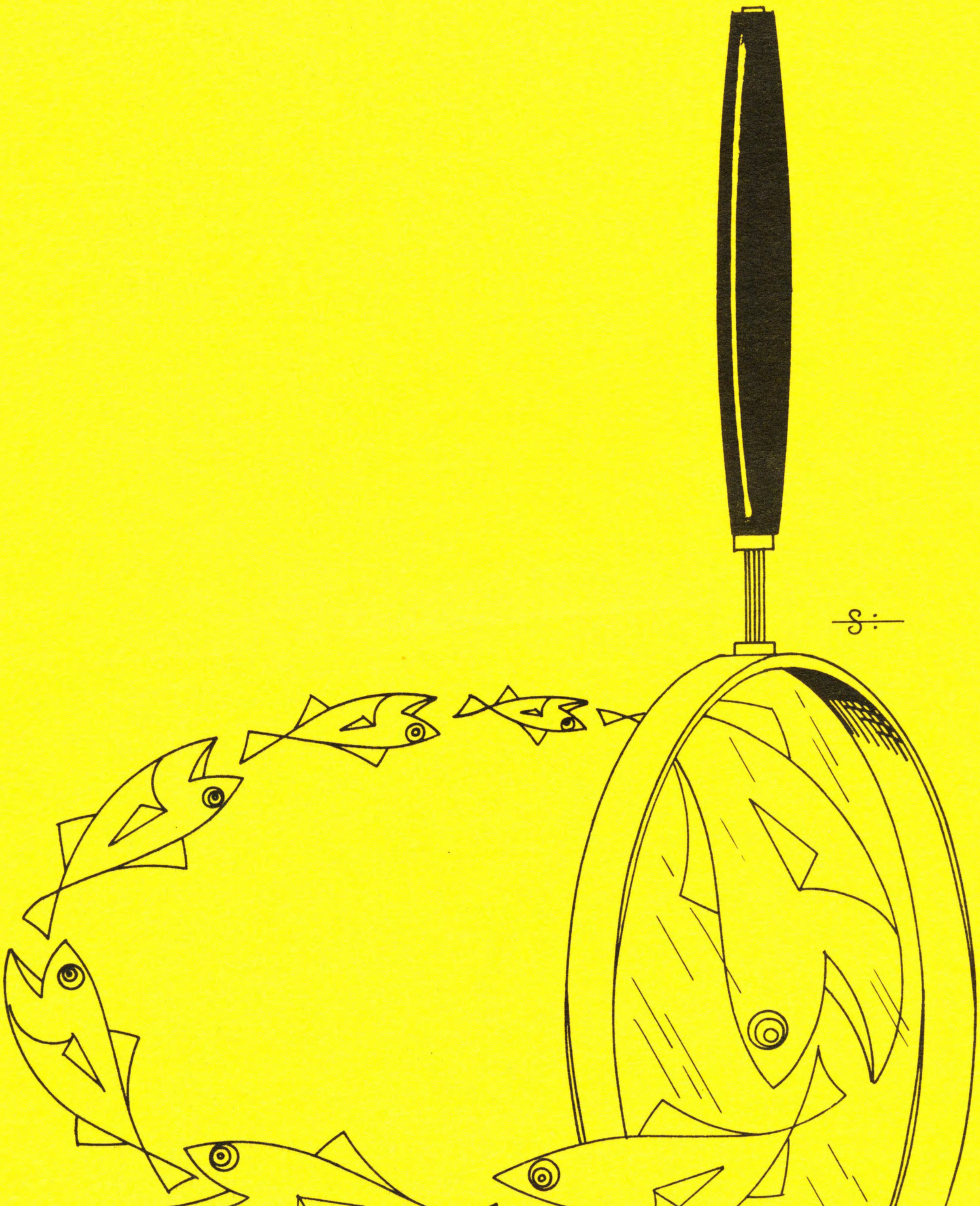
DRUM & CROAKER

THE INFORMAL ORGAN

FOR AQUARISTS

SEPTEMBER 1970

VOLUME 11 (70) NUMBER 3



VOLUME 11 (70), NUMBER 3 SEPTEMBER 1970

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

The Informal Organ

for

Aquarists

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Art work by Craig Phillips, NFCA.

Prepared by the National Fisheries Center and Aquarium, U. S. Department of the Interior, Washington, D. C. 20240, under authority of Public Law 87-758, 76 Stat. 753, as a service to aquariums generally.

COMMENT

Things are looking up a bit. We have six new contributors. There are some 250 subscribers who have never contributed.

In April we suggested an "education" issue. As reported in the May issue we had one response. No change since then - and no further comment.

Note the almost total lack of personnel notes.

Look, fellows, do you want us to keep this thing going?

Wm. Hagen - Editor
Assistant Director -
Operations
National Fisheries Center
and Aquarium

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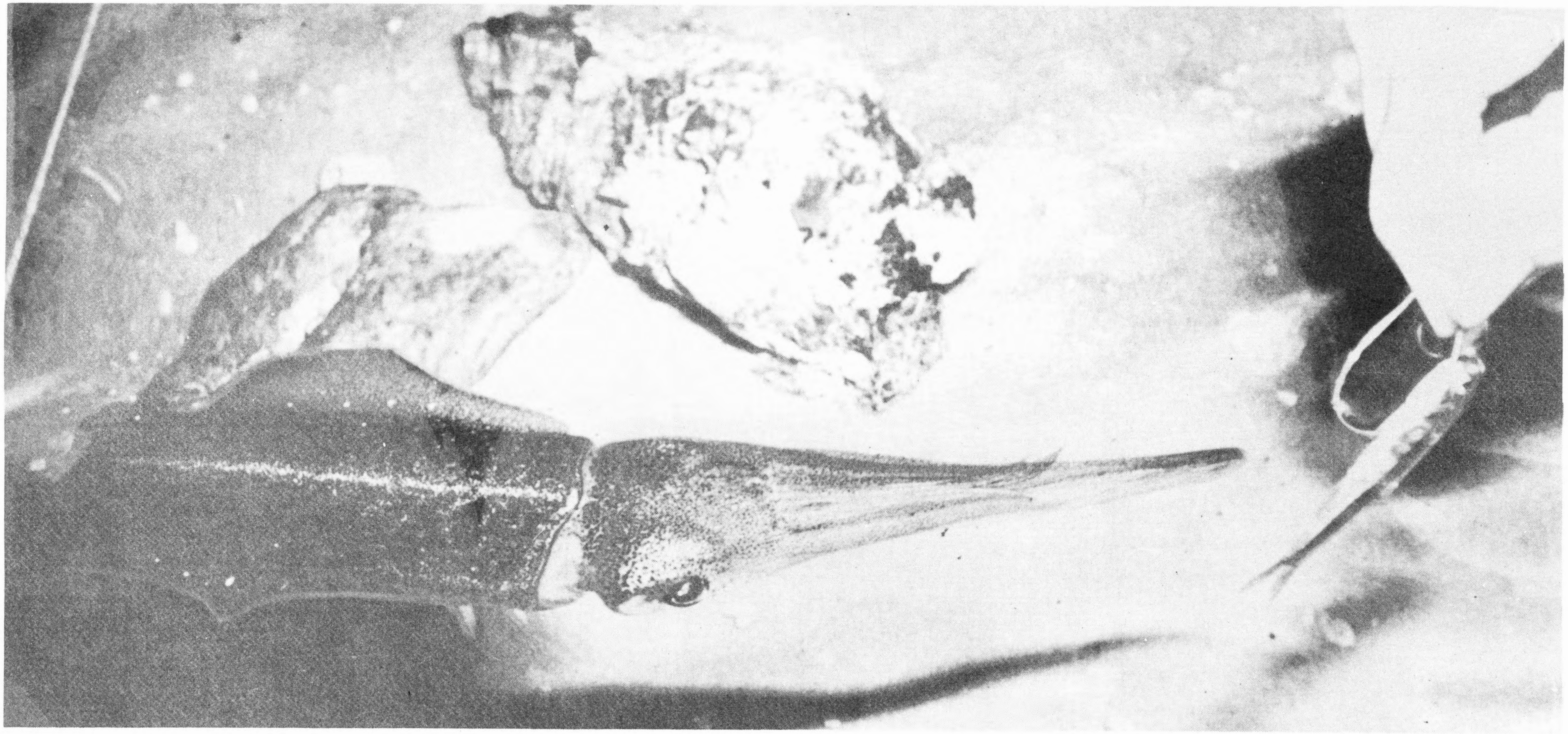


Reared adult *S. sepioidea* attacking food. The reared squid were so tame that they would take food from the author's hand.

