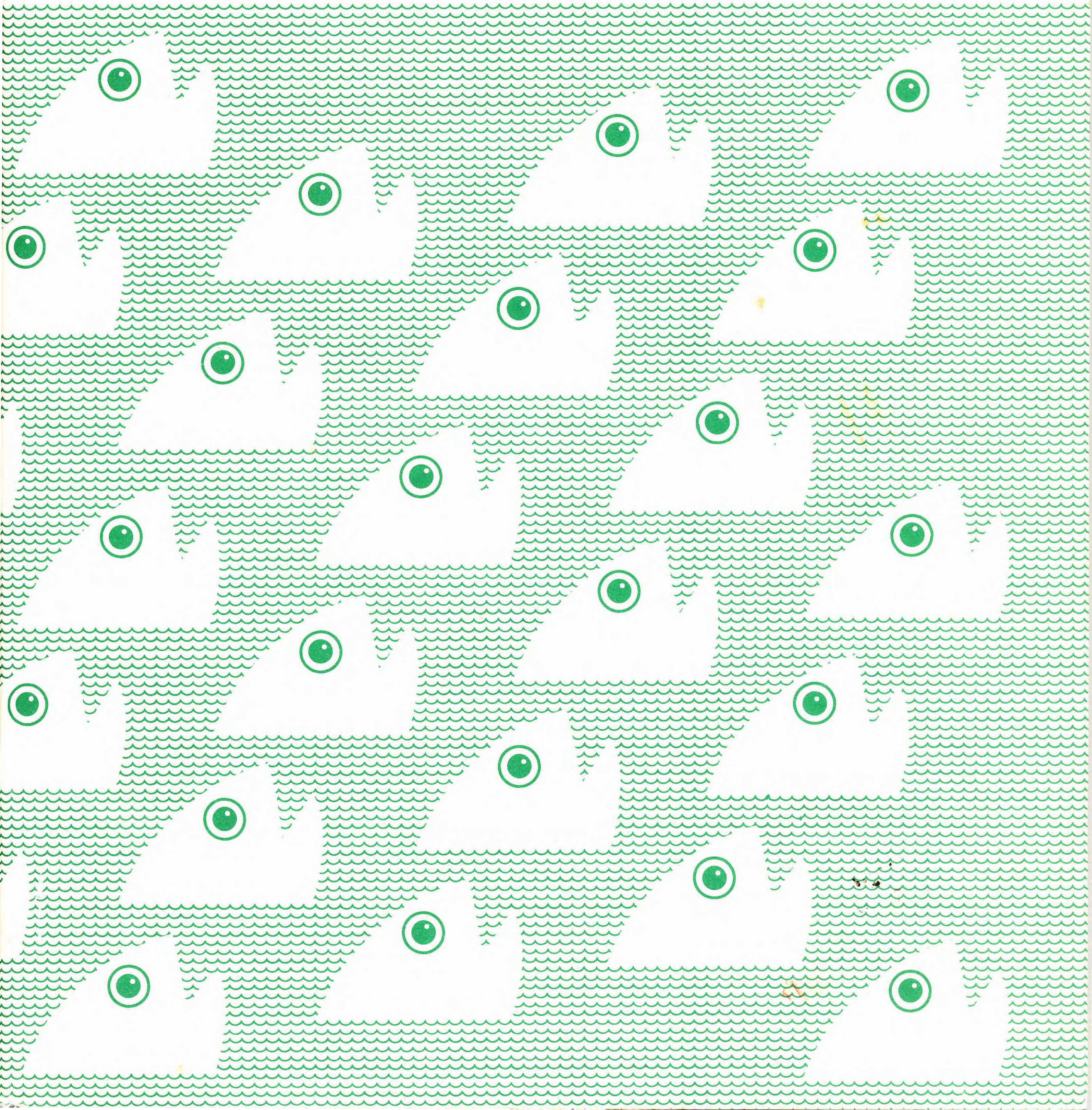
The DRUM and CROAKER

A Highly Irregular Journal for Public Aquariums and Oceanariums

Volume 20 (82)-Number 2
July 1982



ERRATA

Page 6, photo caption "Floating Basket" should read "Collecting Weir".

Page 9, photo caption "Collecting Weirs" should read "Floating Baskets".

DRUM & CROAKER

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In keeping with the spirit and purpose of the Drum and Croaker, manuscript material is reproduced with a minimum of editing and is not returned unless requested.

Spelling and classification are the responsibility of contributors.

This issue of Drum and Croaker was prepared by Stefani Hewlett, Editor, and Margaret Butschler, at

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Contributions for the January,1983 issue of Drum and Croaker will be accepted until November 15th,1982 and should be sent to the above address.

Funds for printing and mailing this issue were provided by a grant from The Vancouver Aquarium Volunteers. Their support of this endeavor is greatly appreciated.

GRUNTING & CROAKING

(also known as letters to the editor)

Dear Editor:

Congratulations on your first issue of DRUM AND CROAKER. The quality in cover, paper, printing and content is most excellent, which is normal for activities of the Vancouver Aquarium. However, if you continue along this vein I am sure that you will have to discard the plebeian, but venerable, title, DRUM AND CROAKER, and substitute something like THE JOURNAL OF AQUARIOLOGY. Perhaps this is what the readership wants.

While at the National Fisheries Center and Aquarium, now defunct, I was editor of DRUM AND CROAKER, with Craig Phillips, during '68, '69 and '70. As an unedited publication we produced articles and other content with some inadvertent errors in spelling, and with "cartoons of middling quality". These editions were easy-going but also included "gems of information", plus irreverent and irrelevant items. I concur in the remarks of David Miller that DRUM AND CROAKER "has become a bit too serious and has lost much of the spontaneous good humour and good will of its earlier days".

Having retired some eleven years ago, my piscatorial pursuits are somewhat limited, but I do enjoy reading of the research efforts in various journals, and I have particularly enjoyed DRUM AND CROAKER for its sometimes tongue-in-cheek articles and its informality.

Mine may be a lone cry in the wilderness of retirement, wishing for the good-old-days. Perhaps your subscribers who are active in the field will want a pure journal.

Regardless of my above comments, I do commend you and the Vancouver Aquarium for the excellence of your first issue.

William Hagen Jr.
1020 Poplar Drive
Falls Church, Virginia 22046

Dear Editor:

Many thanks for including me on your mailing list. The first issue contained a number of articles of interest, but the one which moved me to write was Dr. Hoar's reminiscences about the founding of the Vancouver Aquarium.

Having been a home aquarist some 15 years, I leaped at the opportunity to establish a small aquarium exhibit for the General Biology Program at the University of Tennessee, where I am employed as an Instructor in Biology. In two short years, this "living museum" has become quite popular among students at the Univeristy, and we have hosted tours from some of the local high schools. We are presently developing an exhibit entitled "Aquatic Ecosystems of the World" which will replace our current assortment of tanks with an integrated, permanent display of marine and freshwater habitats and their typical fauna and flora. Since both our space and our budget are small, we try to concentrate on the smaller, less well-known fish and invertebrates that the larger aquariums often do not exhibit. We hope this exhibit, together with two 200-litre marine exhibits featuring shallow water invertebrates of the temperate and tropical Atlantic, can be completed in time to open the museum to the public this summer during the 1982 World's Fair. It is my dream that our little museum can someday grow into a true public aquarium in Knoxville and the University. This is why Dr. Hoar's comments prompted me to write. I would appreciate hearing from your other readers who could take time from their busy schedules to write me with any insights they could provide as to how we can develop a public aquarium for Knoxville. Dr. Nelson Herwig, of the Houston Zoological Gardens, has already been most helpful. Thank you for your kind assistance.

My address is:

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Telephone : (615) 974-3354

P.S. If any of your readers are planning to visit the World's Fair, I would very much enjoy their visiting me at the University. UT is "next door" to the fair site.

Dear Editor:

I would like to make the readers of DRUM AND CROAKER aware of the activities of the Fish Culture Section of the American Fisheries Society. I think the activities and publications of the FCS could be of great benefit to aquarists.

The Fish Culture Section is the largest and probably most active section of the American Fisheries Society. We will soon have printed a new MEMBERSHIP DIRECTORY that will provide bibliographic data of great value when you need to contact others with similar interests. Our NEWSLETTER, printed each quarter, gives abstracts of a number of current publications, a question and answer service, and a calendar of upcoming events. Our new format will include information and announcements by contributing editors located in various areas of the country, giving much local news.

Each year we have an annual workshop which provides the attendees with the opportunity to meet persons with similar interests, to hear of pressing problems in fish husbandry, and to be brought up to date on new developments. Often the workshop is combined with another AFS section such as the Fish Health Section.

We would like very much for aquarists to join our group. Not only will they benefit personally but our interests will be broadened by their input. Our annual dues are only $4.00 to those who also belong to the American Fisheries Society. A complete brochure and membership application can be obtained from:

Beth Dawson

Membership Secretary

American Fisheries Society

5410 Grosvenor Lane

Bethesda, Maryland, 20814-2199

I want to commend you for printing the DRUM AND CROAKER. It has a practical approach that is very refreshing. The recent article <u>Copper Treatment: The Dark Side of the Story</u> by Carol E. Bower was exceptionally good and beneficial to all aquarists.

