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INTRODUCTION

For a period of two weeks during May, 1956, I was privileged to study the corals in the vicinity of the Lerner Marine Laboratory, Bimini, Bahamas. The purposes of that investigation and of the present report are to indicate the extent and variety of the coral fauna, factors involved in its distribution, and to provide a foundation for future work on this important element of the marine epifauna of the region. Although the period was barely sufficient to allow examination of the entire range of the variety of habitats in the immediate vicinity of the laboratory, the greater portion of the fauna is believed to be recorded, particularly that accessible to most workers. More complete collecting in any area would increase the list of recorded species, particularly the deeper water corals which have not been properly studied. Skin diving and the use of self-contained diving apparatus permitted collecting and observation up to depths of 30 feet, but no program of dredging in the deeper waters was feasible. Many unrecorded species are present in waters of this greater depth, as evidenced by specimens collected from the beach drift and by chance collections made during the course of other work. Further, the expanse of the Great Bahama Bank (hereafter called the Bank) has not been touched in the exploration of the region. The few collections made on the periphery of the western portion of the Bank yielded only unusual growth forms or adaptations to the peculiar environment of that area, rather than a different fauna.

The coral fauna of the Bimini region is not so luxuriant as that of the eastern Bahama Islands but, as the list of species indicates, most of the West Indian hermatypic or reef-building coral fauna of 35 species is present. This compares favorably with the fauna of other areas where marine biological stations have been established. Vaughan and Wells (1943, p. 76) list the following areas and faunas: Dry Tortugas, Florida, about 25 species; Jamaica, 21 species; Curaçao, 21 species; Puerto la Cruz, Venezuela, 12 species; eastern coast of Panama, 13 species; Veracruz, Mexico, 10 species.

The number of individuals of many of these species at Bimini is not great, particularly in the case of those species that constitute the organic framework of reefs in other areas. The less luxuriant development of the fauna may be attributed to the position of Bimini on the leeward edge of the Bank, an area in which the environment is not so satisfactory to the corals. The factors responsible for this condition are not completely understood and should furnish a fertile field for future research. Notable among the missing elements of the coral fauna are any extensive growths of the acroporids *Acropora palmata* and *A. cervicornis*. Only three individuals of the former were observed, and the latter is apparently absent from the fauna. The expected suites of the mussid, trochosmilid, and meandroid corals were not present.

Of particular importance is the feasibility of physiologic work on the Bimini corals or their associated fauna. Several factors enhance this phase of research: the corals of the Bahamas have been rather intensively studied and are therefore well known taxonomically, and the laboratory is well equipped for the study of living corals, having circulating, unfiltered, sea water flowing through a nonmetallic system to the many aquaria. In the past, investigators have often experienced difficulty in maintaining corals in the laboratory for periods long enough to permit observation and experimentation. During my stay at the laboratory, as many as six tanks of corals were kept flourishing, and Krumholz reported keeping *Porites porites* in outdoor tanks for as long as six months without special treatment. Corals from the "reef tract" are more difficult to culture owing to the absence of circulating waters from outside the lagoon.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge at this time the aid of a large number of associates at the Lerner Marine Laboratory who made the study possible in the short time available through their knowledge of the area and by aid in collecting. I am especially indebted to

Dr. Louis A. Krumholz, former Resident Biologist, Mr. Edwin D. Holland, Maintenance Engineer, and the many boatmen and laboratory helpers of the laboratory. Members of an American Museum party led by Dr. Norman D. Newell, including Dr. William K. Emerson, and Messrs. G. Robert Adlington, Louis Kornicker, and Edward Purdy, aided in the collecting and furnished information on distribution and assisted in the identification of associated fauna and flora. Mr. Adlington made the photographs of the corals, *en milieu*, which are reproduced here. The remainder of the photographs were made by Mr. Edward J. Hawkins. The field work at Bimini was done within the framework of a program organized by Newell and financed by grants from the Humble, Gulf, and Shell Oil companies.

PREVIOUS WORK ON BAHAMA CORALS

Although there has been no single systematic or experimental work directed particularly at the Bahama corals, studies conducted in other areas of the West Indies can be applied directly to the Bimini fauna. Of note are the researches conducted at the Institute of Jamaica, Kingston, and the Dry Tortugas Laboratory of the Carnegie Institution of Washington during the early portion of this century. Work at the former centered on the elucidation of the histology, morphology, and embryology of the corals, while at the latter problems of growth rate and toleration of environmental extremes were considered. In the following discussion mention is made of some of the more significant contributions to the understanding of the corals and their habits, but for the interested worker reference should be made to the various bibliographies, particularly that of Vaughan and Wells (1943), which will furnish access to the extensive general literature. Further, references to works of a specific nature are not discussed here, but are included in the synonymy of those species concerned, as are those having data on growth rates, environmental tolerances, and the like.

Descriptive works dealing with the West Indian coral fauna in which species found in the Bimini area are described are numerous. Duchassaing and Michelotti (1860, 1864) described portions of the fauna of the Antilles, but the variety of forms discussed by them is not great, although some of the species are found in the Bahamas. Agassiz (1880) described the Florida reefs and reef corals in a publication notable for its excellent lithographs. R. P. Whitfield, after extensive collecting in the vicinity of Nassau, described, in three short papers (1898, 1901a, 1901b), several species now considered as synonyms (*Maeandrina labyrinthica* + *Ctenophyllia quadrata* = *Diploria cerebrum*; *Diploria geographica* = *D. labyrinthiformis*) and noted some unusual growth forms. Verrill (1902a, 1902b, 1902c) discussed Bermudian and West Indian corals extensively and mentions specimens from the Bahamas, particularly those collected by Whitfield. These important works are somewhat marred by a splitting off of ecologic variations into specific units. However, Vaughan (1901a), in a discussion of Puerto Rican faunas, considered the species problem in the corals, particularly the reef forms, and contributed towards clarification of the systematics of the fauna. Another study by Vaughan (1901b) of systematic importance, although dealing primarily with fossil corals, considers in detail the history and synonymy of the names applied to West Indian corals. An appendix to this report lists all important papers dealing with West Indian living and fossil corals, and coral reefs in general. Gregory (1895) discussed the synonymy of some of the more common fossil corals in a paper which is valuable as a historical reference.

Two volumes of particular note are those of Bernard (1906) and Matthai (1928). The two are particularly interesting because of their varied treatment of respective subject matter. Matthai, in dealing with the "astreid" corals, treats of the systematics in detail as well as furnishes information on the polyp, its anatomy and histology, and the morphology of the corallum. For those genera included it is a necessary reference work. Bernard avoided the perplexing problem of speciation versus ecologic variation in a discussion of *Porites* and described specimens according to a scheme devised to avoid using specific names. Although admirable in some respects, it renders the usefulness of the volume almost nil except for a comparison of form. Both works, although describing the collections of the British Museum (Natural History), are comprehensive and provide means for correlating information between the various faunal provinces.

Of general interest to the student of zoogeography, reefs, and the environment of the Bahamas is the discussion contained in a study of the fossil corals of the Central American region by Vaughan (1919a). The volume contains a summary of the studies made by Vaughan on the geologic history of the Florida and Bahama areas as applied particularly to the corals and coral formations. A generalized summary of his work on Recent corals, particularly those of the Bahamas, may be found in Vaughan (1919b). Details of these studies may be found in Vaughan (1909, 1910, 1911, 1912, 1913, 1914, 1915a, 1916a). Butsch (1939) describes Barbados corals in a semi-popular fashion. Several species are figured. More recent studies are those made by F. G. Walton Smith (1943, 1948). The former, a very brief account of the corals of the Miami, Florida, area, contains a key to the genera of corals, but no illustrations. A more formal presentation is given in the latter which supplements popular and scientific keys with a number of photographs.

Prominent among the studies carried out at various biological stations are those conducted at the Carnegie Institution of Washington Marine Biological Station at Dry Tortugas, Florida. Many of the reports of investigations conducted there were published as short notes in the annual reports of the institution, while others were issued as Papers from the Tortugas Laboratory under the auspices of the Carnegie Institution of Washington. A full account is given here of these, as they represent the framework for additional physiologic-ecologic studies. Most of these reports contain descriptions by Vaughan of his experimental procedures for the determination of growth rates of West Indian corals, but incidentally contain valuable information on periods of breeding (at Tortugas) and of his culturing methods.

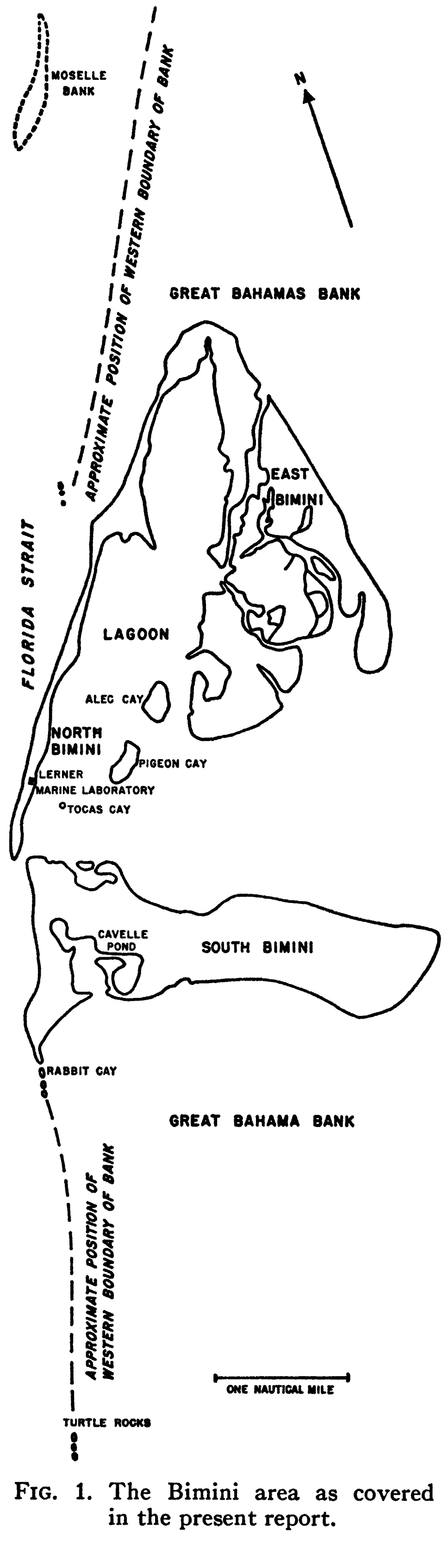

FIG. 1. The Bimini area as covered in the present report.

Additional experiments on duration of the larval stage; tolerance of adult corals to exposure to air, to varying degrees of salinity; on the effects of the exclusion of light; and various other physical factors are reported upon. A summary of his studies on growth rates appeared in another place (Vaughan, 1915b) and in a final report issued from the station (Vaughan, 1916a). Included in the latter are summary reports on the effects of lowered salinity and the exclusion of light.

A. G. Mayer (also given as A. G. Mayor), Director of the Tortugas Station for the longer portion of its existence, carried on studies dealing with the effects of temperature on the corals. A general report (1913) was followed by a discussion of the lower and higher temperatures which can be survived and probable optimum values (1914). The effect of temperature on the feeding reactions of the polyps was reported in 1916, and, finally, temperature in relation to toxic effects and oxygen consumption in 1918. Wells (1932) made studies on the effects of increased salinity values on various species. Yonge (1935a, 1935b, 1937) studied oxygen consumption, the production of mucus, feeding reactions, and the ability of the forms to cleanse themselves of sediment in several species of coral. In reports on the Great Barrier Reef corals, Yonge (1930, 1940) relates those corals and Tortugas forms in their ecology and physiology. Unpublished data accumulated by Vaughan are presented there, particularly in relation to feeding reactions. The data provided in these studies are of value and are applicable to the Bimini corals. It is, however, desirable to obtain more experimental data and, if possible, to develop new techniques for this type of study. Goreau and his coauthors (Goreau, 1953, 1956; Goreau and Bowen, 1955; Goreau and Philpott, 1956) have recently made physiological and histological studies based on the corals in the Kingston, Jamaica, area.

The embryonic and postembryonic development of many species was scrutinized at Tortugas, at Bermuda, and Jamaica. Among the important works dealing with this phase are those of Duerdan (1902, 1904), Matthai (1923, 1926), Boschma (1925a, 1929), and Wilson (1888). Many species have not been studied, and much more information must be accumulated on others.

DISTRIBUTION OF CORALS IN THE BIMINI AREA

THE GENERAL SETTING of the Bimini region has been given by Newell and Imbrie (1955), but some remarks relating the physiographic and sedimentologic provinces with the distribution of corals are in order. Bimini lies on the northwest margin of the Great Bahama Bank and fronts, to the west, on the Florida Strait. Here are the deeper waters, and, indeed, the bottom slopes rapidly downward to the Florida Strait. To the south and east are expanses of the relatively shallow waters of the Bank, while enclosed within the islands of North, South, and East Bimini is an area of extremely shallow water, the lagoon. The latter is ecologically complex because of certain physiographic features. For example, extending approximately north from Entrance Point, the juncture of North Bimini and South Bimini, is a deep natural channel permitting navigation into the lagoon. Approximately one-half of the length of North Bimini to the north, this natural channel shoals and divides several times. Dredging operations carried on by G. B. Lyons have extended one branch of the channel along the eastern shore of North Bimini to just below Mosquito Point. Above a constriction formed by Mosquito Point and a projection of East Bimini is the shallow or upper lagoon which, as is the broad expanse of shallows to the north and east of the channel in the main lagoon, is extremely shoal during low tides.

During the course of collecting, the lagoon was extensively examined, particularly in those areas accessible by boat during most tidal stages. A large number of habitats are present as a result of the channel and various bottom conditions. Reconnaissance trips were also made to various areas on the margin of the Bank. Although no observations were made in the center, it is believed (*fide* N. D. Newell, personal communication) that no corals will be found on the greater expanse of the Bank. Collecting along the western margin of the cays south of Bimini indicated that this area, as would be expected because of its position on the unprotected side, is the closest approximation to a reef environment that can be encountered in the vicinity. Within each of these larger areas local conditions determine a complex of smaller environments.

One of the major determinants of the coral fauna within the larger geographic divisions is the character of the substrate. Often the control on the corals is indirect, but a correlation is present and pronounced. Three general bottom conditions may be defined: (1) a rock bottom, with no permanent accumulation of sediment, although there may be a wash of sand across it during flood and ebb stages of the tide; (2) a sand-veneer bottom, in which a film of sediment several millimeters to several centimeters deep is present over the rock substrate; and (3) a deep sand bottom, in which sand, or mud, is present over the rock in depths of 4 or 5 inches to several feet, the latter being more characteristic.

The collecting sites listed below are indicative of the conditions that are encountered in each of the larger units. No attempt could be made, in view of the limited time available, to map the distribution of the various faunal suites, but the composition of the coral fauna can be predicted from the general faunal and floral character of the various stations, or from the physical setting of the area.

COLLECTING LOCALITIES ON THE WESTERN SIDE OF BIMINI AND ASSOCIATED CAYS

STATION 1: WEST SIDE OF RABBIT CAY, ROUND ROCK, AND THE TIP OF SOUTH BIMINI

Coral development here more closely approximates that of a reef than any found in the Bimini area. As indicated by Newell and Imbrie (1955) there is a relatively sharp drop in bottom profile from the low-tide level to a depth of about 10 feet where the bottom slopes more gently to greater depths. The

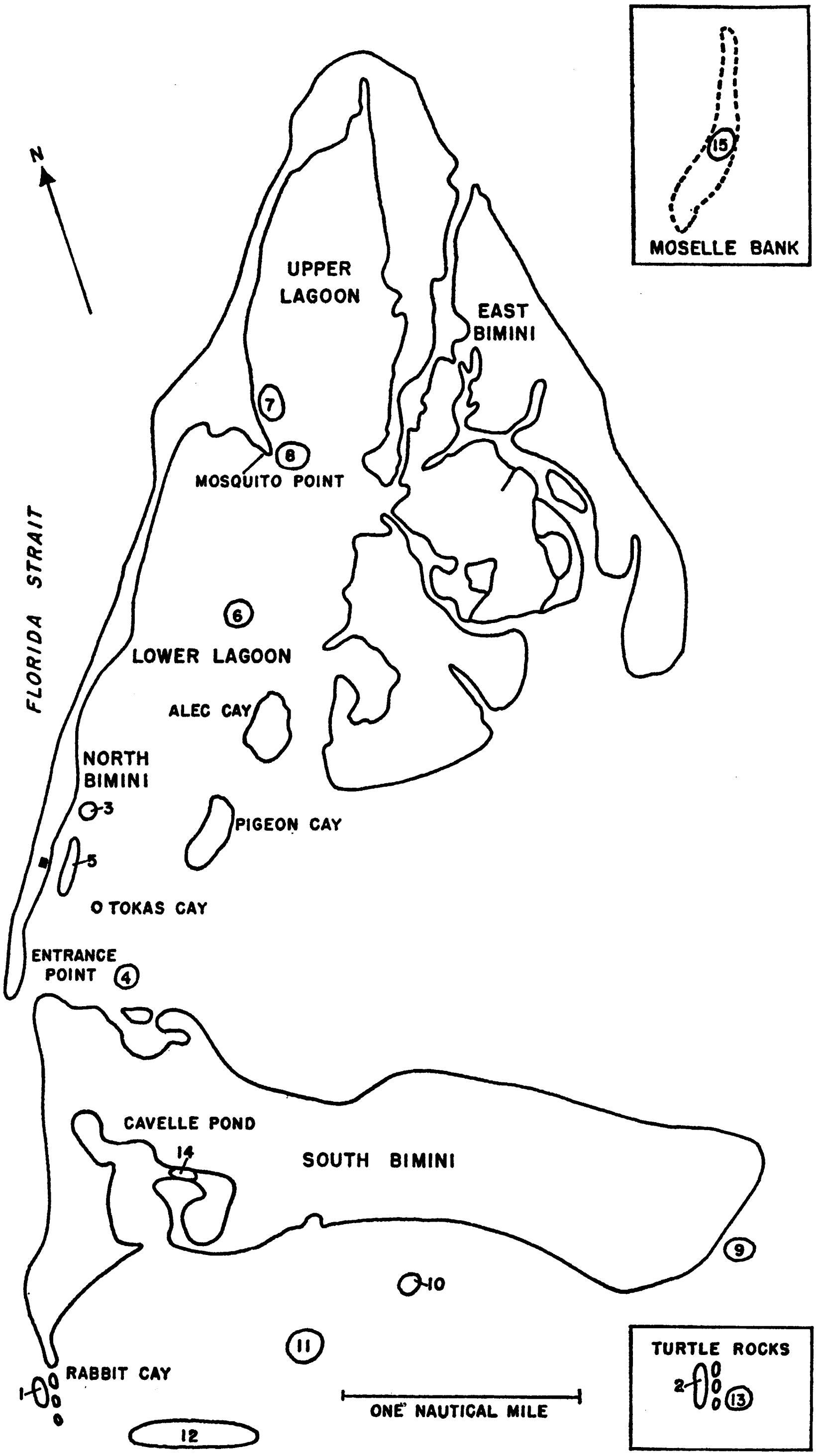

FIG. 2. The Bimini area, with collecting stations indicated. The approximate area of investigation is indicated by the line enclosing the station number.

bottom is rock for the greater part, although in holes or incomplete channels there may be an accumulation of gravel or sand. Beyond a depth of approximately 30 feet, sand, or sand and gravel, are present in increasing preponderance as the bottom type. Surf action is moderate to heavy along the breaker zone.

Between low-tide level and a depth of 10 feet, there is luxuriant coral growth consisting mostly of small coralla. Dominant are *Millepora alcicornis* and *M. complanata* which form encrusting masses, both pinnacled and castellated, along the upper margin of this zone. Small colonies of *Isophyllia sinuosa*, *Isophyllastrea rigida*, *Siderastrea radians*, *Agaricia agaricites*, and *Dichocoenia stokesii* are abundant below this zone but are found principally on lee surfaces of grooves, in holes, and in other protected areas. Where exposed to the surf, the growth form is encrusting rather than as hemispherical masses. *Stephanocoenia michelini* commonly forms encrusting mats on the exposed areas. Hemispherical colonies of *Porites astreoides* and encrusting mats of *Diploria clivosa* are found in the deeper portions of this upper interval. Below a level of 10 feet and extending down to a depth of 30 feet or more are large, nearly spherical masses of *Siderastrea siderea*, *Montastrea cavernosa*, and *M. annularis*. The first and last of these may be up to 6 feet in diameter. These coralla are usually not solid, but have been bored and drilled extensively and contain an interesting fauna of mollusks, bryozoans, ophiuroids, protozoans, sponges, crustaceans, and fishes. Large masses of the brain coral *Diploria strigosa* are common. Unique to this area are tremendous coralla of *Porites porites* var. *clavaria*. Spherical masses of this coral up to 6 feet in diameter are common at depths of 20 to 30 feet. The corallum is formed by long, thick, radial branches developed from a central stem. The branches are closely packed so that the coral, from a distance, appears as a massive form. Because of its dense nature the inner portions of the branches are dead; only the outermost tips are living. A multitude of encrusting and boring organisms have tended to weaken the corallum so that a gentle blow causes large portions to disintegrate into its separate branches. Conspicuously absent are species of *Acropora*.

Species collected from station 1 arranged in order of abundance are:

Millepora complanata Lamarck, 1816
Millepora alcicornis Linnaeus, 1758
Siderastrea radians (Pallas), 1766
Siderastrea siderea (Ellis and Solander), 1786
Montastrea annularis (Ellis and Solander), 1786
Montastrea cavernosa (Linnaeus), 1766
Porites porites var. *clavaria* Lamarck, 1816
Isophyllastrea rigida (Dana), 1846
Isophyllia sinuosa (Ellis and Solander), 1786
Porites astreoides Lamarck, 1816
Agaricia agaricites (Linnaeus), 1758
Agaricia agaricites var. *purpurea* Lesueur, 1820
Diploria strigosa (Dana), 1846
Stephanocoenia michelini Milne-Edwards and Haime, 1848
Favia fragum (Esper), 1797
Dichocoenia stokesii Milne-Edwards and Haime, 1848
Manicina areolata (Linnaeus), 1758
Agaricia agaricites var. *crassa* Verrill, 1902

Station 2: West Side of the Turtle Rocks

This area includes the three low rock cays known collectively as Turtle Rocks which are separated by low passes through which there is flow during rising and falling tides. The bottom is formed by a bench extending outward from the shore at about low-tide level. A rather sharp break to a depth of about 4 feet is developed a short distance from the shore. Coinciding with this, or a short distance farther out, is a drop to a depth of about 10 feet, the bottom sloping gently downward from this point. Bottom conditions here are approximately the same as those encountered at Rabbit Cay. The level, or nearly level, bottom areas have a scanty growth of coral, the intervening areas having a flourishing fauna of purple and yellow sea fans and algae. The surface of the rock is covered by a thin film of fine sediment and algal scum.

The upper zone and the vertical surfaces are generally covered by a thick mat of *Millepora alcicornis* and *M. complanata*. Sheltered areas on the vertical face below this zone are inhabited by *Isophyllia sinuosa*, *Isophyllastrea rigida*, *Agaricia agaricites* and its varieties, *Porites porites* var. *clavaria*, *Favia fragum*, encrusting *Siderastrea siderea*, and other species. On the terrace at 10 feet, the larger corals become more apparent, with

Porites astreoides, *Diplora strigosa*, *Diplora clivosa*, and *Montastrea annularis* present. The habitat is similar in many respects to that of Rabbit Cay but the deeper waters, that is, from 10 to 30 feet, are not so densely populated, and large masses of *Porites porites* var. *clavaria*, *Siderastrea siderea*, and *Montastrea annularis* are absent. Three colonies of *Acropora palmata* were encountered in this locality in various places, the only record of this species from the Bimini area.

Species collected from station 2 arranged in order of abundance are:

Millepora complanata Lamarck, 1816
Millepora alcicornis Linnaeus, 1758
Agaricia agaricites (Linnaeus), 1758
Siderastrea radians (Pallas), 1766
Isophyllia sinuosa (Ellis and Solander), 1786
Isophyllastrea rigida (Dana), 1846
Agaricia agaricites var. *purpurea* Lesueur, 1820
Montastrea cavernosa (Linnaeus), 1766
Montastrea annularis (Ellis and Solander), 1786
Dichocoenia stokesii Milne-Edwards and Haime, 1848
Diploria clivosa (Ellis and Solander), 1786
Porites astreoides Lamarck, 1816
Stephanocoenia michelini Milne-Edwards and Haime, 1848
Favia fragum (Esper), 1797
Siderastrea siderea (Ellis and Solander), 1786
Manicina areolata (Linnaeus), 1758
Porites porites var. *clavaria* Lamarck, 1816
Diploria strigosa (Dana), 1846
Acropora palmata (Lamarck), 1816
Eusmilia sp.

