRNS[1]

ABSTRACT

This manual discusses the 14 species of scleractinian corals known from the northeastern United States coast from Virginia to Nova Scotia. Following a brief introduction to the general biology and morphology of Scleractinia, an illustrated dichotomous key and two tabular keys are given for these species. An annotated systematic list includes complete geographic and bathymetric ranges, references to pertinent literature, and, for some species, ecological and taxonomic notes. Zoogeographic affinities of the fauna are briefly discussed. A selected bibliography is provided.

INTRODUCTION

Fourteen species of stony corals (order Scleractinia) are known from off the northeastern coast from Chesapeake Bay to southern Nova Scotia of which only one, *Astrangia astreiformis*, occurs at depths shallow enough to be collected routinely by snorkeling or scuba diving. The remaining species are usually collected by benthic trawls or dredges and occur as deep as 3,200 m off the northeast coast. Much research has been done on the easily accessible *A. astreiformis*, but little more than physical descriptions and distributions are known for the deeper water species. All 14 species are included in this report.

Of these 14 species, 13 are ahermatypic; i.e., they do not possess symbiotic zooxanthellae (a unicellular dinoflagellate) in their endodermal tissue. Individual colonies of *A. astreiformis* may or may not have zooxanthellae, depending perhaps on water temperature or light intensity; more frequently this species lacks the symbionts. The term ahermatypic is thus a physiological condition determined by ecological factors and therefore is not a character of great value in classification.

Ahermatypic corals have been equated with deepwater corals, solitary corals, or nonreef building corals. This is an oversimplification; in fact, many species occur in shallow water, and some large, colonial deepwater (500-800 m) ahermatypes (e.g., *Lophelia prolifera*, *Enallopsammia profunda*) form the framework for reeflike structures. It is true, however, that all deepwater corals are ahermatypic because below the euphotic zone the zooxanthellae, being plants, cannot photosynthesize. Not restricted by the generally higher (often tropical) temperature and light requirements that zooxanthellae impose on hermatypic corals, the ahermatypes inhabit a more extensive geographic range. They are found in all oceans from the Norwegian Sea (lat.70°30'N) to the Ross Sea, Antarctica (lat.78°29'S), from 0-6,328 m depth (Keller 1976), and in temperatures of −1.1°C to over 29°C.

Scleractinia are monoecious or dioecious; in either case their motile larval form is a planula capable of remaining planktonic for weeks. In addition to sexual reproduction, some species propagate by asexual budding and others have remarkable powers of regeneration. For instance, the corallum of *Dasmosmilia lymani* usually splits longitudinally into several fragments, each wedge-shaped piece subsequently producing 1-30 small buds growing directly from the mesenterial tissue. It is rare to find a specimen of *D. lymani* that grew directly from a planula, i.e., not attached to an inside fragment of a parent specimen.

All planulae need a hard substrate on which to settle. Following settlement and subsequent growth, corals may either remain attached to the substrate or become free, lying unattached on the substrate. The attached corallum usually reinforces its base of attachment by various means, whereas the subsequently unattached corallum becomes free by lacking reinforcement of an originally weak attachment or by completely overgrowing the substrate, as in the case of a sand particle. Some unattached species (e.g., *Caryophyllia ambrosia*) become top-heavy, fall to one side, but subsequently reorient their calices toward an upright position, producing a horn-shaped corallum.

The scleractinian fauna of the northeastern coast of the United States is relatively low in diversity when compared to other areas in the western Atlantic, even when the reef corals (hermatypes) are excluded from consideration. For example, there are approximately 160 species of Scleractinia in the Caribbean: 76 deepwater (over 200 m) ahermatypes (Cairns 1979), about 30 exclusively shallow-water ahermatypes, and about 54 hermatypic species. In the region between north Florida and Cape Hatteras there are about 40 species known: 28 deepwater ahermatypes (Cairns 1979), about 8-10 exclusively shallow-water ahermatypes, and several hardy hermatypic species, i.e., *Solenoastrea*, *Siderastrea*, *Oculina*. In the western Atlantic north of the North Carolina-Virginia border there are 17 species known, 16 deepwater ahermatypes and one exclusively shallow-water species, *A. astreiformis*. Fourteen of these 17 species are treated in this work, the other three: *Vaughanella margaritata* (Jourdan, 1895); *Fungiacyathus durus* Keller, 1976; and *F. marenzelleri* (Vaughan, 1906) are known from localities north of Maine. Other species occurring south of the area of consideration for this manual that may subsequently be found there include: *Dendrophyllia gaditana* (Duncan, 1873); *Pourtalosmilia conferta* Cairns, 1978; *Concentrotheca laevigata* (Pourtales, 1871); and *Polymyces fragilis* (Pourtales, 1868).

The 14 species of Scleractinia known from off the northeastern coast of the United States are, in general, widely distributed species. Six are cosmopolitan and seven are amphi-

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Atlantic. Of the latter, five are primarily cold temperate, one (*A. astreiformis*) is found both in temperate and tropical waters, and one (*Deltocyathus italicus*) is primarily a tropical species with northern limits in the cold temperate region. Only one species, *Enallopsammia profunda*, is endemic to the western Atlantic and is most common in the warm temperate region.

MORPHOLOGY

The calcareous skeleton of a scleractinian coral, the **corallum**, may be composed of numerous individual units producing a **colonial** corallum or it may be a **solitary** coral with only one unit produced by one polyp. The shape of the corallum of solitary corals is important at the generic and specific levels and is commonly described in geometric terms (e.g., conical, trochoid, cylindrical); shapes of colonial corals are described by branching pattern.

Corals may be either **attached** to the substrate or unattached (**free**), this difference usually being consistent at the species level. If attached, the base of the coral is firmly cemented to a hard surface. A solitary attached coral usually has a stemlike **pedicel** directly above the base (Fig. 1), which supports the **calice**, the round to elliptical oral surface of the corallum. The solitary attached coral often reinforces its attachment by thickening its pedicel, expanding its base, and, in some species, producing anchoring rootlets or adding successive rings of compartmentalized, concentric chambers around the base and pedicel. A solitary unattached coral usually has a flat or bowl-shaped base and lacks the pedicel. The sides or walls of solitary corals and corallites of colonies are termed the **theca**. This theca may be granular or porcelaneous in texture and often bears longitudinal ridges called **costae** corresponding to the larger septa. Skeletal deposits formed between individual corallites of a colony are called **coenosteum**.