Keep up the good work.

Ivan B. McElwain

Chairman, Membership Committee

Fish Culture Section/AFS

P.O. Box 75

Lamar, PA 16848

JEFF MOORE, SUPERINTENDENT OF THE DALLAS AQUARIUM RETIRES

A colourful and varied career preceded the retirement of Jeffrey Moore in January of this year.

From 1936 to 1939 Jeff worked as a tropical aquarist at the Dallas Aquarium. Then, because he was a single and the most junior employee, he was fired when the depression years hit.

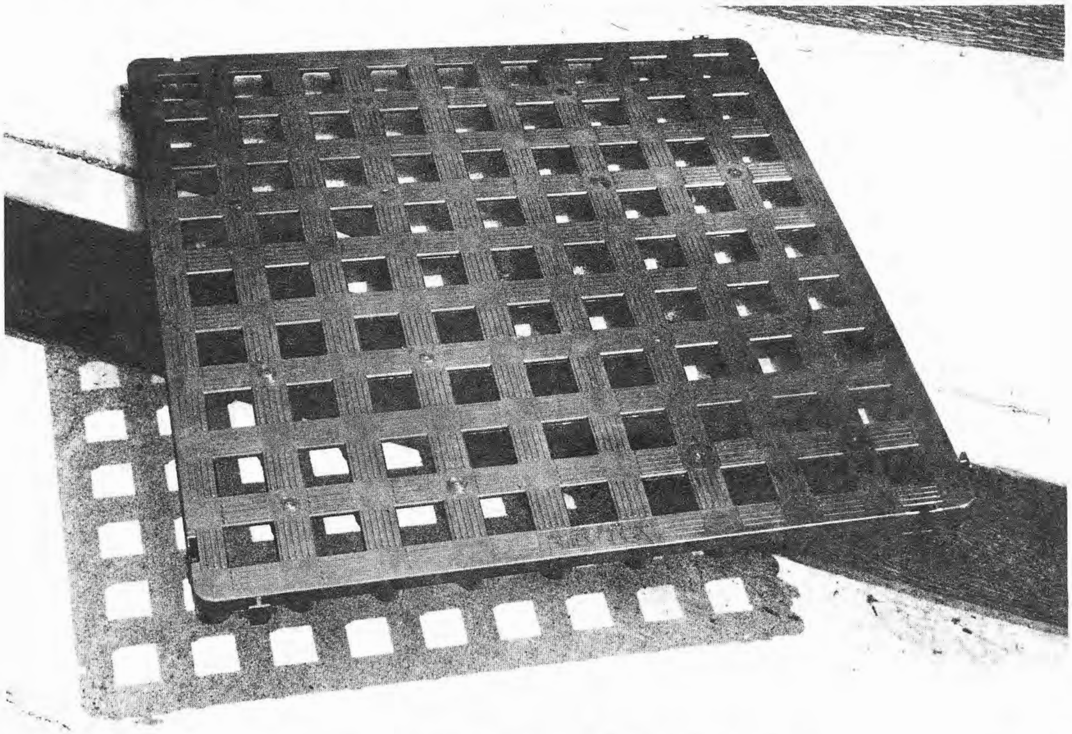
In the war years he saw duty as a Naval yeoman and photographer. This latter experience led to further photographic studies at the end of the decade and two years working in a camera shop.

From cameras to oil wells was the next step as Jeff took an office position with an oil well drilling company between 1954 and 1957.

Yet, after those years away, the Aquarium world still held a real fascination and Jeff Moore returned to the Dallas Aquarium, and stayed for 25 years. His contributions to that Aquarium are many including the development of a new Marine Wing and the improvement of the collection by raising the number of species exhibited from 151 to 348.

The Aquarium community wishes Jeff Moore and his wife Martha good luck on a new career devoted to travel, friends and hobbies.

Sub-sand Biological Filter



Floating Basket

INNOVATIVE IDEAS

K. GILBEY HEWLETT

CURATOR

VANCOUVER PUBLIC AQUARIUM

SUB-SAND BIOLOGICAL FILTERS

Materials for the armature of sub-sand biological filters have ranged from plastic "egg crating" used in flourescent fixtures to the saw cuts in corregated fibreglass panels (Spotte: "Marine Aquarium Keeping"). At the Vancouver Aquarium, we have come up with a couple of materials that work well for us. One is a plastic floor mat called VERSA-TILE that measures 49½ cm by 50 cm. It is raised up from the floor by plastic posts and has 4 cm square openings every 2 cm. Each piece interlocks with the other to make a mat of any size. It can be cut easily with a saw to conform with the shape of any tank. It is made by Universal Plastic Producers in Canada. The mat is covered with the conventional plastic fly screen before sand is added. We have used this mat material for several years now and have found it most successful. Another product that could be considered for the same use is HERONRIB, a plastic gridding available from Gerrard Oval Strapping Limited in Canada. It is 1.2 cm in depth compared to 2.2 cm depth on the VERSA-TILE.

FLOATING BASKET

One of the problems with limited reserve space for fish and invertebrates is how to sort and hold all the smaller species from the larger, predatory species. At the Vancouver Aquarium we use an inexpensive and efficient item: a small meshed, round laundry basket. We secure net floats for buoyancy, usually 10 cm below the lip of the basket to keep "jumpers" in. Such baskets can be floated in a single large reserve tank without worry of predation. It also allows for sorting according to species. The baskets stack easily when not in use. The smallest mesh available is, of course, the most efficient for the smallest species.

COLLECTING WEIRS

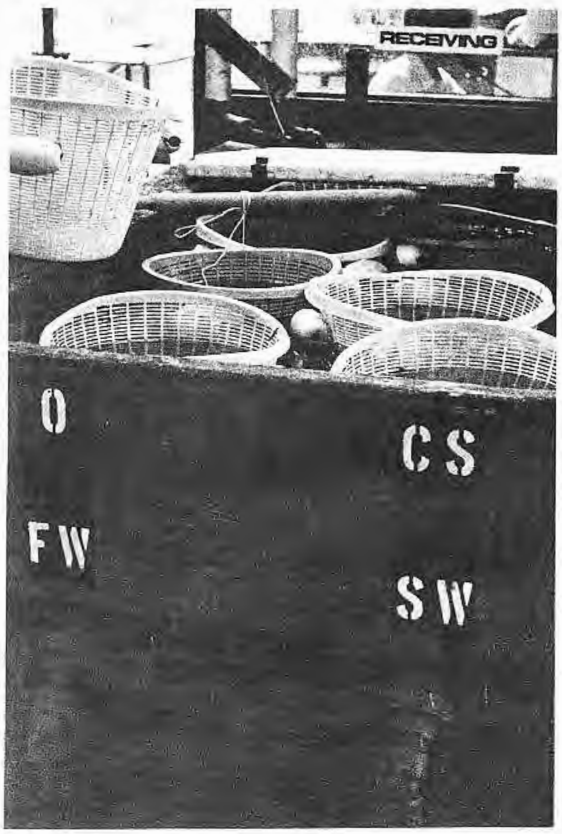
During collecting trips that last more than one day, the problem is the holding of the specimens. We find a simple holding weir made by the staff, inexpensive, portable and efficient. Basically, we obtain two plastic "hula hoops". 1 cm mesh netting is cut to fit around the two hoops which are placed about 30 cm apart. The netting is sewn along the sides and bottom. The top is left open with a long neck. Once the specimens are placed inside, the neck is secured with twine. A small weight is tied to the bottom, small diameter rope ties the weir to a wharf or boat. A plastic tag can be written on and attached for identification to facilitate the addition of further specimens. Because of flotation in the hoops, the weir never collapses. However, out of water they neatly collapse and can be compressed in a relatively small space.

MAKING RESERVE SPACE, WHERE NONE EXISTED BEFORE

We have a 144,000 litre tank with lemon sharks, nurse sharks, great grouper and alligator gars. For years we have wanted to renovate the tiled "bathtub" look of this tank but one thing stopped us: where to put these huge fish! We lacked a large reserve tank to hold them and we lacked the funds to fabricate a "swimming pool" type reserve with all the intrinsic piping and filters. Then our Chief Engineer, John Rawle, hit on a brilliant idea. The shark tank reservoir, below the basement level, held 160,000 litres and was 13.4 m x 4.26 m x 3.3 m in depth. However it was only accessible by a manhole. A section was cut, leaving a 2.4 m x 1.2 m hole in the concrete flooring above the tank. Auxiliary lighting was installed, plus a provision was made for night lighting.

At a relatively inexpensive cost, we created a huge reserve tank overnight. The fish were moved to the holding tank with relative ease and adjusted well to it for the month of renovations. Also, we now have a permanent reserve tank for any emergency.

Collecting Weirs



Reserve Space!

INTESTINAL OBSTRUCTION IN AN ANACONDA , *EUNECTES MURINUS*, CAUSED BY THE INGESTION OF PLASTIC PLANTS

Aquatic Research Institute Contribution No.