ON THE MAINTENANCE OF SQUID IN CONFINEMENT

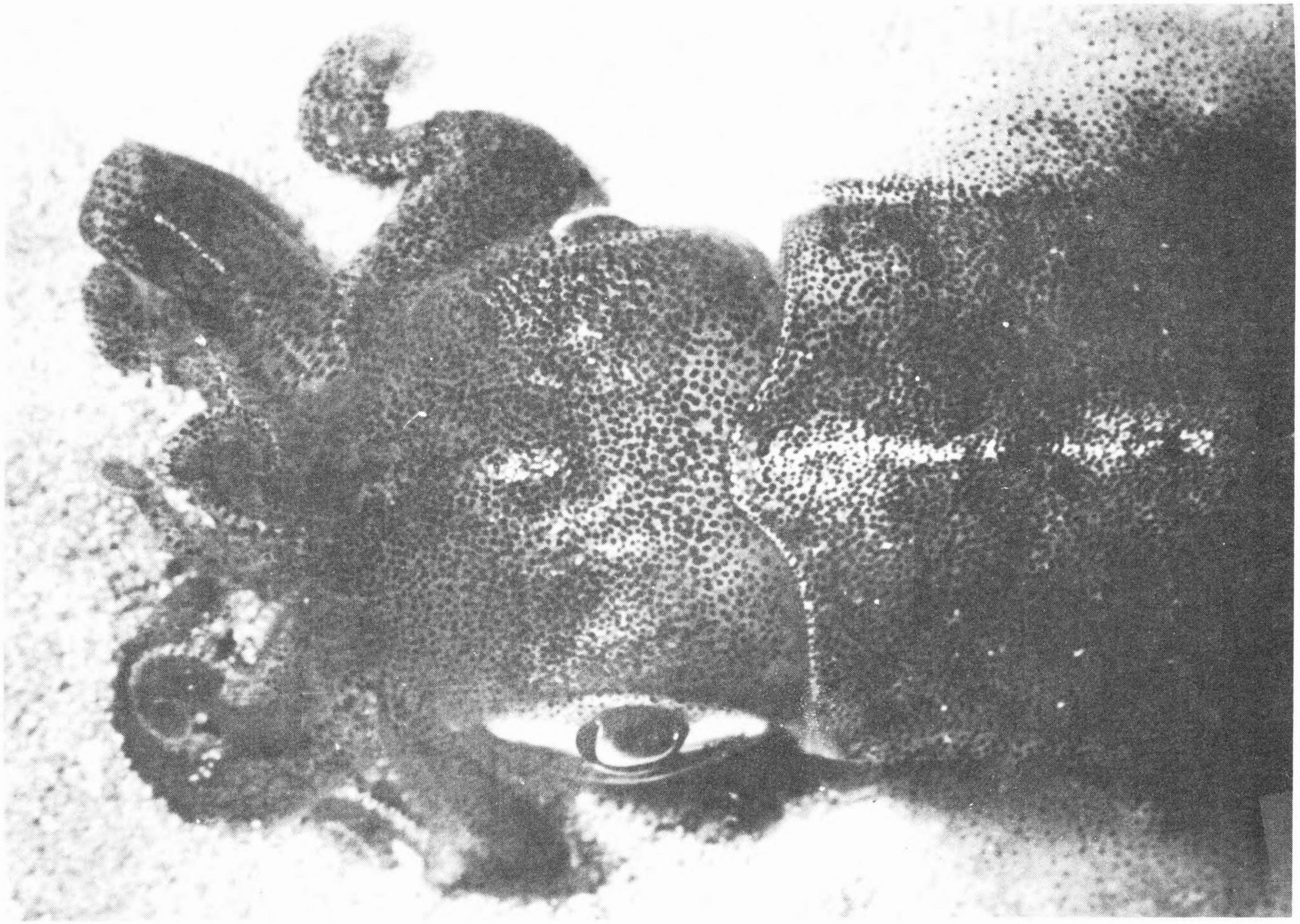
Edward T. LaRoe
Miami Institute of Marine Science

Cephalopods -- squid, cuttlefish and octopods -- have long intrigued man. They have been popular villians in fiction, but are astounding creatures in fact. They can change colors instantly, eject clouds of black ink, and glow with bioluminescent organs; they are perhaps best known for their jet propulsion mode of locomotion and the thousands of tiny suckers that line their arms.

Cephalopods are also of great scientific and economic benefit to man. They are probably the most intelligent invertebrates. Octopods have been used for the past decade in studies of the basic mechanisms of learning and memory. Squid have one of the largest nerve fibers of any animal -- their giant fiber is over 1000 times larger than human nerve fibers -- and these fibers have been the basic tool used by nerve physiologists for the past 30 years. Squid are also a major fishery resource in parts of the world, especially Asia and southern Europe.

Because of the importance of these animals, I have been engaged for the past two years in a pilot program of rearing and maintaining cephalopods -- especially squid -- alive in confinement. Octopods, and to a lesser extent cuttlefish, are rather hardy animals that adapt well to aquarium life. The octopus is usually a very popular exhibit at public aquariums, and survives quite well in captivity. In contrast, however, squid have a reputation of being delicate, nervous animals that seldom live more than a few days in captivity. Squid swim constantly in the open ocean and are simply not use to any physical confinement. They appear to die either from nervous shock or from physical damage caused by swimming into the aquarium walls.

The problem of keeping squid alive in confinement was approached in two ways: adapting young adults caught in the field, and rearing the squid from eggs. It was hoped that the latter approach would provide specimens that, having never known the freedom of the open sea, would be well adjusted to the aquarium. Of course, this created additional problems, such as finding proper foods for the very young. Although many persons have hatched cephalopod eggs, the only known workers who had successfully reared cephalopods were Choe (1966) and Oshima and Choe (1961), who had reared cuttlefish and one species of squid to commercially marketable, but not adult, sizes; and Schröder (1969), who reared the common European cuttlefish. The present study was confined to two species of loliginid squid, *Doryteuthis plei* and *Sepioteuthis sepioidea*, both of which are potentially important research and fisheries species.



Dorsum of head of adult *S. sepioidea*. Each black dot is a chromatophore or color spot. Each is separately controlled by individual nerves.

Despite the limited scale of the study, the program has been rather successful. Specimens of *S. sepioidea* were reared from eggs to sexually mature adults in the laboratory, and young adults of *D. plei* were adapted reasonably well to aquarium life. The laboratory work has provided a wealth of data. It was found, for example, that the growth rate of the squid in confinement was six to eight times greater than had been estimated by field studies. Specimens of *S. sepioidea* reached maturity in five months rather than the three or four years commonly considered.

The greatest difficulty in maintaining the specimens alive was feeding. The squid -- even the very young -- were extremely selective in what they would eat, and would attack only live, actively swimming organisms of a narrow size range. Newly hatched young were found to thrive on opossum shrimp *(Mysidium columbiae)*, and would begin to attack young *Gambusia* or mollies by the time they were six days old. Older specimens were maintained on larger fish and small shrimp. The squid consumed large quantities of food; at times they ingested 180% of their body weight daily, although they were normally maintained at about one-fourth this level. Salinity was 30-35 ppt. and temperature 29-30° C.

The squid were maintained in a variety of tanks, but survival was found to be best in larger (2100 liters) resin-coated, wooden tanks illuminated with a combination of Sylvania Gro-lux and Ultra-violet and Durolite Naturescent bulbs. An interesting finding was that the squid demonstrated strong preferences for swimming over certain types of substrates, and that the choice of substrate influenced the behavior of the squid. In general, the species preferred to swim over patches of artificial grass, and, in decreasing order, calcareous gravel, rocks, sand and the bare tank bottom. The presence of the preferred substrates exerted a calming influence on the squid, drastically reducing their tendency to swim into the tank walls; this was an important reason for their extended survival.

The program provided an opportunity to study the behavior of squid, and several observations were made on the attack and feeding behavior, and color and arm patterns. A major defense mechanism in the squid was to mimic, by a combination of color patterns and arm postures, drifting pieces of seaweeds or algae.

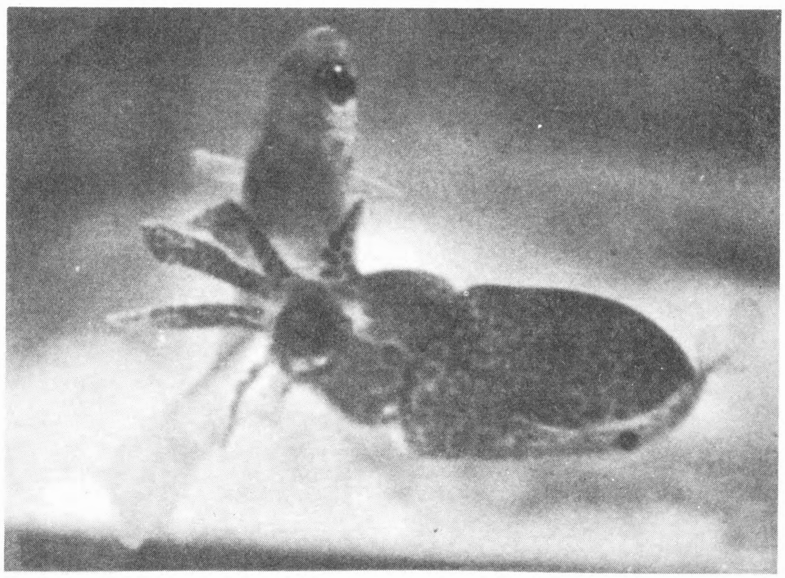
Despite their reputation, squid actually seem to be rather hardy animals if given proper care. The initial, if small scale, success has been very encouraging. The program is continuing and is being sponsored in part by a contract from the National Fisheries Center and Aquarium. Not only are we able to learn much of the basic biology of these animals, but we hope to be able to maintain large stocks for use in nerve research and learning studies. The ability to rear squid might lead to mariculture to supplement the current fisheries. It might also lead to the ability to display squid on a permanent basis in public aquaria. These colorful animals could not fail to be a popular attraction.

LITERATURE CITED

Choe, Sang. 1966. On the eggs, rearing, habits of the fry, and growth of some Cephalopoda. Bull. Mar. Sci. 16(2): 330-348.

Oshima, Yasuo and Sang Choe. 1961. On the rearing of young cuttlefish and squid. Bull. Jap. Soc. Fish. 27(11): 979-986.

Schröder, W. 1969. Observations made during the breeding of cuttlefish *(Sepia officinalis L.)* DRUM AND CROAKER 69(1): 9-15.



Six-day old juvenile *S. sepioidea* eating a young *Gambusia*. Mantle length of squid is less than 6 mm (1/4 inch).

SODIUM CHLORITE FOR WATER CLARITY IN THE MARINE DOLPHIN SYSTEM

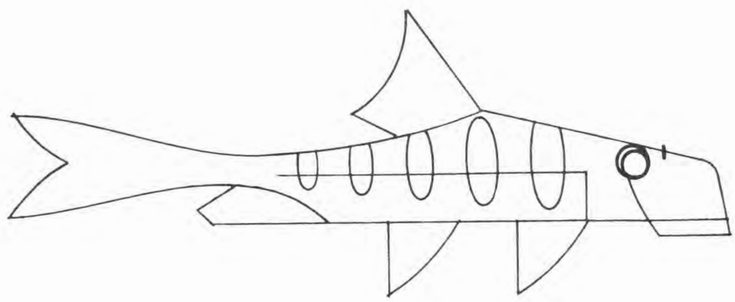
Robert P. Dempster
Assistant Superintendent
Steinhart Aquarium

At the Steinhart Aquarium sodium chlorite is currently being employed as an aid to maintaining clear water in the marine dolphin system. The chlorite is maintained at concentrations of from 0.5 to 2.5 ppm. A simplified test for the presence of this chemical in sea water has been developed by Anderson and Dempster through a modification of the Black and Whittle procedure for determining the presence of total chlorine in fresh water. Maintaining concentrations of 0.5 to 2.5 ppm has had no apparent adverse effect on the dolphins, seal, and two cormorants in this water system. The chlorite maintains a clarity in the dolphin tank that has never before been equaled at Steinhart Aquarium.

