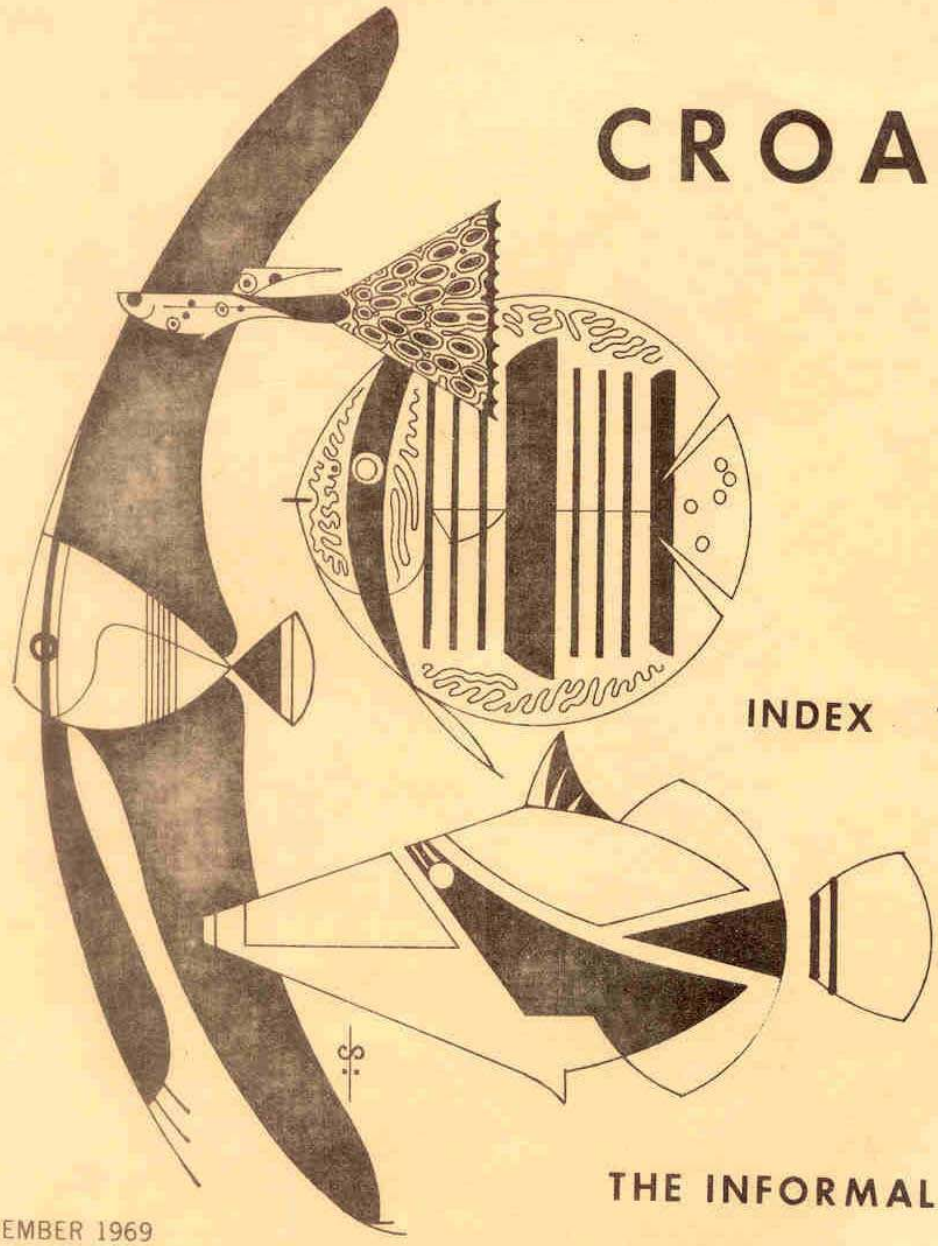
DRUM AND CROAKER



INDEX 1968 - 1969

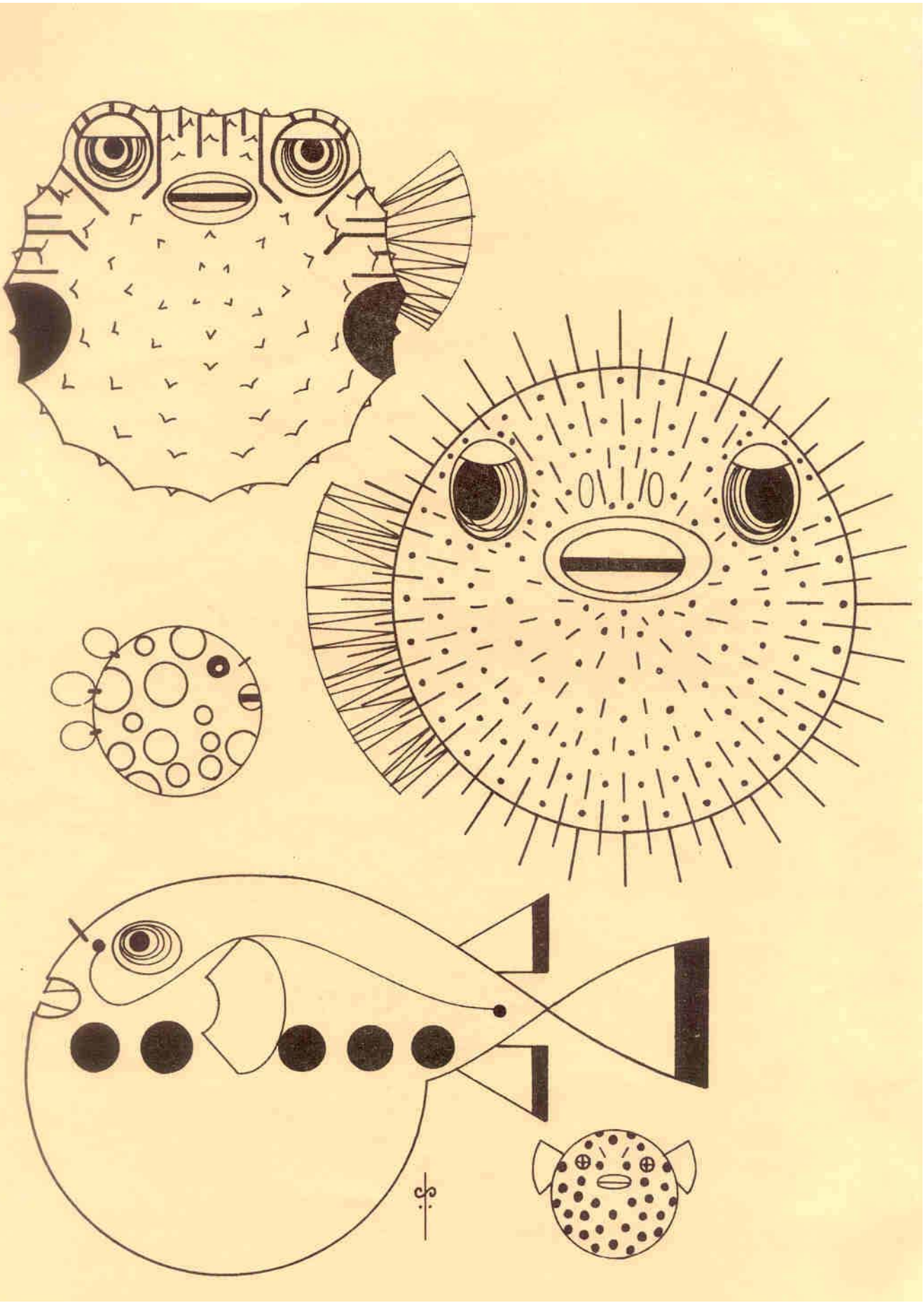
THE INFORMAL ORGAN

FOR AQUARISTS

SEPTEMBER 1969

VOLUME 69 NUMBER 3

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D R U M A N D C R O A K E R

The Informal Organ

For

Aquarists

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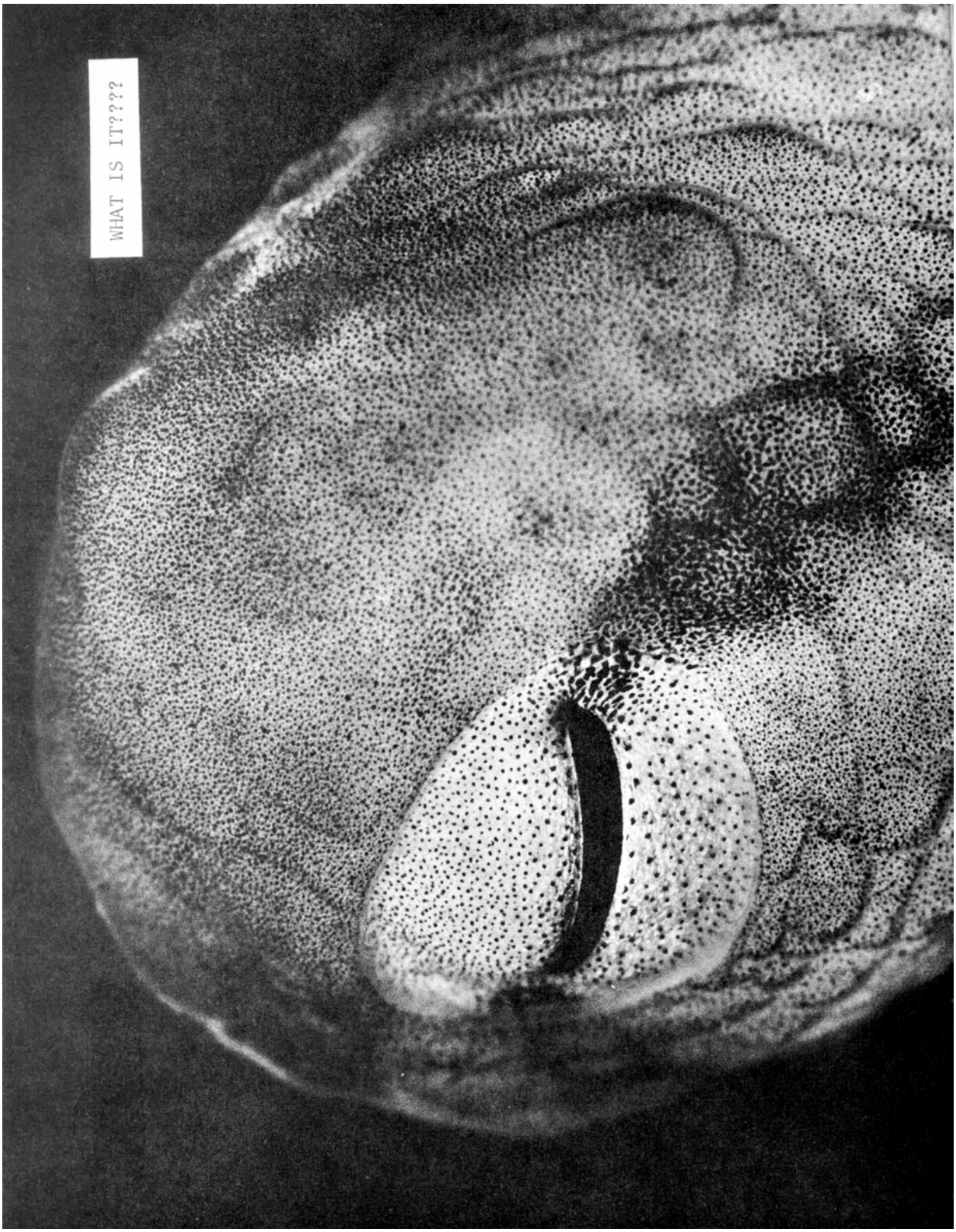
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What is it???? *Answer on page 48*

DRUM AND CROAKER
SEPTEMBER 1969

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NOW IS THE TIME

TO BUDGET

FOR THE

16TH ANNUAL AQUARIUM SYMPOSIUM

OF THE

50TH ANNUAL MEETING

AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

NEW ORLEANS

JUNE 1970

15th Annual Aquarium Symposium -- 1969

All reports indicate that the New York sessions in June were the best ever. Only the Oppressive heat and humidity caused complaint. We hope New Orleans can combat the discomfort index next year.

We have included in tile following pages those Symposium papers or abstracts of papers received from the authors.

FIELD AND AQUARIUM STUDY OF THE BLIND RIVER DOLPHIN, Platanista gangetica*

Earl S. Herald and Robert L. Brownell
Steinhart Aquarium

ABSTRACT

Pliny the Elder (72 AD) was the first to write about the blind river dolphin (Platanista gangetica), but it was not until November 10, 1968, that the species was found to be the first known side-swimmer. Of the three animals collected, one swam in a clockwise direction and two swam in a counter-clockwise direction. The nearly constant sonic discharge apparently provides the blind dolphin with an echo-ranging ability that enables it to sense its surroundings. The rudimentary eye is lacking the lens, but anatomical evidence suggests that it may serve as a light sensor.

