F.T.B.

NEW ENGLAND AQUARIUM GUIDE

The purpose of this synoptic guide is as a working aid for teachers, not as a work-sheet for students. It is designed so that the teacher may choose one or two questions as a theme for a class visit to the Aquarium. Alerting the students to some structural, behavioral, or adaptive characteristics of the animals helps them to gain a greater appreciation for the World of Water. This conceptual approach is designed for all grade levels, so not all of the questions may be relevant to your class. Some questions may be answered by simple observations; others will require reading the information provided on the Graphic Panels.

In the Aquarium there are many animals that live in the transient environment of tidal pools. Find them and examine their adaption to their trying environment.

What makes a fish unique? (Characteristics that make him different from other animals.)

Find examples of the descriptive common names given many marine animals and explain their derivation (such as starfish, snapping shrimp, blubberlips, whale shark).

Through evolution, structures of many aquatic animals have become adapted for unusual uses different from which they were originally designed. Can you locate examples as unique as the parrotfish whose teeth have fused together into a beak-like structure useful for rasping live coral from the reef for food?

A struggle for survival is one important function of all organisms. How does size play a vital role?

Sketch some of the animals in the Aquarium that appeal to you.

Why are penguins, sea otters, and reptiles included in an Aquarium?

What can you determine about a fish's environment and habits from his structure? (For example, arawanas are surface feeders evidenced by their upward angled faces).

Some fish travel in schools, some in small groups, and some individually. Discuss the advantages and disadvantages of each situation.

What is the function of chin barbels in some fish? What other sensory devices can you find on fish?

Choose an animal from each of the following groups and determine which of their five (or six) senses each relies on most (mammals, fish, invertebrates, reptiles).

The lateral line is called the sixth sense of fish; explain its function.

How do fish breathe? How have the respiratory systems of certain fishes been adapted to their distinctive environment?

Identify and label the fins of a number of different fish. Note the relationship between structure and function of the fins in each animal cited. Some fins, for example, enable rapid turning or create better balance.

Discuss the advantages and disadvantages of endo and exoskeletons for animals in the aquatic environment.

How many different methods of locomotion can you find employed by aquatic animals (i.e. jet propulsion, undulation of various fins).

How is color used to advertise, conceal, or disguise a fish's presence?

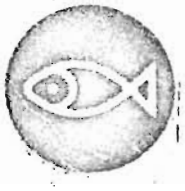
Find examples of symbiotic relationships (mutualism, parasitism, commensalism).

Find a tank with several different kinds of marine animals living together. Try to work out the relationships among the animals, as to territoriality, feeding habits, agression, and possible associations among species.

Determine a relationship between a fish's coloration and its environment.

Many invertebrates seem to be camouflaged or resemble things that they are not. Find examples of this characteristic; you may have to examine a specimen closely to determine what it really is.

Many different "things" provide "homes" or shelter for marine animals. What make-shift housing exists in the tanks of the Aquarium? (For example, discarded shells house hermit crabs).



AQUAVENTURE

This is a "seek and find" exercise designed to further the Aquarium's goal of education as well as entertainment. Answers can be obtained by reading the graphic panels, the labels above the tanks, and by examining the animals themselves.

TEMPERATE MARINE GALLERY

1. Our penguins are "countershaded". Looking at our penguins what would you guess this term means?

   Discussion Question: What is the advantage of countershading?

2. What animals according to our Boston Harbor exhibit, still thrive in Boston Harbor today?

   Discussion Question: How can these animals survive?

3. Examining the Giant Globe, what geologic features will you find in the sea as well as on the land?

   Discussion Question: Could land animals have ever lived on what is now the continental shelf?

4. What iridescent fish in this gallery constantly swim around and around their tank in a single school? These fish swim in parallel lines, and can sense the vibrations from other moving fish against their lateral lines.

   Discussion Question: These fish exhibit a type of coloration called iridescence. How is this effect produced?

SHARK WALL

5. The Great White Shark is known to be a maneater, but the two largest sharks, the basking shark and the whale shark, definitely are not. These two sharks are too big to fit on our Shark Wall! What do they eat?

   Discussion Question: Discuss the food chain in the sea.

TIDE POOL ROOM

6. Pick up a starfish and place it on the back of your hand first on one side and then on the other. How does it hold on?

   Discussion Question: What are the purposes of these structures?

FRESHWATER GALLERY

7. What freshwater fish has a reputation for devouring humans?

   Discussion Question: Each fish can only eat a small bit of flesh before it is full. However, by schooling in large numbers in South American streams, they are dangerous because they can strip a whole cow in minutes. Discuss the advantages and disadvantages of schooling behavior in fish in general.

COLD MARINE GALLERY

8. The Octopus can change color almost instantly to correspond to its moods, or to the color of its environment. What color is it today?

   Discussion Question: How does it change color?