AR182-01

by

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Introduction

The use of plastic plants to simulate natural habitats in public aquaria and zoo dioramas is a common practice. In contrast living plants that do not always adapt to artificial culture; simulated aquatic plantlife permits the permanent construction of the native flora of natural habitats. Live plants used in displays also have the disadvantage of being destroyed by the captive animals that utilize them as a food source. Plastic plants have advantages of easy maintenance, no organic decay, and resistance to destruction by most animals.

Simulated plant use is not however, without potential hazards. Depending on the quality of the plant and method of attachment to the substrate, pieces of leaves and stems, as well as entire strands can detach, often forming a surface mat on the water. Accidental ingestion of any portion of the plants can lead to intestinal obstructions, particularly if the animal is a surface feeder or seizes and swallows its food whole.

The following case report documents an intestinal obstruction in a captive South American anaconda that died in 1979 at the Steinhart Aquarium. The cause of death was confirmed as an intestinal obstruction with secondary enteritis resulting from the accidental ingestion of plastic plants.

Case Report

An adult, female anaconda *Eunectes murinus*, weighing approximately 65 kilograms and measuring 4.3 meters was submitted for a post-mortem on September 7, 1979 to the Steinhart Aquarium Laboratory. The snake had been maintained in an aquatic diorama with various species of South American fishes.

Two weeks prior to death, the aquarium herpetologist had reported the occurrence of some abnormal behaviour. During the week of August 6th, the snake was observed with it's mouth agape for extended periods of time. A possible respiratory infection was ruled out after a clinical examination of the animal. On the basis of the examination, it was concluded that the observed behaviour was caused by the shedding process that had begun earlier in the week. However, a few days after the examination, the snake's condition worsened, and it began to exhibit signs of weakness and anorexia. During the week of August 13, an aquarist reported to aquarium officials the presence of plastic plants in the animals feces. On August 31, the animal was found dead in the diorama and was subsequently placed in cold storage for necropsy.

Results

Upon necropsy the snake was found normal in external appearance without any lesions or irregularities on the body surface. The lungs appeared normal and no parasitic fauna were noted. The heart was enlarged, with the presence of coalesced white foci of unknown etiology over the heart surface. The coronary vessels were normal. The liver and spleen were enlarged, but otherwise appeared normal upon gross examination. The kidneys also appeared normal with no visible pathology.

The anaconda was confirmed as a female with 59 round yolk masses, approximately 50 mm in diameter, recovered from the reproductive tract.

An obstruction was present in the colon, 25 cm anteriorly to the cloaca. The obstruciton was composed primarily of two plastic branches of simulated *Ludwigia*, and measured 17 and 20 cm in lenth. The obstructed area was characterized by mucosal congestion and gastroenteritis, with the accumulation of fluid and solid fecal material anteriorly, and within the obstruction.

Excess fatty deposits in the visceral cavity were noted during the examination, but were considered normal due to the presence of the large number of eggs.

Discussion

Partial or complete intertinal obstructions in reptiles can originate from the proliferation of parasitic fauna, neoplasia, or the ingestion of foreign materials. Foreign body ingestion is often accompanied and complicated by enteritis, endotoxic shock and the development of secondary microbial infections (Wallach, 1969). The formation of hard intestinal fecal masses in snakes can also originate from improper diets and insufficient exercise (Frye, 1973).

The clinical findings in this report indicates the potentially hazardous nature of utilizing plastic plants in reptilian and/or aquatic dioramas. It certainly underscores the need for closer observations of snakes and other reptiles during feeding to insure against the

accidental ingestion of foreign objects. The diorama in which the anaconda was maintained was densely planted; oftentimes portions of the plants would detach forming a surface mat. It is postulated that floating plants were accidentally ingested during one of the feeding periods. After ingestion the foreign objects passed through most of the gut unimpeded, but were eventually retained in the lower intestine as a partial obstruction; later becoming a complete obstruction.
The death of the anaconda could have been avoided by a more thorough physical examination and by the use of radiography. Radiography of the anaconda would have confirmed the ingestion of the suspected foreign body.

LITERATURE CITED

Frye, F.L. 1973. Husbandry, Medicine and Surgery in Captive Reptiles. VM Publishing Inc., Bonner Springs, Kansas.

Wallach, J.D. 1969. Medical Care of Reptiles. J. Amer. Vet. Med. Asso. 155(7):1017-1033.

ACKNOWLEDGEMENTS

The authors thank Dr. Steven M. Schuchman D.V.M. of the Boulevard Pet Hospital, Castro Valley, California for reviewing the manuscript.

LEGENDS FOR FIGURES

Figure 1. Simulated *Ludvigia* used in the South American diorama at Steinhart Aquarium.

Figure 2 Complete obstruction of lower intestine resulting from ingestion of plastic plants.

Figure 3 Exposure of plastic plant obstruction during necropsy of anaconda.

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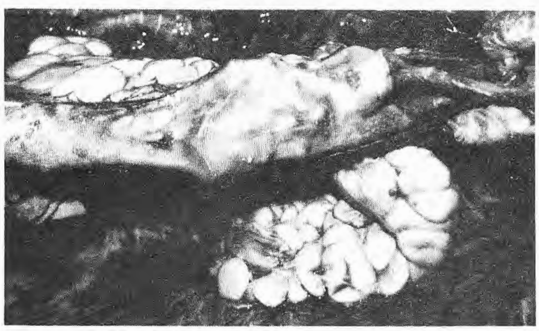

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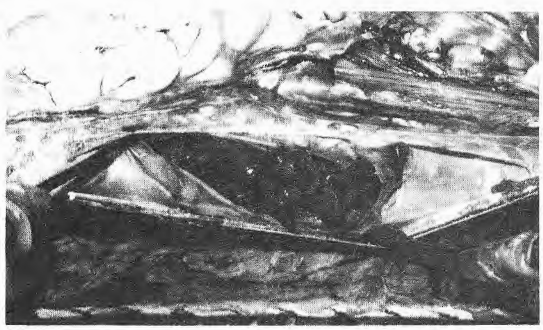


DEATHS OF AQUARIUM-HELD FISHES CAUSED BY MONOGENETIC TREMATODES II *GYRODACTYLUS* SPP. ON *FUNDULUS HETEROCLITUS* (LINNAEUS)

Adrian R. Lawler
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

During my training at the Virginia Institute of Marine Science at Gloucester Point, Virginia, in the 1960's I became acutely aware of "worm power". The common mummichog, *Fundulus heteroclitus* (Linnaeus), was used in display tanks and for various experiments. One of my jobs was to analyze various fishes and treat affected ones for external parasites.

On 10 April 1964 I examined several *F. heteroclitus* which were dying in an outside 4000 gallon concrete tank. The fish were being held by Morris Roberts of the Pollution Department for various experiments. Examination revealed numerous specimens of *Gyrodactylus* spp. on the fins and skin of the fish. One quart of full strength formalin was added to the tank - to give a concentration of 1:16,000 - and when checked two days later the fish were free of *Gyrodactylus*.

Prior to the formalin treatment, I preserved a few of the fish in order to ascertain how many *Gyrodactylus* it would take to kill certain size fishes. From one fish 43 mm long (TL) 1643 worms were recovered, an average of 38 worms per mm TL of the fish. Only a portion (229) of the worms were stained and mounted. Most of the worms were *Gyrodactylus prolongis* Hargis, 1955; a few were *G. stephanus* Mueller, 1937. These parasites were reported from Virginia by Dillon and Lawler (in Dillon, 1966).

On another occasion I held some *F. heteroclitus* in a 10 gallon aquarium from 27 May to 2 July 1970. One fish examined (85 mm TL) when it was near death had 2234 *Gyrodactylus* spp. on its skin, an average of 26 worms per mm TL of the fish. Again, most of the worms were *G. prolongis*. In this case, it took 36 days for the worms to increase to a lethal level.

Two main points of interest come to mind. (1) that this species can support such a large number of worms prior to death; and (2) that although two species of *Gyrodactylus* were present, *prolongis* was much more abundant. Assuming that the worms averaged 300 microns long, then on the 43 mm TL fish the worm would equal about 1/143 of the TL of the host. This would be somewhat similar to a 1.43 m human being having 1643 leeches on his skin about 1 cm long each!! It's no wonder highly infested fish are severely stressed and die. More *prolongis* could indicate that either it has a higher reproductive rate or is a better competitor than *stephanus*.

Presently, I raise various organisms for use in toxicity tests and parasitological life-cycle studies - one being *Fundulus grandis* Baird and Girard, which commonly carries the same two worms. In order to prevent transfer of *Gyrodactylus* to the young fish (eggs are manually stripped), we treat adults with 1:4000 formalin for about one hour.

I suggest that any fish which is a natural host for *Gyrodactylus*, and is to be used in display tanks, long-term experiments, or spawned, be treated with 1:4000 formalin. Recently caught fish should be held several days prior to treatment in order to avoid additional stress which might lead to death. Any abnormal behaviour of fish could indicate external worms, the most common sign being "scratching" on objects in the tank or the tank bottom.