USE OF VARIOUS SALT-ADAPTED PLANTS IN THE TROPICAL SHORELINE EXHIBIT*

Craig Phillips
National Fisheries Center and Aquarium

ABSTRACT

Although land and freshwater plants of various kinds have been used extensively in aquaria and terraria for the purpose of giving a more authentic as well as aesthetic to the exhibit, comparatively little has been done to date with their marine counterparts. Experimental rearing of certain representative shoreline and intertidal Spermatophyte plants under natural and artificial light at the National Aquarium over the past two years has indicated that some of these will thrive under artificial conditions where they are deprived of the natural tidal rhythm. These include the red mangrove, *Rhizophora mangle*, the white mangrove, *Laguncularia racemosa*, the sea purslane grass, *Sesuvium portulacastrum*, and the tropical beach lilly, *Hymenocallis keyeneis*. Information is given on how and where to collect these species, together with a description of the plant habits, methods of transportation, and cultivation.

*Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, June 13, 1969, New York City.

AQUARIUM GLASS:
A STRUCTURAL COMPONENT
(A PROGRESS REPORT)*

By

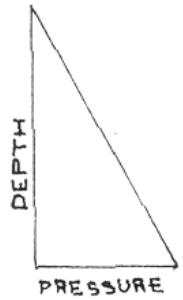
Walter L. West
National Fisheries Center and Aquarium

Our observations indicate that if a panel of glass breaks in a large oceanarium-type tank, it is more likely to be one of the uppermost panes rather than one of those farther down. Assuming that, except for hydrostatic pressure, all panels at whatever depth they occur, are of equal quality, are mounted in similar fashion, are adequately, or at least equally, bedded, and are subjected to an equal amount of visitor and animal abuse, why should those at shallower depth break with greatest frequency?

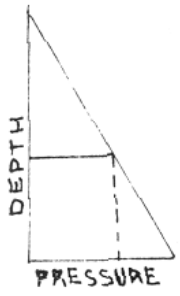
We believe that the fault lies in an engineering convention which in spite of added safety factors, results in glass which, near the surface, is too thin to perform reliably.

Here is our reasoning:

1. The pressures to which any portion of a deep tank are subjected can be portrayed graphically. The vertical axis is depth and the horizonal axis is pressure. Note the straight line relationship.

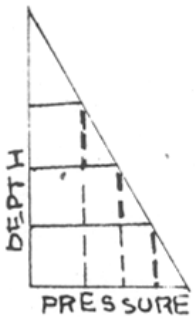


2. Pressure at any intermediate depth can be determined by drawing a line at right angles to the Y axis where it intersects the slope. The formula for a straight line with this slope is $x=ay$, where y is the depth and x is the pressure.

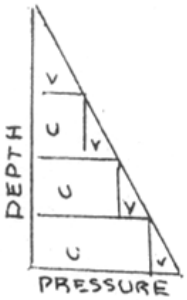


*Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, June 12, 1969, New York City.

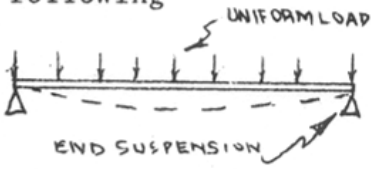
3. We draw on the same graph the top and bottom edges of each of our panels of glass and, forgetting about mullions for the moment, visualize the range of pressures to which each panel is subjected.



4. The figure we have constructed is called a force triangle and deserves a closer look. It can be seen that pressures to which each of our panels is subjected can be considered as composed of a rectangle, representing the pressure to which the upper edge only is subjected, and a triangle which represents the increase in pressure from the top edge to the bottom edge.

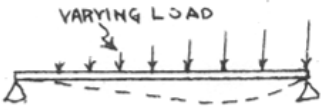


5. How then do we determine the pressures to which each panel is to be designed? Standard procedure, as used by glass engineers, requires that the mean pressure on the pane, or that measured halfway down the pane, be used in the calculation. The formula which is used in the calculation was derived from the following assumptions:



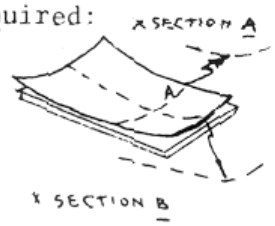
> These are obviously false as concerns aquarium glass, but are satisfactory, however, when used in the calculations for window panes in a building.

6. To correct one of the assumptions requires the following:



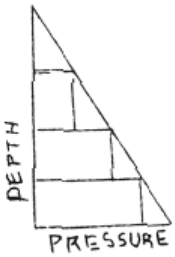
> It will be found, on measuring, that the point of greatest flexure in aquarium glass occurs at about 2/3 of the distance from the edge with least pressure, the top edge.

7. To correct the other assumption, suspension at each end, an additional computation is required:



The pane is not suspended merely from the ends, but all the way around.

8. Now, why do these two factors affect the top glass more than the bottom? Let us look again at our force triangles:



The force action on the lowermost pane is *largely uniform and* only a small percentage of the total force is composed of the triangle representing the change in pressure from the top of the pane to the bottom.

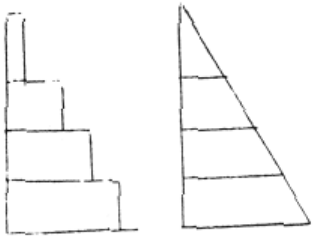
As we go up, however, we see that this triangle *becomes a greater and greater portion of the total* force until, at the surface pane, it is the total. If the thickness of this pane is determined by means of a formula requiring use of the mean pressure on the glass, it will be seriously underdesigned and will be more liable to fracture than will lower panes.

The solution? Use in your calculations, pressures at *the 2/3 point or, better yet, at the lower edge.*

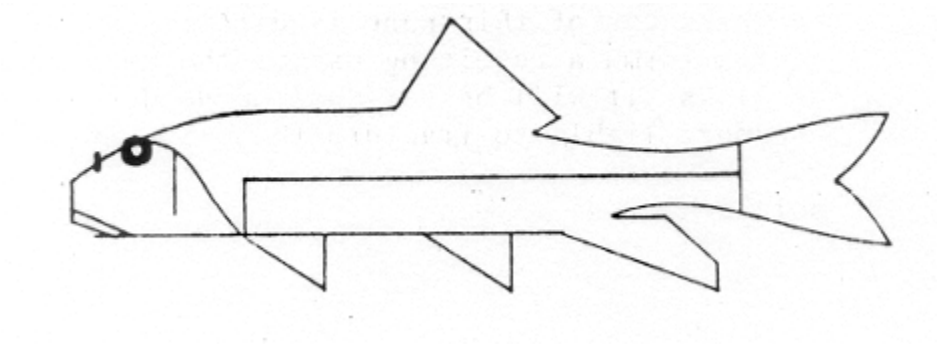
Use a formula which takes into account the variation in pressure from the top edge of the frame to the bottom edge as well as the fact that the glass is supported in a frame running around its periphery rather than on two ends.

A formula which takes these factors into account was *developed by S. Timoshenko in the early 1900's while* he was still in Russia. It has apparently never been used by design engineers for use in aquariums. The glass engineers' formulae in current use for pressure determination disregards the force triangle resulting in a situation like this:

The force triangle *cannot be disregarded.*



The safety factor which we ordinarily inject into a calculation may provide, in part, for uneven bedding in frames which are slightly warped, variation, in strength owing to impurities, glass warping due to tempering and other factors involving uncontrollable departures from the ideal situation. It is doubtful whether, in addition to these, the safety factor would also take care of underdesign resulting from use of a formula based on fallacious assumptions. One can easily visualize what cold happen to a panel of glass which happened to be warped in one direction when it is seated in a frame warped in the opposite direction and then subjected to bending produced by differential pressures which had not been taken into account in the calculation. If, in addition, the glass is clamped around the periphery preventing the corners from lifting partially from the frame, the result, rather than a simple corner crack, could be a disaster.



Burton Clark, General Manager, Miami Seaquarium, and his lovely wife visited the Fisheries Center offices and the National Aquarium following a long delayed visit to a number of aquariums. After the Aquarium Symposium meeting, which included the New York Aquarium, they made "nuts and bolts" visits to aquariums at Boston, Montreal, Niagara Falls ad Pittsburgh. Button reported that they were impressed in one way or another with each of the aquariums and learned of something new behind the scenes.

Murray Newman, Director, Vancouver Public Aquarium, appeared to have somewhat the same itinerary as the Clarks, for they ran into him at Boston and Montreal.

EXPERIENCES WITH Inia geoffrensis (1)

William Flynn
Pittsburgh Zoological Society

ABSTRACT

On June 6, 1967, we were left with a three-month old *Inia*. Her mother died on the day we arrived home from South America, June 5.

The baby was distressed over the death of her mother, but in excellent condition. We began to force feed two whole smelt and 12 drops of Poly-Vi-Sol. Tube feeding was ruled out because of the length of time involved.

A formula was developed by analysis of the mother's milk. On June 8 we were feeding 10 smelt, 12 drops of vitamins, and 12 cc of formula. Her weight was 32 1/4 pounds. By June 26 we were feeding 45 smelt, 12 drops of vitamins and 60 cc of formula.

By this time, the baby seemed quite happy with the way events had turned for her. She played with her keepers almost constantly and no longer had to be chased to be fed. Now she would set herself alongside her keeper and allow him to place the food directly into her mouth. She had no teeth at this time and never did develop any. She always slept flat on her back.

On September 11 she was moved to a tank for the purpose of exhibition. She weighed 33 1/2 pounds and 3 feet 5 112 inches in length. On October 5 her feeding began to fall off and she developed a cough. She was placed on penicillin, 500,000 units three times daily. On October 7 we switched to Polycillin.

She died on October 12 of incipient bilateral bronchopneumonia and pulmonary edema. A defective heating system was instrumental in causing her death. She weighed 34 pounds.

(1) Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, June 12, 1969, New York City.

REVERSE OSMOSIS FOR AQUARIUM WATER (1)

By

Lee M. Kindley (2)

ABSTRACT

Reverse osmosis is a separation process which can be used to separate relatively pure water from a solution containing dissolved solids. If pure water is placed on one side and a water solution on the other side of a semipermeable membrane, the pure water will flow spontaneously through the membrane to the solution side by ordinary osmosis. By exerting pressure on the solution, the flow of water is reversed so that pure water is effectively removed from solution. In recent years semipermeable membranes have been developed which make possible the application of the reverse osmosis principle for practical separations. The most widely used membrane material is asymmetric or "skinned" cellulose acetate film which is currently available in several forms to give various flux and salt rejection performance characteristics. Operating units or modules have been designed to carry out the reverse osmosis principle in several different configurations such as plate and frame, tubular, spiral-wound and hollow-fiber designs. All are based on the common principle that the plastic membrane must have a firm support to withstand the rather high pressure drop across it.

For purification of aquarium water, the reverse osmosis process offers the advantages of low energy consumption with relatively simple processing equipment operating at normal temperatures. Commercially available membranes give rejections of 95%. or more for most ionic species, detergents, bacteria, and most large organic molecules. Rejection of urea, borates, low molecular weight alcohols, ammonia, and phenols is generally poor.

Reverse osmosis water treatment plants operating up to 100,000 gallons per day or about 70 gallons per minute are in use and are available today.

(1) Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, June 12, 1969, New York City.

(2) Office of Saline Water, U.S. Department of the Interior.

SURVIVAL OF CORALS IN AN OPEN AQUARIUM SYSTEM*

By

Robert A. Martin, Curator
Seafloor Aquariam, Nassau

Records have been maintained for the life span of twelve of twenty-one stony corals displayed in the gallery tank exhibit at the Seafloor Aquarium. Eight of the coral species appear to be eminently suited for survival in captivity. These survived not less than two months in our tanks without any special care or feeding. Most survive even longer with proper care and feeding (8 months to 1 year). The heartiest corals are often collected inshore where conditions are variable and are characterized by large polyp or cup size (3mm or more in diameter). (See Fig. 1).

Coral specimens were placed in two 500-gallon display tanks supplied with a constant flow of fresh filtered seawater. Water going to these tanks was filtered underground through porous limestone and pumped directly to the tanks. Fishes occupying the tanks were fed solely on hand-chopped fish filets.

The capture, transport and subsequent display of live corals present certain problems: (1) damage due to excess handling, crowding or exposure to air during transport, (2) subsequent fungusing of damaged areas on corals once in the tank, (3) smothering of corals overturned by tankmates or covered by too much sand, (4) damage to corals by browsing fishes or invertebrates in the aquarium.

*Presented at the 15th Annual Professional Aquarium Symposium of the American society of Ichthyologists and Herpetologists, June Z2-13, 1969, New York City.

Limited feeding experiments carried out in two home aquaria with power or subsand filters indicate that the eight cited coral will feed on all or most of the following items: live brine shrimp, chopped fish and shrimp, and dried foods. Other possible diets to investigate include dried blood, ant eggs and egg yolk. Rose coral *(Mancina areolata)*, slit star coral *(Favia fragum)*, and knobby brain coral *(Diploria clivosa)* are corals that will feed during the day given the proper conditions. Polyps examined under the microscope exhibited a definite feeding reaction when presented with finely ground fish: when given polyps were fed nearby polyps exhibited excitation and extended themselves to the utmost.

Data on the coral feeding habits of tropical Atlantic reef fishes is generally lacking. Randall (1968), an expert on the parrotfishes, examined the stomach contents of many reef fishes, but only *Millepora* was found in the stomachs of two species *(Microspathodon chrysurus* and *Cantherines macrocerus)*. Other species cited by this author are all soft corals. Fishes at the Seafloor Aquarium were found to attack fragile fast-growing corals such as staghorn coral *(Acropora cervicornis)* and porites corals *(Porites)*. The rainbow parrotfish *(Scarus guacamaia)* and stoplight parrotfish *(Scarus vetula)* feed on elkhorn corals and staghorn corals in our main arena. Queen triggerfish *(Balistes vetula)* grind at the surface of elkhorn corals *(Acropora palmata)*.

