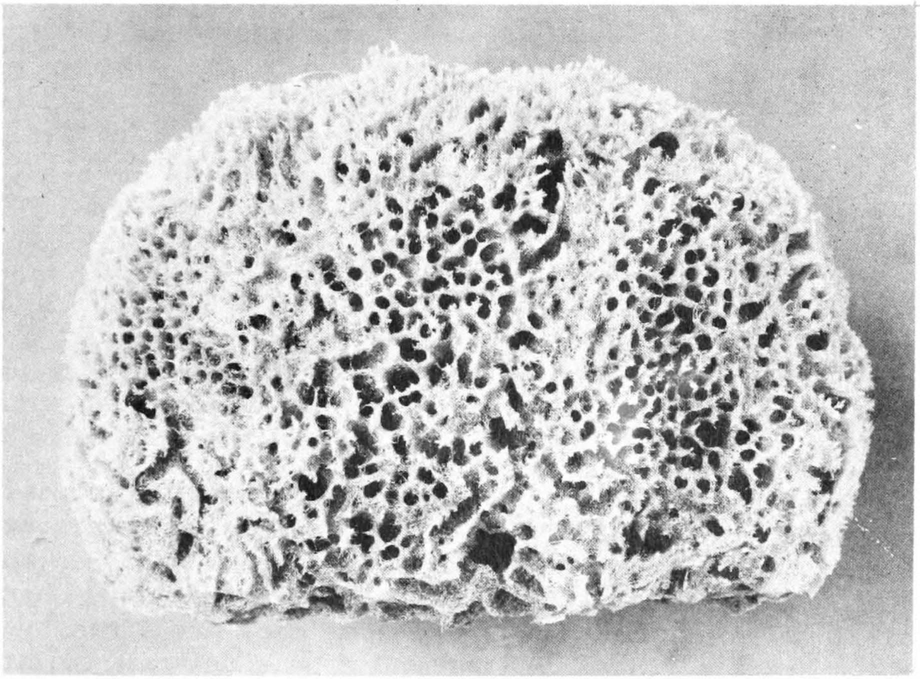
58

FL 490

SPONGES

by Paul S. Galtsoff

Fishery Research Biologist
Woods Hole, Massachusetts



When walking along the sea beach or wading through shallow water your attention may have been attracted by odd-shaped objects that looked like strange plants. These objects may have been sponges, the most primitive multicellular creatures of the animal kingdom. This superficial similarity to plants fooled the zoologists for a long time until the French scientist Dujardin, in 1841, established their true animal nature. Since the sponges are cell-colonies in which the individual units retain a great deal of independence from the whole, their organization is an exciting object of research for a biologist. The cells of a sponge form three principal systems of organs: very small flagellated chambers, fairly large canals, and the skeleton consisting of spicules and fibers which make up most of the body. The

