DRUM AND CROAKER

Issue Six

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DRUM AND CROAKER
September 14, 1962

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WHAT IS A GOOD PUBLIC AQUARIUM?

In 1955, some professional friends traveled eight hundred miles to see a public aquarium in a lion house. They reported back that it was the best in the country. They had not traveled 30 miles to see a public aquarium with one hundred times the capacity and five times the number of species. As far as I know, they have not yet visited their local public aquarium. The lion house aquarium carried on a research program that interested my professional friends. It was, therefore, a good public aquarium.

I have other friends who are vitally interested in the welfare of the animals in their charge. They point with justifiable pride to the animal that is feeding well and to the other beastie that has been in captivity for yea odd years. Such public aquarists are the envy of some others in the profession because of their "special skill" in maintaining animals. These public aquarists will willingly cloud a tank or leave unsightly food in public view to keep their prize specimens going.

I willing concede that contributing to the sum total is of supreme importance and that the captive animal must be adequately maintained.

But I worry about the public in public aquariums.

OCTOPUS, ALIVE

by

John H. Prescott

Marineland of the Pacific

and

Cecil Brosseau

Pt. Defiance Aquarium

Most large aquaria and public aquaria have had problems in the maintenance of octopus displays. In addition to maintenance, octopus are difficult to display and are very sensitive to metallic poisoning. We also have problems obtaining octopus. The Pacific octopus is the world's largest species and is found from southern California northwards to Oregon, Washington, Alaska and across the Pacific, southward to China and Japan. Marineland has been maintaining an octopus display since 1956 of this large species of octopus in a specially refrigerated grotto. In 1958 it became increasingly difficult to obtain Pacific octopus in southern California waters. In southern California we have to trap our octopus in water ranging from 300 to 500 feet deep. During the California water warming period, 1957 to 1959, we had increasing problems with transporting the animals to Marineland once they were brought to the surface, and towards the end of 1958 and in 1959 it became nearly impossible to capture Pacific octopus. Presumable a limitation of their range occurred during this warm period or perhaps the octopus moved to deeper, cooler waters. In December 1960, Cecil Brosseau made an observation that octopus in the fish market at Seattle, Washington, are kept on ice and on one occasion he discovered a live animal that was directly on the ice and had apparently been there for several hours. The same animal was transported to the Pt. Defiance Aquarium and placed in sea water, where it recovered. This accidental discovery of an octopus subject to cold anesthesia led to the experimentation of refrigerating an animal for a possible transportation.

Octopus have been kept at Marineland for a record of sixteen months. However, the average animal is normally kept for less than a year. We find that during August-September breeding season of animals they will go off their food and if a female lays eggs, she will guard them for as long as three months, without eating, eventually dying herself. Removal of the egg mass will elicit a second deposition of eggs, which she will continue to guard. The Port Defiance Aquarium has kept octopus for various periods of time, up to two years.

As one follows the distribution of the Pacific octopus northward, the animals are no longer confined to the cooler, deep water masses as they are in California. They occur in extremely shallow water and large numbers of them are available in the Puget Sound area. In this northern

range, they can be obtained fairly easily by divers or trapping and a commercial fishery exists for marketing octopus.

Shipping

Previously, we have shipped octopus by truck from Monterey from the north-central California area where they occur in shallower, cool water and we always had a problem getting the animals down here alive. The trip lasted some ten or twelve hours and it was difficult to control the tank temperature. In 1953 we attempted shipping octopus by air in a barrel of water. The main objection with this technique is the expense accompanying the shipment of a forty pound octopus with approximately forty pounds of water. Octopus shipped in this manner did come through in good condition. With Cecil Brosseau's discovery that an octopus that had been on ice could be revived it appeared feasible that we could ship the animals with less weight. An experimental program was begun to refrigerate octopus into a cold torpor, maintain them in this torpid state for several hours and then revitalize them by placing them in slightly warmer water. The Pacific octopus does have narrow thermal requirements, the maximum thermal tolerance being near 53° with short exposures as high as 58° not affecting the animal. Prolonged exposure to water temperatures above 54° will cause death. In Puget Sound they are normally found in water of 44 to 48° temperature and do well in captivity there, being kept in bathtubs or tubs of water where no heavy metals are in contact. The present technique we are using to ship octopus is to refrigerate them to a torpid state and place them in a plastic sack with no water and with ice in a separate compartment of the bag. The animal is then placed in a fiberboard drum and shipped via jet air-freight to destination. Upon arrival, it is taken from the bag and placed in water of about 48 to 50° temperature. Revival normally occurs very rapidly. Occasionally some artificial stimulation to initiate respiration is needed.

Method

Octopus are generally brought to the Pt. Defiance Aquarium by skin divers or fishermen, either caught by hand or by trap. Once in the Aquarium Cecil Brosseau maintains them for a few days to make sure they are in good health and prepares them for shipment. The octopus taken from its holding tank, placed in a tub to which ice is added, either sea ice so as not to crate as osmotic problem by dilution to lower salinity or freshwater ice in a plastic bag. An other method of cooling the water could also be used. The sea water is cooled and the temperature is slowly lowered to approximately 35°. At 35° the octopus show no sign of movement and respiration ceases. At this time the octopus are put into a plastic bag called an "icer bag". This type of plastic bag is commercially available in most parts of the country. The octopus are placed in the center section of this compartmented bag. The side of "icer" sections are filled with ice to maintain the temperature of the octopus at 32^0 and the center of the bag is inflated with a small amount of oxygen and then the entire unit is placed in a barrel and sealed for shipment. Upon arrival we pick the octopus up at

