JELLYFISHES AND RELATED ANIMALS

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INTRODUCTION

Jellyfishes or, as they are often called, "sea nettles" belong to a very large and complex group, or phylum, of animals which scientists call Coelenterata. This name is derived from the two Greek words "coel," meaning "hollow," and "enteron," meaning "gut," and refers to the fact that the main cavity of the body of these animals is the digestive one.

Coelenterates are classified among the lowest many-celled animals because they are without many organs and tissues, which characterize the higher forms. The most familiar examples of Coelenterata are jellyfishes, hydroids, sea anemones, corals, and sea fans. Some coelenterates are stationary; of these some branch like plants, some move about by the aid of tentacles, some by vibrating cilia, and others by the contraction and expansion of their soft bodies.

Coelenterates are aquatic animals. The majority of them are marine, but several fresh-water forms are also known. Until the middle of the eighteenth century little exact knowledge was available regarding the structure of coelenterates and their position in the animal kingdom. They were considered either plants or plant-animals. Often they were regarded as the connecting link between plants and animals. Towards the end of the eighteenth century, however, the animal nature of coelenterates was definitely proven.

Coelenterates possess two distinctly different types of structures. They are (1) the hydroid or polyp type and (2) the medusa or jellyfish type. The first type is seen in

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its simplest form in the very common fresh-water animals called hydra, and hydropolyps, and in more complex forms in the corals. In all these animals the body is cylindrical in form, one end usually being attached to some more or less stationary object, while at the other end is the mouth surrounded by tentacles. The second, or the medusa type, is found in jellyfishes. In this case the body is more or less cup-shaped, the convex side corresponding to the attached end of the hydroid polyp, while from the center of the concave side extends the manubrium, a more or less cylindrical projection, at the end of which is the mouth. Tentacles may be present either on the manubrium, at the edge of the cup, or on the convex or concave surfaces of the animals.

STINGING CELLS OR NEMATOCYSTS

The presence of jellyfishes in the water near bathing beaches is undesirable because some of them, coming in contact with the human body, may sting and irritate the skin. The stinging is caused by highly specialized stinging capsules called nematocysts, of which there are several varieties. The stinging capsules lie in special cells located in the outer layer of the jellyfish body. Very often they are found arranged in large groups. A nematocyst is oval in shape. It has an outer capsule provided with a short trigger hair, or cnidocil, at the free end, close to the apical opening. This opening is closed by a special plug. Within the outer capsule is an inner capsule containing a spiraled filament. This filament is a hollow tube, its wall being continuous with that of the inner capsule. When the cnidocil, or trigger hair, comes into contact with an object, or when the jellyfish receives a chemical stimulus, the nematocyst "explodes," i.e., the coiled filament is quickly discharged through the apical opening. The end of the filament, which is armed with several minute barbs, penetrates the body touching the jellyfish.

In addition to purely mechanical injury caused by penetration of the barbed filament, a chemical irritation is also produced by minute quantities of a poisonous substance found in the threads. The nematocysts of jellyfish and other coelenterates serve both as organs of defense and for the purpose of stunning or killing the small animals which form the food of the sea nettles.

The "sting" of the majority of the coelenterates is not perceptible to man. This is especially true of numbers of Hydrozoa, which may be handled with impunity, with the exception of the Milleporina, or Siphonophora, an order containing free-floating communities of hydroids. The millepores, however, and some other corals, as well as gorgonians (sea fans), produce a stinging sensation of short duration. The sponge divers of the Mediterranean are said to suffer greatly from skin lesions and deep wounds of the hands caused by an anemone that lives among the sponges.

Most Scyphozoa, or true jellyfishes, are harmful and should be approached with caution. *Cyanea*, a common jellyfish of American shores, may cause dangerous burns. The most dangerous Scyphozoa are *Dactylometra* and *Chiropsalmus*, inhabitants of warmer waters, whose sting can cause very serious illness or even death. Probably the most dangerous coelenterate is *Physalia* (Portuguese man-of-war), a hydrozoan. The injuries from the last three coelenterates range from a burning pain at the site of contact to skin lesions and eruptions, often severe enough to leave scars, to general pain, fever, prostration, and respiratory interferences.

The nature of the material injected from nematocysts is not known. Formerly it was believed to be formic acid, but recent studies on this subject do not support that conclusion.

