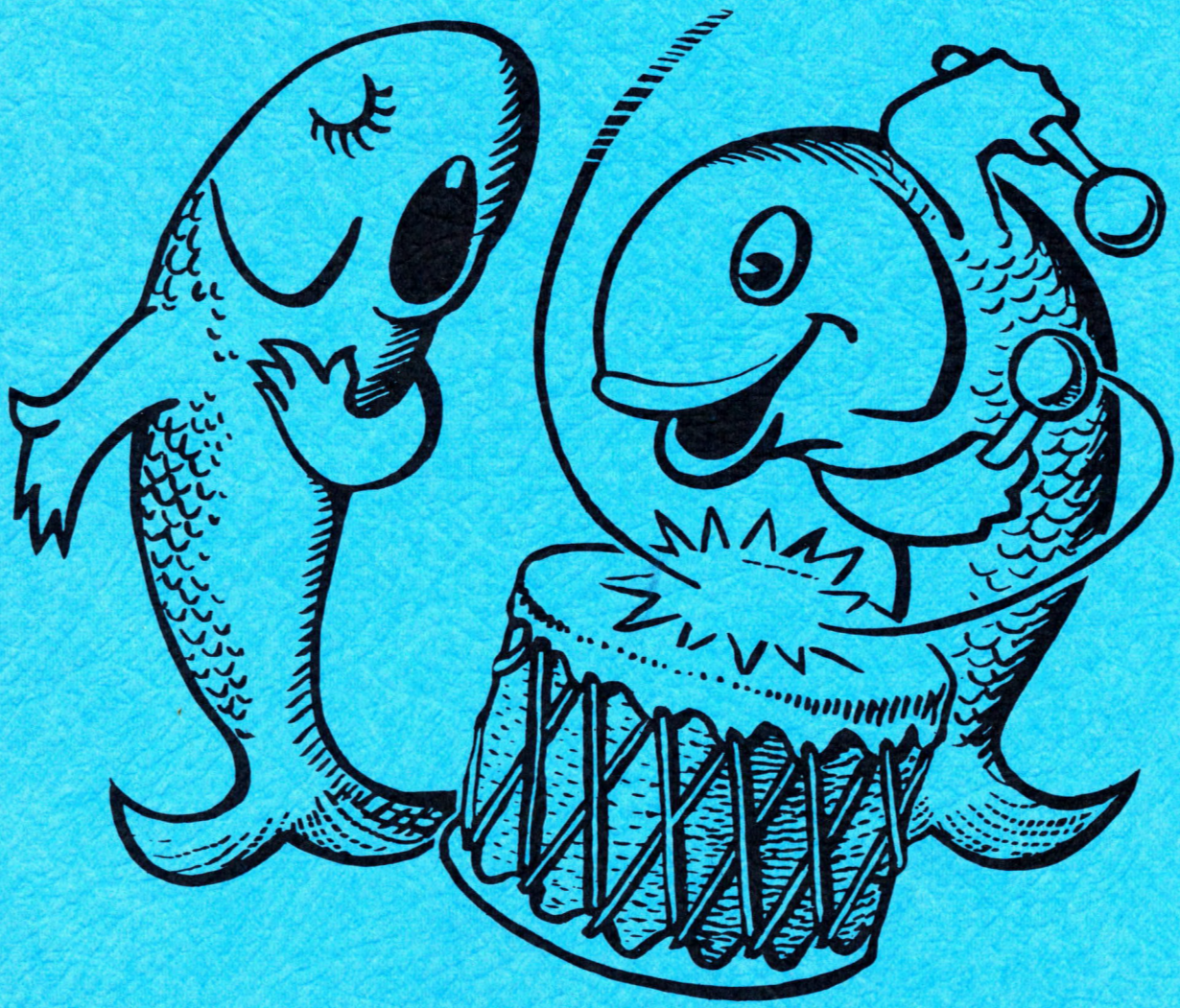
The DRUM and CROAKER

A Highly Irregular Journal for the Public Aquarist



JULY 1972

VOLUME 13 (72) NUMBER 2

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

The Informal Organ

for

Aquarists

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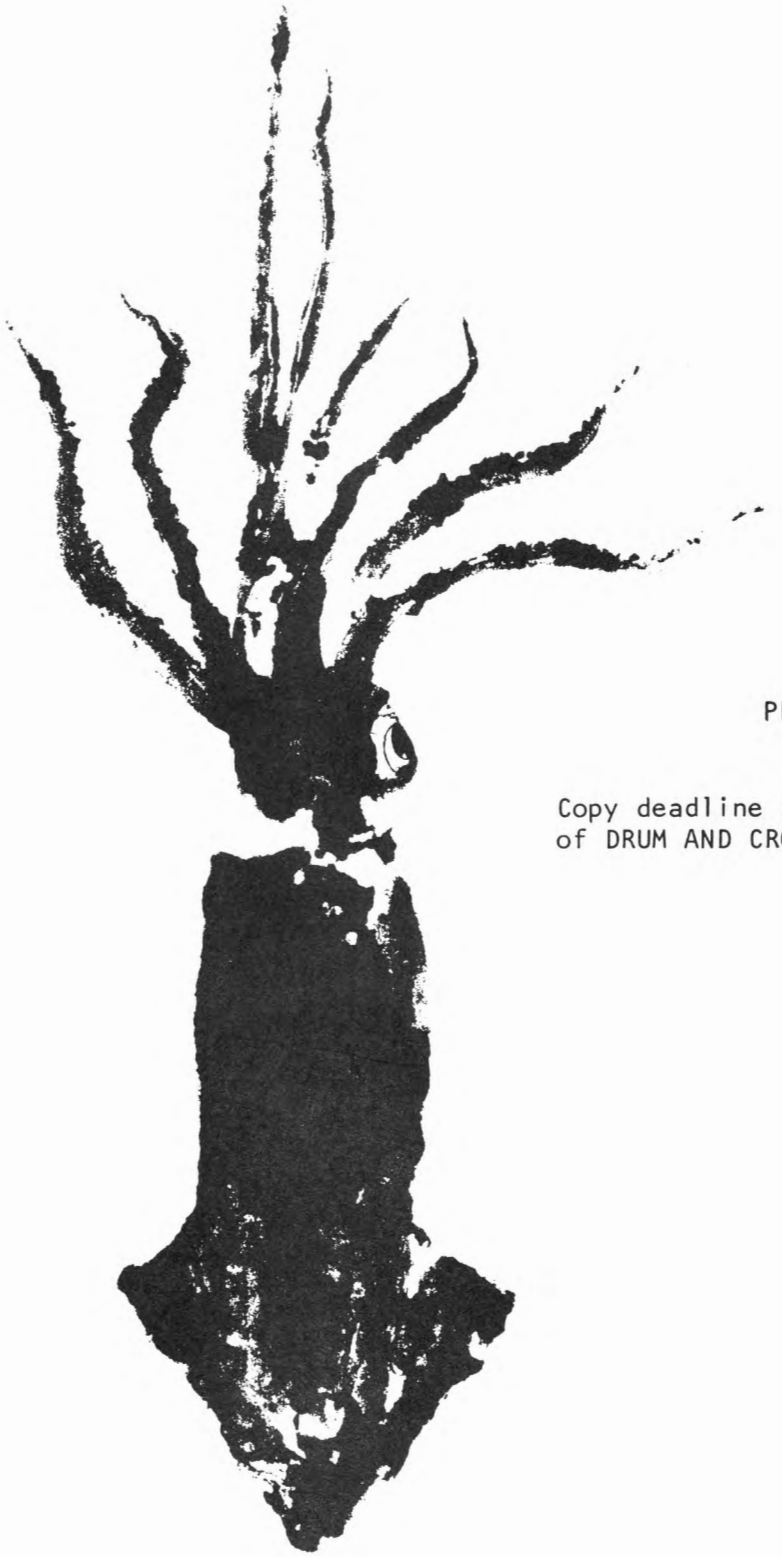
Send material to: John G. Shedd Aquarium
1200 South Lake Shore Drive
Chicago, Illinois 60605

Fish prints (Gyotaku) by Beverly Serrell, Shedd Aquarium.

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

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



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Assistant Curator of Education, Shedd Aquarium

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A LETTER TO THE EDITOR

Thomas R. Hablett
North American School of Conservation and Ecology

First, I apologize to Drum and Croaker readers for no response regarding my thesis proposal (D&C Vol. 13:1), but it was abandoned due to the lack of funding for proper test equipment. I have instead taken the unpleasant task of monitoring domestic sewage outfalls to complete my master's work. Ugg!

I would like to comment on Warren Burggren's article (D&C Vol. 13:1) regarding inexpensive aquaria. His ideas are well founded, but I have found the ultimate in cheapness for refrigerated marine aquaria.

For those organizations lacking sufficient funds for the construction of most needed holding tanks, I suggest the investigation of fiberglassing old freezers. For an average investment of about thirty dollars for an old working unit, and fifteen dollars for fiberglass and paint, one can have a hundred gallon shell. I have found a triple layering of the glass is sufficient to hold this volume. Sub-sand filters or whatever can be added at nominal cost.

I have several such set-ups in operation with nary a leak.

There is one shortcoming to this idea however. There are no viewing ports, so it should not be intended for display use. By using a light color paint on the interior, it is sufficient for observation by research personnel.

# # #

Thomas Hablett has left the confines of Fullerton Junior College after three years as aquarist to take a teaching position in water quality and ichthyology at North American School of Conservation and Ecology in Anaheim, California. The new aquarist at Fullerton is Dennis Kelley.

EUROPEAN UNION OF AQUARIUM CURATORS FORMED

Frank de Graaf, Curator Aquarium & Reptile House
Royal Zoological Society Natura Artis Magistra

During a symposium held in the Basel Zoo May 24-25, 1972, the participating aquarium curators decided to form an European Union of Aquarium Curators to ensure a closer contact between them in the future. The main objective of this Union will be to organize regular symposia during which topics and problems of general interest will be discussed. During these symposia ample time will be allotted for personal contact between the participants. As far as possible working parties will be formed well ahead of each symposium to prepare reviews or other basic material for the topics under discussion. This, we hope, will ensure clear and sound discussions.

Another important objective of the Union could be to publish irregular circulars in which members may put short communications, offers of surplus animals, wanted species, pleas for help and advice from colleagues in special problems and other items. We are also interested in exchanging bulletins and newsletters with aquariums in the Americas.

It was decided in Basel not to form a board of governors but to appoint for the next three years a secretary only. In the years to come as the Union develops, we will have ample time to see whether we will need a board of governors or not.

It was moreover decided, for obvious reasons, that membership of the Union must be personal and restricted to curators of aquaria (public and scientific). However, membership is not restricted to the fish-people only but, as many of us also are curators of reptiles, is open for those colleagues who are curators of reptiles only. Membership should also be open to those who are professionally involved in fishes or reptiles in other capacities than as curator of an Aquarium or Reptile house, for instance veterinarians specializing in fish or reptile diseases.

Dr. A. Schiøtz of Denmark's Akvarium, Charlottenlund, has invited the Union to have its 1973 Symposium in Kopenhagen. Dr. W. Neugebauer of Wilhelma Zoo, Stuttgart, kindly invited us for 1974.

