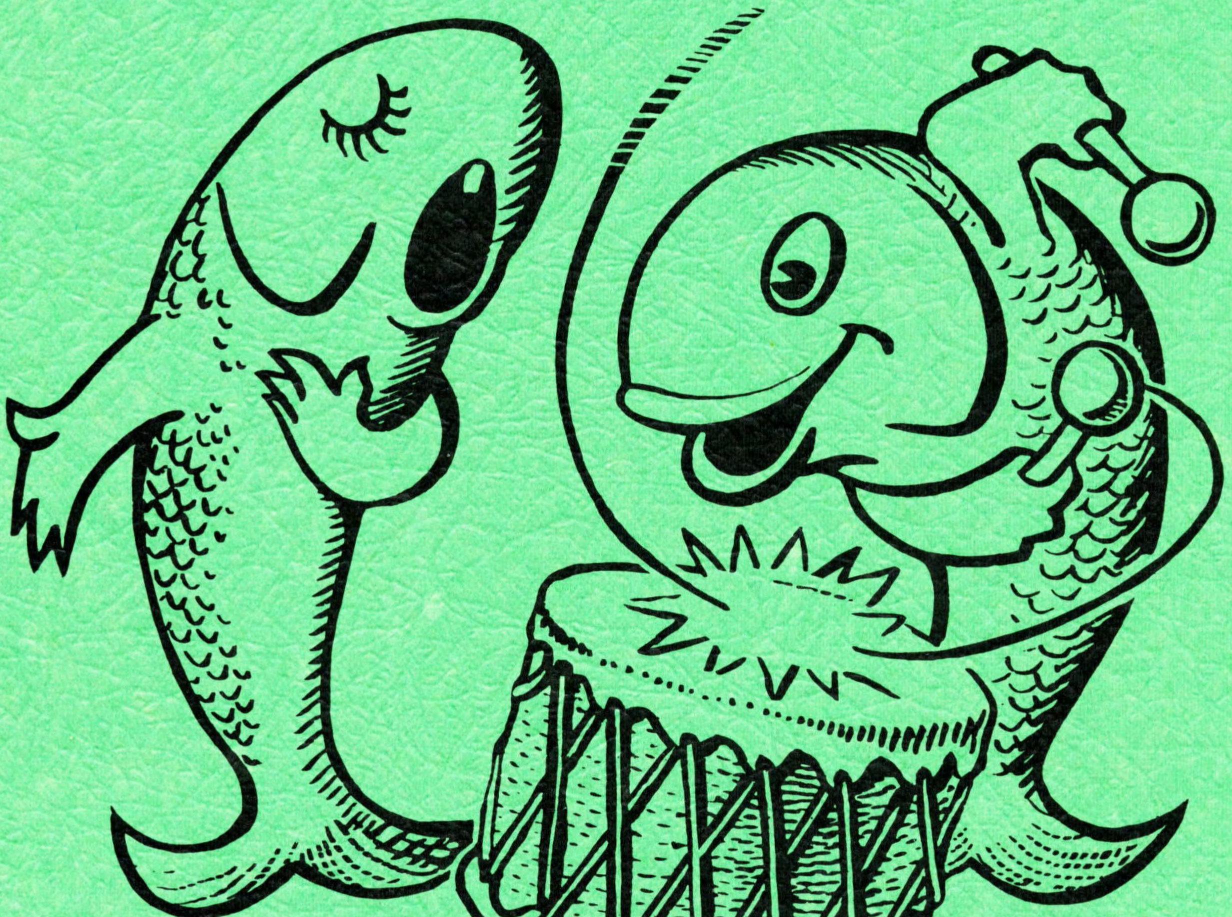
The DRUM and CROAKER

A Highly Irregular Journal for the Public Aquarist



APRIL 1973

VOLUME 14 (73) NUMBER 1

VOLUME 14 (73), NUMBER 1 APRIL 1973

DRUM AND CROAKER

The Informal Organ

for

Aquarists

Manuscript material received is reproduced with a minimum of editing and is not returned unless requested.

We take credit for neither spelling, nor classification.

Send material to: John G. Shedd Aquarium
1200 S. Lake Shore Drive
Chicago, Illinois 60605

This issue of DRUM AND CROAKER compiled by Kim J. Marggraf, Secretary to the Director, John G. Shedd Aquarium.

Prepared by the John G. Shedd Aquarium; 1200 South Lake Shore Drive; Chicago, Illinois as a service to aquariums generally.

Dr. Earl S. Herald, Director of the Steinhart Aquarium, died in a diving accident at Cabo San Lucas, Baja, California on January 16, 1973. A memorial fund in Earl's name has been established at the California Academy of Sciences. Friends wishing to remember him may contribute to the fund.

The next issue of Drum and Croaker will be dedicated to Earl Herald. All those who would like to contribute an article to this issue are urgently requested to submit it as soon as possible.

CONTENTS

THE DEMISE OF THE

NATIONAL FISHERIES CENTER AND AQUARIUM

William Hagen*

About September 1, an order was issued by the U.S. Department of the Interior closing out the offices of the National Fisheries Center and Aquarium. Thus, for all practical purposes, finis is written to an effort of more than ten years, including the expenditure of about four million dollars in planning and research.

Some months ago it was evident that the breath of life was faint in the project when the House Interior Subcommittee reallocated the Fisheries Center construction funds to other Fish and Wildlife activities. Congresswoman Julia B. Hansen (D-Wash.), chairwoman of the Subcommittee, could not be faulted for this action. Since the death of Congressman Michael J. Kirwan, the sponsor of the Fisheries Center, she had continued strong support but could not muster other members of the Congress behind the project. It should be recognized that support of a project of this kind for the District of Columbia could hardly win votes for a Congressman in his own district. Furthermore, a very strong member of Congress would be required to keep the project alive and see it to completion. Such a one was Kirwan, who had no trouble being re-elected and who, through seniority, controlled to a great extent the appropriations for projects throughout the country.

Obviously the writer is not happy about the fate of the Fisheries Center, having started it, written the authorization bill, and entered into the great deal of planning, along with others, resulting in completed plans and specifications for construction.

What went wrong? The initiation of the project, securing passage of the authorizing legislation and appropriations, required constant and successful contact with members of the Congress and with clerks of committees. This the writer did, but was slowed considerably when the then Secretary of the Interior Stuart Udall told the writer, "You are either working for me or for someone on the Hill. Make up your mind." Not wishing to jeopardize over thirty years with the Department, obvious activities were diminished. (This was only one of a long series of events now detailed in the writer's private history of the project.)

*Former Assistant Director, Retired in 1971 after 37 years with Fish and Wildlife Service.

In recent years the Fisheries Center did not maintain and develop the Hill contacts. This was most unfortunate but, it should be said, such contacts probably could not have saved the project after the death of Mike Kirwan. The effort should have been made.

From the early days of the Fisheries Center planning the Office of Budget and Management, an arm of the White House, was in opposition. Quite apparently, then, the occupants of the White House (both parties) were not favoring the project but, also, did not openly oppose it because of the Hill backing, particularly by Kirwan.

Now what? Nothing for the time being. To belabor a near-dead horse will accomplish nothing. We say "near-dead" because the act authorizing the Fisheries Center was not repealed. It is still there for future use and plans and specifications are ready. The $10 million appropriated for construction is gone. At some future time it is possible that new appropriations may be secured for construction of the facility.

In concluding this brief recital of a failure, we wish to thank all of the aquarium people throughout the country, and other individuals and organizations, too numerous to mention, who actively supported the Fisheries Center.

So, we rest in retirement, but not in peace, unlikely to see the Fisheries Center a reality.

Anyone need an experienced legislative consultant?

To "Drum & Croaker" Readers:

Regretfully, our plans for the long-awaited new National Fisheries Center and Aquarium have finally come to an end. The project has been terminated, and the funds originally appropriated by the Government for its continuation will be spent elsewhere. Should it be revived by a new group of planners sometime in the future it is hoped that our years of preliminary work may serve as a useful foundation and not be altogether lost. Whatever else it might have been, the Center would have certainly been the most meticulously planned institution of its kind ever built. For this, we thank our fellow aquarists who have given so much of their time, energies, and enthusiasm in an advisory capacity throughout the years of its conception.

We thought that this history of the present National Aquarium (which was originally written in 1962) would be of interest to readers of "Drum and Croaker". The Junior Author has since moved to Yankton, South Dakota to take charge of the National Fish Hatchery Aquarium at Gavins Point, while the Senior Author (who has worked on the Fisheries Center Project since he left his position as Curator of the Miami Seaquarium in 1959) plans tentatively to leave the aquarium field and to devote more of his outside time to writing and illustrating in the future.

Craig Phillips,
National Fisheries Center
and Aquarium

HISTORY OF THE NATIONAL AQUARIUM

Craig Phillips and Carl F. Wall

The National Aquarium in Washington, D.C. has had a long and varied history as an institution, being the oldest established aquarium in the United States, and one of the oldest in the world. Through the course of its existence, from its conception to final establishment in 1873, until the present time, this aquarium has been situated at various locations, each designated as the National Aquarium in turn.* Its present location, since 1932, is in the basement of the Commerce Building, on Constitution Avenue between 14th and 15th Streets Northwest. By tradition it has always been free to the public and open from 9 to 5 each day of the year except Christmas.

Prior to 1871 there was no branch of the United States Government especially charged with the consideration of fishery affairs, although fishery questions

*This claim on our part has been likened to that of the man who said he had smoked the same pipe for 60 years, during which time he changed the stem three times and the bowl only once.

of varying importance on both the domestic and international scene had been arising with increasing frequency ever since the achievement of National Independence in 1776.

In 1870 a Federal Fish commission was created as the result of a movement by a small, newly organized group, the American Fish Culture Association, predecessor to the American Fisheries Society. Volume XXVIII, 1908 Bulletin of the Bureau of Fisheries states that "...The American Fish Cultural Association directly influenced Congress to establish the office of Commissioner of Fish and Fisheries." The concept of a national aquarium came into being in 1871 when Col. Orville E. Babcock, aide to President Grant and Commissioner of Public Buildings, stated in his annual report of that year that he favored an aquarium under a Zoological Garden Director at the Washington Monument Grounds.

Dr. Spencer Fullerton Baird, an eminent ichthyologist and staff member of the Smithsonian Institution, was appointed Commissioner of Fish and Fisheries in 1872 to prosecute investigations and inquiries on the subject of fishes. In the winter of 1872 the Commissioner's office was moved from Dr. Baird's private home to the Columbia Armory (later to be known as the Fisheries Building, which was demolished in 1964.) Shortly thereafter, summer offices of the Fish Commission were established at Woods Hole, Mass. and the Commission moved back and forth between Washington and Woods Hole according to the dictates of the seasons. In 1873 the first National Aquarium was established at Woods Hole as a summer project.

The Federal Fish Commission realized early that to support the rising rate of sport and commercial fishing it would be necessary to undertake the artificial propagation of desirable fishes. Shad and buffalofish were among the first species to be studied for this purpose. In 1878 the District of Columbia holding ponds, known as Babcock Lakes, were completed in connection with the new Zoological Gardens on the grounds of the present Washington Monument. In addition to the ponds and open aquaria, the zoological section exhibited such animals as monkeys, deer, turtles, an eagle, and several dozen English sparrows, the latter creatures then evidently more of a curiosity than they are today.

In 1881 a hatching station and small aquaria were set up in the basement of Central Station (as the Armory location was called) as interest in the Fish Commission was very high at the time. The drawing down of Babcock Lakes was witnessed by President Chester Arthur and members of the Congress in 1882.

Replacing Dr. Baird (who drew no salary for his position) in 1886 was Marshall McDonald, the first paid Commissioner of Fish and Fisheries. His reported objective for the year states: "To have Central Station grow as rapidly as possible, to experiment, develop, and illustrate methods of fish culture, scientific inquiry, develop aquaria to do this and observe and determine habits and life history of fishes."