9. Find a winter flounder and determine how it differs from a "normal fish"?

   Discussion Question: Apart from their strange shape, flounder can change to many different color patterns. How is it advantageous to them?

10. Mutations in genes are responsible for strange color variations in lobsters. Describe some that appear at the Aquarium.

    Discussion Question: What would be the disadvantage of being an albino lobster in the ocean?

11. How did the anglerfish in the pelagic fish exhibit earn its name?

    Discussion Question: Why is it necessary for deep-water fish to resort to using elaborate methods of attracting prey?

GIANT TANK

12. Sketch the shape of a bonnethead shark.

    Discussion Question: What would be the evolutionary advantage of that broad head?

13. Moray eels live in shallow water in tropical areas in protected places. Where do they live in the Giant Ocean Tank?

    Discussion Question: Study their method of respiration.

TOP OF GIANT OCEAN TANK

14. Sketch the right whale that is hanging from the ceiling. This whale had no teeth. How and what did it eat?

    Discussion Question: Describe the difference between toothed and baleen-whales.

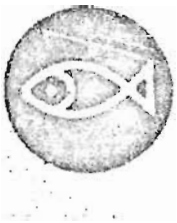
TROPICAL MARINE GALLERY

15. Find the partners that clownfish live with in a symbiotic relationship.

    Discussion Question: What advantage does each partner gain?

16. What is the fish that has the name of a bird?

    Discussion Question: What does it use its "beak" for?



TEACHER'S GUIDE

Answers to Aquaventure, with listing of Graphic Panels for further information:

1. Temperate Marine Gallery

   Penguins are dark on the top of their body and light underneath, as are many whales, dolphins, and sharks.

   Discussion Question: Although penguins divide their time between the land and sea, most of the natural predators of the penguins live in the ocean. Countershading protects them as they swim because, seen from below, their white bellies blend with the lighted surface of the water. For predators searching from above, their dark backs blend in with the dark depths of the water.

   Refer to: First graphic panel in Temperate Marine Gallery.

2. Silverside fish, barnacles, mussels, crabs, starfish, snails. (mummychugs, flounder, worms and shrimp also live in Boston Harbor.)

   Discussion Question: Some live on fecal debris; others are very hardy or very adaptable; some thrive because competition from other less adaptable species has disappeared.

   Refer to: Harbor Room exhibit in Cold Marine Gallery.

3. Valley, mountains, ridges, trenches, plains, volcanoes, (features that are found exclusively in the sea: continental shelves, continental slopes, seamounts, guyots (flat-topped mountains).

   Discussion Question: Yes, continental shelves are the former coastlines of the glacial ages.

   Refer to: "World of Water: - continental shelves", second graphic panel in Temperate Marine Gallery.

4. Alewives

   Discussion Question: Guanin, a waste product in the blood, accumulates in special color cells in the skin causing the silvery tone of the fish. Iridocytes, or mirror cells, reflect the color of the fish's surroundings.

   Refer to: "Schooling Behavior" third panel in Tropical Marine Gallery.

Shark Wall

5. Plankton

   Discussion Question: As photosynthesizers, plankton are the primary producers of the sea. All other animals are consumers at some level of the food chain.

   Refer to: "Energy, oceans food cycle" tenth panel in Temperate Marine Gallery, and labels on shark wall.

Tide Pool Room

6. It holds on by means of tube feet (acting like suction cups) on the oral side, and pincher-like pedicellariae on the aboral side (opposite from mouth).

   Discussion Question: Tube feet are used for walking, prying open shells, and anchoring itself to the bottom. Pedicellariae are used for cleaning the body surface and for defense.

7. Pirahnas

   Discussion Question: Advantages of schooling behavior include assured reproduction and the fact that more fishes are likely to find the scattered food supplies in the ocean. For protection, a large number of fishes may provide protection by sheer numbers and by huddling close together when alarmed, they may seem like one large fish. However, many fish generate much more vibration than a single fish and more readily attract predators. Some fish, such as barracuda herd schools of fish like sheep. Also in schools, often individual fish are robbed of their food by others in the group.

   Refer to: "Dangerous Fresh Water Fishes," sixth graphic panel in Fresh Water Gallery, and "Schooling Behavior" third graphic panel in Tropical Marine Gallery.

Cold Marine Gallery

8. Sometimes scarlet, gray, splotches of brown or gray, or off-white.

   Discussion Question: Color cells called chromatophores are located in the skin. A radial muscle surrounds the chromatophore, and when it contracts the chromatophore spreads out, darkening the skin. Muscle contraction pulls the walls of the color cells outward; when the muscles relax, the walls snap back.

   Refer to: "Cephalopods," second graphic panel in Cold Marine Gallery.

9. The flounder is laterally compressed with both eyes on one side of the head, pigmentation on the underside has faded. Flounders are born looking like other fish, but after its first five weeks, one eye migrates over next to the other eye and the fish begins to swim sideways.