THE EDWARD H. BEAN MEMORIAL AWARDS

Margaret A. Dankworth, Executive Secretary
American Association of Zoological Parks and Aquariums

In September of 1956, the AAZPA established the Edward H. Bean Memorial Awards "to be given to the zoo that has the rarest animal born and raised to the age of nine months". Robert Bean, then director of the Brookfield Zoo, offered the services of the Chicago Zoological Society in sponsoring these awards. They were named the Edward H. Bean awards, as a fitting tribute to the first director at Brookfield. The first award was presented in 1957 for a 1956 animal birth.

Until 1964, the awards were limited to one or two with no distinction for classes, although each year it became more difficult for the committee to choose among mammals, birds, reptiles and amphibians, and fishes. The awards were then expanded for 1963 births to include an award for each class if births were significant. The committee has been given latitude through the years to determine its own criteria, with one exception. In 1964, the original motion was amended to strike out the provision that "the animal must live for nine months". This was based upon the premise that a significant animal birth may be an achievement in itself and much knowledge could be gained by successful breeding and birth even if the animal did not survive.

In 1969, the awards were expanded to also go to the keeper (or keepers) most responsible for working with the animals that enabled the zoo to receive the Bean award. This was and continues to be a joint program of AAZPA and the American Association of Zoo Keepers.

Even today, over fifteen years after the Edward H. Bean award was first conceived, there are no written guidelines for the committee, because the selection process must be flexible enough to change with the changing concerns in conservation. "Most notable birth in each class" is the only guideline, which may include a viable, breeding colony of a certain species over several generations, or a "first" on this continent, or an extremely rare species, or a difficult species to maintain and breed.

The Edward H. Bean award program is one of the AAZPA's significant programs in pursuing its concerns for wild life conservation and propagation.

TO ALL AQUARIUM DIRECTORS AND CURATORS ...

A REMINDER OF BEAN AWARDS NOMINATIONS

The year 1971 cannot have been such a disasterous year for all aquariums that there were no notable spawnings worth recommending for the Edward H. Bean Award. We're sure that if you have not had a significant occurrence you must know of some other humble individual or institution worthy of being nominated. Please read the guide lines (below) concerning the award, give it some serious thought and then remember - "participation is half the fun." The date for our annual meeting in October is fast approaching so don't delay any longer. Let's give the winner some competition.

If you have had reproductive successes worthy of consideration please complete and return the nomination form (page 6) immediately to:

William E. Meeker
Assistant Superintendent
Sacramento Zoo
3930 W. Land Park Drive
Sacramento, California 95822

Extra forms may be obtained from the above.

GUIDELINES - THE EDWARD H. BEAN AWARD

William E. Meeker

The basis for giving the award each year has been left to the discretion of the AAZPA's Honors and Awards Committee in hopes that they could reflect the current thinking and emphasis of the President, Board and general membership.

The words "most notable" are the only guides the committee has and can be interpreted in any number of ways. An institution which maintains a viable, breeding colony of a certain species over several generations (whether or not that species is considered particularly threatened in the wild) may be just as eligible as the institution that has a "first" in North America or the world. Likewise, an institution that just happens to have enough money and contacts to obtain an extremely rare species which just happens

to reproduce for them should be no more eligible than the zoo or aquarium which specializes in a very common, but extremely difficult captive-management species and finally reproduces it. This interpretation reflects the flexibility of the awards and makes them more meaningful as well as making the job of the Committee more difficult.

The forms are mailed through the AAZPA's Central office and thus normally go to AAZPA members only. However, this does not restrict the awards to AAZPA members exclusively. We are awarding to the most notable birth or hatching and, in the interests of conservation, the most notable birth should be recognized whether the institution is an AAZPA member or not.

The forms will be returned to the Chairman who will compile a list of nominees (without the institution being identified) for subsequent referral to committee members. Committee members will make their recommendations for "The Most Notable Birth or Hatching" and, if the situation warrants, for one or more "Honorable Mention" awards. These "Honorable Mention" awards are not to be considered second, third or fourth places, but merely other events that warrant recognition.

Final decisions will be made after consultation with all committee members, the President and Board (if necessary) and arrangements for the preparation of the certificates will be done by the AAZPA Central office.

AAZPA MEETING NOTICE

Don't forget the American Association of Zoological Parks and Aquariums meetings in Portland this year, October 1 through 5.

AAZPA NOMINATION FORM:
Most Notable Birth or Hatch
in Calendar Year 1971

Check Class for Nomination:
Mammals _____
Birds _____
Reptiles & Amphibians _____
Fishes _____

ANIMAL NOMINATED (common name) _____

Scientific Name _____

Date of birth or hatch: day _____ month _____ year _____

Sex _____ Period of gestation or incubation (# of days) _____

As of this date is animal living in your collection? _____

If not, state disposition and date _____

Date of last observed mating: day ____ month ____ year _____

Was this the first birth/hatch of this species? _____

PARENTAGE OF ANIMAL NOMINATED

MALE PARENT Date of acquisition: day ____ month ____ year _____

Birth/hatch date or
age on acquisition: _____
(actual or estimated)

Wild born _____, or Captive born _____

FEMALE PARENT Date of acquisition: day ____ month ____ year ____

Birth/hatch date or
age on acquisition: _____
(actual or estimated)

Wild born _____, or Captive born _____

For AAZK Award, name of Keeper(s)
most involved with care of animals:

_____

_____

Submitted by:

_____
Director

_____
Institution

_____
Governing body

_____
City State/Province

Return as soon as possible to:

William E. Meeker
Assistant Superintendent
Sacramento Zoo
3930 W. Land Park Drive
Sacramento, California 95822

NEW TIDEPOOL DISPLAY AT SEA WORLD, SAN DIEGO

Dave Powell
Curator of Fishes, Sea World, Inc.

In recent years, exhibits which allow physical contact between the visiting public and the animals have become quite popular and successful in both zoos and aquariums. The first aquarium to use this approach to display marine invertebrates was the Point Defiance Aquarium in Tacoma, Washington. On the basis of their success in Tacoma, Sea World designed and installed five open "tidepools" containing invertebrates and fishes of Southern California. Although no tidal fluctuation occurs, these displays have proved to be one of our most popular exhibits.

The display consists of one large central pool, fifteen feet in diameter and thirty inches deep, with a central island. During our periods of high attendance a girl narrates and answers questions from this central island. During slacker periods, a repeating tape give the highlights of the animals displayed. The large central pool contains those animals that cannot tolerate much handling such as abalone (Haliotis), sea hares (Aplysia), spiny lobsters (Panulirus), keyhold limpets (Megathura), garibaldi (Hypsipops), dwarf perch (Micrometrus), turbots (Hypsopsetta), and kelp crabs (Pugettia).

Surrounding the central pool are four small, shallow open pools positioned low enough to be accessible to the smallest child. Each of these contains hardy animals such as starfish (Patiria, Pisaster), hermit crabs (Pagurus), sea cucumbers (Stichopus), opaleye (Girella), tidepool sculpins (Clinocottus), juvenile garibaldi (Hypsipops) and sea urchins (Strongylocentrotus purpuratus). Kelp (Macrocystis and Egregia) and surfgrass (Phyllospadix) are replaced periodically for decoration and as food for the herbivores.

In general, the animals do very well although there has been some loss of small starfish and hermit crabs to unthinking persons who take them as souvenirs. The following sign has recently been added in an effort to curb those with sticky wet fingers.

> "Help protect our seashore life. These tidepools are for your pleasure and education. You are welcome to handle the animals gently but please do not take them. Return them to their pool for other visitors to enjoy."

We have been very pleased with the public reaction to this new display. Because of our favorable climate, our pools are situated outdoors but a similar type of display would be equally suitable for indoor aquariums in areas where marine animals are readily available.

A PROGRAM FOR ENVENOMATION - DO YOU HAVE ONE?

Alan M. Levitt
Education Section, National Fisheries Center and Aquarium

It's 2:30 in the afternoon and you are watching one of your aquarists feed the Pacific Reef Tank. He spots a dead or dying fish and takes a net and reaches into the tank to remove it. Suddenly, he screams loudly in pain.... a Lionfish has just pushed its spines into his arm. What do you do?

Early one weekend morning your aquarium gets a call from the frantic father of a young teenager. It seems that his son purchased a "poisonous" fish the week before and thought it was sick since it rarely moved. The boy went to jab it and got stung. The man wants to know what to do. He doesn't know anything about the fish except that the man at the pet store said it was "poisonous."

Although most aquarium personnel would take precautions not to get stung, how many of us really know what to do if it happens? With some stings, such as those of the Stonefish, proper action in minutes is often necessary. Would you know exactly what to do to save someone's life? Yours perhaps?

This article is not meant to be a discussion of venomous fish since the subject is discussed by such experts as Drs. Russell and Halstead (two authorities in the field of envenomation) as well as in other literature (some cited in bibliography). Rather, it is intended to stimulate other aquariums to evaluate their own safety and information programs concerning venomous animals.

As the salt water aquarium hobby continues to rapidly expand, the number and variety of venomous animals for sale in pet stores will also increase. Lionfish, coral catfish and other nice looking but venomous fish are well within the allowances of many young children. The more deadly Stonefish is also for sale although the cost is somewhat more.

I have seen Lionfish sold to children with the sole warning, "better not let it sting you." Some fish are advertised and bought just because they are venomous or dangerous. Moreover, on at least two occasions this aquarium received phone calls from people who had bought "venomous" fish from pet stores in the area. The fish were described to us over the phone and we were queried about their identities since the stores which had actually sold them did not know!

A spot check with some of the aquarium shops here reveals that the dealers themselves are misinformed about treatment for fish stings. To further complicate matters, many hospital emergency rooms and poison control centers are equally confused about treatment. Yet, in the last few months, this aquarium has received almost a dozen phone calls from physicians and other individuals asking about treatments for envenomations. One person had to have his thumb amputated because of a gangrenous Lionfish wound.

The situation in Washington, D.C. is probably no better or worse than in other major cities. Although no figures are kept, most knowledgeable persons agree that this problem is getting worse.

In another quick survey of over a dozen major aquariums throughout the country, I found that few had any specific procedures to follow for such emergencies. Some did not even have specific preventative measures.

In view of these findings, I decided to look further into the matter and share my findings and my aquarium's subsequent actions with other aquarists.

Over 200 species of marine animals are venomous. Hundreds more are poisonous. Very little is known about the subject. Envenomations widely vary in seriousness and symptoms. However, all are dangerous and in some cases, deadly. Living specimens should never be touched and even dead animals should be handled with extreme care. Although most cases are treated successfully, when someone is stung he invariably thinks he is going to die. He won't if he gets proper treatment, but the shock and ensuing panic may make his condition worse.

The pain, which commences almost instantly, will vary depending upon species, amount of venom injected and the sensitivity of the victim to the venom. Pain is usually severe and far out of proportion to the actual injury. In some cases, pain is so great that the victim may become difficult to restrain or control. This is why our emergency procedures state that at least one aquarist will remain with the victim at all times until he reaches the hospital.

Quick immersion in very hot water helps to neutralize the venom and ease the pain. The hotter the water the better. This is about the only first-aid treatment the layman should attempt. However, further treatment may be required at the hospital. Because secondary infections are a problem in envenomations, victims often have to remain overnight for observation.

A more detailed description of the symptoms and suggested treatments for envenomation can be found in the literature. The important thing to note is that various references suggest different first-aid measures and medical treatments. Your own physician and emergency room should be made aware of them so that an appropriate procedure and treatment can be selected for you well in advance of any emergency. Dr. Russell believes that much more research is required in this area and that existing information is contaminated by myths. "No other area of medicine appears to be more steeped in myth and superstition than the therapeutics for venomous animal injuries."