In October of 1888 an aquarium with 16 feet of running glass was installed in an annex on the west side of Central Station. Another one was built shortly after that and in January 1889, a marine annex, 130 feet long, was added to the south side of the building. Materials used in the new aquarium were glass, wood, slate, and hard and soft rubber. The exhibits operated on the "closed" system, with the water being circulated through the tanks repeatedly. The sea water was brought up the Potomac from Chesapeake Bay by the steamer "Fish Hawk". All the freshwater specimens, with the exception of the trout, were kept in water made slightly brackish with salt to act as a fungicide and to help heal any injuries which they might have acquired in handling and holding.

In 1890 William P. Seal, the first Aquarium Director, wrote Observations on the Aquarium of the U.S. Fish Commission at Central Station. In this work he reported that in his opinion the results of maintaining the aquarium were so favorable that it should be further developed as an institution of practical observation and experimentation. He also mentioned the need for Government help to foster the growing enthusiasm which could offset the general public's lack of information on the subject of aquatic animals and plants. This could be aided, he felt, by the addition of pond aquaria, so that specimens could be observed both from above and beneath the surface.

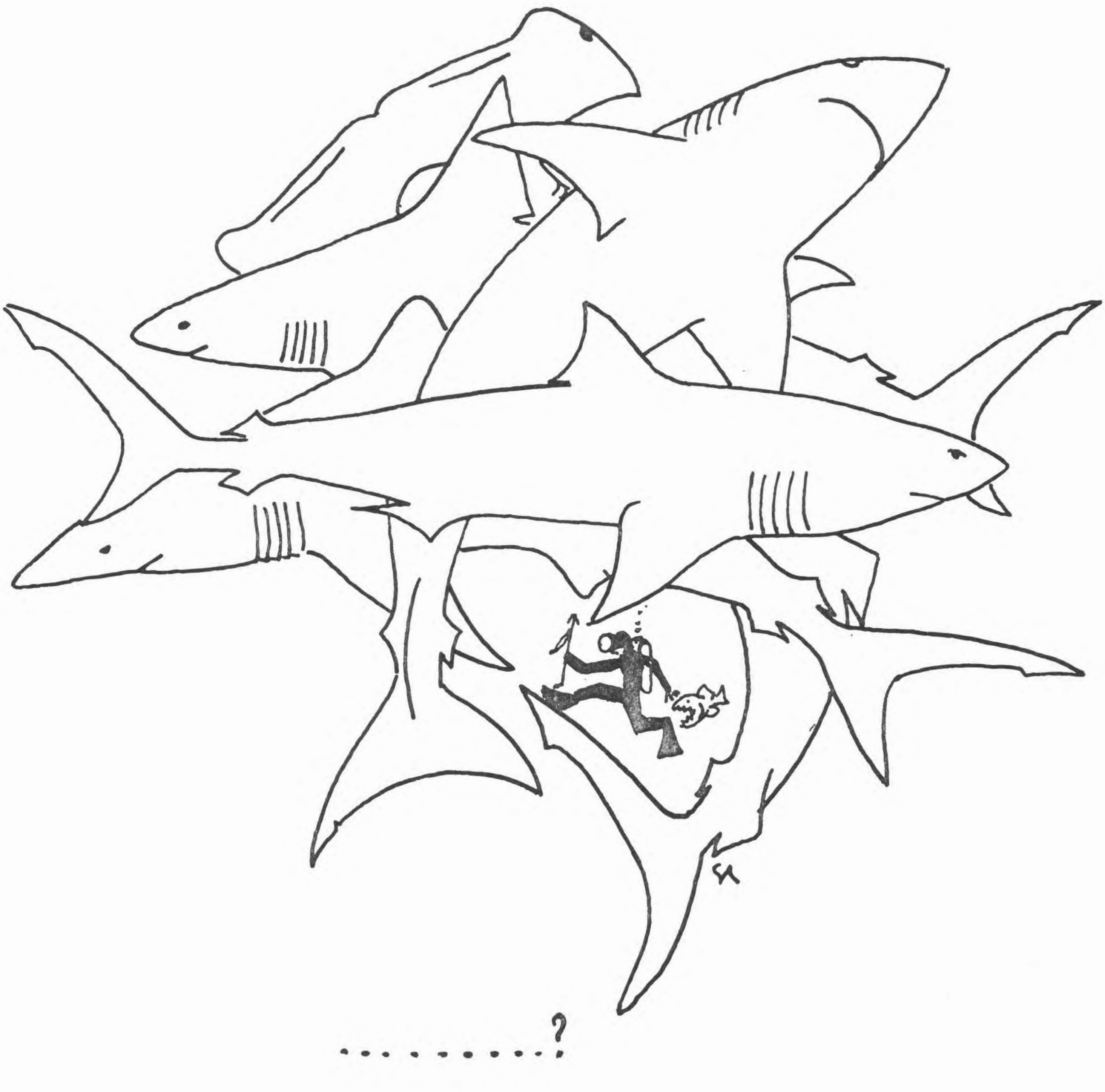
In this same year Seal spoke before a meeting of the American Fisheries Society, proposing that the whole of Rock Creek Park Valley be converted into one great National Zoo-Aquarium for the study of terrestrial and aquatic life, under the auspices of the Fish Commission. Meanwhile, Seal continued his research at the present aquarium, developing, among other things, the forerunner of the aquarium air-stone, which breaks up a stream of air into numerous tiny bubbles for the purpose of achieving maximum air-absorption by the water. His method, an ingenious one was to force small disks made of sections of porous grapevine into the ends of rubber tubing.

Dr. Seal was replaced as Aquarium Director in 1895, and during that summer a mass mortality occured among the aquarium's specimens from over-heating. From this time on, summer heat became a serious problem. In 1899 the Aquarium was renovated and new pumps installed, but the heat problem remained unsolved. In 1902 Director Harron requested a larger aquarium equipped with a refrigeration system. The specimens at that time were fed a varied diet of clams, oysters, minnows, beef, and beef liver.

The Fish Commission became part of the Department of Commerce in 1903, changed its name to the Bureau of Fisheries, but both offices and Aquarium remained in the Fisheries Building until the Commerce Building was constructed in 1932. Babcock Lakes had been finally abandoned in 1905 due to lack of suitable water and spring floods, the fishes being either released or moved to the new National Zoological Gardens. Meanwhile, the Aquarium continued its growth, adding extra tanks of larger size, and until 1924 had little trouble other than that of mortality due to summer heat. In that year chlorine was added to the city water supply and many fish died as a result, followed in early 1925 by a total mortality reportedly due to an infestation by the protozoan *Ichthyopthirius*.

From 1926 to 1932, Director Harron repeatedly secured new specimens for the tanks, only to lose them through heat, chlorine, and diseases.

Finally, in 1932, the new National Aquarium in the Commerce Building was ready, with its refrigeration systems, chlorine removal units, and staff trained in the use of chemicals for the treatment of fish disease, and has successfully maintained a varied exhibit of aquatic life, both native and exotic, up to the present time.



. . . . ?

CALGARY AQUARIUM CLOSED

Calgary Brewing and Malting Co. Limited announced last August that it is embarking on a major program to expand the already well known Horseman's Hall of Fame on the Calgary Brewing grounds. Originally opened in 1963, this exhibit of Western Canadiana has been seen during the last 9 years by more than 3 million people.

As a result of this ambitious plan, the Calgary Aquarium closed permanently on September 5, 1972, in order to provide sufficient space for the Hall of Fame expansion.

The invaluable collection of specimens in the Aquarium were donated to Calgary's twin city, the City of Quebec, for addition to its already famous Aquarium.

# # # # #

WARREN J. WISBY, former director of the National Fisheries Center and Aquarium in Washington, D.C., has joined the University of Miami as associate dean for graduate studies of the Rosenstiel School of Marine and Atmospheric Science.

SOME EDUCATIONAL PROGRAMS FOR AQUARIUMS WITH MINUSCULE BUDGETS

Alan Levitt
National Aquarium, Washington, D.C.

Because of increased requests for more educational services from teachers and students, we have responded with what we call "miniprojects" designed especially for schools.

If any of you know of our aquarium, you will realize why our projects must be "mini" ones. We are a small aquarium with a very limited budget, staff and physical space. We are unable to allow any of our employees to devote a great deal of his time to working with schools. The limited staff and space here prevent the kind of classes and orientations given at the New York, New England or Vancouver aquariums. Professionally prepared dry exhibits such as wall panels or working exhibits (like the wave tank at New England Aquarium) are too expensive and require space. Since we are an inland aquarium, the creation and maintenance of the popular "touch" tidepool displays is also impractical. Finally, because we are a federal facility, we are not eligible for special funds from Sea Grant programs or other foundations.

Our education and information section is essentially a one man operation and since this is probably the case in many other aquariums, some of the programs or projects may be of interest. All are free to the public.

Our first effort was to prepare and make available free printed material. This is available at the aquarium office and basically falls on the kindergarten to 9th grade levels. We are starting to print a wide range of short, one or two page information sheets. Currently, these fall into four categories.

The first group is our "How to do it..." sheets. This includes materials about how to set up a tank, how to care for turtles, how to build an aquarium, etc.

The second type of materials is meant especially for teachers. This is one of the most appreciated services that aquariums can perform. Since teachers often teach several subjects, they do not have time to research a topic and create a lesson about it. We try to help out with material that is simple, short and straightforward, so there is little additional work that the teacher must do. For experiments, we present a general

NATIONAL FISHERIES CENTER AND AQUARIUM

HOW DETERGENTS AFFECT AQUATIC LIFE

Many types of pollution can "kill" a body of water. One type that is becoming increasingly prevalent is detergent pollution. Detergents are found in large amounts in sewage and municipal wastes and are quite rich in nutrients such as phosphates.

Although phosphates ordinarily cause no harm, when present in large amounts they can overstimulate the growth of algae and cause an "algae bloom." This often occurs in slow moving bodies of water where there is little flushing action and phosphates are allowed to accumulate.

When the algae die, they are decomposed by bacteria. It is these bacteria that consume much of the oxygen present in the water. Therefore, fish and other animals depending upon the water for their oxygen do not receive a sufficient amount and suffocate.

Whwn these oxygen consuming bacteria die, they are replaced by other kinds of bacteria that do not require oxygen. These new bacteria break down sewage molecules and release the foul smelling gases that are so characteristic of polluted waters.

The following experiment illustrates the above quite simply:

Materials: 2 jars, cloth, string, soil, small stone, methylene blue (sold in pet stores), plant material

Procedure:

1. Fill two jars to within one inch of top with water.
2. Add same amount of methylene blue to each.
3. Cover one jar and set aside. This is the control.
4. Cut up small amount of plant material (e.g. banana peel, apple core, carrot top, etc.) and mix with two tablespoonfuls of soil and stone. Place in cloth and tie together with string.
5. Drop bundle into remaining jar. Cover and set aside.

Methylene blue, a medicine for fish infections, is blue only in the presence of oxygen.

In this experiment the soil corresponds to the mud on the bottom of lakes and ponds. The plant material corresponds to dead algae tissue. When bacteria decompose the pieces of plant material, they use up the oxygen in the water. You can tell this within a couple of days because the solution will become colorless.

Since there is no plant material in the control jar, it remains blue. The decolorization of methylene blue in the other jar corresponds to a minature lake where this process occurs on a greater scale.

NATIONAL FISHERIES CENTER AND AQUARIUM

FISH PRINTING

Gyotaku, the Japenese word for fish printing ("Gyō" means fish, "taku" means print) was started in China over 600 years ago as a means of recording fish catches. It was developed into an art form by the Japanese.

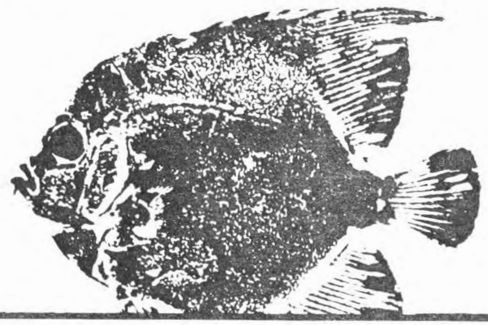
Fish printing is a relatively easy activity for children. It is not expensive.