There is a total animal weight of some 1300 lbs. in this tank (5 dolphins, 1 harbor seal, and 2 cormorants). The total volume of water in this system equals 89,000 gallons therefore we have 1.46 lbs. of animal weight per 100 gallons of water in this water system. The water circulates at the rate of 375 gallons per minute through 300 sq. ft. of filter area (1.25 gpm per sq. ft.). Considering that 2500 gallons of filtered ocean water per hour are added to the system and the volume put through the Aquarium's filters on the recirculation system is at the rate of 22,500 gph, the total filter rate may be considered to be 25,000 gph (22,500 + 2500). Thus the entire water system of 89,000 gallons is only being turned over about once every 3 1/2 hours (low turnover rate). The animals consume 80 to 100 lbs. of fish per day and considering their high metabolic rate they are dumping a substantial amount of excreta in the water during a 24 hour period.

Before we began adding sodium chlorite to the system a very favorable condition for the growth of algae and bacteria existed. Potassium aluminum sulfate is also added to the filters to render them more efficient. Alum is added only after the filters have been backwashed. Six pounds of this chemical are dissolved in 15 gallons of fresh water and added very slowly to the filters with a precision chemical metering pump over a period of approximately 24 hours.

Without the aid of these chemicals it was impossible with the low water turnover rate through our filters and the high animal weight in the tank to maintain the water clarity required to properly display the animals.



INDEX
to
1958-1966 Issues
of
DRUM AND CROAKER

Jim Atz, Associate Curator, New York Museum of Natural History, a frequent contributor to DRUM AND CROAKER, has voluntarily prepared an index for issues of DRUM AND CROAKER for 1958-1966. This was no slight task. We appreciate his effort.

Those of you who have need for this INDEX may request same from DRUM AND CROAKER.

W.A. MARINE AQUARIUM
AND
OCEANARIUM

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P.O. BOX 48
COTTESLOE
W.A. 6011

The Editor

DRUM AND CROAKER

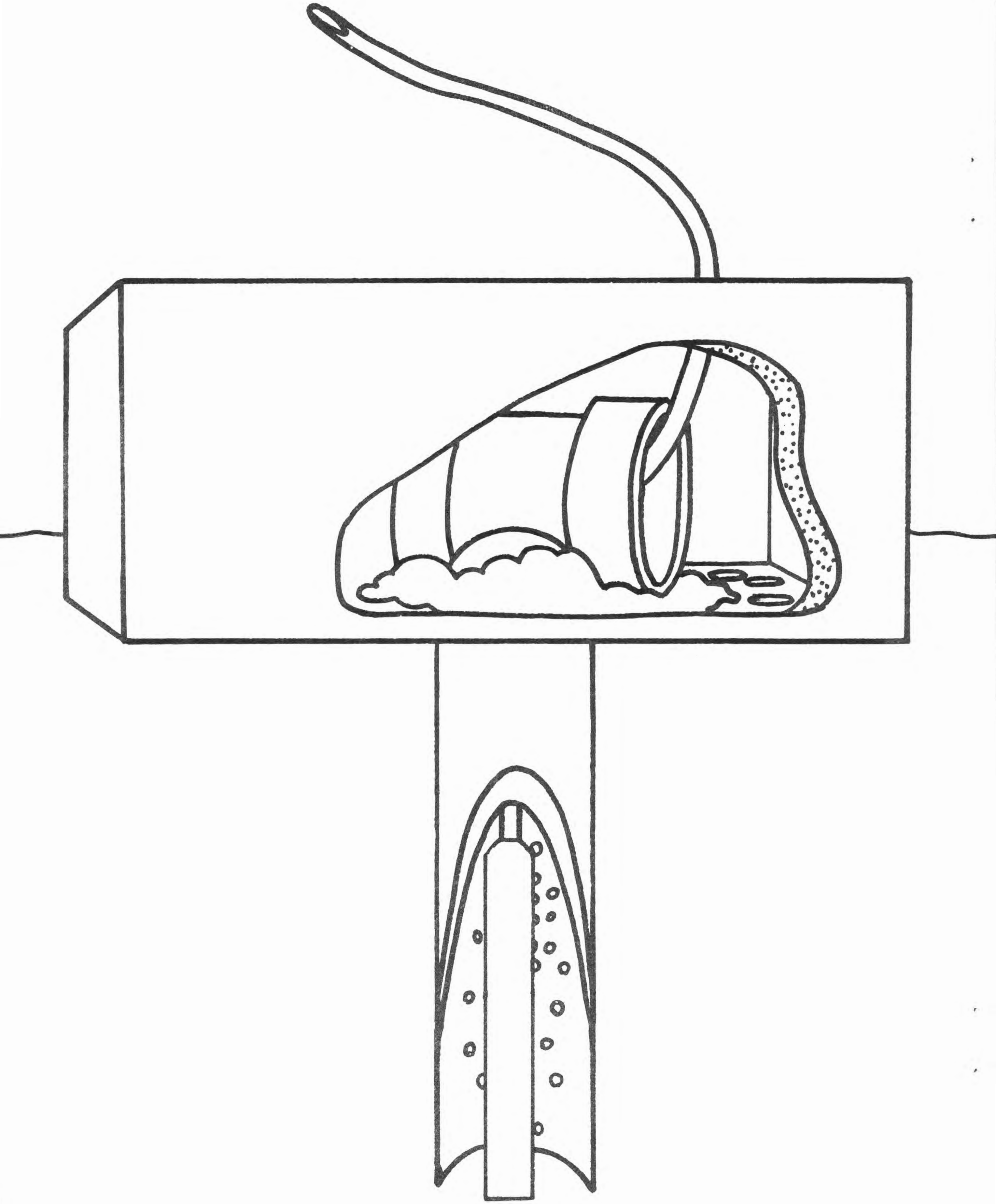
Dear Sir:

As our first year of operations come to a close we would like to thank you very much indeed for your excellent magazine. It has helped us in many ways. My wife and I hope to have an article for you within a few months.

Yours faithfully,

Paul and Lona Comley

Ed.: We are pleased to receive the kind words from Western Australia, and wish the Comleys much success.



A SIMPLE AIRLIFT FILTER

Elmer H. Taylor, Curator
New England Aquarium

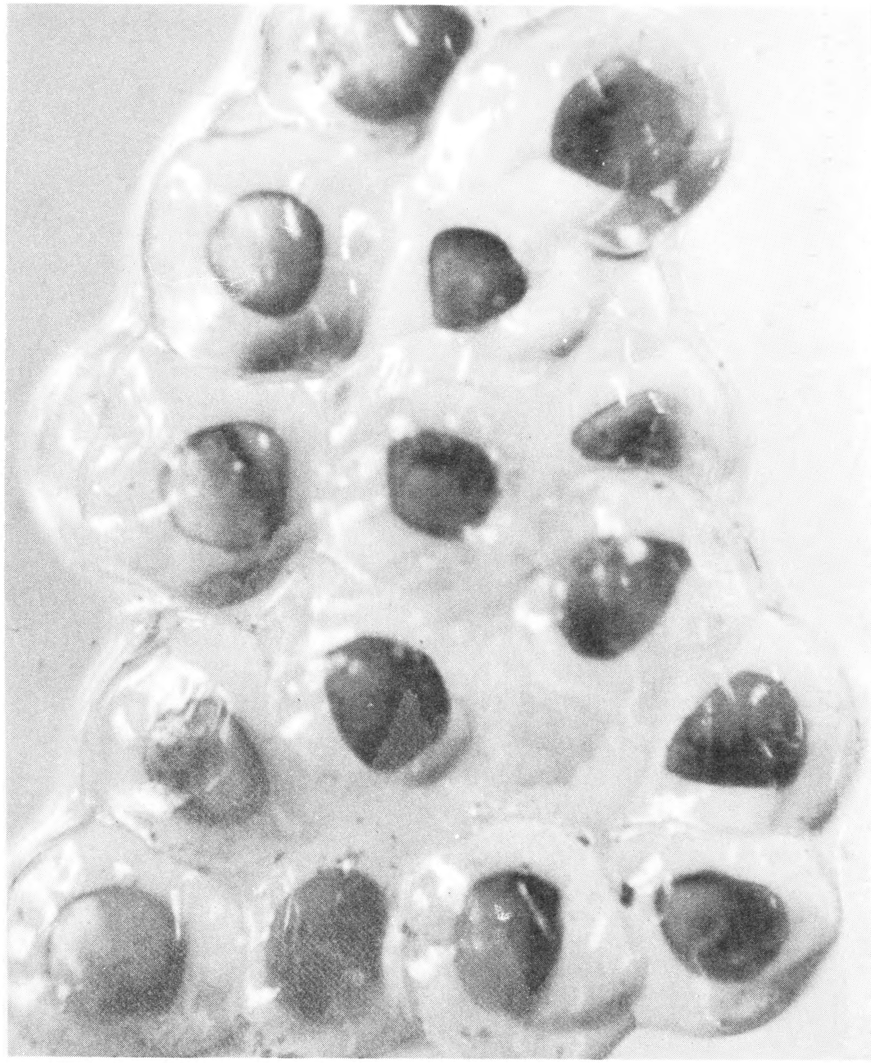
Necessity is the Mother of invention. Necessity helped us temporarily solve our dirty water problem.