the airport much like any other fish shipment and transport it to Marineland where it is opened and the octopus placed inwarmer water. Normally we use 46 - 50° water. In some cases the octopus arrive and revive immediately and need no other treatment other than placing in the warmer water. At other times when they arrive they have been exposed to the ice condition for a longer period of time and need some artificial respiration. This is simply a matter of placing the animals in 48° water and manually filling the mantle cavity with water and squeezing it out. Ten times has been usually sufficient to revive the animals and to have respiration become spontaneous. The octopus' color in the deeper stage of cold anesthesia is often white and is an indication that an artificial stimulation of the respiratory mechanism is needed. Animals in shallower states of anesthesia and which do not need artificial respiration have a deeper red color. The amount of suction that can be detected in the tentacle sucker mechanisms is also an indicator of the state of torpor or anesthesia. Animals that are in the white, deeper stage that need the artificial respiration will often have very little response to touching the tentacle. Animals slightly under the cold effect will have a reaction to touching the tentacles and sometimes actually will wrap around the worker's arm. Recovery is quite rapid in the tanks and one can often feed the octopus the next day. Shipping octopus in this manner is quite economical. The shipping weight of the package is determined by the size of the octopus. The largest animal shipped was 70 pounds and the animal including barrel shipping weight was 88 pounds. Most of the time we are shipping smaller animals 30 pounds to 40 pounds. The container in this case is normally less than 50 pounds total shipping weight. We do not have to ship very much ice with the animal as they are well insulated in the barrel and are already in the cold torpor state before being placed in the barrel. This particular method of transport has also been extremely efficient. We have shipped fifteen octopus from Seattle to Los Angeles and have lost only two. The shipping techniques when we lost the two had been changed from the original method and it is presumed that death was caused by this alteration of shipping method and airline handling. Until this time and since, we ship only one animal per container. The size of the container varies with the size of the animal. In the above instance, a large container containing two octopus in separate bags was shipped. On arrival, the drum had been tipped on end by the airline crew and had not been held in its designated position. This presumably allowed one animal to be dumped on top of the other, causing suffocation of at least one of them. Any rough handling in this position probably could have killed both, such as if the barrel had been tipped on a reverse of positions occurred. The times involved in shipping to Marineland have been, from the time of packing to time of removal of the octopus from plastic bags, between six and nine hours. With jet transport across the country the time would not be greatly lengthened from Seattle to New York or other parts of the country. However, I feel that direct connections are essential and one should be at the airport on arrival. Recently Murray Newman shipped a 30 pound Pacific octopus to the New York Aquarium and it arrived in excellent shape.

Summary

It is now possible to ship Pacific octopus to nearly every part of the U. S. and possibly via polar routes and jet transport to Europe. A point of origin of these Pacific octopus is Seattle or the Tacoma Aquarium. By the use of this refrigerated anesthesia technique, octopus are cooled to a torpor state, placed in plastic bag containers caller icer bags which have separate ice compartments to maintain the cold torpor and shipped via jet aircraft to the point of destination. Upon arrival, octopus are warmed to temperatures between 48 and 50° and maintained at those temperatures. North Pacific octopus require cold water, either in a normal system or in a refrigerated system below 52° . Their upper lethal limit is apparently between 54 and 58° and one should keep the temperature as low as possible, preferably the 40's and between 44 and 48° seems to be the optimum. These octopus can be expected to survive in captivity for periods ranging from nine to sixteen months and occasionally will live for two years.

The Circulation and Chemistry of the sea water in the Amsterdam Aquarium

A. L. J. Sunier

The following report was presented at the annual meeting of the International Union of Directors of Zoological Gardens, held in Amsterdam in June 1951. Although it may not describe the most recent aspects of the venerable Amsterdam Aquarium, Director Sunier's account concerns, in part, a type of sea water system that is strange to aquarists in the U.S.A. where it is generally assumed that filters are an essential part of any closed water system. Two points are particularly noteworthy and they are undoubtedly interrelated: (1) the large proportion of the water that is held in the reservoir, which occupies the entire basement of the Aquarium, and (2) the low rate of turn-over of water in the exhibition tanks. It was estimated that six days passed before water returned from the reservoir. As far as I know, this report and a paper by C. Honig (Journal of the Marine Biological Association of the United Kingdom, Vol. 19, No. (?) , pp. 703-726, 1934) are the only articles about the sea water in the Amsterdam Aquarium that have appeared in English.

James W. Atz

The sea water of the Royal Zoological Society NATURA ARTIS MXGYSTRA of Amsterdam was built to the purely empirical pattern devised by W. Alford Lloyd and was finished in 1882. The sea water aquaria of Antwerp, Berlin and London were subsequently built to the same design, and in all these aquaria the same sea water circulates continually through the tanks containing the animals and through reservoirs. In the Amsterdam Aquarium, the tanks in which the animals live contain only one-sixth of the bulk of sea water in the whole system. The water is permanently circulating and the water in each tank is replaced on the average one-and-a-half times every twenty-four hours. The total volume of sea water is 600 cubic metres (approximately 44,000 gallons).

When I came to Amsterdam in 1927 the sea water did not pass through filters; in the first place some sand filters, in wooden boxes, had been fitted in some of the smaller reservoirs, but these filters had long been out of repair. From 1882 to 1936 part of the sea water was renewed from time to time, and in 1936 the whole sea water was renewed for the first time.

As nobody knew exactly how the organic substances introduced by the animals were removed from sea water circulating in the aquarium for so many years, we were very glad when Miss C. Honig undertook a study of this question in 1933. She found that this organic matter was very quickly broken up into ammonia (NH_3) and carbon dioxide (CO_2). The ammonia was quickly oxidized by the action of nitrifying bacteria, forming first nitrite and then nitrate; only small quantities of nitrite are found in the sea water but the nitrate accumulates. Through the formation of CO_2 the pH became too low, cropping considerably below 7. Filtration of the aquarium sea water through thick beds of broken shells of bivalves from the North Sea shore (Mactra, etc.) was, therefore, introduced with the result that the pH nowadays never falls below 7.6. Miss Honig worked out a method of breaking up the nitrate by the action of denitrifying bacteria, with the subsequent escape of free nitrogen into the air, but the application of this method presents practical difficulties; moreover, so far there has been no indication that the quantity of nitrate accumulated in the aquarium sea water was harmful to the animals living in it.