Materials:
a fish (frozen or fresh)
ink (india, speedball, sumi, acrylic, water colors, etc.,-choose one)
paper (paper towels, rice paper, construction paper, etc.,-choose one)
small paint brush

Procedure:

1. If the fish is covered with slime, wash it with soap and dry it.
2. With a small brush gently paint one side of the fish with ink. Make sure all areas are covered including the fins. Use very little ink. Brush against the "grain" of the scales so ink will accumulate in these areas and make a better print. Most people use too much ink the first time so you will have to experiment.
3. Take paper and gently but firmly press down on fish. Rub evenly over all areas, especially head and fins. Do not move paper while pressing.
4. Carefully lift paper up making sure the fish does not move. This will smear the print.
5. Sign print. Give name of fish, date, etc.

Various papers and inks can be used. Experiment with paper absorbancy. Fish can be washed and reused. Generally, the thicker the ink and thinness of paper, the better the print. Try using different colored inks on various areas of the fish.



summary, materials needed, procedure and expected results. We have lessons on pollution (eutrophication), fish printing, desalinization, etc. We even have a couple of pages of poems about aquarium animals to stimulate awareness.

Background information is the third type of material we disseminate. This includes brief summaries of biological concepts and principles such as adaptation, coral reef building, mouth shape and feeding, etc. The last type of material is information about particular aquarium animals. These are often the most popular specimens like sharks or octopuses. We are now also preparing a number of self-guiding tours on specific topics such as locomotion or body shape. A teacher will be able to pick and choose among these tours and actually tailor her students' tour to the specific subjects being studied.

Some of these printed materials are used as responses to mail and phone requests for information. This helps to cut down on staff time spent answering the same questions. If we cannot send out previously prepared materials, we often send out one of about a dozen different bibliographies on particular subjects. We have contacts in all of the local aquarium societies and often suggest them to callers about "hobbyist" problems. (For example, an individual might have a problem breeding a particular fish.) Aquarium societies in this area are happy to cooperate because it often gets them new members.

Another "miniproject" initiated last spring was our "Teaching Box". This is a styrofoam fish box filled with good sized dried specimens for children to handle. The teacher can check out the box for a week at a time and bring it to her classroom. Most of the items in the box can be seen alive at the aquarium. The box now includes a set of shark jaws, natural sponge, pieces of coral, a cowry, large sea star, a conch, sea fan, abalone and spiny box fish. More items may be added at a future time. The specimens are easily packed in the box which we paint and label. Each box comes with background material about the animals and suggestions for lessons. Although the box was initially intended as a pre-aquarium trip lesson, this summer a workshop of teachers that borrowed the box created a flow chart for its use in math, social studies, art, english and creative writing.

The teaching box costs approximately $6.00 to put together. They are very popular, particularly among inner city and blind schools. Remember that we are an inland aquarium and many children in this area have never seen nor felt these animals before. We also loan out large sea turtle shells and these are virtually indestructible.

Another obvious project was to make many of our 35 mm slides available to teachers. With slides costing only a few cents a piece to duplicate, a series of slide programs was a "natural". If you can't take the slides yourself, many aquarium shots are available for 20¢ to $1 each from major aquariums and biological supply houses. The slides don't have to be masterpieces seen in the expensive picturebooks because teachers and students aren't that concerned with the fine details, etc.

Since we are attempting to publicize the new educational emphasis in the aquarium the first slide program put together was about the aquarium itself. It not only tells about the displays here and suggests teaching areas, it takes the viewer behind the tanks, into the kitchen and on a collecting trip. The program comes with a script so aquarium personnel don't have to narrate. It is intended for faculty meetings, science teacher workshops, and other groups. Other slide programs on camouflage, color and body will also be available this fall. The same set of slides can be used on different age levels merely by changing the script. Each slide program costs us approximately $5 and the cost decreases with number of copies.

This summer we also started making "touchable" exhibits for display in the public area of the aquarium. The first one was a large brain coral (15"). We embedded this in fiberglas and placed it on a waist high stand near some reef tanks along with a sign discussing corals. We have also ordered a large Tridachna and other items to be placed around the aquarium. The stands were made from 2" x 2"s with masonite covers. A cinderblock was placed inside for weight. However, many of these specimens are so heavy that they do not need to be mounted if a place can be found to display them. The Philadelphia Museum of Natural History displays unmounted pieces of coral and a large Tridachna on a carpet in a small alcove with no apparent problems.

These miniprojects, as we call them, give maximum mileage with a minimum of effort and expense. We hope that they help to give children a better appreciation of our animals, and if we are lucky, maybe a few kids will stop banging on the glass.

These projects are not our entire education program. Obviously certain aquariums cannot use these projects at all. A teaching box, for example, would be of little value in the Miami area where schools are well into marine biology. At Scripps or Vancouver, where actual classes are taught inside the aquarium, there is no need for as much printed materials. But for the small inland aquarium, especially one that cannot give tours and that has to operate on a tight budget, some of these ideas may be helpful.

Naturally, we at the National Aquarium hope to hear of other educational programs in aquariums with problems similar to ours.

THE LEGEND OF CHARLIE COPEPOD

Jody Licht
University of Illinois - Champaign

This summer while working at the John G. Shedd Aquarium in Chicago, I had the pleasure of meeting Caroline Cyclops Copepod. I walked into the lab and there she was, swimming around in her drop of water on a slide under my microscope. As I watched, she swam about getting her exercise and nibbling on tidbits of Tabellaria and Asteronella that she had seized.

After a short while she noticed me sitting there watching her. Totally unabashed, she stopped her activity to talk with me. She knew that she was in the Aquarium and said that she felt lucky to be out of her neighborhood, and away from the alewives roving the lake. She mentioned that the old area was beginning to get bad again with the planktivore gangs swimming around and picking on poor defenseless plankton. Then she said, "Do you know who we need right now? CHARLIE COPEPOD, that's who." Having never heard of the name before, I urged her to explain. This is what she told me.

"This happened many copepod generations ago. My mother told it to my siblings and while we were still in our egg cases attached to her body. I shall try to tell you the legend in the same way, because it is a very moving story.

It was the spring of that fatal year 1967, I believe you humans call it the year of the Big Die-off. A strange thing happened that spring. Our Hero was born. It was clear that Charlie was to be something different from the time that he was conceived. Usually eggs are carried by mothers (at least in the Cyclops side of the family) until they hatch into young nauplii. This was not true in Charlie's case. His parents could make only one egg fertile no matter how hard they tried, so they decided to drop it and try again later in the season. Consequently, Charlie was abandoned right off the breakwater, the one near the Aquarium. There he rested on a bed of soft filamentous green algae until he hatched into his first nauplius stage. Then another interesting thing happened. After his first molt, instead of going into the second nauplius stage, he jumped right into the first cope-poid stage, skipping over four major stages. Most of us take the stages slowly so that we can acclimate ourselves to having another set of appendages that we did not have before. Charlie must have been the most courageous plankton ever. I know that I could never stand the emotional trauma that he must have gone through. Then he took the following molts gradually and with each new one, Charlie grew until he was an enormous adult. He was even too big to be swallowed by an alewife. That is really something for a copepod. And fast? Even with his antennae he could beat all of his friends in races. You can just imagine what he could do with his thoracic swimming appendages. It must have been really something to have seen him. My mother said that her great-great-great saw him just before she died."

By this time Caroline was getting a little tired and hungry, so we ended the first session. Needless to say, I was completely overwhelmed to be hearing this fantastic piece of folklore coming from the mouth of a Cyclops. I guess microcosms have their history too. Life does go on at all levels of existence. Well, anyway, after this first session, many more followed. Each night I would put Caroline back into her jar, with fresh water and her phytoplankton and protozoans. She in turn shared with me some of the marvelous stories of her heroic ancestor. She told me of some of Charlie's rescues of fellow plankton; sometimes he would swim up with lightning speed and sweep the defenseless animals right out from under the alewives' gills or sometimes he would set up a whirlpool by swimming in a circle. This whirlpool would suck the plankton right out of the unsuspecting planktivore's mouth.

I will now let the story be finished in Caroline's own words.

"The alewife problem grew worse and worse. Charlie could not keep all the plankton from a dreadful fate, though he tried. He organized the Anti-alewife League, which patrolled the lake saving other little animals, but still plankton were being ingested in ever increasing quantities each day. There were not enough predators left after the lamprey eel scourge to take care of that end of the food chain. Something had to be done. Charlie came through again. The thing that bothered alewives the most was a rapid change in water temperature and Charlie knew that they were weak after spawning. In a flash he knew what must be done. Out to the four mile crib went Charlie Copepod. He used his mammoth strength in swimming around in a circle creating very strange currents in shore where the alewives were hanging out. The brought up confused currents arrived in sets. The first that hit was cold, from below the thermocline. Next, came a warm set which remained. The fishes' metabolism could not stand it and many died. Also, the A.A.L. was effective in keeping the plankton out of the area so many fish were weakened or killed by hunger. It was a great day in the history of the Copepod family, especially the Cyclops side. As you can see, Charlie was the biggest hero that ever existed in Lake Michigan."

I would like to interject my own thoughts here. I do not know if the alewives died because of Charlie Copepod's heroism. Caroline believed it, but as you can see, she was a biased individual. But many alewives did die that year. The population of alewives is now relatively constant though somewhat less than that of 1967. Consequently, the plankton have been allowed to enlarge their population accordingly. There are still alewives preying upon the plankton, thus Caroline was glad to be inside the Aquarium walls.

As you can tell by reading this short synopsis of Caroline C. Copepod's legend of her famous ancestor, which I got straight from the plankton's maxillary palp, there are many interesting things that can be found under a microscope. It is a whole new world, or actually a new dimension added to ours. The educated man of the last century knew about the world to be found there, and this quote from Bushbaum and Milne's chapter on Protozoa in the book The Lower Animals, tells well how I feel after this summer:

> "The almost incredible fairyland of beautiful and bizarre creatures that swim, feed, pursue each other and reproduce - unabashed by the gaze of anyone who chances to look at them through a microscope - may someday again become a source of entertainment and intellectual satisfaction after we have pushed most of the bigger animals to near extinction."

Ah, but what of Charlie Copepod? Well, he worked so hard at keeping the currents moving that in a state of near exhaustion, he caught influenza and died. But, never fear, because according to Caroline, his ghost appears every spring and kills off a few more alewives during his stay.

COLORS BENEATH THE SEA

David C. Powell
Curator of Fishes, Sea World, Inc.

The popularity of scuba diving in recent years has revealed for many people the beauty and fascination of underwater marine life. In public aquariums everywhere, much of this life is exhibited in approximations of their natural habitats. However, one aspect of the sub-marine environment that, to my knowledge, has not been demonstrated, is the visual change that occurs with increasing depth. In a recently completed aquarium display we have attempted to illustrate how the underwater scenery and the associated animals change in appearence with increasing depth.

Seawater, as well as the sediment and planktonic organisms that it contains, acts as a light filter with the result that at a depth of around five hundred meters, little or no light of any kind remains. However, the different wave lengths of white light are not filtered out uniformly: with red light being removed first, followed by yellow, green, blue and finally indigo.

Depending upon its organic and in-organic content there is considerable variation in the light filtering properties of seawater such that on objects seen at a depth of twenty meters in the Sargasso Sea will appear both quantitatively and qualitatively different from the same object at the same depth along the coast of California.

In an attempt to approximate this light filtering quality of seawater, we arbitrarily chose the light filtering curve of water from the Caribbean Sea and then selected Kodak Wratten gelatine filters that most closely approximated it. There was no stock filter made that matched exactly but we did find that the Wratten filters number 38 and 38A came reasonably close to matching the water from the Caribbean.

For our display, a tank of 250 gallon capacity was selected containing rocks that were collected from a depth of about fifteen meters. These rocks were encrusted with a wide variety of animal and plant growth, such an anemones, coral, gorgonians, coralline algae, sponges, tunicates, etc. In addition, the tank contains several species of rockfishes [Sebastes], which are predominantly red in color when viewed under surface illumination. Above the tank are four 150 watt incandescent floodlights that are approximations of the illuminations at the surface and depths of 8 meters, 15 meters and 30 meters.

The Kodak Wratten filters are not normally available in the size that will fit beneath a standard floodlight fixture. However, Kodak will supply them in almost any size upon request.