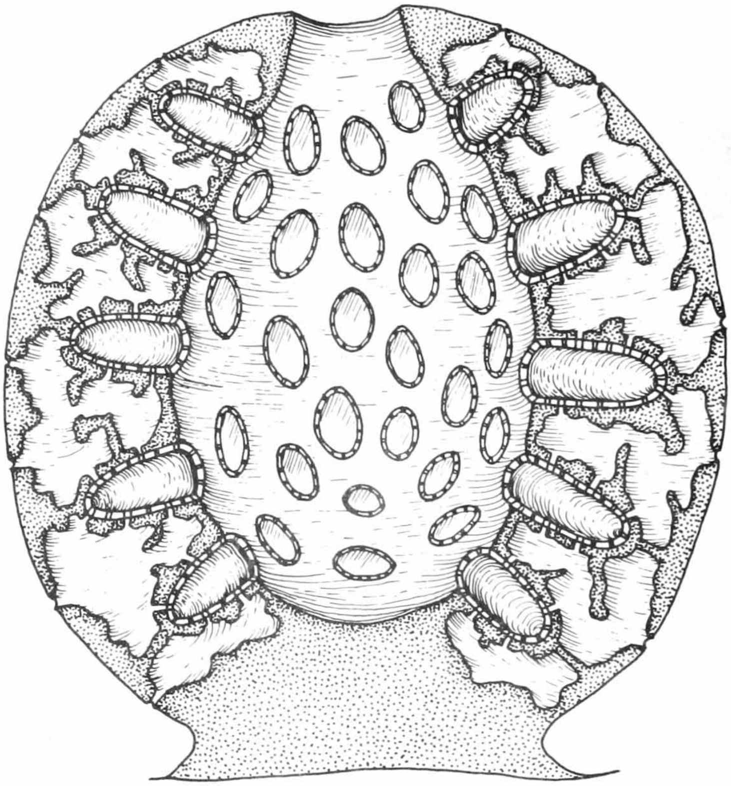


Figure 1.--Diagram of a structure of a simple sponge seen in longitudinal section. Small pores on the surface lead to flagellated chambers which through a system of canals open into a common large space from which water is discharged through an "osculum" on the top.

simplest sponge may be likened to a vase whose surface is pierced by many tiny holes or pores (fig. 1). The spicules and fibers are joined together in a complex framework which supports the soft and rather loosely connected tissues. The round or oval flagellated chambers are the principal units of the sponge organism; they are lined by cells each of which bears a flagellum surrounded by a delicate collar (fig. 2). By the action of the flagella, water is sucked in through the pores into the chambers and is expelled through a wide opening called the osculum (fig. 1). Food brought in with the water is captured by the collar cells and is ingested. Some species have large branching bodies with many oscula while others are more compact and have only one opening on the top. Sponges have no heads or tails, possess no legs, tentacles, or other appendages which may serve as organs of locomotion, and have neither sense organs nor central nervous systems. Many species of sponges grow as irregular masses in which no single individual can be discerned.

The thousands of species of sponges are found under a great

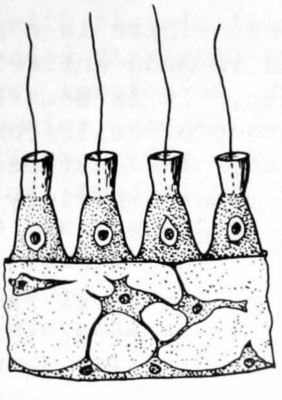


Figure 2.--Cells each bearing a flagellum surrounded by a collar line the flagellated chambers. Highly magnified.

variety of conditions. From the equatorial waters to the cold polar seas they grow prolifically along the shores, where they are continually subjected to violent action of waves and surf. They are equally abundant in the placid, cold, and dark waters of the profoundest oceanic abysses. They thrive in mud and sand, or grow attached to the stems and leaves of marine algae. Some of them incrust the rocks and penetrate narrow crevices while others burrow in the shells of mollusks and destroy them. In size the sponges vary from a small fraction of an inch to several feet in diameter. Their appearance is as diversified as their habitat. Some of them, when examined alive, appear to be nothing but insignificant patches of slimy, grayish substance, while other expand their brightly colored branches over large areas. Red, orange, violet, or yellow, they stand out against the whiteness of the sand or are projected on the greenish background of rocks and look like fantastically beautiful shrubbery planted by an unknown hand in a submarine garden. Judging by the very large number and variety of fossil forms occurring in every horizon, sponges seem to have been at all times equally abundant and widely spread, equally plastic and adaptable, from the earliest geological ages to the present.

