

# American Museum Novitates

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PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY  
CENTRAL PARK WEST AT 79TH STREET, NEW YORK 24, N.Y.

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NUMBER 1965

SEPTEMBER 16, 1959

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## Deep Sea Corals Collected by the Lamont Geological Observatory. I Atlantic Corals<sup>1</sup>

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### INTRODUCTION

The present study records those corals collected by the staff of the Lamont Geological Observatory, Columbia University, during various cruises in the Atlantic from the opening of the laboratory through the year 1956. These early collections are quite scant, as, in a majority of cases, the collections were made incidental to geological or geophysical work. The staff of the Observatory and their associates are to be commended for preserving such materials as came to hand in the course of other work. The quality of the specimens is not often so good as that of materials taken in biologic trawling, because recovery was usually from rock dredges, and the corals had been knocked around a bit. Several specimens were found in cores, and in one case corals that had become tangled in the lead chain of the rock dredge were collected.

Since 1956 a biological program at the Lamont Geological Observatory under the direction of Dr. Robert Menzies has resulted in an increased number of biologic trawls. Specimens of these collections will be the subject of subsequent studies. At the present time, the work conducted by the Lamont Geological Observatory constitutes the major deep-sea collecting effort made by an institution in the United States.

The Lamont Geological Observatory has an excellent file of deep-sea

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<sup>1</sup> Contribution from the Lamont Geological Observatory number 351; Biological Laboratories number 23.

photographs. Of those photographs in which stony corals are apparent, the most satisfactory are reproduced here. It is of particular interest to students of the corals, as well as marine biologists in general, to note the occurrence of the deep-sea corals. Although there are thicket-like banks of some of the branching corals, a majority of the forms must be of the types seen in these photographs, that is, more or less isolated, "shrub-like" growths. As bottom trawling today does not permit a quantitative sampling of the bottom fauna, it is difficult to visualize the densities of population. Factors such as time on bottom, speed of haul, and drag on dredge give only the roughest approximation of the actual collecting time of the gear used. Grab sampling, which would provide a quantitative measure of population density, is as yet impractical in deep waters, and therefore photography provides the best tool yet devised for enumerating populations in the deeper portions of the sea. To a great extent, density estimates based on specimen numbers are complicated by the tendency of colonial coralla to fragment into many pieces.

One of the major drawbacks of deep-sea photography is that pictures are seldom obtained of the area sampled, owing to the technical difficulties presented in getting two or more wires safely overboard and back on ship with their attached gear, and the time required to do both operations independently. Even photographs of the best quality seldom permit generic identifications, although the temptation to identify the specimens photographed is great. Growth form and details of proportional size of portions of the corallum may be misleading or inconclusive in the recognition of coral species, although suggestive of affinities. A sampling of specimens photographed by apparatus now being used is a fortuitous circumstance, but one that can be recorded here. On August 8, 1955, a photographic station was being made at position latitude  $38^{\circ} 09' N.$ , longitude  $61^{\circ} 05' W.$  on the side of a seamount. Two Clarke-Bumpus plankton nets attached to the cross arms of the camera gear became entangled in specimens when the camera gear was accidentally lowered to the bottom, presumably the same individuals that had previously been photographed. This is the first occurrence of the simultaneous photography and collection of specimens at a depth of 3300 meters known to me.

The corals considered here belong to the group termed ahermatypic, the non-reef-building forms. Our knowledge of these corals is based almost exclusively on the results of dredging operations, which have been rather extensive in the Atlantic and have made these faunas among the best known. Such well-known biologic cruises as those of the

"Challenger," "Thor," "Valdivia," and "Porcupine" and the several voyages under the sponsorship of Prince Albert I of Monaco are responsible for our knowledge of the types and distribution of the coral fauna. Regional collecting is often of greater significance, for these operations are frequently more intensive. Notable are the collections of the various United States Coast and Geodetic Survey vessels in the Caribbean and western Atlantic region recorded by Pourtalès, Agassiz, and others. Characteristic of much of this older work (large-scale dredging operations have not been carried out for several decades) is a tendency to separate morphologic variants into species, which has resulted in a plethora of names. Some of the earlier works are also marred by poor illustrations (by modern standards) and inadequate descriptions.

The term "deep-sea" used in this study refers to the most general connotations of the phrase, particularly as encountered in some of the coral literature. According to the system given by Hedgepeth (1957), all but three of the stations are bathyal, the exceptions being from "sublittoral" depths but isolated from the continental shelf and directly related to bathyal forms. The major division of corals into hermatypic and ahermatypic (Wells, 1933, p. 109) refers to the biologic division between reef-forming and non-reef-forming corals. Included within the ahermatypic group are a large number of genera of often diverse ecologies. The important group of sublittoral rhizangiid corals is placed there and is found in a much wider distribution than the hermatypic corals, but is apparently restricted in depth distribution. A large and diverse group of genera, including several discussed in this paper, e.g., *Dendrophyllia*, is found associated with reefs both in shallow and deep waters and ranges well outside the distribution of the hermatypic corals. The remainder of the ahermatypic corals, including the majority of genera discussed here, are deeper-water forms found in waters up to 4000 meters but which may occur in shallower cold waters. These then are the deep-sea corals, sometimes referred to as the simple corals. This is a misnomer; for, although solitary forms are most frequently encountered in deep waters, colonial forms are not absent.

Before any synthesis of the distribution of the deeper water faunas can be made, together with interpretations of the causes and effects, some pattern must be made of the occurrence of species. Although many taxonomic characters of the Scleractinia are not adaptable to mensuration, as many data as possible are recorded here for those samples that warranted treatment. It is possible that the accumulation of such data may give insight into the great population variability observed for these corals.

Although macrofossils collected from depth in the seas are not as yet commonly found, those that have been obtained have been of great interest. Notable among these are Cretaceous corals found in boulders atop several flat-topped seamounts in the Pacific (Hamilton, 1956). To date there is nothing of comparable antiquity from the Atlantic, although several Pleistocene records are included in this paper. Rock dredging on the flat-topped seamounts of the eastern Atlantic brought up large quantities of discoidal cobbles (Heezen and others, MS) containing shells of various invertebrates. Although superficially similar, the matrix of the cobbles was found to be quite dissimilar, and the faunal contents were quite varied. It seems obvious that these may represent erosional remnants from several horizons. Those containing corals were among the youngest, judging from the state of preservation and what carbon-14 dating determinations are available, and are believed in each case to be sub-Recent or Recent in age.

Several coral fragments contained in cores are noted here. All of these are well documented by foraminiferal assemblages as Pleistocene. In one instance, the presence of coral material of this age at the base of a 70-cm. core may be considered anomalous, but the core probably represents a sequence of slumping sediments. All the corals found in the collections discussed here are those that favor a firm or rocky substrate. Indeed, the likelihood of obtaining corals in cores of undisturbed sediments is rather low, as the presumed population density of the soft substrate species is relatively low.

#### ACKNOWLEDGMENTS

It is a pleasure to record the cooperation and encouragement received from members of the staff of the Lamont Geological Observatory. Drs. Robert Menzies and Bruce Heezen aided in the assembling of collections, photographs, and data. Dr. Heezen also provided an unpublished manuscript (Heezen and others, MS) which contained much unrecorded data on the expeditions that had collected these specimens. Dr. John W. Wells, Cornell University, has read the manuscript and made several suggestions on the specific relationships discussed in the text. Mr. Joel Kaplan, Great Neck, New York, compiled the measurements and statistical data.

#### LOCALITIES

Distribution of the stations from which specimens were obtained is shown on figure 1. The stations are widely scattered because of the incidental nature of the collections. Table 1 gives details of the sta-

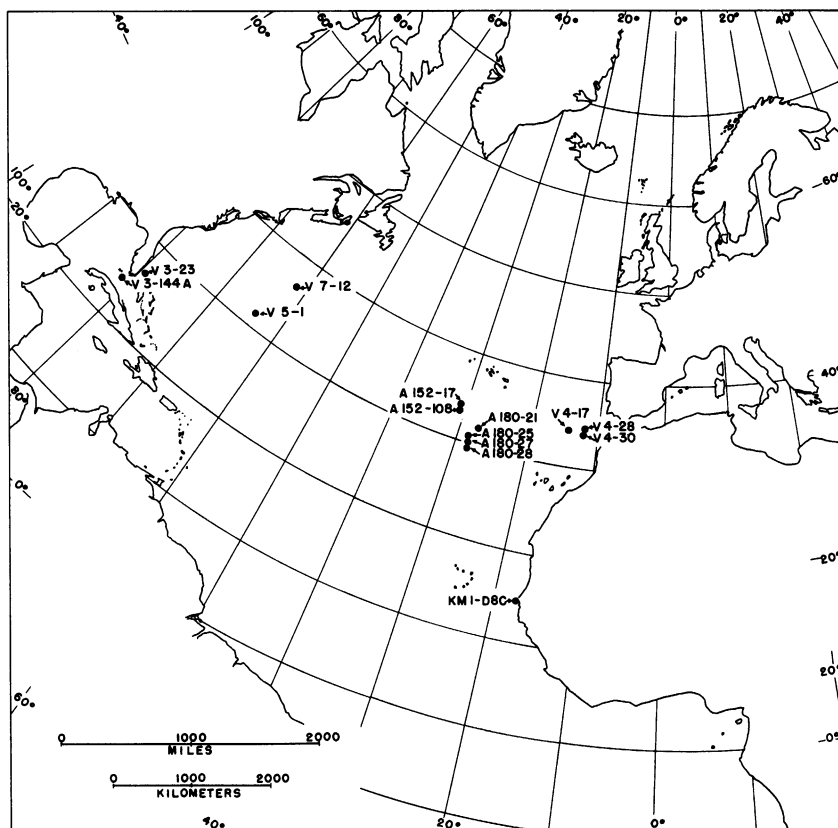


FIG. 1. Stations at which the corals were collected are indicated by collection numbers and prefix letters referring to the cruise vessel (see table 1).

tions occupied, as well as a listing of those species recovered from each one. Letters prefixing the station numbers refer to the various cruise vessels: "KM", "Kevin Moran"; "A", "Atlantis" (both of the preceding were cooperative efforts with Woods Hole Oceanographic Institute); "V," the Lamont Geological Observatory R/V "Vema."

## SYSTEMATICS

### FAMILY OCULINIDAE

#### GENUS *MADREPORA* LINNAEUS, 1758

#### *Madrepora oculata* Linnaeus, 1758

*Madrepora oculata* LINNAEUS, 1758, *Systema naturae*, ed. 10, p. 798.