To achieve approximately the correct color balance and light intensity in the display we use one number 38 filter beneath the 8 meter depth light, one number 38A filter beneath the 15 meter depth light and two number 38A filters beneath the thirty meter depth light.

In the public corridor and mounted in the wall adjacent to the display tank are three momentary contact push buttons that correspond to each of the three depths. These are wired in such a manner that the surface illumination lamp is normally on. When any of the three buttons are pushed, they disconnect the surface lamp and connect the lamp that corresponds to the depth indicated beneath that push button.

The public reaction to this display has been very good and they take great interest in being able to control the light change and to actually see the change in the appearance of the animals with increasing depth.

RECENT RESEARCH ON BIOLOGICAL FILTRATION

Scott E. Siddall

Several good reviews of biological filtration have appeared in the literature recently. For a summary of the basic principles governing biological filtration, see Miklosz (The Marine Aquarist) and Spotte (Fish and Invertebrate Culture). A marine aquarist with a good working knowledge of biological filtration principles has a marked edge over the aquarist who maintains his tanks without knowing what is behind the rules for success he follows.

There has been little research into biological filtration as it applies to closed culture systems (like aquaria) in the United States, the majority of articles coming out of Japan in the period 1957-1966. A research study was carried out over the past two years at Case Western Reserve University in an effort to elucidate more of the chemical and biological principles of undergravel filters such as those used in marine aquaria. The result of this study has been a better understanding of the dynamics involved in biological filtration and new methods to make the best use of such filters.

Maintenance of Optimal pH:

We have known for some time that carbonate gravels make the best material for use in the undergravel filters. It is readily available as dolomite or dolostone and performs well in keeping pH values near 8.0-8.3 in addition to providing the surface area for the growth of beneficial bacteria. But after extended periods of use in a tank supporting some organisms, the pH of the system usually drops (assuming that no extensive changes of culture water have taken place) reaching a sub-optinal level. Some have attributed this failure of the dolomite to a coating of organic materials which commonly associate with carbonate sediments in the ocean. A good washing of the gravel should restore its capacity to buffer the culture water against any drops in pH, at least until another organic coating develops. The reasons for the failure of the gravel to sufficiently buffer the culture water were investigated in this study.

A theory was proposed based on some of the work of Ames* which states that calcium carbonates ($CaCO_3$; dolomite is $CaCO_3$ and $MgCO_3$ combined irregularly in crystal form) can be coated with phosphates present in

* Ames, L.L., 1959. Econ. Geol. 54:829-841.

the water surrounding the carbonate resulting in an insoluble mineral coating, a carbonate apatite coating. Phosphate dissolved in culture water is a result of feeding the cultured organisms foods containing phosphorus. This cannot and should not be avoided since the animals require phosphorus. But the phosphorus appearing in the culture water as phosphates might be able to coat the gravel in the tank, causing it to gradually become isolated from the culture water and of no further use in preventing drops in pH. That is, the reactive sites on the surface of the gravel become blocked.

The buffering activity of several types of dolomite gravel was determined. This activity was measured as the rate of pH increase of acidified artificial seawater as that water was passed through a 1" diameter column 12" long containing the test gravel. All gravels tested were of the same angular shape and size (1-5 mm). The data are presented in Table I as the change in pH during a thirty minute period.

TABLE 1

	pH Change
Tumbled Gravel	3.24
New Gravel	2.73
Culture System Gravel, Cleaned	2.43
Culture System Gravel	2.42
Na_2HPO_4 Treated Gravel	2.15

Gravel exposed to a phosphate solution for 24 hours, then rinsed and tested showed the poorest buffering activity. This is expected if the coating were derived from the phosphates dissolved in the water. In this case, no organic material was present in the phosphate solution. Gravel removed from a marine culture system in operation for one year without any changes of water (containing a relatively high concentration of phosphates) showed an improved buffering activity, but nothing like that of new dolomite gravel which had never been exposed to phosphates. The same type of culture system gravel when cleaned in sodium hypochlorite and hydrochloric acid showed a negligible increase in buffering activity. The cleaning which removed any organic material did not increase or restore the buffering activity of the gravel. However, if the gravel were dried and tumbled in a lapidary unit for ten minutes to remove the entire outer coating of the gravel, the buffering activity was very much improved. New gravel when tumbled showed the same elevated buffering rates. The data for new gravel in Table I is rather low since this gravel had been stored for some time before testing and the active sites had been blocked by ions present in the air.

Attempts were made to analytically identify the material of the coating, but technical problems of the X-ray diffraction method prevented a good determination.

The data of this part of the study seem to indicate that phosphate coatings may be responsible for the failure of carbonate gravels to sufficiently buffer the culture water. Organic coatings may also play a role in this failure, but the long-term effects of a phosphate coating override their importance. For extended maintenance of optimal pH values in large culture systems, further tests have indicated that dilute sodium hydroxide (20%) solutions when added slowly and mixed completely before coming into contact with the cultured organisms are quite useful. The magnesium precipitate resulting from locally high pH values may be filtered out and allowed to redissolve in the culture water. For small systems, the regular change of a portion of the culture water remains the best method.

Nitrifying Bacteria Populations:

The second phase of this study concerned itself with the development of the nitrifying bacteria populations on the undergravel filter. These bacteria convert the ammonia excreted by the cultured organisms into nitrite and then nitrate. This conversion must be quick and efficient for ammonia and nitrite are toxic to marine organisms. These bacteria live attached to the surface of the gravel of the underground filter, and as the water is drawn through the gravel, the conversion is carried out.

Some of the early research from Japan indicated that only about 10% of the total number of bacteria living on the gravel were capable of this important conversion. Where it is important to maximize this conversion, such a ratio between the nitrifying bacteria and all other forms is very inefficient. More ammonia and nitrite could be converted per unit time if a greater percentage of the surface area of the filter were occupied by nitrifying bacteria.

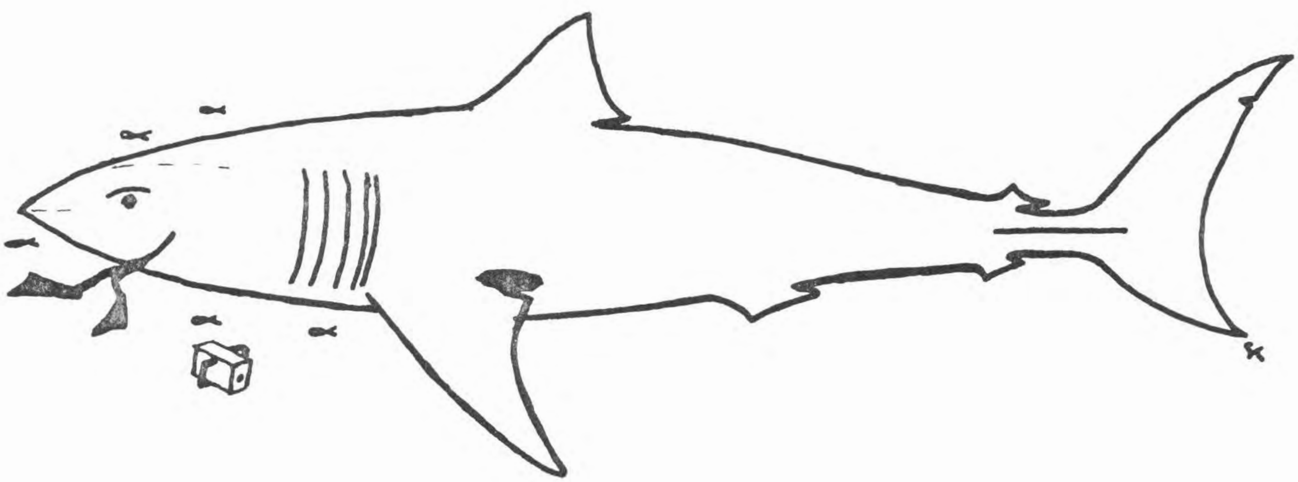
In the usual method for preparing a tank for culturing animals, a hardy organism is maintained in the tank providing ammonia for the proliferation of the nitrifying bacteria. After about two weeks, the nitrifying bacteria have become sufficiently established so that a full load of organisms may be cultured successfully. It is well documented that nitrifying bacteria are inhibited by very small concentrations of organic compounds, the type of compounds which accompany the ammonia excretions of the organism used to condition the filter. Further, these organic compounds provide the material for the proliferation of the less useful bacteria, the heterotrophic bacteria. The final composition of the bacterial populations on the filter is a result of the availability of both ammonia and organics. If the primary use of the filter is to be the conversion of nitrogenous waste products, then the nitrifying bacteria should occupy most of the gravel's surface area. No organic materials should be present during the conditioning of the filter.

Tests were conducted to demonstrate the effectiveness of an artificial ammonia source (devoid of organic compounds) in conditioning the filter. The resultant nitrifying bacteria populations were expected to occupy a greater percentage of the surface area of the gravel, and consequently the nitrification rates should be increased. Theoretically, such an increase in nitrification rates yields and increase in the carrying capacity of the system. The carrying capacity of a system is the maximum number and weight of organisms cultured per gallon of culture water.

When ammonia is supplied as ammonium sulfate, a 3.3 mg-at NH_4-N/liter solution is the optimal concentration for the preparation of maximally dense nitrifying bacteria populations. Such preparation increases nitrification rates 240% over those obtained in the standard conditioning technique. When supplied as ammonium chloride, a 3 to 6 mg-at NH_4-N/liter solution is optimal resulting in a 290% increase in nitrification rates. Such prepared undergravel filter as thus theoretically capable of supporting almost three times the mass of cultured organisms. Later exposure of the filter gravel to the wide range of organic compounds typical of old culture water did not reduce the nitrification rates significantly.

Entire tanks may be set up and prepared at once with this technique, but after the preparation, the water contains a very high concentration of nitrate and therefore must be changed without disturbing the filter before organisms can be added.

Such elevated rates of nitrification enable the aquarist to culture more organisms per gallon, but this also means a much faster rate of accumulation of many organic metabolites in the culture water. One of the most important is nitrate, NO_3, which accumulates as ammonia and nitrite are oxidized. Experiments were conducted which showed that the cultivation of microscopic, attached algae in large quantities is very efficient in removing nitrate and probably phosphates and organics from culture water. See Figures I, II, and III. However, even under conditions of moderate cultivation, care must be taken to see that either all algae removed from the system is returned in some form to the system or changes of water occur at regular intervals. Trace elements are rapidly removed and concentrated in the algae tissue along with nitrogen and phosphorus compounds. See Table II. Removal of the algae eliminates NO_3 and PO_4, but will make the water deficient in trace elements. One technique used during this work was to gradually heat the harvested algae tissue to 1000^{o} C for three hours (in a muffle furnace) then return it directly to the system to redissolve. Lighter elements such as nitrogen volatilized while the heavier trace elements remain in the ash left over from the heating. The exact effects of this heating on the composition of the culture water over extended periods (greater then 200 days) is unknown. Another method is to feed the harvested algae material to the organisms being cultured, if they will eat it. Crabs often accept algae in this manner quite readily. What trace elements they do not require for their own metabolism are returned to the culture water in their excretions.



BLUE WATERS - WHITE DEATH............with a smile

GREEN LIGHT FOR OCEANARIUM*

The go-ahead signal has been given for construction of a spectacular $78 million oceanarium by the Royal Hongkong Jockey Club.

When it is completed in early 1975 on the sprawling slopes of Brick Hill at Aberdeen, the space-age installations will rival all existing marinelands in the world.

Sir Kenneth Ping-fan Fung, Chairman of Ocean Park Ltd.--a non-profit organisation formed by the RHKJC to manage the project--unveiled striking visual impressions of the designers at a press conference.

In an inner park complex, there will be giant glass domes featuring sea life of a coral reef, its main features comprising sharks, moray eels, lobsters and othe sea creatures.

Built over and beneath will be a marine waterway where visitors can cruise by in specially constructed boats powered by a moving force of 500,000 gallons of water through glasspaned tanks, a series of pools, past waterfalls, animals, and bird islands.

There will also be a 2,000-capacity covered auditorium where visitors can relax and obtain a panoramic view of a towering glass tank housing a variety of mammal life, including dolphins, sea-lions and penguins.