In a sea water aquarium such as that of Amsterdam, where there is a considerable volume of water in addition to that in the animal tanks, the use of activated charcoal filters is not advisable. This was understood from the beginning and our opinion has been confirmed by experience in the new aquarium at Charlottenlund, near Copenhagen, where such filters were installed in 1939 and removed some years later, to the great improvement of the water.

In addition to carbon dioxide and nitrates, there is a gradual accumulation of small quantities and phosphate and silicate over a long period; the calcium/magnesium ratio increases while the sodium decreases slightly and the potassium increases slightly.

As far as I know, pump housings in almost all aquaria have been made from a kind of

bronze formerly called gun metal, but it was found at Amsterdam that his bronze gradually releases small quantities of copper over a long period; as iron ions never occur in sea water, the new pumps in the Amsterdam sea water section were made of stainless steel and not an alloy containing copper. A further advantage is that these stainless steel pumps are now obtainable from stock and are, therefore, cheaper than bronze pumps that must be made to order.

PLASTIC PLUMBING CAN MEAN TROUBLE

James W. Atz

New York Aquarium

For some time, I have believed that plastic pipe is the latest and greatest thing for aquarium water systems, and I am sure other aquarists have, too. Although I have known right along that some plastics are not suitable because they are toxic, I did not realize that all polyethylene, polyvinyl-chloride or unplasticized polyvinyl-chloride pipes are not the same. Some of these, at least, are definitely toxic to delicate aquatic animals. On good authority, I have been informed that plastic products made with extenders, plasticicizers or used polyethylene should be avoided. The pipes and fittings from any batch of plastic should be tested for toxicity, since present standards of production permit a lot of significant variation as far as toxicity to aquatic animals is concerned. When a manufacturer claims that his product is completely non-toxic, he is usually speaking in terms of human beings, which are a lot tougher and better isolated from their environment than are most fishes and water-inhabiting invertebrates.

Aquarium Committee of American Society of Ichthyologists and Herpetologists.

At the forty-second annual meeting, President Roger Conant, established an Aquarium Committee for the American Society of Ichthyologists and Herpotologists. The Committee members include the following people: Christopher Coates, New York Aquarium; William E. Kelley, Cleveland Aquarium; Earl S. Herald, Steinhart Aquarium; and F. G. Wood, Marine Studios. L. C. Finneran, New England Aquarium, is Chairman of the new group.

A NEW APPROACH TO A DIORAMIC AQUARIUM

By

Ralph C. Morrill
Chief Preparator in Zoology
Peabody Museum
Yale University
New Haven, Connecticut

A radical departure from the standard type of Aquarium, has been designed, built and patented by Ralph C. Morrill of Peabody Museum, Yale University.

This tank is constructed of three members, a bottom, front, and back. The front is uniplanar, made of glass, quartz, or any other transparent material. The bottom may be slate, glass, or plastic, while the back is formed of a cylindrically curved glass, mirror-plated, on the convex surface.

This mirror-type tank, produces a life-like representation of distant under water scenes, creating an effect that for years we have attempted to produce by the use of dry, curved and painted backgrounds. This cylindrical approach also eliminates the "fish in a box" effect found in so many aquaria, and puts them in a class with museum habitat groups.

Public Aquaria are welcome to use this tank for display provided the U. S. patent number and name are plainly shown on the front.

STAFF ADDITIONS FOR BOSTON'S COMING PUBLIC AQUARIUM

The New England Aquarium is making rapid progress in its plans as an independent charitable organization to build and operate a public aquarium in metropolitan Boston. To facilitate development of the project, two staff positions have been created and filled.

Edward A. Taft, Jr., formerly Exhibits Director at the Museum of Science, has been appointed to the position of Executive Administrator. Mr. Taft, Harvard '50, will coordinate the opportunities to make this institution an important part of cultural life in this community.

Emanuel Ledecky-Janecek, formerly at the American Museum of Natural History, has been appointed to the position of Exhibition Curator. Mr. Ledcky-Janecek, Queens College '56, will work on designs and techniques for displaying the aquatic world to the general public.

A public aquarium session was held on June 14, at the 42nd Annual meeting of the American Society of Ichthyologists & Herpetologists.

Craig Phillips of the National Aquarium arranged and presided over the session. The following papers were given: The voices of American alligators during the mating season. Bill Kelley, Cleveland Aquarium; A brief history of the National Aquarium. Ken Morrison, National Aquarium; The New National Aquarium. William Hagen, U. S. Fish and Wildlife Service, Washington, D. C.; Pinnipeds and white whales in captivity. James W. Atz, New York Aquarium; Comments on the Philadelphia Aquarium. Frank Powell, Aquarama, Philadelphia; Educational and moral responsibilities of future aquariums. L. C. Finneran, New England Aquarium Corporation, Boston; Capture and raising of Atlantic harbor seals. Harry Goodridge, Rockport, Maine; Unusual specimens in aquaria. W. B. Gray, Miami Seaquarium; The New Steinhart Aquarium. Earl S. Herald, Steinhart Aquarium, San Francisco; Plans for expanding the Vancouver Aquarium. Murray A. Newman, Vancouver Aquarium, Vancouver, British Columbia, Canada; The common names of fishes. F. G. Wood, Jr., Marine Studios, Marineland, Florida.

The session was well attended with representatives from aquariums at: Vancouver; San Francisco; La Jolla; Cleveland; Toledo; Cincinnati; Boston; Woods Hole; Booth Bay Harbor; New York; Philadelphia; Washington; Memphis; Dallas; Marineland; Miami; Chicago and Calgary, and Fruit Tree Road.