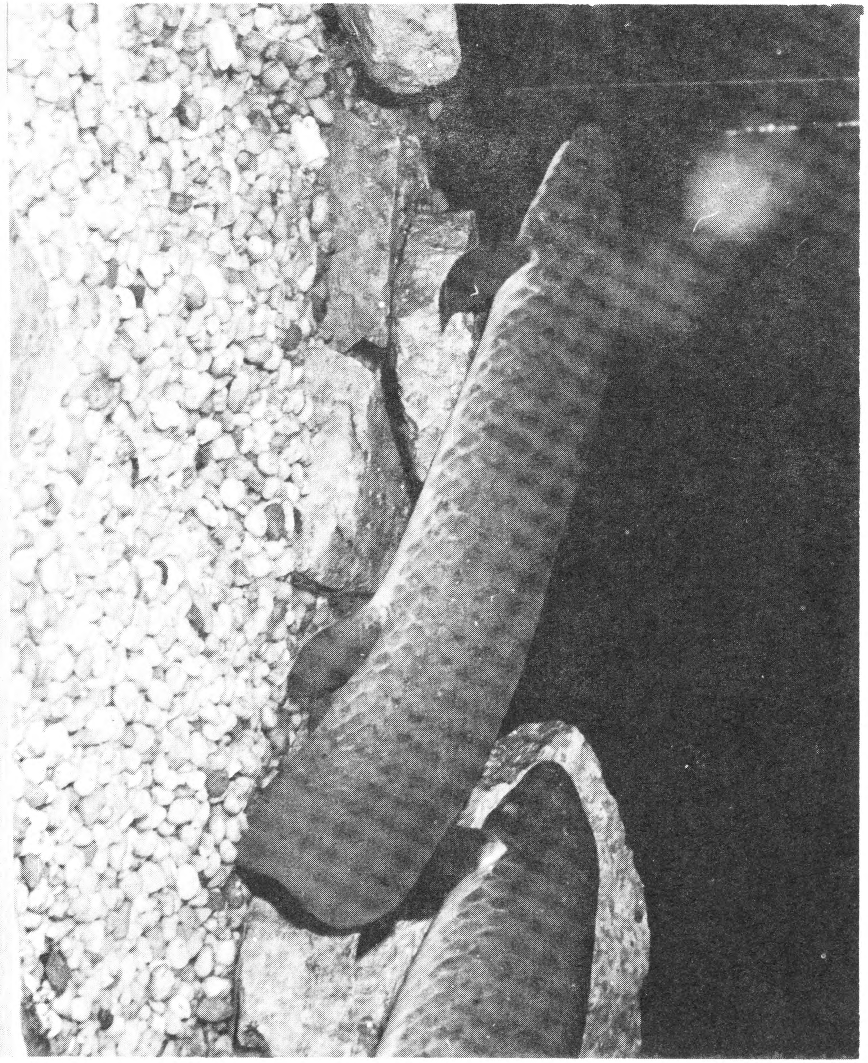
In the early months while setting up the display tanks before opening of the New England Aquarium, we found that most of the prescribed filtration on our closed circulation display tanks was not adequate, and some reserve tanks had little or no provision. Out of the need for a quick solution we utilized what was at hand and at that moment numerous fish shipping styrofoam boxes (17 x 17 x 18") were available. These were employed as floating filter boxes. We proceeded to punch a 2 1/2" diameter hole in the center of the bottom, then punched numerous smaller holes. We floated this on the surface of our tank and inserted a 2" PVC pipe through the hole. When a PVC-T was pressed on to the top of the pipe within the box, the lowermost end of the pipe was just clear of the bottom. It will be noted that the T-piece prevents the pipe from falling through the 2 1/2" hole.

With a 1/4" clear plastic air hose attached to a six inch carborundum diffuser air was introduced to the lower interior of the pipe.

Into the box and around the pipe and T-piece we placed a pad of nylon filter wool which retains the dirt when the dirty water is air-lifted through the tube and spews out the two ends of the T onto the wool. By gravitational flow water percolates down through the holes, returning to the tank much cleaner than when first lifted through the vertical pipe.

This simple and inexpensive airlift filter has proven extremely helpful in large, crowded, and cloudy open reserve tanks and it has also assisted temporarily overnight in some of the display tanks.





SPAWNING OF AUSTRALIAN LUNGFISH

Arthur M. Hegedus (1)

Spawning of the Australian Lungfish, *Neoceratodus forsteri*, was observed March 9, 1970 starting at approximately 9:45 A.M. The female swam toward the top of the tank, gulped air, and maintaining a vertical, head-up position swam to a corner of the seven hundred gallon tank. Her anal fins quivered violently and stiffened to a forty-five degree angle. Almost immediately the tips of the anal fins began waving gently and she released about forty-five eggs, after which she returned to the bottom of the tank. At this time her breathing rate was seventy-six times per thirty seconds. For twenty minutes, the female rested and the male swam leisurely about the tank. During this time, her breathing rate decreased to thirty-one times per thirty seconds. Soon the male began swimming frantically around the tank, gently nudging the female several times and nestling next to her, rapidly moving his fins. The second time the female released eggs, the male was lying beside her. She rolled on her side, moved her fins as before, and released eggs. The rest period and subsequent releasing of eggs followed the pattern observed initially except the male sporadically accompanied the female to the corner. However, at no time was there any sign of milt. This procedure continued throughout the day and approximately five hundred to six hundred eggs were released. All had a thick gelatinous envelope which appeared to develop rapidly after the eggs were released into the water.

A change of coloring was observed in both sexes. A one-half inch black or dark brown band appeared on both the dorsal and ventral outer edge of the female's tail. The male had a light yellow spot in the middle of his head.

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(1) Curator of Aquarium, Columbus Zoological Gardens.

March 10.

Attempts to collect the eggs by using nets and a siphon were unsuccessful because the eggs adhered to the rocks and gravel in the tanks and cohered to each other. Thus, it was necessary to drain the tank and create a current to dislodge the eggs. This was done by swishing the water with the hands. The eggs were then removed with nets and placed in several containers of water, four to five inches deep.

Dr. Don D. Farst, resident veterinarian, and the writer, examined a sample of eggs using both dissecting and a compound microscope. A dark red center was observed, but no signs of development were noted.

March 11.

The majority of eggs showed no visible changes. Approximately ten percent changed from a blackish-green egg to a pale blue and completely transparent egg.

March 12.

The eggs showed no sign of development and many had fungus growing on them. A sample of eggs was preserved in ten percent formalin.

An analysis of the water in the tank where the lungfish spawned was conducted using a Hack Kit. The results, in parts per million, were as follows:

Alkalinity	80.00
Carbon dioxide	5.00
Chloride	45.00
Copper	0.22
Fluoride	0.46
Hardness	70.00
Iron	0.05
Manganese	0.40
Nitrate nitrogen	42.00
Nitrite nitrogen	0.017
pH	8.34
Phosphate	3.30
Silica	15.40
Sulfate	140.00

March 13.

The female lungfish began to lose the dark band around her tail. Neither lungfish had been observed eating since the spawning. The eggs showed no sign of development.

March 14.

The eggs which remained in the tank, where the fish spawned, showed the same signs of deterioration as those that had been removed.

March 15.

The eggs in the containers were discarded.

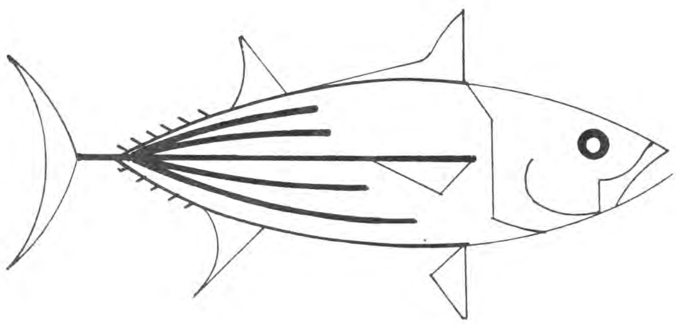
March 16.

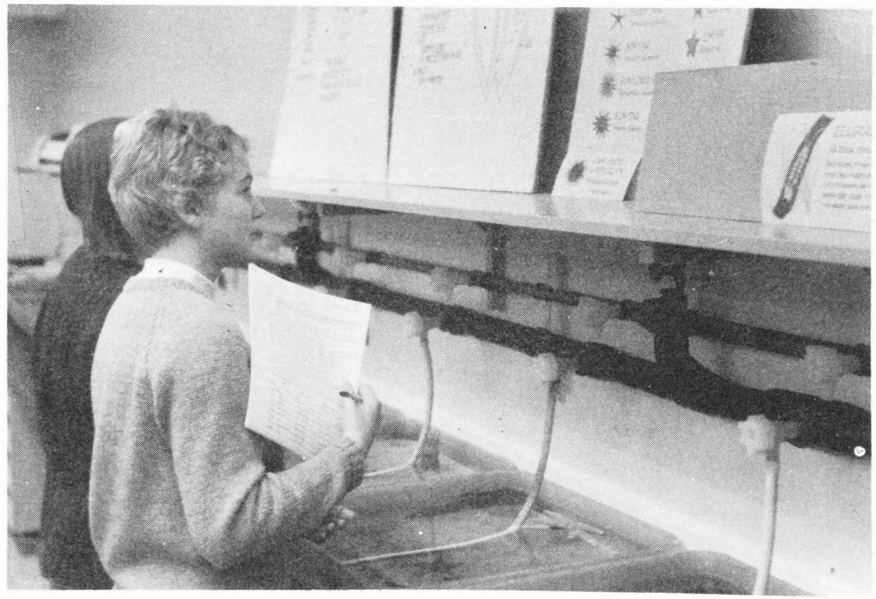
The eggs from the tank in which the fish spawned were removed.

March 24.

The female lungfish still had a small dark band on the dorsal portion of her tail. Her breathing rate was now twelve times per thirty seconds.

Regarding the photographs, there was not enough light to picture the actual spawning.





Above
Thirty students can occupy the bench space in the Aldyen Hamber Student Laboratory.

Upper right
With live creatures at their bench, students discuss the answers to the written questions.

Right
Flat pans with running seawater contain live coastal invertebrates. The students here are about to touch various starfishes to determine if they are intertidal or subtidal.

(Photos by Murray Newman)

BIOLOGY LABORATORY AT THE VANCOUVER PUBLIC AQUARIUM

Sharon Proctor
Education Supervisor

The Vancouver Public Aquarium, in addition to a guided tour program, presents a laboratory session for grade 11 biology students. Utilizing the Aldyen Hamber Student Laboratory, the program centres about seashore ecology. Because the intertidal region is frequently exposed to air at low tide, animals and plants inhabiting this area are threatened with desiccation, high temperatures, high salinity and wave action. Consequently, intertidal animals possess physiological and structural adaptations not found in their subtidal relatives.

The laboratory has bench space for 30 students, and along one wall are large pans filled with constantly flowing seawater. The students are provided with live marine animals, instruments, and two Spencer A-O binocular dissecting microscopes. There is also a sink with tap water.