On the surface will be an open arena for 2,000 people to watch trained whales, dolphins and pelicans performing in a huge artificial lake.

Dotted round the mammoth complex, which will take an average family at least four hours to tour, will be miniature aquariums, a bird island and a sea-zoo where seals and other mammals could be seen at close range and fed by visitors.

Ocean Park's complex will be Hongkong's own Disneyland. Landscaped gardens, picnic spots, restaurants and shops scattered on the hill-slopes will help visitors to while away the day.

But emphasis in the entire project is on education. It is designed by the project financiers, the RHKJC, as one that will provide educational facilities for the young and old.

---

*Reprinted from the "South China Morning Post", May 12, 1972.

Outdoor pools will have featured pageants, scripted animal performances and marine shows, aquaria that unfold fascinating stories of marine animals, and a building to exhibit tiny marine creatures, too small to view in larger tanks.

The Education Department of the Park will reach out to schools with travelling exhibits such as seals, penguins and other mammals to spread marine education to the young.

Within the complex, a park will be set aside for construction of lecture theatres and a maritime museum.

Marine science and marine biology will be conducted in a modern laboratory with up-to-date equipment providing a centre of exchange in information on aqua-life of the Western Pacific.

Its facilities will be open to universities and schools.

Behind this tremendous project lies advanced technology and painstaking design work. The conceptual plan now approved is the 12th to be drawn up. The 11 designed in the past 10 months were rejected as unsuitable for local implementation.

The major technological task is provision of a water system to draw sea water suitable for marine life from Deep Water Bay - a system of pumps well below sea-level to avoid pollution.

Storage is also provided for five million gallons of water, making it possible for the oceanarium to go without fresh sea water for as long as two weeks.

While the Royal Hongkong Jockey Club has not decided on admission charges, the operation will be entirely non-profit-making. It is intended that every one of the four million population will be able to visit the complex.

Tourists may be charged a higher rate in line with practices of marinelands in other parts of the world.

Dr Kenneth Norris, one of the world's foremost authorities on marine life and consultant to the project, visualises the oceanarium as an unique complex unmatched by others in the diverse education and entertainment facilities.

He said more than 1,000 pounds of fish will be required to feed the large number of sea mammals daily.

The mammals will be pre-trained and purchased from other marinelands round the world. Collections of fish will be partially done in expeditions in Hongkong waters.

Cost of the living sea life for exhibits will exceed $6 million.

WATER QUALITY MONITORING AT THE NATIONAL AQUARIUM

John R. Leonard
Research Biologist, Washington, D.C.

Each week from September 1971 to September 1972 determinations of specific gravity, temperature, pH, ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen were performed on all saltwater and selected freshwater aquariums. The recorded values provided information on the present condition of each tank and enabled trained aquarists to save time and specimens by quickly discerning and correcting potentially hazardous situations. Although specific recommendations would be too numerous to mention here, a general checklist of actions taken at the National Aquarium is presented in Table 1.

During the past year operational exercises, based on the water quality records, aided in developing effective filtration systems and in increasing the longevity of specimens. Water quality monitoring also provided data concerning the effect that chemical additives and prophylactic treatments have on nitrification.[1]

# # #

[1] A paper entitled "The Use of Sulfathiazole Sodium for Treatment Against a Protozoan Ectoparasite of Marine Fish, and the Effect of the Drug on the Biological Filter of a Closed Recirculating System" was presented by Mr. David B. Allen during the AAZPA conference at Portland, Oregon in October 1972.

TABLE 1: A checklist of actions relating to water quality records performed at the National Aquarium, Washington, D.C.

Water Quality Value	Action
Specific gravity	
Increase	Add fresh water
Decrease	Add brine water
Temperature	
Increase	Add cooling apparatus
Decrease	Add heating apparatus
pH (fluctuation)	
Freshwater	Increase rate of water replacement
Saltwater	Rinse buffer material and increase rate of water replacement.
Ammonia-nitrogen increase	
Initial	Check for dead organisms or food in tank, measure and reset rate of water recirculation, and increase rate of water replacement.
Prolonged	Check for chemical treatment or filter disruption, continue water replacement with seed from established aquarium.
Nitrite-nitrogen increase	Measure and reset rate of water recirculation.
Nitrate-nitrogen increase	Increase rate of water replacement with unused water, and add algae on nitrate consuming organisms.

ESTIMATE OF AQUARIST POSITIONS IN THE UNITED STATES

Glenn Burghardt
Senior Aquatic Biologist, Steinhart Aquarium

In preparation for a booklet sponsored by the ASIH, subject: Career Opportunities for Ichthyologists, Dr. Victor Springer of the USNM has asked how many aquarium positions there are in the United States (exclusive of pet shops and academia) and what the job opportunities are each year.

Since this question has not previously been asked, an answer has been attempted. Using the Fourth Edition of the Directory of Public Aquaria of the World (1972-73), the following list of principal aquaria was prepared. Total employees came to 1294; and using a ration of 10% management, 10% office and administration, 50% maintenance and guards, and 30% aquarists or similar positions, we come up with an approximate figure of 389 aquarist positions in the United States. Turnover rate is a bit difficult to estimate, but if we assume an arbitrary figure of 25% we would have 97 positions available each year throughout the U.S.

ESTIMATE OF AQUARIST POSITIONS IN THE UNITED STATES

	Aquarium Employees
Aqualand, Boulder Junction, Wisc.	4
Aquarium, Depoe Bay, Oregon	4
Aquatarium, St. Petersburg, Fla.	37
AquaZoo, Pittsburgh, Pa.	9
Atlantic Aquarium, Hull, Mass.	5
Belle Island Aquarium, Detoit, Mich.	7
California Undersea Garden, Santa Barbara, Ca.	7
Cleveland Aquarium, Cleveland, Ohio	4
Dallas Aquarium, Dallas, Texas	8
Gulfarium, Ft. Walton Beach, Fla.	11
Johnson Aquarium, Powell, Ohio	5
J. Record Aquarium, Ft. Worth, Texas	5
Lincoln City Zoo Aquarium, Lincoln, Neb.	5
Marineland, Palos Verdes, Ca.	100
Marineland, St. Augustine, Fla.	125
Marine World, Redwood City, Ca.	105
Miami Seaquarium, Miami, Fla.	100
Milwaukee Zoo Aquarium, Milwaukee, Wisc.	6
National Aquarium, Washington, D.C.	10
New England Aquarium, Boston, Mass.	65
New York Aquarium, Brooklyn, NY	46
Niagara Falls, Niagara Falls, NY	20
Ocean World, Fort Lauderdale, Fla.	12
Oregon, U.S. Garden, Newport, Ore.	5
Overton Park Aquarium, Memphis, Tenn.	4
Pt. Defiance Aquarium, Tacoma, Wash.	4
San Antonio Aquarium, San Antonio, Texas	3
Scripps, La Jolla, Ca.	9
SeaArama, Galveston, Texas	55
Sealand Cape Cod, W. Breuster, Mass.	5
Sea Life Park, Honolulu, Hawaii	58
Seaside Aquarium, Seaside, Ore.	4
Seattle Marine Aquarium, Seattle, Wash.	4
Sea World, San Diego, Ca.	200
Sea World Ohio, Aurora, Ohio	28
Seven Seas, Arlington, Texas	100
Seven Seas, Brookfield, Ill.	6
Shedd, Chicago, Ill.	61
Shipwreck Aquarium, Eureka, Ca.	2
Steinhart Aquarium, San Francisco, Ca.	24
Toledo Zoo Aquarium, Toledo, Ohio	3
Undersea Gardens, Crescent City, Ca.	3
Waikiki Aquarium, Honolulu, Hawaii	12
Westport Aquarium, Westport, Wash.	4
Total Employees	1294
10% Office & Admin.	129
10% Management	129
50% Maint./Guards, etc.	647
Aquarist Positions (apprx.)	389

A NEW EXHIBIT CONCEPT FOR THE PITTSBURGH AQUAZOO

Richard M. Segedi

When I was interviewed for the curatorial position at the Aquazoo in March of last year [1972], the principals of the Pittsburgh Zoological Society told me that they wanted something different for the Aquazoo's exhibits. Thus, we have been working the elements of a new philosophy into the present exhibits and have been planning and building future exhibits based on its tenets.

As far as I can determine, the credit for the origin of this new exhibition philosophy belongs to the National Aquarium in Washington D.C. Dr. Warren Wisby and his able staff have been developing numerous exhibit techniques for some years, among which has been that dealing with the adaptation of certain creatures to their particular environments.

During my last few years on the staff of the Cleveland Aquarium we had been utilizing some of these techniques and had been developing some of our own. Thus in Cleveland there are not only the usual zoo - geographically oriented displays, but there are a number of exhibits which show how certain creatures adapt to their environments.

Now we are working some of these techniques into the exhibits at the Pittsburgh Aquazoo. Basically we re-arranged many of the displays so that groups of labels could be integrated with one another in order to give continuity to the exhibit as a whole. The ground theme is environmental-climatological, with each exhibit section devoted to creatures from a certain climatic region. For example, we originally had a section devoted to native North American fishes. There were the usual game fishes of the area with labels identifying each of them. In some cases there were texts dealing with certain characteristics of the fishes.

To change this section over to the new system, we made a large introductory graphic entitling the section "The Fresh Waters of North America". The text of this introduction is short, explaning only that the visitor will be seeing a cross-section of North American fresh water habitats within that group of displays. Each display in the group deals with a particular habitat, naturally designed. A label then describes the habitat and points out some of the environmental pressures imposed by that habitat upon the creatures living there. The creatures are then identified, and something is mentioned about the way in which each has adapted to the particular pressures exerted by that habitat.

In this North American section we show habitats ranging from cold mountain streams through fast and slow flowing rivers, to the lakes, pond, and swamps. The ubiquitous pollution exhibit emphasizes the fact that even technological man, whom many believe can develop an answer to any crisis, in the end is completely dependent upon his environment and its resources and must realize that misuse of the environment will inevitably work against his own best interests.

Our marine displays are divided into shallow cold water, shallow warm water, reef, grass flat, and open sea habitats. The texts again emphasize the types of environmental pressures each habitat exerts and how the creatures shown are adapted to cope with there pressures.

One section of the building contains crocodilians, sea turtles, a manatee and a dolphin [Inia] exhibited in open pools. In order to carry the adaptation theme through this section a large graphic was made entitled "The Return to the Water" with the subtitle "Aquatic Animals whose Ancestors were Land Dwellers". Along with each identification drawing on this graphic there is a short discussion on the degree in which each animal exhibited has "re-adapted" to the aquatic environment.

A final group of displays shows things like peculiar adaptations in parental care of young [mouthbrooders are shown here], and the way in which a single general body plan can adapt to many ecological niches [miscellaneous tropical catfishes are shown in this one.] Also in this section is a display showing normal and albino cichlids in natural surroundings. The albinos stand out in stark contrast while the normal ones are more difficult to see. This display is entitled "Survival of the Fittest".

One can develop an almost infinite number of really meaningful displays once this environmentally-oriented exhibit philosophy is adopted. We feel that this exhibiting technique is superior in that it is more meaningful, thus the average visitor can retain the information given for a much greater length of time.

Also, by relating each creature to some single idea [its environment in this case] we are using the association principal again helping to make the information dispensed more easily retainable. By sticking to a single general theme and relating everything on exhibit to that theme we are really teaching only one general concept which is far more easily grasped by visitors than is the usual bombardment with hundreds of different and unrelated bits of information.

AQUARISTS AND THE AAZPA

Don Wilkie
Scripps Aquarium

Professional aquarists of the United States and Canada met for many years with the American Society of Ichthyologists and Herpetologists. In recent years there has been some dissatisfaction with this relationship and an increasing feeling that it would be more appropriate for the aquarists to meet with the American Association of Zoological Parks and Aquariums. This matter came to a head at the 1971 AAZPA meeting in Salt Lake City. The aquarists in attendance, after considerable deliberation on this matter, voted to throw their support behind the AAZPA, promote its annual meeting and attempt to develop a strong program on aquarium activities at its annual meeting. This decision was well received by President Gary Clarke and the AAZPA Board of Directors, who asked that the aquarists name a representative to the AAZPA Program Committee for the 1972 annual meeting in Port land. Don Wilkie was chosen by the aquarists to fill this role. Gil Hewlitt and Lou Garibaldi were named to assist; forming in essence an aquarium subcommittee.