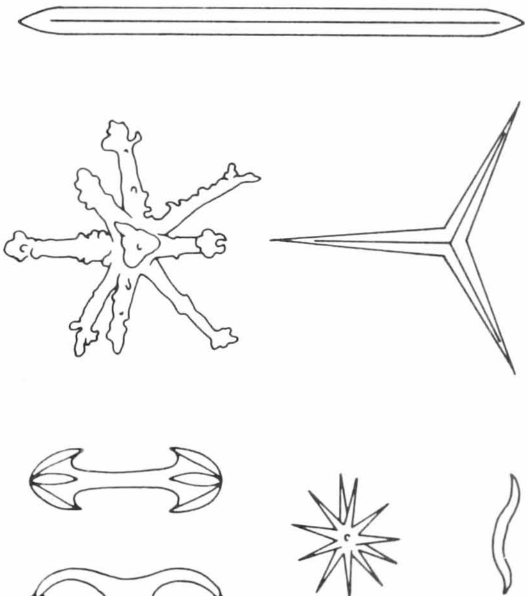


Figure 3.--Several types of spicules which form sponge skeletons. Highly magnified.

It is difficult for a layman to recognize different species of sponges, since their general appearance does not give a clue to their identity. Classification is based on sponge anatomy and on the structure of microscopic spicules which form the sponge's skeleton (fig. 3). There are more than a hundred different types of spicules which the scientists used to identify the sponges. Each spicule is produced by one or in some instances by several cells. It may be made either of lime or of silica, but the two minerals are never found in the same species. There is a group of sponges in which the skeleton lacks spicules and is made entirely of fibers consisting of organic material called spongin. It is remarkable how the spicules secreted by separate cells or a group of cells combine in a precise, geometrical pattern to form a skeleton. The most beautiful specimen which can be seen in our museums of natural history are the transparent, glassy skeletons of the deep-water sponges.

All sponges require large quantities of water for their respiration and feeding. It was found that some commercial sponges, about 6 inches in diameter, may pump over a hundred gallons of water an hour. Many other animals, such as worms, small shrimps, clams, and even fish, take advantage of the shelter and the currents of water and by the thousands infest and dwell within the body of a sponge without inflicting any injury to the host.

Reproduction

Many sponges grow like plants; they incrust the objects to which they are attached, form bulky and irregular masses, or develop large colonies consisting of many branches on the bottom of the sea. This type of reproduction is asexual. In fresh-water sponges it is modified by the formation of thick-walled bodies, called gemmules, which survive freezing, drying, and other unfavorable conditions. In the spring, the specialized cells of a gemmule give rise to a new sponge.

Sexual reproduction involves the formation of eggs and sperm. Eggs fertilized by the sperm released by a male sponge develop inside the body of a female until the larvae are formed and escape through the osculum. After a period of several days during which the larvae are carried by oceanic currents and may be transported some distance from the place of their origin, they settle on the bottom or on submerged objects and develop into small sponges.

Regeneration

Sponges possess remarkable ability to recover from injuries and to restore lost parts. You can easily observe this phenomenon if you find a bright-red sponge (Microciona) which incrusts stones and shells in shallow water of the North Atlantic coast. Take a small piece of it, wrap it in cheese cloth, squeeze it, and let the suspension of separated cells settle on the bottom of a glass dish. In a few moments you may notice that many of them have crawled together and formed small balls which adhere to the glass. Place them in clean sea water and in a week or 10 days you will see that each ball has developed into a tiny sponge with flagellated chambers, canals, and skeleton. Scientists who studied this process called it "regeneration after dissociation." Not every species of sponge possesses this remarkable ability. In some species, as for instance horny sponges of commerce, the separated tissue cells crawl together to form irregular masses which, however, fail to develop and perish in a short time. In shallow waters, sponges are frequently damaged by surf and violent currents. They rapidly restore the lost parts and continue to grow. The body of any large sponge may be cut into a number of small pieces, each of which under favorable conditions, develops into a new sponge. Because of a high regenerative power, sponges may be artificially cultivated from cuttings.

Sponges of Commerce

All sponges of commercial importance belong to the order of horny sponges (Keratosa). They differ from other sponges by the absence of mineral spicules and by the presence of spongin fibers which form their skeleton. In a few genera of this order the spongin skeleton is replaced by a jelly-like substance but these sponges are of no importance.

The skeleton of a good commercial sponge is compressible, resilient, and sufficiently tough not to be worn out in a short time, and absorbs large quantities of water. These desirable properties are dependent on the structure of the fibers, their thickness, and their elasticity.

