MARINE AQUARIA FOR HIGH SCHOOLS AND COLLEGES.

LYELL J. THOMAS, Zoological Laboratory, University of Illinois.

Living marine animals and plants for class use in biological laboratories far removed from the ocean are generally not even considered possible. Students in such laboratories see only preserved specimens or pictures. The University of Illinois zoological laboratory has had living marine animals shipped in from Woods Hole, Mass., for a number of years during the mid winter season. The animals generally lasted but a few days and were soon forgotten. The past four years an attempt has been made to keep these animals alive throughout the year and longer with marked success.

Sea water was shipped in barrels at a cost of about $8.00 per barrel but this was found to be too expensive and results obtained were not as good as synthetic water made according to Ditmar's formula which cost about $1.00 per barrel. Sea water made according to this formula can be made from either tap water or rain water. C. P. dry chemicals were used. The formula is as follows:

Sodium chloride	27.213 gm. per L.
Magnesium chloride	3.807 gm. per L.
Magnesium sulphate	1.658 gm. per L.
Calcium sulphate	1.260 gm. per L.
Potassium sulphate	0.863 gm. per L.
Magnesium bromide	0.076 gm. per L.
Calcium carbonate	0.123 gm. per L.

In making up sea water from tap water the amount of $CaCo_3$ contained should be known. In most cases this may be omitted from the formula. The tap water at the University of Illinois contained 10.22 gms. per gallon. This amount together with other impurities may be reduced by bringing the water to the boiling point and then allowing it to stand and cool. Excess carbonates settle to the bottom of the container and the supernatant fluid is siphoned off. The C. P. dry chemicals are added according to the proportions given in the formula and are allowed to dissolve. This water may be made up a year or more in advance if stored in tightly

corked carboys, however it is best to start the aquaria some time in advance of the arrival of the animals.

Since the publication of a paper by Thomas (1925), considerable advance has been made in the handling of the animals upon their arrival. Shipments have been made from the Pacific as well as from the Atlantic. Animals sent from the Marine Biological Laboratories at Woods Hole, Mass., come in paraffin lined wooden buckets and may be shipped by express without danger of spoiling from November to March to any point in the Central States, although shipments have come through as late as June in good condition. If the aquaria are started with a shipment of Ulva or sea lettuce, Fucus, and eel grass several months before the animals are ordered they will be in better condition to receive animals.

Small aquaria 9″ x 9″ x 14″ with aluminum frames and slate bottoms have proved very satisfactory, although larger aquaria 29″ x 20″ x 18″ with alberine stone ends and bottoms have been better. The small aquaria have loose fitting covers to aid in cutting down evaporation. The use of covers on the large aquaria proved very unsatisfactory as the rise in temperature due to the covers was more detrimental than the cutting down of the evaporation. Loss from evaporation is made by the addition of rain water, sprinkling it on slowly to avoid a sudden change in concentration. When the synthetic sea water is first placed in the aquarium, about three-fourths full, a line is drawn to mark the water level. If rain water is added every few days so as to keep the water level fairly constant better results are obtained.

A layer of coarse wood charcoal covered with gravel and fine white filter sand helps to keep down gases formed from decomposition of organic materials and also gives a place of lodgment for burrowing forms. Bits of brick and shells scattered about on top serve as a place for attachment of plants and sessile animals.

The addition of one or two clams to each aquarium helps to purify the water. Red, brown, and green algae do well, especially Ulva. Practically all tide-pool life has been kept for a year or more, some forms for over two years. The heat of the summer months in the green house at the Vivarium where some aquaria are kept takes a considerable

toll of life, but aquaria in the laboratory in windows on the north at a cooler temperature go through without much loss. A ten dollar order should be sufficient to supply a dozen aquaria. A twenty-five dollar order might give a greater variety but would necessitate a considerable waste unless spread out over two dozen or more aquaria.

The greatest temptation is to crowd too many animals into one aquarium. A typical grouping of animals might be cited taking examples from among fourteen in the vivarium. Aquarium No. 1, size 29″ x 20″ x 18″, has one star fish, two small sea-urchins, one sea cucumber, a sponge, a few serpulids or tube worms, a clam, a few Bryozoa, and corals, four mud snails and numerous small micro crustacea. The sea urchins have developed from larval forms brought in on the introduced Ulva. The sea cucumber has lived for over a year and has regenerated its entire internal organization. The beginner may want to throw out sea cucumbers that have cast their digestive apparatus due to excessive handling, however, if the viscera spewed into the aquaria are removed and the animal is not disturbed regeneration generally takes place. The star fish placed in the aquarium last fall has regenerated two new arms. No. 4 aquarium contains a sea urchin which has developed from the larval state, a sea anemone which has produced numerous small anemones by budding, corals which have spread and developed new colonies, tube worms which have laid their eggs and numerous young have developed and have become attached to the vegetation and to the sides of the aquarium, and Clava leptostyla another colonial coelenterate. No. 10 contains four fiddler crabs which have been living for over a year and six Limulus or horse shoe crabs. This aquarium is divided so that half of it is a miniature beach of fine white filter sand where the fiddler crabs tunnel and the horseshoe crabs bury themselves. Crabs should not be placed with other animals. Different species of crabs with large pincher feet should not be placed together. A shore crab was removed because of its canabalistic habits to another aquarium where on April 10 it was found laying eggs. Aquarium No. 2 contains barnacles, sea anemones, two clams, snails, serpulids and Nereis which have reproduced, and Syncoryne mirabilis, a colonial coelenterate which has spread over the glass of the aquarium. Two years ago Obelia commissura-

lis McCr. produced medusa or jelly fish which were observed by an entire class of over two hundred students. Recently Tunicates have developed and their colonies have spread about the aquarium. They make splendid demonstration specimens to show the reversal of the blood flow and represent the primitive tho degenerate Chordate.

In the balanced aquarium the feeding of the animals is not a problem. The production of micro crustacea is great enough to furnish the coelenterates with food. Crabs and star fish may be fed crushed snails sparingly once a month or the crabs and sea anemones may be given bits of raw beef or codfish on a stick. The codfish is prepared from a good commercial brand of the dried product by soaking it in running tap water for a half day. The sea water in which the animals are shipped should not be used for some time and then only after thorough aeration. However, the plankton which it contains should be strained off through a silk handkerchief or bolting cloth for sometimes it contains larval forms which may develop later to create new surprises.

The success of marine aquaria depends upon the prompt removal of dead animals, excess food, decayed vegetation, and white molds that may appear. Some aeration in addition to oxygen from growing plants is advisable. The appearance of turbid water or a foamy froth indicates animals are dying and should be removed. And last the interest and attention of the one in charge is necessary. For those who are interested in making biology a live subject marine aquaria are practical aids to this end.

REFERENCES:

1925 Thomas, Lyell J. Living Marine Animal for Our Inland Laboratories. Trans. Amer. Micros. Soc. 44:38-41.