After surveying the aquarists, several types of presentations were planned for inclusion in the aquarium portion of the program in addition to the normal "papers". These included a keynote address by a professional from outside the aquarium field, a marine mammal panel, and an aquarium workshop. It was originally intended that the keynote address and the workshop theme address themselves to the same topic. The committee invited Dr. John Halver of the Western Fish Nutrition Lab located in Cook, Washington, some 60 miles from Portland, to be the keynote speaker but decided that since few aquarists were working actively in the field of nutrition this would not be a suitable topic for the workshop. Instead the workshop was held on "water quality" and we were fortunate in having Bryce Anderson consulting water chemist from Berkeley as the discussion leader.

The keynote address and the workshop were highlights of the meeting for the aquarists and we hope this type of program can become a permanent inclusion at the annual meeting. The aquarists received many compliments from zoo people about the quality of the aquarium presentations. Among the more stimulating presentations made by aquarists was the one given by Karen Pryor who challenged not only aquariums but zoos to devise training programs designed at alleviating the boredom of captive animals. Interest expressed in the paper by both aquarium and zoo people was an excellent example of the overlapping nature of the problems which the two groups share.

The meeting was well attended by aquarists with 28 present from 13 different institutions. Expenses toward the invited participants were donated by a number of aquariums including Cleveland Aquarium, Montreal Aquarium, New England Aquarium, New York Aquarium, Scripps Aquarium, Sea World, Shedd Aquarium, and Vancouver Aquarium.

The outgoing aquarium committee believes that including a variety of different kinds of presentations on the program including particularly the keynote address given by professional scientists in a field closely related to aquariology and a planned workshop should be regular features of any meeting of aquarists. Needless to say there were some organizational problems which stemmed from the geographic separation of the program committee members. It was particularly difficult at the last stages of the program to coordinate with the local committee which was faced with the task of putting together the details of the program. The committee recommends that the aquarists make a practice of selecting their own representative to the AAZPA Program Committee. [This recommendation is subject to ratification by the AAZPA President.]

Of major importance was agreement by the vast majority of aquarists to support AAZPA and concentrate their efforts toward providing a strong program at the annual meeting. The aquarists chose Paul Montreuil, Director of the Montreal Aquarium, to represent them on the 1973 AAZPA Program Committee and he was subsequently appointed to this position by Dr. Les Fisher, President. I urge all aquarists to support Paul and in particular to forward to him any suggestions that you have for this year's program including topics for the keynote speaker and the workshop. I hope that once again it will be possible to generate financial support from the various aquaria to enable us to incite prominent outside specialists to participate in our meeting.

All in all the meeting had to be for the aquarists the most successful over recent years. I would like to thank Gil Hewlitt and Lou Garibaldi for their assistance in putting together the aquarium program and commend Ron Reuther for the excellent job he did in coordinating the overall committee. I would also like to thank Gary Clarke for his sincere effort at making the aquarists feel a part of AAZPA. He did much to firm the bond between aquariums and zoos.

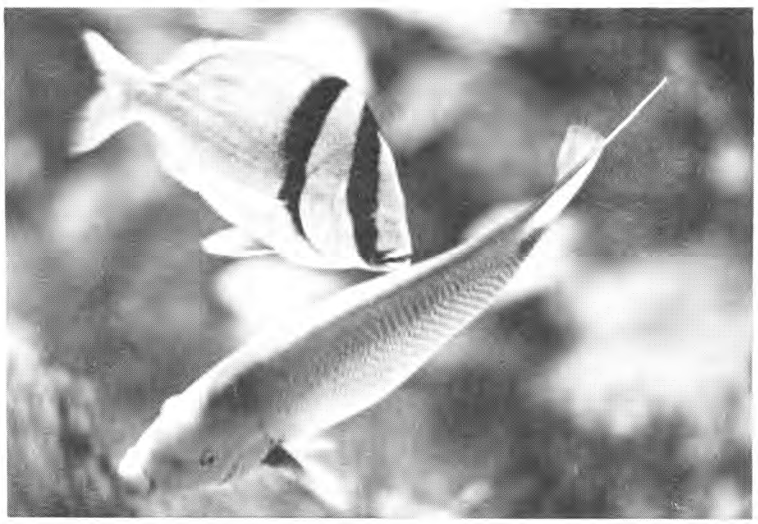
CLEANING SYMBIOSIS

Beverly A. Serrell
Curator of Education, John G. Shedd Aquarium

When a big fish eats a little fish, it's not news. But when a big fish doesn't eat a little fish, it might be because the little fish is a neon goby.

Unlike many small fishes who must constantly hide from predators, the neon goby enjoys freedom from predation because of his mutualistic relationship with many of the bigger fishes of the coral reef environment. The nature of this relationship is one where the goby picks parasites, bacteria, or diseased tissue from the body of the other fish. The goby eats what he finds, and the cleanee gets rid of its pests.

Gobies tend to stay close to the coral at particular locations, or "cleaning stations". The bigger fish seem to recognize these locations and will position themselves next to the station and await the goby. Sometimes one fish will crowd out another fish in line to be cleaned.



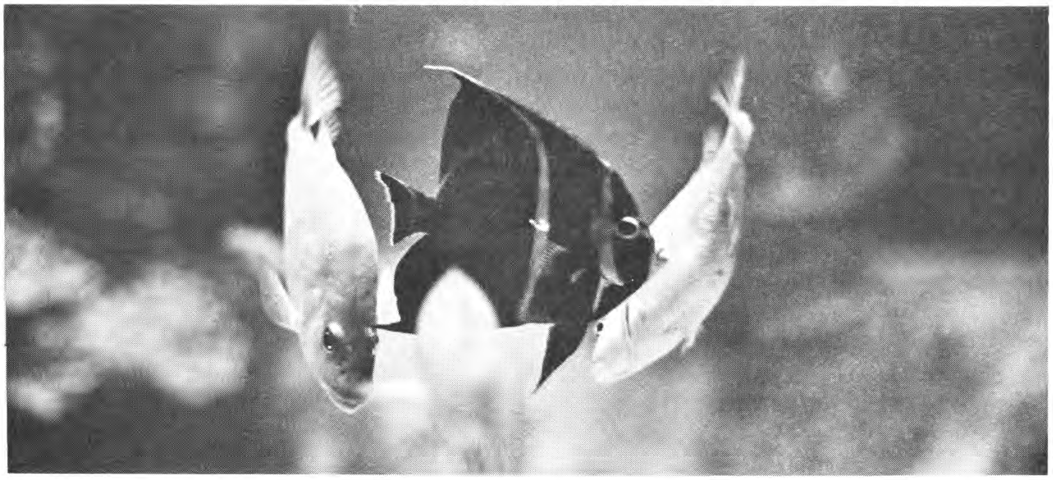
A porkfish nibbles at the side of a blue angel.
Photo taken by the author in Shedd Aquarium's Coral Reef Tank.

The goby not only cleans the external parasites but will also enter the mouth or operculum to eat ectoparasites found on the gills or scraps of food on the teeth. Groupers are particularly fond of being cleaned and will hold their mouths open for minutes while the goby goes about its business.

Cleaning behavior is not restricted to species of gobies. Other fish have been observed performing this service such as the porkfish (Anisotremus virginicus), the juvenile french angelfish (Pomacanthus paru), and the spanish hogfish (Bodianus rufus). Also commonly observed as a cleaner is the wrasse (Thalassoma bifasciatum), and a small, brightly colored shrimp (Stenopus hispidus).

When one fish solicits to be cleaned by another fish it will often be observed swimming slowly at an angle in front of or next to the other. Occasionally, two fish will solicit each other and swim slowly around for minutes, with neither fish adopting the role of cleaner.

It has been reported that the wrasse blenny (Hemiemblemaria simulus) mimics the cleaner wrasse. This enables the voracious blenny to approach potential prey with relative ease and nip off a piece of fin before the other fish "realizes" the hoax. Most often it is the juvenile of the species that is fooled by this mimicking. The adults do not fall for it, perhaps because after one bad experience they are able to discriminate more accurately between the true wrasse and the wrasse blenny.



A juvenile french angelfish is solicited by three gray snappers.
Photo taken by the author in Shedd Aquarium's Coral Reef Tank.

With the sophistication of diving equipment and more interested marine biologists, field investigations of cleaning symbiosis are bound to become more widely reported. Artificial situations can be set up in the aquarium and compared to the natural behavior of fish in the ocean. Cleaning behavior is common among many species of fish and a wide variety of organisms on land also. Other species combinations which deserve mention are crabs which remove ticks from marine lizards, and sea gulls which pick parasites off the Mola mola.

In general, cleaners are conspicuously colored, they often have specific stations, and may go through elaborate display to attract customers. They are important members of the marine ecosystem by serving to protect fish from infection or disease, and thereby maintaining a higher quality of life in the sea. The mutual benefits for the cleaner and cleanee have evolved through time, and cleaning symbiosis is a fine example of positive interactions between different species.

References

Henry, S. Mark, editor. Symbiosis. Volume 1: Associations of of Microorganisms, Plants, and Marine Organisms. Academic Press, New York. 1966.

Bohlke, James E., and Chaplin, Charles, C.G. Fishes of the Bahamas and adjacent tropical waters. Livingston Publishing Company, Wynnewood, Pa. 1968.

A REPORT ON P.V.C. COATED STEEL
IN A LARGE MARINE EXHIBIT

Paul Comley
W. A. Marine Aquarium and Oceanarium

In 1969 a temporary lease for an Oceanarium necessitated a design where the building and tank could be removed and re-erected fairly easily on a new site. This has never become necessary and the original site is still in use.

The design and shape arose out of economic necessity as the circular doughnut shape allowed for pumps and filters to be accommodated in the central 'hole'. The tank section measures 6' x 6' with an overall diameter of 32 feet. The tank sits flat on beach sand with no reinforcing apart from a perfectly flat bed. The 1/4" steel is coated on the inner surface with 1/8" P.V.C. plastic sprayed on in five applications. The outer surfaces are coated with three heavy applications of Epoxy tar.

The building is of fibre glass sections which are bolted onto the tank rim and to each other, with the outer rim of each section securely buried and anchored in the sand. Foyer and toilets fan out an extra 9' on one side and concrete slabs provide a secure floor throughout. The size of this exhibit has proved right for the small local population.

In the central area, a single all-iron pump stands 6' from the tank and is supplied with water by P.V.C. pipes and valves. This provides pressure for a fibreglass ball sand filter, a Protein Separator, and a single overhead jet, all operating together. During the day a two knot current is maintained and this is increased to four knots at night.

The water remains on a closed system for six months at a time when fresh sea water is introduced over a twelve hour period. No copper is added. Alterations in the specific gravity are made good with tap water, and the pH is kept at 7.3 with the aid of a bed of marble pieces at the filter outlet, as well as the help of the protein separator.

Clarity is good for the required 10 feet at each port and the large sharks and fish can be clearly seen against the background. A diatomaceous earth filter purchased in ignorance was discontinued once the vagrancies of the sand filter were understood.

Marauding sharks and persistent turtles have given the plastic coating a severe test. Fine scratches show light rust which does not extend under the surrounding plastic. There are a number of blisters which show clear shiny steel underneath as when the steel was first sand blasted prior to applying the P.V.C.

Three and a half years have passed since the tank was first filled with sea water. The apprehension of possible leakage and breakdown of the steel lingers on. The outer area coated with Epoxy tar has broken down and is rusting wherever a persistent splash has occurred. The underside of the tank cannot be examined.

Soon construction will commence on an 180,000 gallon Dolphin pool. This will be of steel with a coating of fibreglass matting spray, finished with a smooth Jilcoat. This change from P.V.C. arises from two highly successful experimental display tanks and also the effect of concussion produced from performing animals on blisters of P.V.C. may result in tearing or rupturing of the coating.

Absence of severe corrosion is not attributed to any specific selection of materials, application, design or technique, other than sheer good fortune. The distance of the all-iron pump from the tank and its isolation by P.V.C. pipes and fittings, the absence of increased copper levels, and the absence of any metal other than steel in the system will all have some bearing.