The absorption of water by a sponge is determined by comparing the weight of a dry sponge with its weight after its immersion in water. Some commercial Florida sponges retain quantities of water from 25 to 31 times greater than their dry weight.

The principal commercial varieties of sponges are sold under the following common names: Turkey cup, toilet, Zimocca, wool, velvet, yellow, grass, wire, and elephant's ear. These species can be distinguished by their shape, texture, softness, elasticity of fibers, and durability. Marked differences in quality may be found even within one species, depending on locality and condition of the bottom. Good sponge grounds are found in the warm subtropical and tropical seas: in the Mediterranean, Gulf of Mexico, West Indies, Sea of Japan, and Philippine Islands. They extend from shallow water to a depth of about 600 feet.

Best American sponges are obtained by divers who use rubber diving suits and metal helmets supplied with air from a pump at the deck of the boat (fig. 4). They usually descend to a depth of 100 feet

Figure 4. --Diver returning from the bottom after two hours of work at considerable depth. Tarpon Springs, Florida.

or more carrying with them a short handled hook to remove the sponges, and a mesh bag. When the bag is full, the diver sends it up to the boat, and an empty bag is lowered to the diver on his life line. In searching for sponges the diver walks over the bottom while the boat with an air pump follows the trail of air bubbles. One man of the boat's crew stands on the bow keeping the life line in his hand to receive the signals sent by the diver. In water less than 5 fathoms

Figure 5.--Fatigue is clearly seen in the face of the diver who has worked a long time under water. The metal helmet has been removed but the diver rests before taking off the rubber suit.

deep the diver usually works under water for 2 hours, but in deeper water he may remain with safety only for shorter periods of time (fig. 5).

In the western part of the Mediterranean Sea, near Sicily, sponges are taken by dredges which operate at depths from 450 to 600 feet. Dredging is a very destructive method because many undersized sponges are smothered by the heavy gear. This method is not used in the United States or in the West Indies.

Figure 6.--Hookers working in shallow water at Florida Keys near Key West, Florida.

In Florida territorial waters the use of diving equipment is prohibited by State and Federal law and sponges are collected by hooking (fig. 6). The sponge hook is a 2- or 4-pronged metal fork attached to a light wooden pole. Frequently two men work together: one in the stern sculls the skiff while the other amidships watches the bottom through a glass-bottomed bucket (fig. 7). When the sponge is sighted, the sculler maneuvers the boat over it while the hooker brings the pole under and tears the sponge from the bottom. This method can be used only in relatively calm weather and in depths not exceeding 30 feet.

Figure 7.--Hooker scans the bottom through a glass bottomed box. Bahamas.

Sponge Cultivation

Commercial cultivation of sponges is possible because of their great power of regeneration. Selected parent sponges may be cut into as many as 16 pieces, each about 4 x 2 x 1/2 inches. The cuttings are attached to rocks or to concrete disks which are lowered to the bottom. Each small piece develops into a new, well-formed sponge in 2 or 3 years. Before 1938-39 this method was successfully used in the Bahamas and in British Honduras, where many thousands of sponge cuttings were grown every year. In the United States, grounds suitable for sponge cultivation exist in the Florida Keys and in a few places near Tarpon Springs on the west coast of Florida. During World War II the Japanese succeeded in growing the best variety of toilet sponges in the lagoons of the Caroline Islands by stringing small pieces of sponge on long aluminum wire anchored at the bottom and kept in vertical position by a float (usually an empty soft-drink bottle).