LITERATURE CITED

Dillon, W.A. 1966. Provisional list of parasites occurring on *Fundulus* spp. Va. J. Sci. 17(1):21-31

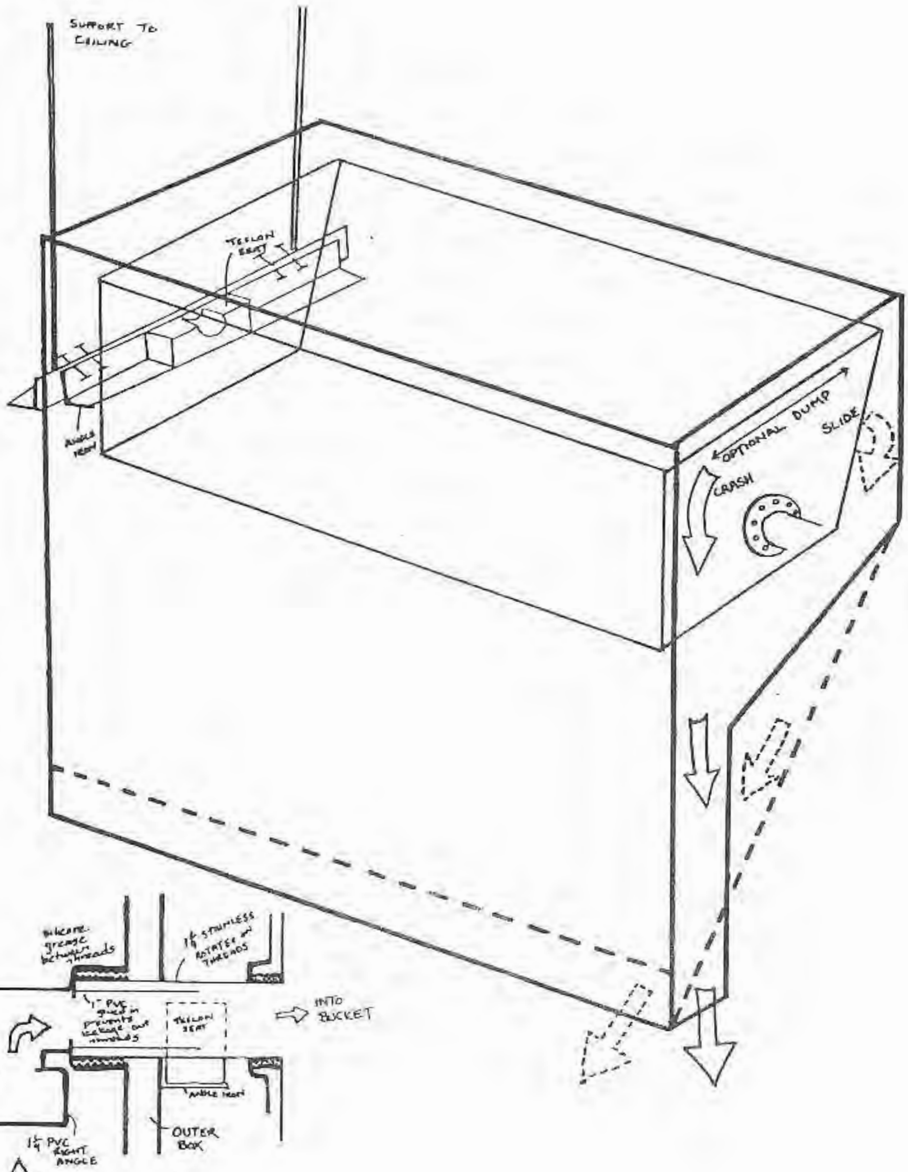
SON OF DUMP BUCKET

Paul Sieswerda, Assistant Curator
&
John Dayton, Tropical Aquarist
New England Aquarium

In the 1979 winter issue of Drum and Croaker Vol. 19(79) number 2 pp. 9-10, we recounted the success we had with a particular design for a wave action mechanism and suggested its application in other biological and exhibit areas. Since that time we have used this mechanism in various proportions on our coral display, coral holding, wave tank and have plans for implementing the principle on a reef display to achieve a surf zone effect. The interest which Dr. Walter Adey sparked with his work on corals at Smithsonian, incorporating dump buckets in the system, has paralleled efforts at public aquariums. Since each construction here had led to innovations, we felt their description might be helpful to those who have interest in such a project. One of the first design changes made in the evolution of the buckets here, was the containment of the spray from the drips slung off from the spin of the bucket. Our first containment was a simple shield of PVC sheet stock. We have now built a GPX box around the whole mechanism which keeps everything neat and dry. Because so many visitors behind the scenes have had interest in this mechanism, we installed the rear panel with plexi-glass to serve as a demonstration. The angle of the chute can allow different impacts to the water from "Crash" straight down to "slide" along the surface.

Another innovation was the development of a moveable connection which allowed the fill line to be incorporated through the containment chamber and pivot support. We find this a neater arrangement than a fill line separate from the pivots since the pipe sizes all match (at least in this case). (see diagram)

One caution we would make is to remember to beef up the support to the glass area on any tank with a substantial wave. (No, we didn't learn that the hard way!). Fiberglass angle has replaced the original aluminum as hangers for the pivots and is built right onto the containment chamber. This in turn, is fastened to the ceiling. Some day we may build the whole thing out of fiberglass and submit the description to Drum and Croaker as "The Return of the Dump Bucket" or "More Than You Ever Wanted to Know About Dump Buckets".



THE ABILITY OF TWO COMMERCIAL FILTRANTS TO REMOVE VARIOUS INORGANIC METABOLITES AND CHEMOTHERAPEUTIC AGENTS FROM FRESH WATER AND SEAWATER

by

David T. Turner and Carol E. Bower

Sea Research Foundation

Institute for Aquarium Studies

968 Capitol Avenue

Hartford, Connecticut 06106

ABSTRACT

Two commercial filtrants, Poly-Filter[R] (PF) and Chemi-Pure[R] (CP), were tested for their ability to remove various inorganic nitrogenous compounds and organic and inorganic chemotherapeutic agents from fresh water and seawater in recirculating systems. Neither product reduced the concentrations of ammonia, nitrite, or nitrate added to seawater, but CP removed 86% of the ammonia, and PF removed 10% or less of the added nitrite and nitrate from fresh water. Both filtrants removed unchelated copper (copper sulfate) from fresh water and seawater, but only PF substantially decreased the concentrations of chelated copper from a commercial formulation (CopperSafe[R]). PF and CP removed approximately 10% and 100%, respectively, of methylene blue, whereas both filtrants effectively removed malachite green from aqueous solution. High percentages of malachite green were also removed in control systems, which contained no synthetic adsorbents, ion-exchange resins, or activated carbon.

INTRODUCTION

Several commercial filter media are being marketed aggressively for the purification of aquarium water. According to the manufacturers' claims, they are capable of removing a variety of inorganic and organic substances, including dissolved inorganic nitrogen and most medications, from solution. The following investigation was conducted to determine the ability of two commercial filtrants, Poly-Filter^R and Chemi-Pure^R, to remove ammonia, nitrite, nitrate, chelated and unchelated copper, methylene blue, and malachite green from fresh water and seawater.

MATERIALS AND METHODS

The filtrants tested were Dick Boyd's Chemi-Pure^R (Boyd Enterprises, Miami, FL) and Poly-Filter^R (Poly-Bio-Marine Inc., South Orange, NJ). Chemi-Pure^R (CP) is described as a mixture of three ion-exchange resins and activated carbon (Anonymous, 1979). According the manufacturer, CP removes ammonia and other nitrogenous waste products, copper and other metal ions, phenol, "colours, odors, and all pollution" from fresh water and seawater. Poly-Filter^R(PF) is described by the manufacturer as a "hydrophilic/hydrophobic terpolymer absorbed in a synthetic matrix", which selectively absorbs and adsorbs ammonia, nitrite, nitrate, phosphate, phenol, dissolved organics, copper and other metals, organic dyes, antibiotics, and insecticides from fresh water and seawater. The material is claimed to "activate" when ammonia, nitrite and nitrate concentrations equal or exceed 0.3, 1.0 and 15 to 20 mg/L, respectively.

The recommended usage for CP is one unit (wet weight approximately 300 g) for filtering up to 40 gal (152 L), or approximately 2.4 g CP/L. One unit of PF (dry weight approximately 37 g) is recommended for filtering 60 to 70 gal (234 to 265 L); this is equal to about 0.15 g PF/L. The quantities of CP and PF used in the present study were 8.3 and 3.0 g/L, respectively, thus exceeding the manufacturers recommendations by factors of about 3.5 and 20, respectively.