Steel was the logical choice in spite of misgivings at the close proximity of a sea water current. Visions of galvanic action, pitting and general total disintegration have haunted the entire operation. This may be imminent however to date there is no evidence of leakage or severe deterioration. The future of this tank looks good.

WILL FALLOUT BE THE END OF THE GREAT WHALES?

Georgina and Stephen Phillips
Port Macquarie, Australia

All over the world today people are becoming more and more aware of the plight of the great baleen whales, but little do they realise just how rare these great mammals are becoming.

It seems that it was not enough to have slaughtered whales for decades until so few are left that nearly all the whaling stations in the world have closed down. Despite this, the needless killing is still being carried out.

The greatest animal that ever lived on earth is the Blue Whale. This mammal is actually still living today, but ONLY JUST. The total world population numbers somewhere between 0 and 200 individuals. Bigger than any dinosaur, the Blue Whale attains a maximum adult length of up to 130 feet and an average adult weight of 100 to 130 tons.

Blue Whales, along with the many other species of baleen whales feed on enormous quantities of krill; these are small herbivorous planktonic crustaceans which feed on the microscopic diatoms that thrive in the cold waters off the Antarctic. Krill is found in concentrations ranging in size from 1/2 an acre to a square mile near the Antarctic convergence, and each summer the baleen whales are attracted to this gigantic feeding ground.

It is now known that every cubic yard of water in every ocean of the world contains man made radioactive material; it is also known that radioactive fallout is normally concentrated by zooplankton, the natural food of the baleen whales. Large whales will hold from 2 to 3 tons of krill in their stomachs at a time, and when feeding, may swallow almost a ton at each mouthful.

A handful of Cetologists around the world are finding evidence that radioactivity is a cause of sterility, deformity and destructive lesions to the baleen plates of these whales, plates which are essential for the filtering of krill, for without a complete set of baleen plates, these mammals would soon die of starvation.

The reproductive capacity of the rare Blue Whale is the lowest of all the baleen whales; the female not being sexually mature until around the age of seven years, and then producing only one calf every two years.

Despite this knowledge, it seems that man's only concern is to out-do his neighbouring country in nuclear device research; thus polluting the atmosphere and the seas while gradually building up the concentration of radioactivity.

What is the future of the remaining whales of the world? If this rate of destruction, depletion and pollution is to continue, then the great harvest of the seas will most certainly come to an end.

SEA TURTLE SHOW

Robert A. Martin
Curator, Seafloor Aquarium

The sound of a conch shell horn signals the beginning of the Bahamian lagoon show at Nassau's Seafloor Aquarium. An Abaco dinghy soon appears and our fishermen cast their "bully" net to retrieve young hawksbill and green turtles. Later a diver enters the water and wrestles a huge 350 pound loggerhead turtle to the surface and compels it to open its jaws for the public. This entire show lasts for but ten minutes but adds an authentic Bahamian touch to our program. Cups of fish are sold for feeding lagoon turtles and fishes. This appeals especially to children and "photo bugs" and provides profits that at least partly cover the costs of maintaining the hundreds of fishes and turtles that we display here. A definite plea for the conservation of sea turtles is made throughout our turtle catching session. Bahamians and other natives of the tropics often tend to catch females and devour eggs during the egg laying seasons. Turtles are rapidly disappearing from beaches in many areas, while on others they have been completely decimated. People must understand the difference between careful farming of the sea and its ruthless exploitation without regard for the future.

The lagoon is sixty feet in diameter, four feet deep in the middle of the channel, and contains a central island in the shape of San Salvador. A sloping sandy beach at one end of the island can be utilized by turtles for laying eggs. Eight large loggerheads and dozens of small green and hawksbill turtles live together with hundreds of lagoon fishes and nurse sharks. At present, all but one male loggerhead have been removed from our lagoon as the result of wounds incurred during the mating season that were aggravated by fishes picking at them. Cowfishes are particularly persistant and should be avoided for this reason.

Our male loggerhead mated for long hours during May of last year, demonstrating that one male can service several females. One coupling lasted overnight and well into the following morning during an estimated 16 hour period. Females ready for mating often try to pull the male from his mate by biting him on the neck or tugging on his flippers.

Egg laying activity is difficult to observe because it normally occurs at night. Females were found wandering over our island during the night on several occasions, but the nests were not located.

Eggs were retrieved from the bottom of the lagoon on four dates: May 23 (22 eggs), June 1 (61 eggs), June 7 (102 eggs), and August 10 (84 eggs). These were buried in the sand when intact. The last eggs were taken almost

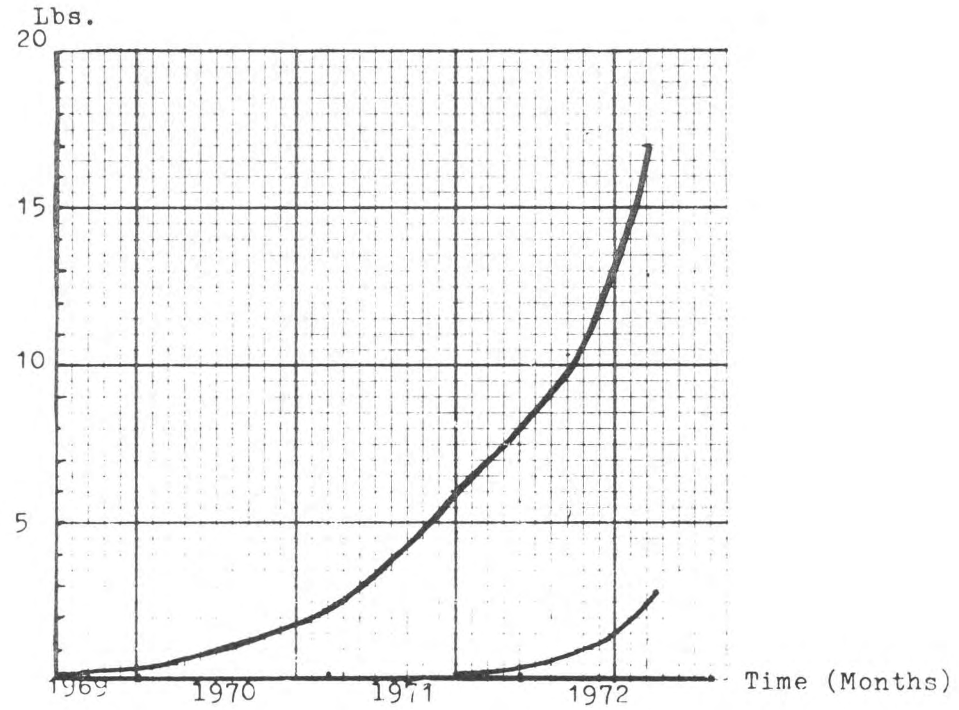


Figure 1. Average Weight of Loggerhead Turtles (*Caretta caretta*) Belonging to Two Groups Given by Month.

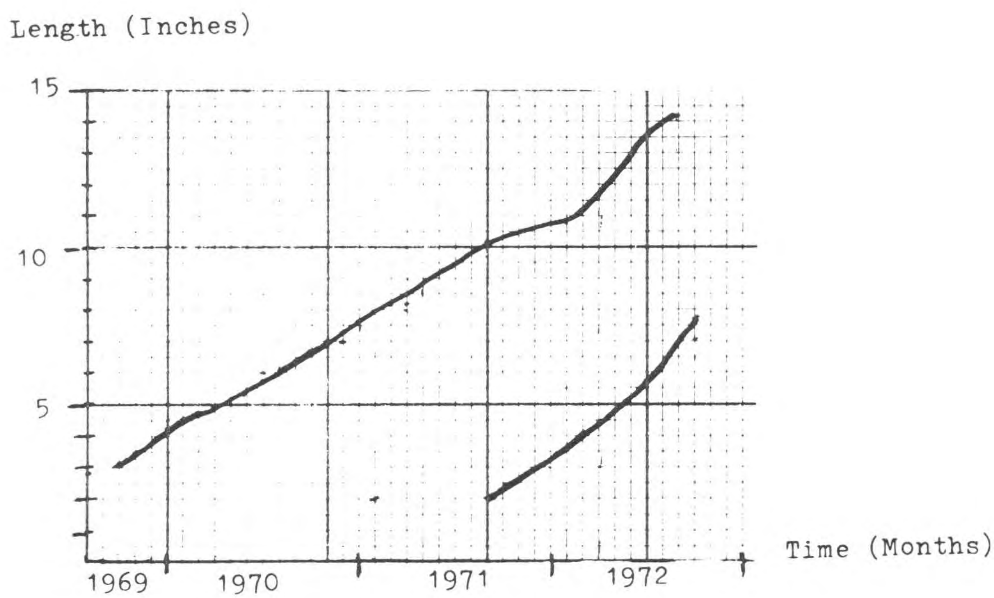


Figure 2. Average Carapace Length for Loggerheads in Two Age Groups.

directly from the female, since she dropped them during the morning when a diver was available. These eggs differed from others in having a substantial coating of oil, which could help them resist dehydration. One newly hatched loggerhead was unexpectedly found swimming in the lagoon on September 17. Others appeared from the August 10th eggs, and have been screened with chicken wire to prevent them from entering the water and being devoured by larger predators.

Two groups of newly hatched loggerheads that were donated by residents have been weighed and measured at intervals during the past three years to obtain growth rates. Such rates are quite variable since they depend on water temperature, diet, frequency of feedings, space provided, and other factors. Some individuals seem to outstrip others from the very beginning. Average monthly figures for the weight of turtles in two age groups and the length of their carapace are given in figures 1 and 2. The second age group (7 individuals) is growing at a faster rate than the first (3 individuals) at a similar stage, because they are being fed once or twice daily. The original group has always been fed three or four times a week.

Food consumption by turtles in group 1 was studied beginning at 31 weeks of age for an entire year (Jan. 8, 1970 - Jan. 5, 1971) to determine the percentage of food consumed that was retained in growth. Turtles increased from an average of 7.9 grams to 1105.7 grams during this period and consumed 3347.5 grams of weighed fish filets. This means that roughly one-third or 30.5% of the food was retained in growth.

OBSERVATIONS FROM INSIDE THE REEF TANK

Kurt O. Thomsen
Former Diver, Shedd Aquarium

After a year of diving and feeding the fish in the John G. Shedd Aquarium's Coral Reef Tank things have become fairly predictable. Of course everytime someone makes a statement like this something happens that makes him a complete liar. Thank heaven for these incidents because without them the feedings would soon become drudgery as anything that is repetitive tends to become. As the diver enters the Reef Tank for a feeding he keeps this in mind and he enters with a feeling of anticipation since he does not know whether or not today will be routine.

The door to the holding tank is opened and the diver glides out and down into a welcoming committee of blue, orange, green, yellow and silver flashes. Momentarily the diver again feels the sense of weightlessness and freedom which he feels everytime he dives.

"Good Morning ladies and gentlemen....", the diver greets aquarium visitors through a microphone built into his mask. He moves to the first window as the Palometas keep darting in and out biting at the air bubbles that surround the diver. He keeps on looking around because it feels like someone is tapping him on the shoulder. The diver comes to a rest on his knees holding his food bucket by the handle with his thumb tucked underneath. The other hand is clenched into a fist unless he is using it to feed. Pointing is kept at a minimum. These are the precautions taken to keep from getting nipped on dangling fingers.

The diver pulls a handful of food out of the bucket, crushes it and releases it in the water in front of him. This is usually done two or three times to stem the initial onslaught of hungry fish. The diver has so many fish around him that it is difficult for him to see. After the initial few handfuls of food the fish thin out and the diver is able to recognize the different varieties.

The angelfish seem to be the most curious. They are constantly around the diver. Of the four types of angelfish inside the tank the French angel and the black angel allow themselves to be touched. The blue and the queen angel fish are also very confident in the presence of a diver although they swim away when a diver attempts to touch them. All the angelfish have the distracting habit of occasionally plucking at the diver's hair by extending their lips and retracting them in a rapid motion.