*Amphihelia oculata* (Linnaeus) DUNCAN, 1873, *Trans. Roy. Soc. London*, vol. 8, p. 326, pl. 45, figs. 1-3. MARENZELLER, 1904, in Chun, *Wissenschaftliche*

TABLE 1  
LOCALITIES OF DEEP SEA CORAL COLLECTIONS OF THE LAMONT GEOLOGICAL OBSERVATORY

Station Number	Type of Gear	Date	Locality	Latitude	Longitude	Depth (Meters)	Species Collected
A150-17	Rock dredge	8/23/47	Atlantis Seamount	34° 01.5' N.	30° 11.5' W.	540	<i>Dendrophyllia cornigera</i> <i>Lophelia prolifera</i>
A152-108	Rock dredge with sediment catcher	8/48	Atlantis Seamount	34° 08.6' N.	30° 14.2' W.	540	<i>Desmophyllum cristagalli</i> <i>Dendrophyllia cornigera</i> <i>Balanophyllia formosa</i>
A180-21	Piston core	8/48	Cruiser Seamount	32° 23' N.	27° 38.5' W.	730	<i>Desmophyllum cristagalli</i> <i>Madrepora oculata</i>
A180-25	Piston core	8/48	Great Meteor Seamount	30° 14' N.	28° 26' W.	1685	<i>Lophelia prolifera</i> <sup>a</sup>
A180-27	Rock dredge	8/48	Great Meteor Seamount	30° 02' N.	28° 29' W.	290	<i>Balanophyllia formosa</i> <sup>b</sup> <i>Caryophyllia arcuata</i> <sup>b</sup>
A180-28	Rock dredge	8/48	Great Meteor Seamount	29° 58' N.	28° 27.5' W.	275	<i>Caryophyllia clavus</i> <i>Anomocora fecunda</i>
A180-112	Rock dredge		North of Rio de Janeiro, Brazil	20° 37' S.	34° 37' W.	55	<i>Madrepora oculata</i>
KM1D-8C	Rock dredge	8/29/52	Off Dakar, French West Africa	14° 30' N.	17° 30' W.	914	<i>Desmophyllum cristagalli</i>
V3-23	Rock dredge	5/26/54	Off Florida	27° 10' N.	79° 34.9' W.	686	<i>Lophelia prolifera</i> <i>Asterosmia prolifera</i>

TABLE 1—(Continued)

Station Number	Type of Gear	Date	Locality	Latitude	Longitude	Depth (Meters)	Species Collected
V3-144A	Core	5/23/54	Gulf of Mexico	24° 15.7' N.	81° 53.9' W.	274	<i>Bathypsammia tintinnabulum</i>
V4-17	Rock dredge	8/4/54	SW. of Cape St. Vincent, Portugal	35° 14' N.	15° 30' W.	695	<i>Bathypsammia fallosocialis</i> <i>Flabellum alabastrum</i> <i>Dendrophyllia profunda</i> <i>Lophelia prolifera</i> <i>Stenocyathus vermiformis</i> <i>Madrepora oculata</i> <sup>b</sup>
V4-28	Rock dredge	8/7/54	SW. of Cape St. Vincent, Portugal	35° 03' N.	12° 57.5' W.	91	<i>Caryophyllia cyathus</i> <i>Balanophyllia formosa</i> <i>Paracyathus pulchellus</i> <i>Stenocyathus vermiformis</i> <i>Dendrophyllia cornigera</i> <i>Paracyathus pulchellus</i> <i>Balanophyllia floridana</i> <i>Desmophyllum cristagalli</i>
V4-30	Rock dredge	8/7/54	SW. of Cape St. Vincent, Portugal	35° 05' N.	12° 58' W.	110	<i>Enallopsammia rostrata</i> <i>Lophelia prolifera</i>
V5-1	Rock dredge	12/1/54	SE. of Bermuda	32° 17.6' N.	64° 42.3' W.	798	
V7-12	Photographic gear	8/12/55	Off New York	38° 09' N.	61° 05' W.	3383	

<sup>a</sup> Pleistocene sample.<sup>b</sup> Sub-recent sample.

Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 308, pl. 14, fig. 1. GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 89, pl. 10, figs. 158-164.

*Amphihelia ramea* Müller [sic], DUNCAN, 1874, Trans. Roy. Soc. London, vol. 8, p. 326, pl. 44, figs. 1-3, pl. 45, figs. 4-6, pl. 46, figs. 1-19.

Much confusion regarding this species has needlessly arisen. Verrill (1902) designated *M. oculata* Linnaeus as the type species of this genus. Dons (1944) argued that *M. ramea* Linnaeus has priority over *M. oculata* Linnaeus, although Milne-Edwards and Haime (1850) clearly selected the former as the type species of *Dendrophyllia*. *Madrepora ramea*, a name attributed to Müller by Duncan (1873, 1879, pt. 1), has been suggested by Marenzeller (1904) as an improper usage of that name on labels accompanying specimens sent to Duncan by M. Sars.

Specimens referred to this species are largely basal fragments, usually in association with the euniciid polychaetes. A few distal portions of the corallum are present in each instance. Specimens from V4-17 are embedded in a lithified foraminiferal ooze containing globigerinids, cavolinid pteropods, molluscan fragments, and a single large terebratuloid brachiopod. This assemblage is here interpreted as sub-Recent. A suite of distal fragments clearly referable to this species were taken from the basal portion of a 70-cm. core recovered from the flank of Cruiser Seamount (A180-21). The upper 61 cm. of this core was composed of alternating layers of well-sorted calcareous and argillaceous sands. The basal portion was composed of large coral fragments, broken shell material, and abundant Foraminifera. Among the identifiable corals were *Madrepora oculata*, *Desmophyllum* sp., and a calcareous internode of an isid gorgonian. The entire sequence has been dated as Pleistocene (Heezen and others, MS).

DISTRIBUTION: Widely distributed in the Atlantic and Indian oceans and the Mediterranean Sea.

OCCURRENCE: Recent: A180-112, north of Rio de Janeiro, Brazil; 55 meters. Sub-Recent: V4-17, southwest of Cape St. Vincent, Portugal; 695 meters. Pleistocene: A180-21, Cruiser Seamount; 730 meters.

#### FAMILY CARYOPHYLLIIDAE

#### GENUS *CARYOPHYLLIA* LAMARCK, 1801

#### *Caryophyllia arcuata* (Milne-Edwards and Haime), 1848

*Caryophyllia arcuata* (Milne-Edwards and Haime), GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 25, pl. 2, figs. 26-29.

A single specimen of this species was recovered from a limestone "sea



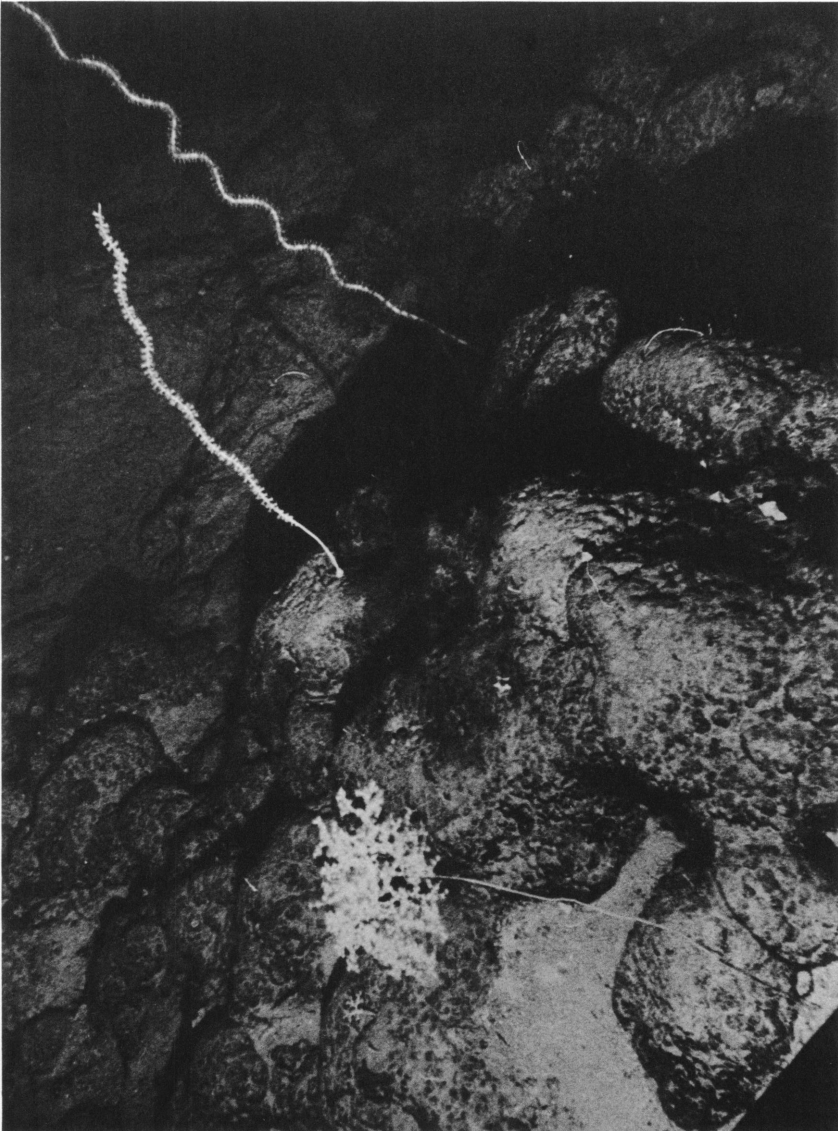


FIG. 2. Rocky side of a seamount of the Ampere group with a large, branching stony coral in the foreground. Immediately below is a stylasterid (?) coral. Long spiral gorgonians in the background have been identified as the genus *Narella*, and the slim whip in the foreground as either antipatharians or gorgonians by Dr. F. M. Bayer (United States National Museum). V4-16 photograph, 1970 meters, off Ampere Bank, latitude  $35^{\circ} 07' N.$ , longitude  $13^{\circ} 04' W.$

biscuit" dredged from the top of the Great Meteor Seamount. The nodular limestone specimen, approximately 6 inches in diameter and 3 inches thick, also contained many specimens of *Balanophyllia formosa* Gravier in solution cavities developed in the dense matrix. Several specimens of these nodules were collected in this haul. The primary rock is a densely lithified, light tan lutite containing abundant Foraminifera and fragments of molluscan shells. In the case of the specimen containing corals, the primary rock had been largely dissolved, the solution passages often cutting directly through fossils in the primary matrix. Filling the solution cavities is an off-white coquina partially cemented but not so completely so as to prohibit removal of the corals. Aside from small pelecypods, the only complete fossil was the specimen of *Caryophyllia arcuata*, the coralla of *B. formosa* being fragmentary. The secondary fillings had in turn been partially dissolved, with some solution passages passing through coquina, matrix, and shells alike. Unfortunately, too little material is present for carbon-14 analysis, and the antiquity of the specimens must remain undetermined. However, it seems fairly evident that two, possibly three, cycles of erosion and solution are represented in the history of the specimen.

DISTRIBUTION: Atlantic and Indian oceans and Mediterranean Sea.

OCCURRENCE: Sub-Recent: A-180-27, Great Meteor Seamount; 290 meters.

#### *Caryophyllia clavus* Scacchi, 1835

*Caryophyllia clavus* Scacchi, GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 16, pl. 1, figs. 3-18, pl. 2, figs. 19-25.

Two specimens of this common species were recovered from a rock dredge haul. Both were dead and were attached to each other. Measurements of the coralla are given in table 2.

DISTRIBUTION: Atlantic and Indian oceans and Mediterranean Sea.

OCCURRENCE: Recent: A180-28, Great Meteor Seamount; 275 meters.