A given biology class comes to the Aquarium once during the school year. With a volunteer "docent" serving as instructor each student is handed a set of printed questions to be answered during his visit. The exercises concern evolutionary adaptations of seashore animals, and to answer the questions the students must examine living specimens. After introductory remarks by the docent, the individual students follow the directions on their sheets. Some exercises involve a student placing an animal in a dish of seawater and taking it to his bench. Others require touching creatures in the pans. Many classes have an exercise which consists of donning headphones and listening to tapes about particular species.

Prior to the class visit, the teachers spend an evening at the Aquarium. After hearing a discussion on the seashore environment, they perform the same laboratory exercises which their students will do. This meeting enables the teachers to prepare their classes for the visit and to discuss answers to the questions back at the school.

There is no charge to participating students and the program has the complete co-operation of local school boards. Each session lasts an hour and a half.

SAMPLE QUESTIONS

MUSSEL *(Mytilus edulis)*

(After the student has opened the mussel with a scalpel and placed carmine particles on the gills.)

How does the mussel remove food from the water?

Why are the gills larger in molluscs which are plankton feeders than in molloscs (such as snails) which eat the thin "film" on rocks?

SHORE CRAB *(Hemigrapsus oregonensis)*

(The student has a crab in a dish of water and compares it to a plastic mounted crayfish.)

Describe the shape of the crab thorax and compare it to that of a lobster or crayfish. How does the shape of this structure benefit the crab in the rocky intertidal environment?

What has happened to the large abdomen possessed by the crab's swimming ancestors?

HERMIT CRAB *(Pagurus sp.)*

(The student has two hermit crabs at his bench; one in a snail shell, the other without its shell.)

The crayfish and true crab have four pairs of walking legs as did the hermit crab ancestors. The hermit crab appears to possess only two pairs. What has happened to the other two pairs?

STARFISH

The student must touch various starfish specimens and tell whether each is "intertidal" or "subtidal" to skin texture.

BURROWING SEA ANEMONE *(Cerianthus sp.)*

(Several burrowing anemones are in pans adjacent to rock-clinging species)

Compare the appearance of *Cerianthus* to that of a rock inhabiting species.

THE PROTEIN SKIMMER

Bryce P. Anderson
Research Associate
Steinhart Aquarium

An adsorptive bubble separation method, known since the turn of the century, has been recently employed by various institutions to remove undesirable constituents from marine and fresh water systems supporting underwater life. Since proteins constitute a major fraction of the undesirable constituents removable, the devices constructed to employ the method have become known as "protein skimmers".

There are two basic subdivisions of adsorptive bubble separation under which all of the methods known to date are categorized. These are the nonfoaming bubble separations, which include bubble fractionation and solvent sublation, and the foam separations, which include foam fractionation, ore flotation, precipitate flotation, macroflotation, microflotation, adsorbed colloid flotation, molecular flotation, and ion flotation. The protein skimmer is specifically classifiable as a foam separation device operating in a nonspecific simple mode.

Historically, foam separation was used as early as 1900 by von Zawidski[1] to remove sodium oleate from its aqueous solution. This experiment was designed as an attempt to experimentally verify the Gibbs adsorption equation[2], which qualitatively describes the interfacial adsorption process.

Foam separation operates due to the selective adsorption of surface active solutes at the interface between a solution and a gas. If one could continuously skim off the gas liquid interface of a solution containing surface active solutes, the resulting solution would be richer in the surface active solutes than the residual liquid. This is of course impractical in itself, however, gases, such as air, bubbling through the liquid generate a gas-liquid interface surrounding each bubble. The resulting foam is easily collectable. Thus foaming provides a simple effective means for both efficient generation and collection of gas-liquid interfaces with their concentrated solutes.

When foam is produced from a water containing surface active solutes, the foam will be richer in these solutes than the water remaining. Collecting and condensing the foam will produce a rich liquid product called the foamate. The foamate produced from water by a well designed protein skimmer originates from materials derived from the life cycle of aquatic plants and animals, domestic sewage, waste chemicals of industrial plants, other man-derived additions, and natural run off. It will include such things as dyes, organic anions, fatty acids, detergents, enzymes, proteins, amino acids, and miscellaneous other organic substances and inorganic ions which are removed due to their coincident association with the above through chelation or counterionic attraction. Some bacteria, algae, and protozoa will also be removed through the mechanism of froth floation acting concurrently due to the presence of the surface active solutes.

The primary material which concentrates in the foamate during foam separation existed in true solution in the liquid from which it originated. An organic molecule soluble in water contains a water attractive (hydrophillic or water loving) group such as -OH, -COOH, =NH, $-NH_2$, -CN, $-NO_2$ = PO_4, etc. Usually the rest of the molecule will have little attraction for water (hydrophobic or water hating) and will tend to accumulate at the air-liquid interfacial surface. There it exerts a surface pressure and lowers the surface tension of the water. It is thereby surface active.

Gibbs equation, applicable to very dilute solutions,

$$\Gamma = -\frac{C}{RT} \cdot \frac{dr}{dc} \qquad (1)$$

where Γ = excess of solute per surface unit (gmoles/sqcm)

C = concentration of solute (gmoles/cu cm)

R = 8.3×10^7 dyne-cm/mole °K

T = absolute temperature (°K)

r = surface tension (dynes/cm)

shows that when either the concentration of the solute in the bulk liquid or the rate of change of surface tension with concentration is high, the interfacial enrichment is high. If both factors are high, enrichment at the interface increases as a function of the product.

The greatest advantage of foam separation lies in its effectiveness at low concentrations. The reason for this can be shown by rewriting equation (1) as follows:

$$\frac{\Gamma}{C} = - \frac{1}{RT} \cdot \frac{dr}{dC} \qquad (2)$$

The factor Γ/C indicates the degree of separation or separation factor. This separation factor depends upon the slope of the surface tension - concentration plot. As concentration decreases the value $|dr/dC|$ increases rapidly, or, stated otherwise, the separation factor increases by decreasing the concentration of the solute.

The relative importance of the many factors which affect the performance - efficiency of a foam separation unit depends upon the specific case. For this reason each unit must generally be designed to fit the specific circumstances apparent in order to achieve a high degree of efficiency. A unit which works well at one location or in one system will not necessarily work well if moved into a new set of conditions.

The major factors which operate relatively independent of each other are the materials (solvent, solute, gas), pH, temperature, pressure, and concentration. Combinations of these major factors establish the secondary factors, such as surface tension, solubility, equilibrium relationships, adsorption kinetics, foam ratio, foam stability, foam drainage, gas flow rate, viscosity, and equipment design.

As mentioned earlier, the separation factor is dependent upon the slope of the surface tension-concentration plot. In the separation of proteins, the slope of this curve is greatest and the optimum separation is found at the isoelectric pH of the proteins being removed. The isoelectric pH is the pH at which the dipolar ions are at a maximum. Isoelectric pH for given protein systems varies from about 4.5 to 12.1 with the majority of systems in the 4.5 to 7.0 pH range. Dipeptides generally have isoelectric pH's near 5.5 and the isoelectric ph's of amino acids are generally near 6.6

Normally the higher the temperature the poorer the foam stability, probably due to a hinderance of adsorption which would be expected as average molecular energies increase. As foam stability decreases the rate of removal of the foam from the system has to be increased to maintain a constant rate of contaminent removal from the system. At the same time the concentration of the solute in the foamate is increased due to the internal reflux created by the collapsing bubbles.

Decreasing the gas flow rate tends to increase the concentration of solute in the foam. This is due to the lowered degree of entrainment of bulk liquid in the foam structure. Decreasing the bubble size increases the area of interfacial surface and thus increases the gross amount of solute transferred from the liquid into the foam.

Increasing the dimensions of the equipment to provide a longer residence time in the liquid for the rising bubble favors a more optimum removal. This effect is due to the fact that equilibrium relationships at the gas liquid interface have more time to establish, thus favoring the better separation.

Foam drainage produces a more concentrated solute solution since the entrained liquid can return to its bulk. Viscosity of the bulk liquid affects this drainage rate. Viscosity also affects the rate at which the bubbles can rise through the liquid. This in turn affects the liquid flow rate per cross-sectional area of the equipment in continuous type units.

In spite of the complex set of interrelationships which must be taken into consideration to produce an efficient protein skimmer, the actual device is deceptively simple in its construction. In most instances, it will appear to be nothing more than a segmented box fitted with spargers and an overflow system for the foam. The overflow might be natural or assisted by a drag conveyor. Once the foam has left the system it is condensed or collapsed, either by natural attrition or by assistance provided by a forced spray of liquid which may originate either from the bulk liquid or from the collapsed foamate solution. The foamate solution height is generally maintained by a constant level syphon.

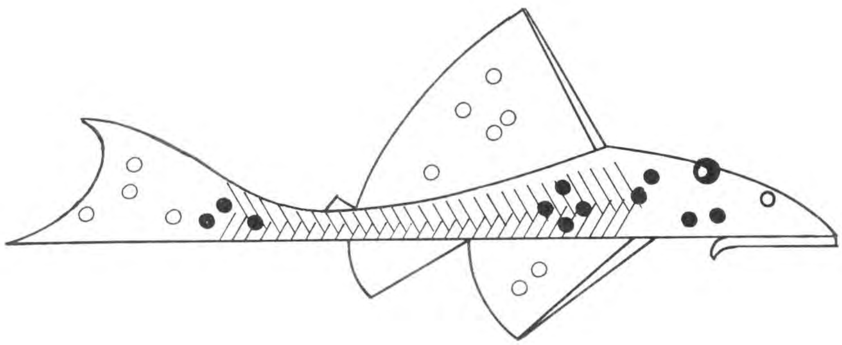
Air is the gas most normally available and used. Due to the isoelectric pH of most proteins, however, CO_2 would provide the highest efficiency in an alkaline system. By simply providing for a multiple stage countercurrent type flow in the protein skimmer design, the reduced efficiency of air can be easily overcome.

A properly designed foam separation unit can be of immense value to aquariums or oceanariums. The low initial cost, low operating cost, and high efficiency of operation can serve to effectively eliminate the problems arising from waste accumulation in the system. Since the unit can remove the bulk of the nitrogenous waste present, the problems arising from ammonia and nitrates in any system using such a device will be significantly reduced and algae growth will be hindered.

