An Algae-Outside Purification System for Marine Aquaria

MICHAEL M. KANE

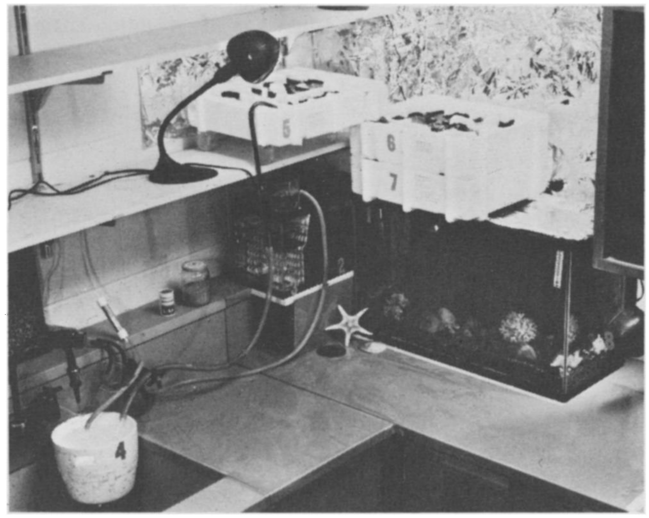

Fig. 1. Overview of the marine aquarium and filtration system. Numbers on equipment indicate stages explained in the text.

WHAT IS MORE FASCINATING than to bring a touch of the ocean into the classroom or the home? However, the maintenance of a marine tank is more elaborate than that of a freshwater aquarium. Salinity, pH, amount of light, temperature, and filtration—especially the last-named—are problems that discourage many people from establishing a marine set-up. Also, marine specimens are expensive. Loss of specimens because of maintenance problems led me to design a simple system that reduces maintenance time, minimizes costs, creates a natural ecologic system that will keep the specimens healthy, and maintains a clean, attractive tank.

The most critical factor in the marine tank is the maintenance of clean water. Urea, ammonia, and other toxic organic waste products are the primary sources of water contamination. In the marine tank these toxic substances accumulate more rapidly than in a freshwater tank, partly because of the activity rate of marine organisms. Most marine-tank filters convert the toxic substance into nontoxic products (nitrates) by means of bacterial action in the filter beds. This type of filter must provide adequate rates of filtration and oxygenation, which depend on the size of the aquarium and number of living specimens. In a water environment nitrates are taken up metabolically by plants. This problem is solved in the freshwater aquarium by the presence of numerous green plants (which also look very attractive). In marine tanks the assimilation of nitrates is difficult, because algae are primarily responsible for this task. Algae are unattractive when they grow on the sides and bottom of the aquarium. A good light source is also required if the algae are to successfully remove the nitrates and reproduce.

Generally, it is undesirable to have too many algae in the tank; so the buildup of nitrates in the water must be accomplished by removing about one-fourth of the water monthly and replacing it with fresh salt solution. This procedure can be time-consuming, messy, and, if the tank is large, quite expensive.

Algae Outside the Aquarium

I have developed a purification system that incorporates the use of algae outside the specimen tank and thus eliminates the requirement of changing the water. Fig. 1 shows the system, which was built in

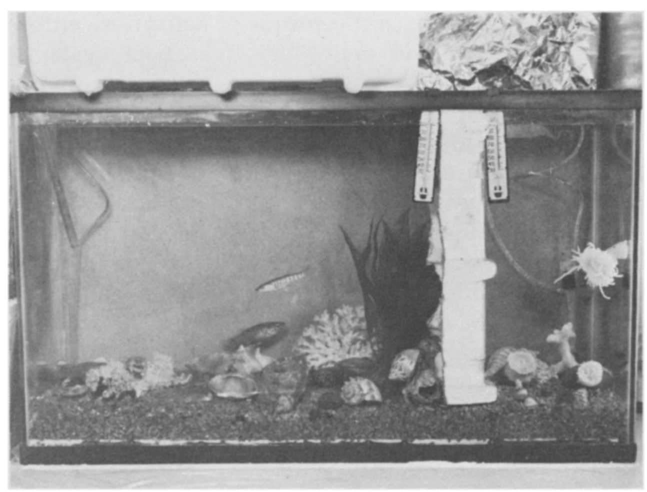

Fig. 2. Specimen tank contains numerous organisms. Styrene-foam partition separates delicate specimens (*right*) from crabs and fish.