The calice of most species is regularly and hexamerally subdivided by radial partitions, called **septa**. The six largest septa, divide the calice into six equal areas or **systems** (Fig. 2), and comprise the first **cycle** of septa. The second cycle also consists of six septa which are generally smaller and occur halfway between the first cycle septa. The 12 third cycle septa are formed in each space created by the previous 12 septa. Calices with 6-7 cycles of septa (192-384 septa) are known. Septa with the upper edges extending above the theca are termed **exsert** septa. Sometimes one or several adjacent septa of a calice are extremely exsert and bent over the calice, forming a hoodlike structure called a **rostrum** (e.g., see figure of *Enallopsammia rostrata*). Small accessory lobes are sometimes present on the inner edges of the septa of certain cycles. These are called **pali** (singular: palus), or **paliform lobes**, and are often used as a generic level character. Directly in the center of the calice there is often a structure called a **columella**, which may appear as a lamella (**lamellar**), a spongy mass (**trabecular**), a single rod (**styliform**), a field of simple or twisted rods (**papillose, fascicular**), or simply a fusion of the inner edges of the larger septa (**rudimentary**). The type of columella is often used to distinguish genera and subgenera.

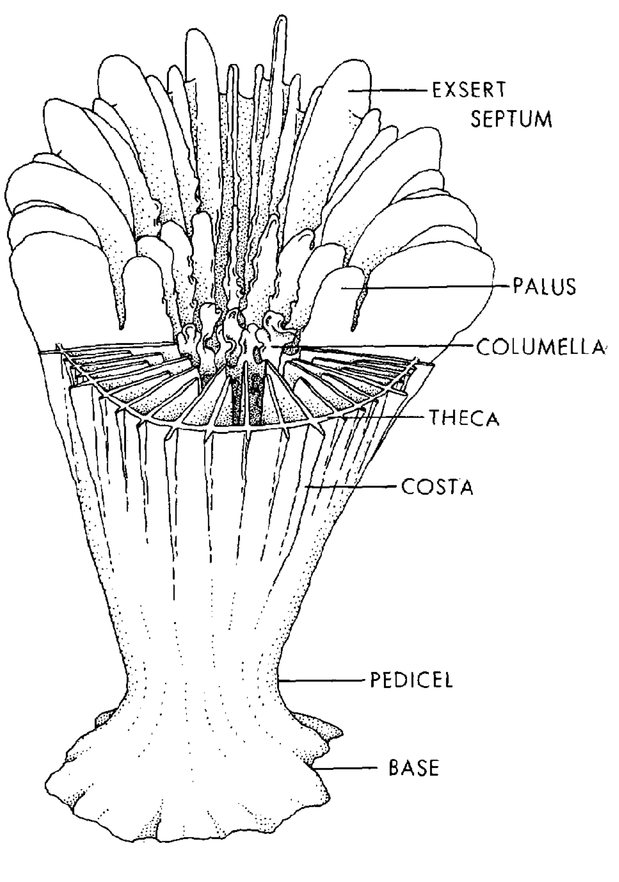

Figure 1.—Cutaway drawing of hypothetical solitary coral illustrating morphological features.

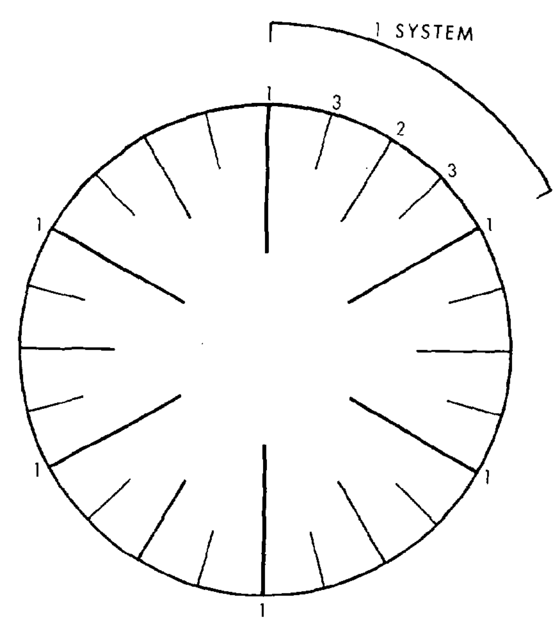

Figure 2.—Diagram of relative sizes and position of septa in a calice containing three cycles (24 septa). Numbers refer to the cycle to which the septum belongs; only the upper right system is completely numbered.

KEYS TO THE SCLERACTINIA OF THE NORTHEASTERN COAST OF THE UNITED STATES

The identification and classification of Scleractinia depend entirely on characteristics of the corallum; therefore, it is generally necessary to remove the tissue from the corallum before using the keys. This is easily accomplished by soaking the coral in full-strength commercial bleach for several hours followed by thorough rinsing. The specimens should then be stored dry.

An illustrated, dichotomous key is presented first, followed by two tabular keys to the same species: one keying the colonial species and the other, the solitary ones. A blank space in the tabular key indicates that this character does not apply to this species.

DICHOTOMOUS KEY

1 Corallum solitary (see tabular key 1) 2

1 Corallum colonial (see tabular key 2) 10

2 (*1*) Corallum firmly attached to substrate 3

2 (*1*) Corallum unattached or attached to small fragment of parent specimen 4

3 (*2*) Five or more cycles of septa ($\geq$96 septa); septa and theca thick, robust; theca granular and costate; inner septal edges straight (Fig. 3) .... *Desmophyllum cristagalli*

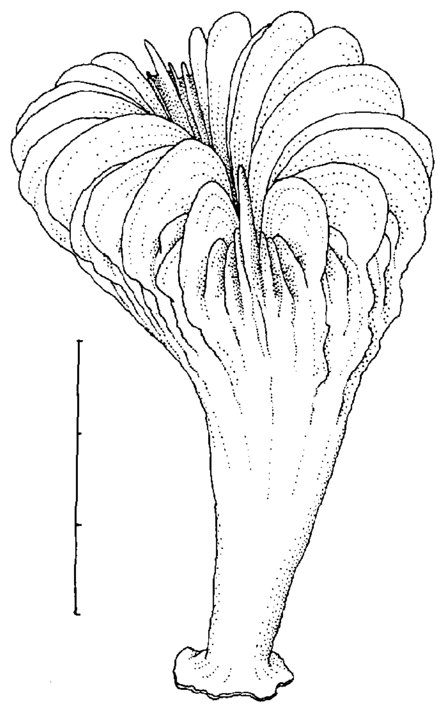

Figure 3.—*Desmophyllum cristagalli*: side view. Scale: 3 cm.