   Discussion Question: Matching one's background is a type of protective coloration. Disruptive coloration makes the animal blend in so well with its background that it is difficult to distinguish the body outline from its background.

10. Blue, white (albino), calico, and half-normal, half orange.

    Discussion Question: Would stand out, strangely colored lobsters may be attacked because of their prominent coloring.

    Refer to: "The American Lobster", sixth graphic panel in Cold Marine Gallery.

11. The anglerfish dangles a lantern-like projection from the head as luminous "bait" for deep sea creatures.

Discussion Question: dark environment; prey is scarce in deep water.

Refer to: Pelagic Fish Exhibit labels.

Giant Tank

12. It has rounded shovel-like head.

Discussion Question: It is thought that the wide-set eyes and nostrils are more efficient for detecting blood. The nostrils are so far apart they seem to act almost like two olfactory centers.

Refer to: Shark Wall panels.

13. Moray eels live in the ancient Greek amphora jars at the bottom of the Giant Ocean Tank. Often one or two will wiggle into a jar tailfirst and remain there with only its head protruding.

Discussion Question: Morays breathe through their mouths and expel water over their gills through an excurrent hole. Their mouths open and close in a gulping motion.

Refer to: "Dangerous Marine Fishes, fish that bite", fifth graphic panel in the Tropical Marine Gallery.

Top Of Giant Ocean Tank

14. The living whale had baleen thin bristles of whalebone, attached vertically to the upper jaw. It would plow through the water with its mouth open. When it closed its mouth it would raise its tongue, squirting out water through the baleen and catching krill, tiny crustaceans, between the bristles.

Discussion Question: Baleen or whalebone whales are recognizable by baleen attached to the gum of the upper jaws, larger head, and paired blowholes. Toothed cetaceans have teeth, 5 digits in the flipper, and a single blowhole. They feed on fish, and in some cases, also on squid, while baleen whales subsist mainly on small crustaceans.

Tropical Marine Gallery

15. Sea Anemones

Discussion Question: Commensalism is a type of symbiotic relationship in which both partners benefit. Here, the fish brings food to the anemones, and the anemones provide protection by means of stinging cells (nematocysts) to which clownfish are immune. It is an unresolved question as to why anemone fish are unharmed, perhaps they build up an immunity over time, perhaps the mucus covering of the fish protect them from the sting, or maybe the anemonefish do not elicit a stinging response from the anemone.

Refer to: "Fish Associations", tenth graphic panel in Tropical Marine Gallery.

16. Parrotfish, named for its beak-like teeth.

Discussion Question: The teeth of the parrotfish have fused together to form a strong beak-like structure with which it scrapes live coral from coral reefs. It grinds skeletons and excreets them as sand.

Refer to: "Feeding habits, grazers," eighth graphic panel in Cold Marine Gallery.

INTRODUCTION TO THE AQUARIUM

These questions are designed to give you an overall view of the Aquarium and should stimulate discussion on various aspects of the World of Water.

COLORATION

Color in fishes may benefit them in many ways. Find examples where color is used to conceal, advertise, or disguise.

SYMBIOSIS - (Find examples of each)

There are three ways organisms can live together symbiotically. Commensalism is a relationship in which one member of a symbiotic relationship benefits, and the other is not harmed. Mutualism occurs when both organisms benefit by living together. In parasitism, one member of the relationship benefits to the detriment of the other.

SENSES

Observe and record how these aquatic animals breathe:
sea - Tray; moray eel - Giant Tank; shark - Giant Tank;
Cod - Cold Marine Gallery; barnacle - Tropical Marine Gallery.

LOCOMOTION

The shape of the body and fins of a fish determine its speed and maneuverability. Try to figure out what shapes are best for swimming rapidly, turning sharply, swimming close to the bottom, living in crevices. Find other specialized shapes.

As you tour the Aquarium, make up questions of your own that you might have your class answer. (You can have your students do the same thing - they make up questions for future classes, or to exchange 1/2 way through their visit). The Education Department would appreciate receiving your suggestions for questions or approaches to the Aquarium.

ANSWERS TO INTRODUCTION TO THE NEW ENGLAND AQUARIUM -

COLORATION

1. The flounder in the Cold Marine Gallery can change colors and patterns to match its background.
2. The lionfish with its bright stripes advertises to other animals in the tropics of its danger because of the poison sacs at the base of its dorsal fins.
3. The bright orange color of the garibaldi in Temperate Marine advertises the fact that it is extremely territorial.
4. The stonefish in Tropical Marine Gallery is disguised to resemble a moss-covered rock.

Refer to: Coloration, seventh graphic panel in Tropical Marine Gallery.

Camouflage, ninth graphic panel in Tropical Marine Gallery.