TABLE 2  
MEASUREMENTS (IN MILLIMETERS) OF *Caryophyllia clavus*

	Specimen 1	Specimen 2
Height	12.8	11.7
Diameters of calice	9.4 × 9.0+	8.6 × 8.5
Number of septa	—	40

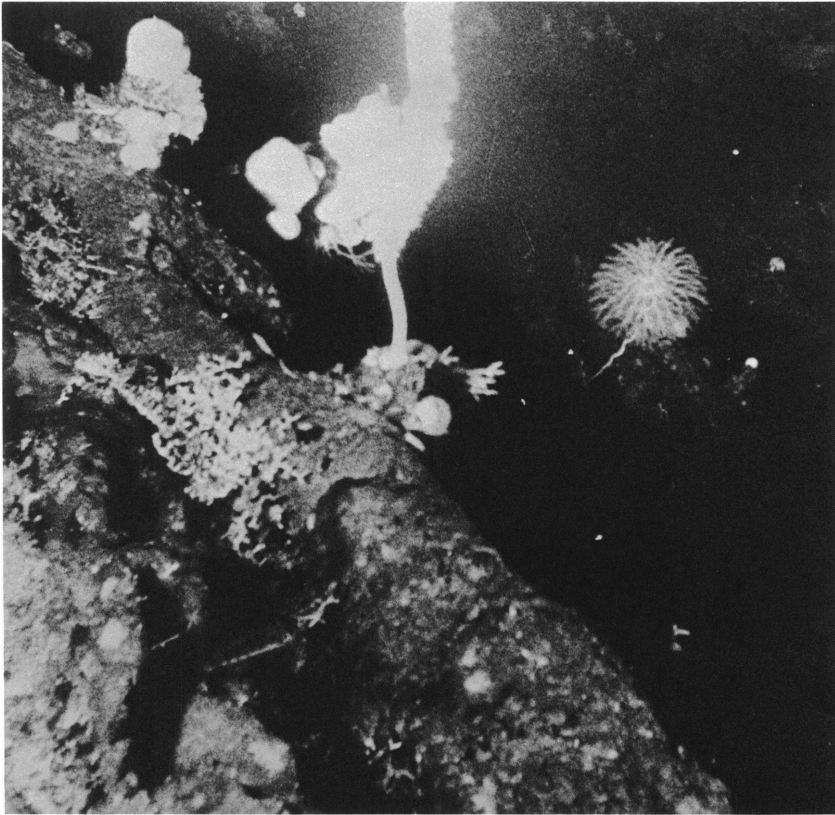


FIG. 3. Ledge fauna consisting of stony corals in the lower foreground with large actinians (?) above. Long streaked object is apparently a gorgonian with a stony coral at its base of attachment. Umbrella-shaped organism in the left center is unidentified. T1-1-2 photograph, about 2500 meters, near Great Meteor Seamount, latitude  $31^{\circ} 36' N.$ , longitude  $29^{\circ} 01' W.$

*Caryophyllia cyathus* (Ellis and Solander), 1786

*Caryophyllia cyathus* (Ellis and Solander), GRAVIER, 1920, in *Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco*, fasc. 55, p. 15, pl. 1, figs. 1, 2.

A single well-preserved specimen of this species was taken attached to a rock in a gravel haul. It measured 25+ mm. in height and 15.2 by 13.7 mm. in calicular diameters. Eighty-one septa are arranged in four complete cycles, with portions of the fifth present, with 18 pali before the septa.

DISTRIBUTION: Atlantic Ocean and Mediterranean Sea.

OCCURRENCE: Recent: V4-28, southwest of Cape St. Vincent, Portugal; 91 meters.

GENUS *ASTEROSMILIA* DUNCAN, 1867

*Asterosmilía prolifera* (Pourtalès), 1871

*Ceratocyathus prolifer* POURTALÈS, 1871, Bull. Mus. Comp. Zoöl. Harvard, vol. 2, p. 19, pl. 3, figs. 8-10.

*Asterosmilía prolifera* POURTALÈS, 1879, Bull. Mus. Comp. Zoöl. Harvard, vol. 6, p. 107, pl. 2, figs. 9, 10.

Four specimens of this species were taken, all attached to stylasterids or *Dendrophyllia profunda*. They are somewhat smaller than those described by Portalès, but in other respects they are identical. Dimensions of the coralla are given in table 3.

TABLE 3  
MEASUREMENTS (IN MILLIMETERS) OF *Asterosmilía profunda*

Specimens	1	2	3	4
Diameters of calice	5.8 × 5.5	4.1 × 4.1	6.4 × 6.4	6.4 × 5.8
Height	10.6	12.0+	6.7	6.4
Number of septa	40	—	40	33

Portalès considered *Paracyathus arcuatus* Lindström (1876) to be conspecific with *A. prolifera*. Every bit of external evidence favors this interpretation, but the septa of Lindström's specimen are so obliterated that no internal details can be determined.

DISTRIBUTION: Western Atlantic Ocean.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

GENUS *PARACYATHUS* MILNE-EDWARDS AND HAIME, 1848

*Paracyathus defilippi* Duchassaing and Michellotti, 1861

*Paracyathus defilippi* Duchassaing and Michellotti, VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1902, vol. 2, p. 292, pl. 1, fig. 1. GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 98, pl. 3, fig. 43.

*Paracyathus confertus* POURTALÈS, 1869, Bull. Mus. Comp. Zoöl. Harvard, vol. 1, p. 134.

*Paracyathus latus* POURTALÈS, 1879, Bull. Mus. Comp. Zoöl. Harvard, vol. 6, p. 104, pl. 1, figs. 9-11.

*Paracyathus agassizi* DUNCAN, 1873, Trans. Roy. Soc. London, vol. 8, p. 319, pl. 43, figs. 5-8.

The several species placed in synonymy here have in common multi-lobate pali. Although the usual condition for some of the species, e.g., *P. confertus* Pourtalès, is bilobate pali, there is sufficient variation within a single collection to warrant consolidation of the two-lobed and three-lobed types. This species differs from the other common *Paracyathus* of the Atlantic, *P. pulchellus* Philippi (= *P. striata* Philippi, *P. aequilamellosus* Milne-Edwards and Haime, *P. striatus* Duncan,



FIG. 4. Boulder fauna on a rippled sand bottom consisting of expanded dendrophyllid-like corals. Note the shadows cast by the polyps. T1-3-6 photograph, 508 meters, southwest of Brest, France, latitude 47° 42' N., longitude 7° 34' W.

*P. insignis* Duncan), in the condition of the pali. In the latter species, the pali are not lobed and are conspicuously larger than the columellar elements. A common type of this species has quadrangular pali, often of some distinctness (Döderlein, 1913, figs. 38-44).

Both species are widely distributed in both the Atlantic and the Mediterranean. Many species described from the Mediterranean by Duncan (1873, 1879, pt. 2), including *P. monilis*, *P. africanus*, and *P. costatus*, are probably based on variants or poorly preserved individuals of *P. defilippi*.

The great majority of specimens were taken from gravel in one rock dredging (V4-28) and were dead and worn. Those specimens that were taken alive invariably showed regeneration or "parricidal budding." This is interpreted here as a response to fluctuations between satisfactory and unsatisfactory environmental conditions. Several individuals possessed three series of superimposed calices, in each instance the younger one being smaller in diameter than the older. That this is not a case of transverse fission is indicated by the presence of shreds of epitheca deposited over the septa of the older calice as the edge

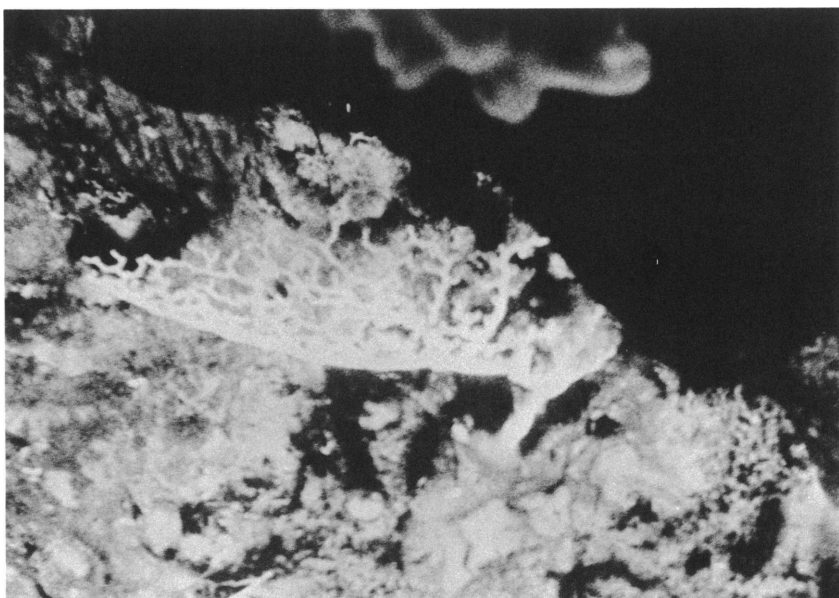


FIG. 5. Large, branching, enallopsammid-like coral on a rocky ledge. Note overhanging material. T1-1-3 photograph, about 2500 meters, near Great Meteor Seamount, latitude  $31^{\circ} 36' N.$ , longitude  $29^{\circ} 01' W.$

zone of the polyp was retracted. In every case the new growth of the corallite was from the central portion of the calice, presumably developing from the remnants of a highly retracted polyp. In no instance was there a question of the young corallite's being partially or wholly free from the older, as there is a continuity of growth. Unfortunately, the causes of this type of regeneration cannot even be speculated upon.

Of the eight specimens from V4-30, seven were alive but showed no regeneration, nor did the single dead specimen. In contrast, of the 56 specimens of *P. defilippi* in haul V4-28, 37 were dead, 19 alive, and 15

specimens showed regeneration. Of the living specimens, 12, or 63 per cent, showed regeneration, while only three (8%) of the dead specimens had evidence of new growth.

**DISTRIBUTION:** Atlantic Ocean and Mediterranean Sea.

**OCCURRENCE:** Recent: V4-28, V4-30, southwest of Cape St. Vincent, Portugal; 91 and 110 meters.

TABLE 4  
MEASUREMENTS (IN MILLIMETERS) OF *Paracyathus defilippi*

	V4-28	V4-30
Maximum diameter of calice		
Number	36	5
Range	4.3-9.5	4.1-14.2
Mean	7.26	7.34
Height of corallum		
Number	32	4
Range	7.7-23.6	5.7-10.9
Mean	12.65	7.85
Number of septa		
Number	27	5
Range	27-57	37-58
Mean	43.7	42.8

GENUS *ANOMOCORA* STUDER, 1878

*Anomocora fecunda* (Pourtalès), 1871

*Coelosmilia fecunda* POURTALÈS, 1871, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 21, pl. 1, fig. 12, pl. 3, figs. 4, 5, pl. 6, figs. 14, 15.

*Parasmilia fecunda* (Pourtalès), LINDSTRÖM, 1876, Handl. K. Svenska Vetensk.-Akad., vol. 14, no. 6, p. 21. MARENZELLER, 1904, in Chun, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 311, pl. 15, fig. 5. GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 91, pl. 11, figs. 169-173.

*Anomocora fecunda* (Pourtalès), STUDER, 1877, Monatsber. K. Akad. Wiss. Berlin, p. 641, pl. 2, figs. 9a-9f.

*Blastosmilia pourtalesi* DUNCAN, 1878, Trans. Zool. Soc. London, vol. 10, p. 244, pl. 45, figs. 14-17.

*Pourtalesmilia pourtalesi* (Duncan), DUNCAN, 1895, Jour. Linnean Soc. London, vol. 18, p. 72.

Thirty-six fragments of this species were collected from the drag chain of a rock dredge during a single haul. Most of the specimens are fragments, but several nearly complete coralla are also present. Coral-

lites in all instances are long and irregular in direction. Budding appears to be ecologically controlled, probably by situation, as there is a tendency for buds to cluster on one side and to curve in the same direction. Septa of all specimens are slightly exsert and arranged in two groups, the first of which, comprising the first and second cycles, reaches the columella. The second group does not do so and may be represented by very low striae on the walls. Costae, which correspond



FIG. 6. Branching coral of the *Lophelia-Madrepora* type on a boulder bottom. Smaller actinians or solitary corals in center and left background. Fish in upper right is unidentified. V4-7 photograph, 984 meters, near Azore Islands, latitude  $37^{\circ} 25' N.$ , longitude  $31^{\circ} 10' W.$

to the septa in position, are pronounced and sharp on the upper portion of the corallites, being less so basally. Costae corresponding to the third-cycle septa appear as moniliform beads. The upper edges of the septa are slightly rounded, but proximally descend nearly vertically. Septa of the third cycle bear horizontally directed trabecular teeth on the proximal edge.