COLLECTING LOCALITIES IN THE LAGOON

Station 3: Off First Point North of Lerner Marine Laboratory, West Side of Channel

This station borders on an area of thick *Thalassia* growth. In such areas few corals were ever seen, but on the margins, a characteristic fauna composed of heads of *Porites astreoides* 6 inches to 1 foot in diameter, scattered branches of *Porites porites* var. *furcata*, small coralla of *Siderastrea radians*, *Manicina areolata*, and *Favia fragum* are present. Most of these species are in moderate abundance.

This station is typical of areas that are marginal on thick growths of *Thalassia* and that have a bottom of the sand-veneer type. Water depth in these areas varies from several feet to 10 feet or more. Associated with the corals is a diversified fauna of sponges, including the large man-jack sponge, *Speciospongia*, various holothuroids, the echinoids *Eucidaris* and *Diocema*, particularly in crevices and holes under the corals. Algae present included *Batophora*, *Udotea*, *Halimeda*, and *Penicillus*. *Thalassia* was present, but scattered.

Species collected at station 3, arranged in order of abundance are:

Porites porites var. *furcata* Lamarck, 1816
Manicina areolata (Linnaeus), 1758
Favia fragum (Esper), 1797
Siderastrea radians (Pallas), 1766
Porites astreoides Lamarck, 1816
Dichocoenia stokesii Milne-Edwards and Haime, 1848

Station 4: "Finger-Coral" Patch Between Tokas Cay and South Bimini

The area is characterized by the extensive development of *Porites porites* var. *furcata*. This species, in several color varieties, is found in great abundance. In all instances the coralla are loose and lying free on the bottom, giving the area the appearance of a thicket. The coralla apparently develop from an insecure attachment and, after reaching a certain size, become unstable and topple. Further growth, directed upward, leads to instability again, and the corallum topples. Various stages of this procedure may be observed through the degree of encrustation and boring of the dead corallum.

The "finger-coral" patch differs from the preceding only in the relative abundance of the faunal elements. The patch is a low depression in the general surface of the lagoon, a feature that generally can be correlated with an absence of heavy *Thalassia* growth. It is surrounded by thick growths of *Thalassia* and is removed from direct connection with the channel, factors that may have a restricting influence on the circulation. The depth of water is never great, the approximate maximum being about 4 feet. Sponges are abundant, including the man-jack, *Spe-*

ciospongia, and *Chondrilla*, *Ircinia*, and *Tedania*. The calcareous alga *Halimeda* was common. Holothuroids, echinoids, and snails (*Fasciolaria*) were also observed.

Corals observed at station 4 listed in order of abundance are:

Porites porites var. *furcata* Lamarck, 1816
Manicina areolata (Linnaeus), 1758
Porites astreoides Lamarck, 1816
Siderastrea radians (Pallas), 1766
Isophyllia sinuosa (Ellis and Solander), 1786

Station 5: Rock Ledge Bordering Natural Channel North of Lerner Marine Laboratory

The channel is one of the most interesting ecological features of the lagoon, and the presence of a rock ledge on its margins presents a unique habitat which is populated by a fauna that is unusual for the lagoon. As indicated above, the channel extends northward from Entrance Point to about Bailey Town where it branches and loses continuity. Due west of the laboratory, the channel is approximately 25 feet deep, and it deepens southward to 30 or 35 feet. Somewhat north of the laboratory, the rock ledge is only 7 to 10 feet deep, but the channel bottom lies at somewhat greater depths. The rock ledge is best developed on the western side but is also found on the eastern margin to the south of the laboratory dock. It is a difficult area in which to collect because of the extreme current during flowing and ebbing tides, the only satisfactory working period being during the short slack tide.

In the upper portion of the channel, the rock ledge bears an interesting coral fauna, including species typically associated with the reef, such as *Millepora alcicornis*, *Agaricia agaricites* var. *purpurea*, *Agaricia agaricites* var. *crassa*, and *Diploria strigosa*. Lagoonal forms, such as *Manicina areolata*, *Favia fragum*, *Siderastrea radians*, and *Porites astreoides*, are also found here. Coralla of *Manicina areolata* are often upside down, apparently turned by the action of the current, but possibly through the activities of the lobster fishers who work the ledge areas, or by dragging anchors. Accompanying these corals are small arborescent coralla of *Oculina diffusa*, which has not been recorded elsewhere in the Bimini region.

The special nature of the coral fauna here can be attributed to the great volume of water flowing through the channel during the tidal changes. Because of the funnel-like nature of the channel and its distributaries, rather vigorous current action is present. To a degree this tidal flow simulates the surf action on the face of a reef, introducing similar conditions and permitting development of these corals. Only a few species of the agitated water fauna are tolerant of the deleterious properties of the lagoonal waters.

In the southern portions of the channel, larger colonies of coral are found, particularly *Diploria* (*D. strigosa*?). Here, in waters of 20 or more feet in depth, they are subject to diurnal flow but are also subject to the extremes of temperature and salinity encountered by the corals living at shallower depths because the lagoonal waters would tend to flow out as a surface veneer.

Corals collected at station 5 listed in order of abundance are:

Porites astreoides Lamarck, 1816
Siderastrea radians (Pallas), 1766
Agaricia agaricites var. *purpurea* Lesueur, 1820
Porites porites var. *furcata* Lamarck, 1816
Millepora alcicornis Linnaeus, 1758
Isophyllia sinuosa (Ellis and Solander), 1786
Montastrea annularis (Ellis and Solander), 1786
Oculina diffusa Lamarck, 1816
Diploria strigosa (Dana), 1846
Agaricia agaricites var. *crassa* Verrill, 1902

Station 6: Grunt Drop

Grunt Drop, so called because of the excellent grunt fishing, is above the fork of the natural channel in the northern portion of the lower lagoon. In situation, Grunt Drop is very similar to stations 3 and 4, as it is a low depression surrounded by thick *Thalassia* growths having a sand-veneer bottom. However, it is somewhat shallower, being covered by only 1 or 2 feet of water during low tide and 4 to 5 feet at high tides. The associated fauna is dominated by sponges and echinoids, particularly the man-jack sponge, *Sphheciospongia*, and the echinoid *Eucidaris*. Among Mollusca present were *Arca*, *Pteria*, and *Fasciolaria*. Algae include *Udotea*, *Penicillus*, and others. The corals show a certain modification, particularly in the character of the branching *Porites*. This is the only area within the lagoon where *P. porites* var. *divaricata* was collected, and the number of *P. porites* var. *furcata* is reduced. Perhaps nowhere else in the lagoon is *Manicina areolata* so abundant and varied.

Species collected at station 6 in order of abundance are:

Manicina areolata (Linnaeus), 1758
Siderastrea radians (Pallas), 1766
Favia fragum (Esper), 1797
Porites astreoides Lamarck, 1816
Porites porites var. *furcata* Lamarck, 1816
Porites porites var. *divaricata* Lesueur, 1820

Station 7: Mouth of the Upper Lagoon

At Mosquito Point there is a constriction in the lagoon formed by the point and a bulge in the western shore of East Bimini, which effectively divides the lagoon into two areas, an upper and a lower portion. The upper lagoon is in general characterized by thin growths of *Thalassia*, crab burrows, and worm mounds. The water is extremely shallow, and indeed during lower tides the area is exposed. Sediment accumulation is extensive, often 2 or 3 feet, and the bottom is very soft. Nowhere in this upper area were corals seen except for one spot on the northern side of Mosquito Point. This, station 7, has an extremely soft bottom, with 2 or 3 feet of sand and mud present. The corals were generally found to be rather deeply immersed in the sediment. *Manicina areolata* was recovered from holes 3 inches deep, as were *Siderastrea radians* and *Porites porites* var. *furcata*. *Porites porites* var. *furcata* was found in a lighter color phase than previously observed, the polyps being almost cream colored. All the corals taken from this area had one feature in common: all were extremely active even during periods of illumination, and the length of the tentacles was noticeably greater as was the extension of the polyp from the corallum.

Corals collected from station 7 listed in order of abundance are:

Manicina areolata (Linnaeus), 1758
Siderastrea radians (Pallas), 1766
Porites porites var. *furcata* Lamarck, 1816

Station 8: Entrance to the Upper Lagoon, East of Mosquito Point

The sediment cover is less than at station 7, with bare rock exposed in some places. There is evidence of sediment motion from the upper lagoon to the lower. The associations are similar to that of Grunt Drop, with abundant sponges, *Strombus*, and the crawfish *Panulirus*. *Manicina areolata* and *Siderastrea radians* were the common forms. Many of the former were found overturned and dead; others were in holes and nearly covered by sediment. *Siderastrea radians* showed the effects of the scour action of moving sediment, as only the upper portions of the hemispheric coralla were alive, the lower portion being dead.

Corals collected from station 8 in order of abundance are:

Siderastrea radians (Pallas), 1766
Manicina areolata (Linnaeus), 1758
Porites porites var. *furcata* Lamarck, 1816

COLLECTING LOCALITIES ON THE MARGIN OF THE GREAT BAHAMA BANK

Station 9: East Side of South Bimini, on Margin of Bank

The sediment cover over underlying rock is less than 6 inches for approximately 500 feet off shore. The depth of water is not greater than 6 feet in any of the area examined. Parallel to the shore is a belt of algae about 10 to 30 feet wide. Beyond this are only sparse coral growth, large sea whips, and scattered patches of thin growths of *Thalassia*.

Corals collected from station 9 listed in order of abundance are:

Porites porites var. *furcata* Lamarck, 1816
Siderastrea radians (Pallas), 1766
Manicina areolata (Linnaeus), 1758

Station 10: Off Shore of South Bimini, Near Eastern Tip

This is an environment similar to that of station 9, but is developed only in a relatively narrow, irregular band near and approximately parallel to the shore. Typically the fauna and flora are sparse, predominantly composed of thin patchy growths of *Thalassia*.

Corals collected at station 10 in order of abundance are:

Porites astreoides Lamarck, 1816
Porites porites var. *furcata* Lamarck, 1816

Station 11: Off Shore of Central South Bimini

On the off-shore side of the zone in which station 10 is located there is an area of deep sediment accumulation, often in the form of a fine muck which is easily dispersed. The bottom is thrown into an irregular topography by crabs and worms and their burrowing activities. This type of bottom does not form a well-defined zone but is broken up into patches by alternation with thick growths of *Thalassia*. *Cassiopea* is common in the bare sand areas where organic activity has been the greatest. Found here were extremely rare individual colonies of *Porites porites* var. *divaricata* which seldom attain a size of over 3 inches and may be easily overlooked. The branching corallum is usually attached to the basal portion of an algal growth but was also observed lying loose on the bottom. In areas of thin *Thalassia* growth, groups of five or six *Manicina areolata* of an unusual growth form were found. These groups are apparently rare, although extensive coverage of this interesting area may show them to be more common. The coralla of this form are deeply embedded in the soft bottom, and only the uppermost portions of the corallum are exposed. As the polyp tends to be a light yellow or cream color, they may be easily overlooked.

Corals collected from station 11 listed in order of their abundance are

Manicina areolata (Linnaeus), 1758
Porites porites var. *divaricata* Lesueur, 1820

Station 12: Off South Shore of South Bimini

Farther off shore than station 11 is a blind channel leading approximately east-southeast from Rabbit Cay, in which is found an entirely different fauna. Water depth increases from approximately 6 feet on the margins to 12 to 15 feet in the channel. The rock bottom there is scoured by sediment flow off the Bank during periods of falling tide, concentrated in this channel. The fauna is composed principally of sea pens, sea whips, and sea fans, among the largest seen in the area. Found encrusting on these is *Millepora alcicornis* which because of the scour seldom extends to the basal portion of the encrusted animal but begins 3 or 4 inches above the base. In this channel, as the water deepens towards Rabbit Cay, large colonies of *Porites astreoides*, *Diploria* sp., and *Montastrea* sp. are found.

Corals collected at station 12 listed in order of abundance are:

Millepora alcicornis Linnaeus, 1758
Porites astreoides Lamarck, 1816
Diploria sp.
Montastrea sp.

Station 13: Eastern or Bank Side of Southernmost Turtle Rocks

The water in this area is shallow for a considerable distance off shore and joins the rock island abruptly without a beach. The bottom is rock, with a variable thickness of sand covering it. As this portion of Turtle Rocks is the windward side, wave action tends to be intense, and the bottom is generally shifting. All the corals indicated the intensity of the current action, many of them having been overturned or torn loose from their attachment to the substrate. The fauna is principally a reduced or impoverished representation of that on the western side of Turtle Rocks. *Siderastrea radians* is one of the more common elements and generally forms hemispherical nodules characteristic of the lagoonal specimens. Only seldom are the entire coralla covered by living polyps; more often, the upper and lower portions are dead, with a central band living. *Favia fragum*, *Siderastrea siderea*, and *Montastrea cavernosa* were found as small colonies, seldom exceeding a foot in diameter, more generally 4 to 6 inches. The fact that both tops and bottoms of these forms were dead and showing evidence of having been eroded suggests that they had been periodically overturned. Massive coralla of *Porites astreoides* were common, as were large encrusting mats of *Diploria clivosa*. These are apparently not affected by the sand, which was seen to move across the surface of the corallum, and the large basal area of these forms would serve to anchor them securely so that overturning would not occur.

Species collected at station 13 listed in order of abundance are:

Siderastrea radians (Pallas), 1766
Favia fragum (Esper), 1797
Montastrea cavernosa (Linnaeus), 1766
Millepora alcicornis Linnaeus, 1758
Porites astreoides Lamarck, 1816
Siderastrea siderea (Ellis and Solander), 1786
Diploria clivosa (Ellis and Solander), 1786
Manicina areolata (Linnaeus), 1758

Station 14: Cavelle Pond

The unusual nature of Cavelle Pond suggests that salinity, pH, oxygen tension, and other physical characteristics would differ from the normal for this region because of reduced circulation. Therefore, the area was searched for corals that could be subjects of a morphologic study of the effects of such environmental factors. In the outer pond, there is a thin covering of sand over rock. *Siderastrea radians* was the only coral found there, and it is moderately abundant. As one proceeds up the channel connecting the lower and upper ponds, the depth of the sand cover increases, and the number of corals decreases. *Siderastrea radians* was collected to about the middle portion of this connection. In all cases the coralla were found in areas that had little cover and were cemented to the rock substrate. No corals were seen in the thick sand-muck bottom of the inner pond.

TABLE 1

Distribution of Stony Corals in the Bimini Area by Stations

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13	Station 14	Station 15	Deep Water
Acropora palmata	—	r[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agaricia agaricites	c	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agaricia agaricites var. *crassa*	r	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—
Agaricia agaricites var. *purpurea*	c	c	—	—	c	—	—	—	—	—	—	—	—	—	—	—
Dichocoenia stokesii	c	c	r	—	—	—	—	—	—	—	—	—	—	—	—	—
Diploria clivosa	c	c	—	—	—	—	—	—	—	—	—	—	r	—	—	—
Diploria strigosa	c	r	—	—	r	—	—	—	—	—	—	—	—	—	—	—
Eusmilia sp.	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Favia fragum	c	c	c	—	—	c	—	—	—	—	—	—	—	—	—	—
Isophyllastrea rigida	a	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Isophyllia sinuosa	a	a	—	r	c	—	—	—	—	—	—	—	—	—	—	—
Manicina areolata	c	c	a	a	—	a	a	r	a	—	c	—	r	—	—	—
Millepora alcicornis	a	a	—	—	c	—	—	—	—	—	—	a	a	—	a	—
Millepora complanata	a	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Montastrea annularis	a	c	—	—	r	—	—	—	—	—	—	—	—	—	—	—
Montastrea cavernosa	a	a	—	—	—	—	—	—	—	—	—	—	c	—	—	—
Oculina diffusa	—	—	—	—	c	—	—	—	—	—	—	—	—	—	—	—
Paracyathus cf. *P. confertus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r
Porites astreoides	c	c	a	a	a	c	—	—	—	c	—	c	c	—	a	—
Porites porites var. *divaricata*	—	—	—	—	—	r	—	—	—	—	r	—	—	—	—	—
Porites porites var. *clavaria*	a	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Porites porites var. *furcata*	—	—	c	a	c	c	r	r	r	r	—	—	—	—	—	—
Siderastrea radians	a	a	a	a	a	a	a	a	a	—	—	—	a	a	a	—
Siderastrea siderea	a	c	—	—	—	—	—	—	—	—	—	—	r	—	—	—
Stephanocoenia michelini	c	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of species identified	19	20	6	5	10	6	3	3	3	2	2	2	8	1	3	1

[a] *Symbols:* a, abundant; c, common; r, rare.

Station 15: Moselle Bank

This is a linear rock ridge trending north-northeast and rising sharply from the surrounding bottom. The shoal is a potential site for reef development, but is subject to intense scour from material being carried off the Bank, with the result that the fauna is limited.

Corals observed on Moselle Bank listed in order of their abundance are:

Porites astreoides Lamarck, 1816
Siderastrea radians (Pallas), 1766
Millepora alicicornis Linnaeus, 1758
Diploria sp.
Porites porites var.
Isophyllia sp.?

NOTES ON FOSSIL CORALS FROM BIMINI

Although fossiliferous rock is widely distributed in the Bimini region, corals were collected in only two localities. On the western shore of North Bimini, to the west of the Lerner Marine laboratory, is an outcrop which yielded a single specimen of *Agaricia agaricites*. The fauna other than this single coral is chiefly molluscan and presumably of lagoonal or bank facies. More significant are the corals exposed by dredging operations in the George Lyons Channel north of Bailey Town. One large specimen of *Montastrea annularis* was found by N. D. Newell in 1955 on the beach alongside dredgings from the channel. Taken from the dredgings were specimens of *Oculina diffusa* and *Porites porites*. Peat underlying these sediments has been dated at 4500 years (Newell, personal communication). There can be little doubt that this coral assemblage is indicative of a channel in this vicinity. The absence of corals of any type from outcrops at the airfield, South Bimini, at Paradise Point in North Bimini, or from the lengthy exposures along the west side of North Bimini is of considerable interest. Apparently only bank facies are represented in these areas.

ECOLOGY AND DISTRIBUTION

AS INDICATED IN TABLE 1, the Bimini coral fauna is composed of two elements, an outer or bank-margin fauna and an inner or bank-and-lagoon fauna. These are not clearly distinguished by different species but are characterized by assemblages of species. Often the distinctions are not so sharply defined taxonomically as they are morphologically because of the rather wide range of tolerance of some species to certain ecologic factors. These species often respond to changes by a modification of the corallum or calicular morphology. Variation of this sort may occur on several levels and has led to a great deal of confusion in the systematics of many groups of the reef corals, as, for example, the genus *Porites*.

Unfortunately quantitative data for many of the ecologic factors of the Bimini area are not known. Qualitative information based on my own short experience in the area and discussions with persons who are more familiar with year-round conditions have indicated some factors of possible importance and directions for future investigation. The following discussion can be considered only as a guide to the possible influences causing the observed distribution.

ECOLOGIC FACTORS

SEA TEMPERATURES

No record of the variations of sea temperature has been compiled for the Bimini area. Raw data, in the form of recording charts, are available only for the lagoon, off the laboratory dock. Data taken from Fuglister (1947) for the western North Atlantic show a seasonal variation in the temperature of the surface water of about 5° C. A high of about 29° C. is reached during August, while a low of approximately 24° C. is shown for February. Further, the depth of the virtually isothermal layer ranges from 60 to 70 meters during the winter to approximately 30 meters in the summer months. These data indicate that the Bimini region is well within the range of temperatures given by Vaughan and Wells (1943, p. 55) for the development of a hermatypic fauna. The depth of this thermal region extends well below the maximum depth of occurrence of hermatypic corals in the vicinity. Vaughan and Wells (1943, p. 55) state that the endurable minimum temperature for a vigorous growth is 18.5° C., while the endurable maximum for West Indian forms is about 36° C. Optimum values for vigorous growth are between 25° and 29° C., slightly above the average annual temperature (based on Fuglister) of approximately 26° C. for the Bimini region.

Of somewhat greater importance is the local effect of cooling or heating of the two large masses of shallow water that border Bimini on three sides. During protracted periods of high or low temperatures, the waters of the lagoon and of the Bank are susceptible to rather great thermal modification. Air temperatures as low as 40° F. (5° C.) have been reported for the Bahamas, and protracted periods of high temperatures are not uncommon during the summer.

Turekian (1957, p. 9) showed a variation in temperature of water entering the lagoon during a 24-hour period of 2.25° C. This change is the result of exchange of lagoon and strait waters.

WAVE ACTION

Records on wave action are not obtainable. There is little evidence that wave action is sufficiently intense to damage coral growth. Bigelow and Edmondson (1947, p. 74) state that the seas in the northern Bahamas and on the coast of southern Florida are lower on the average than those towards either boundary of the northeast trade winds. The seas have been described as "low" in 75 to 80 per cent of the August reports and only seldom as high. Nowhere in the Bimini area are large breakers common, as would be expected from its lee position. The influence of tropical storms cannot be evaluated, but they certainly must affect the Bank area and lagoon, particularly in increasing the transport of sediment. In some lagoon areas, such as the "finger-coral" patch, dislocation of coralla could result from even moderate wind waves. Along the western perimeter of the Bank severe wave activity could activate material in the grooves (Newell and Imbrie, 1955) and perhaps result in dislocation of coralla. On the windward side of Turtle Rocks (eastern side) sediment was observed to be in constant motion owing to wave action. This is undoubtedly a factor in the limitation of growth there, as well as the possible cause of the overturning of insecurely anchored coralla. In general, it seems that wave action does not play so important a role in zonation as on the windward sides of the Bahamas.

Currents

Three major currents are of importance in the Bimini region: the Florida Current, the westerly drift across the Bank, and tidal currents in the lagoon. The Florida Current, which has its axis to the west along the Florida coast, is particularly important as a heat transporting agent. Its effect on the Bahamas is seen from the configuration of the isotherms (figs. 3, 4). This current also acts to isolate the Bahamas from the mainland, as its strength is such that little material is transported directly across the Florida Strait. The Florida Current in conjunction with the Antilles Current and the prevailing winds is responsible for a westward drift of water across the Bank. Both currents flow in a northerly direction; the Antilles Current, more northeasterly. Winds in the Bimini region are easterly, from the northern sector during the winter and the southern in the summer months. The chemistry of the Bank water is not completely known, but the salinity has been shown by Turekian (1957) to be somewhat higher than normal and, as suggested above, is subject to thermal fluctuations. Without quantitative data it is difficult to estimate the effect of this water moving across the coral growth on the western margin of the Bank. Probable effects in terms of turbidity and sedimentation are discussed below. Tidal flow in the lagoon is of great importance relative to the exchange of water within the area and to coral growth within the natural channel. The strength of the tidal current in the lagoon is sufficient to make work difficult in the channel except during periods of slack tide. Both in the lagoon and on the Bank, tidal currents were sufficiently strong to transport sediment.

Tidal Range

Few quantitative data are available for the Bimini area, but a range of 3 to 5 feet in tides is suggested. The importance of the tidal range is somewhat diminished by the effects of the currents.

Salinity

Turekian (1957) has discussed the salinities of the Bimini region and has defined three water masses, two in the lagoon and one on the Bank. The ranges of salinity described are not of a magnitude to be detrimental to coral growth but, in conjunction with other ecologic factors, may be of some importance. There is a gradation from hypersaline waters in the northern lagoon to normal waters at Entrance Point. Similarly, waters on the central portions of the Bank are more saline than those on the margin.

Turbidity

As estimated visually, the waters of the Bimini region are somewhat more than average in turbidity. Seldom was the bottom clearly visible at depths of more than 40 feet. The effect of wind waves on the Bank in stirring up sediment and getting it into suspension so that currents would carry it to the margin of the bank would seem to be an important ecologic consideration. Water flowing from the Bank during ebbing tides could usually be distinguished by its more milky color, and the effect of the accumulation of sediment was strikingly displayed by the paucity of fauna and flora in areas of discharge of Bank water.

Substrate

Bottom conditions are extensively controlled by flora and fauna in the Bimini region and are quite varied. Three general types have been distinguished for the purposes of this discussion: rock, sand veneer, and mud. Intermediates of many variations are present, and some areas are apparently in transition from one bottom type to another. Rock types include those that are quite bare, usually the result of active scour, or those that have a fine film of algal growth and very fine sediment accumulated on the surface. Sand-veneer bottoms are those having a rock substrate covered by 1 to 6 inches of sand, or sand and mud mixtures with the former predominating. Sand bottoms, as are discussed below, usually lack corals and are usually areas of heavy *Thalassia* growth. Mud bottoms were encountered in several areas and in every case bore an interesting coral fauna. The mud, usually 1 to 3 feet in depth, is usually a mixture of carbonate sand and fecal pellets, usually with a high percentage of the latter.

CLASSIFICATION OF ENVIRONMENTS

In developing the following classification of environments, I took substrate to be the most important factor in the delimitation of coral communities. However, because of the close relationship between wave action, currents, and the distribution of bottom types, wave action and water agitation were selected as primary divisions in order to facilitate comparisons with other areas.