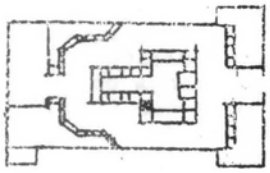
Vancouver Curator Feted at Boston

On Monday, June 25, 1962, a committee consisting of the directors of the local Museum,. Zoo, and Aquarium met at Logan Airport to welcome Vancouver Aquarium Curator, Murray Newman. The big day included a fast run to the Wood's Hole Oceanographic Institution and Aquarium where a tea was arranged in his honor and dinner at Cambridge where introduction to prominent local Zoologists had been arranged. Dr. Newman got his red carpet treatment.

Public Aquarium Information Sheet No. 1

RELATIVE FLOOR SPACE

1 inch = 64 feet



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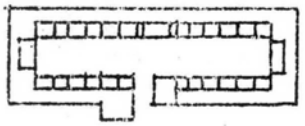

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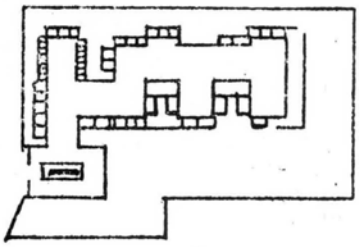
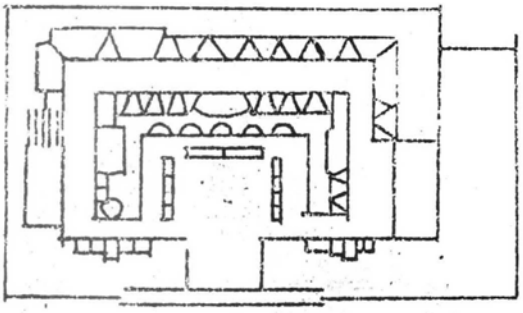


Vancouver



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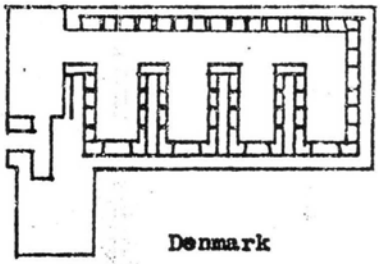

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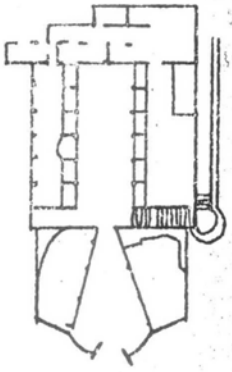
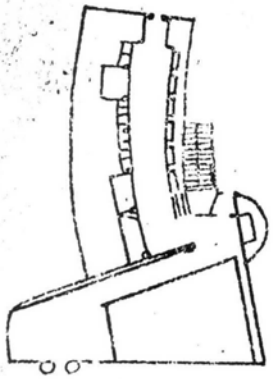
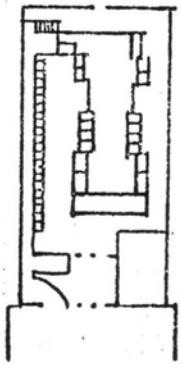


Exotarium
Frankfurt



New York



Calgary

WORLD'S FAIR VISITORS SEEING AQUARIUM

The new Seattle Aquarium at Pier 56, visited on Tuesday, July 24, 1962

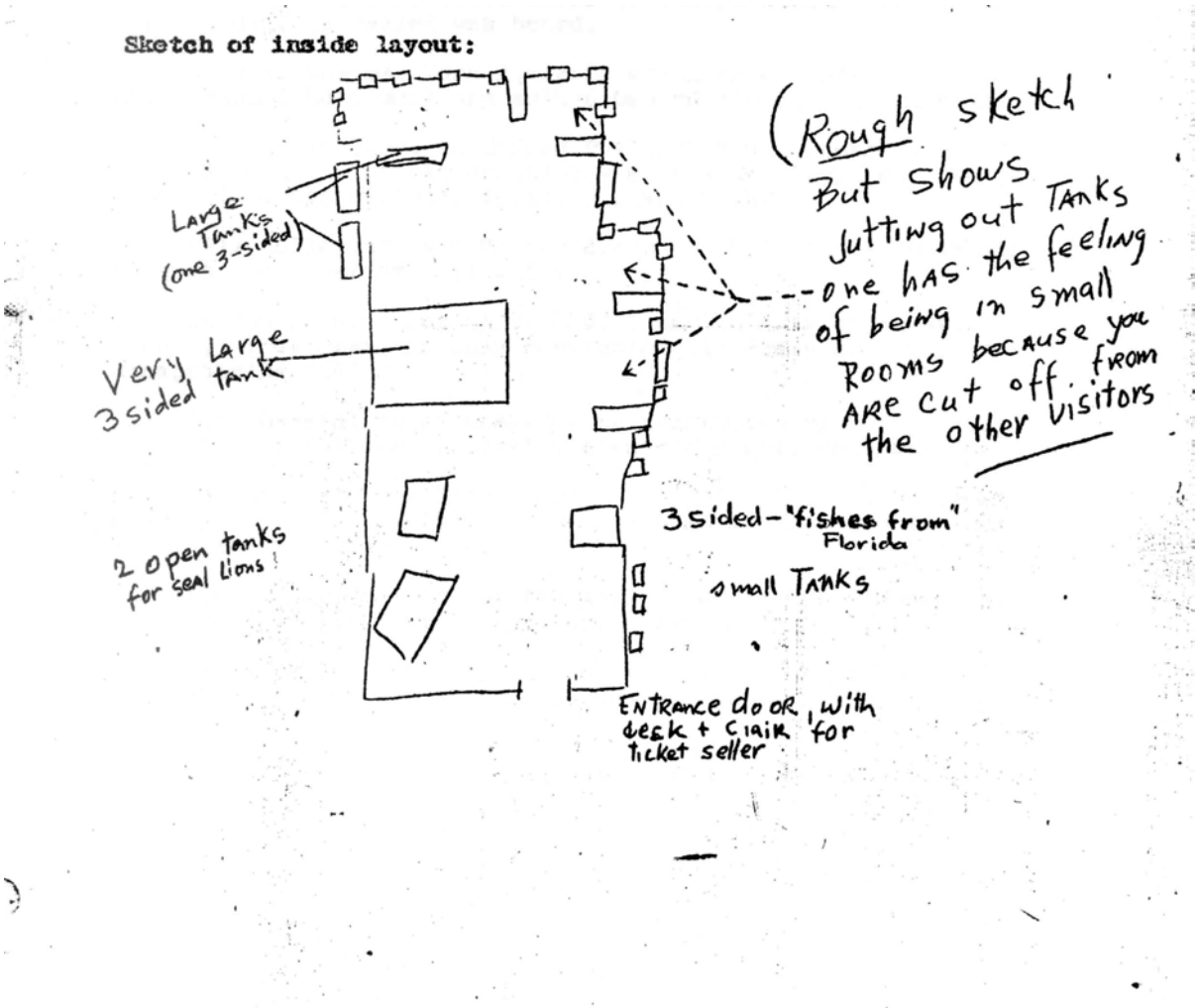
The new Seattle Aquarium had been open less than a month. Some tanks were still empty or had only one fish on display in them (often duplicated in another tank), but there were quite a few people going through. Admission is 75¢ for adults; 50¢ for children. At the end of the pier they had a baby harbor seal in a very small tank as a free "come-on" gimmick. Once inside I was surprisingly impressed, for I didn't expect much from the outside appearance. While the entrance is barn-like, with two large open tanks housing sea lions (one in one tank, two in the other), the visitor then wanders through the corridors, which are darkened and light coming only from the tanks. The walls are wood-lined, redwood I think, and the atmosphere is pleasant.