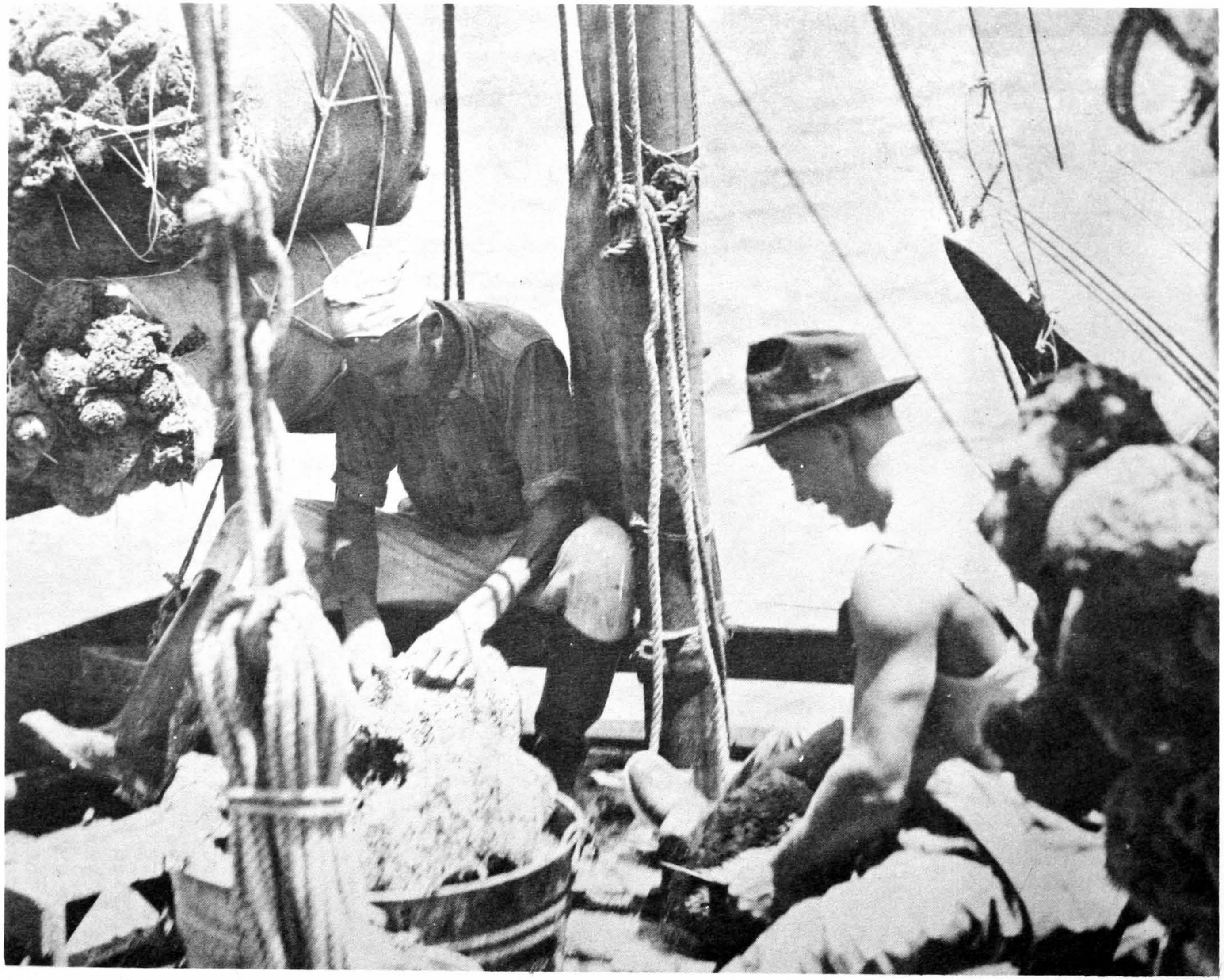


Figure 8.--Sponges are cleaned aboard the boat. Carabelle, Florida.

Figure 9. --Enclosure (kraal) along the shore of Andros Island, Bahamas, where sponges are left to decay. In the background is a hurricane-proof watch and refuge tower.

Figure 10.--Bunch of wool sponges displayed at the Tarpon Springs Sponge Exchange preparatory to public auction.

Figure 11. --Trimming of sponges at dealer's warehouse. Nassau, Bahamas.