- I. Unprotected areas. The Bank margin where wave action is greatest and nearly continuous. Includes bottoms to a depth of approximately 7 feet, where wave action is a factor, and those below this depth.
  - A. Rock bottom. Bare rock, occasionally with shifting sand, but not subject to permanent accumulation of sediment over periods of time.
    - 1. Zone of wave action. Depth ranges from surface to 7 feet (approximately). Examples: Station 1 (west side of Rabbit Cay), station 2 (west side of Turtle Rocks); both in part.
    - 2. Zone below normal wave agitation. Depth approximately from 7 to 30 feet.
      - a. Area receiving sediment from the Bank. Example: Station 2 (west side of Turtle Rocks), in part.
      - b. Area not receiving appreciable sediment from Bank. Example: Station 1 (west side of Rabbit Cay), in part.
  - B. Sand bottom. Accumulation of sand several inches in depth which is more or less permanent, although in a constant state of movement. Example: Station 13 (east side of Turtle Rocks).
- II. Tidal-flow areas. Those channel areas in which the diurnal tidal flow is vigorous.
  - A. Rock bottom. Included are two types: those that are usually bare, and those that are subject to a shifting of sand across them, predominantly in one direction, and in which sand accumulation is not permanent, seldom lasting for more than a few days.
    - 1. Areas without sand movement. The channel areas in which sand is not transported are faunally intermediate between the unprotected and protected environments. Example: Station 5 (lagoon channel).
    - 2. Areas with sand transport. In areas of drainage from sediment-covered rock bottom, tidal flow may be vigorous to initiate movement of sand across a rock-bottom area. The tidal flow is instrumental in keeping the area free from accumulation of sediment. The effectiveness of storms in flooding these areas with sediment is not known. Example: Station 12 (channel on the Bank leading to the Florida Strait).
  - B. Sand bottom. Areas in which there is transport of sand for a period during the tidal flow, but in which there is an accumulation of a more or less permanent nature. Although this accumulation may shift periodically, its position is such that it remains in one place long enough to be detrimental to the forms living in the area. Example: Station 8 (mouth of upper lagoon).
- III. Protected areas. These lack strong tidal flow or surf action and in general are areas of permanent accumulation of sediment.
  - A. Sand-veneer bottoms. Areas in which an accumulation of sediment of 2 or 3 inches in depth is a maximum and in which there is no appreciable motion of the sediment.
    - 1. Areas of protracted sedimentation. Subject to a gradient of chemical and physical char-

acters of the waters according to position. Examples: Stations 3–6 (lagoonal stations); stations 9, 10 (Bank margin).

2. Areas of recent sand accumulation. Example: Station 14 (Cavelle Pond). The accumulation may be of a transient nature but has been present for a sufficiently long time to affect the corals.

B. Sand bottoms. Areas with an accumulation of sand in excess of 3 inches, usually 1 foot or more, characterized by heavy *Thalassia* growth.

C. Mud bottoms. Although basically sand, organic activity has caused fine muck or both organic and inorganic material to be developed. This can be easily dispersed. Usually found to be 2 or 3 feet in thickness.

1. Areas with more or less restricted circulation. Example: Station 7 (upper lagoon).
2. Areas with more or less open circulation. Example: Station 11 (Bank margin).

ZONATION AND COMPARISON OF ENVIRONMENTS

Within several of the environments described in the preceding section, there may be zones characterized by certain coral growths. A complete faunal analysis is necessary for accurate description of zonation, but fortunately, on the basis of the corals alone, it is possible to make comparisons with zonation and ecologic conditions described from other areas of the tropical western Atlantic. I have drawn heavily upon the work of Storr (MS) and Ginsburg (1956) for comparison materials.

Unprotected Areas with Rock Bottom

Along the unprotected western margin of the Bank is the closest approximation to reef development. Here, the coral growth is most abundant and most varied, although it never approximates that of the eastern Bahamas (Newell and Imbrie, 1955; Newell and Rigby, 1957). Two faunas are recognized. At a shallow level, where wave action is most intense, is a zone of encrusting algae. Below this is a conspicuous development of *Millepora complanata* and *M. alcicornis*. These two species form a conspicuous band just beneath low-tide level, almost to the exclusion of all other corals. Below this band in 7 feet of water or less is a zone characterized by abundant *Millepora*, *Stephanocoenia michelinii*, *Siderastrea radians*, *Agaricia agaricites*, and *A. agaricites* var. *purpurea*. In holes or pockets are small specimens of *Isophyllia*, *Isophyllastrea*, *Porites porites* var. *clavaria*, and other species of the zone. Below, in waters not receiving full impact of the surf, are large colonies of *Diploria*, *Montastrea annularis*, *M. cavernosa*, *Porites porites* var. *clavaria*, and *Siderastrea siderea*. This area is most affected by sediment drainage from the Bank, which is indicated to be an important factor by several lines of evidence, despite incomplete evaluation. Between the several Turtle Rocks are passes through which there is strong tidal flow during the ebbing stages. On the strait side are apron-shaped areas of sediment accumulation having little growth of coral or other organisms. Turtle Rocks, as an area, are subject to a greater degree of wash from the Bank than is Rabbit Cay because of the protection afforded by South Bimini and by islands on the north and east (Rabbit Cay and Round Rock) which deflect the ebb tidal flow southward. The accumulation of fine sediment in the Turtle Rocks region can be observed on the oral surface of polyps as a fine film, while no such phenomenon was observed on the specimens from Rabbit Cay. This accumulation may be responsible in part for the lesser degree of reef-coral development in the deeper waters off Turtle Rocks, for there is an absence there of such elements as large *Siderastrea siderea* and *Porites porites* heads, and a lesser development of *Montastrea annularis* and *M. cavernosa*.

Mention should be made of the paucity of *Acropora palmata* and the absence of *A. cervicornis*, among the more important reef constituents elsewhere in the West Indies, from the surf zone and deeper waters of this area. Three colonies of *A. palmata* were found after rather careful search, but none approached the usual size or appearance. Some environmental factor evidently is detrimental to successful reproduction or to development of larvae following settling. In cross section one

TABLE 2

DISTRIBUTION OF STONY CORALS IN THE BIMINI AREA BY ENVIRONMENTS

	Acropora palmata	*Agaricia agaricites*	*Isophyllastrea rigida*	*Porites porites* var. *clavaria*	*Stephanocoenia michelini*	*Agaricia agaricites* var. *crassa*	*Agaricia agaricites* var. *purpurea*	*Diploria clivosa*	*Montastrea cavernosa*	*Siderastrea siderea* (Large Coralla)	*Siderastrea siderea* (Small Coralla)	*Diploria strigosa*	*Montastrea annularis*	*Dichocoenia stokesii*	*Oculina diffusa*	*Favia fragum*	*Isophyllia sinuosa*	*Millepora complanata*	*Millepora alcicornis*	*Manicina areolata* (Normal)	*Manicina areolata* (Cuneiform)	*Porites porites* var. *divaricata*	*Porites astreoides*	*Siderastrea radians* (Encrusting)	*Siderastrea radians* (Nodular)	*Porites porites* var. *furcata*
Unprotected areas																										
Rock bottom																										
In wave zone	r[a]	c	a	c	c	r	c	c	a	—	c	r	—	c	—	c	a	c	c	r	—	—	c	c	r	—
Below wave zone																										
Receiving sediment	—	—	—	—	—	—	—	—	c	—	—	c	r	—	—	—	—	—	—	—	—	—	c	—	—	—
Not receiving sediment	—	—	—	c	—	—	—	—	a	a	—	c	c	—	—	—	—	—	—	—	—	—	c	—	—	—
Sand bottom	—	—	—	—	—	—	—	r	r	—	—	—	—	—	—	—	—	—	r	r	—	—	c	—	c	—
Tidal-flow areas																										
Rock bottom																										
Without sand movement	—	—	—	—	—	r	r	—	?	?	r	r	r	—	c	—	c	—	r	—	—	—	r	—	r	r
With sand movement	—	—	—	—	—	—	—	—	?	?	—	?	?	—	—	—	—	—	c	—	—	—	c	—	—	—
Sand bottom	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—	—	—	c	c
Protected areas																										
Sand-veneer bottom																										
Protracted sedimentation	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	a	r	—	—	a	—	r	c	—	a	a
Recent sedimentation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—
Sand bottom	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—
Mud bottom																										
Restricted circulation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	r	r
Open circulation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	r	—	—	—	—

[a] *Symbols:* a, abundant; c, common; r, rare.

specimen of *A. palmata* showed three periods of growth, separated by intervals during which the branches had been bored and encrusted. Possibly these intervals relate to periods of nearly complete kill followed by overgrowth of the coral through the onset of very unfavorable conditions, perhaps of only short duration, followed by a return of a more normal environment.

Storr (MS) found the following zonation at the Abaco Island reef tract:

Sea fan; surf zone
Montastrea; deep-water zone
Acropora palmata; active-wave zone
Porites; moderate-wave-action zone
Echinoid; low-wave-action zone
  Black sea urchin; reef phase
  Codakia; Thalassia-grass phase
  Sand dollar; fine-sand phase
  Cake sponge; bare-bottom phase

In certain areas along Turtle Rocks, there is a similarity between the first of these and growths of sea fans which occur in waters of about 7 feet in depth. Coral growth is also somewhat the same. Patches of *Millepora* and of mats of *Diploria clivosa* are also found. This type of development is characteristic of those areas in which a 3- or 4-foot shelf extends some distance seaward.

Everywhere below the 7-foot level is the direct analogue of Storr's *Montastrea*, deep-water zone, developed in waters of a depth in excess of 7 feet and characterized by growths of *Montastrea*. The comparison is poor, however, for tall *Acropora palmata* and corymbose or mushroom-shaped *Montastrea annularis* are absent from the area, with the exception of slight development of the latter species off Rabbit Cay. Storr found this zone to be characterized by both of these species down to depths of 60 feet in some areas. More commonly off Turtle Rocks, the accessory species, *Diploria strigosa* and *Porites astreoides*, are dominant. It is also in this area that limited growth of *Agaricia* and *Siderastrea* occurs, but missing are *Meandrina* and *Mycetophyllia*, which were found there by Storr. The coral growth in this zone is not so well developed as that at Abaco.

Where the shelf is not so greatly developed, and the shore drops rather sharply to the 7-foot level, the equivalent of the *Acropora palmata*, active-wave-action zone is found. Once again *Acropora palmata*, which should be the most characteristic feature of this zone, is conspicuously absent. However, other organisms and such characteristic corals as *Millepora* sp., *Agaricia* spp., *Porites porites*, *Manicina areolata*, *Favia fragum*, *Siderastrea radians*, and *Porites porites* indicate the correlation. None of these reaches the size or abundance indicated by Storr for the Abaco reef tract.

Seaward side

Landward side

Newell *et alii* (1951, p. 22) and Newell and Rigby (1957, p. 42) report the same general situation at Andros Island where a *Millepora* zone just below low-tide level is well developed. Below this and extending to about 3 fathoms is a zone of *Acropora* (*A. palmata* and *A. cervicornis*) followed by a development of the large massive corals in waters of 3 to 7 fathoms in depth.

Ginsburg (1956, p. 2407) indicates that the principal coral of the "outer reef-arc sub-environment" is *Acropora palmata*, associated with *Millepora*, *Montastrea*, *Siderastrea*, *Porites*, and *Diploria*. All of these are present in a somewhat greater abundance than the same species in comparable environments at Bimini.

Unprotected Area with Sand Bottom

On the eastern side of Turtle Rocks is an interesting area of sand bottom subject to surf agitation at least during lower tides. There is no well-developed continuous beach here, the bottom being relatively flat for a great distance onto the Bank to the west and meeting the rock of Turtle Rocks abruptly on the west. Sediment was in constant motion during the periods of observation, and the water is usually turbid. With the exception of *Millepora alcicornis* and *Diploria clivosa*, all coralla observed here were of an abnormal nature. *Millepora* is generally found encrusting upon strongly rooted alcyonarians, while *Diploria clivosa* forms large spreading mats, which by virtue of weight and form are stable. It was with some interest that the movement of quantities of sand across a large specimen of *D. clivosa* was observed. No apparent effect could be detected except for the retraction of the polyps.

Siderastrea radians occurred as egg-shaped nodules completely covered with living polyps. Continual rolling of a specimen, broken loose from its attachment, resulted in the form, and, as no position was maintained for a period long enough to kill the polyps on the under side, development was complete. This species is known to have high tolerance to burial, surviving periods of up to 24 hours (Yonge, 1935b). Colonies of *Siderastrea sidera* and *Montastrea annularis*, both decidedly out of place, were small and lenticular, with both tops and bottoms of the coralla dead, active growth continuing only on the periphery. It seems obvious that these forms had been torn loose from the substrate and were subjected to rolling about, but because of low tolerance to burial, the polyps had been killed on the alternate bottom sides. *Manicina areolata* had the same general form of those specimens found on the reef, that is, attachment by a relatively large area of the basal portion and without a well-defined pedicel. The attachment was to alcyonarians or to algal masses which were firmly rooted. The area is an unusual one, and no direct comparisons can be made. This environment is in some respects a transition between the rock-bottom Bank margin and the lagoonal environments. The motion of the substrate and the anomalous occurrence of corals are the unusual features.

Tidal-Flow Environments

An interesting group of environments is found in areas affected by tidal flow; particularly intriguing is the presence of a rather complete fauna on the rock ledge bordering the lagoon channel. Tidal-flow areas would be expected to have a composition more like that of agitated waters than that of the quiet zone, but in this case the effect of the tidal flow is felt quite far into an otherwise unfavorable area. Little or no transportation of sand occurs at this place, while, as a contrast, station 11, a blind channel leading off the Bank, has many elements of the tidal-flow fauna present, but modified because of the sand movement. Western portions of this channel have very few corals, and none are of those species intolerant of sediment movement. *Millepora* is found encrusting on rooted sea fans, but the growth never extends to the basal position, beginning about 3 inches from the rock floor. In the deeper portions of the channel to the west, the larger corals appear, but also the amount of transported sand decreases. Moselle Bank bears the same fauna. Station 8, a sand-bottom association, represents a modified lagoonal fauna, limited by an unstable substrate. *Siderastrea radians* was observed in the nodular form described from the east side of Turtle Rocks. *Manicina areolata* was often overturned.

Storr (MS) recognized three types of tidal-flow environments in his classification of lagoonal zones. They are:

Acropora-Montastrea; strong-tide zone
Sea feather; medium-tide zone
Coral head; weak-tide zone

The channel area within the Bimini lagoon is most comparable to the first of these, but lacks elements such as *Acropora palmata*, *A. cervicornis*, *Eusmilia fastigata*, *Maendrina meandrites*, and *Solenastrea* that were recognized by Storr. Otherwise, in the presence of many representatives of the "reef fauna," the situations are comparable. In the northernmost extremities of the channel, where the water shoals, the equivalent of the coral head, weak-tide zone equivalent may be found. This is characterized by growths of the more tolerant "brain corals" and by abundance of *Porites astreoides*.

Station 12, the blind channel in the Bank, is superficially similar to the medium-tide zone, but conditions are apparently quite different, and the strength of the tidal flow in this area is at least as strong as that in the lagoon channel. It is probable that the scouring action of the sediment is responsible for the depletion of the fauna in this area, and for the development of certain growth habits, particularly that of the encrusting *Millepora alcicornis*.

Sand-Bottom Environments

Sand-veneer bottom associations in the lagoon are characterized by several morphologic types, including pedicellate *Manicina areolata*, hemispherical *Siderastrea radians* and *Favia fragum*, and tall nodular masses of *Porites astreoides*. A gradual decrease in the variety and number of specimens occurs in a northward direction owing in part to increasing amounts of *Thalassia* and to the outflow of unfavorable waters from the upper lagoon. Although all lagoonal species have been demonstrated by Vaughan (1915a, 1916a), Wells (1932), Yonge (1935a, 1935b, 1937), and Mayer (1913, 1914, 1916) to be extremely tolerant to most environmental extremes acting individually, several of these acting together might prove deleterious. The upper lagoon is bordered by mangroves, adding tannin to the water; is very shallow, resulting in high evaporation (which increases salinity) and rising temperatures; and has a bottom composed of a high percentage of fecal material (Kornicker, personal communication) which reduces oxygen content. During the winter the shallow waters may be chilled to low temperatures or become diluted during periods of high rainfall. Although quantitative data are not available to indicate the magnitude of these changes, it is believed that experimentation would demonstrate that they are detrimental to flourishing coral growth.

Stations on the Bank margin are somewhat similar, differing only in the numbers of species present, a factor subject to change through more extensive collecting. The Bank waters are of a different chemical character, and circulation is less restricted than in the lagoon, but the effects, if any, cannot be assessed. Sand accumulation is rapid in areas in which the grass *Thalassia* becomes rooted. The growth of the grass effectively reduces current action, and the extensive rhizome roots of the grass hold the sediment that reaches the area. Areas of dense *Thalassia* growth are generally topographically high, and barren of coral growth except for occasional heads of *Porites astreoides*, but not necessarily of other life. Thin patches of grass, either in development or areas of washout, may have a more extensive coral fauna present. Usually in constructional areas, that is, areas fringing more dense growths of *Thalassia*, *Porites porites* var. *furcata* and *Manicina areolata* may be found. Areas of apparent destruction of the grass growth are usually completely barren.

Among the lagoonal environments recognized at Abaco Island by Storr (MS) were the tidal flow areas discussed above (p. 240) and the following:

Cushion star; open-sand zone
Conch; *Thalassia*-grass zone
Loggerhead sponge; rock zone
Ostrea; mangrove zone

Of these, there are no direct analogues except for the *Thalassia*-grass patches of the Bimini lagoon. The coral fauna of these areas is very restricted, being composed of only an occasional growth of *Porites astreoides*, and this only in those areas which did not have dense grass growth. Ginsburg (1956) also recognizes this environment in the back-reef subenvironment, as did Storr, who found *Porites furcata* and *Manicina areolata* in areas of thin *Thalassia* growth.

Deep sand areas which would correspond to the cushion star, open-sand zone are devoid of coral growth as indicated above. Storr recognized the loggerhead (=manjack) sponge, rocky-shore zone, but this is developed on a sand-veneer bottom at Bimini. Faunal composition remains essentially the same in regard to the stony corals.

Mud-Bottom Environments

Of very great interest are those stations having a mud bottom. Two areas of this type were observed, and corals were collected from each. In the instance of station 7 (the upper lagoon), no particularly morphological changes in the corallum were apparent, although the environment was reflected in the polyps. The bottom, as indicated above, is high in fecal material, which when combined with sand forms a muck easily thrown into suspension. The water is turbid as a general rule. The fauna here consisted of *Porites porites* var. *furcata* and *Siderastrea radians*. The latter is extremely tolerant of sediment cover, and the former, because of its branching form, is able to shed accumulations of sediment with relative ease. In both species, however, specimens from this locality had more active and somewhat larger polyps than specimens of the same species from other areas in the lagoon. The polyps were extended at all times, until physical contact was made with the corallum. In aquaria the polyps were extended day and night. In *Porites porites* var. *furcata*, the length of the polyp was 1 to 2 mm. greater than that observed for other specimens, and the tentacle spread was 1 to 1.5 mm. greater. Specimens of *Siderastrea radians* appeared brown because of the long tentacles stretched high above each polyp, but other portions of the polyp were lighter in color. Preliminary experiments indicate that these specimens were able to rid themselves of sediment more quickly than the same species from other sites. It is interesting to speculate on the relative quantities of food present in the upper lagoon as compared with the lower, as the specimens from station 7 appeared to be voracious feeders.

Station 10, with a similar bottom type but on the Bank, was of particular interest because of its fauna. *Manicina* from this locality are cuneiform and possess unbranched valleys, a form developed in response to the sinking of the corallum in the mud. The only other species present, *Porites porites* var. *divaricata*, is found always attached to an algal frond or some other plant. The species was also collected from Grunt Drop (station 6) where the same habitat was found. Differences in the growth forms of the corals of the two areas are directly related to the character of the substrate. In the upper lagoon, sediment cover is not so thick and the sediment is more resistant to penetration than that at station 10. The corals from the upper lagoon were most usually situated in a depression in the sediment, while those from station 10 were collected from an approximately level surface.

ECOLOGIC FACTORS AFFECTING CORAL GROWTH AT BIMINI

One of the purposes of the rather lengthy discussion and comparison of coral growth at Bimini with that of Abaco, Andros, and the Florida Keys was to establish the fact that coral growth at Bimini is not so luxuriant nor so diversified as that in those other areas. It has long been noted that coral growth on the western portion of land masses is usually not so well developed as that on the eastern side, and many factors have been called upon to explain this apparently anomalous circumstance. Such factors as the upwelling of cold waters along western coasts and absence of favorable substrate for the development of reefs are among ecologic controls known to contribute to this condition. None of these can be successfully applied to the Bimini region, but there are many other factors that can be suggested. In the absence of quantitative data on the physical environment and the lack of more detailed distributional studies of the stony corals, only tentative conclusions may be drawn.

Two factors that have long been recognized as primary controls in the distribution of hermatypic corals are temperature and light. Because of the ease with which the former may be measured, and because of the vast accumulation of data on temperature distribution, perhaps greater attention has been paid to it than to light. As noted above, the range of temperatures encountered at Bimini is within that given by Vaughan and Wells and others for the growth of coral reefs. Although the average annual temperature is somewhat below optimum, it cannot be considered as a major factor at Bimini. According to the data given by Fuglister (1947), surface sea temperatures at Abaco Island, Bahamas, are usually 1° C., often 2° C., lower than those recorded for Bimini, resulting in a lower annual average temperature for that area—an area in which coral development is quite extensive and true reefs are present. Similarly temperatures along the Florida Keys are roughly comparable to those at Bimini, and a more extensive coral growth is to be found there. As is considered above, temporary increases or decreases in temperature due to the presence of large masses of shallow water on the up-current side of Bimini may be detrimental to coral growth. In large part, however, the corals would be able to withstand

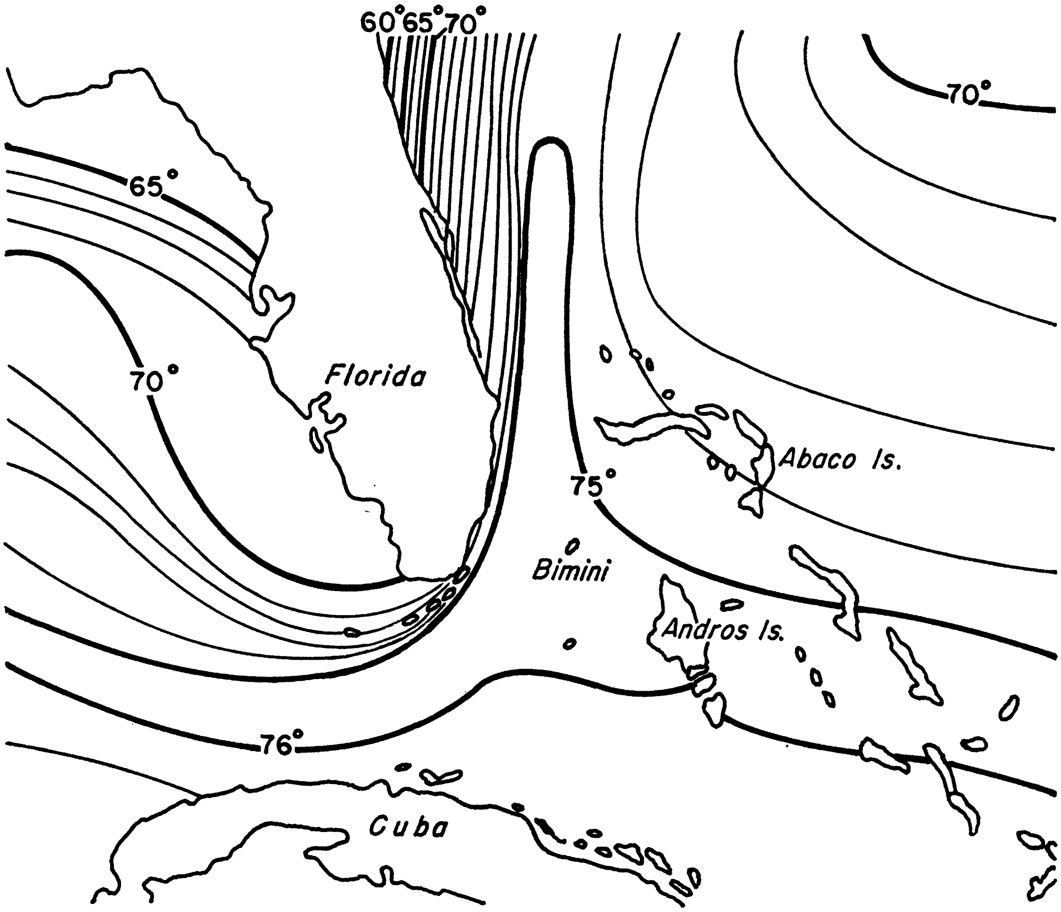

FIG. 3. Distribution of surface isotherms during February. Based on Fuglister (1947, pl. 2).

these changes, as indicated by experimental data. The presence of a generally restricted fauna, rather than a fauna replete with many individuals of a few species, argues against a selection through temperature fluctuations.