I counted 37 small tanks of 25 gal. size (approx); 15 much larger ones, some placed perpendicular to the wall so that visitors could walk around three sides of the tank, and this placement also broke up the tank areas from merely one long wall to smaller, more private areas and helped break the flow of visitor traffic. These larger tanks I would say were about 300 gal. size, but I may be wrong. An arrangement of the layout is at the bottom of this report. Finally, there was one very large tank, again set so that visitors could walk on three sides. The girl taking the tickets at the door said, after some hesitation, that the tank, she thought, was a 20,000 gal. one. She told me the owner, Mr. Griffith, was a skin diver and had collected most of the specimens on display. Unfortunately he was not there and she could offer no further constructive information. When I asked about brochures she said they had had some made up, but had been swamped with visitors (no doubt from the World's Fair, like me).

From the legend material over the tanks I jotted down the following specimens on display. The legend material, incidentally, itemized what was in the tank…nothing about locality, depth, or scientific name…only common names – and some tanks had no identifying legends as yet. Anyway, the following were on display; kelp crabs, sailor fish, gruntfish, white cucumber, cling fish, small sturgeons (one was dead and still floating in tank), small skates and flounders, sea urchins, shell binder tubeworm, coon-striped shrimp, rock scallops, sculpins, spider shrimp, brown Irish lord, small moray, rock cod, hermit crab, convict fish, green blennies, red cucumber, kelp greenling, buffalo sculpin, giant sculpin, anemones rock cod, wolf eel, and a tank of shellfish on rocks. The large tank had two good size octopuses and some sharks – but the water in this tank was very cloudy and it was downright difficult to see. Some of the other tanks were also a little cloudy, but also many were quite crystal clear. They were having trouble with condensation on all the tanks…it was beastly hot in Seattle and most unusual for that area. I might add, that in the medium size tanks two more (smaller) octopuses were on display…four in all. There was one tank labeled "Fishes from Florida" and in it were some seahorses and a few small colorful reef fishes. In one of the small tanks the label read "Searcher Fish" and these appeared to bounce on their pectoral fins on the gravel bottom. They were long (5 ") thin, almost colorless fish, and didn't

show up well since the sandy gravel bottom was the same color as they were. As for tank decorations, it was obvious to me that Griffith had only begun to fix up the tanks….a few were nicely done, but other looked as if a rock or two had been put in for the time being and more would be done later. The sea anemone tank was quite well done.

My overall impression is that Griffith's aquarium has a good location on the waterfront, near the Ferry departure pier (#52), and near restaurants and tourist souvenir shops, etc. I know nothing of his filtration setup. I saw one other person there…(besides the busy ticket seller) a young boy who was feeding the baby seal at the outside. Incidentally, that was to me a bad impression, being such a small tank with a small crab box stuck in it for the animal to crawl out of the water onto, and the water was filthy; but as I said, one inside, I was surprisingly impressed.



Anonymous Minutes of the Forty-second Annual Meeting
of the
American Society of Itchyologists and Herpetologists
Washington, D.C. - 1962

June 13 - Evening session in Room 240, Willard Hotel

An informal gathering of the top seeded aquarium men was held for the purpose of an amiable discussion of mutual problems and to determine who had the greatest capacity. The participants were some of the most broad minded, understanding and convivial that attended the convention. Questions asked and main points discussed were:

Why is the water a 7 Seas Panorama so murky, and why was the building ever designed in the first place? Don Olsen threw up his hands and threatened never to design another aquarium. A great sigh of relief was heard.

When is the New York Aquarium going to exhibit some fish. Atz barked like a seal and sulked behind his scotch and water.

No one was there to defend Philadelphia's Aquarium so it was fair game. The big question was, how are they going to get sharks into the central, isolated shark tank?

Bill Kelley and Dan Moreno defended their right to exhibit blivits and frustrate alligators.

It was pointed out that Shedd Aquarium's water is still cloudy. They have the only conventionally designed tanks with disappearing walls.

Earl Herald, whose position is threatened by automation at Steinhart, still insists that recorders in quintuplicate are a must.

No one could get Elmer Taylor to admit that the water at Calgary is first conditioned and seasoned in the aquarium before it is used in the brewery.

It was agreed that the fat smiling Buddha from Boston is going to have the world's most expensive waterfall.