References

1. vonZawidski, J., Z. Phy. Chem. 35, 77 (1900).

2. Gibbs, J. W., "Collected Works," Longmans Green New York, 1928.

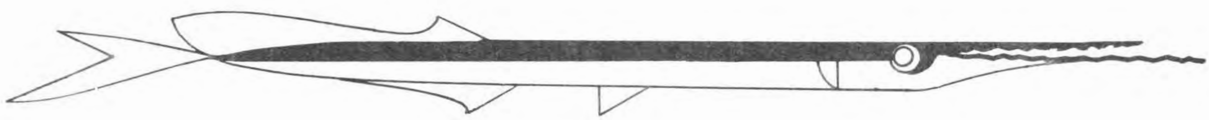


AQUARIUM DIET

In the January 1970 DRUM AND CROAKER is an article titled "A Meal-Gelatin Diet for Aquarium Fishes." Several inquiries have been received regarding the source of some of the ingredients.

The National Aquarium (NFC&A) utilizes Glencoe Trout Meal (granulated) PR-1, which includes all of the ingredients listed in the articles, and Vitamin Premix, both of which are available from Glencoe Mills, Glencoe, Minnesota. The gelatin is Swift's Stabilo gelatin.

As mentioned in the article "Adequate approximation (of the trout diet) is available off-the-shelf from trout food manufacturers."



COASTAL COLLECTING

Steve McCusker
Assistant Aquarium Supervisor
Fort Worth Zoological Park

On the afternoon of June 11th the staff of the Fort Worth Aquarium was kept quite busy with last minute chores of gathering equipment for a collecting trip and packing these necessities securely on the truck. Air pumps, styrofoam boxes, plastic bags, air hoses, nets, seines and, of course, rods and reels were all loaded and ready for the capture of marine specimens and hopefully a viable return trip.

Elvie Turner, Jr., Director of the Fort Worth Zoo; Ronald Kimbell, Supervisor of the Bird Department and I left on our 364 mile journey at 6:10 AM and arrived at our destination, Rockport, Texas at 2:15 PM.

After we had settled and unpacked the necessary equipment, we headed toward the water. The high offshore winds that late afternoon started us wondering as to the effect they might have, but after pulling the 20 foot seine a few times we felt that the winds would not be detrimental to our collecting.

That afternoon many small sheepshead, pipefish, and pinfish were taken. Confident that we could collect these at any time we released the majority of them and took only enough to check our equipment and set-ups.

After darkness had set in we went out on a long lighted pier with rods, reels, handlines and bait consisting of shrimp and small squid. Catches that evening were few and far between and of little display value except for a small stingray, *Dasyatis americana,* which we could definitely use. After a ten minute battle to remove the swallowed hook, we placed the animal in aerated water and hoped that we could return to Fort Worth with this specimen in good health.

The next day we visited a few of the local bait stands in hopes that they would have some specimens that we could use. This method could be most beneficial only if the collecting team were to go on the shrimp boat, because the catch is sorted on the craft, so that, if you are not there to take your pick all but the shrimp are thrown back.

Toward afternoon we returned to the beach with seines and dipnets and planned to add to our collection. With a seine in shallow (2 ft.) water we collected pinfish, *Lagodon rhomboides;* sheepshead, *Archosargus probatocephalus;* pipefish, *Syngnathus fuscus;* edible shrimp, *Penaeus setigerus;* pupfish, *Cyprinodon variegatus;* drum, *Umbrina coraites;* coastal goby, *Dormitator* sp.; killifish, *Fundulus diaphanus;* small mullet, *Mugil cephalus;* needlefish, *Strongylura marina;* silver sides, *Menidia beryllina;* silver perch, *Sebastes marinus;* and assorted small crabs, oysters and clams.

Of these species those we thought we could maintain and use were taken back to the room where we had set up 6 temporary tanks consisting of styrofoam boxes with plastic bags and aerated with pumps and box filters.

While collecting hermit crabs, *Pagurus pollicaris,* on a rocky area of the shoreline we spotted 2 or 3 old tires and pulled them out to inspect their contents. With this we added a whole new family of fish to our collection - clingfish, family *Gobiesocidae.*

That evening many fiddler crabs, *Uca pugnax,* were taken from a narrow sandy beach and then we proceeded to seine this same area and got, on repeated tries, only pipefish in great numbers.

The following day the Fisheries and Wildlife Department took us to several islands where coastal birds are found and we were able to witness nesting and social behavior of sea gulls, least terns, skimmers, herons, cattle egrets, and various common birds. Pelicans, which are usually quite common in that area, were not spotted.

Late that afternoon we began to plan for our return trip. We separated fish so as not to exceed approximately 30 inches of fish/box and we loaded the truck with all but living specimens.

Early the next morning we changed some of the water, pulled the aerators and sealed the bags with rubberbands as if for any normal air shipment. However, our biggest worry was not loss of oxygen from the water, but rather the temperature of the water after 8 or 9 hours in the back of the opened truck beneath the hot Texas sun. The boxes were taped so as to keep the temperature as constant as possible and a tarp was roped over the back of the truck.

About 9 hours later we arrived at the Aquarium and were pleased to find that no gross tragedies had occurred.

A number of hermit crabs were dead, presumably because of polluted water perhaps caused by 1 or 2 initial deaths.

The stingray and one large sheepshead, also caught on a hook, were in good condition and were added to a tank which contained another ray and a remora. At this writing the sheepshead is doing quite well, but the *D. americana* from the gulf coast died after being attacked by the remora, even though the remora had lived peacefully with another ray for some time.

Four of the pinfish have died since our return but other than those mishaps the fish and invertebrates are well and the coastal collecting trip was a success.

The clingfish has acclimated to pollution! Turning tires allowed us to add this family to our collection.

REPORT ON THE SPAWNING OF THE PIRANHA, *Serrasalmus rhombeus*

at the New York Aquarium

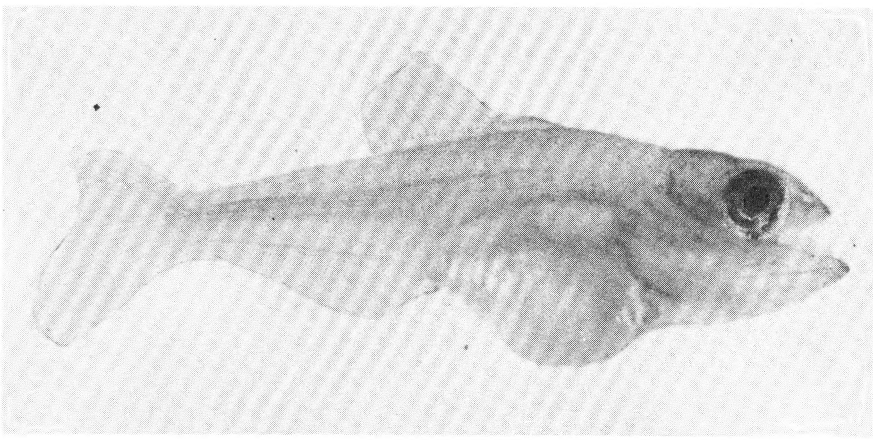
Werner Schreiner

Water Temperature	-	74° F
pH	-	6.9-7.0
Size of Aquarium	-	1,500 gallons
Substrate	-	fine calcium and limestone gravel
Plants	-	surface plants: duckweed and water sprite
Other Inhabitants	-	5 *Colossoma* spp. 14-20 inches 1 Tiger catfish 22 " 1 Arrowana 17 "
Lighting	-	1 - 40W fluorescent, Durotest, bulb (48") 2 - 150W spot lights All lights were on daily from 8 AM to 10 PM.

The female piranha was introduced into a well established 1,500 gallon aquarium on December 28, 1969 and the male introduced March 25, 1970. The male fish had been in a 100 gallon aquarium on display for over seven years, prior to being moved into the 1,500 gallon tank. The fish were fed pieces of frozen brown shrimp, squid and fish once a day. To date, five spawnings have occured, all of which were approximately ten days apart and all in the late afternoon. This report will concern itself with one spawning which was observed in total.

A pre-spawning or courtship ritual lasted from 2 PM to 5 PM on June 5, 1970. During this time the male and female fish swam side by side, quivering their fins and bodies and frequenting the spawning site. The actual spawning occurred from 5 PM to 8 PM, at which time the two fish swam over a small area in the front corner of the aquarium releasing and fertilizing the eggs at the same time. The eggs were released in batches of 25-50 eggs approximately two to five minutes apart. At 7:30 PM, near the end of their spawning, the time period between release of eggs increased to ten minutes at which time as few as 2-5 eggs were released. The male parent, who could be discerned from the female by lighter pigmentation and slimmer body shape, guarded the eggs from other tank inhabitants. Both the male and female piranha are about the same size, the female 9" and the male 10" long.

On four occasions the eggs were removed from the spawning site and placed into a 20-gallon all-glass aquarium into which 2cc of a 1% methylene blue solution was added. The aquarium also contained an airstone for proper water circulation. Eggs were found to hatch within 2-3 days and the yolk sac appeared to be completely absorbed by the 9th day after hatching. The young fish were able to swim about if disturbed by the 10th day after hatching but most settled to the bottom after darting about. Eleven days after hatching the young fish ate brine shrimp nauplii. At this stage the fish remained at the bottom swimming about infrequently. Not until the fish were 14 days old were they found to aggregate, quietly, at the surface, barely moving about.



Piranha, five weeks. x8
(Photo by Bill Greaves)

PERSONNEL ACTIONS

JOHN R. CLARK, long-time biologist with the Bureau of Sport Fisheries and Wildlife at Sandy Hook, New Jersey, has accepted the position of Curator at the New York Aquarium, Coney Island.

The National Fisheries Center and Aquarium has lost, through retirement, two of its employees who have been associated with the project almost from the beginning:

BILL BRYAN (William K., Sr.) Administrative Officer, retired to his Florida home (51 Miruela Street, St. Augustine, Florida 32084) at the end of July. Bill has been with the Fisheries Center since 1963. Prior service with the Government was as an administrative officer for State Department activities in Europe and the Middle East. We hear that he is now becoming involved in race track accounting.

Also retired at the end of July was DANIEL BERTRAND, Assistant to the Director, who has assisted with Fisheries Center activities since 1964. Prior Federal service included many years in responsible staff positions in the Congress. Danny continues to reside at the University Club in Washington.