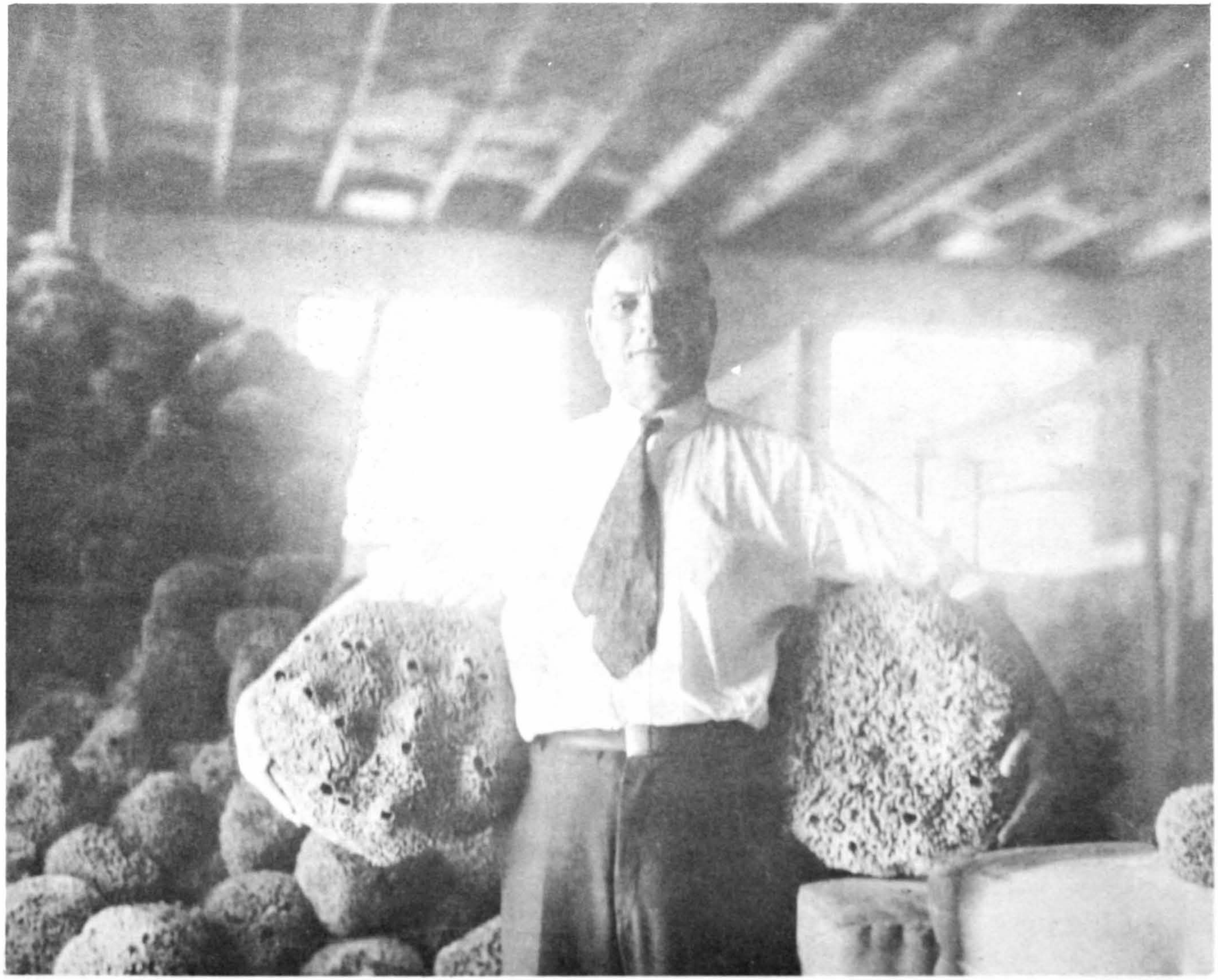


Figure 12.--Proud dealer displays two huge wool sponges. Tarpon Springs, Florida.