There is an antivenin for Stonefish which is made from the extract of Synanceja trachynis. It was developed by the Commonwealth Serum Laboratories in Australia. Although it is legal to sell Stonefish here, it is illegal to sell the antivenin. Exceptions are made for aquariums, zoos and certain individuals with proper cause. Permission must first be obtained from the Director, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland 20014. Your letter

should mention the type and quantity of antivenin desired, the uses, supplier, etc. Needless to say much red tape is involved. While researching this article I talked with two people who said they routinely broke laws to save human lives.

Incidentally, Commonwealth Labs has a free book available entitled "Venomous Australian Animals Dangerous to Man," by J. Ros. Garnet (1968). Commonwealth also makes Sea Wasp and Sea Snake antivenin and will send descriptive literature upon request. The address is 45 Poplar Road, Parkville, Victoria, Australia 3052.

After more research, including conversations with Drs. Halstead and Russell, the National Aquarium (NFCA) has embarked on two programs to deal with these problems. One is for aquarium personnel and the other for the general public.

The Program at the Aquarium

All employees here have seen the film, "Venomous Animals of the Sea" (a Naval Training film available for free loan from your Naval District). Aquarists were encouraged to read appropriate literature in the aquarium library. The subject was discussed during meetings. Since our nearest hospital knew nothing about fish stings, we provided references and put our doctor there, Dr. Holla Brown, in touch with Dr. Findlay Russell. After consultation with him, Dr. Brown discussed with us emergency procedures for the aquarium. Together we formulated a program. She informed the Poison Control Center here of her findings and also informed all those in the emergency room who might treat us.

In my search for information, I contacted the reptile house at the zoo. Many reptile houses have elaborate emergency procedures for snakebites which can provide valuable insights into the problem of fish stings.

We arrived at the following safety and emergency procedures. They are posted in appropriate areas throughout the aquarium.

Precautionary Measures:

1. Doors to all unoccupied areas will remain locked at all times.
2. All aquaria containing venomous specimens will be so marked with red signs.
3. Handling and feeding of venomous specimens will be by authorized personnel only. Care should be taken since dorsal spines are not the only spines that contain venom.
4. When transferring venomous specimens, three (3) aquarists must be present. This includes the handling of dead specimens since the venom of some species does not break down for many hours.
5. Dead specimens will be taken to the Laboratory, wrapped, marked with red tape and placed in the freezer. The Curator will be notified immediately.
6. Except for dead animals, no venomous specimens will be handled on weekends.

Emergency Procedures:

1. Secure animal if not in tank.
2. Immediately bring victim to Lab or Kitchen and place injured part under the hottest water possible. Check to see if water is too hot since victim may be unable to determine this for himself.
3. Notify office which will alert emergency room at hospital that you are coming.
4. Place victim's injured part in bucket of very hot water and bring him to hospital in government car, taxi, or ambulance - whichever is quickest.
5. One aquarist will remain with victim at all times and will not leave until notified by aquarium office.

Dr. Russell, who is at L.A. County-University of Southern California Medical Center, has said that he is available to consult with your physician concerning emergency treatment. His number is: Area code 213/225-3115, Ext. 72801.

Program for General Public

Communicating with the general public required much thought since we did not want to create a scare. However, the problem, in the Washington area at least, is increasing and we felt that a few suggestions today might prevent a larger problem from forming and thereby stop any restrictive legislation that might otherwise be necessary in the future.

Each marine wholesaler and retailer in this area was sent a letter stating our concern about venomous fish stings. The letter described emergency procedures and suggested they remind their customers of the hazards involved in keeping such animals. It further suggested that they use more discretion in selling venomous fish and that they urge the buyer to contact his physician and emergency room of a possible emergency situation. Similar letters were sent to all aquarium societies in the area.

Poison Control Centers in this area were alerted by the physician who helped us with our program. Other letters were sent to various pet industry magazines.

I suggested some story angles to a local reporter, and the subject of venomous fish stings and our efforts in this area received some publicity. As a last measure, we are looking into the possibility of becoming a center for the distribution of Stonefish antivenin.

One final note of caution. Aquarists should be careful not to give medical advice other than the noted hot water first-aid measure. You may be held liable in a lawsuit.

We would like to hear about the efforts of other aquariums in this area. We believe that this type of public education is a prime function of all aquariums.

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"REAL CHEAP" DE FILTER FOR SPOT-CLEANING SMALL SYSTEMS

C. Darby Fulton

The following will be of no interest to those on unlimited budgets. However, if your funds are low.....

Materials required:

Submersible pump, "Little Giants," "Teel," app. 250 gph
1/2 ID garden hose scraps, 2', 3', 4' or 5'
12" lengths of mason's twine
Pants legs from well-washed old army fatigues, or something similar; no holes or rips
Plastic bucket and small plastic garbage can
1 quart plastic orange juice container (or equal)
3 siphon tubes, 3/4" ID
Scraps of plastic window screen, few rubber bands

The aforementioned can be assembled for around $20, assuming you have to buy the pump. For this miserly sum you now have a DE filter which may be used to clean small systems up to 1,000 gal. where the use of a 4,000 gph commercial DE unit would be disasterous, to say the least. The unit may be used on fresh or marine systems, although the epoxy coating on the "Little Giant" does not hold up well under prolonged exposure to salt and should be rinsed in fresh water after each use in a marine environment. Further, the filter may be operated within the system, or, alternately, with small display tanks the pump and filter bag are operated in the plastic buckets outside the tank.

Procedure:

Sew one end (the cut end) of well-washed old pant leg closed; triple stitch and then some. Pant leg should be cut off to give about 18" of length or more. Force 2' hose scrap on output of pump (I use the Little Giant pump which makes this very convenient) and insert other end into pants leg to a depth of about 6 inches. Gather bag around hose and tie off tightly with mason's twine. Lower pump and bag into tank where inflated bag will not disturb exhibit. Plug in pump, inflate bag, and fiddle around with it to exclude any trapped air. Mix 1/2 cup DE with water in the orange juice container, raise pump by its cord, and position intake, pointing up, about 1" below surface of water. Stir DE again, and slowly pour into pump intake; done carefully, no DE will mix with tank water. Lower pump to floor of tank, step back, and let the DE do its work. The results will amaze you...24 hours run time will clear a hopeless 1,000 gal. system, and smaller display tanks take far less time. When run is over, unplug pump and slowly raise it to surface. Grasp neck of bag, hold neck out of water, and twist out hose without untying mason's twine.

Carefully haul bag out of water so as not to lose any spent DE (bag is heavy), discard mason's twine, rinse bag well, and dry. Be sure to use mason's twine as it tightens when wet; be sure to discard twine as it loses strength rapidly in bacterially-active water.

Alternate Procedure for Small Systems:

Position plastic pail on floor or stool, and position small garbage can even with back edge of tank. Fill pail with water (to prevent air leakes at pump connections), and fill garbage can with water. Place and activate the three siphons from garbage can to tank; they will quite adequately carry the flow. Force section of 1/2" hose into neck of pump input, and wrap section of plastic window screen over other end of hose, securing it with a rubber band. Place pump in bucket and position input hose in tank so that flow will not disturb exhibit. Connect pump to bag as above, and place bag in garbage can. Inflate bag as above, and charge with DE in similar fashion. Your writer has used this alternate procedure on tanks as small as 30 gal. with excellent results.

Summary:

The advantages of DE filtration may be had for nominal cost with application to systems too small to warrant or chance use of commercial DE units of high flow capacity. In order to gain maximum benefit from this approach you must observe the Great Axiom: Never Buy Anything Unless Absolutely Necessary. And, if you must buy, buy "real cheap."

Can you identify the mystery guest? Who is Olaf's friend? Ten pounds of whipped cream and clams to the winner.

SHARK-QUARIUM (GROWING UP)

Gerrit Klay

It is always a pleasure to announce a change. In our case, it is incorporation and a shuffeling of names.

Shark-Quarium has become a registered trademark, and a Division of S. Q. Oceanographic, Inc., based in Grassy Key, Florida.

Shark-Quarium has moved from the sketching stage to engineering, with its full building plan off the drawing board. It will be located "somewhere in the Keys".

Also, we have recently acquired a 24 ft. collecting boat, with great speed and plenty of room.

This year's visitors include the Sea World, San Diego group - Dave Powell and Bill Erwin. Recent visitors were Lou Garibaldi and crew from the New England Aquarium in Boston, Mr. de la Poype of Marineland of France was here recently; Kenneth Tong from the soon-to-be-built Atlantic Aquarium (which was designed by Shark-Quarium personnel). We've had visitors from several aquariums in Canada this year also. In addition, it is not unusual for a group of university students to drop by. A number of students have been here on various study programs which we were happy to be a part of, because it is always refreshing to see their enthusiasm and interest.

Our most frequent visitor is Dr. Jensen of the U. of Miami Medical School. He takes home Nurse shark blood by the bottle for his research.

It is our policy to assist any aquarium in their efforts to collect and ship species for new exhibits. In our Shark-Quarium plans are lab facilities to assist the serious aquarist, hopefully to experiment with hard to handle species. Cost for rental is going to be kept at a minimum.

We have had a number of sharks born in captivity and kept successfully - they are Lemon sharks, Black Nose sharks, and Bonnetheads (of which one is still on exhibit at the National Aquarium).

This season will carry Shark-Quarium to:
San Francisco Marine World
Boston New England Aquarium
Cincinnati Zoo
London Nord Sea-Aquarium
Paris and Nice France -
Marineland of France

WHAT'S A PURPLE GUDGEON?

Ross Socolof

A purple Gudgeon is a Mogurnda mogurnda (Richardson). I think it's the name that has always intrigued me and not the fact that this is a beautiful fish. I've spent so many years fooling with this fish that it has become almost an obsession with me.

Mogurnda comes from the Eastern part of Australia and is a typical Goby. Gobies by nature are inclined to be quarrelsome and aggressive fish. This reputation has followed Mogurnda throughout all of the aquarium literature that I have read concerning this fish. I won't disagree with it completely as they certainly are inclined to be nippy, but not nearly as aggressive as I had expected. Their group behavior and their breeding behavior is so peaceful and tranquil that it is almost difficult to believe.

Australia as a continent suffers from a paucity of fresh water fish, and as this is the most extraordinarily beautiful fresh water Australian fish it seemed worthwhile to try to breed it.

I have never seen the fish for sale, and I have never known any breeders who have bred it. Despite this the aquarium literature abounds with spawning accounts. Evidently it is not a difficult fish to breed, but the story of our breedings of this fish while slow and disasterous were mostly a result of inexperience, bad luck and misinformation.

I have had Mogurnda three different times, and in each instance they were part of shipments from my good friend Peter Tsang, of Brisbane, Australia. The first shipment was in 1964, and we had three adult fishes. I could discern no apparent sexual differences and set the three fish up in a large aquarium with a variety of breeding materials so that they could choose their own breeding method. The fish spawned twice and the spawning in each instance was on racks. The eggs were adhesive. The spawnings were made in typical Cichlid fashion. Both spawnings were infertile, and I made the assumption at the time that all three fish were females. I most certainly wasn't sure that they were all females, but it made me feel better to think that this was the case. I still think so.

