## *SPONGE DIVING - PROFESSIONAL BUT NOT FOR PROFIT*

**Klaus Rützler**
Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560 USA

*Sponges and diving are connected by an old tradition, the quest for bath sponges. However, thousands more sponges without elastic-absorbent skeletons were named by early zoologists who did not have the luxury of live observation and provided inadequate descriptions based on dried or pickled specimens. I started to dive in the Mediterranean during the early 1950s because I enjoyed the sport and the technological challenge. Soon I got interested in submarine caves and their colorful occupants, mainly sponges. Studying the animals alive and reading their poor descriptions in the literature convinced me that good spongiology had to start with observation and experimentation under water, and I joined a handful of European scientists with similar interests. Today, thanks to many advances in diving technology, sponge workers are studying many aspects of sponge biology in situ, including systematics, morphology, reproduction, ecology, and physiology. My initial interest in underwater science and sponge biology has proliferated into a multi-disciplinary, long-term research program on Caribbean coral-reef ecosystems (CCRE), based at a field station on the barrier reef of Belize.*

### INTRODUCTION

People have searched for ways to explore the depths of oceans and lakes at least since antiquity. Bath sponges were among the many treasures divers sought for at least 22 centuries but not more than ten species worldwide qualify for this purpose. This is a small number if one considers that the phylum Porifera is estimated to contain near 10,000 species. About half of these species are fairly well known to science because they are preserved in museum collections. However, the principal problem in spongiology is that most early workers were museum researchers who described perhaps 90% of the known species but had not collected the specimens themselves and may not even have seen a sponge alive, certainly not in its habitat. Instead, they relied on material from dredge hauls and other samples brought back preserved from the classical expeditions that went to far and exotic places but were unable to obtain detailed information on most marine organisms in their natural habitats. Everyone who has seen sponges alive and tried to keep them dried or preserved in alcohol knows about the substantial changes that occur by shrinkage, fragmentation, and loss of surface structure and color.

The use of bath sponges is documented as early as the Minoan, the bronze-age civilization of the Mediterranean island of Crete almost 4,000 years ago. Diving as a method for gathering these firmly attached organisms is probably just as old because the coasts around the Greek islands are steep, and sponges are rarely found within the range of hand-held rakes or hooks. Poems from the days of Greek antiquity describe the dangerous and unprofitable occupation of the sponge diver, mention special diets, prayers, and breathing exercises, weights and tethers for faster sinking and returning, sickles for cutting sponges, dangers from sharks and octopuses, even the use of oil carried in the mouth to smooth waves for better visibility (Arndt, 1937). A well-preserved bath sponge was recently discovered in a burial chamber (Macedonia, Greece, 4th Century B.C.) and was most probably occupied by King Philip II,

father of Alexander the Great (M. Mertzani, pers. comm.). Scanning electron micrographs of the sponge fibers by Ms. Mertzani revealed blood platelets, most likely from the deadly wound of the King who was stabbed by one of his body guards during the wedding ceremony of his daughter Cleopatra.

Despite this promising history, serious scientific aspects of sponges ("zoophytes") were not pursued until Linné's monographic series, starting in 1735 (it took another century to establish the animal nature of sponges); and sponge diving as a research technique is less than 50 years old.

## NATURE AND USAGE OF SPONGES

The familiar "bath" or "commercial" sponges mentioned above belong to about 15 taxa (species and ecological forms), but fewer than ten are valid species. In contrast, 5,000-6,000 species of sponges are known and another 4,000-5,000 species are estimated to exist worldwide but are not yet discovered or described.

Sponges (phylum Porifera) are defined as aquatic, filter-feeding metazoans with characteristic flagellated collar cells (choanocytes) lining chambers (choanocyte chambers) that propel water through incurrent and excurrent aquiferous systems (Rützler, 1978). Water enters the body through numerous small pores (ostia) and exits through one or a few larger openings (oscula). Food (mainly bacteria), oxygen, and other life-supporting supplies are taken up by choanocytes and other specialized cells from the mesohyle (ground substance; there are no true tissues), waste products are secreted and expelled in a similar fashion. For details of anatomy and terminology consult DeVos *et al.* (1990) and Boury-Esnault and Rützler (in press). Sponges are encrusting or massive, mostly colorful and of a variety of shapes (*e.g.*, cushion, fan, tree, cup, or tube). The body is usually supported by a skeleton of spongin (a collagen-like protein) with or without the addition of mineral components (calcium carbonate, silicic acid). A pure spongin network occurs in the familiar bath sponges (order Dictyoceratida) and is known for its remarkable elasticity and water-holding capacity. Mineral skeletons can be solid (*e.g.*, the limestone base of sclerosponges) but are more commonly secreted as spicules of fanciful shapes that have great importance in the classification of most taxa.

Sponges are sessile except for sexually produced, free-swimming larvae and drifting fragments or asexually generated, reproduction bodies (gemmules). Representatives of the phylum are widely distributed, including freshwater and all ocean depths, but are particularly diverse and abundant in shallow-water ecosystems with solid substrates, such as rocky littoral, coral reefs, and some mangroves.