The experiments of Vaughan (1914), Edmondson (1925), Yonge and Nicholls (1931), Kawaguti (1937), and others have shown that corals kept in complete darkness for some time are able to survive, if current action is sufficiently strong to provide oxygen and food while also removing waste products of metabolism. In all experiments, the effects of light exclusion were tested on a limited number of individuals rather than on the reef population in general. To this end Verwey (1931, p. 179) suggested that a reef population living under conditions of reduced light would become dependent on currents for the supply of oxygen and the removal of waste products. Measurements of oxygen production of coral reefs by Odum and Odum (1955) and by Sargent and Austin (1954) have shown that reef communities are producers of oxygen through photosynthetic activity during the day, but at night are consumers of oxygen. Verwey (1931, p. 181) demonstrated theoretically that currents would be unable to supply needed oxygen if photosynthetic activity were to cease. It is probable, then, that if light intensity were to be sufficiently reduced, faunal reduction might result.

On admittedly short observations, I state that the waters adjacent to the western margin of the Bank were turbid and that visibility was reduced. Because of this reduction, it is to be expected that the depth of the euphotic zone would be lessened and the growth of photosynthesizing organisms cor-

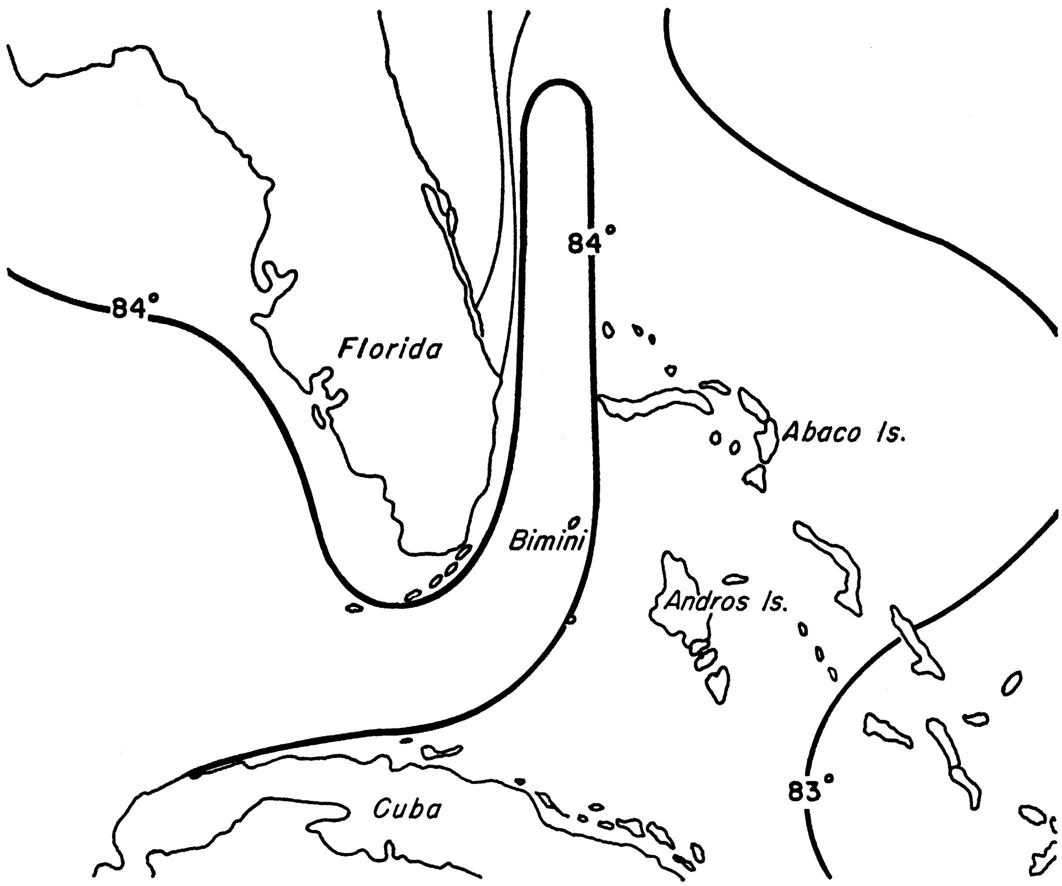

FIG. 4. Distribution of surface isotherms during August. Based on Fuglister (1947, pl. 8).

respondingly restricted. Verwey (1931) and Motoda (1939), studying the effects of turbidity and submarine illumination on the growth of corals, found a close relationship between depth of active coral growth and the turbidity of water as reflected by Secchi disc measurements. However, on the basis of the light exclusion experiments mentioned above, it would seem possible for hermatypic corals to live beneath the compensation level if sufficiently great quantities of oxygen were provided them, and certainly no instances of oxygen depletion as a cause of the reduction in faunal density have been reported from a community in a situation such as the Bank margin. Recent studies by Kawaguti (1953, 1954) on the ammonium metabolism of corals and the effects of ammonium concentrations on the reactions of coral polyps may provide the answer to the problem.

Storr (MS) calculated the depth of the compensation point for waters in the vicinity of Abaco. This he defined as the depth at which light intensity is reduced to 1 per cent of the surface value. For the presumably less turbid waters of Abaco, the depth of the euphotic zone was found to be approximately 50 feet. Kawaguti (1937, p. 194; corroborated by Sargent and Austin, 1954) found that the compensation point for many corals was considerably higher. Among 25 corals for which the compensation point was measured, the values ranged between 3 and 30 per cent of full sunlight, with a mean value of 17 per cent. These figures indicate that depth of coral growth is more restricted than that for plant growth.

Although no data are available for the calculation of the depth of the compensation point for the waters on the western margin of the Bank, it seems probable that turbidity of the waters reduces light penetration more rapidly and effectively to limit the depth of coral growth. As indicated above, in this area, corals are most highly concentrated in the depth range of the surface to 7 feet off Turtle Rocks, while active growth continues to a depth of 20 feet off Rabbit Cay where less turbid waters are present, at least during the period of observation. It would seem, then, that light is an effective control in the development of corals in this region. However, off Turtle Rocks, at a depth of about 20 feet, an increase in coral growth was noted. It was particularly apparent among the large massive heads of meandroid forms. If light reduction was a factor in the limiting of coral growth, particularly on the platform at a depth of approximately 10 feet, the development of these larger heads at greater depth would be anomalous.

Another aspect of turbid waters to be considered is the effect of sedimentation on the organisms. As noted above, between the several rocks comprising Turtle Rocks are passes through which Bank water flows. These are areas of sediment accumulation and are almost devoid of life. On each side of the passes are flat or nearly flat rock platforms at a depth of about 10 feet. They are not bare but are covered by a thin film of organic material and fine sediment. During the period of observation, this film varied from a fraction of an inch to several inches in depth. This covering is not strictly a feature of this platform, being found elsewhere in the vicinity, but its presence is generally correlated with low coral growth. It is plausible to consider this area as one of sediment accumulation following periods of turbulence on the Bank. Permanent accumulation is prohibited by wave action, and presumably sediments reach a stable area only at a depth of 30 feet (approximately) where there is a definite accumulation of sand in many areas. This postulated periodic accumulation of sediment could affect coral growth in two ways: first, through accumulation on established coralla and, second, by prohibiting the settling of larvae. Experiments by Yonge (1935b), and Marshall and Orr (1931) indicate that most species of corals, particularly branching forms, are adept at the removal of sediment, particularly if aided by wave action or currents. Preliminary tests at Bimini indicate that all lagoonal species can tolerate extensive accumulations and even burial for 12 to 18 hours. Reef forms are probably less tolerant of sediments, particularly the finer forms. However, the absence of coralla on the platform indicates that few if any become established and are subsequently killed by sediment accumulation. Many of those growing on this level (found principally in the central area of the rocks) had a thin film of fine sediment on the oral disc.

Little is known of the effects of sediment on the settling of larvae. Motoda (1939, p. 648) suggested that silt may be a factor in the absence of corals through non-settling of larvae, but was unable to substantiate it by experimentation.

These factors of temperature and light, which have been considered in some detail, are not completely assessed as yet. Other controls, such as salinity variations, exposure through tidal changes, and food supply, can be eliminated as primary controls of the distribution of the fauna. In many areas it is very apparent that the type of substrate limits the growth and variety of coral fauna, but it cannot alone explain the character of the Bimini fauna. The total effect of all of these features, many acting adversely, cannot be evaluated until more quantitative information is available on the distribution of corals and magnitude of the ecologic factors. This, then, is a fertile field for future research in the Bimini region, particularly with regard to the fauna of the Bank margin, which is the most restricted. Other studies should be concerned with the lagoon fauna, its development in terms of colonization, longevity of corals, and growth rates, particularly in relation to the ever-changing conditions in the physiography and hydrology of the lagoon as the area becomes more populous.

DESCRIPTION OF SPECIES

SCLERACTINIA

ASTROCOENIIDAE

STEPHANOCOENIA Milne-Edwards and Haime, 1848

Stephanocoenia michelini Milne-Edwards and Haime, 1848

Plate 32, figures 1, 2

Madrepora intersepta Esper, 1795, Die Pflanzenthiere, vol. 1, p. 99, pl. 79, figs. 1–3.

Stephanocoenia michelinii Milne-Edwards and Haime, 1848, Ann. Sci. Nat., Zool., ser. 3, vol. 10, p. 301.

Stephanocoenia intersepta (Esper) Gregory, 1895, Quart. Jour. Geol. Soc. London, vol. 51, p. 276, pl. 11, figs. 5, 6. Synonymy.

Plesiastrea goodei Verrill, 1900, Trans. Connecticut Acad. Arts and Sci., vol. 10, p. 553, pl. 67, fig. 1.

Plesiastrea goodei Verrill, 1902, Trans. Connecticut Acad. Arts and Sci., vol. 11, p. 106, fig. 1, p. 172, pl. 31, figs. 1, 1a.

Stephanocoenia intersepta (Esper) Vaughan, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 356. Synonymy.

Stephanocoenia michelini (Milne-Edwards and Haime) Smith, Atlantic reef corals, p. 74.

Corallum usually encrusting, but often thick, approaching subhemispherical, with form dependent on topography of substrate. Cerioid, the corallites 1.0 to 1.5 mm. in diameter. Septa 20 to 24 in number, arranged in two alternating groups, exsert, thin, with pali before the second cycle. Columella prominent, usually stellate. Marginal corallites usually have six paliform lobes alternating with pali, forming a thick crown. Corallum tan, with red undertones, the calicular pit a deep red.

Several differences between Bimini specimens and others described are significant. Although the species usually forms low hemispherical masses, or highly convoluted growths, those from Bimini are encrusting, which in a large measure may be a reflection of their growth in exposed areas. Also, corallite diameters are consistently less than those reported from specimens collected elsewhere. The environmental significance of these factors cannot as yet be assessed. Also striking is the difference between marginal and central calices, as noted above, although it is not known whether this is a factor of age, as the marginal calices are younger, or due to the different environment presented on the margins, or a combination of the factors.

Although not often reported, it is believed that the species has a wide distribution, but is overlooked because of its superficial resemblance to *Siderastrea radians*. However, examination of the calices is sufficient to distinguish between them, and under water the corallum colors are usually significantly distinct to permit differentiation. *Siderastrea radians*, as found in the surf facies, is an encrusting form, is a lighter color over the entire surface of the corallum, and is brown in the calicular pits rather than red.

Occurrence: Up to depths of 7 feet off Rabbit Cay and on the west side of Turtle Rocks.

Distribution: Miocene, Santo Domingo; Pleistocene, West Indies, Florida; Recent, Antilles, Bahamas, Bermuda, Florida, British Honduras.[1]

ACROPORIDAE

ACROPORA Oken, 1815

Acropora palmata (Lamarck), 1816

Plate 34, figure 1

Madrepora palmata Lamarck, 1816, Histoire naturelle des animaux sans vertèbres, vol. 2, p. 278.

Madrepora muricata forma *palmata* Brook, 1893, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 1, p. 25. Synonymy.

?*Madrepora muricata* Linnaeus Duerdan, 1899, Jour. Inst. Jamaica, vol. 2, no. 6, p. 621. Morphology.

Madrepora muricata Linneaus (part) Duerdan, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 543–549. Morphology, histology.

Madrepora (*Acropora*) *palmata* Lamarck Mayer, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature effects.

Acropora palmata (Lamarck) Vaughan, 1915,

[1] Distribution data are compiled principally from Vaughan (1919a) and other systematic works, as well as specimens in the collections of the American Museum of Natural History.

Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Acropora palmata (Lamarck) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 483. Synonymy.

Colonies branching, with flabelliform or palmate fronds flattened and extending in a horizontal plane. Corallites protuberant, tubular, 2 to 4 mm. long, with porous walls. Septa inconspicuously developed. Color varies from dirty white to a yellow-brown, the latter being more typical.

This species, which is one of the more important corals on the eastern side of the Bahamas, is not abundant in the vicinity of Bimini. Three widely separated colonies were found in one area, all located close to the low-tide level, and, indeed, one specimen may well have been exposed during lower tides. The latter was a large, mushroom-shaped form approximately 5 feet in diameter and showed none of the characteristic palmate branches of the species, while the other two were more typical in the form of their development. All showed evidence of periodic kill, the surface of the corallum then becoming encrusted and bored by numerous organisms. Renewed growth resulted in an encrustation over the older corallum. Mayer (1914, p. 19) has shown that this species is apparently at an optimum at about 33.75° C., at which temperature the specimens are fully expanded. It is quite probable that periods of low air temperatures result in the cooling of the Bank waters below this point, the corallum then being nearly completely killed.

OCCURRENCE: Only on the west side of Turtle Rocks.

DISTRIBUTION: Pleistocene, Central America, West Indies; Recent, Caribbean, Antilles, Florida, Bahamas.

AGARICIIDAE

AGARICIA LAMARCK, 1801

Agaricia agaricites (Linnaeus), 1758

Plate 33, figures 1, 2

Madrepora agaricites LINNAEUS, 1758, Systema naturae, ed. 10, p. 795.

Agaricia agaricites (Linnaeus) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Agaricia agaricites (Linnaeus) VAUGHAN, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 228. Growth rate data.

Agaricia agaricites (Linnaeus) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 426. Synonymy.

Corallum usually foliaceous, but may be massive (variety *crassa*) or encrusting. Fronds are usually bifacial, concave upward, and several millimeters to several centimeters thick. Unifacial fronds are considered to be the variety *purpurea*. Calices are small, 1.5 to 3 mm. in diameter, separated by sharp collines, and arranged in rows more or less parallel to the margin of the corallite. Septa are small, usually about 36 in number, and not arranged in any constant fashion.

As indicated by Vaughan (1919a, p. 427), the variety of growth forms of this genus may be related to substrate type or water agitation and do not represent true species. Typical forms, here, are planar bifacial coralla found growing outward from vertical, or near vertical, surfaces in a horizontal plane in the fashion of the bracket fungi. Calices are found on both the lower and the upper surfaces of the corallum and are inclined towards the growing margin on both forms.

The polyps of this form tend to be darker in shade than the other varieties, although this fact cannot be used to distinguish them with certainty. The valleys are a very dark brown, often having a purplish undercast, while the upper margins of the polyps, particularly over the collines, are a lighter color, usually buff or tan.

OCCURRENCE: In sheltered areas, particularly holes, on the west side of Turtle Rocks and off Rabbit Cay.

DISTRIBUTION: Pleistocene, Bimini, Panama; Recent, Antilles, Florida, Bahamas.

Agaricia agaricites var. **crassa** Verrill, 1902

Plate 33, figure 3

Agaricia crassa VERRILL, 1902, Trans. Connecticut Acad. Arts and Sci., vol. 11, p. 145, pl. 30, fig. 6, pl. 34, fig. 2.

Agaricia crassa Verrill VAUGHAN, 1912, Carnegie Inst. Washington, Yearbook, no. 10, p. 153. Discussion of growth forms.

Agaricia crassa Verrill VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Agaricia agaricites var. *crassa* Verrill VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 427. Synonymy.

Agaricia agaricites crassa Verrill WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity tolerance.

This growth form most closely approximates that which received the popular name of pineapple or lettuce-head coral. Only a few specimens were observed, but in each instance coralla 9 to 10 inches in diameter were formed, often standing 6 to 8 inches high. These subhemispherical forms have short, unoriented, flange-like extensions developing from all portions of the corallum and in all cases were securely anchored to the bottom. The color of the corallum varies from a dark tan to a purplish tan. The tentacles are long and white. A specimen collected from station 5, the lagoon channel, is assigned to this variety with question because of its small size.

As indicated by Vaughan (1912, p. 153), this is a variety developed under conditions of agitated water, an observation substantiated at Bimini. Whereas *Agaricia agaricites* (typical) and *A. agaricites* var. *purpurea* were found in sheltered areas, variety *crassa* is found on prominences which subject them to wave action.

OCCURRENCE: Rabbit Cay in shallow water, and rock ledge in the channel (station 5).

DISTRIBUTION: Pleistocene, Costa Rica; Recent, Bahamas, Florida.

Agaricia agaricites var. **purpurea** Lesueur, 1820
Plate 32, figure 3

Agaricia purpurea LESUEUR, 1820, Mem. Mus. Nat. Hist. Paris, vol. 6, p. 276, pl. 15, figs. 3a–3c.

Agaricia purpurea Lesueur VERRILL, 1902, Trans. Connecticut Acad. Arts and Sci., vol. 11, p. 149, pl. 27, figs. 4, 4a, 4b.

Agaricia crassa Verrill VAUGHAN, 1912, Carnegie Inst. Washington, Yearbook, no. 10, p. 153. Discussion of growth form.

Agaricia purpurea Lesueur VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Agaricia purpurea Lesueur VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity tolerance; effect of exclusion of light.

Agaricia agaricites var. *purpurea* Lesueur VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 427. Synonymy.

Agaricia purpurea Lesueur YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 44. Feeding reactions.

This variety is found with an encrusting base of proportionately large dimensions, with unifacial planate branches developing from the margins of this attached area, the amount of free corallum dependent upon size and situation. Those specimens found in habitats similar to the habitat of the typical form, that is, on nearly vertical faces of rock, have a more extensive development of the unifacial front, while those collected from more nearly horizontal surfaces tend to have more extensive basal attachments and limited frond development. This growth form reflects environments that are intermediate between the environment of the typical form and that of the variety *crassa*. Corallum color varies from tan to buff often with a blue iridescence.

OCCURRENCE: Common on the west side of Turtle Rocks and off Rabbit Cay.

DISTRIBUTION: Pleistocene, Panama; Recent, Florida, Antilles, Bahamas.

SIDERASTREIDAE

SIDERASTREA DE BLAINVILLE, 1830

Siderastrea radians (Pallas), 1766
Plate 35, figures 1–4; plate 36, figure 3

Madrepora radians PALLAS, 1766, Elenchus zoophytorum, p. 322.

Siderastrea radians (Pallas) VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 309, pl. 15, pl. 16, fig. 2. Synonymy.

Siderastrea radians (Pallas) DUERDAN, 1904, Publ. Carnegie Inst. Washington, no. 20, pp. 1–130, 11 pls. Morphology, larval and postlarval development, histology.

Siderastrea radians (Pallas) GRAVIER, 1908, Compt. Rendus Soc. Biol. Paris, vol. 64, p. 1081. Ecologic variation.

Siderastrea radians (Pallas) MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature tolerance.

Siderastrea radians (Pallas) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature tolerance.

Siderastrea radians (Pallas) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 596. Growth rate data.

Siderastrea radians (Pallas) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity tolerance, effects of light exclusion.

Siderastrea radians (Pallas) MAYER, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 212. Temperature tolerance.

Siderastrea radians (Pallas) MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature and feeding reactions.

Siderastrea radians (Pallas) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 439, pl. 114, fig. 1. Synonymy.

Siderastrea radians (Pallas) BOSCHMA, 1925, Proc. Amer. Acad. Arts and Sci., vol. 60, p. 456. Feeding reactions.

Siderastrea radians (Pallas) YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 44. Feeding reactions.

Siderastrea radians (Pallas) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Siderastrea radians (Pallas) YONGE, 1935, Papers Tortugas Lab., vol. 29, pp. 201–208, pl. 1, figs. 1–4. Discussion of variation and ecology.

Siderastrea radians (Pallas) YONGE, 1937, Papers Tortugas Lab., vol. 31, p. 209. Oxygen consumption.

Spheroidal or hemispherical coralla up to 6 inches in diameter formed by cerioid calices 2 to 3 mm. in diameter. Septa usually about 40, seldom more than 48 in number. Columella small.

This species and the following are often confused, but the distinction between them is important because of their preference in habitats. *Siderastrea radians* may be characterized by having fewer than four complete cycles of septa (fewer than 48), while *S. siderea* generally has four complete cycles (48 or more septa). The calices of *S. radians* are generally smaller than those of *S. siderea*, although there is overlap in this measurement between the two species. *Siderastrea siderea*, because of its more numerous septa, appears to have more crowded calices, while those of *S. radians* are more open. In addition, and an aid in collecting, there is a color differentiation between the two species, as *S. radians* has brown tentacles, the portions of the polyp out of the calicular cup are lighter, often light tan or cream in color, while *S. siderea* is lilac to reddish brown. Sometimes specimens of *S. radians* have a faint red overtone, often concentrated in the calices, giving them a reddish brown appearance, but the color is never so intense as in *S. siderea*.

Siderastrea radians is probably one of the most common species in the Bimini area and certainly is most widely distributed. It is also variable in morphology, as all characters are influenced by the environment. In the lagoon and on the Bank periphery, it may be easily overlooked because of the small size of the coralla and because the corallum is the same color as the sand. In the lagoon and other sheltered areas, the general form is of small hemispherical masses seldom more than 6 inches in diameter, more often 1 or 2 inches. The basal portion commonly is cemented firmly to a rock substrate, but coralla developing on sand bottoms often have a pedicel at the base which is lodged in the sand. Extreme tolerance to adverse conditions is indicated by a specimen from station 13 (eastern side of Turtle Rocks) which had broken loose from its attachment and had formed an egg-shaped corallum completely inhabited by living polyps. The specimen apparently rolled about on the bottom freely, not lying in any one position for a period sufficiently long to be detrimental to the polyps on the under side.

Along the reef face, the species assumes a different growth form, usually that of a very thin encrusting mat that assumes the contour of the surface upon which it is growing. These specimens, ranging from 6 inches to 1 foot in diameter, are found on exposed surfaces as well as in holes and sheltered areas.

OCCURRENCE: Widely distributed in the lagoon except for those areas having thick growths of *Thalassia* (stations 3, 4, 5, 6, 7, 8); west side of Turtle Rocks and off Rabbit Cay; east side of Turtle Rocks and along the shore of South Bimini in areas with little sand accumulation; between upper and lower Cavelle Pond and in lower Cavelle Pond.

DISTRIBUTION: Pleistocene, Central America, Antilles, Florida, Bahamas; Recent, Panama, Antilles, Florida, Bahamas, Bermuda, Gulf of Mexico.

Siderastrea siderea (Ellis and Solander), 1786

Plate 36, figures 1, 2

Madrepora siderea ELLIS AND SOLANDER, 1786, The natural history of . . . zoophytes, p. 168, pl. 49, fig. 2.

Siderastrea siderea (Ellis and Solander) VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 309, pl. 14, figs. 1, 2, pl. 16, fig. 1. Synonymy.

Siderastrea siderea (Ellis and Solander) DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, p. 588, pls. 22–24, figs. 150–160. Morphology, histology.

Siderastrea siderea (Ellis and Solander) MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature data.

Siderastrea siderea (Ellis and Solander) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Siderastrea siderea (Ellis and Solander) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Siderastrea siderea (Ellis and Solander) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity toleration.

Siderastrea siderea (Ellis and Solander) VAUGHAN, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 228. Growth rate data.

Siderastrea siderea (Ellis and Solander) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 443, pl. 114, figs. 2, 3, pl. 122, figs. 1–3. Synonymy.

Siderastrea siderea (Ellis and Solander) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity tolerance.

Coralla form hemispherical or spheroidal masses up to several feet in diameter. Calices are 4 to 5 mm. in diameter, sometimes larger. Septa are arranged in four complete cycles, with portions of the fifth present with a small central columella. Corallum lilac to reddish brown; tentacles milky, with white-knobbed tips.

This species has a more restricted development than *Siderastrea radians*. It is found principally on the seaward side, where it forms large spherical boulders often several feet in diameter, particularly off Rabbit Cay in water of 15 feet or more in depth where many large coralla were observed. These large heads are frequently penetrated by borings and are sometimes hollow, furnishing shelter for a large and varied number of organisms. In shallower water, encrusting or attached forms are encountered.