The coelenterates are divided into three classes: Hydrozoa (hydralike animals), Scyphozoa (cup animals), and Anthozoa (flower animals). The following is a brief discussion of each of these classes.

HYDROZOA

Hydrozoa includes the fresh-water hydras, seaweedlike zoophytes, many jellyfishes, mostly of small size, and a few stony corals, which in some respects are different from other stony corals. This class contains over 3,000 species.

The vast majority of Hydrozoa are marine. The best known exception is *Hydra* which is found in fresh water and is cosmopolitan in its distribution. A few species of medusae also have been found in fresh or very brackish waters. Parasitism, although rare, is not unknown in this class. For example, *Polypodium*, one of the forms of this group, is parasitic during part of its existence in the ovaries of the sturgeon living in the Volga River.

Probably the most interesting group of Hydrozoa is found in the order Siphonophora containing free-floating colonies of hydroids. The genus *Physalia* of this order includes the famous Portuguese man-of-war. This animal, or rather colony, is perhaps the best known of the group, since it attracts much attention in southern waters. The most prominent part of the compound body is the float, an oblong, pear-shaped bag, full of air, which floats on the surface of the water. Its color is usually bright blue but sometimes it has different shades. On the upper side of this air-vessel is a crest, or sail, and from the underside hang long tentacles. Some of these tentacles are covered with stinging cells that can readily paralyze a large fish. Others have feeding and reproductive polyps. The tentacles can reach a remarkable length--up to 100 feet. They perform a number of functions, acting as anchors or changing the course of the animal. Ordinarily these long tentacles are more or less curled up under the air-bag protruding on the surface. The vivid blue float is a familiar and very beautiful sight on the surface of warm seas all over the world, but it is not very welcome to swimmers, who know that the trailing tentacles can inflict serious and sometimes fatal injuries.

Some forms of Hydrozoa, such as the hydras, reproduce sexually at certain times of the year, generally in the fall or winter. In some species both male and female cells occur in the same individual, which is then known as a hermaphrodite. In other species the two sexes are always separate. When the animals are ripe the eggs, in the case of females, and spermatozoa, in male individuals, are discharged in the surrounding water. When the egg and spermatozoon meet, the egg is fertilized and begins to develop into a hydra.

Sexual reproduction does not occur in hydroids, which are the nearest marine relatives of fresh-water hydras. Asexual reproduction by budding is the usual method of increasing their numbers. In old colonies of hydroids not all members of the colony, the so-called "polyps," are alike. Some are reproductive polyps and are designated for a special type of asexual reproduction.

Each reproductive polyp is enclosed by a transparent, horny, vase-shaped covering and consists of a stock on which are borne little saucerlike buds. The largest and most completely developed buds are near the top, while the smallest and least developed are found near the base. If the colony is kept in a dish of sea water, it will be easy to observe that the topmost "saucer" escapes through the opening at the upper end of the vase-shaped covering and swims about as a tiny animal, which is called a medusa, the name often applied to any free-swimming jellyfish type of coelenterate.

The primary function of the medusa is sexual reproduction. When the medusa has matured, the eggs and sperm are shed in the water where fertilization takes place (fig. 1). The fertilized egg undergoes gradual development into a ciliated larva. The larva swims about for a time, finally settles on a rock or on a piece of kelp, becomes fastened at one end, develops tentacles around the mouth at the other end, and grows into a polyp which, by asexual budding, produces a new colony of sessile hydroids. The life cycle is thus completed. This process is known as "alternation of generations." The most familiar example of this type is the *Obelia*, a common zoophyte, occurring in the form of a delicate, whitish or light brown, almost furlike growth on seaweeds, the wooden piles of docks, etc.

Not all Hydrozoa are of the above type. In some forms there is no medusa stage. In others there is no hydroid stage, the animal always being a free-swimming medusa.