Experimental Procedures

The filter materials were weighed and then transferred to cylindrical plastic bottom-filter boxes 7.5 cm in diameter and 5.5 cm high. In addition to the respective filtrants (25 g of CP or 9 g of PF), 50 cm^3 of crushed glass and two layers of polyester fiber were also placed in each filter box, the former to prevent the box from floating and the latter to keep the crushed glass and filtrants in place. The experimental systems were 3.8 L capacity glass jars. The jars were filled with 3.0 L of either (1) artificial seawater, prepared by dissolving Instant Ocean® sea salts (Aquarium Systems, Mentor, OH) in tap water ($\underline{S}$ = 30 ‰), or (2) tap water (total hardness = 16 to 24 mg/L; total alkalinity = 7 to 11 mg/L). Immediately before each experimental trial began, the water in the jars was spiked with measured amounts of ammonia, nitrite, nitrate, copper, methylene blue, or malachite green. The ammonia, nitrite and nitrate solutions were prepared with reagent grade ammonium sulfate, sodium nitrite, and sodium nitrate, respectively. The copper solutions were prepared with reagent grade copper sulfate or with Saltwater CopperSafe® (Mardel Laboratories, Inc., Villa Park, IL), the latter being a chelated form of copper. The methylene blue solutions were prepared from a 2.303% commercial solution (Hill's Kordon, Hayward, CA), and the malachite green solutions were prepared with a chloride salt of malachite green (provided by Aquascience Research Group, North Kansas City, MO). Each trial for removing ammonia, nitrite, nitrate, and unchelated copper employed six jars, two containing box filters packed with CP, two with PF, and two controls. The box filters in the control jars contained only crushed glass and polyester fiber. In the experiments involving the removal of chelated copper, methylene blue, and malachite green, duplicate jars in an additional control group contained box filters packed with 10 g of granular activated carbon (Breedmore Aquarium Products Ltd., Shohola, PA). crushed glass, and polyester fiber; this group was used to compare the performance of the test filtrants with that of activated carbon, alone.

All experiments were carried out at ambient temperature (25 to 27^{o}C). At $\underline{t}$ = 0 the packed box filters were submerged in the water-filled jars and then connected with flexible tubing to a supply of compressed air. Turnover rates were not measured, but air flow was adjusted to produce equally vigorous bubbling from each of the filter boxes. After 19 to 21 h (time constant for all jars in a given trial), aeration was stopped and duplicate water samples were collected from each jar and analyzed immediately.

Water analysis

Total ammonia-nitrogen (NH_4-N) was determined by the salicylate-hypochlorite method (Bower and Holm-Hansen, 1980) for seawater samples, and by the phenol-hypochlorite method (Solorzano, 1969) for freshwater samples. Nitrite-nitrogen (NO_2-N) was measured by the diazotization method (Strickland and Parson, 1977), and nitrate-nitrogen (NO_3-N) was measured by a modified hydrazine-reduction method (Bower and Holm-Hansen,1981). Total dissolved copper(Cu_T) was measured by the modified cuprethol method (American Public Health Assoc. et al., 1965). Concentrations of methylene blue and malachite green were determined by comparing the absorbances of the water samples (at wavelengths of 609 and 668 nm for methylene blue, and at 617 nm for malachite green) with values on standard curves. All of the above measurements were performed with a

Turner Model 380 spectrophotometer (Turner/AMSCO Instrument Co., Carpenteria,CA). The pH values of the water samples were determined with an Orion Model 501 pH meter (Orion Research Inc., Cambridge,MA) using a glass pH electrode and a double-junction reference electrode with saturated KCl in the outer chamber. Salinity was measured with an AO Model 10419 hand refractometer (American Optical Corp., Buffalo, NY).

RESULTS AND DISCUSSION

Removal of Inorganic Nitrogen

Neither Chemi-Pure^R nor Poly-Filter^R reduced the concentrations of NH_4-N, NO_2-N, or NO_3-N in seawater (Tables 1 through 3). In freshwater however, CP decreased the concentrations of NH_4-N by an average of 86% (Table 1), and PF decreased the concentrations of NO_2-N and NO_3-N by averages of 10% and 7% respectively (Tables 2 and 3). The failure of Chemi-Pure^R to remove inorganic nitrogen from seawater is not surprising, in the light of the composition of this product. Free ammonia and ammonium, nitrite, and nitrate ions cannot be removed from aqueous solution by physical or chemical adsorption on activated carbon. Moreover, the process of ion exchange, in which natural or synthetic materials with electrochemical charges remove ions from water by exchanging them for other ions carrying the same charge, decreases sharply in water of high ionic strength, such as seawater (Johnson and Sieburth,1974). The reason for this is competition between the contaminant ions and similarily charged ions in the water for exchange sites on the ion exchanger: the higher the concentration of competing ions, the less likely it becomes that the contaminant ions will be removed from solution.

Natural and synthetic ion exchangers perform well in freshwater, when ionic competition is low, and they have been used extensively for the removal of ammonia from wastewater and culture water, and of nitrate from wastewater (see Spotte, 1979, for a review). The removal of nitrite from aqueous solution by ion exchange has not been studied. The test conditions in the present study were more favourable for ion exchange than they would have been if tests had been conducted with water from a stocked aquarium. Because neither live animals nor decaying food were involved, the amount of organic matter in the water, which is known to impede ion exchange (Johnson and Sieburth, 1974: Jorgensen et al., 1976) was restricted; moreover, the ratio of filtrant weight to water volume was well in excess of the manufacturer's specification for optimum performance. The reasons for the failure of Poly-Filter^R to remove dissolved inorganic nitrogen cannot be speculated upon, because of the proprietary nature of the product. It is noteworthy, however, that no published studies have demonstrated the removal of ammonia, nitrite, or nitrate from aqueous solution by synthetic polymeric adsorbents.

Removal of Copper

Both Chemi-Pure^R and Poly-Filter^R decreased the concentrations of Cu_T (copper sulfate) in fresh water and seawater by averages of 91 to 98% (Table 4). Substantial amounts of Cu_T were also removed in the controls, particularly when seawater was the solvent. This observation is consistent with the report of Keith (1981) that unchelated copper is removed rapidly from solution by adsorption on solid substrates, including activated carbon and silica, the latter having similar surface properties to those of glass.

It should be pointed out that the initial concentration of copper tested was approximately 10 times higher than that which is recommended for the treatment of fish diseases. Because the rate at which a substance such as copper is adsorbed from solution depends strongly on its initial concentration, with the rate of adsorption increasing as the initial concentration increases (Barrow, 1966), one would not expect therapeutic dosages of unchelated copper to be removed as rapidly as higher concentrations. It has, in fact, been found that only 36% and 73% of Cu_T is removed by recirculation for 24 h through PF and CP, respectively when the initial concentration of Cu_T is only about 0.26 mg/L (R.E. Keith, personal communication).

Poly-Filter^R removed greater than 90% of chelated copper (CopperSafe^R) from both fresh water and seawater; in contrast, the amounts removed by CP and the crushed-glass and activated-carbon controls were considerably lower (Table 5). The percentages of chelated copper removed in the present study by activated carbon were considerably higher, than those reported by Keith (1981), who found that only 1% of the copper in CopperSafe^R was removed from seawater after 48 h. R.E. Keith (personal communication) has also observed that PF and CP remove only 55% and 5%, respectively, of the Cu_T for CopperSafe^R in seawater after 24 h of recirculation. The discrepencies among our findings and those of Keith probably reflect differences in experimental conditions, particularly the pH values, ratios of filtrant weight to water volume, and turnover rates, along with variations in the specific capacities of the individual packages of the commercial filtrants and activated carbons to adsorb copper.

Removal of Methylene Blue and Malachite Green

Chemi-Pure[R] and granular activated carbon removed 100% of the methylene blue from fresh water and seawater, whereas Poly-Filter[R] reduced the concentrations by only 8 and 11 %, respectively; nine percent of the methylene blue was removed in the freshwater controls, and 5 % in the seawater controls (Table 6). CP, PF, and activated carbon removed 97 to 100% of the malachite green from fresh water and seawater, but similarly high reductions also occurred in the controls (Table 7). Based on these findings, it is difficult to evaluate how much of the malachite green was removed by the test filtrants and how much by adsorption on the crushed glass, polyester fiber, and the glass walls of the jars. It was observed, however, that the water in the jars containing activated carbon and CP became completely decolourized after only a few hours of recirculation, whereas the colour of the water in the control jars and the jars containing PF diminished very slowly throughout the experimental period. This suggests that activated carbon is highly effective in removing organic dyes, such as malachite green, from culture water. Adams and Spotte (1980) reported that the concentration of total organic carbon in water from a marine mammal pool was reduced by 37% after only 10 min of contacting with granular activated carbon.

Effects of Commercial Filtrants on pH

Although the manufacturers of PF and CP claim that the products remove acids from water, the abilities of the filtrants to maintain a constant pH were not tested. At the conclusion of each experimental trial, however, the pH values of water samples from each jar were measured to determine if any changes in pH had been produced by the filtrants. The mean pH values of fresh water (14 samples) and seawater (16 samples) circulated through the controls, PF, and CP, and of fresh water and seawater (6 samples) circulated through activated carbon are given in Table 8.

Poly-Filter[R] caused a slight increase (0.04 pH unit) in the pH of both fresh water and seawater, as compared with control values, and Chemi-Pure[R] increased the pH of fresh water by 0.53 pH unit, but did not alter the pH of seawater. It was also observed that the addition of CopperSafe[R] at the recommended dosage raised the pH by approximately 0.5 pH unit in fresh water, and by about 0.2 pH unit in seawater. It was not determined whether any of the above effects on pH were transient or of long duration.