OCCURRENCE: Off Rabbit Cay, west side of Turtle Rocks, and the east side of Turtle Rocks.

DISTRIBUTION: Miocene, Jamaica, Santo Domingo, Cuba; Pleistocene, Costa Rica, Antilles, Florida, Central America, Bahamas; Recent, Antilles, Florida, Bahamas, Bermuda, Gulf of Mexico.

PORITIDAE

PORITES LINK, 1807

Porites astreoides Lamarck, 1816

Plate 39, figures 2, 3

Porites astreoides LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, vol. 2, p. 269.

Porites astreoides Lamarck VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 317, pl. 32, pl. 33, pl. 34, figs. 1, 2. Synonymy.

Porites astreoides Lamarck DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, p. 550, pls. 3–5, figs. 28–42. Morphology, anatomy, histology.

Porites astreoides Lamarck VAUGHAN, 1911, Carnegie Inst. Washington, Yearbook, no. 10, pp. 148–156, pl. 4, figs. 3a, 3d, 3e, pl. 5, fig. 5b, pl. 6, figs. 1c, 2e. Growth rate data.

Porites astreoides Lamarck MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature tolerance.

Porites astreoides Lamarck MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Porites astreoides Lamarck VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Porites astreoides Lamarck VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower salinity tolerance, exclusion of light.

Porites astreoides Lamarck MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature toleration.

Porites astreoides Lamarck VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 503. Synonymy.

Porites astreoides Lamarck WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Porites astreoides Lamarck YONGE, 1937, Papers Tortugas Lab., vol. 31, p. 211. Oxygen consumption.

Massive, subnodular coralla with hummocky surface are formed by closely packed, small calices, 1.0 to 1.5 mm. in diameter. Septa are 12 in number and lack distinct pali; the columellar tubercle is small. Color of corallum varies from yellow to mustard, to dark brown, mustard being the most common.

The typical form of the corallum of this species is large hemispherical masses with an encrusting base and a gibbous surface, a form designated by Vaughan (1901a, p. 317) as forma *alpha*. Forma *beta*, lacking the gibbous surface, is also present but is not so common. No ecologic corollary for this difference could be found. The specimens from Bimini differ from those described from other areas in the smaller size of the calices, which are seldom over 1 mm. in diameter. *Porites astreoides* is found in nearly all environments and is apparently one of the more successful corals in the Bimini area. It is particularly to be noted for its tolerance of conditions in heavy *Thalassia* growths, as it is the only coral to be found among them.

OCCURRENCE: Off Rabbit Cay, west side of Turtle Rocks, east side of Turtle Rocks, in channel off South Bimini (station 12), widely distributed in the lagoon (stations 3, 4, 5), Moselle Bank.

DISTRIBUTION: Miocene, Cuba; Pleistocene, Panama, Florida, Bahamas; Recent, Antilles, Bermuda, Florida, Bahamas, Brazil.

Porites porites (Pallas), 1766

Madrepora porites PALLAS, 1766, (part), Elenchus zoophytorum, p. 324.

Porites porites (Pallas) VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 316.

Vaughan, in his discussion of the Atlantic branching forms of *Porites*, recognized three varieties which show intergradations. As such, these forms are recognized not as species but as variations on a single plan; this is borne out by the differences in habitat observed for the several varieties at Bimini. It seems a useful scheme to utilize the term "variety," particularly for description of corallum form in relation to habitat. However, Vaughan (1919a, p. 498) was not consistent in this and often refers to variations as distinct species. There can be no doubt that the determination of the varieties *furcata* and *clavaria* is highly subjective and of little taxonomic significance, the differences between them being either of small degree or subject to great variation. Variety *divaricata*, on the other hand, is rather distinctive, but, given environments of an intermediate nature between those with which it is usually associated and those typical for *furcata*, a gradational form might be produced. A careful study of these forms will be required for the complete evaluation of the taxonomic significance of the forms. Until such a study is made, I retain the scheme of varietal names and reserve *Porites porites* for those forms not readily distinguished or of a fragmentary nature.

Porites porites var. **clavaria** Lamarck, 1816

Plate 38, figures 1, 2

Porites clavaria LAMARCK, 1816, Histoire naturelle des animaux san vertèbres, vol. 2, p. 270.

Porites porites forma *clavaria* Lamarck VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 316, pl. 29, pl. 31, fig. 2. Synonymy and discussion of growth form.

Porites clavaria Lamarck VAUGHAN, 1912, Carnegie Inst. Washington, Yearbook, no. 10, pp. 148, 152, 156, pl. 4, fig. 4c, pl. 6, figs. 3, 4. Growth rate data.

Porites clavaria Lamarck MAYER, 1913, Caregie Inst. Washington, Yearbook, no. 11, p. 126. Temperature tolerance.

Porites clavaria Lamarck MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature tolerance.

Porites clavaria Lamarck VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Porites clavaria Lamarck VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower limits of salinity tolerance, exclusion of light.

Porites clavaria Lamarck MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature toleration.

Porites porites (Pallas) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Corallum forms thick-branched, stout masses often up to several feet in diameter. Branches usually somewhat swollen near the ends and are blunt. Calices range from 1.5 to 2.0 mm. in diameter. Six pali and columellar tubercle are present. Color of the corallum varies from dark brown to gray.

The typical form is found off Rabbit Cay as large, densely branching, nearly spheroidal clumps. The branches are long and essentially straight, there being few lateral digitations, but only the tips of the branches are living, the remainder being inhabited by a large fauna of encrusting, boring, and nektonic animals. This fauna has weakened the branches, so that a single blow breaks off large portions of the corallum. In shallower waters this variety forms short, stubby, branched coralla strongly attached to the bottom.

OCCURRENCE: The variety has been recognized off Rabbit Cay and on the west side of Turtle Rocks.

DISTRIBUTION: Miocene, Cuba; Pleistocene, Antilles, Bahamas; Recent, Antilles, Central America, Florida, Bermuda, Bahamas.

Porites porites var. **furcata** Lamarck, 1816

Plate 39, figure 1

Porites furcata LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, vol. 2, p. 271.

Porites porites forma *furcata* VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 316, pl. 30, pl. 31, fig. 1. Synonymy and discussion of growth form.

Porites furcata Lamarck MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature toleration.

Porites furcata Lamarck MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Porites furcata Lamarck VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Porites furcata Lamarck VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower limits of salinity tolerance, effects of light exclusion.

Porites furcata Lamarck MAYER, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 212. Temperature tolerance.

Porites furcata Lamarck MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature tolerance.

Porites furcata Lamarck VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 499. Synonymy.

Porites furcata Lamarck WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Corallum in form of ramose, thin-branched colonies. Branches average about 10 mm. in diameter, the ends usually tapering to a slightly smaller diameter, but often with terminal bifurcation. Calices about 1.5 mm. in diameter, often with only five pali.

The distinction between this variety and the typical form is difficult. The calices are relatively small, from 1.5 to 1.75 mm. in diameter; the pali and the columellar tubercle are in general more pronounced in development than in variety *clavaria*.

Colors of the coralla are varied, several shades often being found in a single area or, indeed, in a single corallum. Most common are yellows or buff browns, but in some specimens the latter may possess purple undertones on the lower portions of the corallum. Other specimens, particularly those associated with softer sediments, are a cream or very light yellow in color, a phase also generally correlated with highly extensile polyps. Orange hues may be found, but only rarely, while in "finger-coral" patches, one may often collect orchid-colored specimens.

Porites porites var. *furcata* is widely distributed in the lagoon where it commonly forms "thickets" or patches densely populated by unattached coralla. It is presumed that the original attachment of these forms was so small as to render the corallum unstable with additional growth. Often the secondary position, too, became unstable. Various attitudes of the coral through its ontogeny may be reconstructed from an examination of the condition of the branches, as the older ones are more heavily encrusted.

OCCURRENCE: Off Rabbit Cay, on the west side of Turtle Rocks, widely distributed in the lagoon (stations 3, 4, 5, 6, 7, 8), and on the margins of the Bank (stations 9, 10, 11) where it is more rare.

DISTRIBUTION: Pleistocene, Antilles, Central America, Bahamas; Recent, Florida, Bahamas, Antilles, Central America.

Porites porites var. **divaricata** Lesueur, 1820

Plate 38, figure 3

Porites divaricata LESUEUR, 1820, Mem. Mus. Hist. Nat. Paris, vol. 6, p. 288.

Porites porites forma *divaricata* Lesueur VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 316, pl. 2, figs. 4, 4a, 4b.

Corallum formed of thin, delicate, arborescent branches less than 6 mm. in diameter. Calices shallow and about 1.5 mm. in diameter.

Of all the branched forms of *Porites* in the western Atlantic, this is probably the most distinctive because of its delicate structure. The largest coralla collected were only several inches in diameter and were composed of a relatively few branches. In color, the corallum departs from the plan of other species of *Porites*, usually being yellow to yellowish brown, but usually with a striking red calicular pit. In almost every instance, the corallum was found attached to an algal frond which supported it above the substrate.

OCCURRENCE: Grunt Drop, and soft-bottom areas off South Bimini (station 10).

Distribution: Recent, Antilles, Florida, Bahamas.

FAVIIDAE

FAVIA Oken, 1815

Favia fragum (Esper), 1797

Plate 34, figures 2, 3

Madrepora fragum Esper, 1797, Fortsetzungen der Pflanzenthiere, p. 79, pl. 64, figs. 1, 2.

Favia fragum (Esper) Vaughan, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 303, pl. 3. Synonymy.

Favia fragum (Esper) Mayer, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature tolerance.

Favia fragum (Esper) Mayer, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature tolerance.

Favia fragum (Esper) Vaughan, 1915, Jour. Washington Acad. Sci., vol. 5, p. 596. Growth rate data.

Favia fragum (Esper) Vaughan, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity tolerance, effects of exclusion of light.

Favia fragum (Esper) Mayer, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature tolerance, oxygen consumption.

Favia fragum (Esper) Vaughan, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 412. Synonymy.

Favia fragum (Esper) Wells, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Favia fragum (Esper) Yonge, 1937, Papers Tortugas Lab., vol. 31, p. 209. Oxygen consumption.

Coralla form hemispherical or capuliform masses several inches in diameter. Calices are usually elliptical and are about 4.5 mm. in diameter. Septa number about 40 and are arranged in no distinctive pattern; margins of the septa are irregularly dentate, the individual dentations not of great size. The surface of the corallum is costate, and the costae bear dentations. The corallum is a light yellow when expanded, a mustard to light brown when contracted.

Occurrence: Off Rabbit Cay and west Turtle Rocks in shallow water, east side of Turtle Rocks, and stations 3 and 6 in the lagoon.

Distribution: Pleistocene, Canal Zone, Antilles, Florida, Bahamas; Recent, Antilles, Bermuda, Bahamas, Florida, Azores.

DIPLORIA Milne-Edwards and Haime, 1848

Diploria clivosa (Ellis and Solander), 1786

Plate 42, figure 2

Madrepora clivosa Ellis and Solander, 1786, The natural history of . . . zoophytes, p. 163.

Maeandra clivosa (Ellis and Solander) Mayer, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature tolerance.

Maeandra clivosa (Ellis and Solander) Vaughan, 1915, Jour. Washington Acad. Sci., vol. 5, pp. 596, 597. Growth rate data.

Maeandra clivosa (Ellis and Solander) Vaughan, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity toleration, effects of light exclusion.

Maeandra clivosa (Ellis and Solander) Vaughan, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 227. Growth rate data.

Maeandrina clivosa (Ellis and Solander) Matthai, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 71–78, pl. 11, figs. 1–3, pl. 12, figs. 5, 7, pl. 49, fig. 7, pl. 63, figs. 4, 8, pl. 72, fig. 7a. Synonymy, corallum morphology, polyp morphology.

Maeandra clivosa (Ellis and Solander) Wells, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Maeandra clivosa (Ellis and Solander) Yonge, 1937, Papers Tortugas Lab., vol. 31, p. 211. Oxygen consumption.

Coralla forming heavy spreading mats often several feet in diameter, with an irregular, convoluted surface often thrown up into pinnacles. Valleys are discontinuous and have a width of about 4 mm. The colline is rather sharp, 1 to 2 mm. wide, and lacks a central groove. Septa are thin and arranged in two alternate groups, the larger one bearing conspicuous paliform lobes. The polyp ranges in color from brown to brown with green valleys. The tentacles are often green.

Occurrence: In 10 feet of water off west side of Turtle Rocks and Rabbit Cay. One large specimen on the east side of Turtle Rocks.

Distribution: Pleistocene, Florida, Central America; Recent, Florida, Bahamas, Antilles.

Diploria strigosa (Dana), 1848

Plate 42, figure 1

Maeandrina strigosa Dana, 1848, United States exploring expedition . . . 1838–42 under . . . command of C. Wilkes, Zoophytes, vol. 7, p. 257, pl. 14, figs. 4a, 4b.

Maeandra strigosa (Dana) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 596. Growth rate data.

Maeandra strigosa (Dana) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity toleration, effects of exclusion of light.

Maeandra strigosa (Dana) VAUGHAN, 1917, Carnegie Inst. Washington, Yearbook, no. 14, p. 227. Growth rate data.

Maeandra strigosa (Dana) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 420. Synonymy.

Maeandrina cerebrum (Ellis and Solander) MATTHAI, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 55–63, pl. 8, figs. 7, 8, pl. 9, figs. 1–9, pl. 11, fig. 4, pl. 34, fig. 2, pl. 46, fig. 1, pl. 48, figs. 2–3, pl. 50, fig. 2, pl. 55, fig. 18. Synonymy, polyp morphology, corallum morphology.

Maeandra strigosa (Dana) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity tolerance.

Coralla form large hemispherical to spherical boulders up to several feet in diameter. The surface is evenly convex and covered by sinuous irregular valleys about 5 mm. in width. Valleys are separated by a colline 2 to 3 mm. thick which may bear an ambulacrum. Septa exsert, thick, and less numerous than in *D. clivosa*. Prominent paliform lobes are developed on the longer septa. Color of the corallum varies from a light brown to tan, often with a purple iridescence, and the tentacles are yellow-brown.

Chief differences between *D. strigosa* and *D. clivosa* are in the habit of growth, the former found in hemispherical masses, the latter in spreading mats. Although the third species of the genus common in the West Indies, *D. labyrinthiformis* (Linnaeus), is apparently not represented, it may be present in deeper waters. As the differences between *D. strigosa* and *D. labyrinthiformis* are in the larger size and the more sinuous, narrower, and deeper valleys of the latter, careful and extensive collecting is required to determine its presence.

OCCURRENCE: Found in the deeper water (15 feet or more) off Rabbit Cay, and at station 5 in the channel in the lagoon.

DISTRIBUTION: Pleistocene, Caribbean, Florida, Bahamas, Antilles; Recent, Bermuda, Florida, Bahamas, Antilles.

Manicina areolata (Linnaeus), 1758

Plate 37, figures 1–3

Madrepora areolata LINNAEUS, 1758, (part), Systema naturae, ed. 10, vol. 1, p. 795.

Manicina areolata (Linnaeus) WILSON, 1888, Jour. Morph., vol. 2, no. 2, pp. 191–242, pls. 1–7. Larval development, histology, anatomy.

Manicina areolata (Linnaeus) DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 577–579, pls. 18, 19, figs. 129–137. Morphology, anatomy, histology.

Maeandra areolata (Linnaeus) MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature tolerance.

Maeandra areolata (Linnaeus) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature tolerance.

Manicina areolata (Linnaeus) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Maeandra areolata (Linnaeus) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity tolerance, effects of exclusion of light.

Maeandra areolata (Linnaeus) MAYER, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 212. Temperature tolerance.

Manicina areolata (Linnaeus) VAUGHAN, 1916, Carnegie Inst. Washington, Yearbook, no. 14, pp. 225, 227. Growth rate data.

Maeandra areolata (Linnaeus) MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175.

Maeandra areolata (Linnaeus) BOSCHMA, 1925, Carnegie Inst. Washington, Yearbook, no. 24, pp. 223–224. Postembryonic development.

Manicina areolata (Linnaeus) MATTHAI, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 80–91, pl. 20, figs. 1–10, pl. 21, figs. 1–9, pl. 53, figs. 1–4, pl. 55, figs. 10–16, pl. 62, figs. 10, 14, pl. 63, fig. 7, pl. 64, fig. 6, pl. 68, figs. 3–4, pl. 69, figs. 4–7. Synonymy, morphology.

Manicina areolata (Linnaeus) BOSCHMA, 1929, Publ. Carnegie Inst. Washington, no. 391, pp. 129–147. Post-larval development.

Maeandra areolata (Linnaeus) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Maeandra areolata (Linnaeus) YONGE, 1935, Papers Tortugas Lab., vol. 29, pp. 187–198, pls. 1–3. Feeding reactions, cleaning of sediment, reproduction.

Maeandra areolata (Linnaeus) YONGE, 1937, Papers Tortugas Lab., vol. 31, p. 207. Oxygen consumption.

Coralla generally small, oval in horizontal outline, with convex upper surface and a stalked base. Meandroid valley usually continuous, about 12 mm. wide. Colline about 6 mm. thick, with narrow ambulacrum present in some specimens. Septa thin, arranged in two groups, the longer septa having a prominent paliform lobe. Colors range from a yellow-brown or mustard to a dark brown. The valley surface is marked by white stripes, usually coinciding with the position of the pali.

Manicina areolata is probably one of the best-known species of West Indian corals, having been studied from nearly every aspect. In the Bimini area, as elsewhere, *Manicina* is one of the more important lagoonal forms. The corallum is usually attached by the stalk in the early stages, but later becomes free and lives in an upright position. The species has an unusually high tolerance for sediment deposition, as indicated by the experiments of Yonge (1935a), who demonstrated the ability of *M. areolata* to uncover itself.

A problem that should be further investigated is the occurrence of a number of overturned specimens of *M. areolata* in the vicinity of the channel. These may have been the result of current action, of the dragging of anchors, or the use of dip nets utilized by the natives in the capture of *Strombus gigas* or rock crayfish. Whatever the cause, the corallum is apparently not injured, although prolonged periods of repose in this position should result in death of the polyp in whole or in part. It may be that through inflation of the tissues the species is able to right itself.

A variety of growth form collected from a small patch of individuals living in soft mud off the shore of South Bimini (station 11) that differs from other described specimens is figured here. The explanation and derivation of the growth form will be the subject of a more extensive discussion in another place. It is believed, however, that this does not represent a distinct species, but is merely a reflection of the environment through the corallum form. This variety generally has lighter coloration, being light yellow to cream over the surface of the polyp, but the white stripes in the valleys are present.

OCCURRENCE: Rare off Rabbit Cay and on the west side of Turtle Rocks. Common in the lagoon (stations 3, 4, 6, 7, 8), on the eastern shore of South Bimini, on the south shore of South Bimini (station 11), and on the east side of Turtle Rocks.

DISTRIBUTION: Pleistocene, Bahamas, Canal Zone, and Florida; Recent, Bahamas, Antilles, Florida.

MONTASTREA DE BLAINVILLE, 1830

Montastrea cavernosa (Linnaeus), 1766

Plate 40, figures 1, 2

Madrepora cavernosa LINNAEUS, 1766, Systema naturae, ed. 12, vol. 1, p. 1276.

Orbicella cavernosa (Linnaeus) VAUGHAN, 1901, Samml. Geol. Reichs Mus. Leiden, ser. 2, vol. 2, p. 27. Synonymy.

Orbicella cavernosa (Linnaeus) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Orbicella cavernosa (Linnaeus) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 596. Growth rate data.

Orbicella cavernosa (Linnaeus) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224–225. Lower range of salinity toleration and effects of light exclusion.

Orbicella cavernosa (Linnaeus) VAUGHAN, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 227. Growth rate data.

Orbicella cavernosa (Linnaeus) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 380, pl. 87, figs. 1, 1a, 1b, 1c, pl. 88, figs. 1–3. Synonymy and discussion.

Orbicella cavernosa (Linnaeus) YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 25. Feeding reactions.

Orbicella cavernosa (Linnaeus) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Orbicella cavernosa (Linnaeus) YONGE, 1937, Papers Tortugas Lab., vol. 31, p. 211. Oxygen consumption.

Coralla usually form hemispherical or subhemispherical boulders, often of great size. Calices are elevated, 3 to 5 mm. apart, about 6 mm. in diameter. Septa are arranged in about four complete cycles (48 septa), of which usually the first three reach the columella. Costae are prominent and correspond to the septa.

Larger colonies are typical of water depths in excess of 10 feet, while in shallower water the coralla are smaller, more spreading, and may be dead on the upper surface. The polyps appear polygonal and are an iridescent green; the oral disc is white. The white color of the disc is principally due to an accumulation of fine sediment about the margins of the stomadeum. A second color phase is less green and possesses a purple iridescence over an olive drab background. These have green tentacles.

OCCURRENCE: Found off Rabbit Cay and on the west side of Turtle Rocks, and on the east side of Turtle Rocks. May be present in the deeper waters of the channel.

DISTRIBUTION: Pleistocene, Florida, West Indies, Caribbean; Recent, Florida, Antilles, Caribbean, Bahamas, Bermuda.

Montastrea annularis (Ellis and Solander), 1786

Plate 40, figure 3; plate 41, figures 1, 2

Madrepora annularis ELLIS AND SOLANDER, 1786, The natural history of . . . zoophytes, p. 169, pl. 53, figs. 1, 2.

Orbicella annularis (Ellis and Solander) DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 564–566, pls. 8–10, figs. 64–73. Morphology, histology, anatomy.

Orbicella annularis (Ellis and Solander) MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature toleration.

Orbicella annularis (Ellis and Solander) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Orbicella annularis (Ellis and Solander) VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 596. Growth rate data.

Orbicella annularis (Ellis and Solander) VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity toleration and effects of light exclusion.

Orbicella annularis (Ellis and Solander) VAUGHAN, 1916, Carnegie Inst. Washington, Yearbook, no. 14, p. 227. Growth rate data.

Orbicella annularis (Ellis and Solander) MAYER, 1918, Papers Dept. Marine Biol., Carnegie Inst. Washington, vol. 12, p. 175. Temperature toleration and oxygen consumption.

Orbicella annularis (Ellis and Solander) VAUGHAN, 1919, Bull. U. S. Natl. Mus., vol. 103, p. 364, pl. 80, figs. 7, 7a, 7b, pl. 81, figs. 1, 1a, 2, pl. 82, figs. 1, 1a, 2, pl. 83, figs. 1, 2, 3, 3a, pl. 84, figs. 1, 2, 3, 3a. Synonymy.

Orbicella annularis (Ellis and Solander) YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 25. Feeding reactions.

Orbicella annularis (Ellis and Solander) WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Orbicella annularis (Ellis and Solander) YONGE, 1937, Papers Tortugas Lab., vol. 31, p. 207. Oxygen consumption.

Coralla form large spherical or nearly spherical boulders up to several feet in diameter. Calices are nearly circular, 2 to 3 mm. in diameter, with margins raised. Septa arranged in three cycles (about 24), with the septa of the first two cycles reaching the columella. Costae correspond to septa.

Typically the species forms large spheroidal masses 1 to 5 feet in diameter, but it may occur as domed or hemispherical coralla. In either case, the center is usually hollow. The polyps are a dark brown to olive drab, but appear to be maroon when wet. The oral disc and tentacles are often green.

A variation of this species, named *Orbicella hispidula* Verrill, 1884, was collected from the rock ledge in the channel (station 6). It differs from the others in having a spinulose peritheca and densely spinose costae and septa, and in its color, which was yellow-brown.

OCCURRENCE: Off Rabbit Cay and on the west side of Turtle Rocks, and in the Rock Ledge channel (station 5). Pleistocene (7), in channel dredged by G. Lyons.

DISTRIBUTION: Pleistocene, Florida, Antilles, Caribbean, Bahamas; Recent, Bermuda, Bahamas, Caribbean, Antilles, Florida.

OCULINIDAE

OCULINA LAMARCK, 1816

Oculina diffusa Lamarck, 1816

Plate 38, figure 4

Oculina diffusa LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, vol. 2, p. 283.

Oculina diffusa Lamarck VAUGHAN, 1901, Bull. U. S. Fish Comm., for 1900, vol. 2, p. 294, pl. 1, figs. 5, 5a. Synonymy.

Oculina diffusa Lamarck DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 585–588, pl. 22, fig. 149. Morphology, anatomy, histology.

Oculina diffusa Lamarck MAYER, 1913, Carnegie Inst. Washington, Yearbook, no. 11, p. 126. Temperature toleration.

Oculina diffusa Lamarck MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Oculina diffusa Lamarck VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp.

224, 225. Lower range of salinity toleration and effects of light exclusion.

Oculina diffusa Lamarck VAUGHAN, 1915, Jour. Washington Acad. Sci., vol. 5, p. 597. Growth rate data.