The author is a graduate teaching assistant in biology at Eastern Michigan University, Ypsilanti, Mich. 48197. He obtained his B.S. (1972) and M.S. degrees, in biology, from Eastern Michigan. Kane is presently working on the natural history of the soft-bodied millipede *Polyxenus* and is experimenting with ways of keeping invertebrate animals alive in a laboratory environment. This is his first published paper.

a corner of the laboratory. The numbers in the photograph indicate the seven stages in the system. This particular system has been in operation for more than 18 months. The water has never been replaced, nor have any specimens died as a result of a failure of the system.

Fig. 2 shows the specimen tank (stage 1), which contains 110 l (29 gallons) of artificial seawater and includes invertebrate and vertebrate animals. Gravel on the bottom of the specimen tank is calcium carbonate, which can be purchased from most aquarium

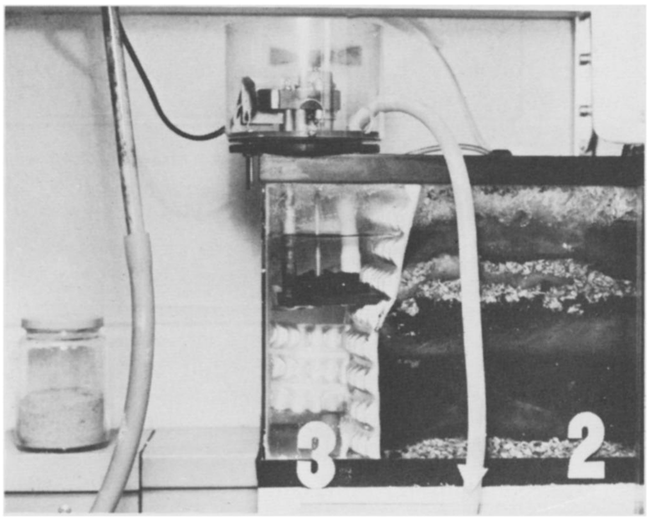

Fig. 3. Filtration tank and electrical pump. Bacteria in stage 2 break down the organic waste products. In stage 3 the pump removes the filtered water.

shops or biology supply houses. Two underground filter units and air-supply mechanisms are contained in this tank.

Fig. 3 shown the 30-l (8-gallon) filtration tank, into which water enters from the specimen tank. Two cane-shaped plastic tubes siphon water from the

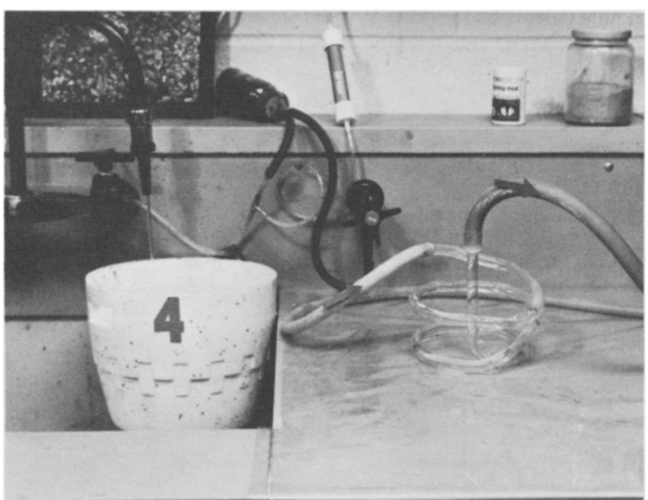

Fig. 4. Water temperature is controlled in stage 4. The coiled tube rests in a styrene-foam container, which contains flowing tap water. Water in the coil is moved along to the algae tanks.

Fig. 5. In stages 5 and 6 the algae, in tanks, convert the nitrates. In stage 7 the algae are prevented from entering the specimen tank. Lights burn continuously above the tanks, to promote algal reproduction.

specimen tank; as a result, the water level in the two tanks remains the same. The filtration tank is divided into two equal sections. The first section (stage 2) consists of layers of charcoal, glass wool, and stones. As water flows through these layers, it enters the second section (stage 3) through small openings in the bottom of the styrene-foam divider. At this stage the electric pump removes the water that has passed through the layered sections. The pump is operated by an electrical induction motor that is self-priming. It pushes water through the system at the rate of 1 l every 25 seconds, or 3,456 l/day. An extended rotor mechanism on the motor prevents excessive splashing of water and reduces the evaporation rate. At the filtration stage of the purification process, bacteria convert the animal urea, ammonia, and other organic products into nitrates; and the filter also removes the larger particles suspended in the water.