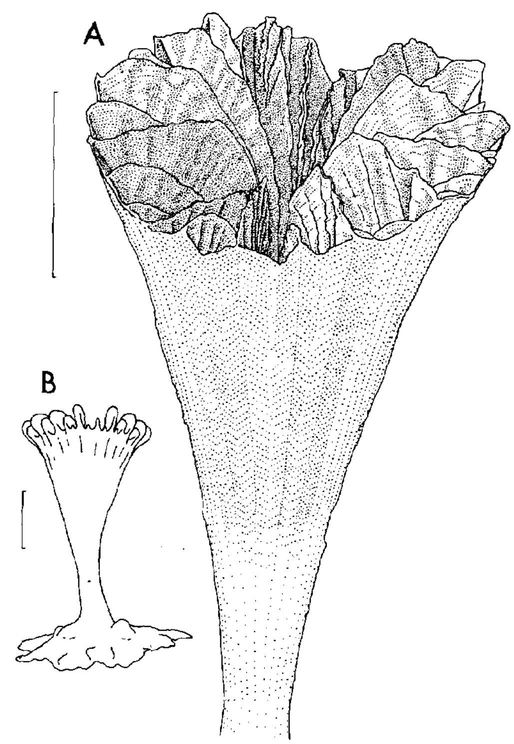

Figure 4.—*Javania cailleti*: A, side view of specimen with damaged upper septal edges; B, side view of specimen with intact septa, illustrating broad, encrusting attachment. Scales: 1 cm.

3 (*2*) Usually four cycles of septa (48 septa), occasionally 64 septa; septa and upper theca very delicate; theca smooth and porcelaneous; inner septal edges sinuous (Fig. 4A, B) .... *Javania cailleti*

4 (*2*) Pali or paliform lobes present 5

4 (*2*) Pali or paliform lobes absent 7

5 (*4*) Corallum attached to fragment of parent corallum or has broken base; corallum fragile, easily fragmented; paliform lobes often multilobate and indistinguishable from the columella (Fig. 5A, B) . . . . *Dasmosmilia lymani*

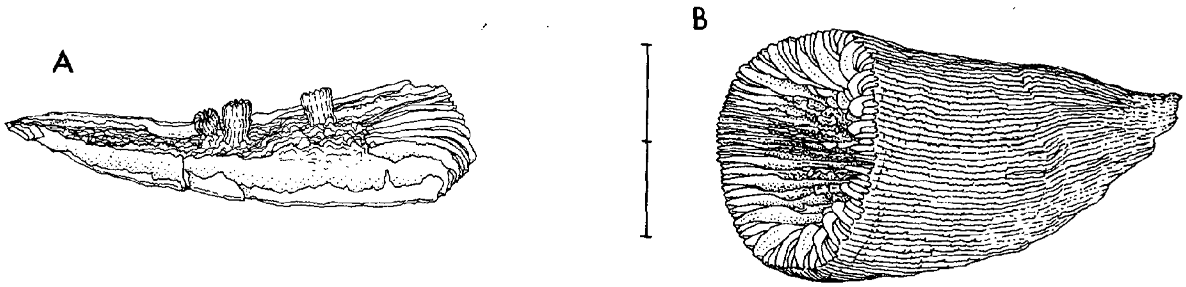

Figure 5.—*Dasmosmilia lymani*: A, fragment of larger parent corallum with three small coralla asexually budding from parent; B, side view of intact corallum. Scale: 2 cm.

5 (*4*) Corallum free, base intact; corallum strong, not easily fragmented; pali single-lobed and distinct from columella 6

6 (*5*) Pali (12–18) of uniform size occur on inner edges of third cycle septa; corallum a curved cone (horn-shaped); calicular diameter up to 40 mm (Fig. 6) . . . . *Caryophyllia ambrosia ambrosia*

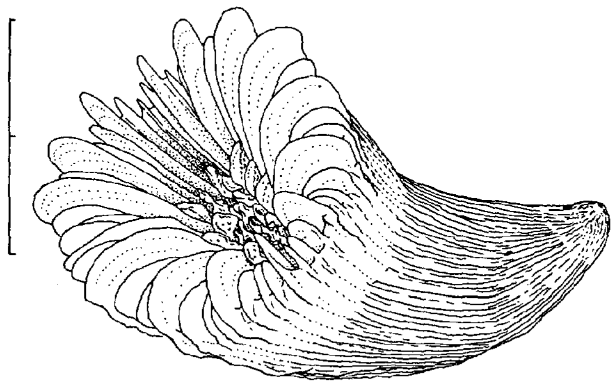

Figure 6.—*Caryophyllia ambrosia ambrosia*: side view showing crown of pali and several central columellar ribbons. Scale: 2 cm.

6 (*5*) Pali of different sizes occur on first, second (sometimes missing), and third cycle septa; corallum conical but not curved; calicular diameter rarely over 15 mm (Fig. 7A, B) . . . . *Deltocyathus italicus*

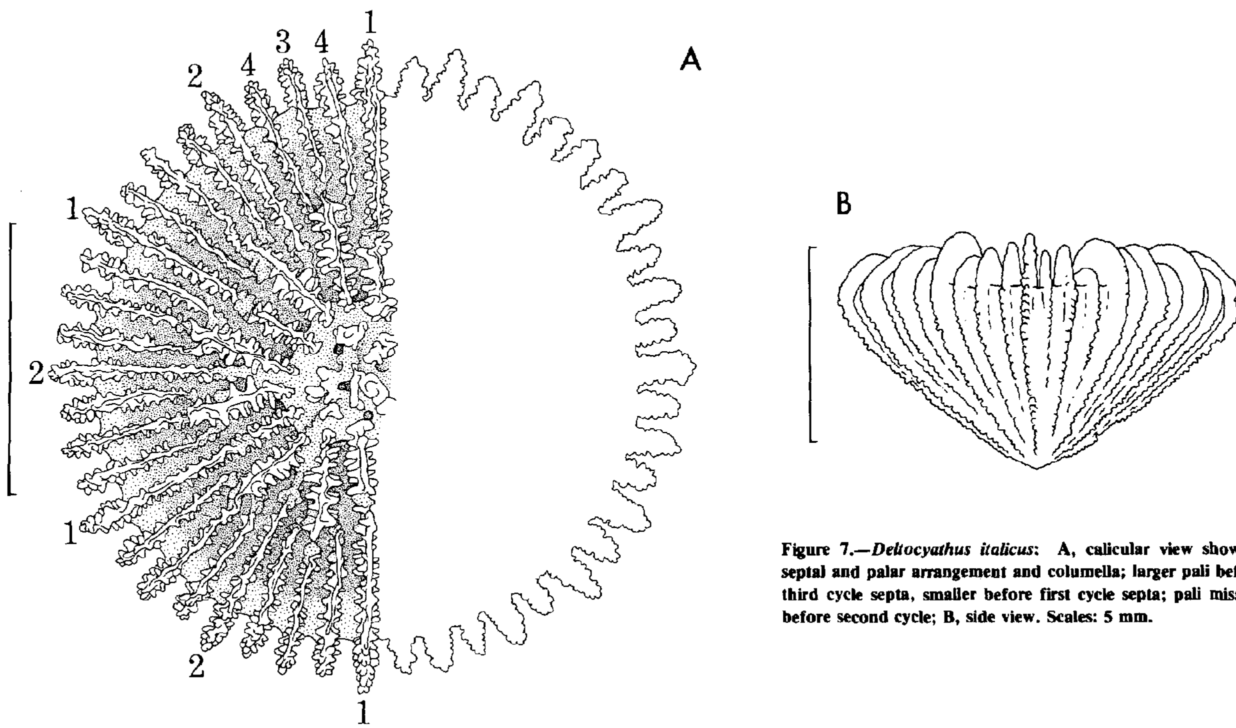

Figure 7.—*Deltocyathus italicus*: A, calicular view showing septal and palar arrangement and columella; larger pali before third cycle septa, smaller before first cycle septa; pali missing before second cycle; B, side view. Scales: 5 mm.