In general the sheepsheads act normal. There is one exception though, and as luck would have it this one happens to be the largest. The sheepshead has teeth that look almost human. As can be imagined a bite by one of these fish is painful. The particular sheepshead in question has a mania for shrimp, as a matter of fact he won't eat anything else. Unfortunately the diver's thumbs happen to resemble shrimp and it is only by blocking the fish with the feed bucket and throwing the shrimp in front of the sheepshead that the diver escapes being bitten.

We have two moray eels in the reef tank. Both are full grown and about six feet long. The eels have a very good disposition, so much so that the diver almost has to chew their food for them. They come out only when they are hungry and entwine themselves around the diver. It is quite fun, from a diver's vantage point, to watch the reaction of the people on the outside of the tank when a moray eel comes up behind the diver and swims between his legs and then up so that there is not enough room between the diver's face mask and the eel's nose for a good size smelt. The people regard a moray eel as one of the classic monsters of the deep and they try to warn the diver of the eel's approach. The diver naturally is very nonchalant about the whole thing which has the audience quite frantic by this time. Of course the diver can see the reflection of the eel in the windows of the tank and knows the eel's whereabouts at all times. Occasionally the morays do manage to sneak up on the diver without the diver being aware of it and if one watches closely one can detect a distinct contraction of the diver's muscles as the eel's slippery body brushes the inside of the diver's leg.

We have named our two moray eels Maria and Mort although we are unable to distinguish their sex. As a matter of fact most of the time we have difficulty deciding which is Maria and which is Mort. The only way we can tell them apart is that Mort has a scar on his left side and he generally acts more aggressive than Maria. Maria is a great one for posing for a photographer. If a picture is called for which shows the diver with a moray eel the diver has only to go to Maria's hole in the reef and gently pull her out and lead her to the spot where the picture is to be taken.

We have had only one incident of an attack by a moray eel, and this incident was not aggressive in nature but a normal reaction on the part of the eel to a feeding situation. It is not uncommon for an eel to just barely hold the food in its mouth without really grasping it. In order to try to get the eel to grab the food and swallow it the diver must hold the mackerel in the moray's mouth and jiggle it to simulate life before the moray will take the hint and eat. After a few minutes of coaxing, the diver rightfully gets tired and leaves the eel with the mackerel still hanging in its mouth. Now the eel has the choice of having someone steal the fish or eat it himself. During this particular incident the diver was trying to feed Mort on the bottom in the middle of the tank when, after giving Mort the usual encouragement, one of the nurse sharks stole Mort's mackerel and proceeded to tear it apart. During the ensuing commotion Mort struck out at the white of the diver's calf as it flashed by his mouth. He promptly released his hold as if his new found food did not agree with him. This insult probably hurt the diver more than the wound did.

There are three nurse sharks in the tank. All are about four feet long. One remains relatively trim while the other two have gotten rather fat and developed goiters. They seem to have changes in mood from periods of aggression to periods of almost non-existence in that the sharks do not come out and feed at all. During their aggressive periods the sharks will bump into the diver when he is in midwater. It is a very funny sight indeed to watch a diver feed in open water about six feet above the bottom feeling very secure in the knowledge that he has the situation under control, when a nurse shark comes out of nowhere and hits the diver square in the small of the back. The diver invariably does one of those exaggerated "thrown off balance" acts that one sees in the old silent comedy movies.

Most of the time the nurse sharks stick to the bottom of the tank. Their eyesight leaves a lot to be desired but their sense of smell makes up for this failing. The sharks will eat anything although they get into very fussy moods occasionally where they will spit out anything that is offered them. The audience really enjoys watching the diver lure a shark up the window glass by leading the nurse shark with a piece of squid. What goes over even better is the nurse shark's ability to rip apart a mackerel while it rushes back to its den along the bottom of the tank. He shakes his head from side to side tearing away at the dead fish leaving a trail of blood and debris, most of which is expelled from his gills. I am sure any one of the divers would like to meet the person or persons who maintain that nurse sharks have no teeth. The divers have all, at one time or another, found out that a nurse shark has teeth which are the same as other sharks---the only major difference being their smaller size.

If we were to take a poll on which fish the divers liked the most the unanimous decision would be the porcupine puffer. We call our porcupine puffer "Pete" and he will do just about everything except blow himself up. He seems so accustomed to the divers that no amount of prodding will cause him to inflate. After a diver prods Pete two or three times he gives up trying rather than put up with the look in Pete's two big brown sorrowful eyes.

Pete has one really big stomach and it's no wonder the say he puts away the food. He will follow the diver all over the tank to get that extra squid or smelt. When the diver feeds Pete he must let go of the food as soon as Pete comes in range otherwise Pete will suck the diver's hand into his mouth along with the food. Porcupine puffers do not have any teeth but Pete can inflict one of the most painful bites of anything in the tank. His bony mouth feels as if someone clamped the diver's finger in a vise.

Pete allows himself to be petted but the diver must be careful to pet him from front to back otherwise he will get hung up on Pete's quills. Sometimes Pete backs up while the diver is petting him and runs his quills into the diver's hand.

Another of our bottom feeders is the sting ray. The sting rays always seem to be underfoot and at first the divers were concerned about kneeling on one while feeding, but the rays seem to have an uncanny knack of getting out of the way at the very last minute.

The rays are voracious eaters, they get so excited about food that they jump right over the diver's hand while he is trying to put their food under them. To prevent this the diver must hold the hand with the food in such a position that when the sting ray jumps he hits the diver's hand, bounces off and lands on top of his food.

Every once in a while the diver gets into the reef tank and realizes that he should have stayed in bed that morning. Every thing in the tank seems out to get the diver. Not only does the diver get attacked by the usually non-aggressive fish but both moray eels come out at the same time, and come out fast, going directly to the diver. Now the diver can not decide which of the two eels to feed first as they both wind around him. To make things worse the two sting rays are underneath the diver as he tries to settle on the bottom for more stability. The three nurse sharks come in to the act by bumping into everything including coral heads, diver, eels and rays. The whole tank seems to smell the food all at the same time. The diver tries a mackerel on the nearest moray who as usual is being fussy. The porcupine puffer hovers over the eel's head in order to steal the mackerel out of the moray's mouth while the nurse sharks are repeatedly running into the diver trying to find the same mackerel. The diver does not know what will happen and he really is not particularly fond of the situation. The incident when Mort bit the diver flashes through his mind. In this type of situation we have seen the sharks steal the mackerel out of the moray's mouth only to have it stolen by the puffer. On the other hand we have also seen the moray snap at his mackerel as the puffer moved in to take it. The different possibilities of this situation are limitless so it is no wonder that the divers are a little skeptical when confronted in this manner.

The diver continues on his way around the reef tank stopping at every window pointing out the various fish. Of the more than 500 fish in the tank there are only a small number that have personality. These naturally become the divers' favorites. Actually these favorites are the fish that are a little less cautious. The overwhelming majority of the fish are very reserved in their contact with the diver and this naturally relegates them to relative obscurity. They are pointed out when they are seen, otherwise they remain in the background.

The parrotfish comes into view and the diver points him out explaining to the audience that this particular fish survives in his natural surroundings by biting off pieces of coral and extracting the polyps the coral contains. Since the coral in our reef tank is made of fiberglas and other synthetic materials the parrotfish becomes a little frustrated in our artificial surrounding. In order to get our parrotfish to eat we make up a cake, using plaster as the matrix and saturating it with trout food pellets. When the plaster hardens we throw the cake into the tank and the parrotfish attacks it as if it were coral. Eventually they become accustomed to trout food and feed on it when it is thrown on the surface of the water.

The diver heads up to point out some of the fish that only feed at the surface such as the tarpon. The tarpon very often come within a foot or so of the diver although they will not take food from the diver. Having the tarpon come this close is in itself quite an accomplishment considering the fact that a diver cannot even approach a tarpon in the wild. The tarpon along with the other surface feeders are fed by the tender, who is on top of the reef tank while the diver is down below.

After making another round of the windows the diver hovers just below the surface about ten feet away from the holding tank waiting for the tender to open the door which will release our three turtles. The turtles are the only predictable thing we have in the tank -- we know they will bite. We have tried everything from beating them over the head with a fist to yanking on their tail to scare them away only to have them come right back again with their mouths open for another try. Finally we resorted to locking them up in the holding tank before the feeding starts. The tender feeds the turtles in the holding tank while the regular feeding is in progress.

The first turtle out of the holding tank is usually our little hawksbill who we call "Tiger". The diver gives him a piece of food while watching the approach of the Ridley turtle who we call "Reggie". The Ridley is by far the most aggressive of the three. The diver has to give him something that has some size to it otherwise Reggie will take one bite, swallow and be right after the diver again. The last turtle is the loggerhead. He is the biggest of the three, slowest and, in general, a gentleman in that he has never bitten anyone. He moves so slow, gets trapped in corners and just manages to bumble around the reef tank that he earned the name of "Stupid". After the diver has fed the loggerhead, Tiger is ready for another piece of food. At the same time the Ridley is fended off with the food bucket by punching him squarely in his wide open mouth. From then on it's tweak a turtle's tail, hit one with the bucket, spin the first one around, etc., etc. while the diver literally retreats from the tank.

The author during a feeding show in the Coral Reef Tank

A LARGE INSECT EASILY REARED FOR FISH AND ANIMAL FOOD

Craig Phillips

For several years the National Aquarium in Washington has successfully raised colonies of giant neotropical roaches of the genus Blaberus which reach a size of from two to three inches, depending on the species. Since one of these insects has the equivalent bulk of several large field crickets, the following information may be of interest to aquarists who maintain insectivorous fishes, amphibians, and reptiles. In addition to large size, we find Blaberus to have the following advantages:

1. They can be reared with a minimum of care under crowded conditions.

2. Adult females bear 25-40 living young at frequent intervals.

3. Newly-molted [soft] individuals are pure white and may be easily selected when desired.

4. They are relatively slow-moving and cannot climb glass or a smooth surface, reducing the possibility of escape.

5. They do not infest buildings, but live under fallen palm fronds and other debris in the wild.

The only disadvantage appears to be relatively slow growth, so that it is necessary to maintain a fairly large colony [about 500 individuals] if they are to be used frequently for feeding.

Newly "born" young [who hatch as the egg-case is extruded] are less than a quarter-inch long and bear a close resemblance to terrestial isopods or pill-bugs. After going through a half dozen instars, the winged adult stage is reached in seven and a half to eight months. The adults then live for about a year, the final brood of young often immediately preceding the natural death of the female. Females are somewhat larger than the males, and the larger nymphs may be easily sexed due to the fact that in female roaches the last two abdominal segments are fused, easily observable from underneath.

Rearing is easily carried out in an empty glass tank or plastic tub containing one-and-a-half to two inches of sand or aquarium gravel, which should be occasionally moistened.

This is in turn covered with a sheet of folded newspaper or burlap, under which the roaches will hide by day. For feeding we use broken pieces of lab chow of the kind used for rearing mice and rats, although Blaberus will accept a large variety of other foods, including slices of fruit. Watering is done with a large cotton-plugged test tube on its side.

We are at present raising three species; the three-inch Blaberus gigantea, the two-and-a-quarter inch B.craniifer which has been introduced into Key West, Florida, and has an orange marking resembling a jack-o-lantern face on the thorax, and a 2-inch so far unidentified Blaberus that I collected in Key West two years ago. Accidental overheating on the return trip resulted in the loss of all but six of the latter specimens, which were all females. Nonetheless these produced several broods of both sexes before they eventually died, indicating that a mechanism for sperm storage may be possessed by these roaches.

Blaberus, like most roaches, are quiet by day but move about actively at night. Females ready to mate flutter their wings in a shaking dance as they broadcast the mating scent and are soon followed by a line of excited males. Copulation with one of them ensues and may take place for several hours.

Although many wild cockroach species have an offensive stinkbug odor and emit a foul sticky "roach-paste" when touched, Blaberus is a neat and relatively odorless insect readily accepted by fish, amphibians, lizards, and other small animals.

We regret that the National Aquarium cannot give out brood stock of our roaches, but B. craniifer at least, is sold live by some biological supply houses. Before ordering these, it is well to check with your state's regulations on exotic insects, as a permit may be required.