Both the foureye butterflyfish *(Chaetodon capistratus)* and the reef butterflyfish *(Chaetodon sedentarius)* will peck at the polyps or tentacles of clubfinger and porous coral *(Porites)* as well as knobby brain coral *(Diploria clivosa)*. Elkhorn corals left for several months in our circular main reef tank lose their former texture and bear the distinct bite marks of browsing parrotfishes. Glynn (1964) points out that invertebrates also prey on stony corals. The green crab *(Mithrax sculptus)* and a bristle worm *(Hermodice corunculata)* are cited for the shallow waters of Puerto Rico. A boring lamellibranch *(Lithophaga)* is cited by Moore (1962). Other coral predators will likely be found among tropical Atlantic reef dwellers, since some species probably feed at night when some corals are exposed to the fullest. Coral tentacles or portions of polyps can be difficult if not impossible to identify in the stomachs of some diminutive species such as the butterflyfishes.

Figure I. Data on eight species of stony corals that survived exceptionally well in captivity.

Species	Cup Size (mm)	Survival Time (Mos)
1. *Ridged Brain Coral, Diploria labyrinthiformes*	4-8 wide	7
2. *Rose Coral, Manicina areolata*	6-24 "	4
3. *Rough Star Coral, Isophyllastrea rigida*	7-23 "	3 3/4
4. *Grooved Coral, Favia fragum*	3-7 "	3
5. *Common Star Coral, Montastrea annularis*	2-2.5 "	2 1/2
6. *Porous Coral Porites astreoides*	1-1.5 "	2 1/2
7. *Club Finger Coral, Porites porites*	1.5-2 "	2 1/2
8. *Star Coral Dichocoenia stokesii*	3.5-28 "	2 1/4

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Glynn, T. F. 1964 Common marine invertebrates of the shallow waters of Puerto Rico. (Historia Natural de Puerto Rico) Institute of Marine Biology. University of Puerto Rico, Mayaguez. (Mimeo 39p.)

Moore, H. B. 1963 Marine ecology. New York, John Wiley and Sons, Inc. 492p.

Pederson, H. 1968 Fluorescent flowers of the sea. Sea Frontiers 14(4): 194-199.

Randall, J. E. 1968 Caribbean reef fishes. Jersey City, T.F.H. Publications, Inc. 318p.

REMOVAL OF AMMONIA FROM AQUARIUM WATER BY CHLORINATION AND ACTIVATED CARBON*

By

John Charles Baummer, Jr. and Loren D. Jensen**

ABSTRACT

This paper proposes a method of treating aquarium water that incorporates mechanical filtration, activated carbon treatment, chlorination to remove ammonia, and dechlorination.

Ammonia removal is essential to any process for treating aquarium water because of the toxicity of this compound. The conventional biological aquarium filter converts ammonia to nitrate and does not remove nitrogen from the water. High nitrate concentration is to be avoided in aquarium water since it promotes algal growth which is aesthetically undesirable.

It was found that in the process of chlorination followed by activated carbon treatment, about 10 parts by weight of chlorine is required to oxidize 1 part of ammonia-nitrogen when the reaction time allowed is 15 minutes. The products of the reaction are gases which are eliminated from the water. Thus, eutrophication is avoided.

A pilot treatment system incorporating mechanical filtration, activated carbon treatment, chlorination and dechlorination with activated carbon was constructed, and was found capable of maintaining the ammonia-nitrogen concentration of an aquarium at less than 0.1 mg/l.

This method of treatment is effective for both fresh and saline water.

*Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, June 12, 1969.

This research was supported by a contract with the Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior in connection with the proposed construction of a National Fisheries Center and Aquarium in Washington, D.C.

**Graduate Student and Associate Professor, respectively, Department of Environmental Engineering Science, The Johns Hopkins University, Baltimore, Maryland 21218.

USE OF GPX HIGH-DENSITY PLYWOOD IN THE CONSTRUCTION OF AQUARIA (1)*

By

Richard H. Reckeweg
National Fisheries Center and Aquarium

The personnel at the National Aquarium have been using a type of plywood which is impregnated and coated on both sides with a resin which renders the plywood waterproof. Known as GPX, high-density, clear, 60/60 plywood, it is manufactured by the Georgia-Pacific Corporation (2). We have used this for many applications where wood contacts water and have had no problems with the separation of layers as is the usual case with most plywoods. The largest tanks we have built are two, 750-gallon storage tanks constructed in the summer of 1965 and still in use. Many of our display aquariums are also constructed from this wood with a glass or plastic window installed on one side. These aquariums are used for both fresh and marine systems.

For a cost comparison a 4-by 8-foot sheet of 3/4-inch, A-C, exterior plywood coated with fiberglas cloth and resin would cost approximately $40.50 while a sheet of GPX would cost $23.00--a savings of $17.50. This does not take into account the man-hours involved in the numerous fiberglasing and sanding steps required to provide a smooth finish; the GPX has a smooth surface.

The construction of aquaria from this wood is relatively simple requiring a minimum of both tools and carpentry skills.

1. All pieces are cut to the desired sizes so that when put together the ends fit on the inside of the sides and the bottom fits on the outside, screwing into the sides and ends.

*Presented at the 15th Annual Professional Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, ,June 12, 1969, New York City.

2. Starting with a corner, square the edge and drill a hole at the top and at the bottom and insert a screw halfway into each hole or enough to hold the pieces square. Continue to drill the rest of the holes approximately three inches apart.

3. Remove the two screws holding the side and end together, place a bead of silicon rubber sealer (3) along the edge and place the screws into the predrilled holes and tighten firmly. Repeat the above steps for the remaining corners and the bottom.

Do not attempt to wipe off the excess sealer until it has thoroughly dried and then it may be trimmed off with a razor blade.

If a viewing window is desired a hole should be cut of the desired size and the tank laid so that the viewing side is down. Place a bead of sealer around the frame and press the glass or plastic into place. The glass should lap over the wood frame at least 2 1/2 inches. Pressure may be applied throughout the night to insure a good seal. After 24 hours the tank is ready for use. It should be noted that the viewing glass is held in place by the silicon sealer and that clamps or an indented area in the wood are not required. Also, the frame of the viewing window should be of a single piece of wood to insure maximum strength.

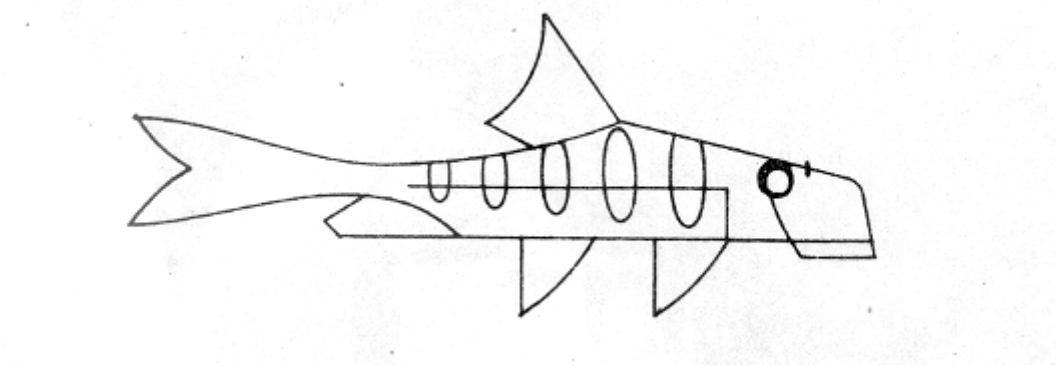
For tanks over three feet in length, it is necessary to add cross-bracing to prevent bowing. This can be accomplished by attaching 2- by 2-inch pieces of wood across the top of tile tank at no more than two-foot intervals.

If a color other than that of the wood is desired, we have found that Gleem Swimming Pool Paint (4) does an excellent job. This paint is easily washed out of brushes, but holds up very well under water and the tank can be used within 48 hours of painting. We have used this paint with freshwater and marine fish and invertebrates.

Containers subject to rough use of constant movement from one area to another should be reinforced with 2- by 2-inch lengths of wood and fiberglas resin on the inside seams.

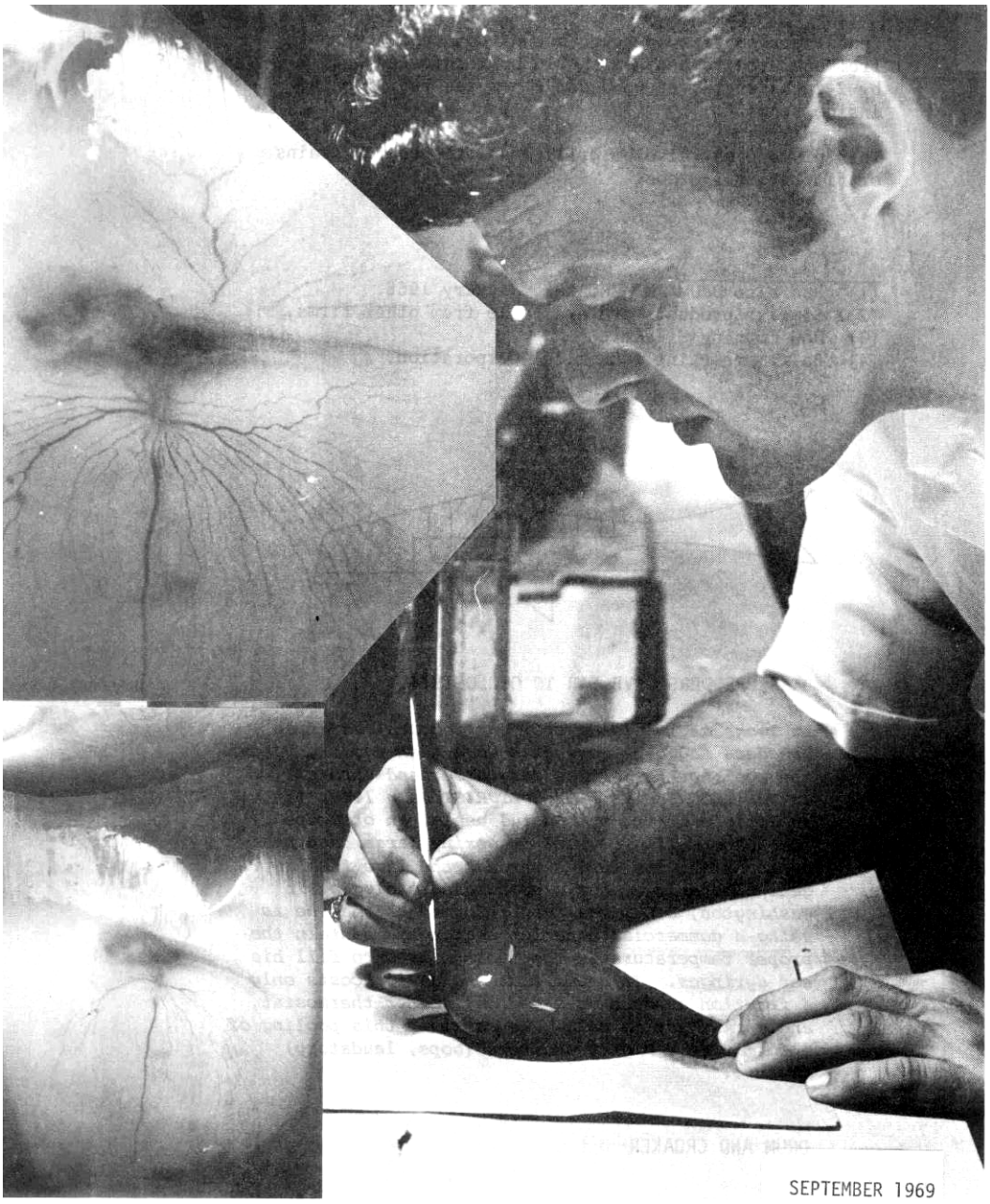
This plywood may also be drilled and tapped for drains or filtration systems.

(1) See also DRUM AND CROAKER, January 1968.
(2) Similar products are available from other firms.
(3) Dow Corning Silastic
(4) Baltimore Paint & Chemical Corporation.



BASS BREEDERS GIVE EAR TO OTOLOGISTS

It looks as if ecologists (ear doctors) and fish breeders may have more in common than usually meets the eye (not to mention ear, nose, and throat). In THE PROGRESSIVE FISH CULTURIST, July 1969, is an article on the successful use of an otoscope (the ear-peering device) in sexing largemouth bass by inserting the device through the live fish's genital opening. Now a practicing ecologist in Washington, D.C., has just informed us that he is using a commercial aquarium heater to maintain the proper temperature in the tank he uses to fill his ear syringes. It seems that the device costs only a fraction as much as a medical heater-thermostat, and works just as well. We consider this pooling of information a highly auditory (cops, laudatory) advance.