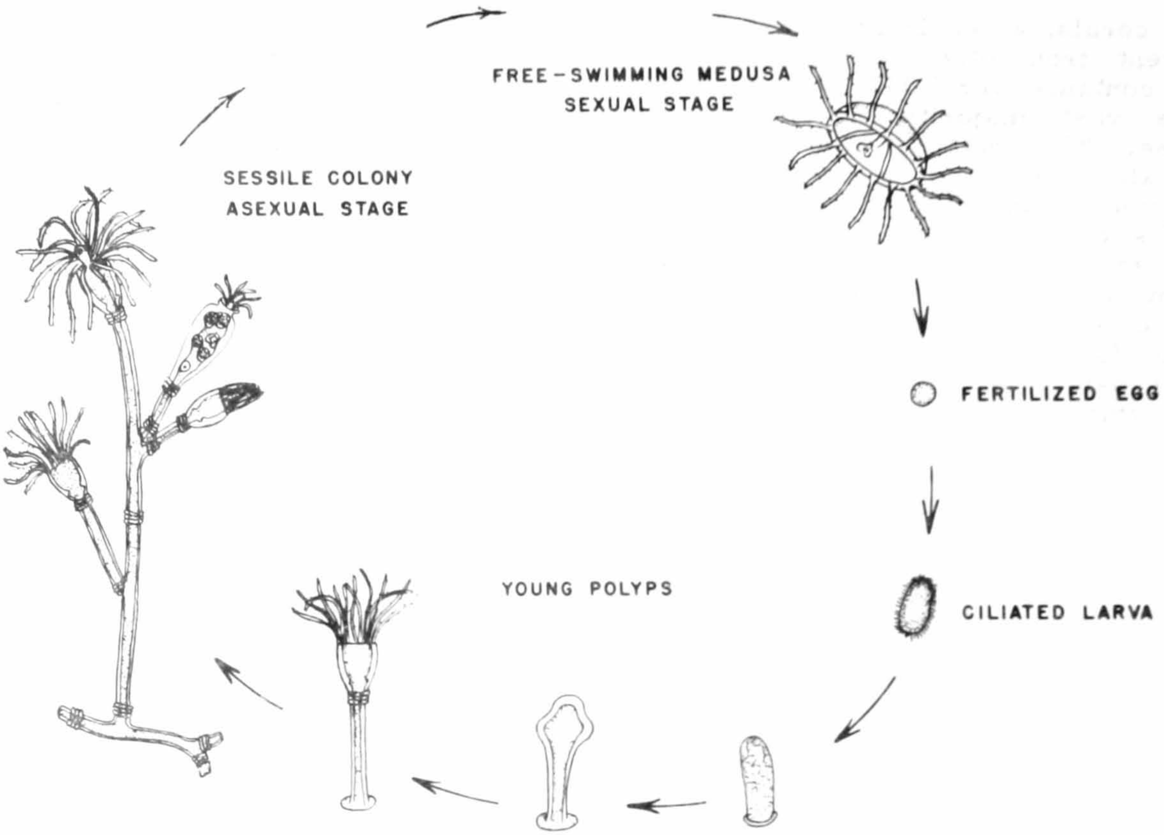

Figure 1.--Life cycle of *Obelia*. Description in text.

SCYPHOZOA

The second class of coelenterates, Scyphozoa, includes the large jellyfishes. Scyphozoa are all marine and the majority are pelagic, i.e., they swim freely on the surface of the ocean. A few inhabit the deep sea and have been dredged from a depth as great as 2,000 fathoms. Nearly all are free-swimming in the adult stage; some, however, live on coral reefs or mud banks on the bottom of the ocean. The Scyphozoa class includes about 200 species.

Jellyfishes vary in size from a fraction of an inch to 12 feet in diameter. They differ in the number, size, and position of the tentacles, the position of the egg sacs, etc.; but the general plan of the internal structure is the same in all species. Many jellyfishes are semitransparent and glassy, but often with brilliantly colored tentacles, radial canals, and egg sacs (gonads). They are all carnivorous, mostly living on small organisms, but are able, in the case of the larger species, to digest crustaceans and fishes. The body of a jellyfish consists mostly of water; the solid matter usually does not exceed 1 percent. The life span of jellyfishes does not exceed 1 year. Even the giant *Cyanea*, which sometimes has discs 12 feet in diameter and trailing tentacles over 100 feet long, attains its immense growth in 6 months.