SYMBIOSIS

An example of commensalism is the shark-sucker in the Cold Marine Gallery.

Mutualistic relationships include the decorator crab in Cold Marine which anchors small anemones on its back for disguise. The anemones, in turn, receive scraps of the crab's meal as they float by.

Some of the large white sea anemones in Cold Marine have green algae growing in their cells giving them a greenish caste. The algaes contribute oxygen to the anemones which provide the algae a place to live.

The clownfish find protection in the tentacles of the anemones in Tropical Marine Gallery, and the fish bring food to the anemones.

Refer to: Fish Associations, tenth graphic panel in Tropical Marine Gallery.

SENSES

The seal takes in and expels air through its nostrils. The nostrils close under water and open by reflex as it surfaces.

The moray eel gulps in water through its mouth, expels water through hole behind eyes.

The shark takes in water through its mouth and passes it out through five gill slits. They usually swim continuously to achieve this.

The cod's mouth opens slightly to take in water, forces it out through gill slit.

The barnacle opens shell and kicks in water with jointed appendages ("feet")

Refer to: Senses fifth graphic panel in Temperate Marine Gallery.

LOCOMOTION

Shapes for fast swimming - streamlined, cigar-shaped.
for turning sharply - large pectoral fins
for swimming close to the bottom - underside is flat
for living in crevices - flexible, snake-like.

Refer to: Diversity in Fishes, Shapes, eight panel in Temperate Marine Gallery.

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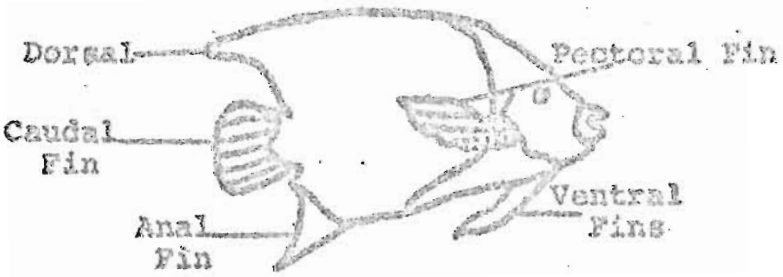
New England Aquarium

FISH FORM

A fish, unlike a land creature, needn't expend much energy carrying its body around. Because his specific gravity is almost the same as that of the surrounding water, it requires little or no effort to support himself. His major problem is overcoming the resistance of water in order to propel himself through a medium 773 times denser than air.

His fins are useful, but not wholly necessary, for propelling him forward. Even without fins, a fish can navigate fairly well. Experiments have shown that the caudal or tail fin is useful in locomotion; the dorsal and anal fins act as keels to keep the fish upright. The pectorals and ventrals increase maneuverability. When swimming forward, the animal keeps these fins folded back. One or both can be opened to act as a rudder in turning or as brakes for stopping short. It is the muscular movement of the whole body that is most important for locomotion.

FIN STRUCTURE



Body form also relates to how a fish moves through water (as well as to how it behaves). There are five basic body shapes:

1. Fusiform (torpedo-shaped) - This is the characteristic stream-lined shape of fish that move quickly through the water, common in open-water fish such as striped bass.
2. Depressed (flattened dorsoventrally) - The skate and the goosefish, both slow moving bottom-dwellers, exemplify the depressed form.
3. Attenuated (elongated) - The Atlantic silverside is an active forager. The barracuda has a similar shape and rapid movements characteristic of attenuated fishes.
4. Truncated (blunted) - Truncated fish, like the lumpfish, often are benthic or semi-pelagic fish which don't need rapid swimming ability.

5. Compressed (Flattened laterally) - The compressed flounder is perfectly adapted for life on the sea floor. Born looking like a "normal" fish, a few weeks later one eye migrates to the other side of the head, it begins to swim sideways, and it loses pigment on the bottom side or "blind" side.

References:

The Life Story of the Fish, by Brian Curtis
Dover Publications, New York, 1949

"Variety of Form: Coastal Fishes" by Robert D. Anderson, Man and Nature, December, 1971

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NEW ENGLAND AQUARIUM

STRUCTURE AND BEHAVIOR

The basic behavior of any animal includes eating, hunting, mating, hiding, and schooling. Behavior is difficult to observe in the restrictive environment of an Aquarium tank. Often one can deduce bahavior by observing the physical characteristics of an Aquarium animal. The structure of each animal varies slightly or greatly from an idealized "norm" to help it adapt better to its particular life style. Examine the following animals and decide what behavior may be indicated by their structures of the following animals.

Temperate Marine Gallery

Tank Number	Exhibit
	penguins
6	sea robin
10	garibaldi

Freshwater Gallery

	electric eel
15	paddlefish

Cold Marine Gallery

21	octopus
23	flounder
23	skate

Giant Ocean Tank

	sawfish
	sharksucker
	sea turtle

Tropical Marine Gallery

32, 36	squirrelfish
37	parrotfish
38	butterflyfish
39, 36 and GOT	triggerfish

Choose 2 specimens and describe how their structure may reflect their behavior.