SEPTEMBER 1969

MORE ON BABY NURSE SHARKS

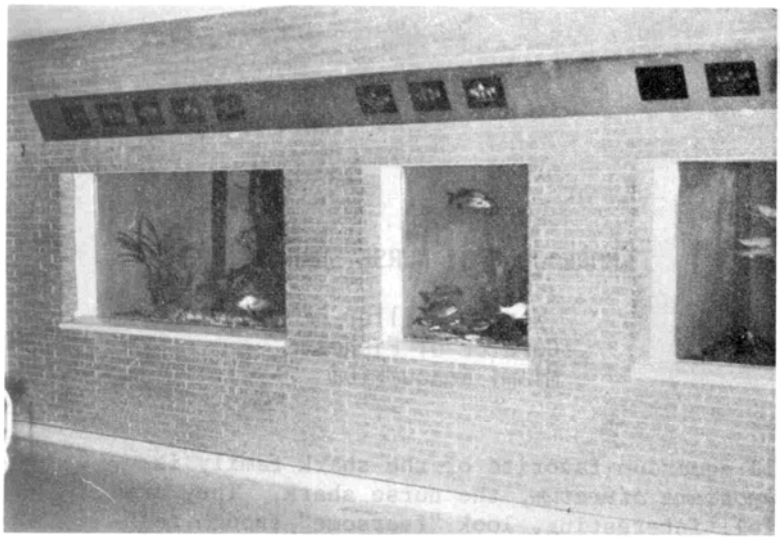
Warren Zeiller
Curator of Fishes
Miami Seaquarium

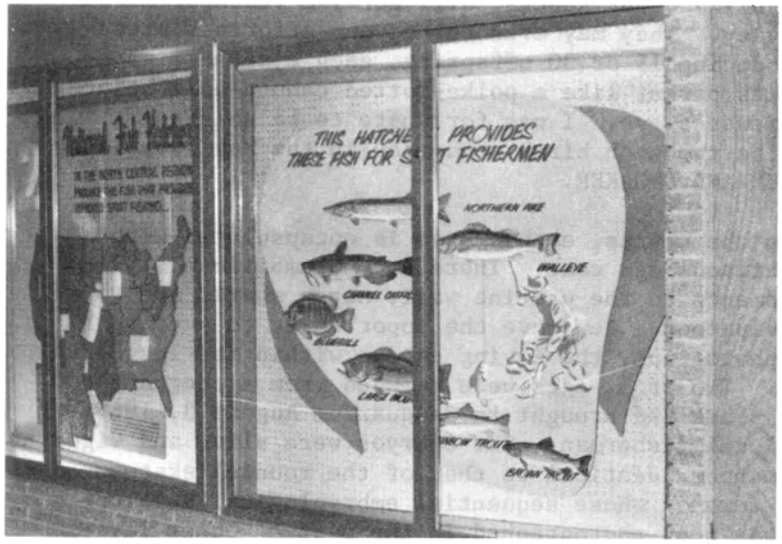
The old aquarium favorite of the shark family is *Ginglymostoma cirratum*, the nurse shark. They are colorful, interesting, look "fearsome" enough to satisfy vicarious thrills sought by the public ... and, unlike other sharks, will survive years of captivity. They may even reward our efforts further by producing 15 or 30 offspring, each ejected live from its parent like a polka-dotted cannon-ball before the viewer's eye. I was fortunate to be able to describe two such birth sequences in the May 1968 issue of DRUM AND CROAKER.

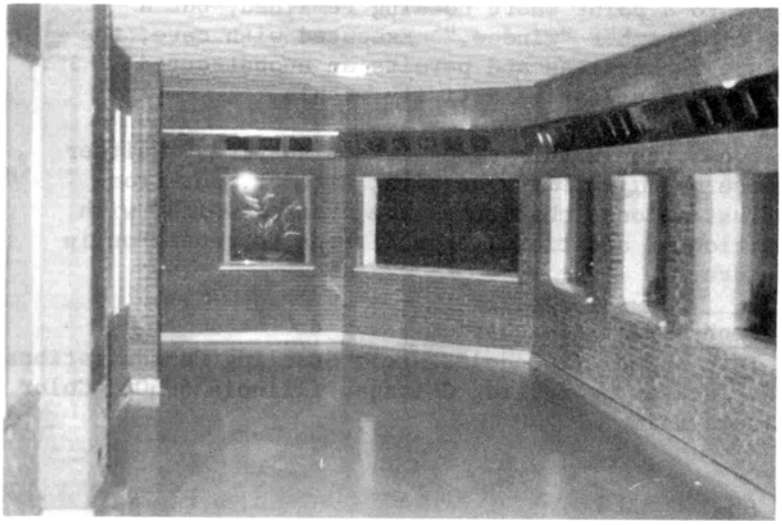
Within the uterus each embryo is encapsulated within a keratinous egg case. There are no umbilical attachments to the uterine wall; nurse sharks are ovoviviparous. Few have the opportunity to see, much less photograph, the living embryo within its leathery pouch. Two of 32 eggs were removed from a pregnant nurse shark and brought to Seaquarium August 3, 1969, by a local fisherman. The embryos were alive and wiggling in a manner identical to that of the roundel skates *(Raja texana)* whose sequential embryological development has been photographed in the past.* Outer layers of one egg case were peeled away with scalpel and tweezers to a point where nothing remained, but a frail, clear amber "window." Executed with care, the procedure is harmless and permits an unobstructed view of the fascinating activity within.

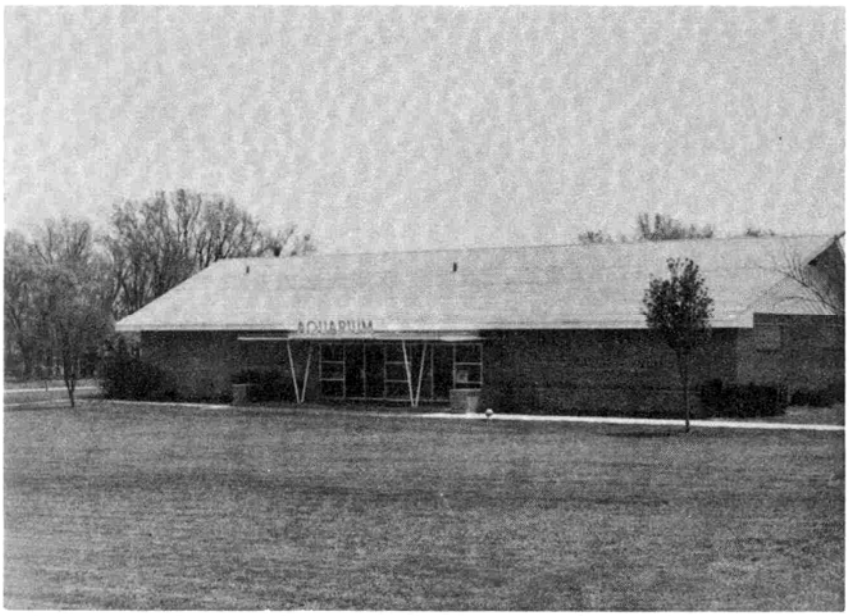
The two embryos in this case did not survive. Neither did those of *Raja texana* on first attempt, but from such frustrations, challenges are created which, with acquisition of additional eggs, I hope to report on in the future.

Photographs--Miami Seaquarium
*Eggs Into Animal (Roundel Skate); Sterling Communications, Inc.;
309 W. Jackson Boulevard, Chicago, Illinois 60606; Color, 12-minute film.




PROVIDES
FISHERMEN
NORTHERN PIKE
WALLEYE



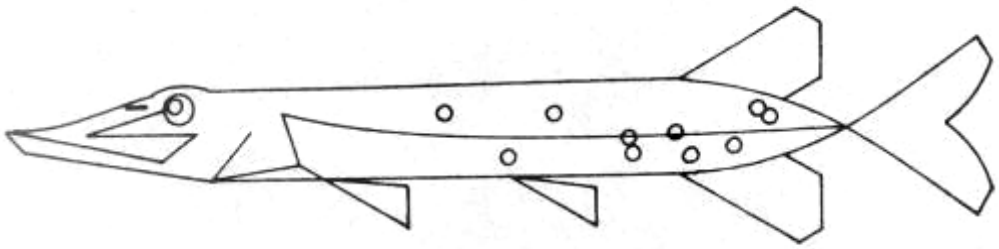


AQUARIUM AT THE GAVINS POINT

NATIONAL FISH HATCHERY (YANKTON, S. D.)

This is one of the more modern and better planned aquariums operated in conjunction with the fish hatcheries. It has twelve 400-gallon, two 1600-gallon and two 280-gallon display tanks in which are exhibited fishes native to the Missouri River.

BILL HUNT, Manager, advises that the aquarium had over 160,000 visitors in 1968.



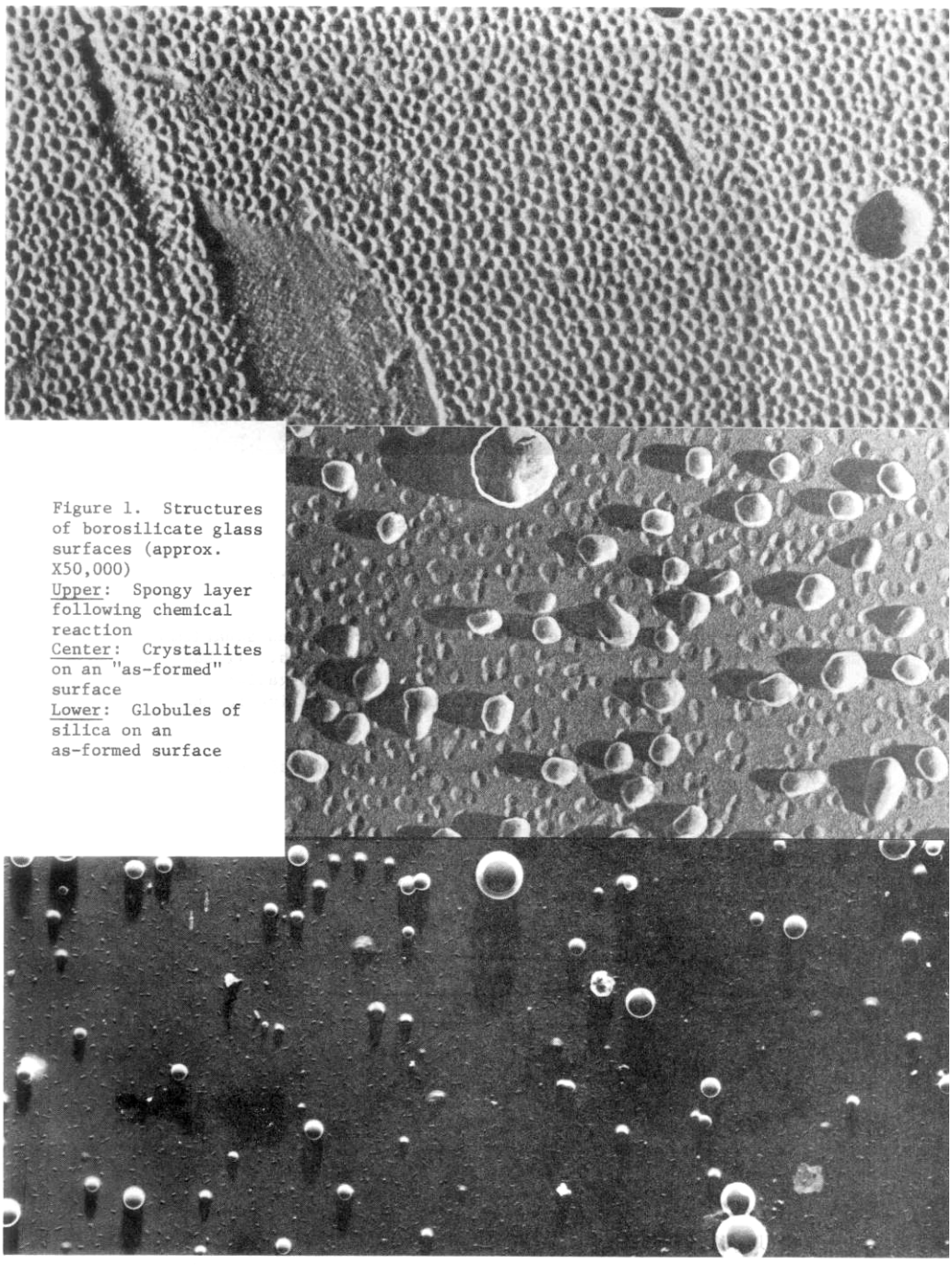


Figure 1. Structures of borosilicate glass surfaces (approx. X50,000)
Upper: Spongy layer following chemical reaction
Center: Crystallites on an "as-formed" surface
Lower: Globules of silica on an as-formed surface

THE BIOLOGY OF GLASS [1]

P. B. Adams
Research Chemist
Corning Glass Works

Glass has played an important part in nearly all the sciences. Glass vessels contain chemical and biological systems inexpensively without concealing them from the eye. Glass lenses extend the scope of the eye upwards and downwards. Glass windows give us sight of events in media ranging from outer space to the ocean depths. In all this, we expect this ubiquitous material to remain as impassive as the observer himself is expected to be. It is not always so, and in some specialities the activity of glass is a well-known inconvenience (e.g., it causes blood to clot in a matter of minutes.)