I did learn quite a bit about the fish at that time. Contrary to aquarium literature the fish is not necessarily a live food eater. Actually they will eat almost anything. They are completely omnivorous and today they are feeding and growing mostly on our gelatinized Commercial Paste Food. The other thing that I learned was that they do not necessarily lay eggs on the top or sides of a breeding contrivance. They normally lay their eggs on a flat horizontal surface.

I did not have an opportunity to confirm the unusual shape of the eggs as described in some literature.

In 1967 we made our second importation, and we lost the fish before we ever got close to an actual spawning attempt. The shipment from Peter that arrived in 1971 was the best and this time we had 11 healthy, mature living specimens. As the fish supposedly comes from hard and alkaline water and our natural outdoor pool water is hard and alkaline, I decided to try and breed them in a natural fashion and released the eleven fish in one of our dirt fish ponds. I harvested the pond in October and recovered only one of the eleven original breeders. There was one spawning in the dirt pool and we managed to salvage about 35 one and one half inch juveniles. These, then, we decided to hold indoors and attempt a pool spawning of second generation fish the next spring, which we feel, and felt at the time, would be more successful.

I was delighted as these were the first juveniles I had ever seen and they were actually as colorful as the adults. The colors on these fish are really remarkable.

Much to our surprise about January 1 they started to spawn. They were broken up into groups of four and five fishes and given 25 gallon tanks for each group. We have to date over 15 successful spawnings and our older young (which are now the third generation) are about 1 1/4" in length. No one takes any credit for these spawnings, as they were unanticipated, and we took advantage of the situation as soon as we learned the fish were about to breed. We learned the easy way when a pair spawned.

In all cases the fish spawned directly on the bottom glass of the tank, or on a flat rock, or on the bottom side of an inverted flower pot. In only one instance was a small part of the spawn placed on the side glass of the aquarium.

At this point it was easy to confirm the descriptions of the unusual shape of these particular fish eggs. The eggs are tear dropped shape and they are attached to the spawning medium by a filament. The pointed end of the egg is always down. The males and the females both stay in beautiful color, and the only really apparent sexual difference is the length of the male's secondary dorsal fin. The female is slightly rounder and I think the head is not quite as pointed. The male takes a guard position over the eggs and by utilizing his pectoral and anal fins he constantly brushes and fans the eggs. The female need not be removed from the tank. The Mogurnda mogurnda will not eat its young or its eggs. We have confirmed this over and over again. We have had as many as five fish in one aquarium and have raised the juveniles with the five adults and they have not eaten any of the young. The normal aggressive attitude of a fish guarding eggs is not displayed by Mogurnda and other fish can crowd around the eggs (provided they are also Mogurnda) with no difficulty.

Recently we have had a pair with approximately 250 three week old babies swimming freely all over the tank spawn a second time. No attempt has been made by either the male guarding the eggs or the female free swimming to molest any of their original spawn or the newly arrived babies now being fanned by the male in a normal fashion.

The requirements of hard alkaline water with the addition of salt are not necessary. We have kept and raised all of the these fish in a normal peaty-colored water that is very soft with a PH of 6.6 to 6.8. with no salt of any kind added, and the fish are in apparent good color and health.

At 78° F (which is the temperature we are maintaining) the eggs hatch in four to six days and then in another 48 hours are free swimming. The reports in other literature of nine days to hatch are probably incorrect or the length of time taken was dependent on the temperatures which may have been lower than that which we maintained.

The babies, when they are first able to swim freely, stay low in the tank and usually crowd around the dark edges of the bottom. After about a week of this they are all over the tank and swimming freely.

Realize that our spawning fish (which are very small) are in the two to two and one half inch range and we are still averaging at least 100 eggs to each spawning and I think the largest spawning must be close to 300. The degree of infertility has been almost nil.

I think this is a specialist fish. I don't think I would recommend it for a community tank as Gobies are all aggressive. I think a tank of Mogurnda by themselves are extraordinary and very worthwhile. I think they can do well with fish that are of equal size or larger, but in a normal community set up I think they could be troublesome fish. There are many other fish that are just as aggressive and most certainly can't rival these jeweled Australian beauties. I hope that with this article we can stimulate some interest in the fish as it is so pretty that we must overlook any minor objectionable faults.

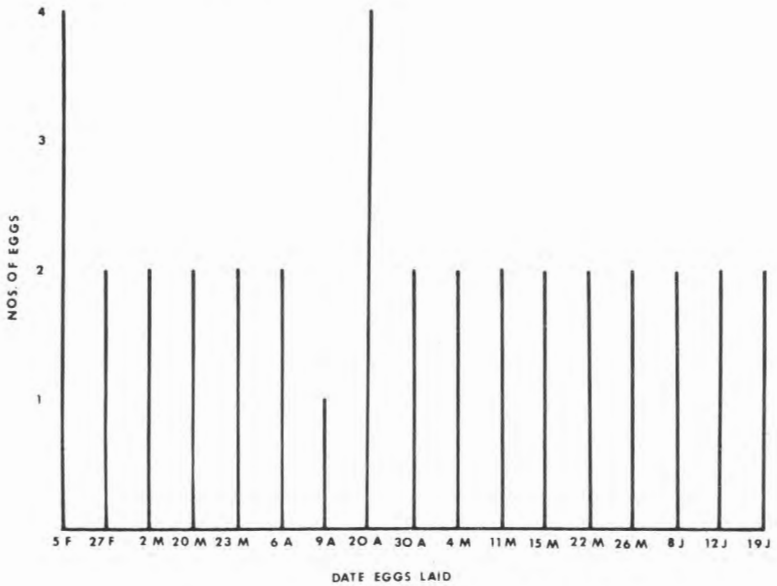
OBSERVATIONS ON EGG LAYING IN THE HORN SHARK, *Heterodontus fancisci* (Girard)

Charles Farwell
T. Wayland Vaughan Aquarium*

A female horn shark which has been on display at Scripps Aquarium since January 1971 produced 37 eggs in a five month period. The first eggs were laid on the fifth of February and the last on the 19th of June. Both male and female specimens were on display, but were never seen copulating. The male was slightly handicapped in that he had only one clasper.

The eggs were usually found during the morning rounds which may indicate that egg laying in nature is a nocturnal event. Most of the eggs had yolks, but none of them appeared to be fertile. One or both of the sharks were seen on several occasions swimming with an egg case in its mouth which may account for the empty egg cases that were found.

The eggs were laid in pairs with a three or four day period between the laying of a second pair. This sequence was repeated every seven to 22 days, and occurred seven times. On two occasions four eggs were laid on the same day--these cases were not as rigid as the others. A single egg was laid on April 9th, and was followed in eleven days by four eggs laid in one evening.



The eggs were put on display or in a holding tank and watched for developing embryos, however, none were found. The female is still on display, and if a sexually agressive male can be found, it may be possible to produce a clutch of fertile eggs.

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METHODS AND TECHNIQUES FOR COLLECTING AND MAINTAINING ALEWIVES FOR BIOLOGICAL RESEARCH

Fred P. Binkowski
University of Wisconsin at Milwaukee

Abstract

This paper is for the purpose of compiling the results and data from the methods and techniques for collecting and maintaining alewives. This report is to be used as a reference guide only and not as a steadfast rule concerning these techniques.

The results of this project showed the growth of these fish had increased by 300% in weight and 40% in length over a five month period, and they were healthy enough to be used in an investigation where the experimental conditions could be manipulated.

After the fish were collected and brought into the laboratory, they were placed on an artificial diet. Disease and temperature were kept in check and controlled for the entire study. It is possible to maintain and condition alewives to a healthy state over an extended period of time, where they can then actually be exposed to different experimental parameters.

Introduction

The objective of this paper is to analyze the data which is related to alewife culturing. The alewife, Alosa pseudoharengus (Wilson), is being used as an experimental fish for various projects related to the Sea Grant research program. The investigation for the specific use of these alewives was to study the temperature relationship to oxygen consumption of the alewife. Many factors effect the artificial culturing of fish, such as temperature and temperature control systems, the effect of drugs, types of food and transport of fishes.

The alewives collected for this project were dip netted in Lake Michigan, off the Milwaukee harbor. The total alewife collection was made from May 1, 1970 to August 28, 1970. The temperature range in Lake Michigan inside the McKinley Marina slip during this time was between 7.25°C and 21.0°C. The fish were always acclimated in the laboratory at their capture temperatures. After the acclimation period, of about six to ten days, the temperature was then adjusted to the experimental temperature, which was 14°C and 22°C.

One important aspect in the initial acclimation of the fish was the prevention of diseases due to bacteria and fungus. These infections usually develop when fish are handled or collected improperly, or are weakened due to starvation. In most cases the diet of experimental fish is set up on the basis of availability and source of the food supply. In this specific case, once the fish were acclimated to their artificial environment, they fed on all foods that were given to them. Because of the higher metabolism of alewives, they had to be fed about five to six times daily.

The transport of fishes requires the most expert professional care and knowledge. This would include collecting and handling techniques, proper transporting temperatures, problems related to metabolic waste build up, and the use of anesthetics.

The success of this project was based on conscientious care, a lot of luck and a great deal of organization related to facilities, equipment and speed of working time.

Methods and Materials

The result of this study is based mainly on fish collected on July 16 and 17, 1970. The specimens were transported in thirty and fifty gallon plastic cans. Usually thirty fish were transported in each can, using lake water. The total time of collecting and transporting consisted of approximately thirty to forty minutes. In some of the collections an aeration system was used, either of the piston type or compressed air. The most important factors in the collecting and transporting procedures was to handle the fish very carefully, by collecting two or three fish at a time out of the lift net, and to work fast, but with a great deal of care.

Malachite green was the only medicinal drug used in the laboratory -- for treatment of fungus, Saprolegnia. An ozonizer was used in the holding tanks to reduce bacteria build up. The holding tanks were set at two temperatures, 14°C and 22°c. When fish were first introduced into the laboratory they were placed in a water temperature equal to their capture temperature. If there was a problem in the availability of holding tanks, the fish were always put into a temperature colder than that at which they were captured.

The temperature of the environmental tanks was controlled by having a continuous flowing water system operating. The water was regular city tap water, but it was circulated through a dechlorinator, and then run through a hot water heater. The warm temperature was regulated at a master control for the entire system and mixed with cold water at the outflow. Whenever the temperature had to be increased or decreased, it was done over a time interval of 1°C per day. After a period of seven days the fish were put on a diet

of frozen daphina, which was collected from Lake Nagawicka in Waukesha County, Wisconsin. On the twelfth day after capture the fish were then fed a diet of tetramin, trout chow, and frozen brine shrimp. Once the fish were well acclimated, their feeding habits improved and the die-off rate was reduced to two to three fish per day. This rate was reached after about fifty days. The tanks were cleaned about every other day. The flowing water system helped in the circulation of water to maintain the proper temperature and also aided in keeping the tanks clean.

Results and Discussion

The results of this study indicate that alewives which are collected and introduced into the laboratory can be maintained under artificial conditions. The major obstacle connected with the use of alewives as an experimental animal is the lack of information on the techniques for collecting and maintaining them. This apparent need has prompted me to attempt to bring together some of the more important considerations associated with this problem. Most important among these considerations are collecting and handling, transporting, nutrition, disease, temperature and the maintenance of suitable environmental conditions.