7 (*4*) Corallum discoidal; base flat (Fig. 8) . . . . *Fungiacyathus fragilis*

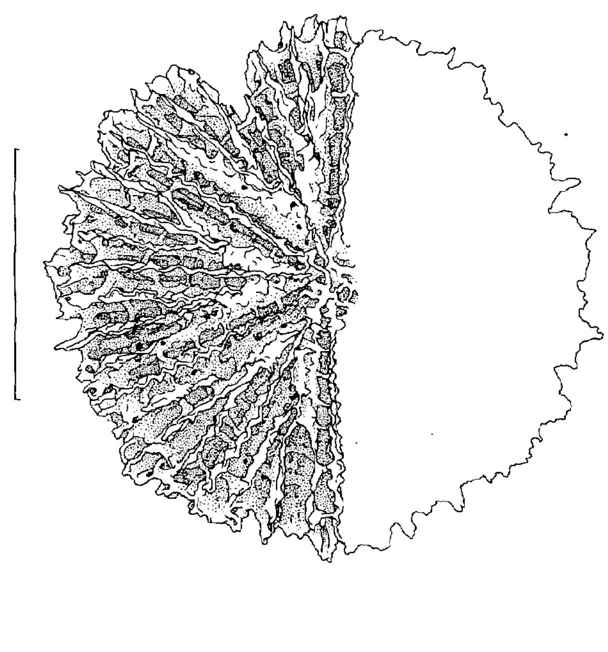

Figure 8.—*Fungiacyathus fragilis*: Calicular view of slightly damaged specimen. Scale: 1 cm.

7 (*4*) Corallum conical, compressed-conical, or fragmented; base not flat 8

8 (7) Rudimentary columella formed by fusion of lower inner edges of larger septa; corallum usually intact 9

8 (7) No columella; corallum invariably fragmented
(Fig. 9) . . . . *Flabellum macandrewi*

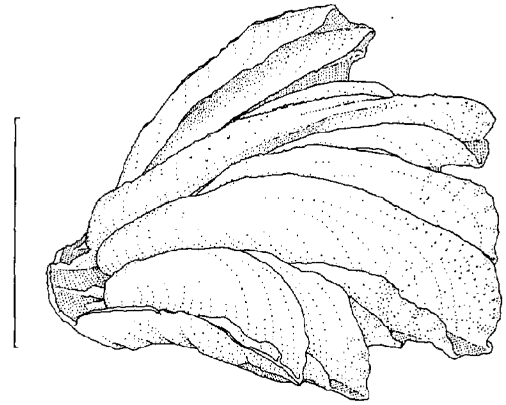

Figure 9.—*Flabellum macandrewi*: side view. Scale: 1 cm.

9 (8) Calice compressed or constricted in center (Fig. 10A, B) . . . . *Flabellum alabastrum*

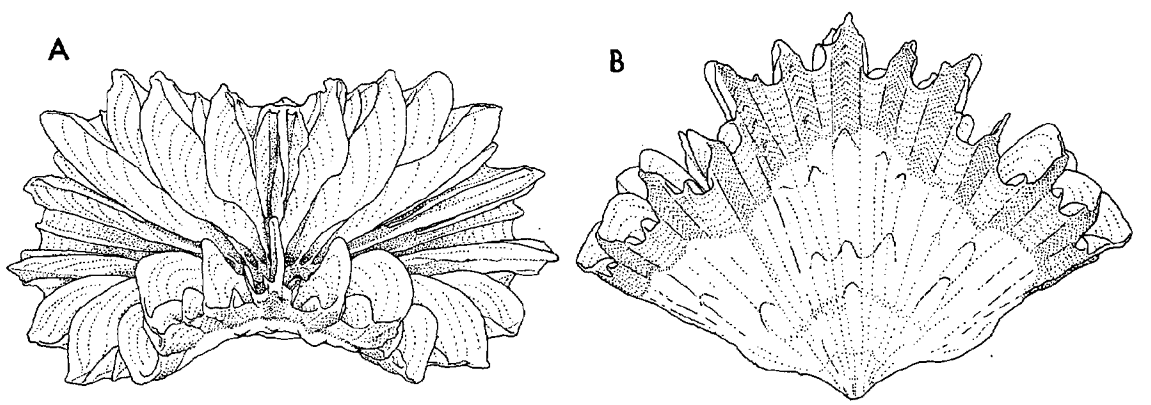

Figure 10.—*Flabellum alabastrum*: A, calicular view showing constricted calice; B, side view. Scale: 2 cm.

9 (8) Calice a regular ellipse (Fig. 11) . .
. . . . *Flabellum angulare*

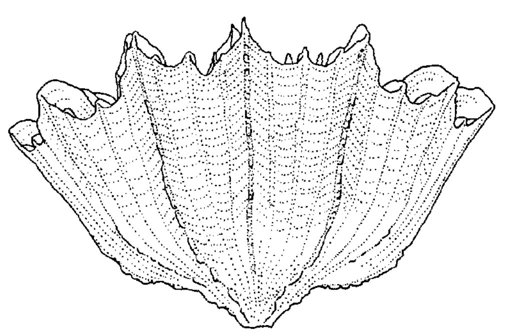

Figure 11.—*Flabellum angulare*: side view. Scale: 2 cm.

10 (*1*) Corallum encrusting, rarely producing short, stubby branches; inner edges of septa dentate; corallites directly adjacent (Fig. 12) .... *Astrangia astreiformis*

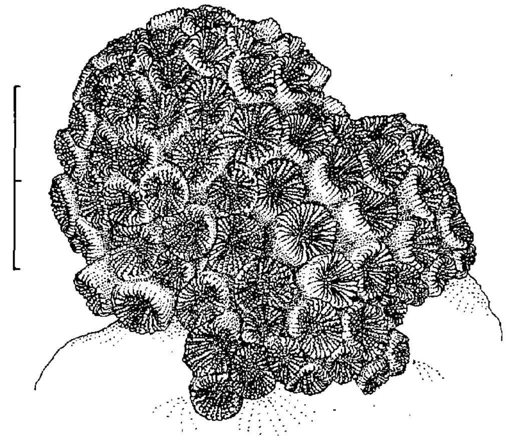

Figure 12.—*Astrangia astreiformis*: an average-sized colony encrusting a rock. Scale: 2 cm.