It seems then, that as the scientist investigates progressively more alien environments, he should take a closer look at what is likely to happen to his glass- and in particular at the interactions between it and living things. These interactions are subtle and, in some cases insignificant, but in most cases they are far from well understood. New frontiers for glass, such as the ocean depths and the cavities and organs of the human body constitute a compelling reason for undertaking some fairly intensive research. For the moment, however, it is possible to do little more than describe some of the interactions that have been discovered so far.

[1] Reprinted with permission from NEW SCIENTIST, January 2, 1969.

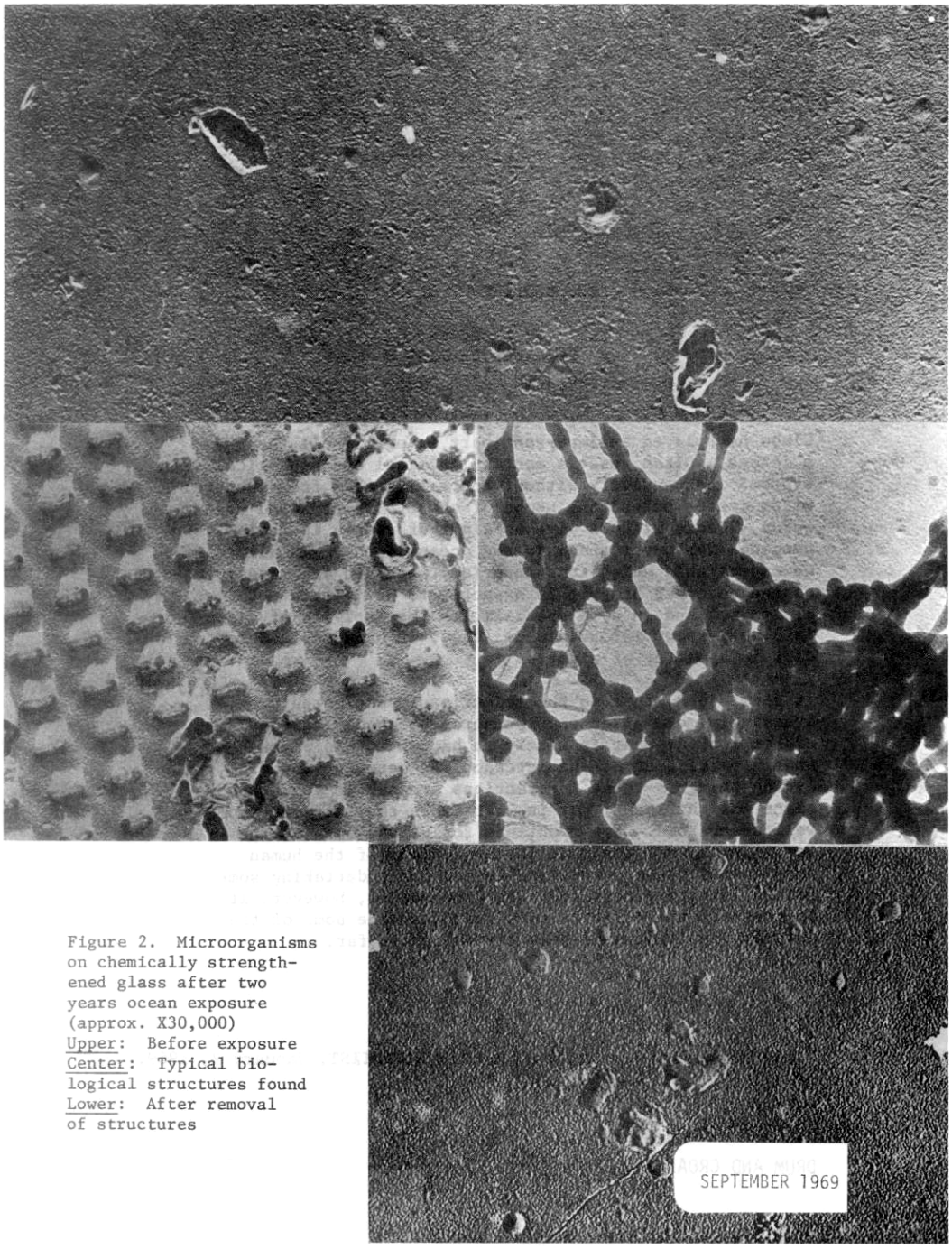


Figure 2. Microorganisms on chemically strengthened glass after two years ocean exposure (approx. X30,000)
Upper: Before exposure
Center: Typical biological structures found
Lower: After removal of structures

First, let us discuss briefly the nature of the glass surface. Basically, glass consists of a random network of silicon and oxygen atoms, interrupted by other atoms. The surface may not be perfectly smooth. It may be roughened or show some deposits on it as a result of the forming process, heat treatment or environmental history. Figure 1 shows examples of topographic structure on glass surfaces. Furthermore, glass has a surface reactivity due to the surface silicon bonds which are free to attract various groups such as hydroxyl (-OH), methyl ($-CH_3$) and amino ($-NH_2$). Finally, ion exchange can occur so that atoms in the glass are replaced by atoms from the surrounding environment.

Both acid and alkali attack glass, but in different fashions. Alkali destroys the glass network by breaking silicon-oxygen bonds; this etching process generally removes the surface glass at a linear rate which doubles for each unit rise in pH. Glasses do not differ greatly in their ability to resist alkalies, since they all have the same basic structure.

Acid attack is quite different: the hydrogen ions of the acid exchange with other ions in the glass, such as sodium. The further this ion-exchange process goes, the more it is slowed down, as ions most travel progressively greater distances from the exchange sites to the surface. In other words, the process is diffusion-controlled. Surprisingly, increasing the acidity makes relatively little difference for a given glass, although acid resistance varies widely from glass to glass.

Biological interactions are, probably, essentially chemical in nature. They can range from simple attachment to corrosion of the glass. Sometimes the biological system itself is affected. Sometimes attachment of the organism can accelerate glass corrosion. Following are some examples of various sorts of interaction.

The first is simple attachment without corrosion. Figure 2 shows micrographs of some marine organisms on chemically strengthened aluminosilicate glass that was left for two years at a depth of one mile in the Pacific Ocean about 100 miles southwest of Los Angeles. In spite of these growths and the corrosive sea-water environment, the surface and strength of this glass was essentially unaffected although other materials exposed at the same time were badly corroded.

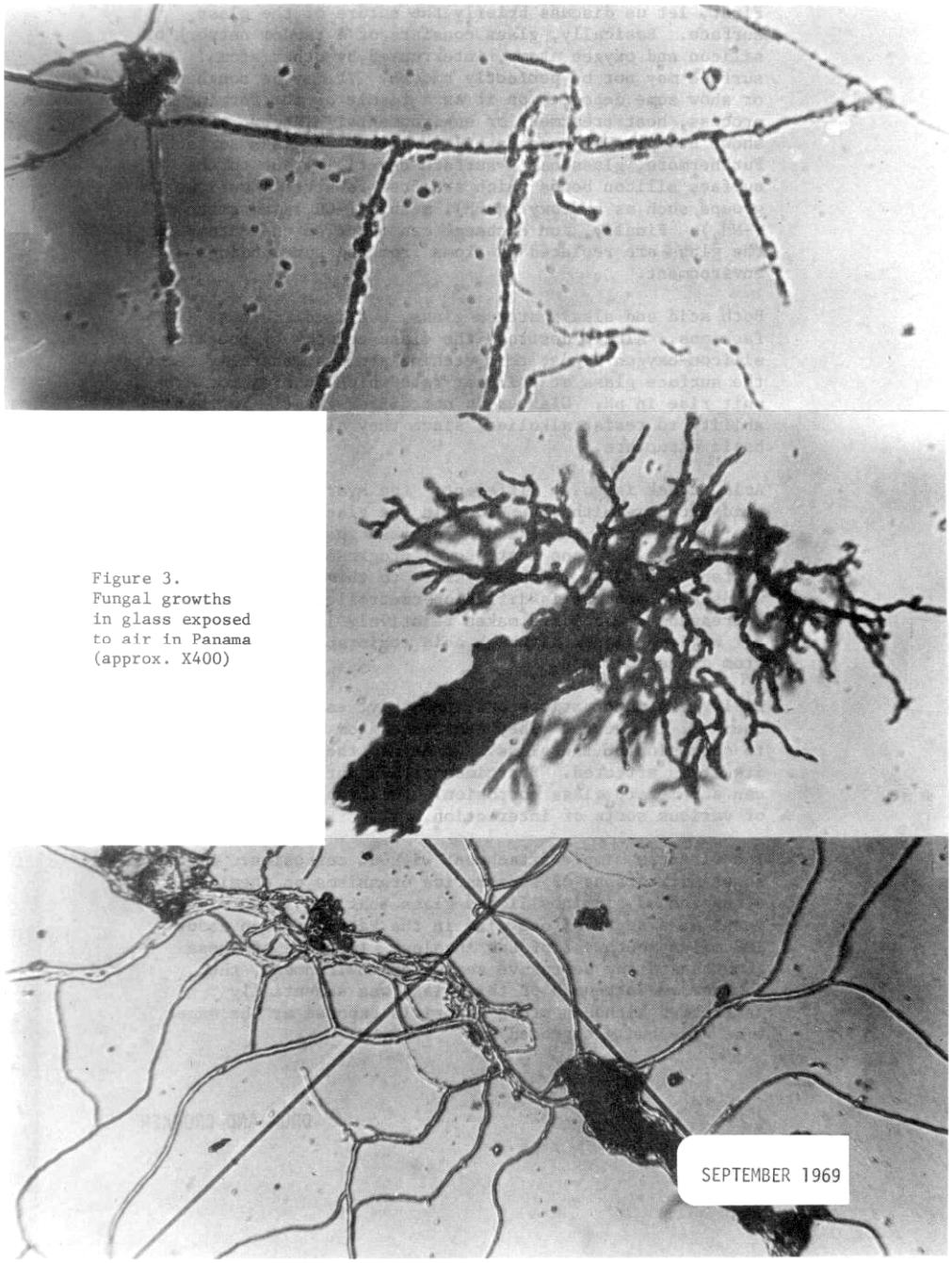


Figure 3.
Fungal growths
in glass exposed
to air in Panama
(approx. X400)

Fungi can have a corrosive effect and are a real problem to users of microscopes in the tropics; optical systems are sometimes coated with mercury salts to inhibit fungal growth. Figure 3 shows micrographs of organisms that grew on some glasses left in the open air in Panama for four months. Some fungi left self-portraits etched into the glass. Those glasses that contained trace amounts of heavy metals were less severely affected.

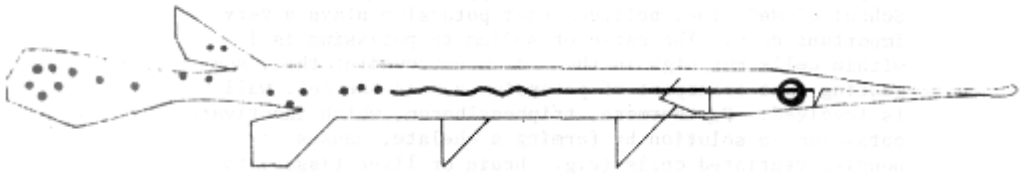
Glass can affect living things. The blood-clotting effect has already been mentioned. Another observation relates to a rather strange effect that occurs with the tuberculosis vaccine. If the vaccine is kept in borosilicate glass bottles that have been blown by hand, its effectiveness is decreased--to a different degree than if contained in machine-blown bottles. In another instance, some lots of borosilicate ampoules caused vitamin B-12 to precipitate, while other lots did not exhibit this effect.

The classical theory of cells bonding to glass states that calcium ions--which have a double positive charge--form bridges between the cell and the glass, both of which have negative surface charges. This theory my not supply the complete answer. Dr. Katherine Rappaport, of the Yale School of Medicine, believes that potassium plays a very important role. The ratio of sodium to potassium is low within cells but high in the medium surrounding them, suggesting that transport of potassium across the cell wall is involved. Furthermore, triphenylboron, which inactivates potassium in solution by forming a chelate, causes nondifferentiated cells (e.g., brain or liver tissue) to disintegrate. This suggests that potassium ions hold the tissue together. A further clue that refutes the theory of calcium as a predominant factor in cell bonding is that ethylene diamine tetracetatic acid, which forms complexes with metal ions such as calcium, supports the growth of nondifferentiated cells. Such cells had in fact refused to grow in vitro, until suitable glass substrates were found. They die in ordinary lime or borosilicate glass, but grow quite well in certain special glasses, notably one into which potassium has been introduced by ion exchange.

It may be that not only chemical composition but also structure is sometimes important in deciding what happens when glass encounters living material. It is known that silicosis, a disease characterized by the growth of fibrous tissue in the lungs, is caused by breathing crystalline quartz dust. There is other evidence that vitreous glass dust--which is essentially just another physical form of silica--has no such effect.

Two microorganisms deserve to be mentioned by virtue of their specialization. One is the sulphuric-acid-generating thiobacillus which is reported to have damaged marble statues. The second is an alga form which can actually metabolize silica.

We see, then, that there is a variety of ways in which glass and biological material can affect one another. There are almost certainly many such phenomena that have not yet been reported. What should be emphasized is that most of the questions that can be asked about the mechanisms involved have yet to be answered--or even asked properly. We are thus not always in a position to predict what is likely to happen to a particular glass--although new types of glass are continually being tried out--in a particular biological environment over a long period. A better understanding of these interactions would do much to direct the search for new glasses along useful lines and perhaps reveal not merely limitations of glass but conversely new applications. One such new application may well be in the field of implant surgery.