Collecting and Transporting

To get the field work done properly, the collector should have good equipment and be familiar with it. This would consist of thirty or fifty gallon capacity plastic cans, a lift net apparatus and a transporting vehicle. The best results in collecting fish was usually in the early morning, about seven to eight-thirty. In almost all cases an overcast sky and cool weather produced the best results. The most successful procedure in using the lift-net was to raise it out of the water slowly, but leaving enough slack in the net so the fish could actually be netted out of the water. This would prevent the fish from becoming too active, in which case they would injure themselves. It was found that it was much better to dip two or three fish out at a time to prevent injury. The results showed that healthy fish introduced into the laboratory had a better survival rate, as compared to mass collected fish, where the number injured was greater. Although some fish are sensitive to low temperatures, many can be handled and transported much easier at lower temperatures. In warm weather lower temperatures are easily maintained by using ice. When fishes are crowded into a collecting can, a shortage of oxygen is most apt to cause early mortality. It is better to transport about one fish per one gallon of water. Due to the extremely high metabolism of alewives oxygen depletions occurred easily. In field work you could aerate the water by using battery operated pumps, or compressed air. Either one of these devices is available and works well.

Temperature and Temperature Control Systems

A researcher will often wish to have facilities which are rugged, simple, versatile, and fairly precise for controlling temperatures in a laboratory. The equipment in our laboratory had to be shared by several workers, each of whom had different requirements. The most important factors are that the system be simple and accurate. The holding of fishes requires fairly accurate control of water temperature. Experimental conditions usually prescribe a particular water temperature. Temperature characteristics of water are dependent upon the source. Lake, stream, and tap water are markedly affected by air temperature, although water from a spring fed stream and water from twenty or more feet of depth from a lake have a stable temperature quite similar to well water. A constant temperature for the holding tanks was maintained by regulating the hot water master control, and mixing the cold and warm water at the out-flow. This system was accurate within 1°C to 1.5°C, if the primary water supply was not upset in any other way, such as by the use of an excessive amount of water over a short period of time. The only disadvantage to the use of our water supply was that it is dechlorinated water. This type of system required a longer period of time to acclimate and condition the fish, as compared to filtered natural lake water.

Medicinal Applications

Many diseases and parasites of fishes have been described (A Symposium On Diseases Of Fishes And Shellfishes, 1971), but our principal interest is in the parasites and diseases that are apt to develop under aquarium conditions. The most important are the bacterial and fungal. They are quite contagious and usually produce acute symptoms. Fishes are more sensitive to mechanical damage than is realized. Even slight abrasions may result in fungal and bacterial infections. Among the fungi, Saprolegnia is usually present, but normally becomes a problem as a result of fishes being mechanically damaged or becoming weakened due to a poor diet. There appears to be a relationship between temperature and fungal infections. Lower temperatures favor molds, thus where a mold problem becomes evident, an increase in water temperature may be the solution. Molds are also encouraged by accumulation of excess food in tanks. The presence of the cotton-like growth of mycelia, does indicate that Saprolegnia is involved. Malachite-green and copper sulfate are most commonly used as fungicides for fishes as reported by Martin (1968). A dip of 1:15,000 parts for ten to thirty seconds is recommended. Malachite-green is very effective against certain external fungi under certain conditions (Martin, 1968), but is ineffective against other fungi in concentrations that are not lethal to fish. It would appear that if absolute control of parasitic fungi is to be obtained with long hour treatments, concentrations that are lethal to fish will have to be used. If higher concetrations and shorter exposures are used the treatment may not be effective. On the alewives a ratio of 1.5 grams of malachite-green to 600 gallons of

water was used over a short period of time. The water system for the tank was kept open, to get a complete turn over in approximately four hours. This procedure was followed throughout the entire study. It acted as a safety measure on the toxic effects of malachite-green to the fish. A similar system and procedure was used by Hale (1970) on lake herring. Rather than to try and treat individual pathogens, a technique was used to control all those specific to fish under aquarium conditions. A Sander Ozonizer was used to prevent microbial diseases, keep the water from becoming turbid, and sterilize the tanks. A ratio of thirty mg. of ozone per 600 gallons of water was used. This system was used continuously throughout the entire experiment.

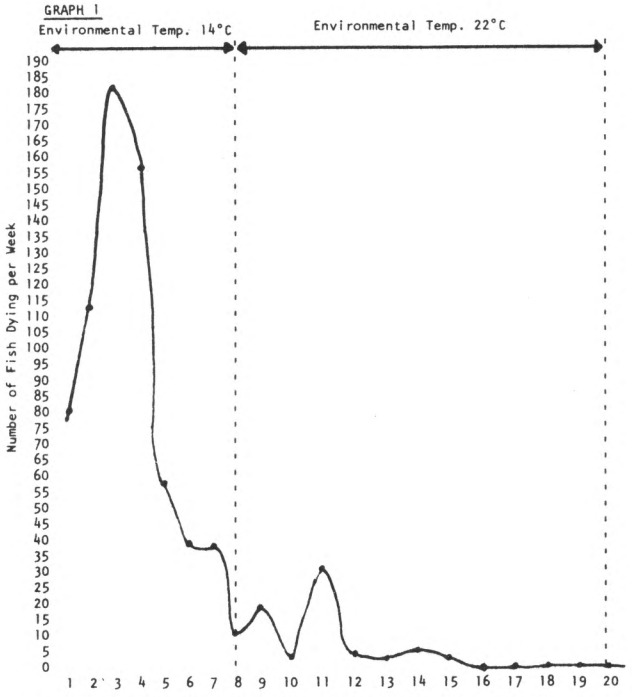
Nutrition

The amount of food to be fed is of special concern in the use of compounded rations. Over feeding results in polluted conditions that can cause the loss of fishes by oxygen depletion. The wide availability of commercial fish feeds has eliminated the necessity of compounding one's own ration. For surface-feeding fish, which is the type of behavior that the alewives exhibited, food in pellet form which floats is best. As reported by Stanley and Colby (1971), the alewives that they were using in their investigation fed well on Purina Trout Chow pellets and Tetramin, which is a flake type food that also floats. Nearly all of the food that was eaten was taken while it was suspended in the water or floating on the surface.

Very little was used after it had reached the bottom of the tank. This was also reported by Purkett (1963) on the culturing of paddlefish. One method used to prevent the accumulation of food in the tank was to freeze the trout chow pellets and tetramin in ice cube form. This kept the food on the surface longer and enabled the fish to feed more naturally.

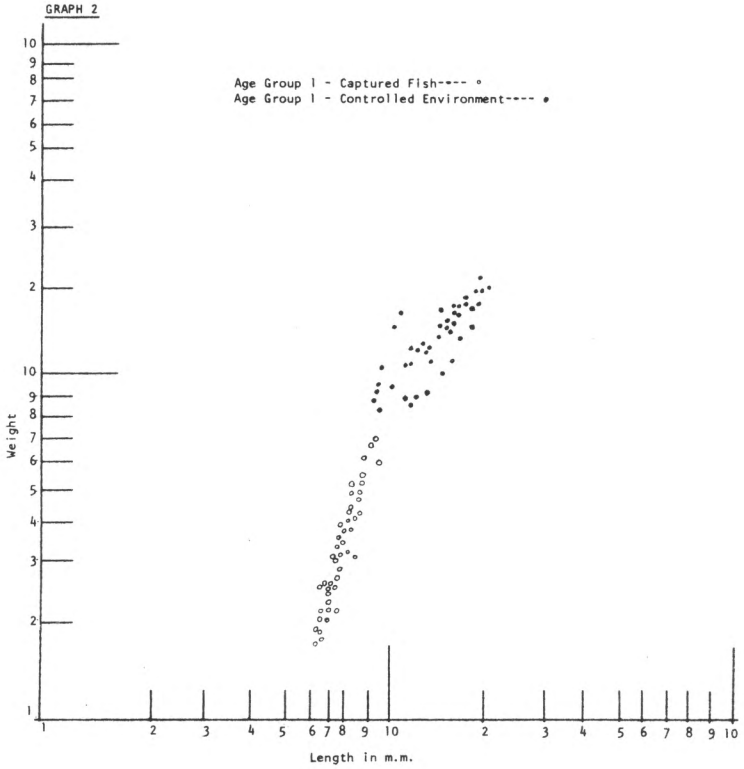
In general fishes do better on live food rather than pellets or flakes. Daphina is an excellent food for fishes. This was fed to the alewives in a fresh-frozen form when they were first introduced into the laboratory. One of the problems that occurs in the feeding of wild fish is that they are not familiar with the food in an aquarium. By using daphina, a type of food which they feed on naturally, the problem was solved because they were able to recognize it. One unusual thing that occurred in the feeding of daphina was that after the fish were well acclimated and feeding well on other foods, they refused to feed on it. This happened after a period of about 50 days in captivity. During this period a diet of frozen brine shrimp were also fed to the fish. One speculation could be that they preferred the larger shrimp over the daphina, except they preferred the pellets and flakes to daphina also.

GRAPH 1



Between the eighth and ninth week the temperature of the environmental tank was raised about 1.0°C per day until a temperature of 22°C was reached. The fish were then held at this temperature for 11 more weeks.

GRAPH 2



Growth Under Artificial Conditions

The primary age group under consideration in this study was age group 1. The fish collected in July had an average length of 79.4mm and an average weight of 3.7g. These same fish five months later under artificial conditions had an average length of 111.1mm and an average weight of 14.0g. A coefficient of condition was calculated for these two groups. The age group 1_0 (captured fish) had a coefficient of condition of 7.2, by use of the formula $K = \frac{(1{,}000{,}000)\ (W)}{L^3}$ (W=weight; L=Length). The age group 1_5 (captured fish five months later) had a K value of 10.0.

There was an approximate increase of 40% in coefficient of condition between these two groups. A 300% increase was calculated for the weight, and a 40% increase for the length. Graph 1 describes the rate of die-off per week. The largest die-off occurred at the end of the third week. At the end of the fifth week the rate was reduced from 160 fish to 55 fish. Between weeks six and eleven the average die-off rate was about twenty-three fish per week. After the twelfth week the rate was approximately three fish per week, and on the sixteenth week the rate had decreased to zero and was held there until the end of the study. Graph 2 is a representation of the length-weight relationship between the two groups. The age group 1 of captured fish displayed a normal straight line relationship between length and weight. The age group 1 controlled environment showed a larger increase in weight as compared to their length increase, which was 40% as compared to 300% in weight.

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NURSE SHARK - 300 POUNDS OF HELL

Gerrit Klay

It is known that the Nurse shark (c Cirratum) is a shark with a docile nature and is usually stacked on top of other sharks of same species, when you have more than two together.

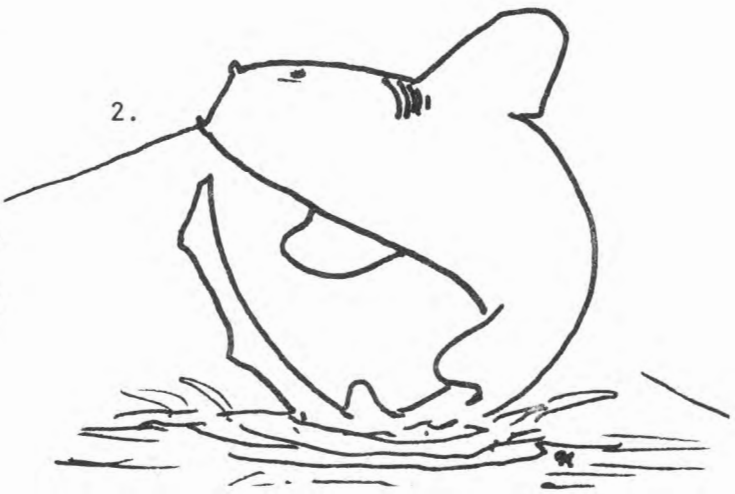
It is also known to be harmless and not at all a game fish for the angler. However, when one is hooked on a set line such as is used by Shark-Quarium which consists of 1 block, 30 ft. of nylon rope, 1 large float, 6 ft. of nylon, 1 small float, and 6-8 ft. of steel wire and a hook, total withstanding 2,000 pounds of pull, all hell breaks loose....especially if the animal is over 8 ft., which is usually the case.