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AQUAVENTURE

Structure and Behavior of Aquarium Animals

Teacher's Info Sheet

By observing the structures of the Aquarium animals, you can determine how they adapt to their natural environment. You can make educated guesses how the following animals use their particular structures in nature. There are several more possibilities than those listed below.

Temperate Marine Gallery

Tank #	Exhibit	
	Penguin	Countershading - its black back blends in with the water when seen from above, while its white underside blends with the light surface when seen from below by a potential predator or prey. Its feathers keep it dry because they're coated with oil. The short flat tail is used with the feet as a rudder. Flipper-like wings helpit to swim up to speeds of 30 mph.
6	sea robin	Its pectoral fins are adapted into sensing organs that feed and taste.
10	garibaldi	This fish uses its bright colors to warn others against entering its territory. Juveniles of the same species have bright blue spots which prevent them from being attacked by adult garibaldi.

Freshwater Gallery

	Electric eel	It uses electricity it generates to stun prey.
15	paddlefish	It has an elongated nose for balance and sensing.

Cold Marine Gallery

21	Octopus	This mollusk has a compressible body that enables it to squeeze into narrow crevices where it hides from predators. Its coloration changes to match the color and texture of its background. Its suckers grasp prey and when the octopus is attacked, anchor it to the rocks inside its hiding place.
23	flounder	Both eyes are situated on one side of its head because it lives on the bottom. The flounder can undergo color changes to match its background for camouflage.

Tank #	Exhibit	
23	skate	Its depressed shape, typical of a bottom-dwelling animal, fit it closely against the bottom. Spiracles on the top of its head admit oxygenated water. If it took in water through the gills on its underside, it would also ingest sand.
Giant Ocean Tank		
	sawfish	It attacks schools of fish with its saw-teeth, wounding several members of the school by a single slashing motion.
	sharksucker	This fish uses its sucker disk for hitching rides on other animals. Its fusiform shape presents the least resistance to water when swimming, and probably does little to detract from the host's speed.
	sea turtle	Its nostrils are placed near the top of its head so it only needs to protrude a small part of its body out of water to breathe. Its webbed feet provide greater surface area to push aside water when swimming.
Tropical Marine Gallery		
32,36	squirrelfish	Its large eyes aid it in nocturnal feeding.
37	parrotfish	Its teeth have fused together into a beak-like structure for breaking off chunks of coral to eat the soft coral polyp inside.
38	butterflyfish	A compressed shape makes it easy for the butterflyfish to slip between coral stalks for protection. Its tiny, slightly elongated mouth is adapted for feeding on small algae on the coral.
39,36 and GOT	triggerfish	Its long dorsal spine anchors it under rocky crevices. Large dorsal and ventral fins give it greater maneuverability within the coral reef.

beginner's guide to home aquaria

by Marcella Cohen

New England Aquarium

Man's fascination for water and animals living in the aquatic world is universal. Next to dogs, fishes in home aquariums constitute the second largest pet business in the United States. The opportunity to create a total environment, whether in a tiny clay bowl or a five hundred gallon tank, is both informative and enjoyable for the aquarist.

It is believed that men living ten thousand years ago kept water creatures alive in clay bowls. Egyptians living before Christ, Chinese of the Ming Dynasty (1300's), and even Madame Pompadour are credited with keeping fishes. If 1971 is your year to join this long line of aquarists, the following suggestions should contribute to your success.

For your first aquarium, a fresh water system is much simpler to maintain than a marine or salt water environment. Keeping in mind that a constant temperature must be maintained in the aquarium, choose a draft-free area in your home. An electric outlet should be accessible to the tank. The next consideration should be the kind and size of aquarium; the most practical is a ten gallon, rectangular, glass and stainless-steel tank. You can always go on to a larger tank as your interest and your fishes grow. To determine the weight of water in the aquarium, multiply the gallon capacity by 8⅓. (For example, nine gallons of water weighs 75 pounds.)

"Setting-up" your aquarium will require a small amount of equipment, a great deal of patience, and an understanding of four basic principles. A successful aquarium, be it a ten or ten thousand gallon tank, needs oxygen, light, a constant temperature and proper feeding of the animals. Fishes breathe by extracting dissolved oxygen from the water with their gills. The surface area of an aquarium provides some of this oxygen, and a small electric pump, called an aerator, will supply the rest by pumping oxygen into the water. A filtering system is an important part of the aquarium; in a small tank it can be used in conjunction with the aeration system. A heater and a thermometer are essential in maintaining a constant water temperature. Overhead reflectors or lights, which provide light and help heat the water, can be purchased to fit most small aquariums. Fishes are "cold-blooded" animals whose body temperatures are dependent on the temperature of their environment; sudden changes in temperature can be deadly.