The amiable, friendly, broadminded group broke up its gathering at 0300 and groaned at the prospect of the 10 A.M. joint session.

Thursday - June 14 - 8:00 A.M. Registration for meetings, field trips and hangover pills.

10:00 A.M. Joint session
All the joints visited the night before were discussed.

Noon Group photograph

Some publisher of tropical fish literature materialized for the picture and then just as mysteriously, vaporized.

Noon recess for lunch

Six well-known aquarium characters ate a delicious lunch at Jack Hunt's through the generosity of Bill Hagen. It was generally agreed among the six that they never enjoyed a meal more and that the occasion should be repeated as often as possible.

Afternoon session

Events of this time are a little out of focus. There is some faint recollection of the stag bar and a bed in Room 240.

Evening session - Aquarium symposium

Everyone attended this so there was no point in taking minutes.

Wee small hours session - Room 240

More of the same of previous night.

Friday, June 15th - 9:00 A.M.

The same small hardy band that survived the lunch at Jack Hunt's appeared at the New Senate Office Building and presented their views, along with those of members of the ADA and PTA on the new National Aquarium and Fisheries Center. Latest word is that the committee reported favorably on the bill.

Afternoon session

While most members attended the afternoon session in the Jackson Room, a mysterious femme fatale was found snoozing in Room 240 by a few errant and restless persons looking for something to quench their thirst. (Everyone had a key for 240). As it was obvious that she belonged to the Poeciliidae, they hastily and discreetly made their retreat. She was finally roused by some uncouth souls who wanted to display sketches of some new aquarium.

Saturday, June 18 - Field trip to CBL

Net results of field trip

3 fossil shark teeth
1 cut foot
3 hog chokers
1 toadfish
1 bitten finger
2 pipe fish
1 pouch Old Briar
2 eels
49 bales ell grass
6 x 10 tunicates
1 case beer
14 crabs

urp!!

NOTES ON REARING BRINE SHRIMP

By James W. Atz
New York Aquarium

This collection of miscellaneous facts and bibliographic references on the culturing of the brine shrimp (Artemia salina) is offered in the hope that somewhere, either among these data or in the experience of some reader, may be found the infallible method for rearing brine shrimp to adult size. We have been searching for such a method at the New York Aquarium since we opened up our new place in 1957. There have been times when it looked as if we had the answer, but inevitably, sooner or later (and mostly sooner), we found ourselves out of brine shrimp again. Nor is our experience unique, because there had yet to be a commercial outfit in the New York metropolitan area that has been able to stay in the adult brine shrimp business for any length of time. All the firms have folded up – and not for any lack of customers. I do not know whether other public aquariums have had similar problems. This potpourri is accompanied by an appeal to send to DRUM AND CROAKER any ideas or techniques you may have developed.

The San Francisco Aquarium Society and the California Academy of Sciences (parent organization of the Steinhart Aquarium) are in the process of preparing a bibliography on Artemia which will probably be published by the Academy in 1963. Until that time, however, the list of references provided here may help would-be brine shrimp culturists.

Brine shrimp first came to the fore as a food for captive fish in the 1930s. Alvin Seale, who was in charge of the Steinhart Aquarium for many years, is generally credited with developing the new live food, and he was one of the first, if not the first, to write about it (Seale, 1933, 1934), but Dr. Rolf L. Bolin of the Hopkins Marine Station at Pacific Grove, California has also been credited with introducing Artemia to aquarists (Morris, 1956, page 42). Perhaps the people at Steinhart will include a brief history of the brine shrimp with their bibliography and thus be able to clarify this point.

The best general account of the brine shrimp was written in 1953 by the Steinhart Aquarium's Robert P. Dempster, who played a major role in developing techniques for processing brine shrimp eggs in commercial quantities. One of the useful facts he uncovered is that the eggs will live for years when kept in a high vacuum. Although Artemia eggs have been known to remain alive for as long as 15 years if kept dry, only a tiny percentage will do so. Dempster and Hanna (1958), however, have shown that vacuum-packing keeps mortality at significant levels for a period of at least four years.

A handy booklet on "The Brine Shrimp and How to Hatch its Eggs" may be purchased from the San Francisco Aquarium Society (California Academy of Sciences, San Francisco 18). The paper by Robert Straughan (1960) also has some worthwhile points to make. Everyone seems

to agree that aeration is absolutely essential, the shrimp being sensitive to carbon dioxide or a low pH, or both. According to Baud (1937), sea water fortified with five to eight grams of table salt per hundred cc. is the best hatching medium. Artemia will live at the most only several days in a solution of pure sodium chloride, although they will hatch in it; a balanced salt solution, such as sea water, is required for normal existence. Good hatches are said to be regularly obtained with a solution of non-iodized table salt (eight level tablespoons per gallon of tap water). Various artificial sea waters apparently work as well as the natural stuff. The following is a formula for an artificial hatching and rearing medium used successfully by workers in the U. S. Department of Agriculture (Michael et al., 1956) :

Sodium chloride	60 grams
Calcium sulfate	3.4 do.
Magnesium sulfate	6.4 do.
Magnesium chloride	17 do.
Potassium chloride	1.6 do.
Sodium bromide	0.2 do.
Distilled water	2,000 ml. (cc.)

The pH of this solution is adjusted to 9.5 with sodium hydroxide. (For another formula, see Appendix II.)

Most people eventually master the technique of hatching Artemia eggs, but rearing the young to adult size is another matter. This crustacean can exist in very dilute sea water and also in crystallizing brine, but it will usually not live more than a day or so in distilled water (Croghan, 1958). Temperatures ranging from 50 to 98 degrees Fahrenheit are tolerated. Such "toughness" is deceptive, however, and the environmental conditions necessary to make brine shrimp thrive often seem quite mysterious. Phillips (1956), Klee (1960) and Straughan (1961) have reported considerable success in rearing Artemia, but to us it seems problematical whether their methods would work indoors on a large scale. Our experience at the New York Aquarium appears to show that out-of-doors culturing is easy, at least as long as there is enough sunshine.