TIPS & BITS FROM SIO

Donald W. Wilkie
And
Charles J. Farwell

T. Wayland Vaughan Aquarium Museum
Scripps Institution of Oceanography

WATER

Scripps Aquarium is entirely natural sea water which is pumped to a reservoir on the hill above the aquarium. The water is crudely filtered by gravity through sand, which is inadequate to control turbidity during runoff periods and redtide blooms. A Baker hi-speed sand filter was added a year ago, and has given excellent service. There have been no turbidity problems in the aquaria in spite of the worst ocean conditions in the past several years.

STUDENTS

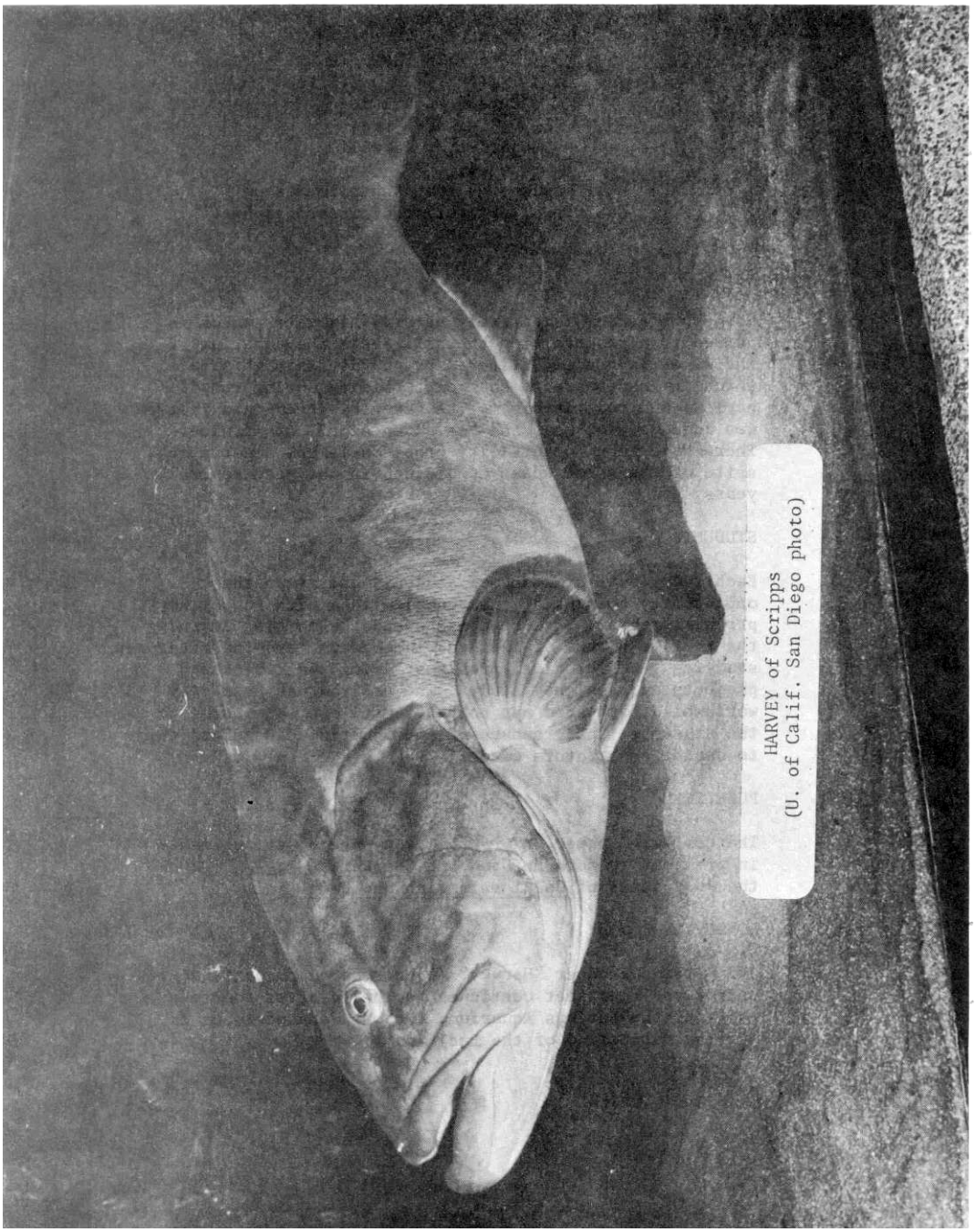
Each year local high school students are given the opportunity to work at the aquarium in a high school work project program. The students spend the morning learning the routine chores of the Aquarium-Museum, and the afternoon studying the biological problems, doing small research projects and assigned study. The program has been very worthwhile both from our point of view and, according to the students, their tenure at the aquarium has helped them to decide on a future career.

PUBLISHED

The completed paper on *Cryptocaryon*, which was published in preliminary form in Drum and Croaker, appeared in the July issue of California Fish and Game.

LONGEVITY

Our veteran grouper "Harvey" *(Mycteroperca jordani)* at 180 pounds and four feet continues to thrive after fourteen years at the Scripps Aquarium. He was donated to us in 1956 by Marineland of the Pacific.


HARVEY of Scripps
(U. of Calif. San Diego photo)

OBITS

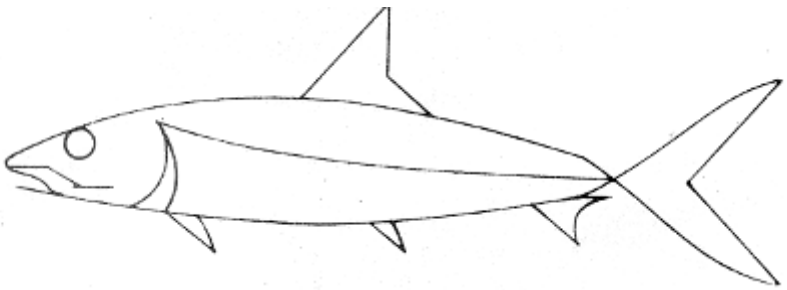
A snook *(Centropomus sp.)* which had been caught at Magdalina Bay, Baja California, in 1962, died of unknown causes last April after residing at Scripps Aquarium.

MONEY

Funding continues to be a serious problem at the Aquarium-Museum. Again, no increase in university funding is anticipated. The possibility of charging admission is being considered. The charge would be $0.50 for adults, children under 16 free, and a $2.00 annual membership would be available. Your comments would be valued.

VlSITS

Attendance for the year coding July 1, 1969, was over 300,000 including 35,000 school children ho will have partaken of our group program. This program is handled almost entirely by trained volunteers.



For the Sick Bay

The Use of Copper Sulfate as a Medicament for Aquarium Fishes and as an Algaecide in Marine Mammal Water Systems (Occasional Papers, California Academy of Sciences, No. 71, June 6, 1969), by Robert P. Dempster, Steinhart Aquarium, and William H. Shipman, U.S. Naval Radiological Defense Laboratory.

For the past 15 years copper sulfate has been periodically added to the tropical sea water system at Steinhart and as a consequence there has been no epizootic outbreak of disease among the fish in this system since an *Oodinium* attack in 1951.

Most forms of algae succumb to copper concentrations up to 1 ppm and marine mammals appear to tolerate such concentrations if the copper is sequestered.

Explicit directions and procedures are given.

John Allen holds Mini Moby
while Jesse White probes
(Miami Seaquarium photograph)

THE FISHERMEN AND THE WHALE (1)

An infant pigmy sperm whale was left on the waterstep of the Miami Seaquarium one night recently.

The foundling, which seemed to be new born or nearly so, weighed about 50 pounds and was about 44 inches long.

The motherless infant boy was found swimming slowly in shallow waters off the ocean side of Key Largo by two commercial fishermen. They picked him up in their arms and put him in the live well of their boat. For a long time they watched for his mother. They saw no other whale. They speculated that she might have died in childbirth. They named him Mini Moby.

The fishermen gave him to Dr. John Allen, who is studying marine mammals at the Institute of Marine Sciences. Dr. Allen, who has no facilities for wet-nursing a miniwhale, took him to the Seaquarium.

There Dr. Jesse White, staff veterinarian, sat up all night with the pretty little fellow, feeding him every two hours. Burton Clark, general manager of the Seaquarium, had to rush ingredients for the whale baby formula from an all-night pharmacy. The formula included Similac, cod liver oil, and calcium glutonate.

The next day the handsome little boy seemed to be thriving. He had a full stomach and napped cradled between Dr. White's knees. Dr. White sat in the water of a Seaquarium tank with him all night long to keep the baby from bumping his nose against the side of the tank.

Wet nurses were to stay with the little foundling for 24 hours a day until the tank could be lined with plastic so that the whale would not bump or scrape himself. He was to be fed every two hours with a syringe, as much as he would eat. A sunshade was put over the tank to keep Mini Moby and his nurses from being sunburned.

Tender Loving Care was evident.

THEN CAME THE BLOW!

That afternoon the two fishermen came to the Seaquarium and said they wanted to take their baby back to Key Largo. They said they had not intended to give the tiny whale to Dr. John Allen, who gave it to the Seaquarium.

As evening came the fishermen took the foundling back to the key. Mini Moby died during the night. An adult female pigmy sperm whale was found a couple of days later dead on the beach in the vicinity.

The pigmy sperm whale *(Kogia breviceps)* grows to be only 10 to 13 feet in length. It resembles in many respects its larger relative, the sperm whale, and also looks like its cousin, the porpoise. It is black on top, gray below.

These little whales are not common and not much is known about them. They are said to eat crabs and small cuttlefish. They are, of course, mammals, and suckle their young.

Pigmy ape= whales have been found stranded on French, Dutch, and Florida coasts. None have ever lived long after they were rescued from going aground.

(1) From a Miami Seaquarium press release and comments from Captain W. B. Gray.

WILL WE EVER LEARN?

This is an attempt to catalog some of the causes of operational failures in aquariums. It is based on the observations and experiences of a number of individuals as well as the writer. Many of you could add substantially to this list. The items are stated in terms of what the planners or builders did wrong.

1. Designing

   Planning without the full-time collaboration of a qualified aquarist or two, or failing to take heed of their advice. (The sponsor has his own ideas or the architect knows best: "Son, I'm a professional engineer.") Even worse is no engineering at all. ("We're going to put the money out front; operations is your problem.")

2. Piping

   Right angle turns too short and/or not properly reinforced externally.

   Plastic pipe bedded in loose soil.

   Harmful metals in pumps and valves.

   Air lines not provided for all tanks (to handle emergencies like power failures). Intakes and drains under-designed (too small) or in the wrong spot. Inferior plastics (such as plasticized materials).

3. Water and Filters

   Water source questionable. ("But go ahead; it's cheaper. We can correct it later.")

   No built-in alternate for recirculating water.

Diatomaceous earth filters only. (These are wonderful for polishing water, but they cannot do the job alone when water is recirculated. A biological filter or some other kind of ammonia remover is necessary.)

4. Work Area

Too small, holding facilities inadequate. ("So we have more money for specimens.")

Little consideration for convenience. (Food preparation way over there; loading dock, if present, out of sight.)

Slick floors and poor drains.

Work floor elevation not considered-ladders (and chimpanzees) needed.

Too few reserve tanks and no way to treat sick specimens or quarantine new ones.

5. Glass

Faulty frame design and poor installation.

Incorrect glass selection formula.

Inadequate sealing.

Fastenings ignore forces of water on glass.

6. Lighting

Not enough and/or installed by means of inflexible fixtures.

7. Tanks

No plan for balancing of electrolysis in some saltwater tanks.

Concrete not sealed on water side.

Insufficient piling or other support. (Water weighs more than eight pounds per gallon.)

Materials toxic to aquatic animals used. (When the manufacturer says "non-toxic," he means for people.)

8. Communication

No inter-com ("Go find Joel")

Front office distant from operations -- both in feet and mind.

In summation, we should state exactly just what is the recommended method of building an aquarium or an oceanarium.

First of all it must be recognized that an aquarium is a house for fish and other aquatic organisms, and only secondarily is it a house for people. A good example is the Waikiki Aquarium which externally is one of the most attractive buildings designed for the appreciation of Homo sapiens. The die-hard architect had a stranglehold on the administration, and would listen to no one. The mess he left for the fishes to live in, has required many years to correct. To restate a well recognized, but usually overlooked principle: The living requirements of the animals and the ease of operation of the plant are primary, and around this must be designed the needs of the visitors.

After aquarium funds are available, careful selection should be made of a skilled, but flexible architect who must lack the messiah complex. At about the same time, or perhaps even before, a consultant professional aquarist who has new and good ideas on aquarium presentation techniques should join the team. The design, construction and operational concept must be good, otherwise those that follow will most certainly bring curses upon your head. The third man of this team who will either make or break the proposed installation is the design mechanical engineer. He must have extraordinary knowledge of the

capabilities and use of aquarium materials. Together with the architect and the aquarist he must put this knowledge to good work. More than a million dollars in construction and reconstruction cost, could have been saved in this country in the past ten years if it had been recognized by architects and engineers that inert materials are not required for a cetacean system.