10 (*1*) Corallum branching, arborescent; inner edges of septa smooth; corallites not directly adjacent 11

11 (*10*) Colonies uniplanar, with calices arranged on only one side; each calice bordered proximally by a rostrum (hood) (Fig. 13A, B) .... *Enallopsammia rostrata*

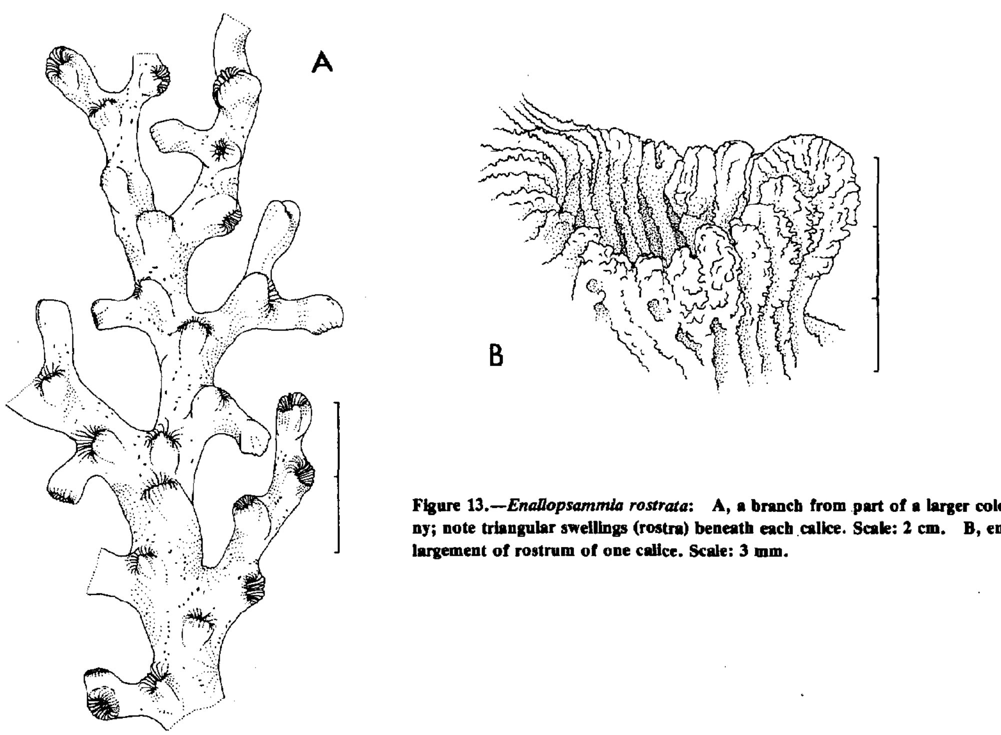

Figure 13.—*Enallopsammia rostrata*: A, a branch from part of a larger colony; note triangular swellings (rostra) beneath each calice. Scale: 2 cm. B, enlargement of rostrum of one calice. Scale: 3 mm.

11 (*10*) Colonies bushy, with calices randomly arranged on branches; no calicular rostra 12

12 (*11*) Columella present; septa not exsert; coenosteum finely porous, especially near calices; usually only 24 septa per calice (Fig. 14) . . . . *Enallopsammia profunda*

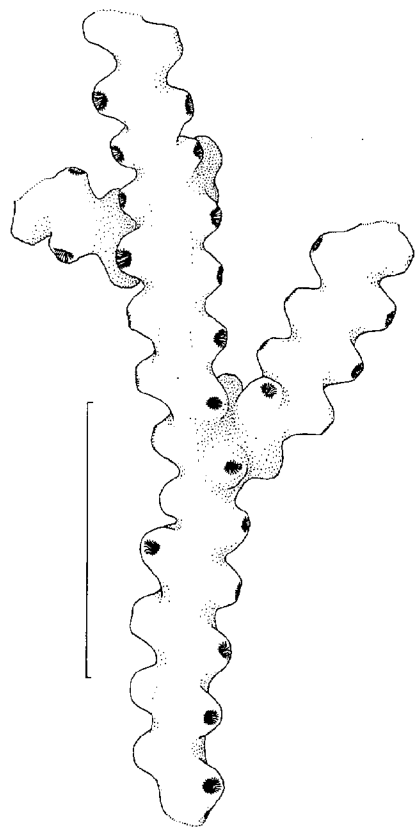

Figure 14.—*Enallopsammia profunda*: a branch from part of a larger colony. Scale: 5 cm.

12 (*11*) Columella absent; septa exsert; coenosteum not porous; usually more than 24 (up to 60) septa per calice 13

13 (*12*) Calices in the process of intratentacular division common (various stages of splitting usually present); first three cycles of septa hexamerally-arranged, septa of fourth and fifth cycles added irregularly; nonsplitting calices rarely exceed 5 mm in calicular diameter; coenosteal costae often extend up to 10 mm from calicular edge. . . . .
(Fig. 15) . . . . *Solenosmilia variabilis*

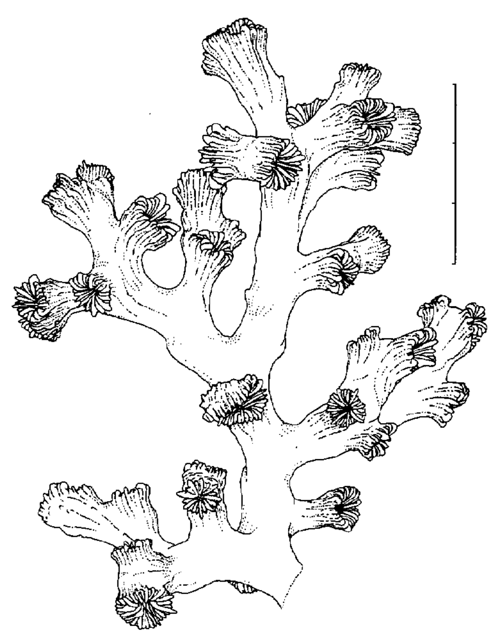

Figure 15.—*Solenosmilia variabilis*: a distal branch of a larger colony. Scale: 3 cm.