Among the species that have been referred to this genus are *A. fecunda* (Pourtales) and *A. pourtalesi* (Duncan). The former has been found in the eastern and western Atlantic and on the west coast of Sumatra. The latter has been reported only from the Mediterranean. Significant characters of the two are listed in table 5, in which it is apparent that the only differences are in the degree of development of

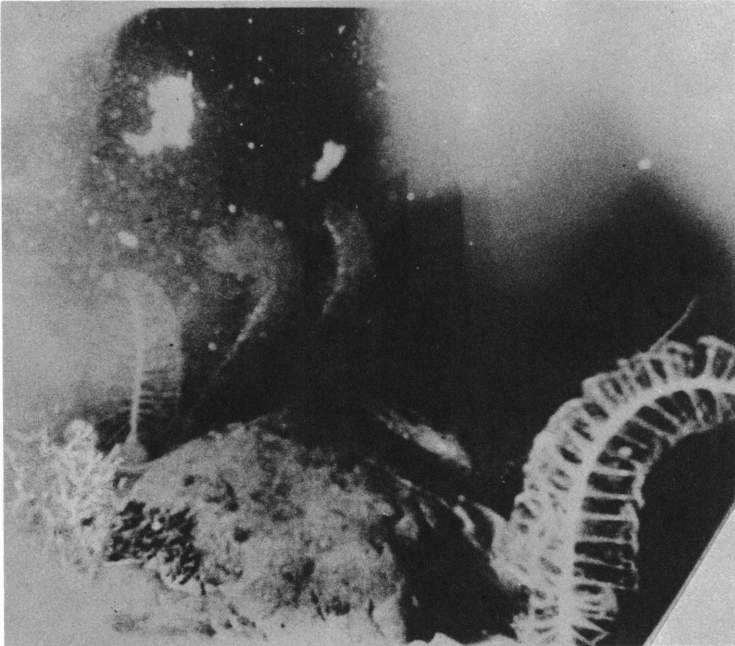


FIG. 7. Pennatulid alcyonarians identified as *Anthoptilum* cf. *A. grandiflorum* (Verrill) by Dr. F. M. Bayer, associated with living stony coral (*Lophelia prolifera*, *Enallopsammia rostrata*) and dead coral (*L. prolifera*, *Desmophyllum cristagalli*) on a rock bottom. The coral appears as an indistinct white mass in the left foreground, with the manganese-coated specimens to the right. This figure is reproduced from a print made on shipboard which accounts for the vibration images. The negatives from this station were not available in 1958. Specimens of coral and alcyonarians seen in this photograph were collected by Clarke-Bumpus nets attached to the camera rig. V7-12 photograph, 3380 meters, off New York, latitude 38° 09' N., longitude 61° 05' W.

the costae. The specimens at hand show, in the majority of instances, costae of variable size extending to, or nearly to, the base of the corallite. In one instance, however, the costae were not found below a distance of one-half of the corallite height. Although I have not exam-

ined specimens referable to Duncan's species, the character of the costae does not seem sufficient in this instance to warrant distinction.

DISTRIBUTION: North Atlantic and Indian oceans; Mediterranean Sea.

OCCURRENCE: Recent: A180-28, Great Meteor Seamount; 275 meters.

TABLE 5  
COMPARISON OF MORPHOLOGIC CHARACTERS OF SPECIES OF *Anomocora*

Characters	<i>Anomocora fecunda</i>	<i>Anomocora pourtalesi</i>
Corallum shape	Elongate conical, irregularly bent	Elongate conical, irregularly bent
Costae	Costae fully developed, granulated, becoming obscure basally	Costae developed only on upper margin of corallite
Shape of calice	Circular to elliptical, fossa deep	Circular to elliptical, fossa deep
Septa	Six systems, four incom- plete cycles	Six systems, four incom- plete cycles
Septa exsert	Not exsert to slightly so	Slightly exsert
Character of columella	Slightly developed, formed of septal trabeculae	Slightly developed, formed of septal trabeculae
Endotheca	Thin, sparse	Thin, sparse

GENUS *DESMOPHYLLUM* EHRENBERG, 1834

*Desmophyllum cristagalli* Milne-Edwards and Haime, 1848

Figures 8-10

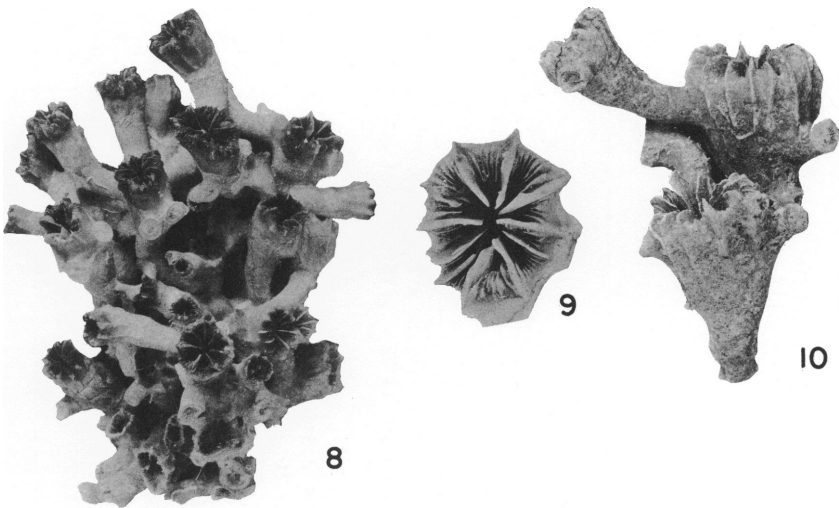
*Desmophyllum cristagalli* Milne-Edwards and Haime, DÖDERLEIN, 1913, Mitt. Zool. Stat. Neapel, vol. 21, p. 126, pl. 8, figs. 45-45a. GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 72, pl. 8, figs. 130-135. DUNCAN, 1873, Trans. Zool. Soc. London, vol. 8, p. 321.

*Desmophyllum solidum* POURTALÈS, 1871, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 17, pl. 5, figs. 5-6.

*Lophelia prolifera* (Pallas), JOUBIN, 1929, Faune et flore Méditerranée, vol. 9, p. 166, fig. 9.

Although there seem to be many reasons for accepting the specimens collected in this dredge haul (KM1D-8C) as a distinct species, the well-known variability of the cosmopolitan *D. cristagalli* requires restraint, and I am therefore considering the specimens as variants. It is interesting to note the degree of correspondence between the younger specimens here illustrated and those figured by Joubin (1929).

The coralla are dendroid, consisting of many cornute corallites budding irregularly from one another and anastomosing into a fused mass. Corallites trochoid, higher than broad, generally straight, surmounted by a crown of exsert septa. Walls thick, dense, finely granulate. Costal ridges well developed and often pronounced for a distance of several centimeters on the side of the corallites. Edge zone of polyps not extensive, seldom over 1 cm. in length. Septa exsert, those of the first group most so. Seven to nine may be more highly exsert and correspond to the primary, strongly developed costae. Septa fine, smooth proximally,



FIGS. 8-10. *Desmophyllum cristagalli* Milne-Edwards and Haime. 8. A.M.-N.H. No. 3340, fragment of corallum.  $\times 0.55$ . 9. A.M.N.H. No. 3341, calice.  $\times 1.25$ . 10. A.M.N.H. No. 3342, fragment of corallum.  $\times 0.62$ .

rounded above, and descending sharply into the calice. Septa finely ornamented laterally. Four or more cycles of septa present in most calices, some of the larger ones having nearly complete insertion of the fifth cycle; usually arranged in three to four groups. Endotheca apparently absent. Measurements of the specimens are given in table 6.

Of the approximately 500 fragments of coralla collected in this haul, the bulk of the specimens were dead. The few calices that had contained live polyps on otherwise dead coralla displayed reduced or contracted edge zones. Live coralla were more complete and, in general, smaller in size. Calicular diameters were, on the average, less than those of the dead coralla. The dead specimens presumably formed a "sub-

TABLE 6  
 MEASUREMENTS (IN MILLIMETERS) OF EIGHT SPECIMENS OF *Desmophyllum cristagalli* FROM DREDGE KM1D-8C  
 (Specimens 1-4 were taken dead; specimens 5-8 were alive when collected.)

	1	2	3	4	5	6	7	8	Average Values
<b>Maximum diameter of calice</b>									
Number	3	2	4	3	8	13	27	15	75
Range	13.6-24.4	13.4-16.4	16.1-21.7	12.8-25.8	11.5-23.8	8.5-22.7	4.6-22.2	3.5-20.7	3.5-25.8
Mean	20.72	14.90	18.45	19.83	17.44	15.02	12.49	10.75	14.17
<b>Minimum diameter of calice</b>									
Number	3	2	4	3	8	13	27	14	74
Range	11.8-21.0	8.2-11.8	5.4-19.1	9.5-19.6	8.6-20.9	5.5-14.9	4.4-17.8	4.6-14.9	4.4-21.0
Mean	16.80	10.00	13.72	15.63	13.20	11.05	9.57	8.10	10.72
<b>Height of corallite</b>									
Number	3	2	4	3	8	13	27	15	75
Range	30.0-43.9	39.7-42.5	18.5-45.3	27.7-37.9	15.3-51.4	4.8-40.5	6.1-46.5	4.3-34.4	4.3-51.4
Mean	35.81	41.10	31.02	35.06	31.34	26.41	22.69	16.27	24.93
<b>Basal diameter of corallite</b>									
Number	3	2	4	3	8	13	27	15	75
Range	0.8-6.5	6.2-8.6	7.7-9.0	8.0-8.9	7.5-11.8	4.8-10.2	4.5-11.2	2.5-7.5	0.8-11.8
Mean	4.36	7.40	8.40	8.53	9.23	7.98	7.29	5.88	7.33
<b>Height of edge zone</b>									
Number	3	2	4	1	8	6	22	9	60
Range	6.8-11.5	6.2-9.5	3.0-9.4	5.9	8.5-13.6	4.0-10.8	1.9-7.2	2.3-6.7	1.9-8.7
Mean	9.83	7.90	5.07	5.9	9.81	7.5	3.81	3.67	4.33

TABLE 6—(Continued)

	1	2	3	4	5	6	7	8	Average Values
Height of exsert septa									
Number	3	2	2	3	8	11	22	9	60
Range	4.8-6.0	3.9-5.8	7.4-8.7	4.1-7.2	2.6-6.7	2.2-5.2	1.9-7.2	2.3-6.7	1.9-8.7
Mean	5.51	4.80	8.05	5.90	5.03	3.92	3.81	3.67	4.33
Number of primary exsert septa									
Number	3	2	3	3	6	7	21	12	57
Range	7-10	7-8	6-9	6-9	7-9	7-8	6-9	5-9	5-10
Mean	8.6	7.5	7.3	8.0	8.0	7.4	7.1	6.5	7.27
Number of septa									
Number	3	2	3	3	6	6	25	12	60
Range	57-76	53-65	47-69	43-49	43-69	42-70	23-60	18-63	18-76
Mean	67.7	59	60.6	45	60.5	55.3	41.0	41.1	47.5

strate" for the upward growth of those coralla that were taken alive.

A fragment of calice assignable to this species was collected from photographic station 12 (V7). The specimen is heavily coated with manganese and was broken before the accumulation of the manganese.