Oculina diffusa Lamarck VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 14, p. 227. Growth rate data.

Oculina diffusa Lamarck YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 17. Feeding reaction.

Oculina diffusa Lamarck WELLS, 1932, Carnegie Inst. Washington, Yearbook, no. 31, p. 291. Upper range of salinity toleration.

Coralla form densely branching, ramose colonies less than 6 inches in diameter. Callices are 2 to 4 mm. in diameter. Septa are arranged in three cycles, with one circlet of pali mingling with a papillose columella. The corallum varies from mustard to yellow in color near the calices but is more olive between the calices. The tentacles are long and filamentous, the tips being white, with white, spirally arranged, nematocyst batteries.

Oculina diffusa was collected at only one locality, where it is apparently relatively rare.

OCCURRENCE: Rock ledge in lagoon channel (station 5), Pleistocene (?).

DISTRIBUTION: Pleistocene, ?Bimini, Panama Canal Zone; Recent, Florida, Bermuda, Bahamas, Antilles.

TROCHOSMILIIDAE

DICHOCOENIA MILNE-EDWARDS AND HAIME, 1848

Dichocoenia stokesii Milne-Edwards and Haime, 1848

Plate 34, figure 4

Dichocoenia stokesii MILNE-EDWARDS AND HAIME, 1848, Ann. Sci. Nat., Zool., ser. 3, vol. 10, p. 307, pl. 7, figs. 3, 3a.

Dichocoenia stokesii Milne-Edwards and Haime DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 572–573, pl. 16, figs. 117–120. Morphology, anatomy, histology.

Dichocoenia stokesii Milne-Edwards and Haime VAUGHAN, 1915, Carnegie Inst. Washington, Yearbook, no. 13, pp. 224, 225. Lower range of salinity tolerance and effects of exclusion of light.

Dichocoenia stokesii Milne-Edwards and Haime MATTHAI, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 198–201, pl. 44, fig. 1, pl. 45, figs. 2, 5 pl. 72, fig. 8a. Morphology, synonymy.

Coralla form small nodular masses, or somewhat larger platy growths. Calices oval, not forming distinct valleys, about 10 mm. long at maximum. Walls thick, up to 3 mm., and are granular or vesicular. Septa of variable thickness, and not arranged in an apparent order. The corallum is usually a yellow-brown or olive color, with white tentacles.

The specimens from Bimini differ from those described as typical of other areas in several particulars, as the coralla and calices are in general somewhat smaller, The width of the latter is seldom more than 3 mm., while the length is rarely greater than 10 mm. Specimens from what are considered marginal environments, from the point of view of the coral, tend to have even smaller dimensions, the width being about 2 mm. and the length about 6 mm. The differences are not sufficiently great for the forms to be distinguishable completely from those of other areas, but may be an indication of a marginal environment for the development of the species. Duerdan (1904, p. 572), in speaking of Jamaican *D. stokesii*, noted that small specimens of this species "do not exhibit the meandering discal systems such as are figured in 'Florida Reefs,' pl. X (Agassiz, 1880)."

OCCURRENCE: Off Rabbit Cay and on the west side of Turtle Rocks and station 3, alongside the lagoon channel.

DISTRIBUTION: Recent, Florida, Bahamas, Antilles, Caribbean.

MUSSIDAE

ISOPHYLLIA MILNE-EDWARDS AND HAIME, 1848

Isophyllia sinuosa (Ellis and Solander), 1786

Plate 40, figure 4

Madrepora sinuosa ELLIS AND SOLANDER, 1786, The natural history of . . . zoophytes, pp. 160–161.

Isophyllia dipsacea Dana DUERDAN, 1902, Mem. Natl. Acad. Sci., vol. 8, pp. 574–576, pls. 17, 18, figs. 121–128. Morphology, histology, anatomy.

Mussa (Isophyllia) dipsacea (Dana) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 19. Temperature toleration.

Isophyllia dipsacea Dana BOSCHMA, 1925, Proc. Amer. Acad. Arts and Sci., vol. 60, pp. 451–455. Feeding reactions.

Isophyllia sinuosa (Ellis and Solander) MATTHAI, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 237–247, pl. 2, fig. 14, pl. 3, figs. 15–16, pl. 23, figs. 3–4, pl. 35, figs. 1–13, pl. 36, figs. 1–7, pl. 37, figs. 1–2, pl. 38, figs. 1–6, pl. 39, figs. 1–9, pl. 55, figs. 1–9, pl. 57, figs. 4a, 4b, pl. 61, fig. 6, pl. 72, fig. 8b. Synonymy, morphology, anatomy.

Isophyllia dipsacea Dana YONGE, 1930, *in* Great Barrier Reef expedition, scientific reports, vol. 1, p. 34. Feeding reactions.

Coralla form hemispherical nodules up to 8 inches in diameter. Valleys continuous, about 22 mm. wide, and are separated by a narrow colline. Septa rather coarse and bear pronounced spines, six to 10 spines being found on the proximal margin.

The polyps are similar to those of *Isophyllastrea rigida* in that the surface is studded with wart-like excrescences, often highly inflated. The color is iridescent green, with the oral disc appearing yellow. The lower, or under, portions of the corallum are darker, particularly tending towards purple. Brown phases of this coral were observed, but it is believed that the color is indicative of the state of health of the polyp, as those forms kept in aquaria tended to darken before their demise.

OCCURRENCE: Off Rabbit Cay, west side of Turtle Rocks, the "*Porites*" patch (station 4), and along the rock channel in the lagoon (station 5).

DISTRIBUTION: Recent, Antilles, Bermudas, Florida, Bahamas.

ISOPHYLLASTREA MATTHAI, 1928

Isophyllastrea rigida (Dana), 1848

Plate 41, figure 3

Astrea rigida DANA, 1848, United States exploring expedition . . . 1838–42 under . . . command of C. Wilkes, Zoophytes, vol. 7, p. 237, pl. 12, figs. 8a–8d.

Mussa (*Isophyllia*) *rigida* (Dana) MAYER, 1914, Papers Tortugas Lab., vol. 6, p. 14. Temperature toleration.

Isophyllastrea rigida (Dana) MATTHAI, 1928, Catalogue of the madreporarian corals in the British Museum (Natural History), vol. 7, pp. 263–268, pl. 54, fig. 3, pl. 57, figs. 2–3. Synonymy, morphology, anatomy.

Coralla form small hemispherical or irregularly convex masses up to 7 inches in diameter. Calices cerioid, monostomadeal or distomadeal. Septa are thin, with six to eight coarse teeth on proximal margin. Columella feeble. The surface of the polyp is usually rough, wrinkled, and verrucose, unless the polyp is expanded. The color is variously green or brown but always with a striking iridescence. The oral disc is frequently white, usually because of the accumulation of fine sediment on it. Tentacles, which are not overly long, tend to be brown.

When active, the species is striking for the tremendous expansion of the polyps. Water is taken into the coelenteron until the oral surface may be raised as much as 4 or 5 cm. above the corallum. The oral disc is then stretched quite tightly and is in the form of a cone. When the coral is quickly raised from the water, contraction of the expanded oral disc causes water to squirt from the stomadeum as far as 10 inches.

OCCURRENCE: Found only on the reef margin at Rabbit Cay and on the west side of Turtle Rocks.

DISTRIBUTION: Recent, Bahamas, Antilles, Florida, Bermuda.

CARYOPHYLLIIDAE

PARACYATHUS MILNE-EDWARDS AND HAIME, 1848

Paracyathus cf. **P. confertus** Pourtales, 1868

Paracyathus confertus POURTALES, 1868, Bull. Mus. Comp. Zoöl., Harvard College, vol. 1, p. 134.

One small immature specimen was brought up by Edwin C. Holland during the course of deep-sea fishing off Entrance Point. The specimen, which has a calicular diameter of 3 mm. and is approximately 3 mm. high, was growing in a cleft in the typical lime rock of the region and is associated with calcareous algae and other organisms not identified.

OCCURRENCE: Off Entrance Point (station 15), depth 750–800 feet.

DISTRIBUTION: Recent, Bimini, off Florida Keys.

Eusmilia sp.

A single specimen representing this genus was collected during bottom-sampling operations by Louis Kornicker. The entire corallum was heavily encrusted, particularly by calcareous algae, rendering complete identification impossible. It seems probable that dredging in the outer reef area at suitable depths would yield many more specimens of this genus. In other areas of the Bahamas, it may be collected in shallow waters, but is apparently absent from this habitat at Bimini.

OCCURRENCE: Off west side of Turtle Rocks in approximately 30 feet of water.

MILLEPORINA

MILLEPORIDAE

Millepora alcicornis Linnaeus, 1758
Plate 28, figures 1, 2

Millepora alcicornis LINNAEUS, 1758, Systema naturae, ed. 10, p. 791.

?*Millepora* sp. DUERDAN, 1899, Jour. Jamaica Inst., vol. 2, no. 6, p. 622. Morphology, reproduction.

Millepora alcicornis Linnaeus BOSCHMA, 1948, Zool. Verhandel. Rijksmus. Natuurl. Hist. Leiden, p. 23, pl. 14, fig. 3, text fig. 6. Synonymy, growth form discussion, anatomy, morphology.

Corallum of variable shape, but usually divided into finger-like branches at the growing edge. Surface of corallum even or with shallow depressions in which are located the gastropores.

To this species have been assigned a large number of specimens, predominantly encrusting forms. It is not entirely certain that this assignment is correct, but until more is known of the taxonomic value of the characters of gastropores and dactylopores, or anatomy, distinction of the millepore species remains difficult. The species is widely distributed and is commonly associated with *M. complanata* in about equal abundance along the surf zone at Turtle Rocks and Rabbit Cay. Here the development of digitations is not so great as in specimens from more quiet waters. The species is also known from the lagoon, where it was collected from the rock ledge at station 6. The specimen taken here, however, was a dirty gray in color in contrast to the usual orange-brown. It may, in fact, have been dead, often a difficult point to determine. Louis Krumholz has in his possession a bottle collected from the lagoon channel which has been entirely encrusted by *M. alcicornis*.

Several specimens assigned to this species were taken from areas in which the substrate was in active motion (stations 11, 12, and 14). Here it was invariably encrusting sea fans, usually to the extent that it had killed the gorgonian.

OCCURRENCE: Off Rabbit Cay, west side of Turtle Rocks, east side of Turtle Rocks, lagoon channel on the rock ledge, on the south shore of South Bimini (station 11), and on Moselle Bank.

DISTRIBUTION: Recent, Tropical Atlantic.

Millepora complanata Lamarck, 1816
Plate 43, figure 3

Millepora complanata LAMARCK, 1816, Histoire naturelle des animaux sans vertèbres, vol. 2, p. 201.

Millepora complanata Lamarck BOSCHMA, 1948, Zool. Verhandel. Rijksmus. Natuurl. Hist. Leiden, p. 34, text figs. 2a, 2b, 11, pl. 7, fig. 2. Synonymy, discussion of growth forms, anatomy, morphology.

Corallum formed of thin upstanding plates growing from a common encrusting basal portion. Surface of the free edge of the plates is usually truncated. Surface smooth or nearly smooth. Color of corallum varies from orange-brown to fawn.

This species has been recognized only off Rabbit Cay and Turtle Rocks where it is prominently developed in the shallow waters in about equal abundance with *M. alcicornis*. It is one of the more prominent corals of the surf zone.

OCCURRENCE: Off Rabbit Cay, west side of Turtle Rocks.

DISTRIBUTION: Recent, Tropical Atlantic.

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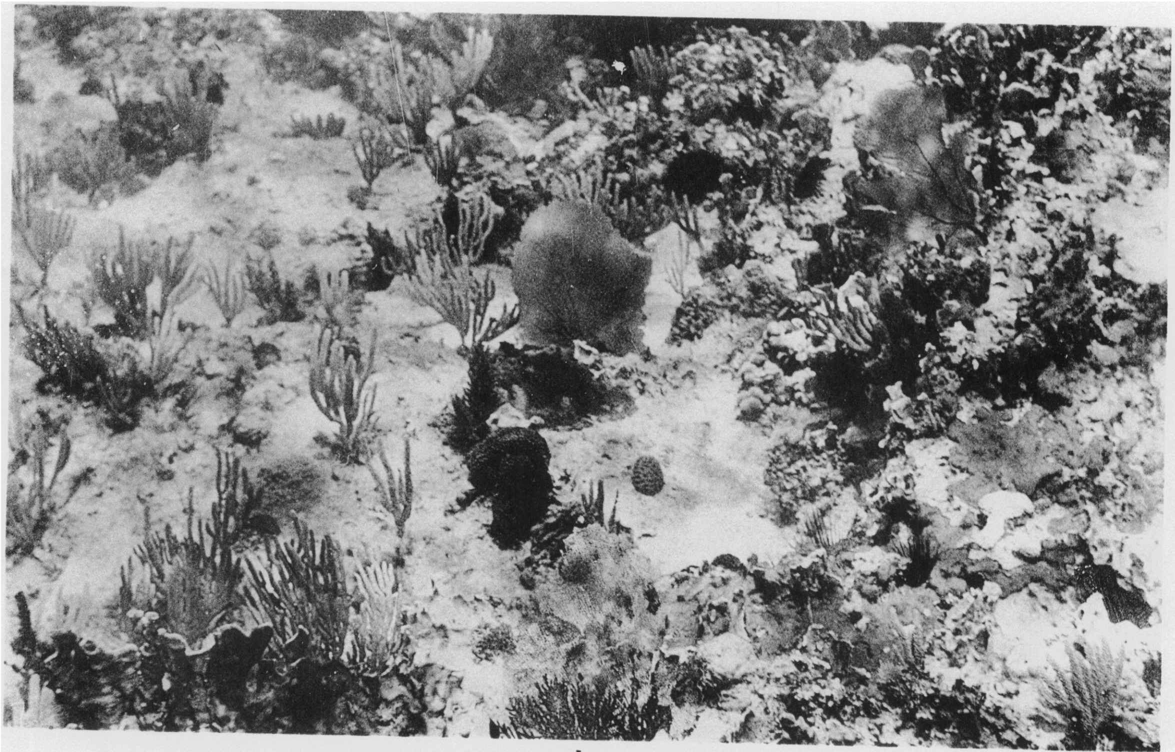

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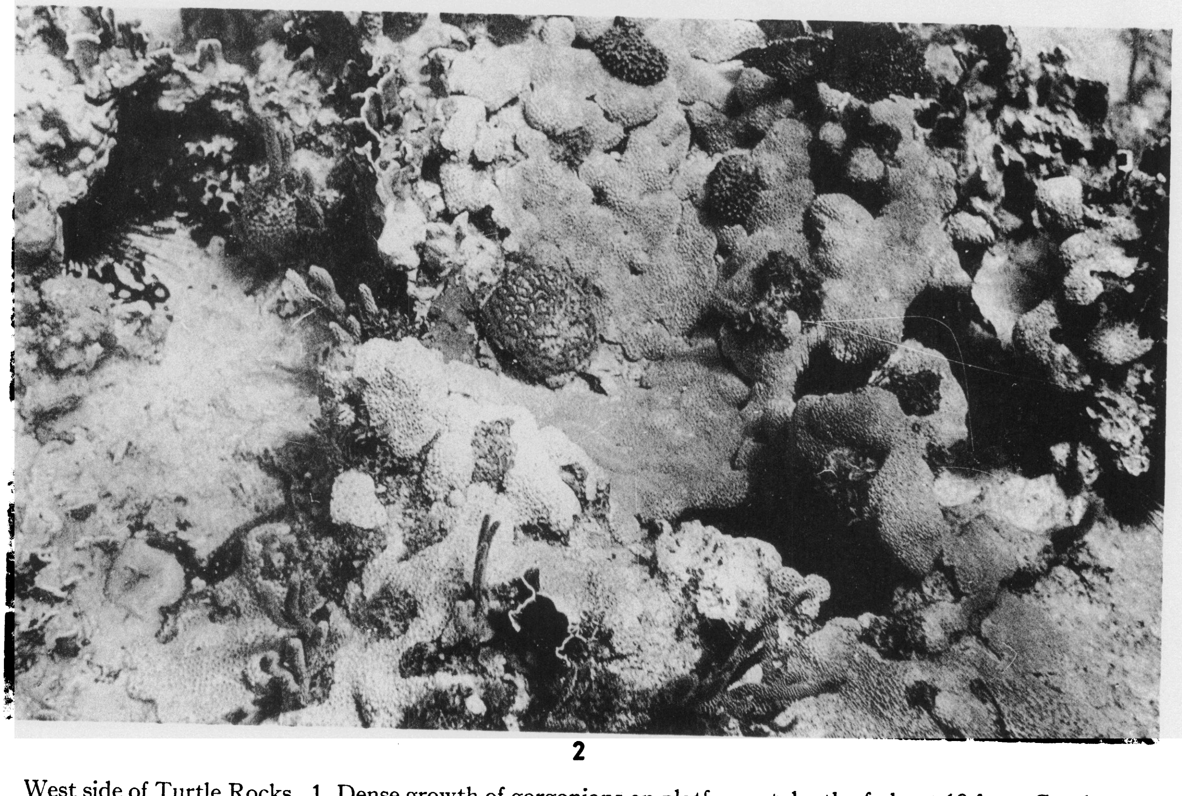
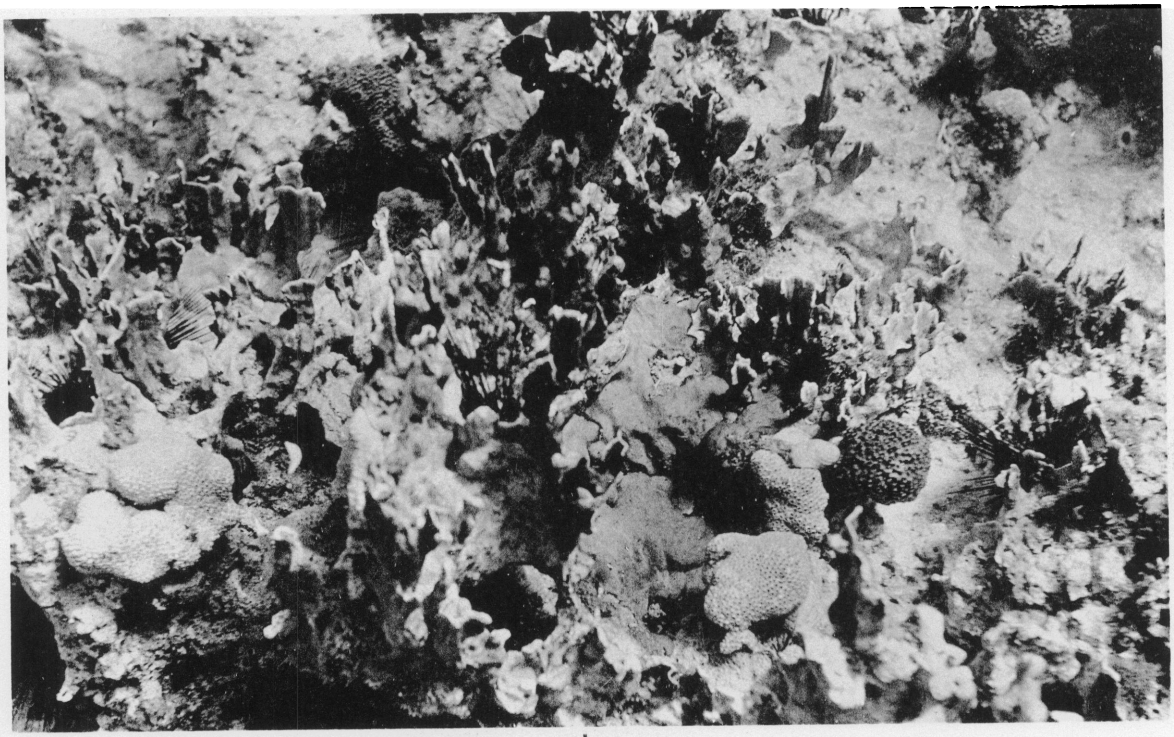


2

West side of Turtle Rocks. 1. Dense growth of gorgonians on platform at depth of about 10 feet. Coral growth scattered. 2. Typical growth below *Millepora* zone with soft corals, gorgonians, and *Isophyllia sinuosa*. Underwater photographs by G. R. Adlington



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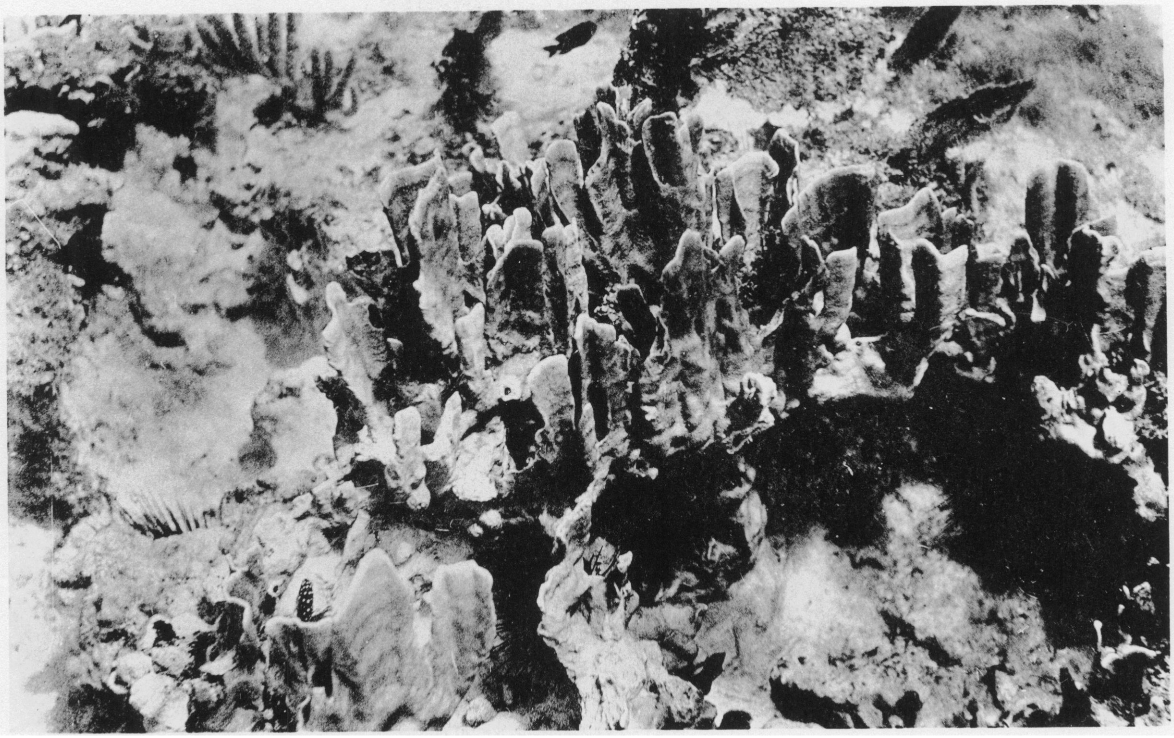


2

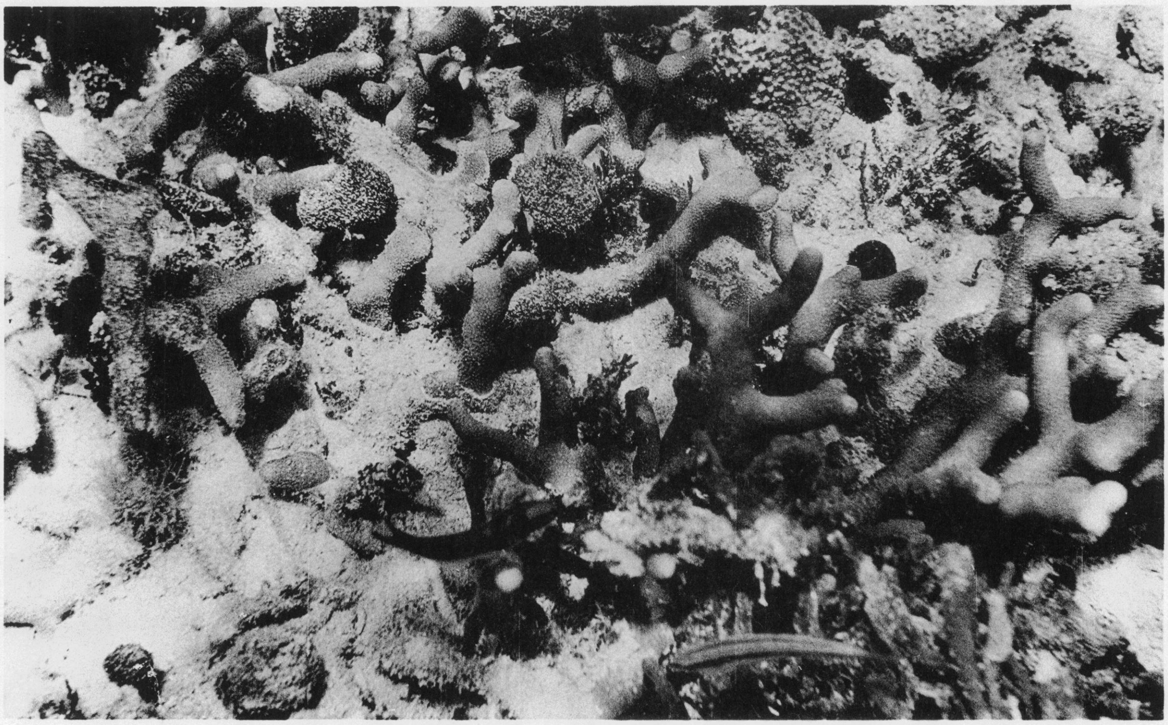
West side of Rabbit Cay, the *Millepora* zone. 1. Typical growths of *Millepora complanata* Lamarck, on sides and head of surge channel. 2. Castellated growth of *M. complanata* Lamarck. Under-water photographs by G. R. Adlington