Sunshine plus salt water equals algae, and algae are a natural food of the brine shrimp. Perhaps a proper diet is the key to successful rearing of Artemia. The yeast suspensions that are usually used may simply be inadequate as a sole diet. The studies of Dr. Luigi Provasoli and his collaborators, who have grown Artemia in germ-free cultures, indicate that its dietary demands are complex – too complicated and poorly understood for the aquarist to be able to apply the preliminary findings of the bio-chemical microbiologist. Studies by Janine Dutrieu of the Faculte des Sciences de Bordeau help explain the importance of algae in the diet of Artemia. (I do not pretend to understand the full significance of this work, but Dr. Sarane T. Bowen of San Francisco State College kindly sent me a translation of an important part of a recent paper by Dutrieu, which I am including as an appendix, because it would undoubtedly not otherwise be available to most

aquarists.) Dr. Bowan herself was able to rear Artemia to adulthood with less than 50% mortality on Brewer's yeast alone, but her feeding methods are not applicable to mass culturing. It usually takes three weeks or a little more from the time of hatching until sexual maturity is attained and reproduction occurs. *(Text not legible on original copy)* workers claim to have grown sexually mature, egg producing Artemia in only nine to eleven days. (Since their paper, too, would not be available to most U.S. aquarists, I am including the greater part of its English summary as a second appendix.)

The Japanese workers consider the presence of chelated metals vital to their success with brine shrimp, but ionic metals like silver, copper and mercury are toxic to these crustaceans – as they are to practically all aquatic life. Brine shrimp are also sensitive to acids, which may account for some, or all, of their sensitivity to carbon dioxide. They are also adversely affected by the bicarbonate ion (Croghan, 1958), and sodium bicarbonate should therefore not be used to maintain the alkalinity of their culture medium. At the New York Aquarium, Carlton Ray has experimented with Tris-amino in maintaining a high pH in brine shrimp cultures but without any notable improvement as far as keeping the animals alive.

An interesting point that concerns the nutritive value of Artemia was made by Morris (1956, page 43). He found that larval brine shrimp (nauplii) were not nearly as nutritious (for larval fishes) two or three days after hatching as they were when newly hatched. This is apparently because "the yolk with which the nauplius hatches is used up within two or three days." It would seem from this observation that Artemia should not be fed when more than one day old or less than, say, a week old. Further studies on this aspect of the brine shrimp are needed.

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APPENDIX I

Janine Dutrieu

Quelques observations biochimiques et physiologiques sur le developpement d'Artemia salina Loach.
Rend. Iat. Sci. Camerino, 1:196-218.

Translation from pp. 217-218:

1. If the female eats algae, lives in a well oxygenated environment, she does not synthesize hemoglobin. Her blood very low in proteins, contains only small quantities of chlorophyll. The
female eliminating practically nothing by way of the shell glands is viviparous. The nauplius so produced contains some "astacone" arising from the mothers plant diet.

2. If the environment is low in oxygen, the blood of the female is rich in two distinct hemoglobins: R_1 and R_2. R_2 is eliminated by the shell glands in the form of brown shells which surround the embryos: The female is oviparous. In the case of males and young females which have not laid eggs yet, R_2 which cannot be eliminated becomes highly concentrated in the blood.

3. If the diet does not contribute either chlorophyll or carotenoids, as is the case with yeast diet, the elimination of R_2 does not take place: the females remain viviparous and R_2 accumulates in the blood. The elimination of R_2 is therefore dependent upon a factor contributed by a diet of chlorophyll.

4. An elevated temperature appears to facilitate this elimination.

APPENDIX II

Ken-ichiro Toramoto and Shiskuo Kinoshita (1961)

Some information on the culture of Artemia. Bulletin of the Japanese Society of Scientific Fisheries, Vol. 27, No. 8, pp. 801-804. (In Japanese with English summary).

Dried eggs of Artemia obtained commercially were used. They were allowed to hatch in artificial sea water (Table I). The culture was started by inoculating 300 or so newborn larvae into 500 ml of the culture medium. During the culture, the medium was incubated at 28° C and aerated 20 ml per min., and fine ground food was added, 100 mg per 100 individuals every day.

The results obtained are summarized as follows:

The larvae hatched from dried eggs under aerated conditions showed more successful results than those under stationary conditions.

Artemia were allowed to grow rapidly to adulthood and multiplied enormously in the culture medium of NaC1 and chelated metals added to artificial sea water (Table 2). The addition of chelated metals raised the survival ratio, accelerated the speed of growth and increased egg production. The beneficial actions of chelated metals were mainly due to chelated iron and manganese.

The most suitable specific gravity of the medium was restricted to the range of about 1.04.

Baker's yeast was a good food, but "WAKAMOTO" composed of yeast and vitamin B complex materials in addition, was better.

The newborn larvae grew to adults (at 50-65% survival) and began to copulate after 6-7 days. The copulated females began to spawn after 3-4 days. The number of eggs produced by a female was 100 on average. The hatching out of the fresh eggs took place within several hours in the culture medium.

APPENDIX II continued

Table I. Artificial sea water.

NaC1	28.3g	H_2BO_3	60.0 mg
MgSO4.7 H_2O	7.0	Na silicate	3.8
$MgCl_2$.6 H_2O	5.1	$ALCL_3$.6 H_2O	2.6
$CaCl_2$.2 H_2O	2.4	$LiMO_3$	0.14
KCl	740 mg	H_3PO_4 (85%)	0.24
$NaHCO_3$	210	NH_4OH (28%)	0.06
NaEr	80	H_2O	1000. ml

Table 2. Culture medium for Artemia.