Fragments of *D. cristagalli* were taken from a piston core from the flanks of Cruiser Seamount. The core was 70 cm. long, the upper portion consisting of alternating layers of calcareous and argillaceous sand. The lower 9 cm. contained fragmentary shell material, including *Madrepora* cf. *M. oculata* and *Desmophyllum*. The entire core is considered to be Pleistocene.

Abundant fragments of *Desmophyllum* cf. *D. cristagalli* were found in sediments taken from the top of Atlantis Seamount (A152-108).

*Desmophyllum solidum* Pourtalès apparently is an immature specimen referable to this species.

DISTRIBUTION: Cosmopolitan.

OCCURRENCE: Recent: KMID-8C, off Dakar, French West Africa; 914 meters. V7, photographic station 12, off New York; 3383 meters. A152-108, Atlantis Seamount; 540 meters. Pleistocene: A180-21, Cruiser Seamount; 730 meters.

### *Lophelia prolifera* (Pallas), 1776

*Lophelia prolifera* (Pallas), GRAVIER, 1920, in Résultats campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 87, pl. 10, fig. 157.

This species, one of the more ubiquitous of the deeper water Atlantic corals, is well represented in the collections of the Lamont Geological Observatory. One of the more interesting suites is that taken at V7, photographic station 12. In the preparation for this station, Robert Menzies attached two Clarke-Bumpus plankton nets to the cross arms supporting the lighting apparatus of the camera gear to obtain a bottom sample. In the course of lowering the gear down the flanks of the rough topography, the entire camera apparatus fell to the bottom, simultaneously taking a photograph. Upon recovery of the photographic gear, the plankton nets were found to have corals and alcyonaria entangled in them. The corals included *Lophelia prolifera*, *Enallopsammia rostrata*, and *Desmophyllum* cf. *D. cristagalli*. The first two of these were represented by living and dead specimens, the latter with coats of manganese of varying thickness. In addition, a pennatulid, provisionally identified as *Anthoptilum murrayi* Kolliker by Dr. Frederick Bayer, United States National Museum, was collected. The photograph taken at this time (fig. 4) shows corals of the *Lophelia* type as well as alcyonaria of the type identified as *Anthoptilum*. This occur-

rence of *Lophelia* and *Enallopsammia* represents a new depth record for each genus, as well as providing a unique occurrence of photographs *in situ* of recovered specimens.

Among the "sea biscuits" recovered from the Atlantis Seamount (A152-17) is a specimen composed of a mass of encrusting worm tubes and bryozoans and other unidentified organisms containing a poorly preserved *Lophelia prolifera*. This specimen is clearly of a different age than the other cobbles, which are composed of a well-lithified coquina, or chalk containing pteropods, Foraminifera, and fragmentary mollusks and Bryozoa. The specimen containing *Lophelia* is considered as being sub-Recent in the absence of other dating.

A piston-coring attempt on the flanks of Great Meteor Seamount (A180-25) retrieved only a disc of white limestone in which were included *Lophelia prolifera*, barnacle fragments, echinoid plates, and Foraminifera. This occurrence is believed to be of Pleistocene age.

DISTRIBUTION: North Atlantic and Indian oceans, Mediterranean Sea.

OCCURRENCE: KM1-D8C, off Dakar, French West Africa; 914 meters. V3-23, off Florida; 686 meters. V7, photographic station 12, off New York, 3383 meters. Subfossil: A150-17, Atlantis Seamount; 540 meters. Pleistocene: A180-25, Great Meteor Seamount; 1685 meters.

#### FAMILY GUYNIIDAE

GENUS *STENOCYATHUS* POURTALES, 1871

*Stenocyathus vermiformis* (Pourtalès), 1868

*Stenocyathus vermiformis* (Portalès), POURTALES, 1871, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 10, pls. 1, 1a, pl. 3, figs. 11-13.

Single specimens were taken living from two localities.

Duncan (1873, 1879, pt. 2, p. 237) described *Caryophyllia carpenteri* and *C. simplex* on the basis of two specimens obtained in a single dredge haul. In every respect these species seem to be identical with *Stenocyathus vermiformis*. Duncan, however, comments that both specimens possessed epitheca. Until the original specimens can be reexamined, it is impossible to determine their actual nature. It seems quite probable that they will be included in this species.

DISTRIBUTION: Atlantic Ocean and Mediterranean Sea.

OCCURRENCE: V3-144A, Gulf of Mexico; 274 meters.

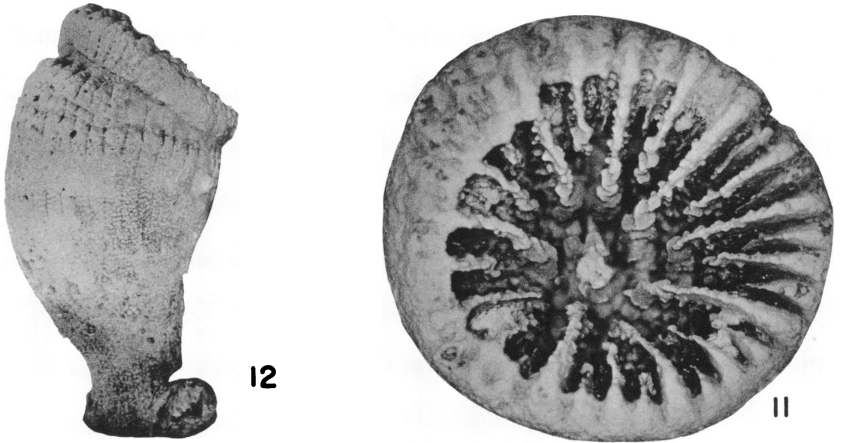
GENUS *AULOCYATHUS* MARENZELLER, 1904

*Aulocyathus* sp.

Figures 11, 12

A single specimen from dredge V3-23 is assigned to this genus. Un-

fortunately, it was taken dead and slightly worn. Few of the characters of the wall are known, except for the fact that the costae are low. There is no well-defined epitheca except immediately above paracidal "buds." Septa number 28 and are arranged in two groups, the first of which nearly reaches the columella. The septa of the second group extend only about half of the distance of those of the first. The columella is parietal, central, low in the open calice, but conspicuous. Septa are non-exsert, rounding gently to the center of the calice, and then



FIGS. 11, 12. *Aulocyathus* sp., A.M.N.H. No. 3347. 11. Calice.  $\times$  3.25. 12. Corallum.  $\times$  6.5.

descending vertically. Septa are laterally spinose and are slightly thickened on the proximal edge. The subcylindrical corallum is 8 mm. in diameter and 14 mm. in height.

Only one other species of the genus is known: *A. juvenescens* Marenzeller, which was described from the "Valdivia" collections from off East Africa. The only differences between that species and the specimen at hand are in the greater diameter of the corallite, the more conspicuous columella, and less granular wall of the West Indian specimen. A larger suite of specimens is necessary for the significance of these differences to be determined.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

#### GENUS *FLABELLUM* LESSON, 1831

At least a dozen names have been applied to specimens of *Flabellum* collected from the north Atlantic Ocean, although the probable num-



ber of actual species is about one-third of that number. Much of the nomenclatural confusion has resulted from early works which based descriptions on poor or fragmentary specimens, too brief or general descriptions, and poor illustrations. A general review of the nomenclature of several species of *Flabellum* was made by Marenzeller (1904), but a more complete summary seems in order now.

The first *Flabellum* described from the north Atlantic was *F. macandrewi* Gray (1849), based on fragments of a single corallum. Sars (1856) described and figured *Ulocyathus arcticus* from Norwegian collections. Both the generic and specific appellations are attributed to Sars (1851) by Lindström (1876). [The pagination given for Sars (1851) by Lindström refers to the pagination of a separate.] Gosse (1860) cites *Ulocyathus arcticus* as occurring in British waters, placing Gray's species in synonymy with it.

Duncan (1873, 1879, pt. 1) reported two species from the dredgings of the "Porcupine": *Flabellum distinctum* Milne-Edwards and Haime and *Flabellum laciniatum* Milne-Edwards and Haime. The latter was represented by a single specimen poorly illustrated and not described. Duncan included *U. arcticus* in *F. laciniatum*, first proposed by Philippi (1841) for a well-preserved Pliocene form as *Phyllodes*. In the same year a woodcut and a complete description of *Flabellum alabastrum* Moseley (in Thomson, 1873) appeared in a preliminary report of the dredgings of the "Challenger."

Pourtalès (1874) described *F. braziliense* from a single dead specimen and compared it with the Antarctic form *F. thourasi* Milne-Edwards and Haime. Lindström (1876) united *Phyllodes laciniatum*, *Ulocyathus arcticus*, *F. macandrewi*, and *F. alabastrum*.

Moseley (1876), in the preliminary records of the "Challenger" expedition, described *F. angulare*, *F. apertum*, and *F. alabastrum* from the north Atlantic. Later (1881) he redescribed these species, commenting upon the record of *F. angulare* from the Gulf of Mexico by Pourtalès (1878) and the nomenclature utilized by Lindström (1876).

Verrill (1878) described *F. goodei* from the northeastern coast of the United States, comparing it with *F. alabastrum*. Pourtalès (1880) described *F. mosleyi* from the West Indies. Duncan (1873, 1879, pt. 2) based *F. minor* on an unidentifiable fragment of a *Flabellum*.

By this time, most of the new species had been recorded. Marenzeller (1904) took the opportunity of the publication of the corals of the "Valdivia" to review the situation. Declaring that the figure and description given by Philippi (1841) were not usable for identification, Marenzeller erected a new species, *F. deludens*, for the reception of

Indian Ocean forms identified as *F. laciniatum* by Alcock (1898), contending that Duncan's (1873) usage of *F. laciniatum* [*F. laciniatum*=*U. arcticus*] was correct and that Alcock had been led astray by Duncan's illustrations. He further showed that Lindström's judgment was in error in regard to the affinities of *F. alabastrum*. Marenzeller founded *F. chunii* on the species identified as *F. distinctum* by Duncan (1873), an unnecessary maneuver. Marenzeller named *F. stabile* as a new species for the reception of specimens from the Cape Verde Islands.

Vaughan (1907) followed Marenzeller's interpretation of *F. laciniatum* and reunited *F. chunii* and *F. distinctum*. Gravier (1920) utilized three names for specimens in his collections: *F. alabastrum*, *F. distinctum*, and *F. deludens*.

Typical *F. alabastrum* has a roughly triangular distribution, the apex lying on the western shores of the Atlantic in the area between Chesapeake Bay and Cape Cod, with the base extending from the Cape Verde Islands to northern Norway. Over most of this area it is found at depths below 1000 meters. *Flabellum moseleyi* is a variation of the typical form, having a more nearly circular calice, and a conical pedicel of greater length than that of *F. alabastrum*. It has a distribution within the West Indies. *Flabellum braziliensis* and its synonym *F. stabile* seem also to be closely allied with *F. alabastrum*, differing only in the lesser expansion of the calice of the latter and the thickening of the proximal edges of the septa to form a pseudocolumella in the former. This variety is found in the equatorial region of the Atlantic.

*Flabellum distinctum* is apparently confined to the eastern Atlantic and is generally found in shallower depths than *F. alabastrum*. *Flabellum angulare*, *F. apertum*, and *F. arcticus* seem to be closely related, although the last is not well-known. *Flabellum angulare* has a smoother wall than *F. arcticus* and may represent a distinct variety. It has a western Atlantic distribution, while *F. arcticus* is found in the eastern Atlantic. *Flabellum macandrewi* is known to me only by Gray's (1849) figure. On the basis of the poor illustration I cannot recognize it, so follow other authors in tentatively assigning it to *F. arcticus*. *Flabellum deludens* Gravier apparently belongs with the *F. arcticus* group, although the calice is much more open.