In Scyphozoa the sexes are separate. The gonads of the female produce eggs; those of the male, sperm. These sexual organs are usually very brightly colored. The eggs in the female are fertilized in the large central cavity by sperm which enter the body of the female with currents of water (fig. 2). The fertilized egg (fig. 2A.) begins to divide (fig. 2B.) and develops into a ciliated larva called "planula" (fig. 2C.). It is a transparent sphere covered with hairlike structures by means of which it swims about for some time after leaving the body of the mother jellyfish. Finally, it attaches itself to some object and becomes a young polyp (fig. 2D.). It continues to

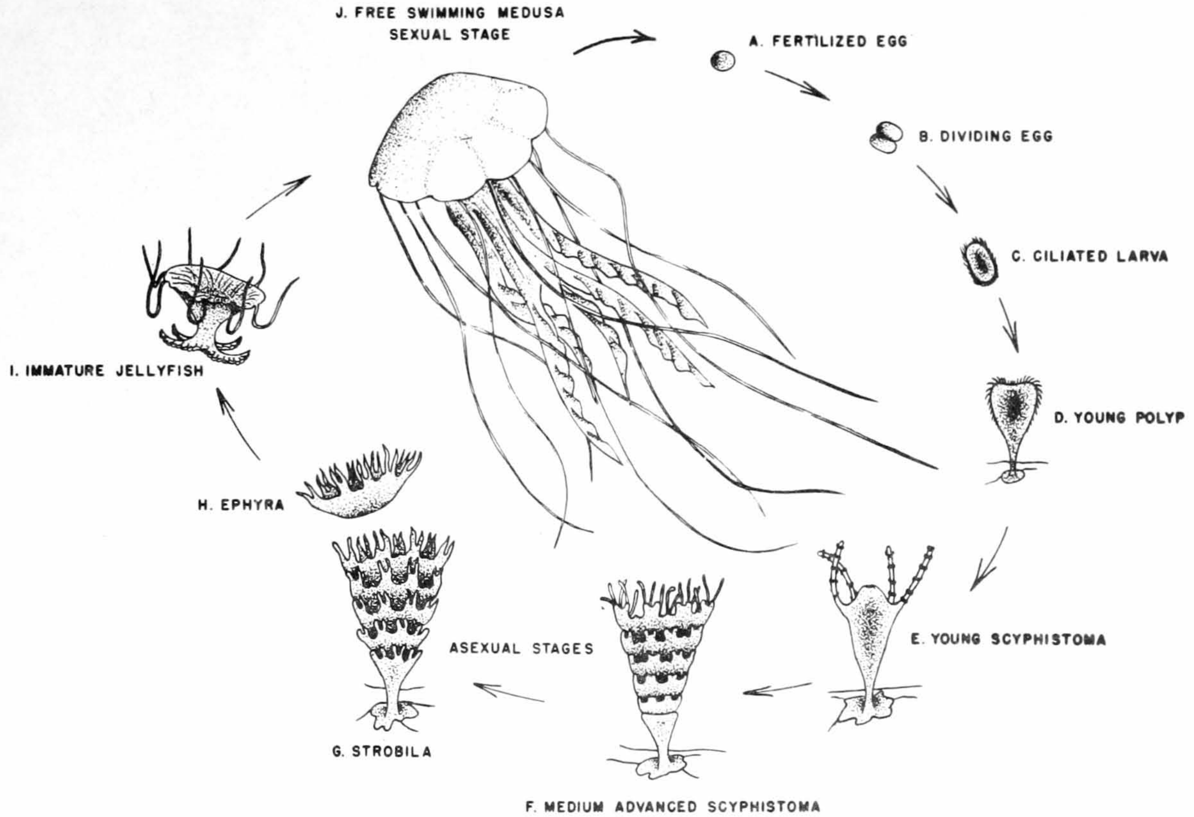

Figure 2.--Life cycle of *Aurelia*. Description in text.

grow and acquire a more elongated form with tentacles, a stage known as "scyphistoma" (fig. 2E.). At certain seasons these polyps develop a series of horizontal constrictions which gradually deepen until the polyps begin to resemble a series of saucers piled one on top of the other (fig. 2F.). In the late stages of this development polyps are called "strobila" (fig. 2G.). Each of these saucers, beginning with the topmost, is finally detached and becomes a free-swimming premedusa form known as "ephyra" (fig. 2H.). Sometime later ephyra develops further into an immature jellyfish (fig. 2I.) and eventually becomes a mature, free-swimming medusa ready for sexual reproduction again. There are some species, however, which have neither a hydroid nor strobila stage and which mature without an alternation of generations.