As originally shown by Marineland, cement-lined pipe, metal valves and pumps do an excellent job in a cetacean system without the inherent problems found in large size PVC fittings, pipe, and the costliness of inert pumps.

The errors of aquarium construction in this country can often be traced to the absence of one or more of the three specialists described above. So if you are planning an aquarium or oceanarium, please take heed!

The foregoing is a composite effort of Bill Hagen, who puts D&C together, Jim Atz, and Earl Herald, who contributed the summation.

Aldrin On The Moon?

Assistant Director Ray Johnson recently answered the following letter which had been sent to Secretary Hickel.

"Dear Mr. Hickel:

I keep hearing all this talk about putting aldrin on the moon in this next trip up there. Seems to me that we should not start polluting the moon with these pesticides. We got enough pollution going on right here on earth. Besides, how do they know there are any bugs on the moon? I hope that you will talk to these astronauts about this.

Yours truly,
Mrs. _____"

To which Dr. Johnson replied, in part:

"Dear Mrs. _____:

Your letter of June 29 to Secretary Hickel expresses concern about putting aldrin on the moon on the next lunar mission. In answering your letter on behalf of the Secretary, let me assure you that, to the best of our knowledge, the United States does not intend to place insecticides on the moon during this or any other mission.

If all goes well, however, Astronaut Buzz Aldrin will step on the moon about July 20 and will help his other astronaut friends to bring back samples of the moon's material to earth. I believe we all hope that this Aldrin not only gets to the moon, but returns safely...

Sincerely yours,

Raymond E. Johnson
Assistant Director, Research"

From Bureau of Sport Fisheries and Wildlife INSIGHT, August 1969.

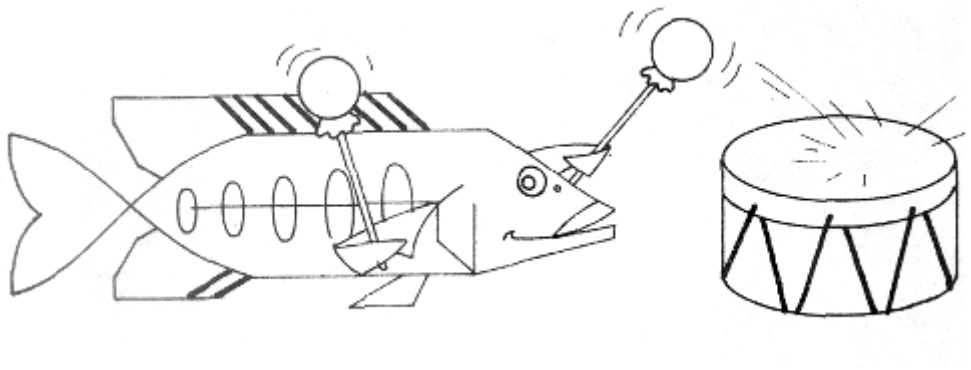
MYSTERY SOUND

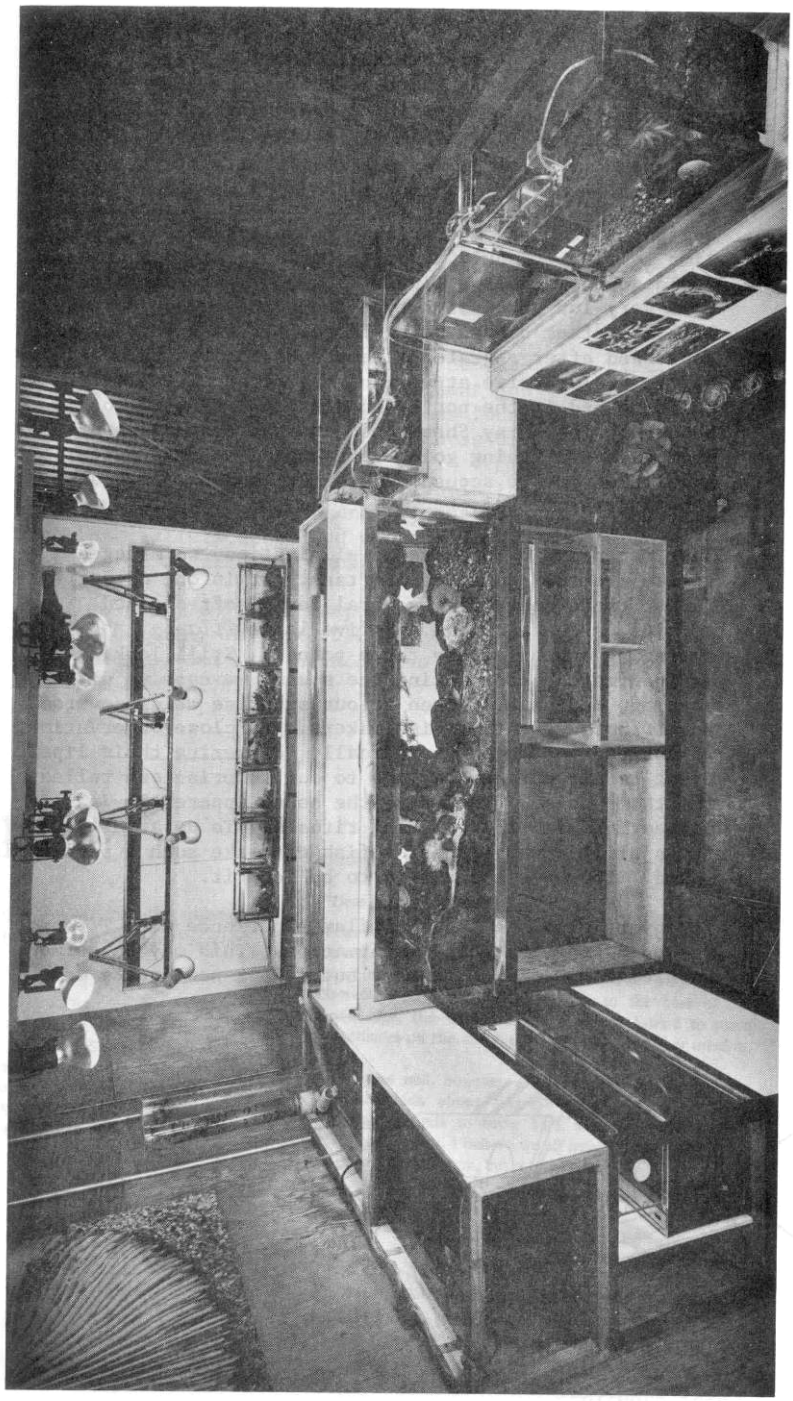
Herb Reichelt
Millen (Ga.) National Fish
Hatchery Aquarium

For several years, we at the Millen Aquarium had been quite puzzled by a mysterious "thumping" noise. From time to time it would be quite noticeable, then weeks would go by without a single "thump." The sound itself is a very low percussion-type thump and sounds somewhat like a distant cannon being fired. It is a very elusive sound and after repeated attempts to locate its origin all we could arrive at was that it occurred inside the building and in the north end section. We used to kid about how our noisy Sheepshead and the mysterious thumper had a "thing going" exchanging sounds. After a while we became accustomed to the thumps and thought very little of them.

Just recently, by process of elimination, we managed to isolate the sounds to one tank. It is one of our larger tanks containing several large soft-shelled turtles, a Buffalo fish and five large Tilapia averaging approximately three pounds. Still looking for an inanimate object making the sound, we came up with nothing, per usual. Then to our surprise we discovered the Tilapia were the noise makers. By close observation, we noticed the males periodically "quivering their lips" (just barely noticeable) and to our surprise out rolled the thump noise. They make the sound apparently in connection with their mating rituals. To us at Millen it is still a wonder that a fish can make such a penetrating sound. You have to hear it to believe it.

If anyone else has had a similar experience with Tilapia, we would appreciate any information. This may be common knowledge to some aquarists, but it's a new one to us!





Aquaria for Specimen Study
and Photography
Charles Eames photograph

The Design Approach

Darrel Conybeare
Office of Charles Eames
Venice, California

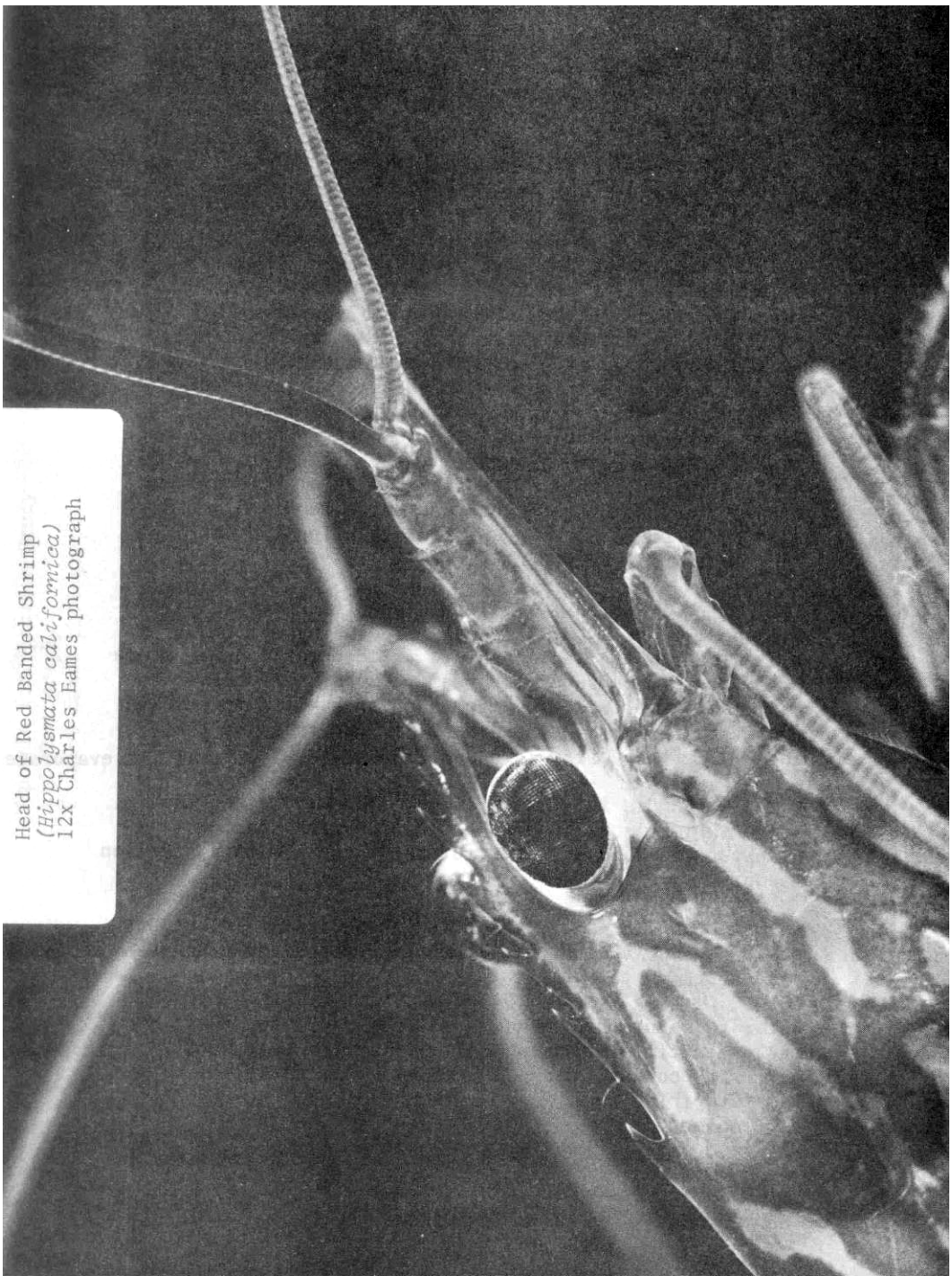
The tank system illustrated here was established in September 1967 for the purpose of developing exhibits for the National Fisheries Center and Aquarium. It has required that designers become familiar with the problems of collecting and maintaining a variety of aquatic animals with the aim of designing interesting ways to present live specimens in public exhibits. These tanks are also being used to develop underwater still and motion photography for supporting orientation to the live specimens. The flexibility of this system allows tanks to be added or removed as required. Many more tanks could be added without changing the basic life-sustaining components.