These varieties may well be a series of geographic variants and eventually be recognized as subspecies. Work that is now in progress must be finished before the distribution of the various types can be determined.

*Flabellum alabastrum* Moseley, 1873

*Flabellum alabastrum* MOSELEY, 1873, in Thomson, Nature, vol. 8, p. 400, fig. 2; 1881, in Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873-76, Zoology, vol. 2, pt. 7, p. 169, pl. 7, figs. 1, 1a, 1b, 2, 2a, 2b, pl. 16, fig. 11. MARENZELLER, 1904, in Chun, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 273. GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 65, pl. 7, figs. 112, 115.

*Flabellum goodei* VERRILL, 1878, Amer. Jour. Sci., ser. 3, vol. 16, p. 377; 1883, Bull. Mus. Comp. Zoöl. Harvard, vol. 11, p. 64, pl. 5, figs. 3, 4.

*Flabellum moseleyi* POURTALÈS, 1880, Bull. Mus. Comp. Zoöl. Harvard, vol. 6, no. 4, p. 105, pl. 2, figs. 13, 14.

*Flabellum braziliense* POURTALÈS, 1878, Mem. Mus. Comp. Zoöl. Harvard, vol. 6, no. 8, p. 38, pl. 2, figs. 13, 14, pl. 6, figs. 16, 17.

*Flabellum stabile* MARENZELLER, 1904, in Chun, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 273, pl. 17, figs. 12, 12a, 12b.

Four basal fragments clearly allied to *F. moseleyi* were taken in dredge V3-23. The basal portion of the corallum is nearly conical for a height of 10 mm. The upper margin of the corallite becomes lacerate. Three of the specimens show no mingling of the proximal margin of the septa, while the fourth has a well-defined "pseudocolumella."

DISTRIBUTION: Atlantic Ocean.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

## FAMILY DENDROPHYLLIIDAE

GENUS *DENDROPHYLLIA* DE BLAINVILLE, 1830*Dendrophyllia cornigera* (Lamarck), 1830

*Dendrophyllia cornigera* (Lamarck), GRAVIER, 1920, Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 104, pl. 12, figs. 186-192.

This species is represented only by fragments of coralla in the collections of the Lamont Observatory. None is sufficiently well preserved for any of the details of septal arrangement to be determined. Specimens collected from A152-17 represent fragments of the branches of young specimens, while the single specimen from V4-30 is the basal portion of a large branching corallum 38 mm. in diameter. Abundant fragments of a *Dendrophyllia* doubtfully placed here were found in sediment taken during rock dredging on the Atlantis Seamount (A152-108).

DISTRIBUTION: Atlantic and Indian oceans and Mediterranean Sea.

OCCURRENCE: Recent: A150-17, A152-108, Atlantis Seamount; 540 meters. V4-30, off Florida; 110 meters.

*Dendrophyllia profunda* (Pourtalès), 1867

Figures 13, 14

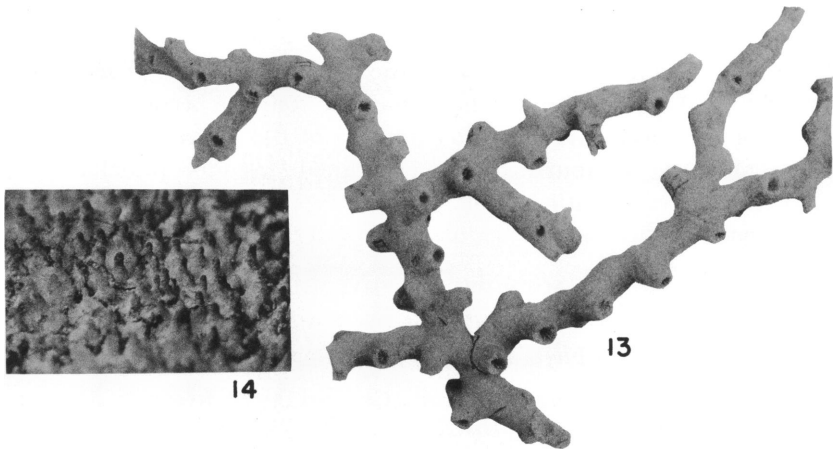
*Diplohelia profunda* POURTALÈS, 1867, Bull. Mus. Comp. Zoöl. Harvard, vol. 1, p. 114; 1871, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 25, pl. 6, figs. 6, 7.

*Amphihelia ramea* Müller [sic], part, DUNCAN, 1874, Trans. Zool. Soc. London, vol. 8, p. 326.

*Dendrophyllia profunda* (Pourtalès), POURTALÈS, 1878, Bull. Mus. Comp. Zoöl. Harvard, vol. 5, p. 208, pl. 1, figs. 6-8.

*Stereopsammia profunda* (Pourtalès), POURTALÈS, 1880, Bull. Mus. Comp. Zoöl. Harvard, vol. 6, p. 111.

*Coenopsammia profunda* (Pourtalès), MARENZELLER, 1904, in Chun, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 313, pl. 18, fig. 24.



FIGS. 13, 14. *Dendrophyllia profunda* (Pourtalès), A.M.N.H. No. 3343. 13. Fragment of corallum.  $\times 0.55$ . 14. Wall ornamentation photographed with ultraviolet light.  $\times 16.5$ .

Corallum large, diffusely branching. Corallites tending to be alternate in development, elevated and becoming inversely conical on the older portions of the branches. Coralla massive, thick-walled in older portions, and densely filled with stereome. Wall porous, but only slightly so. Surface of corallum non-costate and covered by a profusion of fine granules not arranged in any pattern. Septa usually in three cycles, although portions of the fourth cycle may be present in some calices. Septa arranged in a single group; seldom may septa of the third

TABLE 7  
 MEASUREMENTS (IN MILLIMETERS) OF *Dendrophyllia profunda* (POURTALES)  
 (Ten calices measured on each specimen.)

	Inside Diameter of Calice	Height of Calice	Number of Septa
Distal branch, diameter 4.7 mm.			
Range	2.4-3.9	4.0-11.1	21-25
Mean	3.12	5.43	23.6
Distal branch, diameter 5.4 mm.			
Range	3.0-3.9	3.2-7.2	23-24
Mean	3.55	4.73	23.5
Intermediate branch, diameter 7.5 mm.			
Range	2.9-4.1	2.4-7.2	21-25
Mean	3.69	5.04	23.4
Intermediate branch, diameter 9.0 mm.			
Range	3.1-5.0	5.8-10.3	21-24
Mean	3.92	8.05	22.9
Intermediate branch, diameter 9.1 mm.			
Range	4.3-5.3	4.7-12.7	21-24
Mean	4.89	8.95	22.9

cycle be differentiated from those of the first two cycles. All septa reach the columella which is situated at depth in the calice. Bifurcation of septa occurs close to the wall and merges indistinctly with the perforation of the upper margin of the wall. Septa not exsert. Septa of all cycles smooth on proximal margin near upper portion of calice, but at depth those of the third and higher cycles may be finely denticulate. Septa are laterally finely granulate, the granules becoming more strongly developed at depth. Columella small, trabecular. The measurements of the coralla are given in table 7.

Approximately 1000 fragments of coralla of this species constituted the bulk of haul V3-23. Superficially, the specimens closely resemble distal portions of *Madrepora oculata*, but are, of course, readily distinguishable from it. The species differs from typical *Dendrophyllia* in the absence of costae. However, in several specimens the wall granules are aligned in such a fashion as to suggest costae. The density of the corallum is also much greater than that encountered in most *Dendro-*

*phyllia*. Even in relatively young portions of the coralla, deposition of stereome cuts off the internal connection between corallites.

DISTRIBUTION: Western Atlantic and Indian oceans.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

GENUS *BALANOPHYLLIA* WOOD, 1844

*Balanophyllia formosa* Gravier, 1915

*Balanophyllia formosa* GRAVIER, 1920, in Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 99, pl. 11, figs. 174-178, pl. 16, fig. 222.

Two Recent specimens are referred to this species. They are not a sufficient basis for a comparison of this and the species below, *B. floridana* Pourtalès. The distinction between the two seems to rest on the degree of perforateness of the septa, *B. formosa* having the more perforate septa, particularly those of the later cycles. A much greater series of specimens than are available now will be needed for the validity of this distinction to be determined.

Fossil specimens assigned here also show the perforate character of the septa. The occurrence of these specimens at station A180-27 is discussed (p. 2) in relation to *Caryophyllia arcuata*. All the fossil specimens of *B. formosa* are fragmentary, but show little evidence of having been transported.

A badly eroded specimen probably belonging to this species occurred in a "sea biscuit" taken in rock dredging on the Atlantis Seamount (A152-108). Specimens of "sea biscuit" from this station were analyzed both for age, by carbon-14 methods, and for temperature by oxygen isotope analysis. Emiliani reported in 1954 (communication quotation in Heezen and others, MS): ". . . the temperature data of the benthonic materials seem to indicate that the top of the sea mount was at a certain time in a region where the temperature of the water was at least 16.8° C." Dr. Lawrence Kulp obtained a carbon-14 age of 12,000 ± 1200 years (L.G.O. Ref. No. 181) in 1948. A more recent determination (L.G.O. Ref. No. 389A) by modified techniques gave values of approximately 8400 years (W. Broecker, personal communication). The apparent discrepancy may be due to differences in methodology, varying amounts of contamination, or the use of specimens of different ages for the test. Unfortunately there was no excess matrix from either run, and no comparisons can be made. Some of the "sea biscuits" are dense, fine-grained lutite containing Foraminifera and molluscan fragments. Others, such as that containing the *Balanophyllia*, are composed of a nearly white coquina which is extremely vesicular.

DISTRIBUTION: Eastern north Atlantic Ocean.

OCCURRENCE: Recent: V4-28, southwest of Cape St. Vincent, Portugal; 91 meters. Sub-Recent: A180-27, Great Meteor Seamount; A152-108, Atlantis Seamount; 540 meters.

*Balanophyllia floridana* Pourtalès, 1868

*Balanophyllia floridana* POURTALÈS, 1871, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 41, pl. 4, figs. 4, 5.

As discussed above, the differences between *B. floridana* and *B. formosa* are slight and seem to rest solely on the degree of porosity of septa. A single, slightly crushed specimen from near Bermuda is identified with this species. The septa of the higher cycles are not so perforate as in the specimens referred to *B. formosa*.

DISTRIBUTION: Western north Atlantic.