Aurelia is one of the commonest of the scyphozoan jellyfishes and occurs all over the world. Large schools can be seen drifting along together or swimming slowly by rhythmic contraction of their saucer-shaped body (fig. 3). They range in size from less than 3 inches to about 12 inches across the bell. These jellyfishes may be called annual animals, for they make their appearance regularly as free-swimming medusae in the latter part of April, when they may be seen in large numbers. At that time they are only about 1 inch in diameter. However, they grow rapidly and by the end of June attain full size. At the end of July, when they are fully developed, they begin to discharge their eggs. After the spawning period the jellyfishes appear to be exhausted and die later in the year.

The genus *Cyanea* is another well-known group of this class. It contains the largest jellyfish known. As mentioned previously, some individuals measure 12 feet across the disc and have tentacles about 100 feet long. *Cyanea* is usually

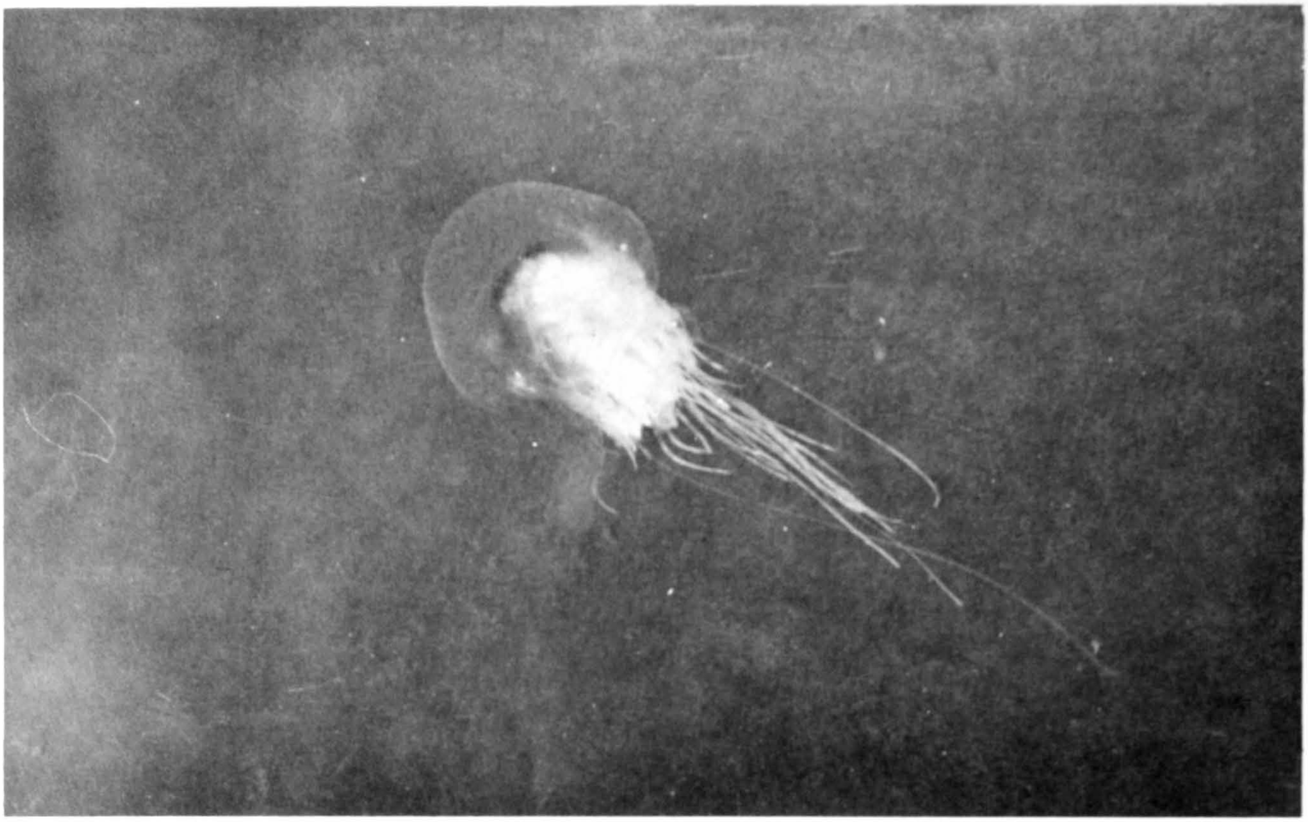

Figure 3.--A typical free-swimming medusa.

solitary, seldom being seen in company with others. The common name for *Cyanea* is sun jelly or sea blubber.