CONCLUSIONS

Our findings indicate that neither of the commercial filtrants tested can control the accumulation of ammonia, nitrite, or nitrate in seawater aquariums. CP removes ammonium from fresh water, as do clinoptilolite (a naturally occurring zeolite mineral) and a variety of synthetic ion-exchange resins (Breck, 1974; Johnson and Sieburth, 1974). The ammonium-exchange capacity as compared with that of other ion exchangers, is not known. Both PF and CP could conceivably provide surfaces for the attachment of nitrifying bacteria, and in this respect they might contribute to the removal of ammonia and nitrite in established culture systems. In fact, the manufacturer of PF specifies that the filtrant be installed only after the conditioning of a new aquarium is complete.

Both PF and CP might be useful for accelerating the removal of copper sulfate from treated culture systems. Only PF, however, proved effective in removing the chelated form of copper present in CopperSafe[R] from recirculated water; this function appears to be the major attribute of the filtrant.

The removal of methylene blue and malachite green was tested because both dyes are organic compounds that are frequently used in the treatment of fish diseases (Herwig, 1979). Our results indicate that activated carbon, a constituent of CP, is superior to the polymeric adsorbent in PF for removing such chemotherapeutic agents from culture water. The removal of other types of dissolved organic matter (e.g. antibiotics, humic substances, etc.) was not evaluated. It is reasonable to assume, however, that the performance of CP would be similar to that of activated carbon alone, even though there are differences in the capacities of various carbons to adsorb the same and different substances from waters of different compositions (Adams and Spotte, 1980). The ability of the polymeric adsorbent in Poly-Filter^R to remove other categories of organic substances from water is not subject to speculation because its composition is proprietary. It has been observed, however, that the performance characterics of various synthetic adsorbents differ greatly (Van Vliet et al., 1980; van Vliet and Weber, 1981; Suffet et al., 1978), and it has also been found that synthetic polymeric adsorbents are less effective in decreasing the content of total organic carbon in sea-water than in fresh water (Spotte and Adams, 1982).

ACKNOWLEDGMENTS

We thank Randy E. Keith of Ohio State University and Stephen Spotte of Sea Research Foundation, Mystic Marinelife Aquarium, for their critical reviews of the manuscript.

The use of trade names does not imply endorsement of the named products by Sea Research Foundation, Inc., nor criticism of similar products not mentioned.

Table 1. Removal of NH_4-N from fresh water and seawater by recirculation through Poly-Filter[R] and Chemi-Pure[R]. Initial concentration ~ 1.0 mg/L.

Filtrant	Fresh water		Seawater	
	Concentration (mg/L)	Percent difference from control	Concentration (mg/L)	Percent difference from control
Control	1.05	-	0.813[a]	-
Poly-Filter[R]	1.00	-5	0.826	+2
Chemi-Pure[R]	0.149	-86	0.807	-1

[a] The artificial sea salts used to prepare the seawater contained up to 0.2 mg NH_4-N/L. The difference between the spiking concentration and the concentration of NH_4-N in the control was attributed to oxidation by nitrifying bacteria known to be present in the mixing tank and therefore in the seawater used in these trials.

Table 2. Removal of NO_2-N from fresh water and seawater by recirculation through Poly-Filter[R] and Chemi-Pure.[R] Initial concentrations ~ 0.1 and 3.0 mg/L.

Filtrant	Fresh water		Seawater			
	Concentration (mg/L)	Percent difference from control	Concentration (mg/L)	Percent difference from control	Concentration (mg/L)	Percent difference from control
Control	3.15	-	0.109	-	3.05	-
Poly Filter[R]	2.85	- 10	0.110	+ 1	3.05	0
Chemi-Pure[R]	3.14	0	0.110	+ 1	3.04	0

Table 3. Removal of NO_3-N from fresh water and seawater by recirculation through Poly-Filter^R and Chemi-Pure.^{R} Initial concentrations ~10 mg/L and 7.5 mg/L for fresh water and seawater, respectively.

Filtrant	Fresh water		Seawater	
	Concentration (mg/L)	Percent difference from control	Concentration (mg/L)	Percent difference from control
Control	10.05	-	7.63	-
Poly-Filter^R	9.32	- 7	7.53	- 1
Chemi-Pure^R	10.18	+ 1	7.49	- 2

Table 4. Removal of copper sulfate from fresh water and seawater by recirculation through Poly-Filter^R and Chemi-Pure^R. The initial concentrations were 1.95 mg/L and 2.22 mg/L total dissolved copper for fresh water and seawater, respectively.

Filtrant	Fresh water		Seawater	
	Concentration (mg/L)	Percent removed	Concentration (mg/L)	Percent removed
Control	1.35	31	0.400	82
Poly-Filter^R	0.033	98	0.040	98
Chemi-Pure^R	0.041	98	0.205	91

Table 5. Removal of CopperSafe^R from fresh water and seawater by recirculation through Poly-Filter^R and Chemi-Pure^R. The initial concentrations of total dissolved copper were 2.15 and 2.11 mg/L for fresh water and seawater, respectively.

Filtrant	Fresh water		Seawater	
	Concentration (mg/L)	Percent removed	Concentration (mg/L)	Percent removed
Control	2.08	3	2.34	0
Poly-Filter^R	0.198	91	0.110	95
Chemi-Pure^R	2.01	7	1.79	15
Activated carbon	1.91	11	1.74	26

Table 6. Removal of methylene blue from fresh water and seawater by recirculation through Poly-Filter^{R} and Chemi-Pure^{R}. The initial concentrations were 5.29 and 5.40 mg/L for fresh water and seawater, respectively.

	Fresh Water		Seawater	
Filtrant	Concentration (mg/L)	Percent removed	Concentration (mg/L)	Percent removed
Control	4.79	9	5.11	5
Poly-Filter^{R}	4.88	8	4.82	11
Chemi-Pure^{R}	0.001	100	0	100
Activated carbon	0	100	0	100

Table 7. Removal of malachite green from fresh water and seawater by recirculation through Poly-Filter^{R} and Chemi-Pure^{R}. The initial concentrations were 2.97 and 3.01 mg/L for fresh water and seawater, respectively.

	Fresh water		Seawater	
Filtrant	Concentration (mg/L)	Percent removed	Concentration (mg/L)	Percent removed
Control	0.319	89	0.074	98
Poly-Filter^{R}	0.087	97	0.041	99
Chemi-Pure^{R}	0	100	0	100
Activated carbon	0	100	0	100

Table 8. Mean pH values (ranges given in parenthesis) of fresh water and seawater recirculated through Poly-Filter^{R}, Chemi-Pure^{R}, and granular activated carbon.

	pH	
Filtrant	Fresh water	Seawater
Control	7.25 ± 0.27 (6.97-7.74)	8.15 ± 0.05 (8.07-8.23)
Poly-Filter^{R}	7.29 ± 0.25 (6.83-7.74)	8.19 ± 0.05 (8.11-8.29)
Chemi-Pure^{R}	7.78 ± 0.24 (7.44-8.21)	8.16 ± 0.05 (8.10-8.25)
Activated carbon	7.32 ± 0.45 (6.64-7.64)	8.11 ± 0.03 (8.08-8.14)

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HOW TO RAISE HOUSE CRICKETS, *Acheta Domestica*, FOR AQUARISTS USE

Neb Krstic

Aquarium de Montreal

I started to raise house crickets, *Acheta domestica*, about two years ago. First, I raised them as live food for fishes (archer fish, monos, damselfishes, barbs, etc...), then, also, for lizards (water dragons, iguanas), turtles (painted turtles, red-eared turtles) and amphibians (newts, bullfrogs, clawed frogs, etc...) to provide them with a better balanced diet. Crickets are also ideal food for birds. House crickets are very clever: they keep themselves clean as well as their environment. They have a pleasant chirping sound during the mating season, which is produced by the male rubbing one of his wings against the other. The female hears it through auditory organs located on the anterior tibiae near the knee (Grzimek, 1975).