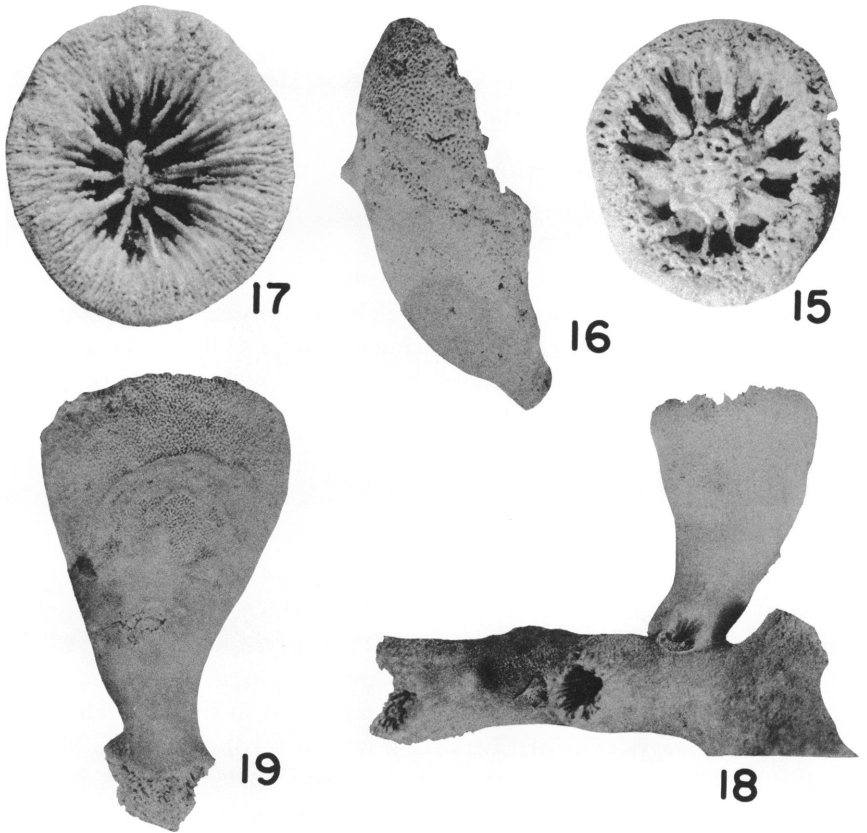
OCCURRENCE: Recent: V5-1, southeast of Bermuda; 798 meters.

GENUS *BATHYPSAMMIA* MARENZELLER, 1906

Portalès (1868) established the genus *Thecopsammia* for the reception of two species of balanophyllid corals which he characterized as simple, non-costate, epithecate forms. Two species were described, *T. tintinnabulum* and *T. socialis*. The latter is elongate-conical in form, with a small columella, and with septa arranged in the Pourtalès plan in the early stages. The first, separated from *Thecopsammia* by Marenzeller (1906) and made the type of the genus *Bathypsammia*, is characterized by a subcylindrical corallum which a short distance from the base becomes suddenly turbinate and has a larger columella and lacks the balanophyllid arrangement in the septa. Although corallum shape may be influenced greatly by attachment, it is significant that both species were based on attached specimens.

Two lots of specimens, numbering over 80 in all, from the material in dredge V3-23 were assigned to either of the two species on the basis of corallum form and size of columella. However, both lots of specimens lack the Pourtalès plan of septal arrangement. To ascertain the degree of development of this septal arrangement the types were sought, and, through the courtesy of Dr. Elisabeth Deichmann of the Museum of Comparative Zoölogy, one of the types of *T. socialis* (M.C.Z. No. 2773) and a suite of Pourtalès specimens of *T. tintinnabulum* were obtained for study. These confirm the diagnoses of Pourtalès and Marenzeller.

The absence of the Pourtalès plan from specimens otherwise identi-



FIGS. 15, 16. *Bathypsammia tintinnabulum* (Pourtalès), A.M.N.H. No. 3346. 15. Corallum.  $\times 2.1$ . 16. Calice.  $\times 2.8$ .

FIGS. 17-19. *Bathypsammia fallosocialis*, new species. 17. Holotype, A.M.N.H. No. 3344, calice.  $\times 2.8$ . 18. A.M.N.H. No. 3345, corallum attached to *Dendrophyllia profunda*.  $\times 2.1$ . 19. Holotype, A.M.N.H. No. 3344, corallum.  $\times 2.1$ .

cal with *T. socialis* indicates that there is a remarkable homeomorphy between these two closely related genera.

*Bathypsammia tintinnabulum* (Pourtalès), 1868

Figures 15, 16

*Thecopsammia tintinnabulum* POURTALÈS, 1868, Bull. Mus. Comp. Zoöl. Harvard, vol. 1, p. 138; 1874, Mem. Mus. Comp. Zoöl. Harvard, vol. 2, p. 43, pl. 1, figs. 9, 10.

*Bathypsammia tintinnabulum* (Pourtalès), MARENZELLER, 1907, Denkschr.



Akad. Wiss., Vienna, Math.-Nat. Kl., vol. 80, Ber. Komm. für Ozeanogr. Forsch., p. 8.

The specimens assigned to this species are somewhat different from the Pourtalès specimens. Figures 20, 22, and 23 present the measurements of these specimens and show the correspondence between them and Pourtalès' specimens. The only difference not indicated by these graphs is in the shape of corallum. The specimens from V3-23 are not only larger, but do not expand so suddenly from the pedicel. The correspondence between these two suites is otherwise quite remarkable, and such differences as may be present are due to population variability.

It is appropriate to append here a few more details of the septa than have been given before. These notes are based on the topotype

TABLE 8

MEASUREMENTS (IN MILLIMETERS) OF SPECIMENS OF *Bathypsammia tintinnabulum*

	Number of Specimens	Range	Mean	Standard Deviation
Height	31	9.1-33.9	22.7	5.78
Maximum diameter of calice	31	8.5-16.0	12.0	2.20
Wall thickness	31	0.5-2.5	1.31	0.47
Diameter of columella	31	0.7-6.7	3.56	1.30
Number of septa	28	18-52	37	9.13

specimens, as all of the specimens taken in V3-23 were dead and badly worn about the interior of the calice. Septa of both the first and second cycles join the columella, but those of the first cycle are somewhat more prominent, standing farther to the center of the calice. The upper margins of these septa are smooth, and the proximal faces are smooth and nearly perpendicular as they descend to the center of the calice. There is little fenestration of the first and second cycle of septa. Third- and fourth-cycle septa are, on the other hand, often quite fenestrate and usually prominently dentate on the proximal margin. Certain coralla seem to have entire septa in all cycles. In these instances the lateral granulations are more highly developed. Third-cycle septa are better developed in the systems adjacent to first-cycle septa. All septa are laterally granulate, some granules being so close to the proximal edge of the

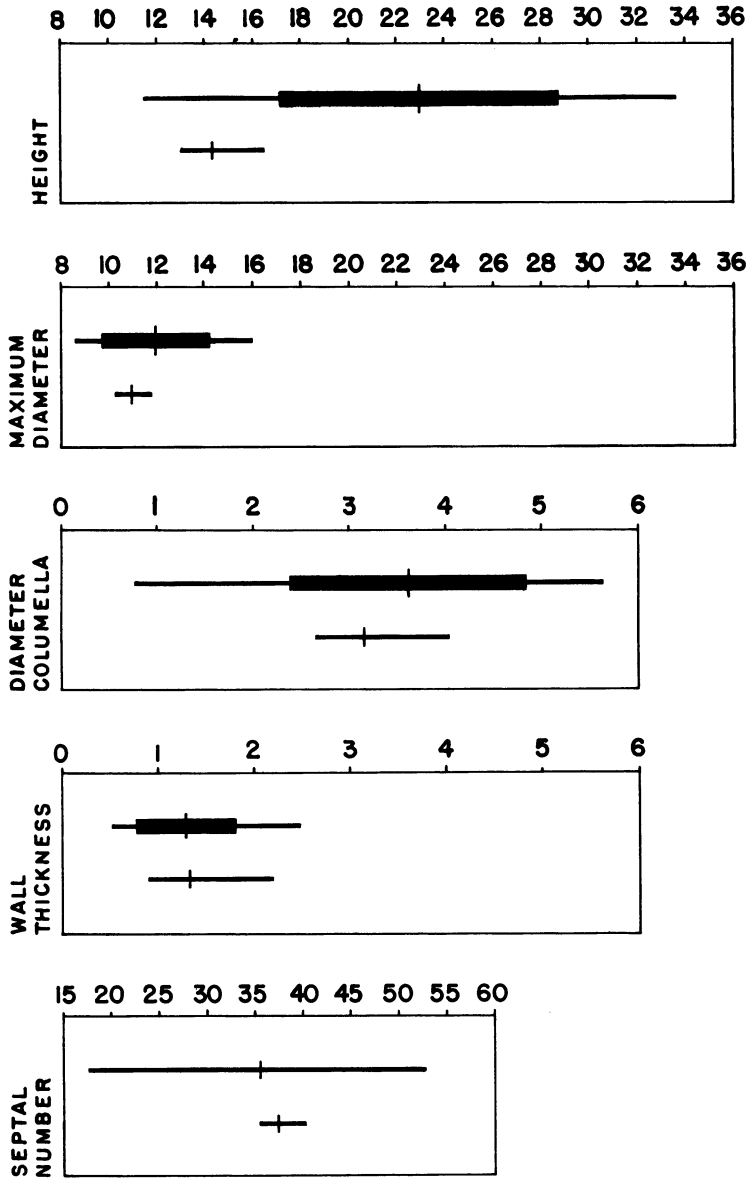


FIG. 20. A comparison of various measurements of *Bathypsammia tintinnabulum* from station V3-23 and six specimens from the Museum of Comparative Zoölogy. Measurements are in millimeters. The top figure is of the V3-23 specimens. The vertical bar represents the mean, the heavy line, where present, a value of one standard deviation on each side of the mean.

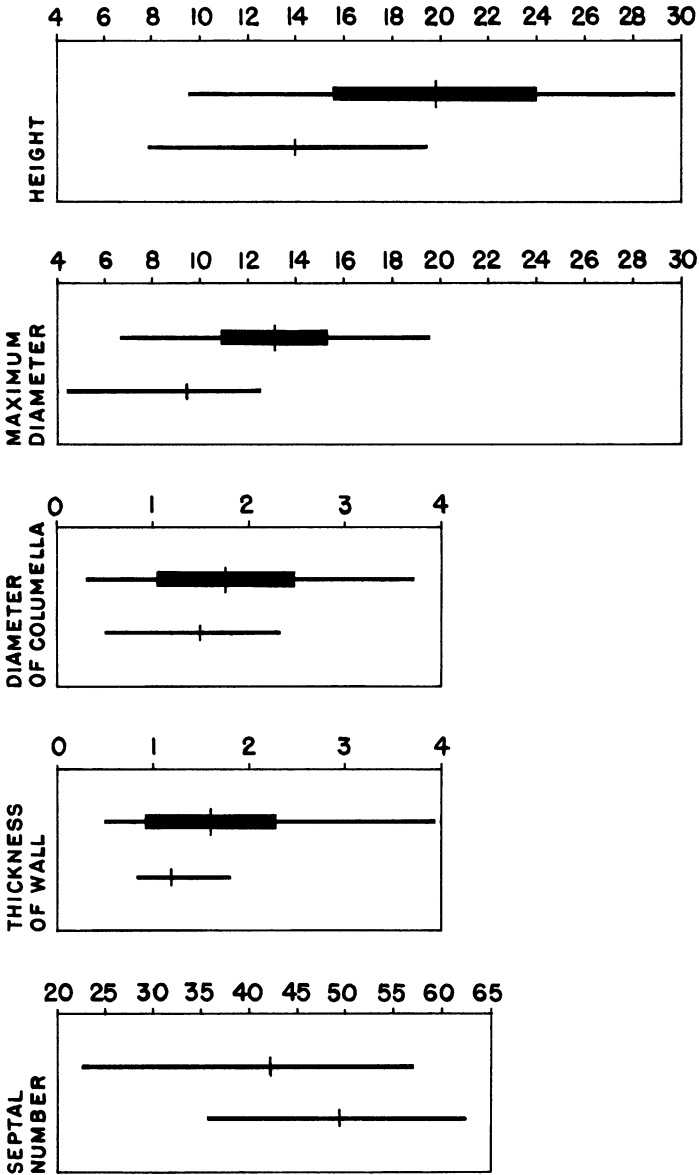


FIG. 21. A comparison of various measurements of *Bathypsammia fallosocialis* and the type specimens (three) of *Thecopsammia socialis* Pourtalès. Measurements are in millimeters. The upper figure represents *Bathypsammia fallosocialis*; the lower, *Thecopsammia socialis*. Construction of figure the same as that of figure 20.