Artificial sea water	500 ml
Chelated metals soln.*	5 ml
NaC1	14 g

- Five ml of chelated metals soln. contains:

$Na_2EDTA.2\ H_2O$	10 mg	$ZnSO_4$. 7 H_2O	5 mg
$MnSO_4$.n H_2O	1500 gamma	$FeSO_4$. 7 H_2O	500 gamma
Na_2MoO_4. 2 H_2O	250 gamma	$CoSO_4$. 7 H_2O	15 gamma
$CuSO_4$. 5 H_2O	5 gamma		

FOULED-FORMULA

The formula for "Instant Ocean" (table II) in volume 62 number 11 of the Drum and Croaker contains the following errors:

1. $Mn(SO_4)_2$; should be $MnSO_4$

2. .27 g of KBr should be 270 g. (only wrong by 3 decimal places!)

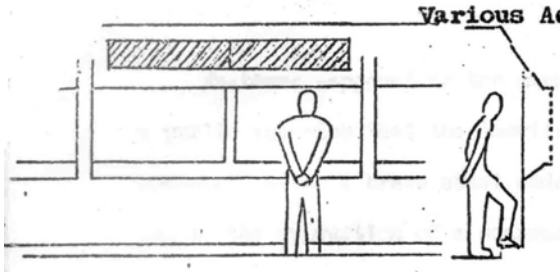
W. E. Kelley

Information Sheet No. 2

Label, Exhibit Height, and Visitor Barriers

in

Various Aquariums



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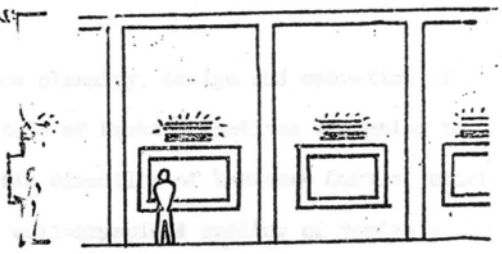

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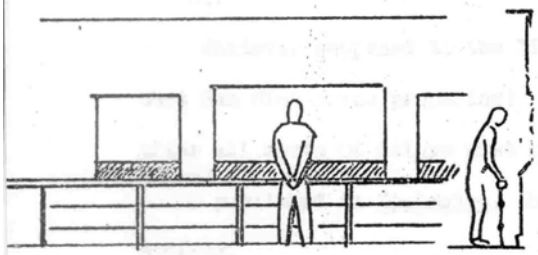

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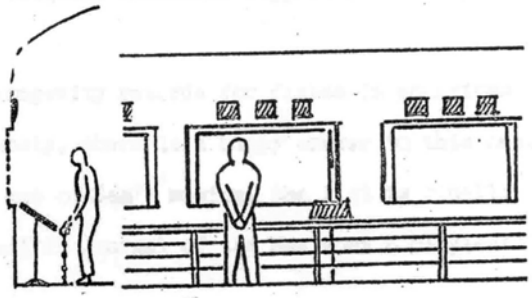

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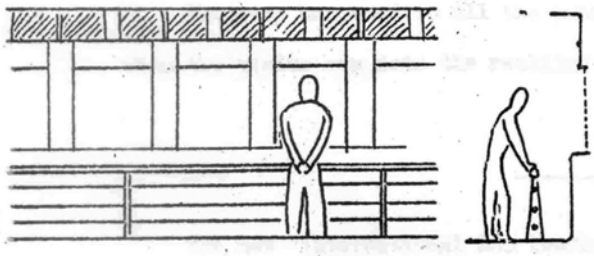

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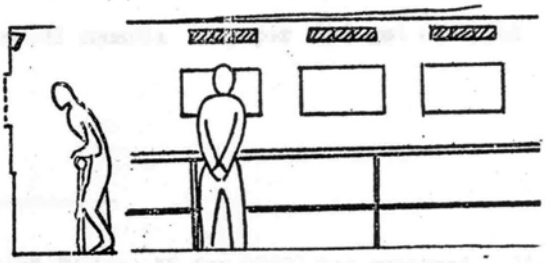

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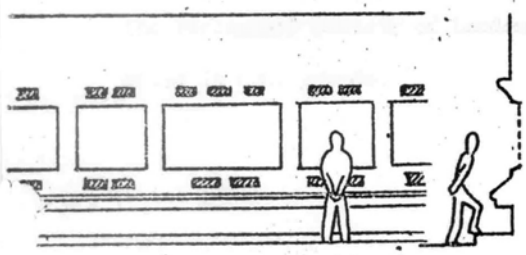

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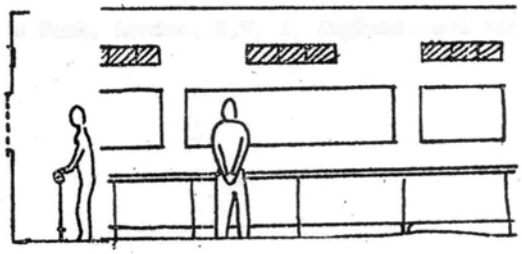

San Antonio

WHATEVER HAPPENED?

Whatever happened to the manual on the planning, design and operation of a public aquarium that the American Institute of Parks Executives was going to sponsor? After a brave start under the able direction of Lawrence Curtis, which led to the production of a comprehensive, well-organized outline of topics to be covered, the project apparently now lies moribund, or is it actually dead? Would the outcome have been any different if adequate financial support had been forthcoming?

Whatever happened to the list of longevity records for fishes in aquariums that Sam Hinton was preparing? Fortunately, there is a happy answer to this one. After all sorts of delays most of them not of Sam's making, the list is finally to be published in Zoologica, the scientific journal of the New York Zoological Society.

Whatever happened to the Proceedings of the International Congress of Aquariology held in Monaco in November of 1960?

Whatever happened to all the wonderful aquaria on paper that got scrapped when the vision ran into the reality?

The new "International Zoo Yearbook" (Volume II for 1960) has appeared. It contains material of interest to aquarists, principally the addresses, staff and brief descriptions of foreign as well as domestic aquariums. It is published by the Zoological Society of London, Regent's Park, London, N. W. 1, England, and the price is four pounds.