Water is forced by the pump through rubber tubing, which is led to a sink in which a coiled glass tube rests inside a styrene-foam container (fig. 4)—stage 4. By allowing tap water at 18–21 °C to flow over the glass tube, a desirable temperature below room temperature is maintained in the circulating water; otherwise the aquarium temperature would equal the room temperature. This eliminates the cost of an expensive refrigeration unit.

Water continues through rubber tubing to the first algae tank, which is stage 5. The water flows through channeled styrene foam, which provides a surface on which the algae can grow and thereby convert the nitrates (fig. 5). (These particular styrene-foam pieces were padding from a shipment of microscopes; an alternative source is a styrene-foam ice bucket, from which pieces can be cut to size and then channeled.) Gravity forces the water from the first algae

(Concluded on p. 372)

self of all that is toxic, of all that is degenerate in his own store of ideological concepts.

Indeed, it is not Dr. Woodward's looseness that offends the most severely, but that of the editors of *The American Biology Teacher.* If the editors are so short on material that we must be served up great heaping hunks of anti-American propaganda with our monthly diet, may I suggest as an alternative that you print either my recipe for sweet and sour pork or perhaps the one for peanut soup. They're more intriguing, have more biological portent, and are certainly much more palatable.

John R. Guthrie
Biology Department
Fayetteville Technical Institute
Fayetteville, N.C. 28303

Val Woodward comments:

Guthrie's response to my article isn't unpredictable, given the quality of his educational experience, but it is an extreme case. I first considered responding to it point by point, until I re-read it and found it to be without one. On second reading his words appeared more a Benedictine rule for humankind, one with which I disagree. Guthrie is at his best when he speaks for himself. . . no interpretor could further illuminate his message. I would, however, caution anyone who may take Guthrie seriously to check his "facts," note the quality of his reference citations, and to assay his "logic" for androgens and epinephrin.

Purification System... from p. 345

tank into the second tank (stage 6). This second algae tank provides additional surface area.

The algae growing in these tanks are a culture of a common marine blue-green alga, *Oscillatoria.* Two 100-watt light bulbs burn continuously above the algae tanks as an aid to the algal reproduction. The algae reproduce very rapidly under the proper light conditions, so they should be thinned out monthly by removing large masses that accumulate in the channels. The channels of the tank should be designed so that, in case of a power failure, water will be contained in the channels to keep the algae alive. At the end of the channel of the second algae tank, some kind of mesh should be installed, to help prevent the algae from leaving the second tank.

Beneath the second algae tank (fig. 5) is a third styrene-foam tank, which is the final filtration unit (stage 7). This tank is similar to the algae tanks except that it contains large amounts of charcoal, diatomaceous earth, and gravel. This final filter unit prevents the algae from entering the specimen tank, thus keeping the tank clear.

Evaporation, pH, and Feeding

The total capacity of the specimen tank and filtration unit is 152 l (40 gallons) of water. Evaporation of water from the system is kept at a minimum if the algae tanks are covered with a clear plastic film. (This also helps to keep dust from entering the system.) Very little salt will condense on the styrene foam; thus, any water lost by evaporation can be replaced with fresh water, to maintain the proper salinity.

Another important aspect of the water in a marine tank is pH. Animal specimens cannot adapt to a rapid fluctuation in the pH; and pH changes can occur very rapidly in seawater. The natural control on this system has kept the pH of our tank at a constant 7.1, which is just about neutral.

All animal specimens are fed once a day with frozen canned shrimp. Occasionally a piece of lettuce is attached to some coral and is allowed to sink to the bottom of the aquarium. This helps to maintain a proper diet for the crabs and sea urchins. A light by the specimen tank is controlled by an electrical timer, which turns on the light at feeding time and shuts it off 2 hours later.

Acknowledgment.—The photos are by Douglas Lirette, of Eastern Michigan University.

REFERENCES

Braker, W. P. 1966. *Know how to keep saltwater fishes.* Pet Library Ltd., New York.

James, D. E. 1973. *Carolina marine aquaria.* Carolina Biological Supply Co., Burlington, N.C.

Pelczar, M. J., and R. D. Reid. 1972. *Microbiology,* 3rd ed. McGraw-Hill Book Co., New York.

Straughan, K. P. L. 1970. *The salt water aquarium in the home,* 2nd ed. A. S. Barnes & Co., Cranbury, N.J.

Real Relevance

. . . I believe the real relevance of science is to cultivate, as immediate or ultimate goals, a vision of the resolution of the great mysteries of nature. As we toil at our individual tasks, investigating the function of a gene or the structure of a membrane or the specificity of a synapse, we gain if we connect our work with some further and grander goal.

S. E. Luria, "What Can Biologists Solve?"
New York Review of Books 21(1):28