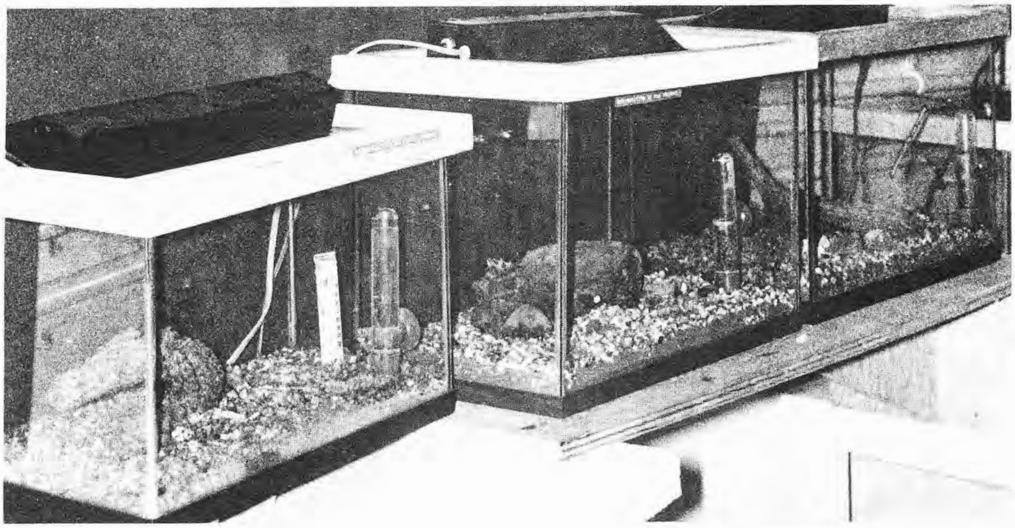
HOUSING

Contrary to Jocker (1973), I recommend the use of glass aquariums because they conserve heat, humidity and provide better observation. For best results, use five or six 60 litre aquariums. Cover them with a fly screen to prevent escape and to allow proper air circulation. Place a 20 watt light bulb above the screen. Keep the light bulb on for nine hours a day. House crickets require a considerable amount of heat; therefor the air temperature must be kept between 24^{o}C and 27^{o}C. (Figure 1)

SOIL

In regard to the soil, mix one part coarse top soil with one part fine vermiculite and cover the bottom of each tank with five to eight cm of this

1



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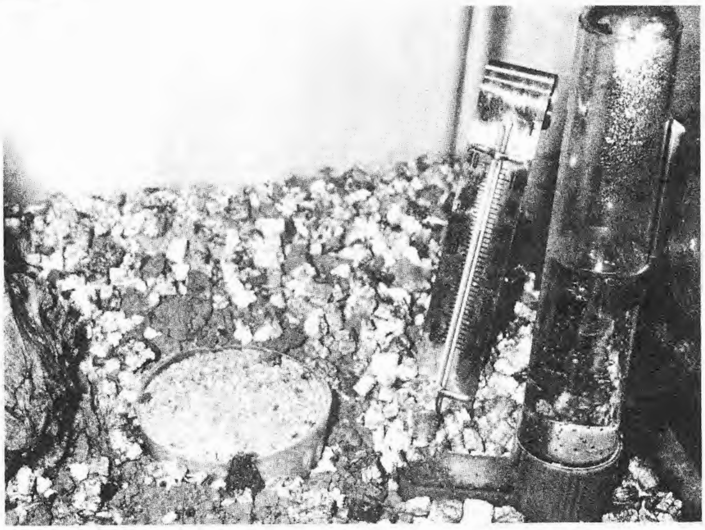

3

mixture. The soil should be moderately moist and light enough for the female to lay her eggs in. The soil temperature must also be kept between $24^{O}C$ and $27^{O}C$. In the center of each aquarium, place a piece of driftwood to allow the moulting crickets to dry off their damp bodies and to escape from mature adults, which are liable to attack and kill moulting insects (Masters, 1975). House crickets moult often during their growing period.

FOOD

Initially I fed crickets exclusively on vegetables. This caused some problems: bad odor and breeding was poor. A few months later, I discovered the proper diet and feeding method for these vegetarian insects. I subsequently began feeding them with "Game Bird Breeder Layana" chow ground in a mortar with a pestle. This food consists of 20% minimum crude protein, 2.5% minimum crude fat and 7% maximum crude fiber. In addition I give them a dash of powdered calcium (Cal-P-I). Food is served in a small dish and provides the insects with as much food as required. During the mating season, they are also offered sliced fresh apples, carrots and lettuce. (Figure 2)

WATER

For a water supply, a bird feeder is used with a piece of sponge in the aperture. This prevents the crickets from crawling in and drowning. (Figure 2).

HOW TO SELECT CRICKETS FOR BREEDING

Choose adult crickets to start with, i.e. winged individuals. For a 60 litre aquarium, about 10 males and 25 females are recommended. Females are easily recognized by the presence of large laterally compressed ovopositor stylets. Soon after their introduction in the aquarium, these females will

be ready for mating and the males will begin chirping to attract them. Sexual contact is made by the male placing himself under the female and attaching a sperm bag - the spermatophore - to the outside of the female genital aperture. This act is visible to the naked eye; with patience, you should be able to see it. If breeding is successful, the female will immediately lay her eggs and two to three weeks later hatching will occur. At this time the parents can be removed and used as food. The new-borns are pin-head in size, growing to adults in about four weeks. (Figure 3)
New-born are used to start new cultures in the other tanks. An attempt should be made to have them bred at different time intervals. This way, there will be a constant supply of house crickets of all sizes and you will be able to clean one or two aquariums without having to interfere with your culture. In less than four months, your production should amount to 400 to 600 house crickets per week. (Figure 4)

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PART OF THE FOLLOWING BIBLIOGRAPHY WAS INADVERTENTLY OMITTED FROM DRUM AND CROAKER, Volume 20(82) Number 1. January 1982, page 39.

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COPPER TREATMENT: THE DARK SIDE OF THE STORY

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URI SCIENTISTS FIND BRINE SHRIMP QUALITY CAN VARY

by

Uri Marine Advisory Service

a Sea Grant Program

Just as human foods contain varying amounts of fatty acids, minerals and sometimes pollutants, so do brine shrimp *Artemia*. These tiny crustaceans are a staple for fish in aquaculture systems around the world and in home aquariums.

How the chemical and biochemical composition of brine shrimp affects both growth and survival rates of fish has been the subject of extensive studies by Dr. Kenneth L. Simpson and Dr. Charles E. Olney, both professors in University of Rhode Island's department of Food Science Technology, Nutrition and Dietetics.

Scientists there have found that different geographical locations and varying water quality can dramatically affect the quality of a particular shrimp strain.

Brine shrimp are familiar to many fish hobbyists as the tiny, wriggling creatures which hatch from the brown powdery eggs sold as live fish food or in freeze-dried cubes. These shrimp grow naturally in over 145 areas around the world where the water is too salty for any other animals, and thus any predators, to live.

For years the only quality criteria in the industry for a brine shrimp stock has been hatchability. Dr. Simpson has found evidence to support his contention that companies should also be concerned about the quality of the water from which the shrimp is collected because what the shrimp eats, it becomes. Some brine shrimp tested have resulted in poor growth and survival in the fish to which it was fed.

Ultimately, the researchers hope to identify just what substances in brine shrimp can cause problems and to develop quality control measures to catch these. They would then like to see companies add such measures to their current screening practices. Until these specific procedures are developed, Dr. Simpson is willing to lend assistance to companies wanting to learn some simple and general quality control tests.

The URI researcher's studies are part of a much larger international comparative project prompted by lack of knowledge about the shrimp's nutritional qualities. Since 1978, research groups from URI, Belguim, Wales, Spain, and the U.S. Environmental Protection Agency, have been investigating various aspects such as the ecology, morphology, mass culture techniques and genetic characterizations of five shrimp strains.

Three volumes of papers produced from the brine shrimp studies have been published and an Artemia Reference Center has been established in Ghent, Belgium. The center offers a standard reference stock which can be used in testing whether a brine shrimp strain is the cause of growth and survival problems in aquacultural or aquarium systems. It also offers training in brine shrimp culture for aquaculturists.

The following are free publications available from U.R.I.,
Marine Advisory Service, Publications Unit,
Naragansett Bay Campus,
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University of Rhode Island Sea Grant
Marine Advisory Service

New Publication Abstract

Title: INTERNATIONAL STUDY ON ARTEMIA. VIII. COMPARISON OF THE CHLORINATED HYDROCARBONS AND HEAVY METALS IN FIVE DIFFERENT STRAINS OF NEWLY HATCHED ARTEMIA AND A LABORATORY-REARED MARINE FISH

Author(s): C.E. Olney, P.S. Schauer, S. McLean, Y. Lu and K.L. Simpson

Publication Number: P 906 **Date:** 1980

Newly hatched nauplii of Artemia from Brazil, Australia, Italy and the United States (Utah and San Pablo Bay, California) were analyzed for chlorinated hydrocarbons. The Brazil and Australia nauplii contained very low levels of PCB and chlorinated insecticides. Italian nauplii contained the highest levels of HCB, BHCs and DDTs, while San Pablo nauplii were highest in chlordanes, dieldrin and PCBs. With the exception of 188 ppb pp-DDT in Italy nauplii, none of the residues exceeded 100 ppb on a wet weight basis. Atlantic silversides (Menidia menidia) and mud crabs (Rhithropanopeus harrisii) from two Artemia feeding studies were analyzed. Residue levels in the organisms generally reflected the concentrations in the nauplii. Attempts to correlate nauplii residue levels with the survival of laboratory-reared marine fish and crabs disclose no obvious component(s which could totally account for the poorer performance of the Utah and San Pablo strains. The satisfactory performance of the Italian strain seems to eliminate HCB, BHCs and DDTs as causative agents per se. If chlorinated Hydrocarbons are involved with the poorer survival of marine fish and crabs fed San Pablo nauplii, chlordane, dieldrin or high molecular weight PCBs would appear to be the most likely suspects. Twelve metals, were measured by atomic absorption and neutron activation analysis. Differences between nauplii were small and no particularly high concentrations were observed. (Book Reprint: The Brine Shrimp Artemia, 3 G. Persoone, et.al. eds., Universa Press, Belgium, Pages 343-352.)
10 pages