1

2

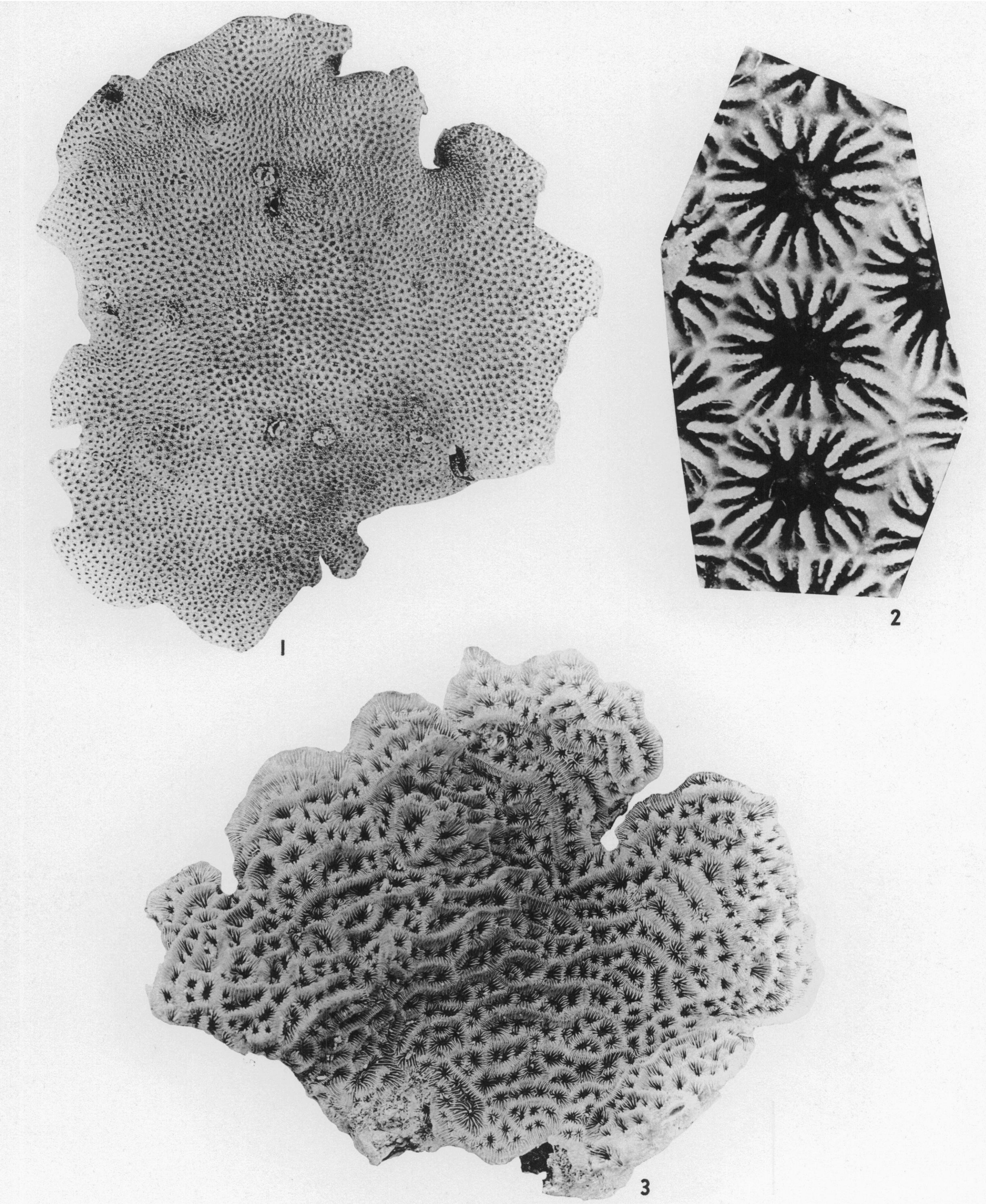
Grunt Drop, lagoon. 1. General aspect. Note scattered growth and lack of dense coral growth. 2. Details of growth. Corals present include *Porites astreoides* Lamarck and *Manicina areolata* (Linnaeus). Under-water photographs by G. R. Adlington

1



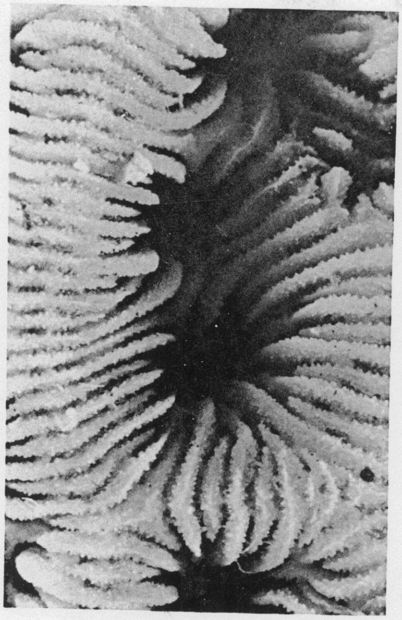
2

"Finger coral" patch, south of Tokas Cay, lagoon. 1. General aspect showing density of growth. 2. Growth of *Porites porites* var. *furcata* Lamarck. Notice sediment accumulation on corals. Under-water photographs by G. R. Adlington



1, 2. *Stephanocoenia michelini* Milne-Edwards and Haime. 1. A.M.N.H. No. 3281, corallum, × 0.5. 2. A.M.N.H. No. 3281, calices, × 10

3. *Agaricia agaricites* var. *purpurea* Lesueur. A.M.N.H. No. 3299, corallum, × 1



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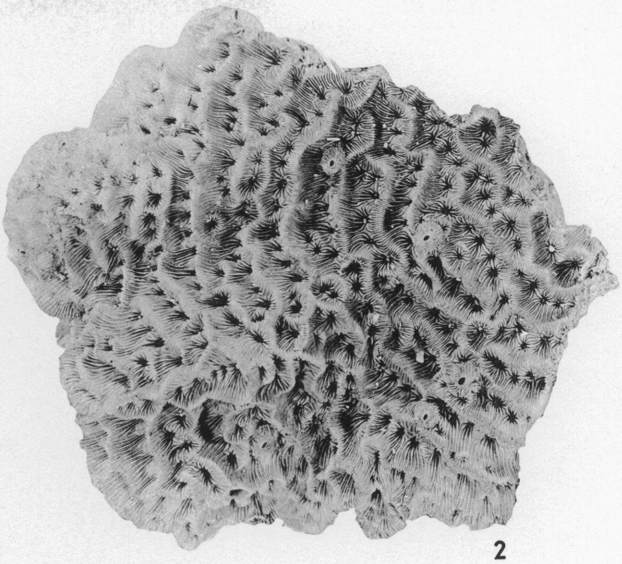

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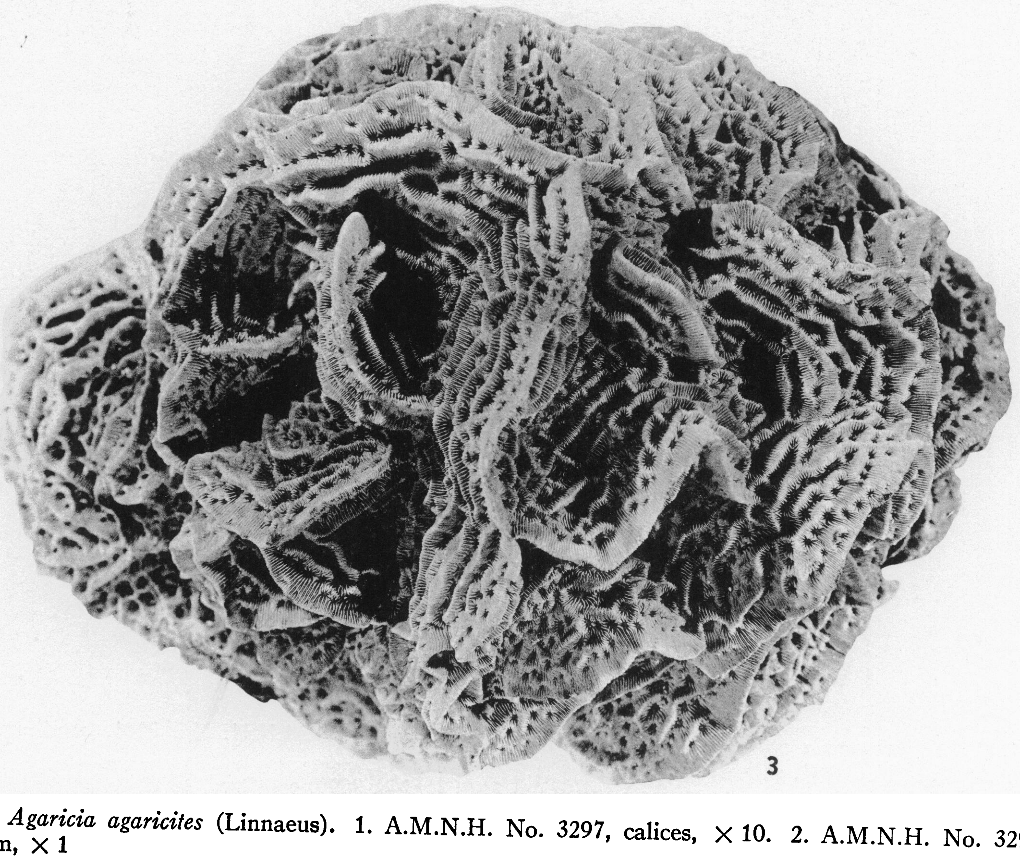

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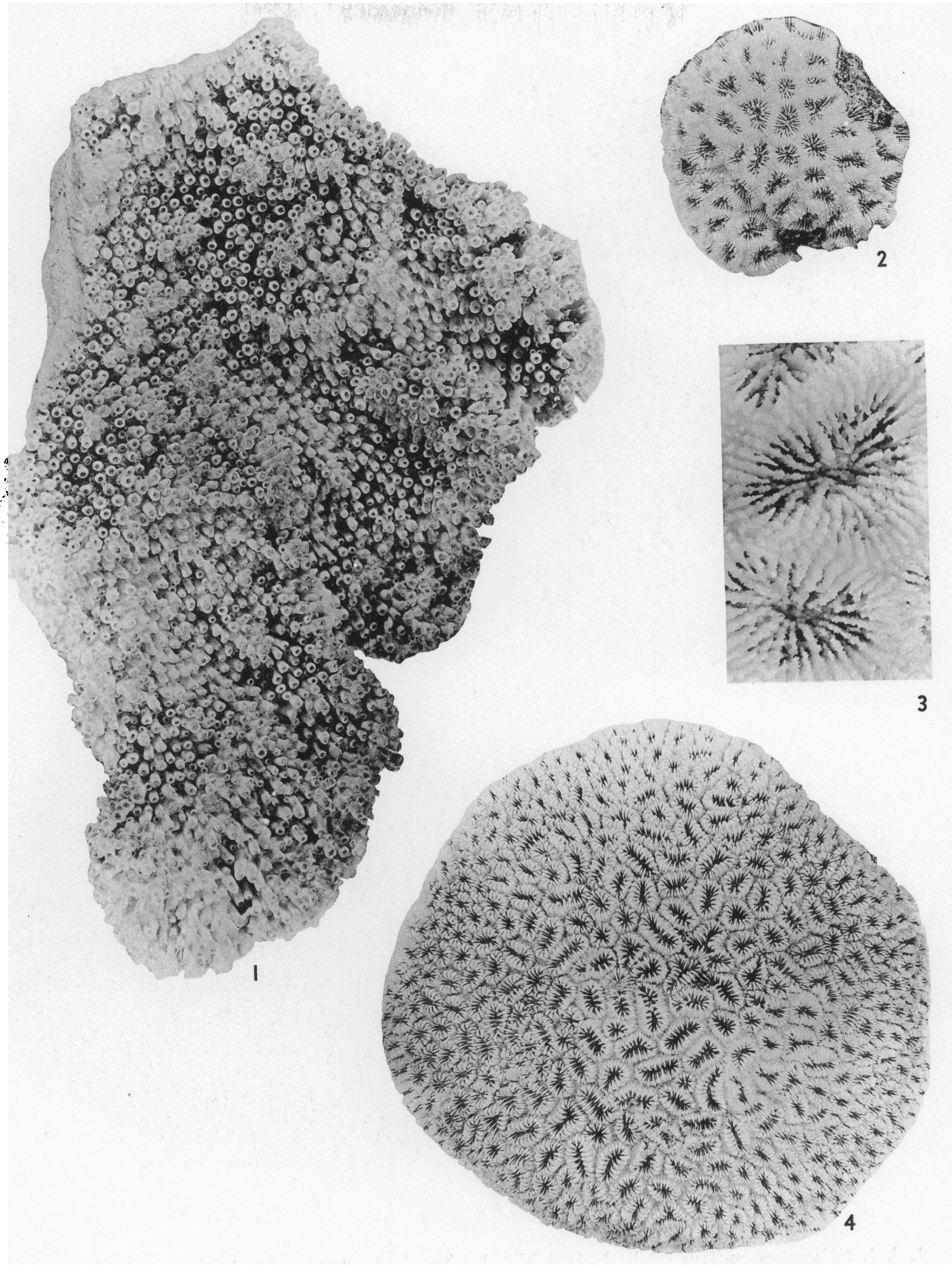
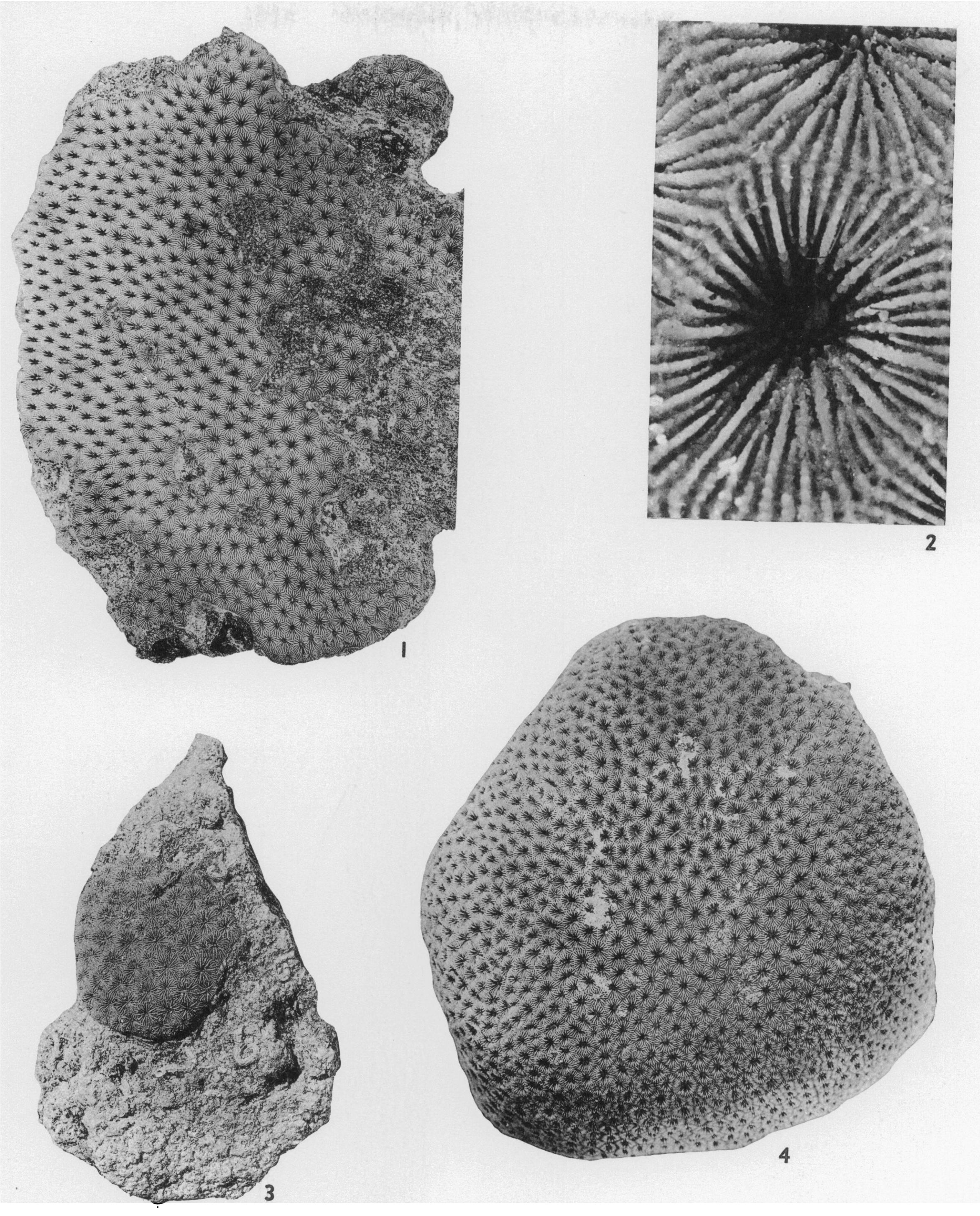
1, 2. *Agaricia agaricites* (Linnaeus). 1. A.M.N.H. No. 3297, calices, × 10. 2. A.M.N.H. No. 3297, corallum, × 1

3. *Agaricia agaricites* var. *crassa* Verrill. A.M.N.H. No. 3296, corallum, × 0.8

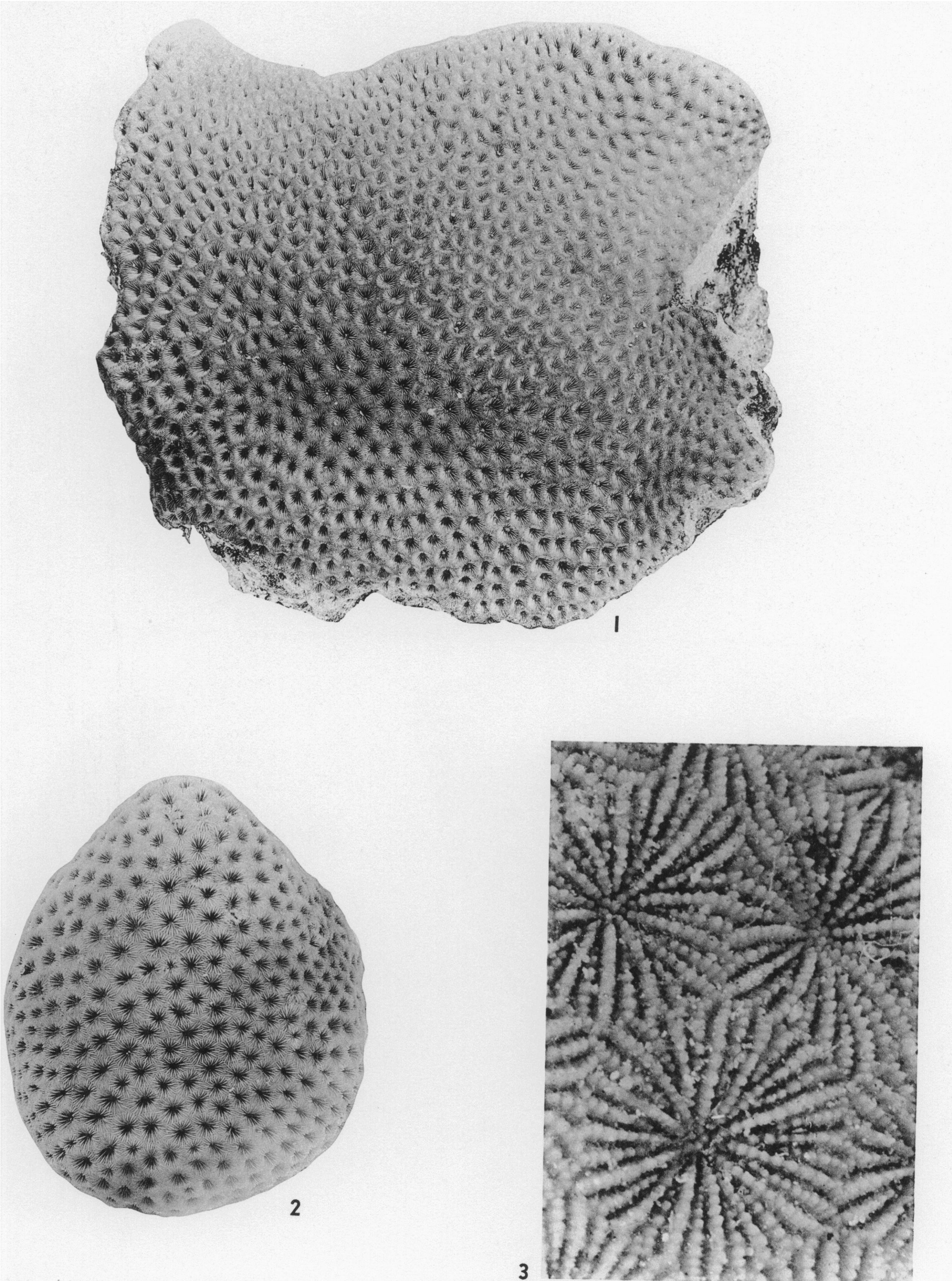


1. *Acropora palmata* (Lamarck). A.M.N.H. No. 3282, corallum, × 1
2, 3. *Favia fragum* (Esper). 2. A.M.N.H. No. 3287, corallum, × 1. 3. A.M.N.H. No. 3287, calices, × 10
4. *Dichocoenia stokesii* Milne-Edwards and Haime. A.M.N.H. No. 3284, corallum, × 0.625

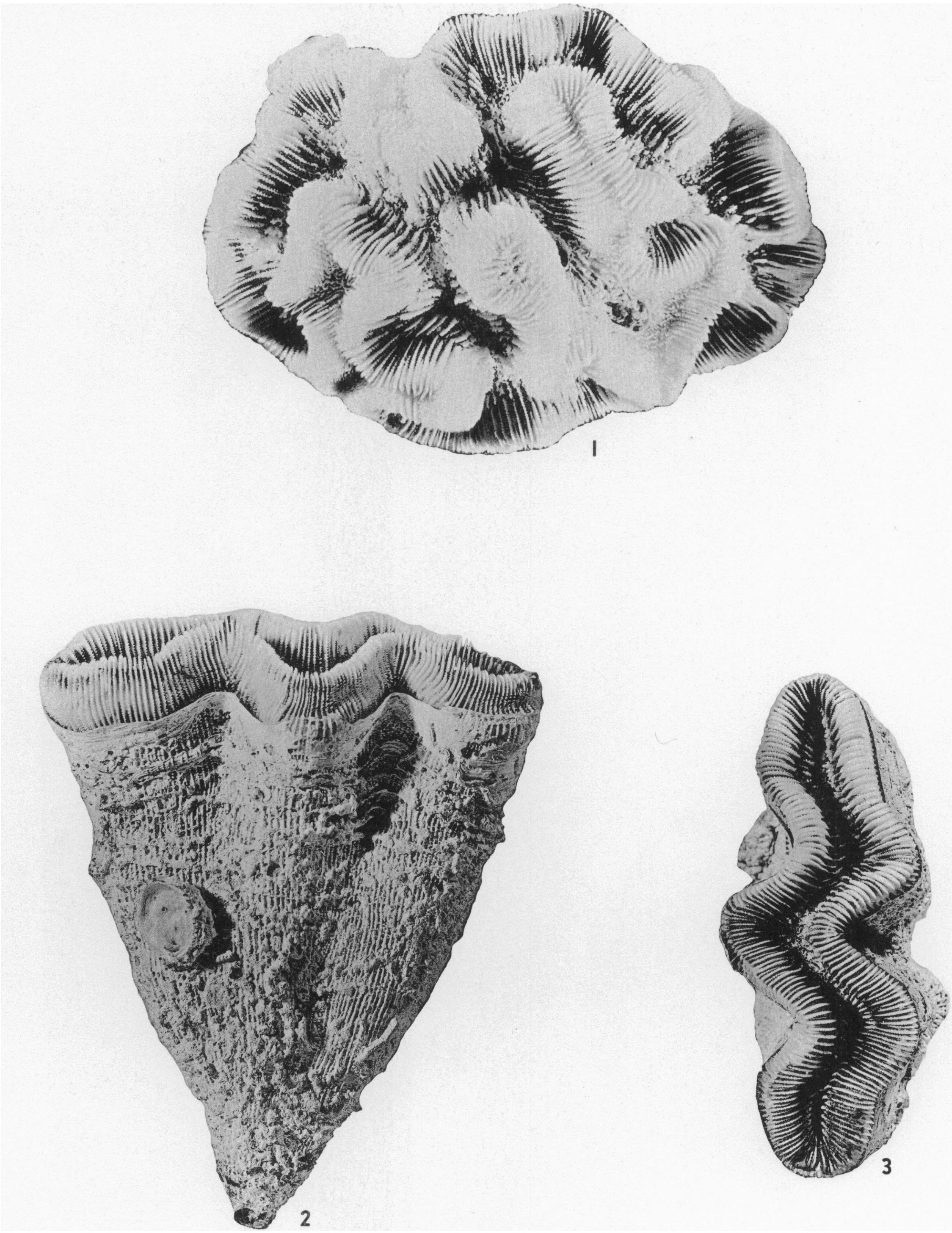


1, 3, 4. *Siderastrea radians* (Pallas). 1. A.M.N.H. No. 3308, corallum, × 1. 3. A.M.N.H. No. 3314, corallum, × 1. 4. A.M.N.H. No. 3311, corallum, × 1