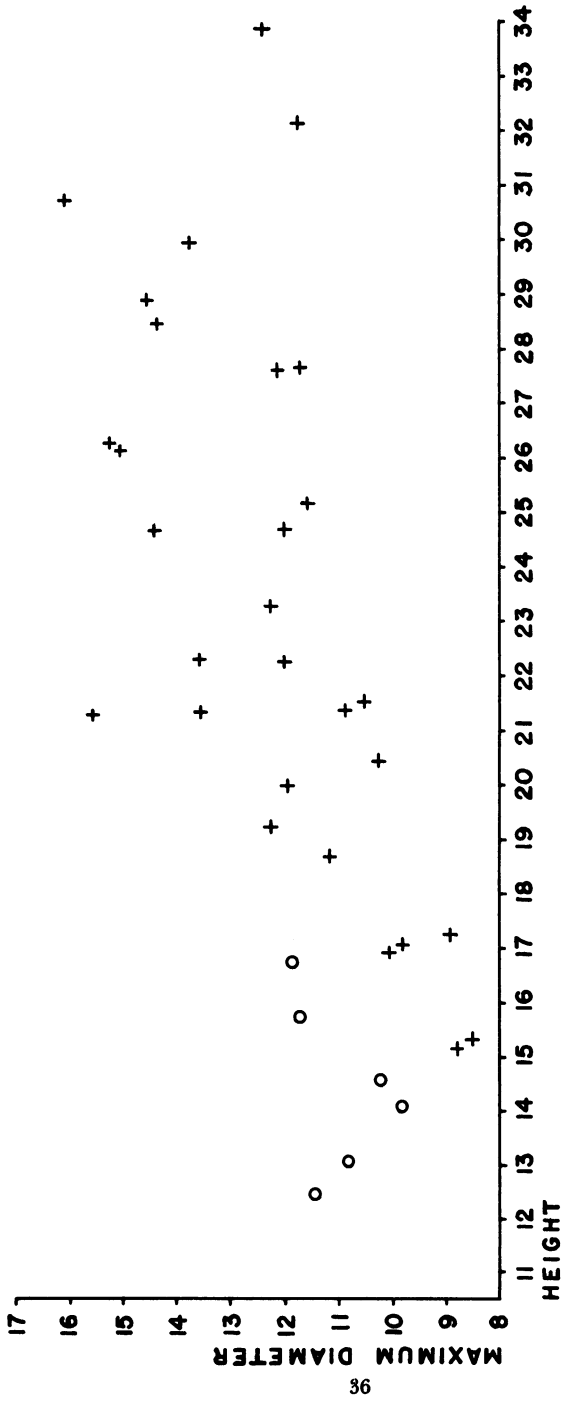


FIG. 22. Scattergram showing the relationship between maximum diameter of the calice and the height of the corallum in *Bathypsammia tintinnabulum*. Circles represent measurements on six specimens from the Museum of Comparative Zoology; crosses represent measurements on specimens from V3-23.

septa that they cause an apparently dentate condition. The character of the columella is quite variable, ranging from a dense trilobed mass to a dispersed group of interlaced trabeculae.

DISTRIBUTION: Western north Atlantic.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

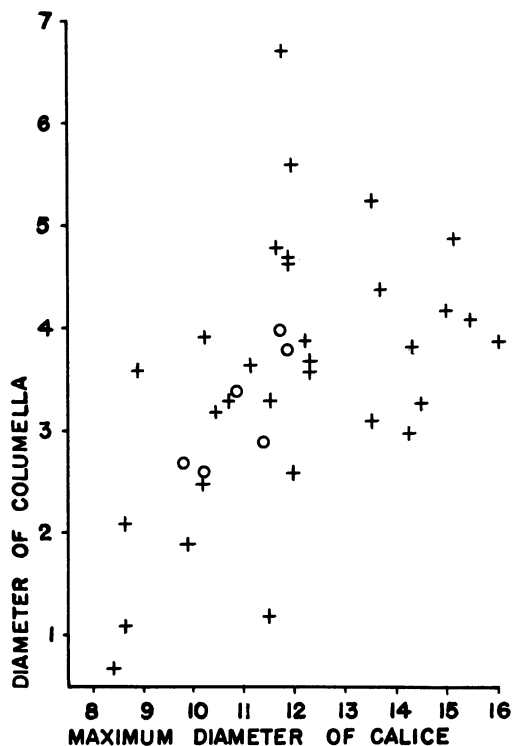


FIG. 23. Scattergram showing the relationship between diameter of calice and the diameter of the columella in *Bathypsammia tintinnabulum*. Circles represent measurements on six specimens from the Museum of Comparative Zoölogy; crosses represent measurements on specimens from V3-23.

### *Bathypsammia fallosocialis*, new species

Figures 17-19

HOLOTYPE: A.M.N.H. No. 3344, Department of Fishes and Aquatic Biology, the American Museum of Natural History.

Corallum solitary, trochoid, attached by a narrow pedicel. Corallum arises in an irregular fashion from the basal scar of attachment, but usually expands at an almost constant rate. Wall thick, irregularly

porous, the structure being very fine. The height to which the epitheca rises is variable, but approximates one-half of the height of the corallum. The epitheca is thin and finely rugose. Costae are absent. Septa thin, wedge-shaped, closely arranged. The upper margins are very slightly exsert, and rounded, with the proximal margin's being nearly vertical as the center of the calice is reached. Septa of the first and second cycles reach the columella; those of succeeding higher cycles are less than half of the radius of the calice in length and successively shorter. All septa are entire, and none is apparently fenestrate. Laterally, the septa are finely granulate and slightly ridged. Septa are ar-

TABLE 9  
MEASUREMENTS (IN MILLIMETERS) OF *Bathypsammia fallosocialis*, NEW SPECIES

	Number of Specimens	Range	Mean	Standard Deviation
Height	50	10.0-30.5	20.4	4.99
Maximum diameter of calice	50	6.7-18.6	13.28	2.23
Wall thickness	50	0.5-4.0	1.58	0.66
Diameter of columella	49	0.3-3.7	1.79	0.69
Number of septa	50	22-56	40.44	7.37

ranged in the normal fashion. Columella variable in character, usually trilobed, but always relatively small and trabecular in nature.

The resemblance between this species and *Thecopsammia socialis* Pourtalès is very close. Figure 21 shows the similarities in measurable characters. The only difference between the two species is that of the arrangement of the septa, those of the new species being normal in insertion, and in the non-perforate character of the septa, particularly those of the higher cycles.

A comparison with *Bathypsammia tintinnabulum* is also apt, as it occurs in the same collection. Data presented in figures 21 and 24 and in tables 8 and 9 show that in most characters of size there is considerable similarity. Differences in shape are apparent, however, *B. fallosocialis* having the same form as *T. socialis*. All the specimens of *B. fallosocialis* were attached or showed evidence of having been attached, while the majority of specimens of *B. tintinnabulum* from V3-23 were worn and showed no scar of attachment. Those specimens that were

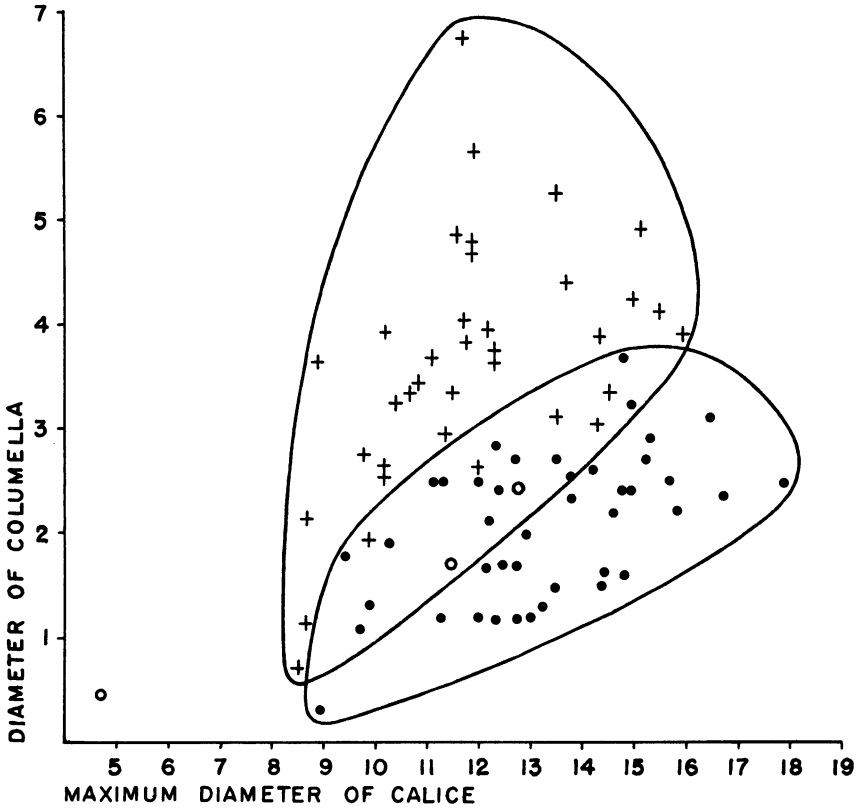


FIG. 24. Scattergram showing the relationship between diameter of calice and diameter of columella in *Bathypsammia fallosocialis*, *B. tintinnabulum*, and *Thecopsammia socialis*. Crosses represent measurements on *B. tintinnabulum* from V3-23; dots, measurements on *B. fallosocialis* from the same locality; circles, measurements on the type of *T. socialis*. Measurements are in millimeters.

not worn showed basal scars and tended towards a more trochoid form. I believe both species are usually attached, although some free forms may develop cornute coralla. The most significant feature is a rather conspicuous difference in the relative sizes of the columella (see fig. 24).

*Thecopsammia imperfecta* Gravier, 1920, is clearly a member of the genus *Bathypsammia*, judging from calicular details. It differs from both *B. tintinnabulum* and *B. fallosocialis* in the character of the well-developed costae and the development of the epitheca apparently on only the upper margins of the calice.

OCCURRENCE: Recent: V3-23, off Florida; 686 meters.

GENUS *ENALLOPSAMMIA* MICHELOTTI, 1871*Enallopsammia rostrata* (Pourtalès), 1878

*Amphihelia rostrata* POURTALÈS, 1878, Bull. Mus. Comp. Zoöl. Harvard, vol. 5, p. 204, pl. 1, figs. 4, 5.

*Stereopsammia? rostrata* (Portalès), PORTALÈS, 1880, Bull. Mus. Comp. Zoöl. Harvard, vol. 6, p. 110.

*Anisopsammia rostrata* (Portalès), MARENZELLER, 1904, in Chun, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition . . . "Valdivia," vol. 7, p. 314, pl. 18, fig. 23. GRAVIER, 1920, Résultats des campagnes scientifiques . . . par Albert I<sup>er</sup> . . . de Monaco, fasc. 55, p. 102, pl. 12, figs. 181-185.

A number of fragments of this specimen were taken at photographic station 12, V7 cruise, in the camera gear (see p. 2). The occurrence of the species at this depth represents a new record, as the greatest depth previously recorded (Gravier, 1920) was 2165 meters. Several of the specimens were taken alive, while others were coated with manganese to varying degrees of thickness. All were distal portions of the branches.

DISTRIBUTION: North Atlantic Ocean.

OCCURRENCE: Recent: V7, photographic station 12, off New York; 3383 meters.

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