We thank both Bill and Danny for their excellent service to the Fisheries Center and wish them long and active retirement years.

LIVE SNOWFLAKES

Louis Garibaldi
National Fisheries Center and Aquarium

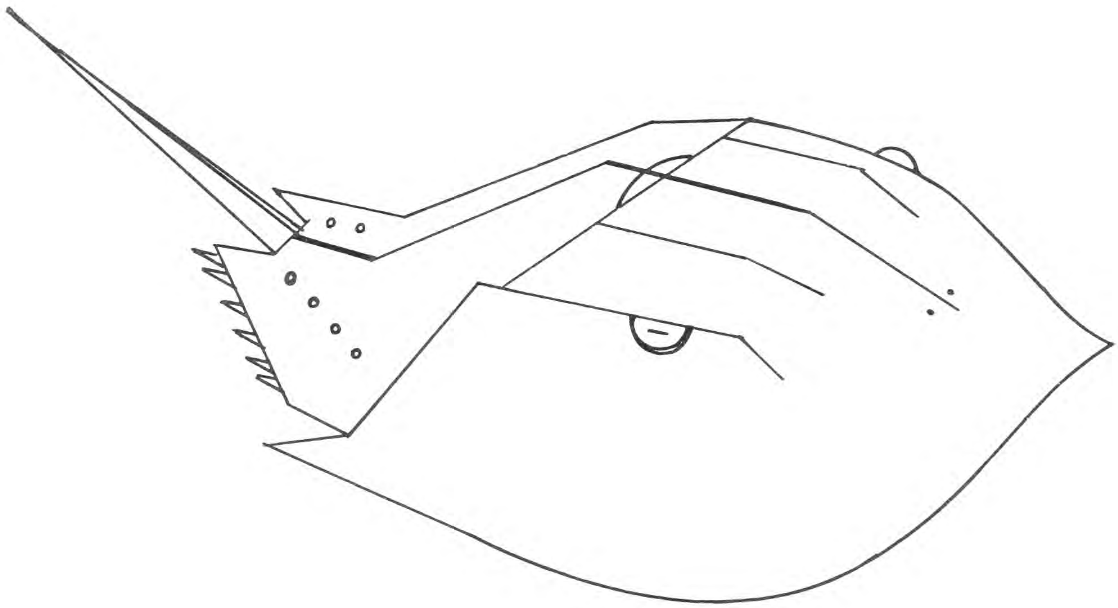
The past July two members of the National Aquarium's staff collected ten large adult horseshoe crabs (*Limulus polyphemus)* and 235 small juveniles. At least three pairs of the adults were caught while swimming together with the males hanging on to the rear portion of the female's shell by means of their hooks. This is typical of mating pairs at this time of the year. The males sometimes cling on like this for days or weeks at a time as they are towed along by the females until they (the females) are ready to deposit eggs. Often a female will be seen towing a chain of four or five males, each one attached to the one ahead of him. Normally, when the female is ready to lay her eggs, she will drag herself and her mate out of the water at a sandy spot during a high tide. Here the two crabs burrow into the sand and the eggs are laid. During the spring and early summer the beaches of quiet bays and inlets are covered with millions of eggs.

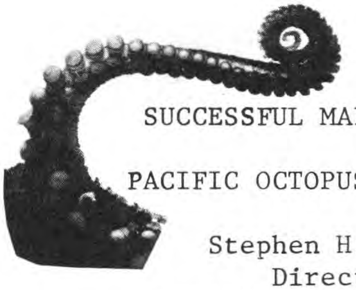
After being released into our 2,500 gallon artificial seawater tank the males were seen to immediately reattach themselves to the females and were often seen swimming in this manner.

On July 9th, there was a filter breakdown on this closed system and all of the specimens died except a hawksbill turtle and the horseshoe crabs. The horseshoe crabs were removed from the tank and placed into a 1000 gallon aquarium. Meanwhile, the 2,500 gallon tank had its filtration restored and was left to "clean up" with only the sea turtle on display. At the same time the normal illumination for this tank was in the process of replacement so there were no lights on in the tank.

Upon installing the new lighting on August 19 we found an unexpected display. Almost immediately after turning on the high intensity lamps we noticed what appeared to be oyster shell chips floating upward toward the light. Closer inspection revealed thousands of newborn horseshoe crabs being attracted to the light. Apparently, the adults had laid their eggs without leaving the water and the eggs had hatched similarly.

The water temperature during this period ranged from 23° to 25° C. with a pH of 7.8. At this writing some of them have gone through their first molt and are starting to show short tails. We introduced some of them into our smaller tropical tanks as food for the fish but they were rejected by clown anemone fish, small lionfish, seahorses, and Dascyllus. However, they were eaten by both tropical Atlantic and Pacific anemones. The crabs are fed dry flake food.





SUCCESSFUL MAINTENANCE OF A PACIFIC OCTOPUS (*O. apollyon*)

Stephen H. Spotte
Director
Aquarium of Niagara Falls

A 50-lb female octopus (*O. apollyon*) has survived at the Aquarium of Niagara Falls for one year in an 800-gallon closed system containing refrigerated INSTANT OCEAN Synthetic Sea Salts.

The system was in the design stages when described in a paper presented at the 1968 ASIH meeting in Ann Arbor (see abstract in DRUM AND CROAKER, LXVIII, No. 3, page 7), and was not completed until the following year. This is the only specimen ever to be kept in the system. It was received from the Seattle Public Aquarium on August 1, 1969.

The octopus is fed once daily on 7 oz. of blue runner and is given a 1-lb live American lobster weekly. It has fed regularly, except for a 9-day period last December and a 25-day stretch in May of this year. During the spring fast the animal laid enormous quantities of infertile eggs. Some were attached in clusters to the fiberglass decor, but most were scattered randomly about the floor of the tank. Additional eggs have been laid sporadically through July of this year.

The turnover rate through the culture system is 2 gsfm and the temperature is kept at a constant 45° F by a 3/4 hp refrigeration unit and heat exchanger. Make-up water is room temperature (75° F), which causes a slight rise in the ambient temperature of the system. This does not seem to affect the animal adversely.

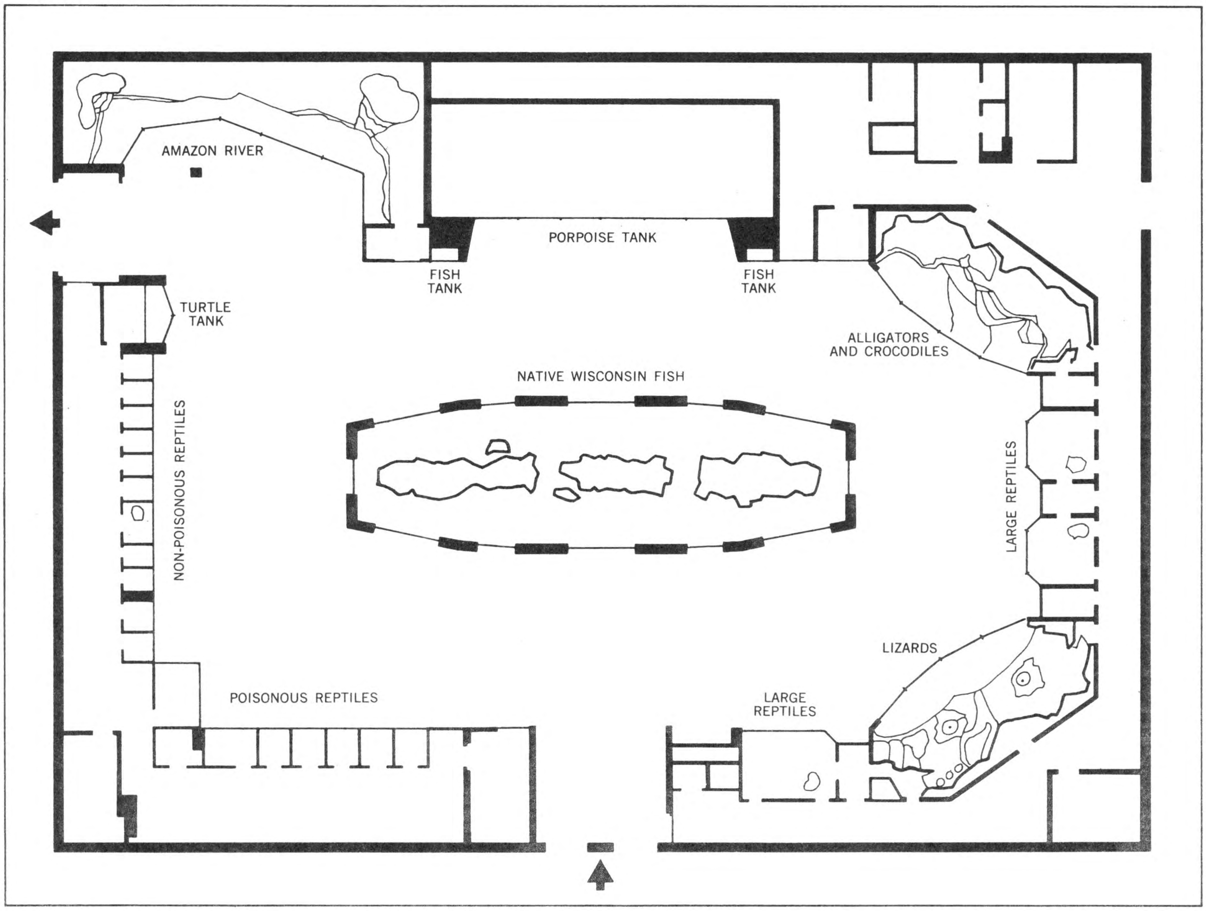
Laboratory tests have revealed no measurable ammonia (measured as total NH_4^+) and a nitrate level of less than 20 ppm. Measurable nitrite is always present, presumably from denitrification.

THE AQUARIUM REPTILE BUILDING

AT THE MILWAUKEE ZOO

Ken Schoenrock
Aquarist

It is two years new and has proven to be a tremendous success. Following the theme of the park, the building is constructed of Wisconsin fieldstone, has a pleasing and conservative appearance, and is set in a beautifully wooded section of the park. Visitors enter the building directly in front center while the service entrance is located to the right and rear, away from the public view. The public exit is at the left rear. Also at this point provisions have been made to add to the building in the future.