13 (*12*) Calices in process of intratentacular division rare (most calices, even terminal ones, appear discrete); septa not hexamerally arranged; calices up to 15 mm in calicular diameter; coenosteal costae rarely extend more than 5 mm from calicular edge (Fig. 16) . . . . *Lophelia prolifera*

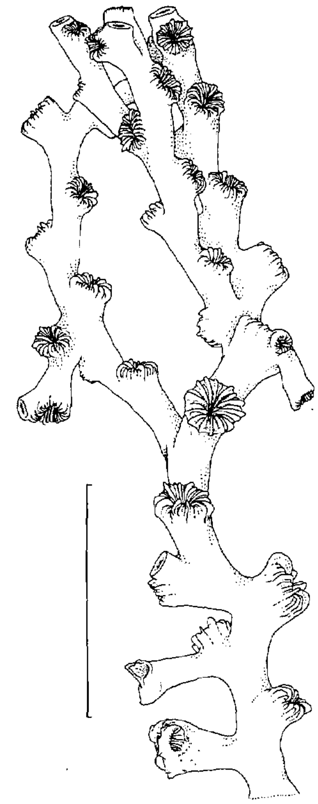

Figure 16.—*Lophelia prolifera*: a branch from part of a larger colony. Scale: 5 cm.

Table 1.—Tabular key for solitary species.

	Corallum attachment[1]	Septal height[2]	Thecal texture[3]	Pali, paliform lobes[4]	Asexual budding[5]	Corallum fragility[6]	Columella[7]
Fingiacyathus fragilis	f	e	g	O	O	vf	s
Caryophyllia ambrosia	c	e	p	1	O	r	f
Dasmosmilia lymani	c	n	g	2	+	f	r
Deltocyathus italicus	c	e	g	2	O	r	f
Flabellum alabastrum[8]	c	e	p	O	O	f	r
Flabellum macandrewi		e	p	O	O	vf	O
Flabellum angulare[8]	c	e	p	O	O	f	r
Desmophyllum cristagalli	a	e	g	O	O	r	O
Javania cailleti	a	e	p	O	O	r	r

[1]Attachment of corallum: a—attached; f—unattached, flat base; c—unattached, conical base.
[2]Height of septa: e—exsert; n—not exsert.
[3]Texture of theca: p—porcelaneous; g—granular.
[4]Presence of pali or paliform lobes: O—absent; 1—on third cycle septa; 2—on all but last cycle septa.
[5]Asexual budding: +—present; O—absent.
[6]Fragility of corallum: r—robust, usually intact; f—fragile, easily broken; vf—very fragile, usually found in fragments.
[7]Columella: O—absent; r—rudimentary; f—fascicular (rods, twisted ribbons, papillose); s—trabecular (spongy).
[8]*Flabellum alabastrum* and *F. angulare* differ mainly in the shape of their coralla, which is not a coded character in this key.

Table 2.—Tabular key for colonial species.

	Corallum shape[1]	Inner septal edges[2]	Calicular orientation[3]	Calicular rostrum[4]	Budding[5]	Columella[6]	Septal height[7]	Coenosteal texture[8]	Septal arrangement[9]
Astrangia astreiformis	e	d		O	e	p	n	s	h
Lophelia prolifera	a	s	2	O	is	O	e	s	i
Solenosmilia variabilis	a	s	2	O	id	O	e	s	i
Enallopsammia profunda	a	s	2	O	e	s	n	p	h
Enallopsammia rostrata	a	s	1	r	e	s	e	p	h

[1]Shape of corallum: a—arborescent; e—encrusting.
[2]Inner edges of septa: d—dentate; s—smooth.
[3]Orientation of calices on branch: 1—calices occur on only one side of branch; colony uniplanar; 2—calices occur on all sides of branch; colony bushy.
[4]Calicular rostrum: r—present; O—absent.
[5]Budding: e—extratentacular; is—intratentacular, sympodial; id—intratentacular, dichotomous.
[6]Columella: s—spongy; p—papillose; O—absent.
[7]Height of septa: e—exsert; n—not exsert.
[8]Texture of coenosteum near calice: p—porous; s—solid.
[9]Arrangement of septa: h—hexameral; i—irregular.

ANNOTATED SYSTEMATIC LIST

This list follows the classification proposed by Wells (1956). Genera are arranged alphabetically within families. Geographic ranges include all published records and data from additional specimens examined at the National Museum of Natural History, Smithsonian; Yale Peabody Museum; and Museum of Comparative Zoology, Harvard. References to significant papers are cited in brackets at the end of each account.

Suborder **FUNGIINA**
Superfamily **FUNGIICAE**
Family **FUNGIIDAE**

Fungiacyathus fragilis Sars, 1872. Distribution probably world wide. In western Atlantic, known from continental slope south of Cape Cod, Mass. (412-460 m), 5.5°-6.1°C. Also known from eastern Atlantic, off Hawaii, and south of New Zealand (285-2,200 m). Because of its fragility it is usually damaged or in fragments when collected. It is distinguished from other closely related species by its possession of five cycles of septa and septa with sinuous upper edges. [Zibrowius 1980.]

Suborder **FAVIINA**
Superfamily **FAVIICAE**
Family **RHIZANGIIDAE**

***Astrangia astreiformis* Milne Edwards and Haime, 1849 (=*Astrangia danae* Agassiz, 1850; not *Astrangia danae* Milne Edwards and Haime, 1849). Star coral, Northern coral. Massachusetts to Texas from low tide to 35 m (−1°-22°C). This is the only scleractinian likely to be seen by snorkeling or with scuba off the northeastern coast of the United States. Also known from Puerto Rico and off tropical western Africa. Common on any hard substrate, i.e., stones, shells, pilings. May or may not have zooxanthellae. Often used as an experimental laboratory animal. Physiological studies include: Cummings (1976); Jacques et al. (1977); Szmant-Froelich and Pilson (1977); and Jacques (1978). Natural history accounts include: Agassiz (1850); Fewkes (1889); and Bachand (1978).**

Milne Edwards and Haime (1849) described both *Astrangia astreiformis* and *A. danae* in the same paper; *A. danae* has page priority but, because the type is lost, the description is poor, and the type-locality is unknown, it is considered a *nomen dubium*. The type of *A. astreiformis* is also lost, but because Milne Edwards and Haime at least designated the type-locality of United States, it is chosen as the valid name for the common shallow-water *Astrangia* of the eastern and Gulf coasts. Louis Agassiz, in a paper read on 15 August 1849, independently described the same species and called it *Astrangia danae*, but because his account was not published until 1850, it is a junior synonym of *A. astreiformis*.

Suborder **CARYOPHYLLIINA**
Superfamily **CARYOPHYLLIICAE**
Family **CARYOPHYLLIIDAE**

Caryophyllia ambrosia ambrosia Alcock, 1898. Continental slope off Georges Bank (1,487-2,286 m), 3.3°-4.2°C. Also known from eastern Atlantic and Indian Oceans (1,600-2,670 m). The other subspecies, *C. ambrosia caribbeana* Cairns, 1979, is found in more southern, shallower waters. It differs in having a broader, more open corallum and a rougher thecal texture. [Zibrowius 1980.]