Sponges of all kinds have been put to good use in many cultures through time. Besides the obvious application of bath sponges for cleaning, blotting, and soaking, they served as stuffing for cushions, as artist's tool for producing patterns on walls and pottery, for polishing, as breast implant and prophylactic for women, as fertilizing aid in cattle breeding, and, their ash dissolved in wine as cure for goiter. Various marine sponges served as agricultural fertilizer, some species were used by fishermen as food or food additive, as scouring pads for their boats and to keep glass face plates of dive helmets from fogging (*Axinella polycapella*, de Laubenfels, 1953), and as tooth brushes. Siliceous sponges were often used as cement, nicely shaped hexactinellids ("glass"sponges) or fossils as jewelry in some cultures. Many more examples were compiled by Arndt (1937). Despite this popularity, most research of the past did not deal much with practical applications or learning about the biology of the group except for chemical analysis of the raw material and experiments with bath-sponge culturing. Part of the difficulty was that most sponges were not accessible for direct observation and only a few survived in aquaria for extended periods of time. The great diversity of marine sponges was not really known until the time of the world-wide oceanographic expeditions and the founding of the great marine stations in the second half of the 19th Century.

Today, bath sponges are gaining renewed popularity in hardware and fashionable bath stores but there are few other direct uses. On the other hand, recent research on natural-product chemistry has

shown hundreds of sponge species to be a precious natural resource for they contain substances useful in pharmacology (*e.g.*, Garson, 1994).

## HISTORY OF SPONGE DIVING

The first diving for sponges was certainly done by commercial collectors. It is understandable that skin diving for this purpose started in the eastern Mediterranean (Fig. 1) because the rugged rock bottoms of the Greek islands did not allow fishing sponges by harpoon or "gangava" (a heavy drag net), as it was, and in part still is, practiced on the flat, shallow sediment bottoms off Tunisia, Libya, and in the Gulf of Mexico. Travelers from northern Europe report already around 1860 that wealthy citizens of Ikaría (Sporades islands, Aegean Sea) held sponge-diving competitions to pick the best eligible men as husbands for their daughters (Arndt, 1937). Depths of 10-40 m (75 m maximum) were routinely reached by breath-hold diving and dive times of up to 5 min are on record. "Scaphanders" (Fig. 2), dive suits with heavy metal helmets, lead boots, and hose connected to a ship-board air pump, were imported from India by a Greek sponge diver in 1860 and made their way to the West Indies in 1905. Sponge diving in the West Indies and the Gulf of Mexico was mainly conducted by Greek immigrants. These "machines" allowed work times of 2 h at 20 m, 1 h at 40 m, but caisson disease (the bends) were common among sponge divers who often died or ended up crippled, particularly during the first decades of using the new tool. In the early 1920s, many Mediterranean sponge fishermen replaced the scaphanders with a lighter and cheaper type, the Fernez apparatus (Arndt, 1937), comparable to our familiar hookah. This gear consisted of a rubber bag worn on the back attached with a belt and connected to a pressurized air supply in the boat (Fig. 3). Flexible tubing and a mouth piece allowed breathing from the bag that maintained air at ambient pressure. A mask with lenses replaced the heavy helmet.

Figure 1. Skin divers with sickle, collecting net, weight, and tether line (from Arndt, 1937).

Figure 2. Scaphander or hard-hat diver, Tarpon Springs, Florida (J. Vacelet).

In Florida and the Caribbean, the scaphander remained in use and even today is still displayed as a tourist attraction. Its actual use in these days of scuba is no longer practical and by Florida statute all "deep-sea apparatus" is banned to prevent damage to young sponges by heavily weighted divers stepping on them. In fact, commercial sponge fishery all but disappeared in Florida and the Caribbean

during the late 1930s because a disease related to a series of red tides (dinoflagellate blooms) killed most suitable species. Interestingly, at just about this time one of the first modern sponge studies took place in Florida employing at least once a "diving apparatus" for walking the bottom to 10 m (de Laubenfels, 1936). Because the author described sponges of the Dry Tortugas, site of a laboratory run by the Carnegie Institution of Washington, one must assume that this apparatus was the same or a similar diving helmet first employed by A.G. Mayor, Director of the Department of Marine Biology at the Carnegie (Yonge, 1930) and made popular through several writings by Beebe (1926, 1932; Fig. 4). De Laubenfels concluded the brief description of his experience with "comparisons to a 'fairyland' are appropriate." In a subsequent paper, the same author described sponges from Bimini, Bahamas, some of which were collected "by using the diving helmet" (de Laubenfels, 1949).

Figure 3. Fernez apparatus (courtesy M. Pansini and R. Pronzato).

Figure 4. Diving helmet (from Beebe, 1926).

## DIVING, FROM SPORT TO RESEARCH DISCIPLINE

Like many post-World War II generation marine biologists, I was first attracted by technological challenges of exploring the ocean and only later by the mysteries of the organisms. In 1952, I was 16 years old and growing up in Austria, a tiny central European, land-locked nation. At the time, skiing and swimming were my primary sport interests and my professional ambition after high school was inspired by the Austrian animal behaviorist Konrad Lorenz. But then I acquired books by my fellow countryman H. Hass and by the French L. Boutan, J. Cousteau, and D. Rébikoff, on diving technique, underwater exploration and photography, and I knew my final professional destination. Absolutely no diving equipment was commercially available in Austria at the time and even goggles and fins had to