Preparation for Market

Sponges gathered by fishermen are left on deck to decay or are put in shallow ponds (kraals) (figs. 8 and 9). After 2 days the tough outer skin is scraped off and the sponges are repeatedly washed in sea water. After drying they are sorted by size and strung in bunches, which are stored until they are sold. A chemical bleach is sometimes used on inferior sponges, giving them a lighter color but weakening the fibers.

Sales of Sponges

Sponges are sold at auction (fig. 10) to dealers who remove them to packing houses where they are cleaned, sorted, and trimmed (figs. 11 and 12). During the best year, around 1935, the world's annual production of sponges slightly exceeded 2.6 million pounds, valued at 3.35 million dollars. Of this amount 655,000 pounds valued at $837,650 were produced in the United States (1934). Since 1938 there has been a steady decline in the catch of sponges in United States waters. Judging from the records of sales in the Tarpon Springs Sponge Exchange the quantity of wool sponge declined from 421,000 pounds in 1938 to the lowest figure of 16,000 pounds in 1953. Since this time production has been increasing and reached 29,651 pounds in 1956. Because of the scarcity of sponges, the price increased from $2 a pound in 1935 to $16 a pound in 1946. During the last decade the price has stabilized at about $7 to $8 a pound.

Sponge Disease

The decrease in sponge production in the United States was due to heavy mortality which was first noticed in December 1938 among the commercial sponges of the Bahama Islands in the West Indies. The mortality spread rapidly from the eastern islands and by February 1939 it had reached the north coast of Cuba and the waters of British Honduras. In March dead and dying sponges were reported from Key West, Florida and in the following months the mortality spread along the entire west coast of Florida. It was found that the spread of the disease followed the direction of principal water currents in the affected areas and the diseased sponges were infected by a fungus (fig. 13). The fungus disease killed nearly all velvet sponges in the Gulf of Mexico and in the Caribbean waters and destroyed over 80 percent of the wool sponges. Other varieties of sponges also suffered from the disease but not as badly as the two most valuable species. Since 1950 the population of wool sponges has been gradually increasing but the velvet sponge has not recovered.