To describe what happens would take too long, but to the people who have seen it and even attempted to land "just a Nurse shark", memories of burning hands, slapping tails, and a small but ferocious mouth snapping at every possible object, will come back. And, for those who have handled one, a respect for the docile shark is quite likely.

1. Approach Run Position - Usually causes the person holding the other end to let go. Burn marks are left on palms of hands.

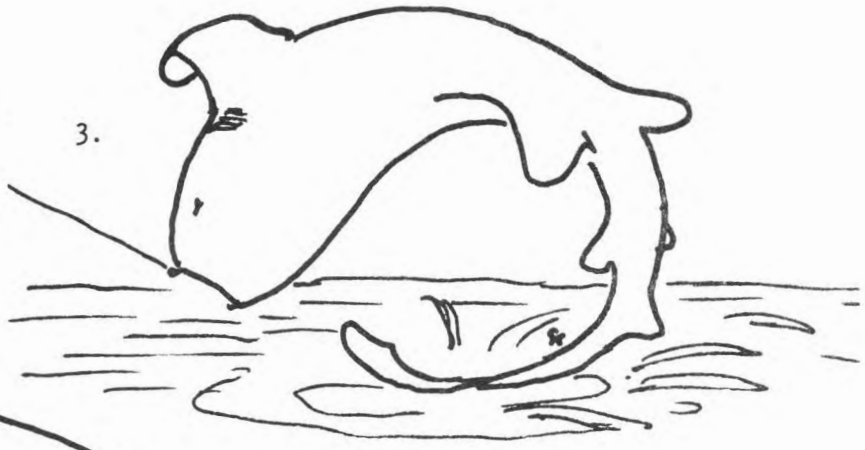
1.

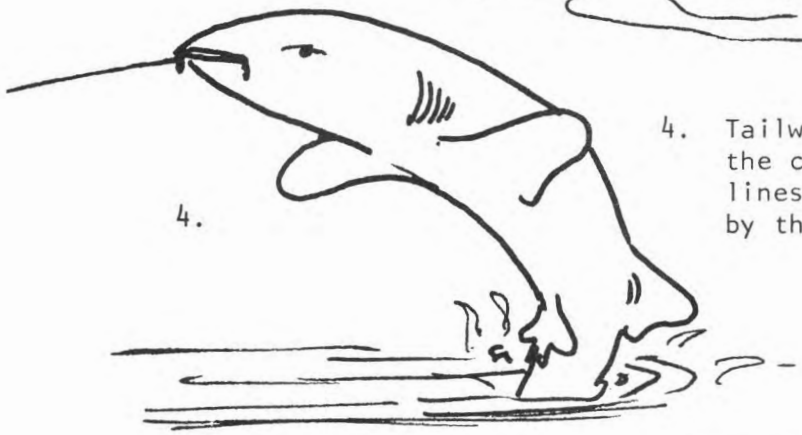
2. Back Flip Position - At the end of the maneuver a slam against the transom of the boat or the lower part of the person hauling in the line. This maneuver usually occurs within 6 ft. of the boat.



2.

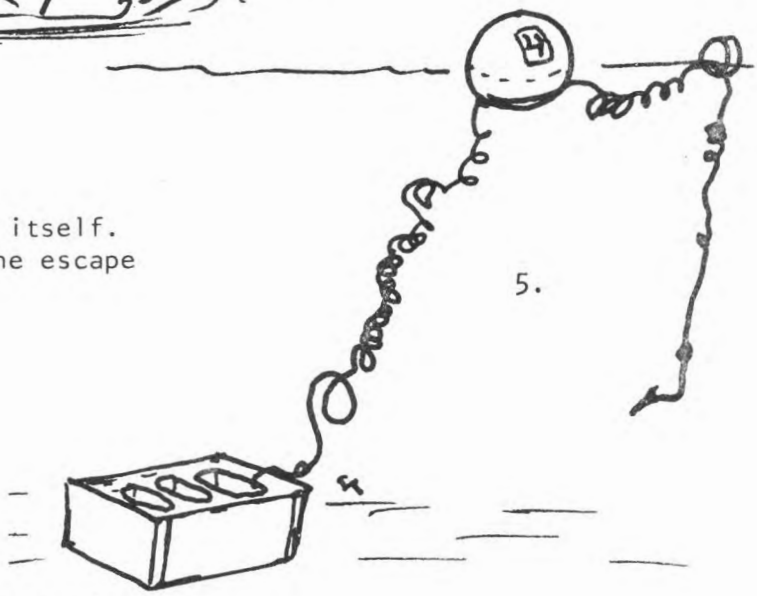
3. Forward Flip Position - This also occurs within 6 ft. of the boat with the terrifying result of beaching the boat and the unlucky catcher.





4. Tailwalk - This results in the catcher letting go of the lines and a successful escape by the shark.

5. This position speaks for itself. This could be known as the escape position.



6. The most popular position - which gives the Nurse shark its reputation of laying around harmlessly.

ON THE PRESERVATION OF THE MANATEE

Craig Phillips
National Fisheries Center and Aquarium

The manatee is certainly the most retiring and inoffensive of all aquatic mammals, and before man started to decimate its numbers, it probably had few natural enemies. Crocodiles, alligators, and perhaps sharks may have occasionally taken the young, especially in the days when crocodiles and alligators were more abundant and their average size was larger. The subsequent history of man's having brought the species to near extinction is well documented, and although at least partially effective laws exist today to protect the relict populations from human predation, the past twenty years have introduced a new and deadly peril -- the power boat.

It is difficult now to find a large Florida manatee that does not bear at least one scar obviously inflicted by a boat keel or propeller, and numerous individuals are killed outright when struck by boats. Lacking the dolphin's ability to echolocate, being virtually invisible from a short distance as it surfaces to breathe, and relatively sluggish in its reflexes, the manatee is in imminent danger of having its final numbers reduced to "the point of no return" in its last two strongholds in the U.S. -- the Miami River and the western portion of Everglades National Park.

Recently it was hoped that manatees could be used in Florida as they have been in the Guianas to control aquatic vegetation, and that their impoundment might provide the added benefit of increasing the native stock under protected conditions. Experiments conducted for several years at Florida Atlantic University in Boca Raton have shown some promise, but in addition to the continuing boat problem (one main purpose of weed control is to improve conditions for boat traffic), I feel that the following three major obstacles would have to be overcome before this plan could be put into effective practice:

1. Keeping the animals from succumbing to winter cold (minimum tolerance is about 60° F.) where migration is impossible.

2. Successfully impounding the animals where they are needed while still leaving the waterways open to navigation.

3. Herding them and keeping track of individual animals in large areas, particularly where the water is turbid.

At the present time it does not appear that a solution to these problems is forthcoming.

At this point I would like to suggest, guardedly, that at the present time at least, water pollution and other human influences may be indirectly

benefitting the standing manatee population to some degree. If this is true, it is at best only a temporary respite for the animals. My reasons for this statement are as follows:

1. Enrichment of the water by certain pollutants may temporarily result in additional plant growth, providing more food.

2. Thermal pollution in certain cases may increase the chances for winter survival (e.g., in the vicinity of the Cutler power plant in Biscayne Bay).

3. The construction of drainage and access canals may provide additional living and grazing areas.

4. Storm drains provide freshwater for drinking (pers. observation in Biscayne Bay and Coconut Harbor), reducing the necessity of periodic migration to the canals.

5. Introduction of the water hyacinth has provided a vast source of potential food in certain areas.

Also, enrichment of the water by pollutants usually causes turbidity which seems to the manatee's liking (its eyesight is poor); being an air-breather, the animal is presumably not directly affected by low concentrations of dissolved oxygen. Still, conservative measures and rehabilitation seem to remain the only answer to the manatee's survival, and toward this end I feel the following immediate measures would have the greatest beneficial effect:

1. A thorough study by qualified persons of the manatee's life history and biology, both in the wild and in captivity. In the latter case tanks or impoundments suitable for holding self-sustaining manatee populations should be constructed with means for both surface and underwater viewing. Reproductive rate, behavior, range of tolerance to various conditions, and diseases (skin infection is frequently seen) can be studied by this means.

2. Establishment of sanctuary areas where propeller boats are banned, or some means devised to protect manatees from blades and keels.

3. Encourage the breeding of manatees and careful record keeping by aquariums and zoological parks that have the facilities to do so. (I do not agree with the idea prevalent among some conservationists that these institutions should be prevented from exhibiting manatees; they should be granted permits contingent on the quality of their facilities and their scientific staff and their agreement to keep detailed records which will be published and circulated freely to other institutions).

4. Improvement and more thorough enforcement of the present laws protecting manatees, including increased penalties for molesting or harming them in any way.

Finally, as a possible future measure (following thorough studies of the possible ecological effects of such introductions), manatee colonies might be established in suitable areas where they do not presently occur or have not occurred in the past.

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INTRODUCTION TO KEY TO RECENT SIRENIA

Craig Phillips
National Fisheries Center and Aquarium

The following provisional key to the Order Sirenia makes use of the bulk of their definable characters and is the result of some years' perusal of the literature on these unique relict animals, examination of museum specimens, and numerous observations on manatees in captivity and in the wild.

Of the manatees (Trichechus), only one, the freshwater Amazonian species, may be easily separated from the others on the basis of external morphological characters. Precise measurements and other morphological data on a greater series of specimens than are now available are obviously needed.

In the course of examining a preserved adult male dugong from Palau at the National Museum (USNM 307610), I found an interesting character that I have not encountered in the literature to date. Imbedded in the otherwise smooth skin were a number of scattered and minute sharp spines which made it unpleasant to handle. These short spines which I term "spicules" apparently consist of modified hairs, and are interspersed with other hairs of normal form. Since it is possible that these spicules in this particular specimen represent either an aberrancy or a case of sexual dimorphism, this character was not included in the key.

KEY TO FAMILIES, GENERA, SPECIES AND SUBSPECIES OF RECENT SIRENIA

Craig Phillips

1. Rostrum long, jaws bent downward at an angle; proboscis-like snout projects downward beyond nostrils; seven neck vertebrae; ribs slender, unmodified; flippers nailless; tail base compressed forming a caudal peduncle; tail flukes pointed, expanded laterally with concave rear margin as in a cetacean; ear-hole visible externally in living forms; marine.
.....Family Dugongidae, 2 genera. Dugongs and Stellers sea-cow.....3

2. Rostrum short, jaws curved downward to moderate degree; nostrils located dorsally near tip of snout; six neck vertebrae; ribs massive, ivorylike, with thickened centers; flippers nailed or nailless according to species; tail base depressed; tail flukes united forming a broad flattened paddle; ear-hole closed, visible externally as a minute pit; freshwater to euryhaline.
.....Family Trichechidae, 1 genus. *Trichechus*, Manatees.....5

3. Teeth and finger bones absent; jaws covered by horny pads; skin dark, heavily rugose, and furrowed; size to 20 feet.
.....Genus Hydrodamalis; 1 species, *H. gigas*, Stellers sea-cow. Bering Sea. (Unreported since 1780).