Once you have acquired all your equipment, the aquarium must be sterilized before it is "set-up." Thoroughly rinse the tank with a solution of salt water; one cup of salt to each gallon of water is effective. After sterilizing the aquarium, thoroughly wash the sand or gravel that will line the bottom of the aquarium by running clean water over it in a large pan.

Line the bottom of the tank with an inch and a half of washed gravel and fill the tank with water, leaving a couple of inches at the top. Set your filtration and aeration systems into action, turn your heater on, and wait. Wait until the water has "seasoned" in the tank for at least forty-eight hours, and the temperature has stabilized at approximately 74° F without artificial lighting. While you are patiently waiting for your system to stabilize, consult a book about fresh water tropical fish, if you haven't done so already, and also visit a pet shop and a large aquarium. Keeping in mind the size of your tank and your unfamiliarity with the equipment, select two or three fishes, preferably inexpensive animals, for your first experience. Learn about the proper temperature, food and growth potential of the fishes you select before bringing your pets home.

Introducing animals to a new environment should be done gradually. Float the fishes in a small, water-filled plastic bag in the aquarium for about an hour, slowly exchanging small amounts of the water in the bag with the tank water. This waiting period will lessen the shock to the fish's system at entering the new environment. As you become a more experienced aquarist you will want to add more animals to your tank. An overcrowded aquarium is not advisable and a safe rule to follow is an inch of fish per gallon of water. Your possibilities, however, are limitless; for example, you may stock a ten gallon tank with five two inch swordtails, thirty small tetras or any compatible combination of fishes.

Prepared dried and frozen foods, as well as finely chopped raw meat and vegetables are desirable food for most fish. Try not to feed your animals more than

can be consumed in six minutes, and clean out any residue with a siphon or net. Over-feeding is a common aquarium problem which leads to fouled tanks and diseased fishes.

Because the aerator supplies your tank with oxygen, plants are not necessary in an aquarium, but they do add to the aesthetic quality of a tank. Certain fish will uproot plants while other species do better psychologically in a planted aquarium. It is sometimes better for the inexperienced aquarist to wait awhile before dealing with the intricacies of a planted aquarium.

Rock formations, plantings, backgrounds, water and the fishes themselves all contribute to the aesthetic quality of an aquarium. Anything that is introduced into a tank must be sterilized. Natural rocks can release harmful materials into the water, and salt water coral and shells are definitely hazardous in a fresh water aquarium. Specially treated aquarium materials come in a wide variety of colors, textures and shapes and can be purchased in most pet stores.

Dissolved materials account for the acidity or alkalinity (pH) of water. Kits can be purchased in pet stores to aid you in establishing the desired pH level for your aquarium. Acid or alkaline materials can then be added to the tank to achieve the desired pH.

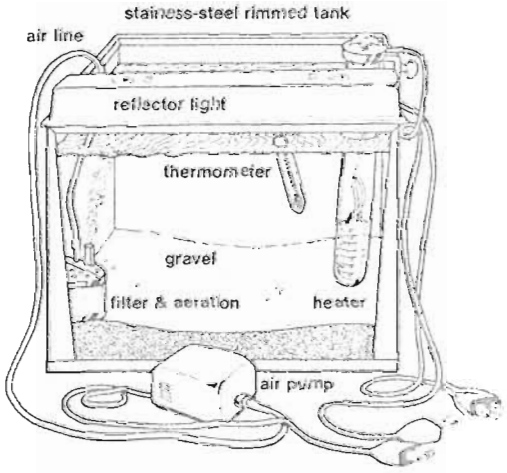
A small amount of water will evaporate from the aquarium each day, but replenishing the tank water can be done quite simply. Keep a supply of 3 or 4 gallons of tap water on hand, that is at least 24 hours old. Glass bottles with air holes in the covers make the best containers. Replenish evaporated water with seasoned water a quart at a time. If large amounts of water evaporate from your tank, occasionally remove 10% of the remaining water and renew it with seasoned water.

Fishes are subject to a variety of diseases, including tumors, parasites, fungus infection and malnutrition. You should be able to avoid most of these problems by consulting home aquarium literature and following their suggestions.

If a disease appears in your fish, an early diagnosis is your pet's best hope. Visually examine your animals frequently in search of swollen areas, blotches, and growths on their bodies. Treatment varies with symptoms. *Exotic Aquarium Fishes* by Dr. William T. Innes is just one of many aquarium handbooks that will help you deal with this and the many other aspects of aquaria.

From personal experience in keeping a rapidly-growing Jewel Fish, *Cichlasoma bimaculatis*, in a ten gallon tank, I can vouch for the satisfaction one receives as you see your aquatic pets grow and respond in the environment you have created for them. ■

Diagram / New England Aquarium



The basic equipment of fresh water home aquaria serve specific functions in the life support of your animals.