Dasmosmilia lymani (Pourtalès, 1871). Common on outer edge of continental shelf from Alabama to south of Cape Cod, Mass. (48-366 m), 7°-21°C. Also known from off Venezuela, southeastern Brazil, and, in the eastern Atlantic, in area bordered by Portugal, the Azores, and Spanish Sahara (85-316 m). This species most frequently propagates by asexual budding from longitudinal fractures of the fragile corallum. Five to ten small buds originating from one wedge-shaped fragment are not uncommon. This is the most commonly collected coral from the study area and is not likely to be confused with any other species. [Cairns 1979.]

Deltocyathus italicus (Michelotti, 1838). Common from Florida to southern Brazil, including Gulf of Mexico and Caribbean; Bermuda (403-2,634 m), 3°-7°C. One disjunct record on continental slope off New Jersey (*Albatross* station 2103), 4°C. Also known from eastern Atlantic and Azores (1,500-2,300 m). Some deepwater trawls result in hundreds of specimens. Distinguished from other species in this genus by its distinctive conical base and frequent absence of pali on the second cycle septa. Coralla of some specimens have a pink pigmentation. [Cairns 1979.]

Desmophyllum cristagalli Milne Edwards and Haime, 1848. Cosmopolitan: widespread in Atlantic, Pacific, and Indian Oceans; Subantarctic; off Georges, Sable, and Grand Banks (off New England coast); Muir Seamount and seamounts between San Pablo and Kelvin Seamounts (off New England coast). Worldwide depth range: 35-2,460 m. This species has no columella or pali. Polyp light orange. Found in great numbers on undersides of ledges in Lydonia Canyon, off Massachusetts. [Cairns 1979.]

Lophelia prolifera (Pallas, 1766)(=?*L. pertusa* (Linnaeus, 1758) *nomen dubium*). Common in western Atlantic from Nova Scotia to southeastern Brazil (95-1,000 m), 3°-12°C. Also known from eastern Atlantic, Indian, and Pacific Oceans (60-2,170 m). Abundant on Blake Plateau and in Straits of Florida as a major constituent of deepwater coral banks. Growth rate 6-8 mm/yr. Systematics [Cairns 1979]; ecology [Wilson 1979a, b].

Solenosmilia variabilis Duncan, 1873. Known from only two records off northeastern United States: Lydonia Canyon, off Cape Cod, Mass., and south of San Pablo Seamount. Also known from Muir Seamount; continental slopes from Georgia to southeastern Brazil (excluding Gulf of Mexico); eastern Atlantic; south of Greenland and Iceland; Indian Ocean; off southeastern Australia (280-2,165 m). Similar to *L. prolifera* but easily distinguished by its equal, intratentacular budding, which always produces some terminal calices that are in the process of splitting in two. Polyps light orange.

Superfamily **FLABELLICAE**
Family **FLABELLIDAE**

Flabellum alabastrum Moseley, 1873 (=*Flabellum goodei* Verrill, 1878. in part). Common on continental slope from Georgia to Davis Strait, including Gulf of Maine (357-1,977 m), 3.3°-7.0°C. Also known from eastern Atlantic from off Hebrides to Gulf of Guinea (1,200-2,000 m). Corallum sometimes reddish brown. [Zibrowius 1980.]

Flabellum macandrewi Gray, 1849 (= *Flabellum goodei* Verrill, 1878, in part). Fairly common on continental slope from Virginia to Nova Scotia (180–667 m), 4.5°–8.3°C. Also known in eastern Atlantic from Norway to Senegal (128–1,170 m), 5°–7°C. Very similar to previous species but differs in that it 1) is invariably found in fragments having 3–24 septa, 2) lacks a columella, 3) has a more jagged calicular edge, and 4) has a shallower bathymetric range. [Zibrowius 1980.]

Flabellum angulare Moseley, 1876. Known from southern Nova Scotia south to the continental slope of South Carolina (2,266–3,186 m), 2.5°–5.0°C. Also known in the eastern Atlantic from off Scotland south to Morocco and the Azores (1,647–2,800 m). Very similar to *F. alabastrum* but differing in that 1) the outline of the calice is always elliptical, not constricted, and 2) the corallum is always white, never reddish brown. [Zibrowius 1980.]

Javania cailleti (Duchassaing and Michelotti, 1864) (= *Desmophyllum eburneum* Moseley, 1881; *Desmophyllum nobile* Verrill, 1885). Known from off Banquereau Bank, Nova Scotia, south to Oceanographer Canyon, off Cape Cod, Mass., and the continental slope of Georgia south to Burdwood Bank, Argentina; eastern Atlantic; Indian and Pacific Oceans (400–2,165 m), 6°–16°C. Distinguished from *Desmophyllum cristagalli* by a lesser number of septa and porcelaneous theca; however, probably indistinguishable in situ, i.e., from a submersible. [Cairns 1979.]

Suborder **DENDROPHYLLIINA**
Family **DENDROPHYLLIIDAE**

Enallopsammia profunda (Pourtales, 1867). Known from only three records off northeastern United States, all on continental slope off Georges Bank (1,211–1,748 m), 3.5°–3.7°C. Also known from continental slope from South Carolina south through Straits of Florida and Lesser Antilles (403–1,337 m), 3°–12°C. Abundant on Blake Plateau and in Straits of Florida where, along with *Lophelia prolifera*, it is a primary constituent of deepwater coral banks. [Cairns 1979.]

Enallopsammia rostrata (Pourtalès, 1878)(= *Enallopsammia amphelioides* (Alcock, 1902)). Known from only three records off northeastern United States: continental slopes off San Pablo, New England, and Atlantis II Seamounts (1,174–1,646 m). Also known from continental slope from Georgia to Brazil (5°–13°C.); eastern Atlantic, western and central Pacific, Indian Oceans, and south of New Zealand (229–2,165 m). Requires hard substrate to support large corallum. Each calice bordered by a rostrum. [Cairns 1979.]

SELECTED BIBLIOGRAPHY

AGASSIZ, L.
1850. On the structure of coral animals. Proc. Am. Assoc. Adv. Sci. 2:68–77.

ALCOCK, A.
1898. An account of the deep-sea Madreporaria collected by the royal marine survey ship Investigator. Trustees Indian Museum, Calcutta, 29 p., 3 pls.
1902. Report on the Deep-sea Madreporaria of the Siboga-Expedition. Siboga Exped. 16a, 51 p., 5 pls.

BACHAND, R. G.
1978. Cold water coral. Sea Front. 24:283.

CAIRNS, S. D.
1979. The deep-water Scleractinia of the Caribbean Sea and adjacent waters. Stud. Fauna Curaçao Other Caribb. Isl. 57(180), 341 p. including 40 pls.

CUMMINGS, C. E.
1976. The effects of temperature and salinity on the survival and respiration of *Astrangia danae* with and without zooxanthellae. M.S. Thesis, Univ. Rhode Island.