Title: INTERNATIONAL STUDY ON ARTEMIA. IX LIPID LEVEL, ENERGY CONTENT AND FATTY ACID COMPOSITION OF THE CYSTS AND NEWLY HATCHED NAUPLII FROM FIVE GEOGRAPHICAL STRAINS OF ARTEMIA

Author(s): P.S. Schauer, D.M. Johns, C.E. Olney and K.L. Simpson

Publication Number: P 907 **Date:** 1980

Artemia cysts and newly hatched nauplii from Australia, Brazil, Italy, and the United States (California and Utah) were analyzed for their total lipid level, total fatty acid level and composition, and their energy content in an effort to evaluate their lipid nutritional value as diets of marine organisms. Results are compared to biological data from a nutritional evaluation of these five Artemia strains on various marine organisms. The total lipid, fatty acid methyl ester and energy levels of all strains appeared to be adequate to promote good growth and survival of the marine organisms. The fatty acid spectrum of the cysts and nauplii were nearly identical, indicating that the cyst shell contains little fatty acid-type lipids. However, significant differences were found in the fatty acid composition between the various strains. It is possible that there is an interaction between an essential fatty acid deficiency and a dietary contaminant. This possibility is discussed with reference to biological results obtained when these five Artemia strains were fed to three different marine organisms. (Book Reprint: The Brine Shrimp Artemia, 3, G. Parsoone, et.al. eds., Universa Press, Belgium, pages 366-373.)
9 pages

Title: INTERNATIONAL STUDY ON ARTEMIA. XII. THE CAROTENOID COMPOSITION OF EIGHT GEOGRAPHICAL STRAINS OF ARTEMIA AND THE EFFECT OF DIET ON THE CAROTENOID COMPOSITION OF ARTEMIA

Author(s): T. Soejima, T. Katayama, and K.L. Simpson

Publication Number: P 908 **Date:** 1980

Echinenone and canthaxanthin were the only carotenoids isolated from the cysts and freshly hatched nauplii of Artemia from nine samples representing eight geographical locations. The concentration of echinenone ranged from 0.5-5.5% of the total carotenoid composition. Canthaxanthin was the major pigment in all samples tested, ranging from 94.5%-99.5%. Three isolates obtained from San Francisco Bay and San Pablo Bay were very similar in their carotenoid concentrations. Australian Artemia were fed on rice bran for ten days. Racemic, synthetic astaxanthin and the pigments extracted from Rhodotorula and Spirulina were fed to the ten-day-old Artemia. The bioaccumulation of torularhodin, zeaxanthin and astaxanthin was observed. These pigments were observed to be lost more readily than canthaxanthin in Artemia returned to a carotenoid-free diet. The rapid turnover of B-carotene and echinenone from the diets is consistent with a biosynthetic pathway in Artemia: B-carotene echinenone canthaxanthin. (Book Reprint: The Brine Shrimp Artemia, 2, G.Persoone, et.al. eds., Universa Press, Belgium, Pages 613-622.)
10 pages

Title: INTERNATIONAL STUDY ON ARTEMIA. XI. AMINO ACID COMPOSITION AND ELECTROPHORETIC PROTEIN PATTERNS OF ARTEMIA FROM FIVE GEOGRAPHICAL LOCATIONS

Author(s): C.R. Seidel, J. Kryznowek, and K.L. Simpson

Publication Number: P 913 **Date:** 1980

The cysts of five geographical strains of Artemia (Australia, Brazil, Italy, Utah, and San Pablo Bay, California) were hatched, and the newly hatched nauplii were acid hydrolyzed and analyzed for their amino acid content. The San Pablo Bay strain exhibited several values different from the other four strains. Essential amino acid levels for all five strains of Artemia were considered adequate in terms of the dietary requirement levels for Chinook salmon and levels that appear to be adequate for Atlantic silversides. Electrophoretic protein patterns for the five strains of Artemia were compared in an effort to differentiate the strains. No two strains, when paired, showed identical banding patterns. Whether this variation in electrophoretic protein patterns may occur among batches of one strain of Artemia, as well as among many strains, remains a question. This preliminary study pointed out the need for future work in this area to test for the effect of temporal and environmental factors on the protein patterns of Artemia. (Book Reprint: The Brine Shrimp Artemia, 3, G. Persoone, et.al. eds., Universa Press, Belgium, pages 375-382.)

8 pages

CONCH MARICULTURE FOR THE CARIBBEAN

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Queen conch *Strombus gigas* is a natural resource throughout the Caribbean waters. It has been harvested by the island people for the past 1,000 years, as a high protein food source and to provide tools and ornaments which are made from the shell. The export market for conch began with the drying of conch. Many thousands were brought from Turks and Caicos Islands to Haiti by sloops beginning in the late 1800's. When the frozen market for conch began in the 1960's the amount of conch fished increased. By the late 1970's many countries such as Bahamas, Bonaire and Belize could no longer harvest for the market. The export market for conch to the U.S., Canada and the Caribbean is still increasing. This demand, the improved market, along with the good prices is contributing to severe overfishing. The Turks and Caicos Islands are now the largest exporters, exporting close to three million conch in the past year. This depletion of the natural resource is of great concern to the fishermen for it is their livelihood.

The development of conch mariculture is necessary in order to keep the conch as an indigenous species of the Caribbean. It will supplement and reseed depleted habitats, supporting the market demand thus supplying income and jobs. This mariculture is in the research and developmental phase. However, it is progressing towards a production level that will make conch commercially viable in the near future.

The research is mainly in the areas of hatchery and grow-out studies. Once the conch are raised in the hatchery from the egg, through the floating 24-day veliger larval stage, to the crawling snail, they then need to be placed back into the natural waters. This can be done by placing them in pens, park areas or in open sandy grass beds. The most important aspect of the grow-out of conch is to determine the optimum habitat, as regards substrate and food, and to protect the conch from predation.

The following is a summary of the state of conch mariculture. The first rearing of eggs in a hatchery facility began in Los Roques, Venezuela, in a small remote island laboratory. Their methods for raising conch are very primitive for they use aquaria with coarsely filtered water, no aeration and natural phytoplankton bloom. The optimum density in this situation is 10 veligers per litre. From this hatchery experience, other laboratories have been able to expand on the rearing of conch in captivity.

PRIDE is located on Pine Cay in the Turks and Caicos Islands. This past year (1981) they have been doing field research and during the breeding season (April-September) an egg farm was established. Twenty-five females and twenty-five males were placed in a pen enclosure in a natural breeding habitat. The breeding behaviour and the frequency of egg masses laid was observed. Prior to this research, it had been throught that females may lay only one egg mass per season. By monitoring these tagged conch three times a week, the frequency was determined to be an average of one egg mass per month. An egg farm shows that conch can breed in captivity in a natural habitat and that a reliable source of eggs can be harvested for hatchery work. The demand for egg masses is increasing as more hatcheries are scaling-up and beginning operation. Researchers have paid up to $50.00 per mass. The egg mass supply must be steady so that the hatchery can make maximum use of it's facilities.

Another project PRIDE has been working on is pen design for small juveniles and adult conch. Over 200 plastic toy "Slinkies" were attached together and a lead line was fastened onto the bottom. This pen is now keeping small juveniles (5cm - 15cm) in a controlled space. The conch cannot crawl under or over the "Slinky". The shape of the "Slinky" spirals allows the water to flow through it and the pen forms to the substrate contours. The next step is to find a larger version of the "Slinky" , which will keep the conch in captivity until they are large enough to harvest at two and half to three years in age.

This coming breeding season PRIDE will begin rearing conch from the egg as the existing wet lab is now being changed into a hatchery facility. Further studies in the grow-out area will follow along with the hatchery work.

Dr. Siddall and Leroy Caswell are working with the hatchery facility located at the University of Miami. Their efforts are determining techniques for mass-rearing conch in high densities, ie. 400 veligers per litre, necessary for economical production. They had great success in 1980 and increased their operation for the 1981 season. However, due to the low number of egg masses available, it was difficult to process as many eggs as were necessary for determining the proper techniques.

The University of Miami is involved in research regarding induced spawning, predation studies and the grow-out experiments in the Bahamian waters.

The University of Puerto Rico Marine Laboratory is presently involved with a conch hatchery facility. They are funded by the National Marine Fisheries. Their first rearing season (1981) was very successful. They raised over 2,000 juvenile conch through the critical larval period in aquaria, buckets and wading pools. In a facility such as this the optimum density of larvae could be as high as 100 veligers per litre. They have shown that with a proper understanding of the animal along with the right water and handling conditions, conch can be raised in just about any container. Hundreds of these conch were offered to other researchers such as the University of Miami and PRIDE, who are presently using them for grow-out studies and feeding research. This hatchery will continue for a second year with 1,000 litre larval rearing tanks and should therefore be even more productive.

The greatest problem is funding for conch mariculture. More hatcheries are needed to establish techniques and to produce great amounts of seed for the islands' waters. Grow-out studies require expansion in the areas of pen design, optimum substrate, density levels, food preference and predation. Conch mariculture can be transferred from the laboratory to the local people and will provide a job alternative to conch fishermen. With the collaboration of funders, researchers and fishermen this animal will continue to flourish in the Caribbean waters.

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