Natural ocean water is collected by office staff. The total capacity of salt water including reservoir is 250 gallons which is maintained at comparable ocean shore temperature throughout the year. Rocks, surface sand and plants are collected from a given habitat to furnish tanks that provide near natural surroundings for the animals. Fresh water is added to replace water that has evaporated,

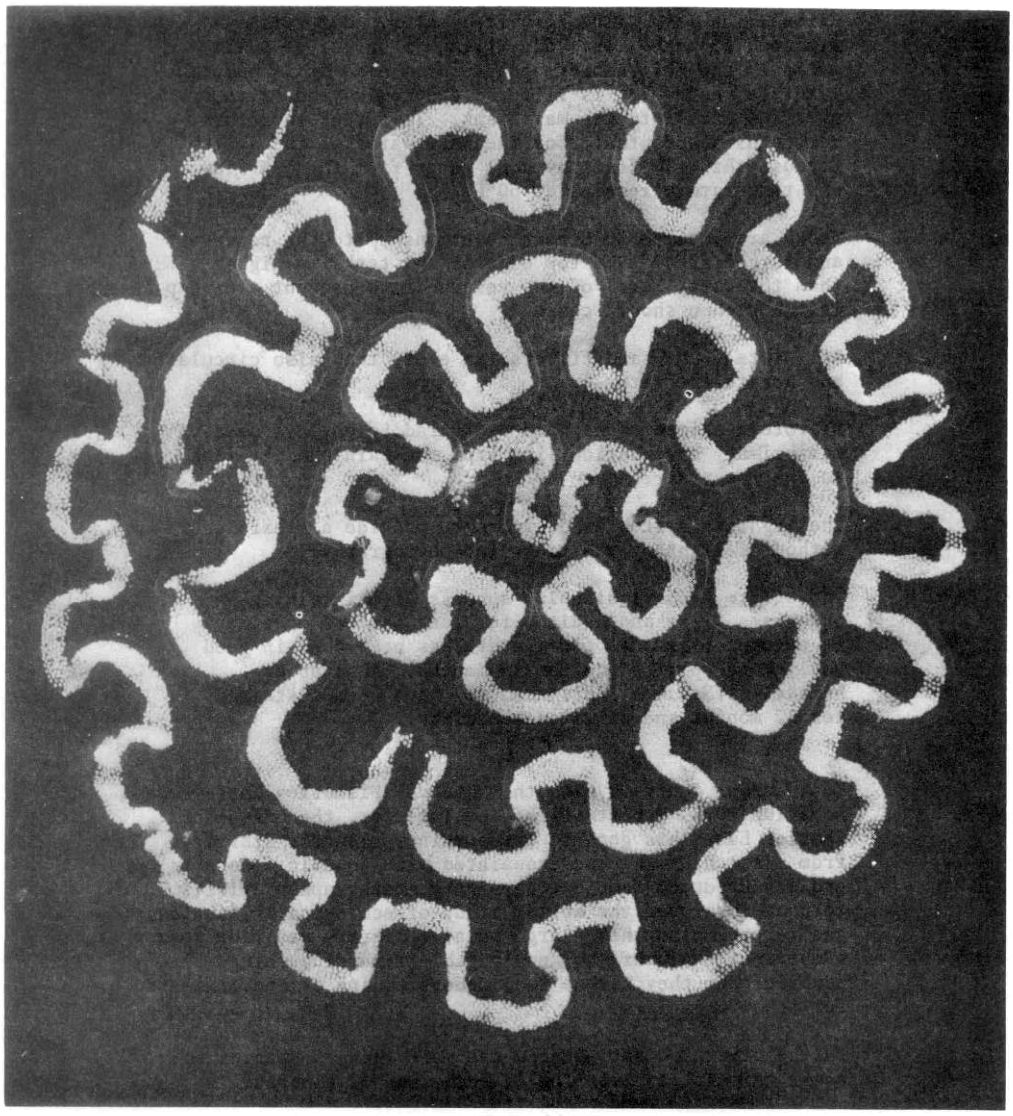
Brine shrimp is the primary food. The water that the brine shrimp is shipped in contains a rich source of plankton and this accounts for the success with suspension feeders.

Hermit crabs *(Pagurus)* collected periodically in batches of 200 to 400 are used to feed the octopus and also as scavengers in the larger tanks.

Water is maintained at 60° - 65°F by a 1/2-ton heat exchanger circulating a 50-50 solution of water and glycerin coolant through a 100-foot closed circuit of plastic piping submerged in the reservoir. No heating is required.



Head of Red Banded Shrimp
(*Hippolysmata californica*)
12x Charles Eames photograph



Nudibranch Eggs (*Flabellina*)
15x Charles Eames photograph

Circulation is a simple gravity system. Water is siphoned from the reservoir through a series of small tanks to the main exhibit tank. From here it is pumped into the reservoir, is filtered and cooled and exits by overflow back into the main tank. This tank therefore serves as a receptacle for the warm water of the system. Because this is offset by cool water from the overflow, its temperature remains at 60°F.

Tanks are located in direct relationship to the reservoir and large tanks. The top edge of the tanks is higher than the water level of the reservoir to prevent a mishap if the siphon should cease.

Air lifts (sub. sand filters) in every tank also circulate and aerate the water.

A protein skimmer (designed by Konrad Lorenz) is used on the primary circulation line from the main exhibit tank to the reservoir.

The lighting system is designed to provide a flexible method of lighting the tanks for photography.

The office reports singular success in maintaining organisms alive and healthy for long periods of time. An octopus *(Octopus bimaculatus)* has been kept in good health and spirits now for 19 months. A group of barnacles *(Balanus tintinnabulum)* have been sustained for 12 months and still seem healthy.

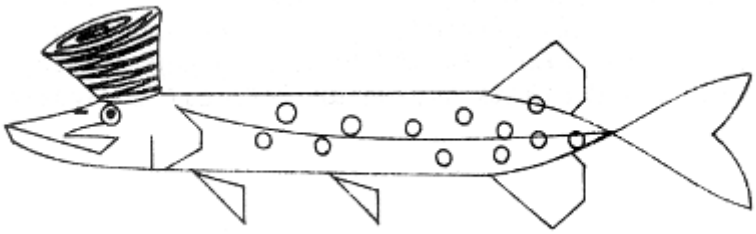
Ed.: Under contract with the National Fisheries Center and Aquarium, U.S. Department of the Interior, the Office of Charles Eames has gone to extraordinary lengths, starting from scratch, to become acquainted with aquatic creatures, and has produced some extraordinary photographs. Visits to aquariums over the world, study of ecological situations, and reference to their large aquatic library has made some members of the staff so knowledgeable regarding things aquatic that they have a real understanding of requirements for these organisms.

In the crystal clear aquaria are more than 75 species of ocean animals representing 12 phyla and 22 classes.

NATIONAL AQUARIUM RECEIVES RUSSIAN PIKE

On June 30, the National Aquarium received a shipment of 16 six-inch pike from the Pennsylvania Fish Commission at Bellefonte, Pennsylvania. Half of these were the hybrids between *Esox masquinogny* and *E. luvius* known as "Tiger Muskies," while the remaining eight were specimens of the Amur River Pike, E. richerti, which is the only Esocid found outside the Western Hemisphere. The original stock of these pike was received by the State of Pennsylvania from Chabarovsk in the Soviet Union in exchange for eggs of salmon, striped bass, and trout in the summer of 1968.

The National Aquarium specimens were acquired as a result of efforts by Ray Robinson and Ronald Lloyd of the National Aquarium. The specimens were donated through the generosity of Delano R. Graff and Keen Buss of the Bellefonte station. At the present time all of the pike are thriving and undergoing rapid growth.



Gerrit "Gerry" Klay, who has been with the Cleveland Aquarium since 1966, left his post as Aquarist in August to assume management on a part-time basis of the Marine Specimens Unlimited, Inc. He will also collect Elasmobranchs for aquariums and other institutions on his own. His address is: P.O. Box 877, Marathon, Florida 33050.

PUBLISHED

Our old friend SAM HINTON, formerly Director of Scripps Aquarium, La Jolla, California, is the author of recently issued Seashore Life of Southern California, University of California Press, Berkeley, California, $2.25.

The 181-page paperback is an introduction to the animal life of California beaches south of Santa Barbara, replete with the author's excellent drawings and eight pages of beautiful color plates. Of the 237 creatures of the seashore described, 232 are illustrated by drawings. The twenty-nine pages of introduction to the tides, waves, currents, water chemistry, life cycles, the intertidal zone and animal classification, are well done and very readable. This volume should be a very popular reference for students and others having an interest in seashore life.

WE STAND CORRECTED--

We have the following communication from RONALD T. REUTHER, President, American Association of Zoological Parks and Aquariums:

> Thank you for sending me Drum and Croaker. I note in the May 1969 issue on page 30 the comment about the AAZPA meeting in Rochester, Now York. I would appreciate it if you would publish a correction to the effect that this meeting was only the North Eastern Regional Meeting.
>
> The Annual Meeting of the AAZPA will take place in Oklahoma City, September 21-25, 1969. All aquarium personnel as well as zoo personnel are encouraged to attend this meeting and information may be obtained through the Oklahoma City Zoo, Route 1, Box 478, Oklahoma City, Oklahoma 73111.

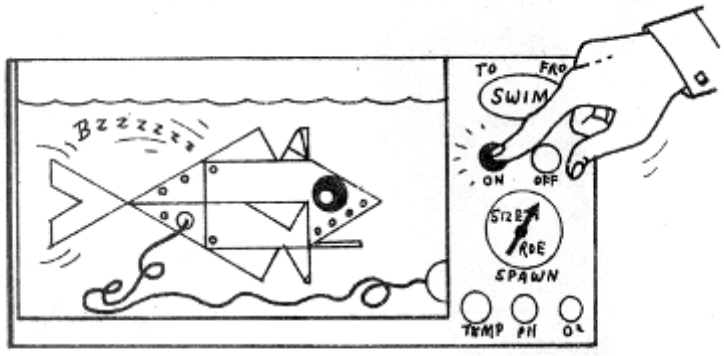
AUTOMATED AQUARIUMS

Automation must eventually come to public aquariums. Not that there will ever be a time when the art of fish-keeping can be dispensed with, but that the aquarist will more and more be able to depend on machines to tell him automatically exactly what is going on in his water systems and even to make the necessary adjustments to maintain the water just as it should be. The Steinhart Aquarium has taken some preliminary steps in this direction, and the National Fisheries Center and Aquarium will do much more.

An indication of the shape of things to come, as well as the capabilities of present-day equipment, is shown in the 1967 annual report of Fisheries of Scotland in which we are told that a major part of the work of one of the sections "was concerned with development of automation of chemical analysis using a Technicon analyzer. This provides for continuous monitoring of several possible parameters. The methods for phosphate and nitrate worked satisfactorily and techniques for silicate and ammonia are being tested."

Temperature, salinity, oxygen, and now nitrate and ammonia can all be measured continuously by machine. What next? No matter what, the aquarist doesn't have to worry about a computer or other gadget ever replacing him. His fishes will see to that.

Jim Atz



Werner Schroder, Director, Berlin Aquarium, sends us this photograph and comments, "I have some fishes which I am sure are *Rhinomuraena amboinensis*, described by Barbour in 1908. My fishes are more than one meter long, are azure blue with long yellow dorsal fins, and the nostrils have ends like fans. Their mouths are always open, but they are bad eaters."

Werner will be in New York in October to attend the International Convention of Zoo Directors. We hope to see him thereafter.

THE SALT WATER AQUARIUM MANUAL
By Robert J. Valenti; Aquarium Stock Company, New York,
1968; 162 p., profusely illustrated. $6.95.

The author has attempted to provide a basic reference and guide for the amateur saltwater aquarium hobbyist. He emphasizes a natural environment, including the presence of algae and bacteria, as contrasted with the superclean saltwater aquarium frequently recommended for beginners.

The book provides a very good treatment of the basic considerations involved in the selection and establishment of a marine aquarium. The author has been careful to explain the reasons for his many suggestions on bow to avoid the disasters which befall so any beginning saltwater aquarists. His treatment of water chemistry, temperatures, light, and filtration is good and easily understood. The book provides sketchy treatment of marine plants, marine invertebrates, and marine fishes. The chapter on marine fishes has some very helpful hints on keeping them successfully in an aquarium.

Many of the photographs are of very poor quality, and the author's style of presenting one thought and then supplying several counter or qualifying thoughts is disconcerting in that it tends to confuse the reader.

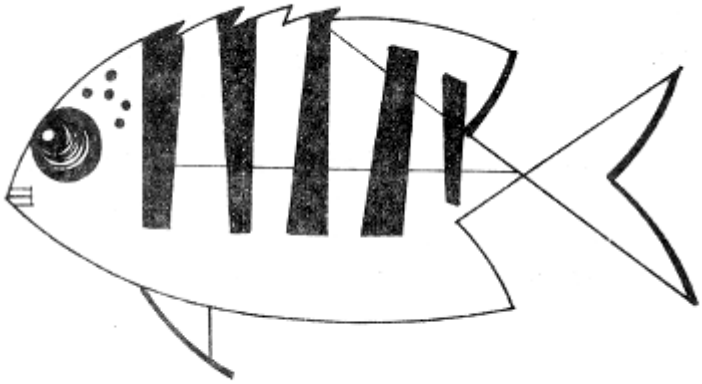
The book should be helpful as a guide to the beginning saltwater aquarist and also to the biologist who may find it necessary to occasionally hold saltwater fish for bioassays or other studies. *J.C. Fraser.*

From California Fish and Game, July 1969.

JAPANESE AQUARIUM TOUR

The three-week tour of Japanese Aquariums originally scheduled for next May has been postponed until the following year. The influx of visitors for the 0saka World's Fair has been partially responsible for the change. If you plan to attend this tour, then please set it up in your budget for May 1971. The approximate total cost from San Francisco is $1,500. A half-day stopover in Honolulu will enable us to visit Waikiki Aquarium, SeaLife Park and the experimental tuna tanks of the U.S. Fish and Wildlife Service at Kewala Basin. Wives are welcome on the tour. As many will know, Japan Has almost 100 aquariums and oceanariums, and some of their installations are so good they make our efforts look sad by comparison.

Earl S. Herald
Steinhart Aquarium



WHAT IS IT???
Eye of *Octopus bimaculatus*
10x Photo by Charles Eames

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