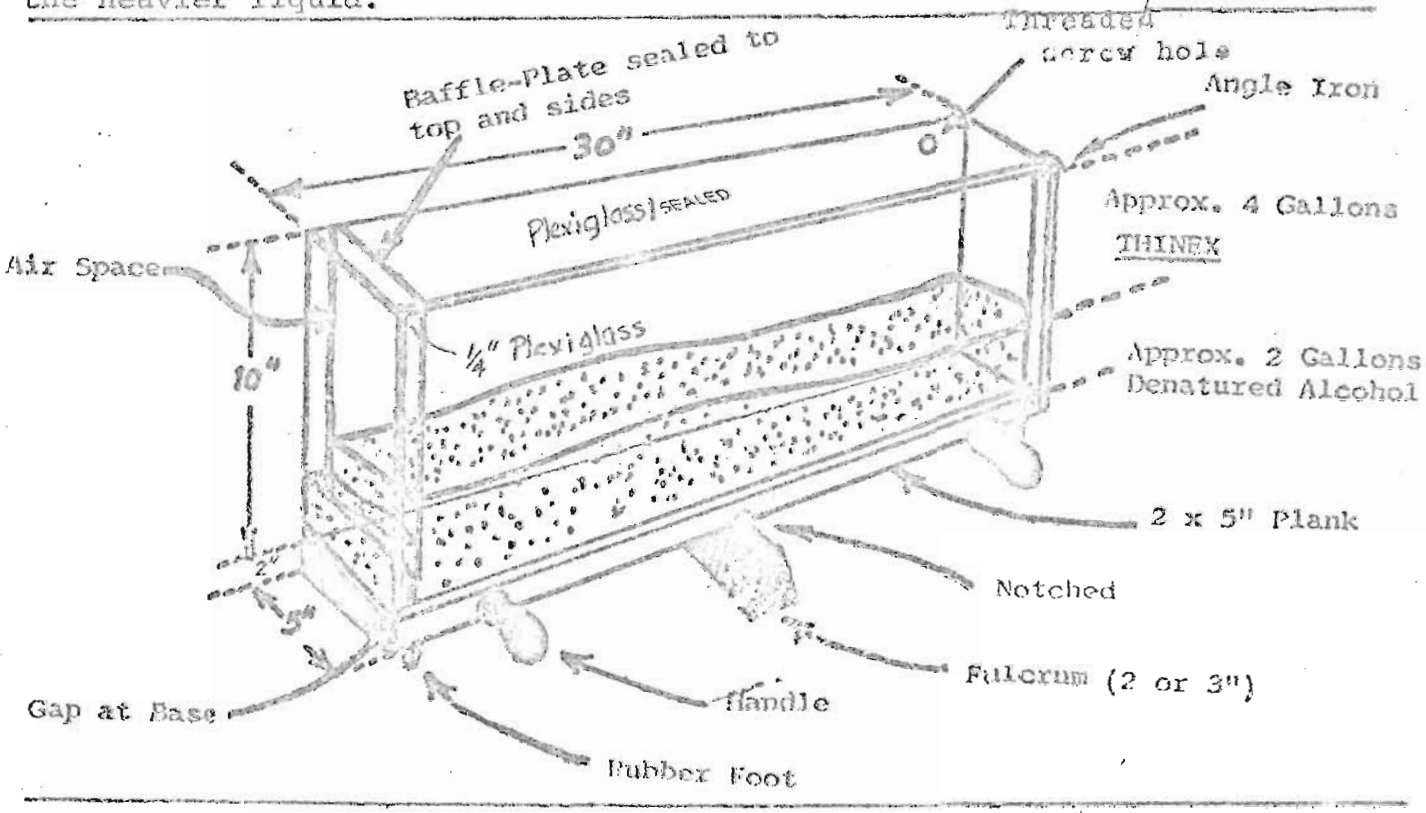
Reprinted from AQUASPHERE, Journal of the New England Aquarium
Volume 4 Number 4/1971

CONSTRUCTION DETAILS FOR WAVE MACHINE

The modified diagram below is suitable for construction by the amateur scientist. Instead of a cumbersome external expansion tank, we suggest simply allowing an air space at the top, equal to about 10% of the total volume. Another idea might be to warm the liquids before sealing the tank to a temperature slightly above the highest room temperature expected. In any case take extreme care against possible breakage or fire following breakage. The tank is constructed with Lexan Plexiglass, using plexi solvent to bond the sides together.

The slow-motion effect of the waves is achieved by the use of two non-mixing liquids, one just slightly heavier (more dense) than the other.

Since the liquids are all most identical in density, only very slowly can the heavier one displace the lighter one. As much flow resistance occurs at the interface, waves are cast up and slowly fall to rejoin the heavier liquid.