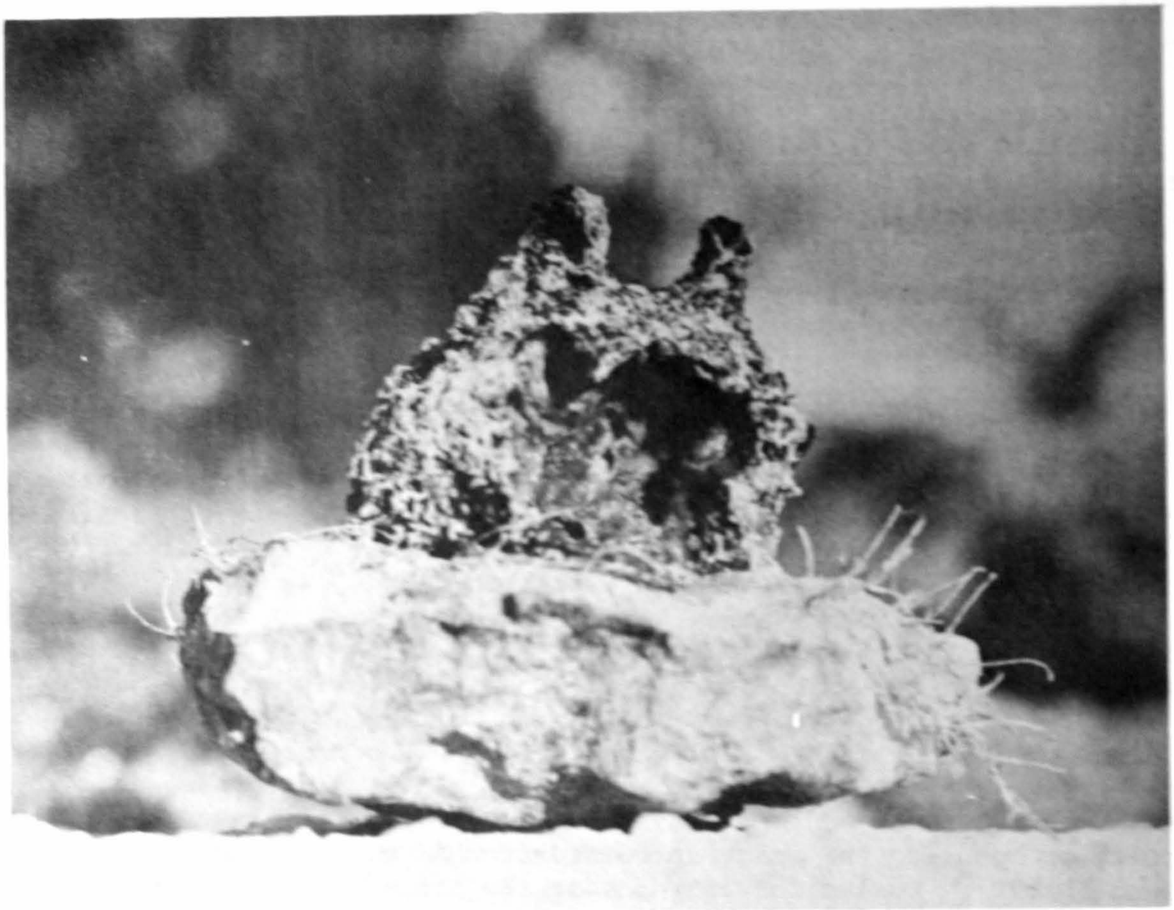


Figure 13.--Wool sponges partially destroyed by disease. Bahamas.

Artificial Sponges

Scarcity of sponges on the world market stimulated the manufacture and sale of artificial sponges made of cellulose and plastic which gradually displaced the use of the natural product. It is doubtful whether the sponge fishery will ever be restored to its former economic importance. Artificial cultivation may be successfully carried out on a small scale, but it is wishful thinking to expect that sponge culture will ever be able to produce the quantities required by world markets. The principal obstacles to sponge culture in the United States are the shortage of bottoms suitable for cultivation, the high cost of labor and materials, the uncertainty of good harvest because of the frequent hurricanes, the pollution to which the sponges are very sensitive, and the competition with synthetic sponges of many grades and sizes sold at relatively low prices.

Reference Material

Useful information about sponges may be found in a number of publications available in many public libraries. If you want to identify and classify various sponges, we suggest that you consult a small pamphlet by M. W. deLaubenfels, A Guide to the Sponges of Eastern North America (University of Miami Press, Miami, 32 pp., 1953). Information about the commercial sponges and sponge fishery can be found in the paper of H. F. Moore, The Commercial Sponges and the Sponge Fisheries (Bulletin of the U. S. Bureau of Fisheries, vol. 28, pp. 399-511, 1910); in D. K. Tressler and J. M. Lemon's book, Marine Products of Commerce (wnd edition, Reinhold, New York, pp. 733-751, 1951); and in a pamphlet by J. H. Tierney, The Sponge Industry of Florida (Educational Series, No. 2, Board of Conservation, State of Florida, 1949). General biology of sponges is discussed by P. S. Galtsoff in an article, "Sponges" (15th edition of the Encyclopedia Britannica, vol. 21, pp. 253-260), and in his article, Regeneration After Dissociation : An Experimental Study on Sponges (Journal of Experimental Zoology, vol. 42, pp. 183-255, 1925). The occurrence of sponge disease in the Gulf of Mexico and Caribbean area is given in the paper by P. S. Galtsoff, Wasting Disease Causing Mortality of Sponges in the West Indies and Gulf of Mexico (Proceedings of the 8th Annual Scientific Congress, vol. 3, pp. 411-421, 1940).

INT.DUP.,D.C.60- 72499

TABLE OF CONTENTS

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
WASHINGTON 25, D. C.

Fishery Leaflet 490

March 1960