DUCHASSAING, P., and J. MICHELOTTI.
1864. Supplément au mémoire sur les coralliaires des Antilles. Mem. Acad. Sci. Turin, Ser. 2, 23:97–206.

DUNCAN, P. M.
1873. A description of the Madreporaria dredged up during the expeditions of H.M.S. 'Porcupine' in 1869 and 1870. Part 1. Trans. Zool. Soc. Lond. 8:303–344, pls. 39–49.

FEWKES, J. W.
1889. The anatomy of *Astrangia danae*. Smithsonian Inst., Wash., D.C., 22 p., 6 pls.

GRAY, J. E.
1849. Description of some corals, including a new British coral discovered by W. MacAndrew, Esq. Proc. Zool. Soc. Lond. 17:74–77.

JACQUES, T. G.
1978. Metabolism and calcification of the temperate scleractinian coral *Astrangia danae*. Ph.D. Thesis, Univ. Rhode Island, Kingston, 187 p.

JACQUES, T. G., M. E. Q. PILSON, C. E. CUMMINGS, and N. MARSHALL.
1977. Laboratory observations on respiration, photosynthesis, and factors affecting calcification in the temperate coral *Astrangia danae*. Proc. Third Int. Coral Reef Symp. 2:455–461.

KELLER, N. B.
1976. Glubokovodnee madreporovee koralle roda Fungiacyathus iz kurilo-kamchatskogo i aleutskogo zhelobovoi nekotorekh drugikh rajonov mirovogo okeana. (The deep-sea madreporarian corals of the genus *Fungiacyathus* from the Kurile-Kamchatka Aleutian trenches and other regions of world ocean.) Tr. P. P. Shirshov Inst., Okeanol. Akad. Nauk SSSR 99:31–44, 3 pls.

LINNAEUS, C.
1758. Systema naturae. 10th ed. Vol. I, 824 p.

MICHELOTTI, G.
1838. Specimen zoophytologiae diluvianae. Turin, 222 p., 7 pls.

MILNE EDWARDS, H., and J. HAIME.
1848. Recherches sur les polypiers. Mémoire 2. Monographie des Turbinolides. Ann. Sci. Nat., Ser. 3, 9:211–344, pls. 7–10.
1849. Recherches sur les polypiers. Mémoire 4. Monographie des Astréides (1). Ann. Sci. Nat., Ser. 3, 12:95–197.

MOSELEY, H. N.
1873. Figs. 2-3. *In* W. Thomson, Notes from the "Challenger" VII. Nature (Lond.) 8:400–403, 6 figs.
1876. Preliminary report to Professor Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff, on the true corals dredged by H.M.S. 'Challenger' in deep water between the dates Dec. 30th, 1870, and August 31st, 1875. Proc. R. Soc. Lond. 24:544–569, 1 fig.
1881. Part III.—On the deep-sea Madreporaria. Rep. Sci. Results Voyage H.M.S. Challenger, Zool. 2:127–208, 238–248, 16 pls., 21 figs.

PALLAS, P. S.
1766. Elenchus Zoophytorum. Hagae Comitum, 451 p.

POURTALÈS, L. F. de
1867. Contributions to the fauna of the Gulf Stream at great depths. Bull. Mus. Comp. Zoöl. Harv. Coll. 1:103–120.
1871. Deep-sea corals. Illustr. Cat. Mus. Comp. Zoöl. Harv. Coll. 4, 93 p., 8 pls.
1878. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer "Blake," Lieutenant-Commander C. D. Sigsbee, U.S.N., commanding. Corals. Bull. Mus. Comp. Zoöl. Harv. Coll. 5:197–212, 1 pl.

SARS, G. O.
1872. On some remarkable forms of animal life from the great deeps off the Norwegian coast. I. Brøgger & Christie, Christiania, 82 p., 6 pls.

SZMANT-FROELICH, A., and M. E. Q. PILSON.
1977. Nitrogen excretion by colonies of the temperate coral *Astrangia danae* with and without zooxanthellae. Proc. Third Int. Coral Reef Symp. 2:417–424.

VERRILL, A. E.
1878. Notice of recent additions to the marine fauna of the eastern coast of North America, no. 2. Am. J. Sci. Arts, Ser. 3, 16:371–378.

1885. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, no. 11. Am. J. Sci., Ser. 3, 29:149-157.

WELLS, J. W.

1956. Scleractinia. *In* R. C. Moore (editor), Treatise on invertebrate paleontology. Part F, Coelenterata, p. 328-444, figs. 222-339. Univ. Kansas Press, Lawrence.

WILSON, J. B.

1979a. The distribution of the coral *Lophelia pertusa* (L.) [*L. prolifera* (Pallas)] in the north-east Atlantic. J. Mar. Biol. Assoc. U.K. 59:149-164.

1979b. 'Patch' development of the deep-water coral *Lophelia pertusa* (L.) on Rockall Bank. J. Mar. Biol. Assoc. U.K. 59:165-177.

ZIBROWIUS, H.

1980 Les Scléractiniaires de la Méditerranée et de l'Atlantique nord-oriental. Mém. Inst. Oceanogr., Monaco 11:284 p., 107 pls.

SYSTEMATIC INDEX

ACKNOWLEDGMENTS

Preparation of the "Marine Flora and Fauna of the Northeastern United States" is being coordinated by the following Board:

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Thanks are expressed to Duane Hope, Department of Invertebrate Zoology, Smithsonian Institution, for permitting the author to work at the National Museum of Natural History during this study. Preparation of the illustrations by Charles G. Messing is also gratefully acknowledged.

COORDINATING EDITOR'S COMMENTS

Publication of the "Marine Flora and Fauna of the Northeastern United States" is most timely in view of the growing universal emphasis on environmental work and the urgent need for more precise and complete identification of coastal organisms than has been available. It is mandatory, where possible, that organisms be identified accurately to species. Accurate scientific names unlock the great quantities of biological information stored in libraries, obviate duplication of research already done, and often make possible prediction of attributes of organisms that have been inadequately studied.

Stephen Cairns started his research on Scleractinia at the Rosenstiel School of Marine and Atmospheric Science, University of Miami, where he studied the deepwater corals of the western Atlantic. He has continued his studies as a Research Associate at the Smithsonian Institution, with an emphasis on western Atlantic, Hawaiian, and Antarctic Scleractinia and Antarctic Stylasterina.

Preparation of this manual was supported in part by a grant from the Environmental Protection Agency to the Editorial Board of the "Marine Flora and Fauna of the Northeastern United States." Work on the "Marine Flora and Fauna of the Northeastern United States" by the Coordinating Editor is supported by the College of Marine Studies, University of Delaware.

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TABLES (provide headings, including "Table" and Arabic numeral, e.g., Table 1.--, Table 2.--, etc.)
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FIGURES

ADDITIONAL INFORMATION

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