The stinging capsules of *Aurelia* do not readily penetrate the human skin, but even a small *Cyanea* can raise huge welts on the arms or legs, and the monster orange and blue *Cyanea* of the North Atlantic is a real danger to swimmers.

ANTHOZOA

The third class of coelenterates, the Anthozoa, contains the sea anemones, the stone or reef corals, and the less conspicuous forms, such as gorgonians or sea fans, and sea whips. In general, this class consists of animals which have no jellyfish or medusa stage. It contains over 6,000 species.

Sea anemones are probably the most common representatives of Anthozoa. They vary greatly in color and form, and when expanded resemble flowers. They are cosmopolitan in their distribution, but larger and more highly colored species are found in tropical waters. Many of the species are found in tidepools and on piling of wharfs and bridges at the low-water mark. Others have been dredged from depths of 10 to 2,900 fathoms. The majority of the sea anemones are attached but are able to change their location. Some forms swim when they are young, but in the adult stage they burrow in the sand or mud leaving only their tentacles exposed. The sea anemones reproduce from the eggs and pass through a larval stage. At the end of the free-swimming period the larvae attach themselves to solid objects and grow into adult individuals. Reproduction by budding or fission is also common (fig. 4).

Figure 4.--A typical sea anemone, *Metridium dianthus*, in the process of fission.

The sea anemones are carnivorous and very voracious. They feed on small organisms. To secure their prey they are armed with an abundant supply of stinging cells located under the tentacles, and also with stinging threads which are ejected from their bodies.

The genus *Metridium* contains the best known species of sea anemones. It is common along our shores and is found near the low-water mark in tidepools and in sheltered crevices of rocks. Some of the species found in Florida are 18 inches in diameter. When irritated many of the species throw out long slender white threads, which are covered with stinging cells. These organs of defense protect the animals from attack by many enemies.

The stone or reef corals, the second well-known group of Anthozoa, resemble sea anemones in their general structure, but are usually colonial and secrete protective limestone cups into which the small delicate animals can retreat (fig. 5). They have a wide distribution, but the number of forms in temperate regions is small.