4. Teeth and finger bones present; incisor tusks on upper jaw of male; skin pallid, smooth, with scattered hairs; size to 12 feet.
.....Genus *Dugong*: 1 species, *D. dugon*, Dugong. Red Sea, Bay of Bengal, Malay Archipelago, Moluccas to Philippines southward to New Guinea and northern Australia.

5. Flippers short, nailed; skin rough and pebble-toned, color uniform; skull dense, smooth; size to 13 feet; euryhaline
.....Coastal manatees.....7

6. Flippers elongate, nailless; skin velvety to moderately rugose; large white or pinkish breast patch frequently present; skull soft, chalky, with rugose surface; size to 6 feet; freshwater.
.....*T. inunguis*, Amazonian manatee. Amazon and Orinoco River drainages of northern South America.

7. Vomer extends past level of orbits to posterior edge of incisive foramen or beyond; deep symphysal groove in adult mandible.
.....*T. manatus*, American manatee. 2 subspecies.....9

8. Vomer extends only to level of middle of orbits; no symphysal groove in adult mandible.
.....*T. senegalensis*, West African manatee. Coast and river drainages from Senegal River south to Canuga River, including Lake Chad drainage.

9. Foramen magnum narrower, its index (breadth divided by height) in most individuals 0.65 to 0.71.
.....*T. m. manatus*, Caribbean manatee. West Indies and eastern Continental coast from central Mexico to near Rio de Janero.

10. Foramen magnum broader, its index in most individuals 0.54 to 0.61.
.....*T. m. latirostris*, Florida manatee. Discontinuous on Florida coast from Jacksonville to Suwannee River drainage. Occurs in St. Johns River upstream to near Orlando; abundant near mouth of Miami River and bays and rivers of western portion of Everglades National Park. Absent from Florida Keys and main portion of Everglades including Lake Okeechobee. Enters large spring areas in winter months.

NOTE: *T. manatus manatus*, *T. m. latirostris*, and *T. senegalensis* are virtually impossible to differentiate on the basis of external characters, and skeletal details are subject to some individual variation. Locality alone should suffice for identification in most cases. Due to the present paucity of comparative measurements on manatees, the following supplemental characters could not be fitted into the key: *T. inunguis* is more slender than *T. manatus* and *T. senegalensis*. *T. manatus* has a longer and proportionally more slender snout than *T. senegalensis*. The pectoral limb bones of *T. manatus* are about twice as thick as those of *T. senegalensis* of comparable size.

HOUSING REQUIREMENTS FOR MANATEES AND DUGONGS

Craig Phillips
National Fisheries Center and Aquarium

Of all marine mammals, the sea-cows or sirenians to date have appeared to be the most neglected when it comes to adequate housing and effective exhibition, whether they be kept at aquariums or zoos. This is most unfortunate, since the five living forms (most of which are endangered species) seem potentially capable of thriving and breeding in captivity.

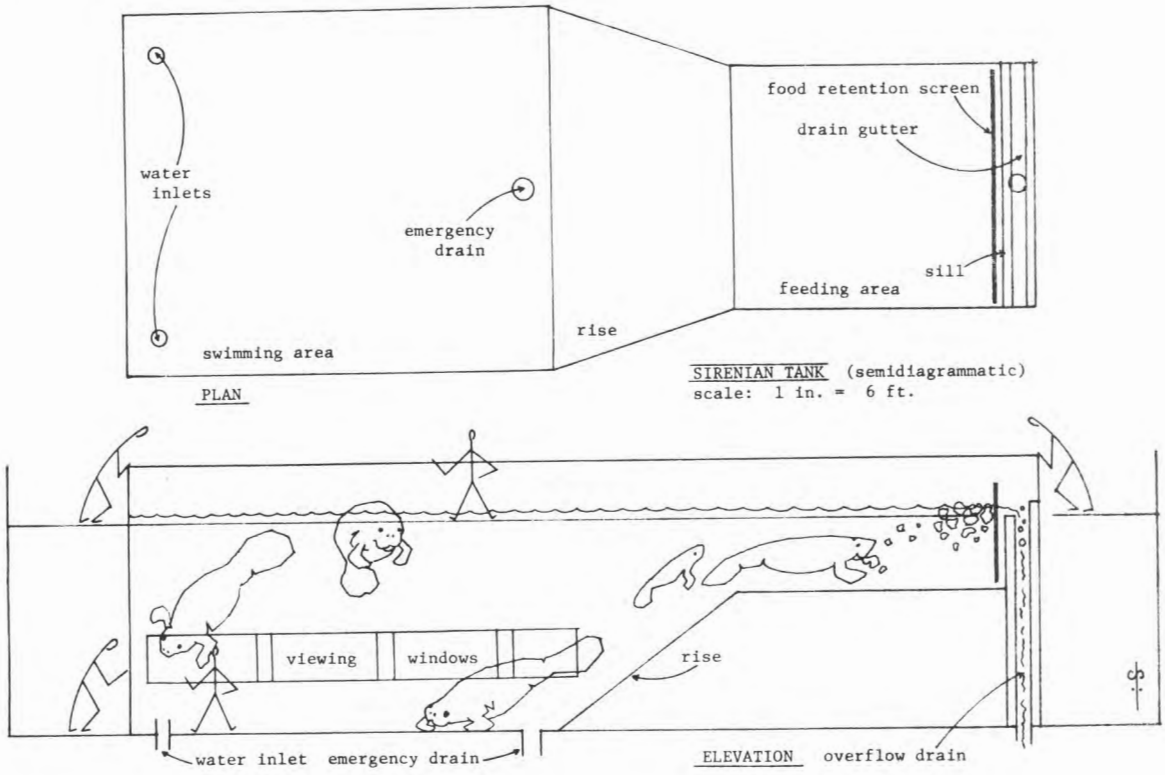
In the past manatees and dugongs have been traditionally kept in bin-like shallow concrete tanks with viewing from the top only, or else in glass-fronted aquariums with water systems that were originally designed for fish or fish-eating mammals. Neither of these, in my opinion, is adequate. The vegetarian habits of sirenians and the large quantity of vegetation they consume poses special problems of water cleanliness, and in addition the euryhaline forms seem to do best in water of periodically changing salinity. The purpose of this paper is to present in generalized form a design for a tank to house sirenians in an effective manner, and at the same time be most efficient in operation.

Basically, such a tank should consist of a swimming area with a depth at least equal to the length of a large animal and a shallow browsing area with a retaining screen for floating food, bottom water inlets at the deep far end, and a drain gutter at the shallow near end beyond the screen. The shallow browsing area is narrowed so that a maximum water current is produced to keep the vegetable material against the screen until it is consumed. Two water inlets are suggested, one fresh and one salt, which may be used alternately or in any desired combination. If a closed system is mandatory, it is recommended that the water be kept slightly brackish for manatees other than the Amazonian freshwater species (see Key to Sirenians, page 33) which never enters the sea.

Manatees living in salt water (e.g., in Biscayne Bay at Miami) are adept at drinking freshwater from hoses tossed to them from fishing piers, holding the end to their mouth with their flippers. This suggests that some sort of freshwater spigot could be devised which they could activate by nuzzling with their snouts when thirsty.

Newly captured specimens will usually feed on aquatic Naias grass (difficult to collect in quantity, and messy) or water hyacinths (fine if your installation is in Florida), but can sometimes be exasperatingly stubborn in accepting other foods at first. A trick

that seems to work is to chop their preferred food into a salad and "spike" this with increasing amounts of lettuce and cabbage, which can eventually become their sole diet if necessary. Other foods that have reportedly been accepted by manatees and dugongs in captivity include bananas, sweet potato leaves, green alfalfa hay, and bread.



Manatees kept in tanks exposed to the sun soon acquire a luxuriant algal growth on their backs, necessitating periodic scrubbing. Changing the salinity helps to offset this problem, but the best "final solution" I know of was hit upon at the Miami Seaquarium and consisted of placing several large gray mullet (Mugil cephalus, a euryhaline fish) in with the manatees. These not only kept the backs of the manatees reasonably free of algae, but the sides and floor of the tank as well.

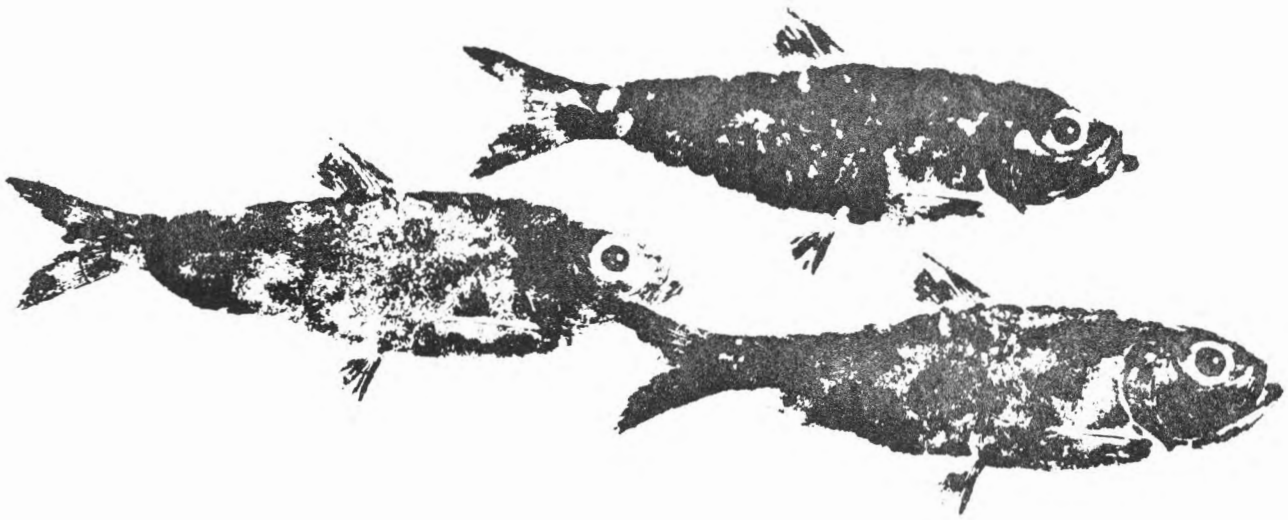
AQUARIUM DIRECTORY NOW AVAILABLE

The Directory of the Public Aquaria of the World is now out in its Fourth Edition. The pamphlet contains about sixty (60) pages of the world's "fish houses" by countries including names and addresses, either current or as last reported, together with a few succinct facts on each institution.

Two (2) copies will be mailed to all aquaria listed including those who did not reply. Persons desiring more copies may request a limited number after July 1, 1972.

The directory is available from:

Spencer Tinker, Director
Waikiki Aquarium
2777 Kalakaua Avenue
Honolulu, Hawaii 96815



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Snyder Oceanography Services, also a supplier of ecological instruments, has a new catalogue of instrumentation packages for industry.