NOTES:

1. The liquids we use are a paint thinner called THINEX (clear) and denatured alcohol dyed blue (add small quanity of food coloring). Both are highly inflammable and extreme care must be taken. Other liquids similar in density could be substituted; Experiment!

2. The iron frame might be dispensed with if tests reveal very strong bonding of epoxy to glass.

3. The tank could be made of Plexiglass, but will slowly soften over a period of two to three years.

All Aboard

-an environmental survey of Boston Harbor aboard the Rocket II.

Prepared by: George Hahn-Newton Jr. College
Sandy Wiper-Newton High School

I. Purpose: To examine the waters of Boston Harbor and Mass. Bay from the inner harbor to a point about 10 miles out.

II. Before boarding:

necessary:
a. Arrange a date with Capt Matthew Hughes, Rocket II on Long Wharf, well in advance. Boat located directly across from the Aquarium.

strongly suggested:
b. Arrange with Aquarium to go to their lecture on the Boston Harbor. Call or write Mary Moore at the N.E. Aquarium Central Wharf Boston, Mass. 02110

background information:
c. Save our Shores (SOS) a group devoted to saving Boston Harbor-excellent slides-showing free. Also have film available. Write Save Our Shores, Inc. P.O.Box 103 North Quincy, Mass. 02171

d. Sierra Club of Boston - This organization is very interested in the harbor. Have materials and speakers available. Write them at 373 Huron Ave. Cambridge, Mass.

e. Port Authority of Boston. Concerned with future development of the harbor. Would be good to hear their program. Contrast it with a speaker from the Sierra Club. Write them at 100 Terminal Street Charlestown, Mass.

wear:
f. Dress in old clothes - bring foul weather gear. In cooler weather may be good to wear thermo underwear usually windy. For sunny warm days bring sun tan cream

collect money:
g. Usual charge for about 30 students is $6.00 for the day. Have money ready to give to Capt Hughes on the day of the trip.

lunch:
h. You can buy a snack aboard ship or you can bring a bag lunch. Boat has hot dogs, coffee, potato chips, etc.

meeting place:
i. Best from school area, if taking cars. It is accessible from the MTA. Get off at the Blue Line Aquarium stop. Boat docked just across the street

sea-sickness:
j. Good to have the 'anti-sea sick pills' along. Take just prior to boarding - will keep you in good shape for the day

equipment
k. Bring your own, or arrange to borrow. (look over the on board studies in the next section to see what you might need). Should get a Hach or Lamotte test kit for chemical tests.

fishing:
l. Those that like to fish - he has lines aboard. Could arrange with Capt. Hughes to have bait and get in a little fishing.

time: m. Plan to use whole day - will return to dockside about 4:30.

organization: n. Have your group set up in small groups - each assigned to perform an activity at each stop. Make sure each group has a recorder. Collect their reports at the conclusion of the trip.

III. The Trip:

tour ofboat and route that will be taken: a. Good to take tour of boat to learn lay-out. Have Capt. Hughes say a few words about boat. Have him show on a coastal chart the route you will follow.

first test: b. Make your first tests at dockside, gives you chance to get teams together and test equipment also report on weather of day and report on tide

stop & go c. Plan on making about five or six stops going out. Most tests are done when boat comes to stop. Be sure to take pictures of activities aboard ship and also of landmarks in harbor

activities on board: d. Tests that can be undertaken

1. water temp. at different depths
2. underwater visibility using a Seechi disc
3. plankton samples (could have microscope along)
4. may catch fish (analyse stomach contents)
5. pH of water (acid-alkalinity)
6. bottom dredge - need a dredge that completely closes-sieve contents on deck-keep contents in plastic shoe boxes
7. BOD (biological oxygen demand)
8. specific gravity - determine salinity
9. Soundings - use marked rope method
10. dissolved oxygen of water
11. take weather readings at each station
12. nitrate - phosphate tests
13. coliform counts
14. hardness of water
15. CO_2 reading
16. benthic trap - baited crab trap

other activities: e. Could do current readings - simple navigation locate self

also bring: f. Bring preservatives, plastic buckets and bags, rubber gloves, magnifying lens, cameras (take slides) fish and plankton keys.

g. Good to tie all dredges, materials going over board to rails.

IV. On Land Again

in classroom a. have teams report on data in classroom. Could be done by putting up poster paper and have each group post their results-put presentations in order taken so relationships can be seen. Instructor

1. can take the information and compile a report. When a final report comes out a discussion can be held.

b. Examine plankton under microscopes.
c. finish examination of fish stomach analysis, parasites on scales, blood samples, weigh fish, etc.
d. follow up on biological oxygen demand (BOD)
e. follow up on dredge samples.

Printed for Massachusetts Marine Educators by

the New England Aquarium