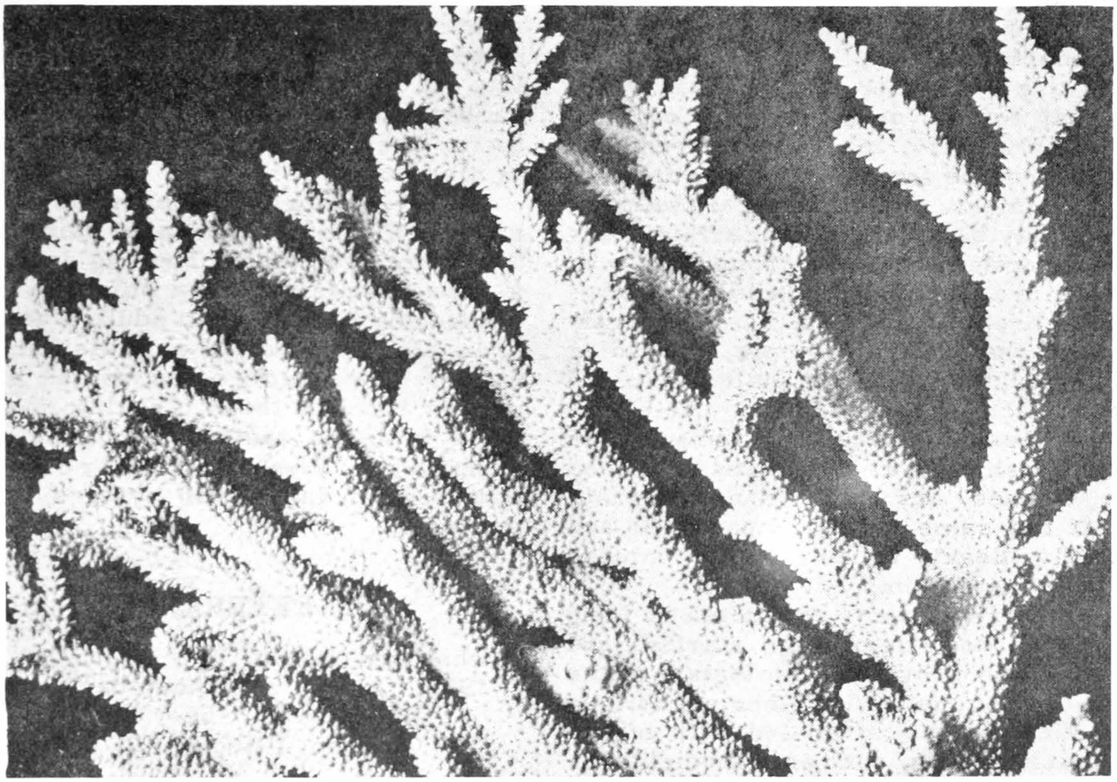

Figure 5.--Stony coral, *Isopora muricata,* from Dry Tortugas, Florida.

The majority, including stone or reef building corals, are confined to tropical parts of the Atlantic, Indian, and Pacific Oceans, flourishing only when the lowest winter temperature does not drop below 68° F. Many of the Pacific Islands are formed entirely of coral rock. The Great Barrier Reef of Australia, extending for a distance of 1,250 miles, consists of gigantic masses of coral rocks fringed by living corals. Some of them are considered precious and command quite a high price.

CONTROL OF JELLYFISH

In the summer, jellyfish are abundant along the shores of our Middle Atlantic States, and their presence, at times, prevents people from swimming. Unfortunately, so far, no satisfactory method has been developed for their control or eradication. The practice of fencing off swimming areas with small mesh wire netting was tried in several localities. However, since small jellyfish can easily squeeze through the netting, and because fragments of their bodies, broken by contact with the wire netting, can also easily enter fenced off areas, the method is often ineffective.

Recently, experiments have been conducted to keep jellyfish from entering bathing areas by creating in the water a wall of air bubbles released from perforated hoses laid on the bottom. The results of these efforts have not been thoroughly evaluated as yet. It appears, nevertheless, that during periods of relatively strong winds, or in areas where tidal currents are strong, this method cannot stop jellyfish or parts of their bodies from entering bathing beaches.

There are a number of chemicals which are known to kill jellyfish, but most of them, unfortunately, may also injure other important marine forms or may be dangerous to swimmers. Some chemical methods, however, may be applicable in certain areas where currents are not strong and will not, therefore, bring new masses of jellyfish into areas that have been recently cleaned of them. For example, spreading finely granulated, hot lime (calcium oxide) on the surface of the water may be effective. Particles of lime falling upon surfaces of the jellyfish bodies will become imbedded in the tissues and quickly disintegrate them. At the same time, the particles are sufficiently heavy to carry the injured jellyfish to the bottom.

In recent experiments conducted in Long Island Sound to exterminate starfish and other enemies of oysters, biologists of the Bureau of Commercial Fisheries noticed that particles of sand coated with highly insoluble chemicals, such as orthodichlorobenzene, also quickly killed jellyfish and carried them to the bottom. These experiments and observations may suggest a clue for the control of jellyfish. Perhaps spreading sand alone on the water surface will be sufficient to sink jellyfish to the bottom, thus clearing the areas of their presence. This method may be especially suitable where currents are slow and, therefore, no new masses of jellyfish will quickly reinvade the cleared areas.

CTENOPHORA

Another group of animals, which resemble jellyfishes in general appearance, was formerly included with coelenterates, but is now classified in the separate phylum Ctenophora. The name of the phylum means "comb-bearers" because of the rows of flat cilia, arranged as the teeth of a comb, along eight meridional lines over the surface of the animal. These animals are commonly known as "sea gooseberries" or "sea walnuts." The phylum Ctenophora consists of about 100 species, 21 of which occur off the Atlantic coast. In this group the stinging cells are replaced by adhesive cells which stick to, and entangle the prey.

The ctenophores are transparent, gelatinous creatures, which float on the surface of the sea mostly near shores. Being feeble swimmers they are carried about by currents and tides so that they often accumulate in vast numbers in some bays or harbors where winds and tides have driven them. They are widely distributed and found in all seas.

The ctenophores are hermaphroditic, both male and female sex cells being found in the same individual. The egg develops into a free-swimming larva which, in turn, develops directly into an adult. They subsist upon small plants and animals found in sea water, which enters the bodies of ctenophores through their circulatory systems. It is believed that at least one genus of ctenophores, *Mnemiopsis*, destroys large numbers of larvae of oysters and other mollusks.

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