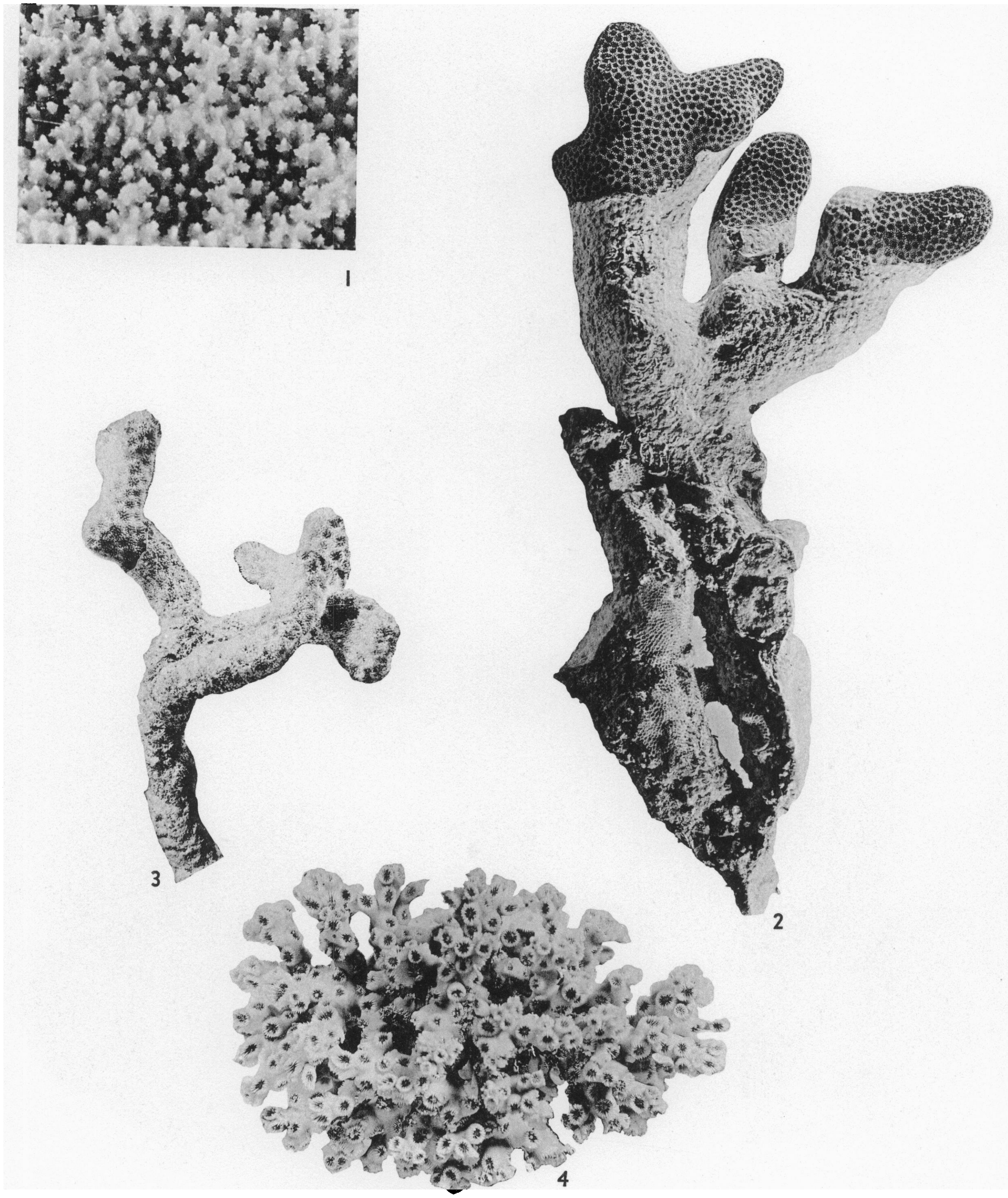
2. *Siderastrea siderea* (Ellis and Solander). A.M.N.H. No. 3313, calices, × 10



1. *Siderastrea siderea* (Ellis and Solander). A.M.N.H. No. 3313, corallum, × 0.75
2, 3. *Siderastrea radians* (Pallas). 2. A.M.N.H. No. 3307, corallum, × 1. 3. A.M.N.H. No. 3307, calices, × 10



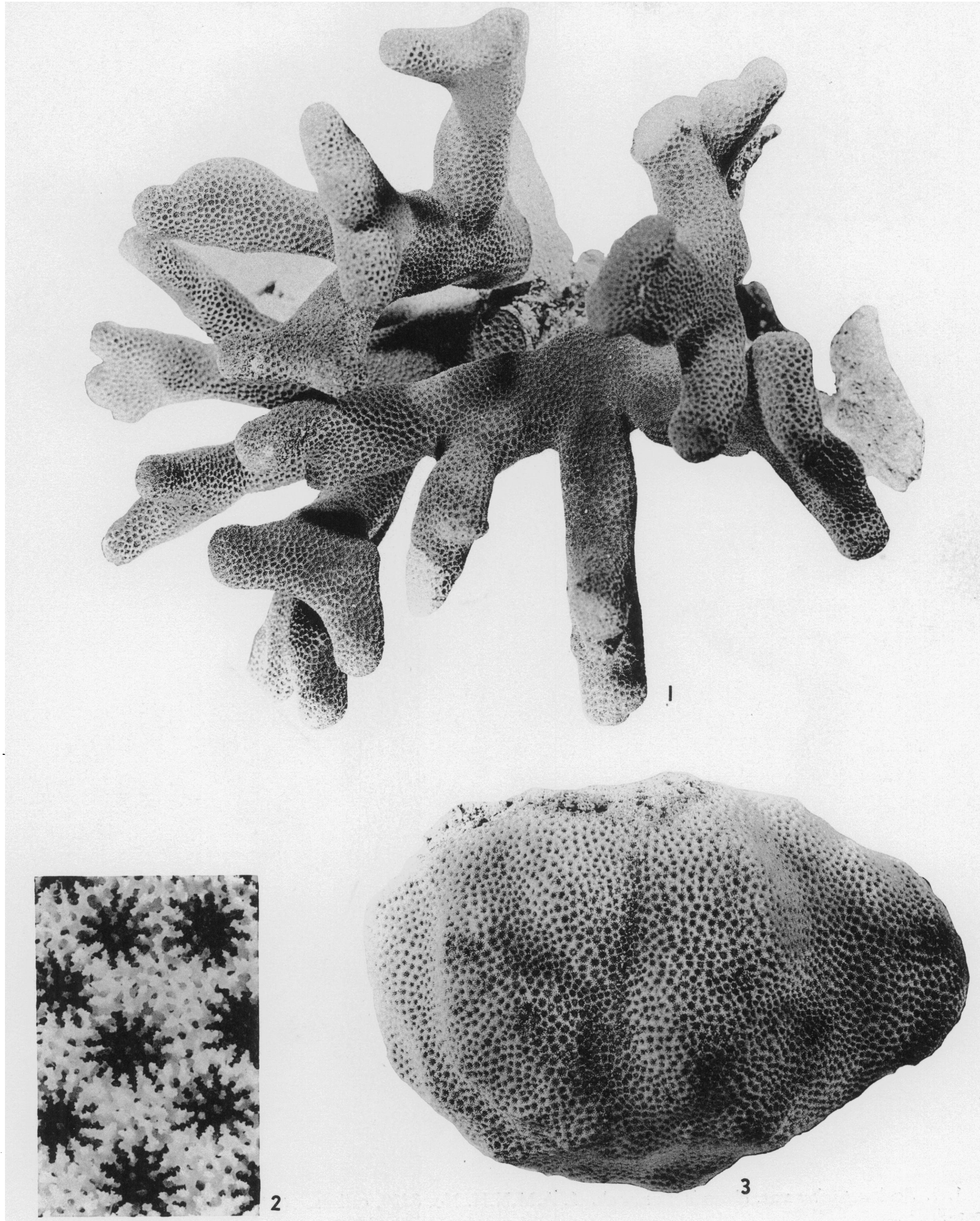
1–3. *Manicina areolata* (Linnaeus). 1. A.M.N.H. No. 3334, corallum, × 1. 2. A.M.N.H. No. 3335, corallum, × 1. 3. A.M.N.H. No. 3335, calice, × 1



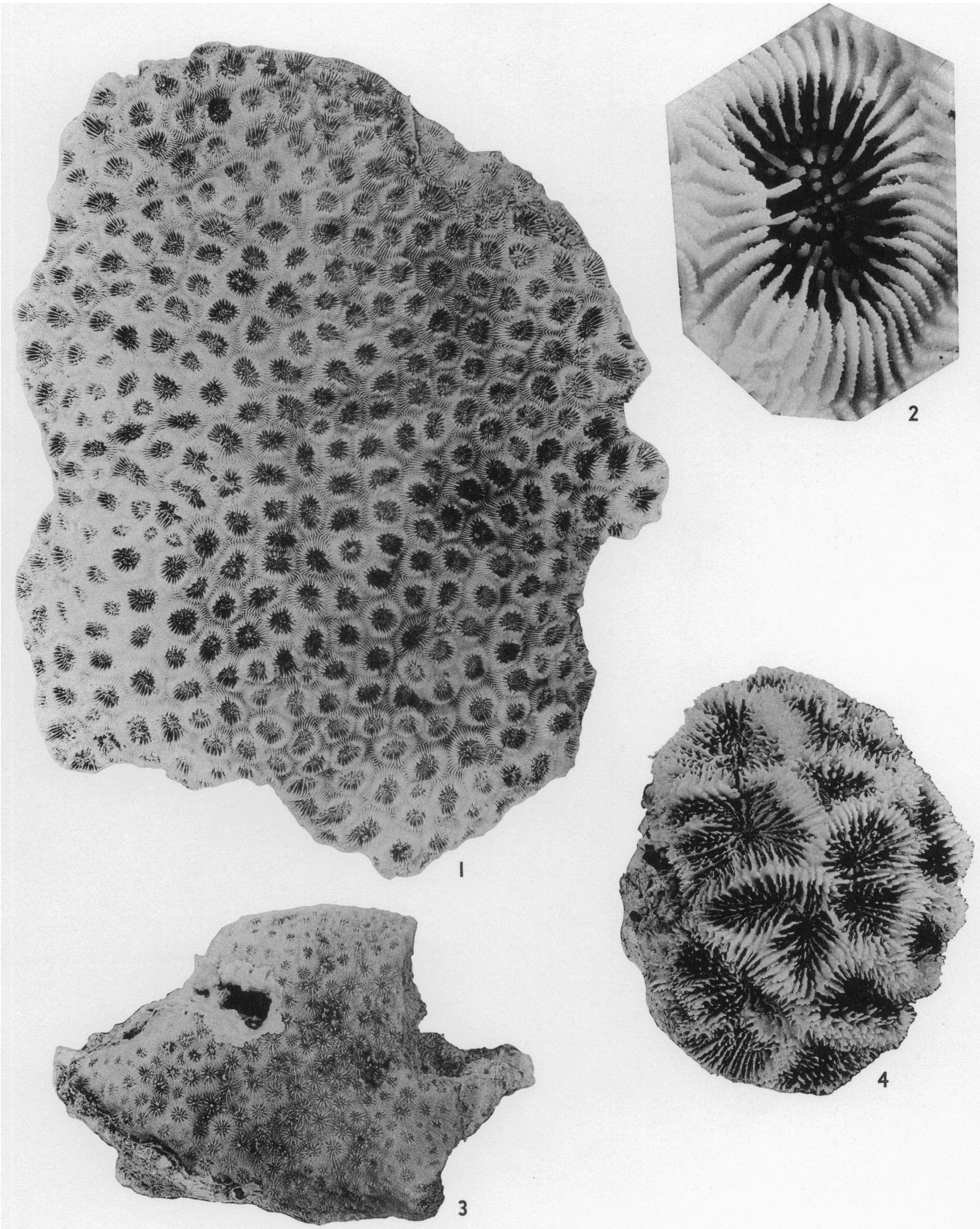
1, 2. *Porites porites* var. *clavaria* Lamarck. 1. A.M.N.H. No. 3329, calices, × 10. 2. A.M.N.H. No. 3329, corallum, × 1

3. *Porites porites* var. *divaricata* Lesueur. A.M.N.H. No. 3331, corallum, × 2

4. *Oculina diffusa* Lamarck. A.M.N.H. No. 3291, corallum, × 1



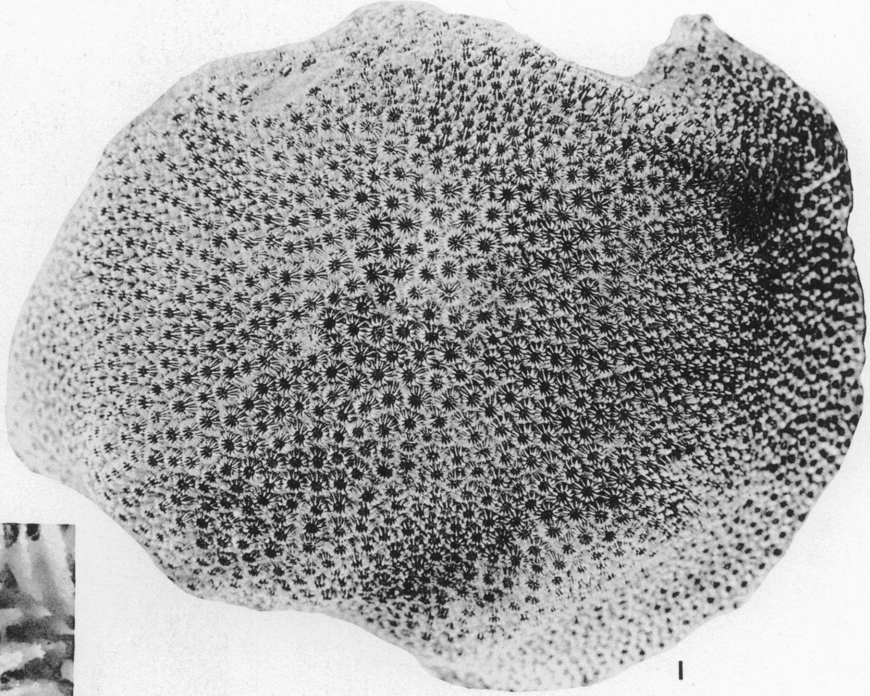
1. *Porites porites* var. *furcata* Lamarck. A.M.N.H. No. 3322, corrallum, × 1
2, 3. *Porites astreoides* Lamarck. A.M.N.H. No. 3319, calices, × 10. 3. A.M.N.H. No. 3319, corallum, × 1



1, 2. *Montastrea cavernosa* (Linnaeus). 1. A.M.N.H. No. 3289, corallum, × 0.75. 2. A.M.N.H. No. 3289, calice, × 10

3. *Montastrea annularis* (Ellis and Solander). A.M.N.H. No. 3294, corallum, × 1

4. *Isophyllia sinuosa* (Ellis and Solander). A.M.N.H. No. 3305, corallum, × 1



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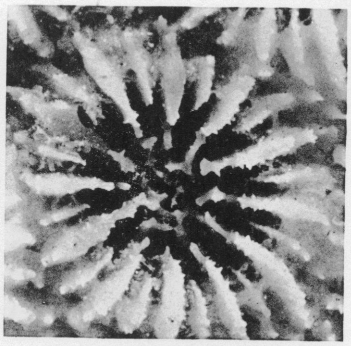

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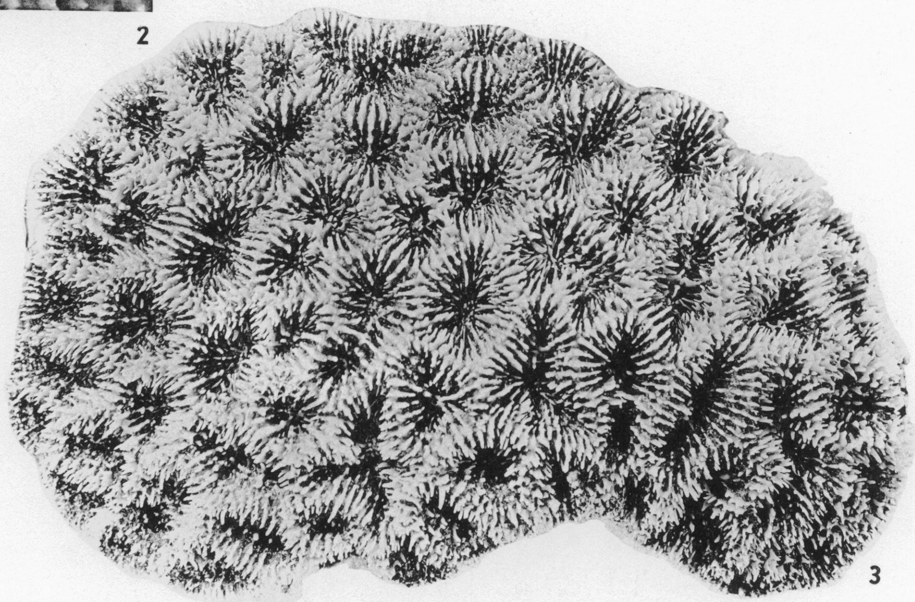

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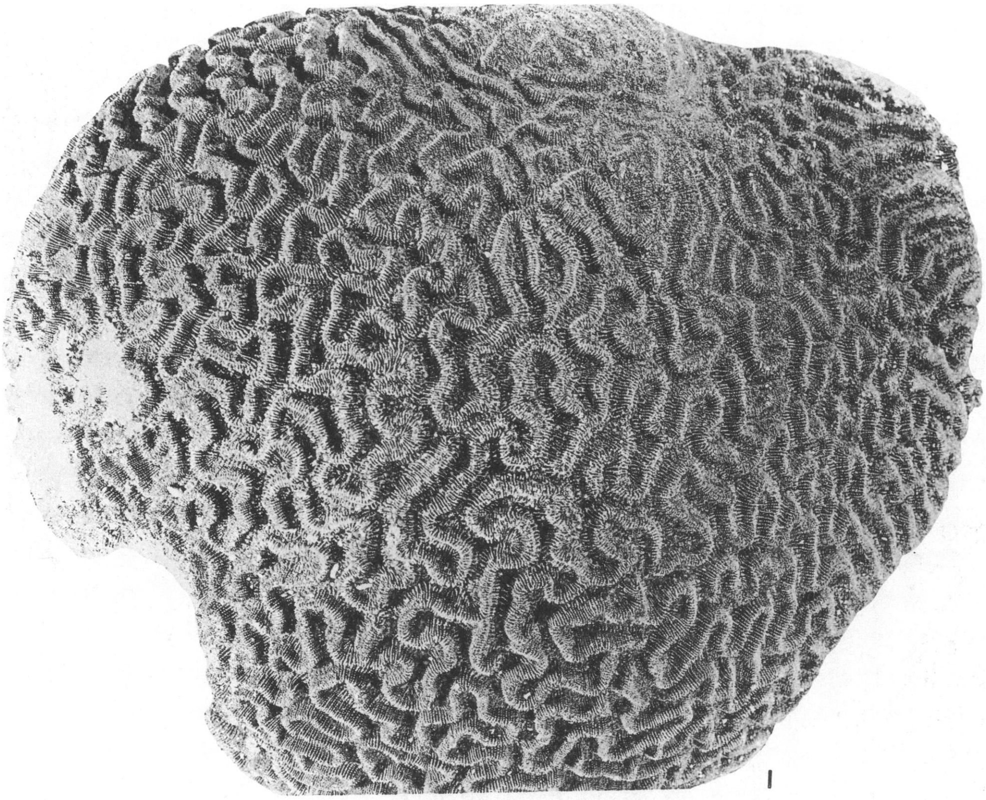
1, 2. *Montastrea annularis* (Ellis and Solander). 1. A.M.N.H. No. 3292, corallum, × 0.75. 2. A.M.N.H. No. 3292, calice, × 10

3. *Isophyllastrea rigida* (Dana). A.M.N.H. No. 3302, corallum, × 1



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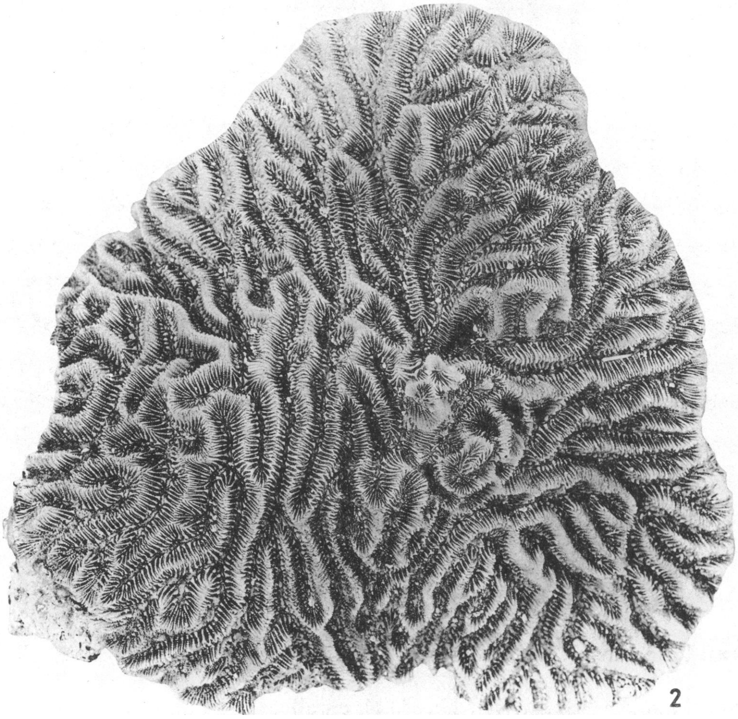

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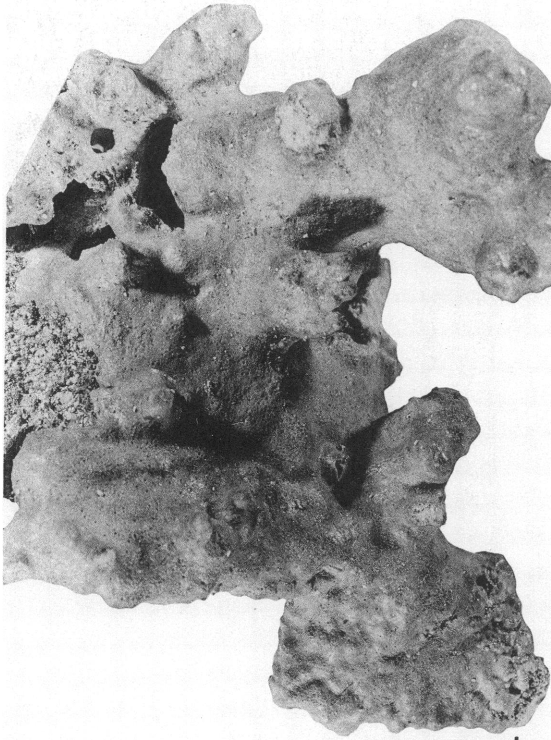
1. *Diploria strigosa* (Dana). A.M.N.H. No. 3316, corallum, × 0.5
2. *Diploria clivosa* (Ellis and Solander). A.M.N.H. No. 3300, corallum, × 0.875



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1, 2. *Millepora alcicornis* Linnaeus. 1. A.M.N.H. No. 3338, corallum, × 1. 2. A.M.N.H. No. 3337, corallum, × 0.9

3. *Millepora complanata* Lamarck. A.M.N.H. No. 3339, corallum, × 1