Upon entering, the visitor is greeted with a direct view of our 65,000 gallon tank which we call "Lake Wisconsin." This display is the dominant feature of the building. Rectangular in shape, it boasts eighteen windows, affording the visitor a fantastic view of a typical lake bottom one might find here in Wisconsin. This picturesque display has, of course, a particular attraction for fishermen. It is stocked with just about all of the state's game fish, as well as "rough" fish. Turtles, snails, crawfish, and even frogs are included - along with large schools of golden shinners (*Notemigonus chrysoleucas auratus)* fathead minnows (*Pimephales promelas promelas)* and the common white sucker *(Catostomus commersonnii c.)*. All of these provide a predator-prey balance, which is so essential in a display of this type. Rock work, logs and aquatic plants all play their own small but important role in providing the animals with concealment as well as territorial areas.

Lighting of the lake is completely artificial and is controlled with rheostats to illuminate the exhibit in a variety of intriguing ways. A year round temperature of 65 degrees F. is what we strive for, although in the summer months the water may climb as high as 80 degrees F. Filtering is accomplished with sand and gravel located in the basement with a follow-up diatomaceous earth filter polishing the water at the rate of 600 gallons per minute. Native fish for this display are supplied by the State of Wisconsin - Department of Natural Resources.

Another truly dramatic exhibit is the "Amazon River Display." Here we have tried to put together a typical section of shore from that great river in South America, displaying some 100 to 200 species of fish, including discus *(Symphysodon sp.)* stingrays *(Potamotrygidae)*, oscars *(Astronotus ocellatus)*, and cardinals *(Chirodon axelrodi)*, all swimming together along a section of river bank shrouded over by lush green jungle plants, with simulated broken sunlight filtering through to the water below. Holding over 8,000 gallons this display is approximately 40 feet long with a water depth of 4 feet. Two impressive waterfalls return 85 degree water to the exhibit from a sand and gravel filter in the basement. A filter rate of about 50 gallons per minute keeps the water crystal clear. In addition to displaying fish indigenous to the South American fauna, a few birds, reptiles, and amphibians also are included to help make this a very impressive ecological arrangement. This display is most attractive to the many tropical fish fanciers in the community.

A dozen smaller cage displays are along the wall. Here we find several species of aquatic turtles in a large, attractive, naturally-planted exhibit. The display is set up to give the animals the option of swimming in two feet of water or sunning themselves on the rocky shore. Numerous logs and live plants help make this display very popular with the children. Eleven of the cages contain the more popular and colorful non-poisonous snakes. A large corner cage contains King cobras *(Ophiophagus hannah)* with Green Mambas *(Dendroasips angusticeps)* occupying the adjoining cage and beginning a series of seven cages of the more impressive poisonous snakes.

At the opposite end of the building we exhibit the giant serpents in three large cages equipped with pools and special heating apparatus.

One hugh corner display contains American Alligators *(Alligator mississippiensis)*, and is planted to resemble a swamp scene. The public has an excellent view of the animals from anywhere along the 25-foot glass-enclosed front. A similar corner exhibit has a large grouping of various lizards. This is heavily planted, with a waterfall and pool worked into the artificial rock, providing the visitor a chance to pick out animals that have used their camouflaging abilities to the fullest.

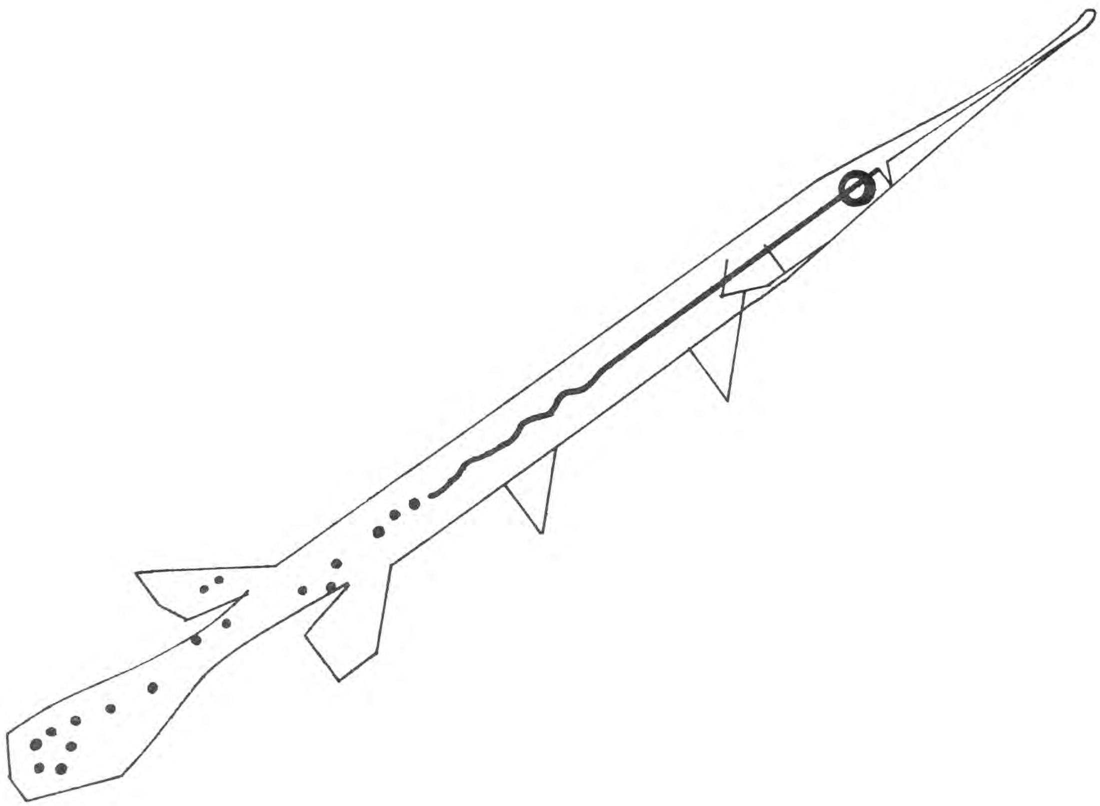
In each of six areas between the larger exhibits are 4 to 6 glass tanks, which can be removed. In these, we show a large number of small, brightly-colored coral fishes, with some of the rarer types of small reptiles and amphibians.

The dolphin display is located between the Amazon and alligator exhibits. Two Amazon River Porpoises (*Inia geoffrensis)* are companions to a three-foot giant river turtle (*Podocnemis expansa)*. Six floor-to-ceiling 2 1/4" thick glass plates, retaining over 50,000 gallons of water, expose the entire tank area to the public view. The floor of the tank slopes to the center, giving a maximum water depth of 12 feet, six feet of which is exposed above the public floor level. This display is the only one in the building not following a naturalistic theme. The public appreciates an unobstructed view of these amazing mammals - feeding, performing and being trained. Three 3,000-gallon holding tanks are located directly behind the main exhibit tank, each capable of being isolated from the main system. A sand and gravel filter with the option of using a D.E. filter as a polisher, keeps the water unbelievably clear. Water and air temperatures are held at 78 to 82 degrees F. the year round.

Flanking the porpoise display are two 150-gallon tanks. One is set up to display the radiantly beautiful lionfishes *(Pterois volitans)*, while the other has the famed Piranhas *(Serrasalminae)*.

Three separate rooms in the basement hold tanks and cages for surplus specimens. A reservoir of 65,000 gallons also is in the basement directly below the "Lake Wisconsin" exhibit. All water destined for fish use is stored here. City-treated Lake Michigan water passes through two carbon filters here, is heated to 60 degrees and pumped into the reservoir until needed.

A line or two expressing our sincere gratitude to those who helped make the building the success it is, with special thanks to Warren Wisby, Bill Braker and Earl Herald.



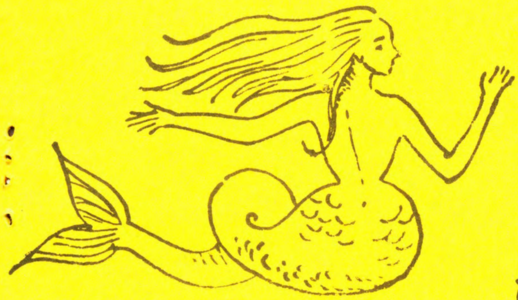
"AQUARIUM DESIGN CRITERIA"

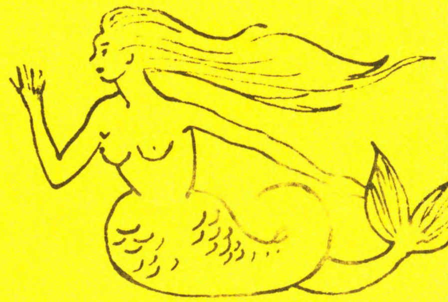
A special edition of DRUM AND CROAKER has been prepared by your editor, which includes contributions by others on specific subjects.

This volume of about 100 pages is primarily a correspondence aid, providing essential information to those planning public or other aquariums. It is not intended for the home aquarist. It details the "What" and "Why" of aquarium design - not the "How."

This DRUM AND CROAKER Special is available only for those who can best utilize it. Only a limited number of copies are in stock.

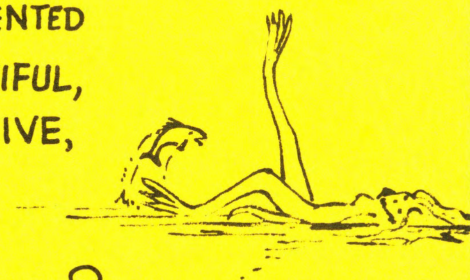
MYTH OR MYSTERY





The ELUSIVE MERMAID

SINCE TIME BEGAN, SEAFARING MAN HAS REPORTED SIGHTINGS OF MERMAIDS. HE'S DESCRIBED THEM, MADE DRAWINGS, PAINTINGS AND SCULPTURES-PRESENTED THEM IN INFINITE VARIETY; BEAUTIFUL, HOMELY, BEGUILING, TIMID, SECRETIVE, MOST WITH FISH-LIKE TAILS.



HAVE YOU SEEN A MERMAID LATELY?

Rex Schmidt
U. S. Fish and Wildlife Service