NOTES ON THE GALAPAGOS ISLANDS*

Ed Zern

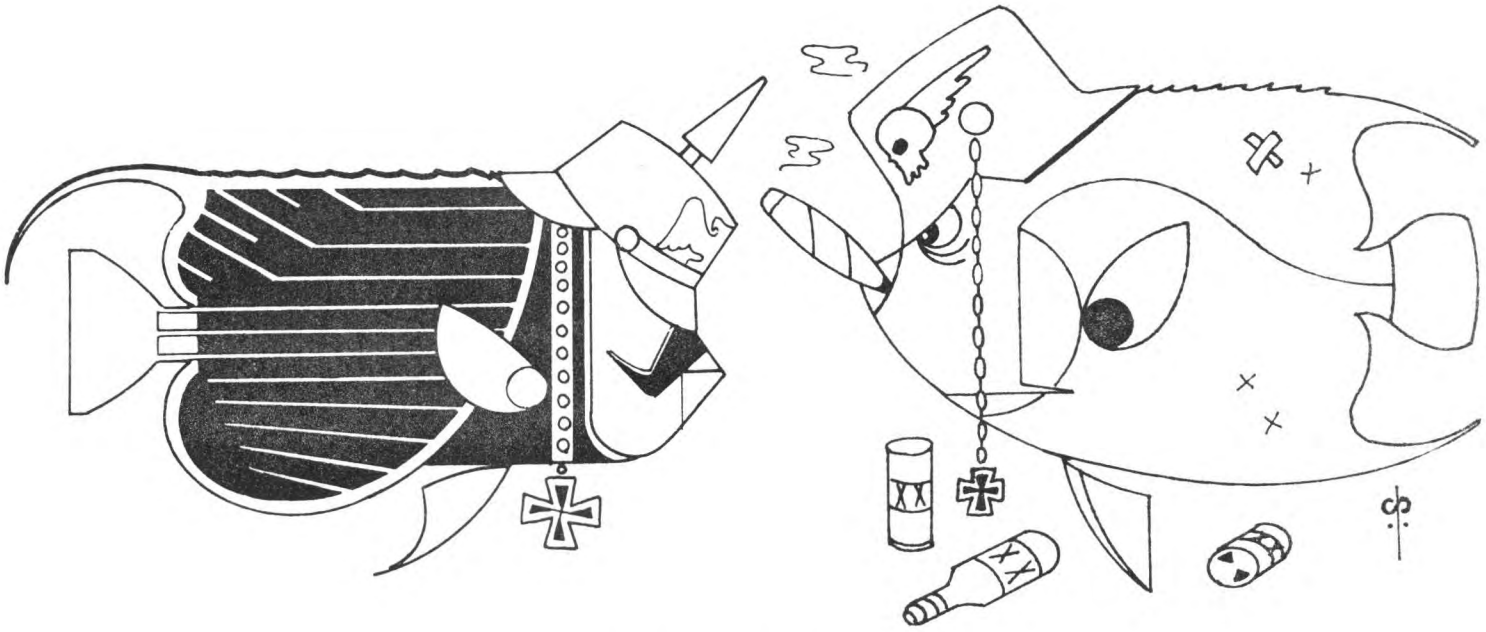
Last January I spent five days touring the Galapagos Islands, 600 miles off the coast of Ecuador, aboard the Greek cruise ship Lina A, in the company of a mixed Greek and Ecuadorian crew and a mixed North American and North Italian passenger list, with a Dutch microbiologist as guide during our numerous excursions ashore. The islands are, geologically speaking, of recent volcanic origin, and although there are no active craters at the moment, the landscape is acneous with inactive ones, giving the whole place a decidedly lunar look.

Hence, the Galapagos landscape is quite interesting in a rather bleak way, but unfortunately virtually every square foot of it is cluttered with such a melange of 200-year-old tortoises, who knows-how-old penguins, pink flamingoes, blue-footed and pink-footed boobies, swallow-tailed frigate birds, brown pelicans, seaweed-munching marine iguanas, sea turtles, assorted lizards, sea lions, herons, gulls, cormorants, finches, and garishly scarlet crabs that it's almost impossible to see the scenery, and I wonder that the Ecuadorian government, which runs the place, hasn't done something about it. They could borrow a crew of vermin-control experts from the Bureau of Sport Fisheries and Wildlife which could move in there with cyanide bombs and poison baits and have the place cleaned out in no time at all. But of course one doesn't expect a small South American country to be as advanced as we are.

In the course of the trip I was interested to observe that each major island harbored a different and unique variety of finch, each of which had adapted itself to conditions on that particular island and had developed a beak designed for, say, cracking seeds or prying grubs out of crevices in tree bark, and as I presumed that these finches had at some time in the past shared a common ancestor, it occurred to me, in a sort of blinding flash of intuition, that possibly the Old Testament account of creation in the book of Genesis is not strictly and literally true, that in fact the story of Noah and the Ark may be a myth rather than the scientific fact I had hitherto accorded it to be, and that it may well be that in place of God having created an immutable set of fauna sometime around 4000 B.C., different species of plants and animals may have come into being through a much lengthier and ever-continuing process of "evolving", during which only the fittest organisms among thousands of mutations and variants survived.

*Originally published in Mr. Zern's "EXIT/LAUGHING" column.

So struck was I by this conjecture that I decided to develop it into a full-length book which, while no doubt incurring the wrath of devout Bible-believers the world over, might nevertheless have intrigued the scientific community and even amused a few nonscientific perusers. Unhappily, by the time I had got fairly well into this project I discovered that a previous visitor to the Galapagos archipelago, a chap named Donovan or Dorfman or some such, had had the same idea and had beaten me to it with a volume entitled, with a total lack of wit or imagination, The Origin of Species (I had planned to call it To Hell With Finches). I understand it started out well enough but that sales have since fallen off, and perhaps it's just as well I didn't waste my time.



Kaiserfish meets Hell's Angelfish.

SPAWNING THE CLOWN LOACHES*

Tom Cotten

I happened to be reading an advice column in one of the aquarium hobbyists' magazines the other day and was startled to read that there had been, heretofore, no reported spawnings of the Botia Macracantha--startled because my pair spawn so often that it was becoming a nuisance until I discovered that my guppies dearly love the Clown Loach fry.

Reluctantly, I'll admit that I had exhausted all hope of a successful spawning before I finally discovered the secret about three days later.

The major difficulty, it seems, is obtaining a pair, however sexing them is not as difficult as one might think. The females, of course, are the more colorful, having bright red-orange finnage and a rather pale-orange body with wide dark-black stripes (or is it a dark-black body with wide pale-orange stripes?). The males, on the other hand, have dull, chartreuse finnage and wide, royal-blue stripes on a navy blue body. I also understand that the females outnumber the males about 60,000 to 1, and after observing several spawnings, I think I know why; this will become evident later. I was fortunate enough to find my male in a new shipment of "mixed" dwarf cichlids, so that may be a good source.

The spawning setup is not elaborate, consisting of nothing larger than a ten-gallon tank into which a minimum depth of thirty-two inches of hard water is introduced and allowed to stand for about five days. On the bottom spread about six inches of finely-crushed sawdust which should be weighted down by an airstone. Now comes the secret ingredient: three table-spoons of your favorite cola. (This great "breakthrough" was the result of a drink being accidentally tipped over into my tank during one of my parties.) This seems to serve the same purpose as the "peat filter", but is a lot simpler. Also, there should be about three or four short springs of myriophyllum located just about center of the tank, embedded in the sawdust.

The male should be introduced at sunrise on a Sunday morning and he will promptly begin construction of the bubble nest. The nest, being slightly heavier than water, will remain suspended about mid-way of the aquarium depth. Now introduce the female...gently, though, because throwing her in may destroy the nest.

*Reprinted from "The Hobbyist".

The female will begin her courtship immediately, swimming around the male to get his attention, then darting around behind the plants enticing the male to follow. When the male is sufficiently aroused, he will chase her up the myriophyllum and into the bubble nest. Just what occurs within the confines of the nest remains a mystery, however about two hours later a few eggs are emitted from the nest, most rising to the surface and one or two sinking to the bottom of the aquarium.

The surface eggs seem to hatch quicker, about six hours, possibly due to the drying effect of the air. During the next hour these fry develop the characteristic female colors, become free-swimming and begin feeding on the few eggs on the bottom. If one of these "bottom-bound" eggs happens to escape this onslaught, it will hatch in seven days and immediately burrow into the sawdust to become a male Clown Loach hiding there until it becomes a full-grown, mature male able to hold his own against the over-bearing female population.

Now that the spawning secrets have been finally released and entrenched in the minds of the hobbyists, I expect to hear of many more successful spawnings of the elusive Clown Loach.

KILLER WHALE AT HOME DOWN UNDER*

Ramu II, the male killer whale flown to Australia from San Francisco last year, has settled down in its new home at Marineland on the Gold Coast of Queensland, where it has been taught several tricks and performs in its own show.

The whale consumes 60 lbs. of fish a day, 30 lbs. of which is imported North Pacific herring (Clupea pallasi) and 30 lbs. of local fish. Of the local species Ramu prefers bonito (Sarda chiliensis australis) which is not available in large quantities.

Bonito, or horse mackerel as it is known in New South Wales, is a common coastal species but is rarely caught by commercial fishermen.

Ramu II is the only killer whale in captivity in the Southern Hemisphere and according to Marineland's director and curator, Mr. David Brown, it may be the only one Australians will ever have if a proposed ban on their capture is implemented by the United States later this year.

Killer whales are found in many parts of the world but few are taken alive because they live in deep water -- their natural habitat. Nor, says David Brown, can they be captured by the same methods used for dolphins.

The whale replaced Ramu I, previously flown to Australia by Marineland, which died. It failed to survive the traumatic effects of the change in environment.

Ramu II caused some anxiety when some weeks ago it lost interest in showing its sleek black and white coat to visitors and was off its food.

With Ramu currently worth $50,000 and probably irreplaceable, David Brown lost no time in putting it on antibiotic drugs. It was given massive doses of ampicillin every six hours.

Tests revealed a chronic lung infection to be the cause of the trouble but latest reports state that Ramu is convalescing quietly and will soon be back to demonstrate its remarkable gentleness and skill.

The killer whale lives in a specially constructed pool, measuring 50 ft. long, 35 ft. wide and 12 ft. deep. Windows are let into the side for underwater viewing. New quarters for the whale may be needed when it grows to its full size of between 27 ft. and 30 ft. Its present length is 12 ft. 8 ins.

*Reprinted from Australian Fisheries; August, 1971.

In its natural habitat Ramu would have been a voracious killer, feeding on other whales, dolphins, turtles and aquatic life, but in Marineland it has adapted quickly to a diet composed mostly of Pacific herring, supplemented by locally caught fish (mainly gar) and large quantities of minerals and vitamins.

Despite the bad reputation killer whales have Ramu II has proved to be extremely gentle where humans are concerned. It has allowed its handlers to withdraw blood samples, which are taken routinely, without fuss and when ill never attacked 'nurses' giving intra-muscular injections.

David Brown says that the reputation is undeserved. Ramu will allow its trainer to put his head in its massive jaws and lets one of the girls on the staff ride on its back in the pool. Ramu peacefully demonstrates other skills and responds with great intelligence to commands.

Ramu's potential as a valuable subject for research is taken seriously at Marineland and detailed records of behavioural patterns are kept for the future attention of marine biologists and other oceanariums.

THE USE OF ULTRA-VIOLET LIGHT FOR WATER PURIFICATION

Robert E. Flatow, R. E. Flatow & Co., Inc.

We have done a tremendous amount of research work as well as development work in the field of water purification and particularly ultra-violet light water purification for fish hatcheries. Our Company is the one that suggested and developed the first control in the hatcheries for Myxosoma Cerebralis (whirling disease) which had been identified in 1903 in Germany and spread all over Europe as well as into the U.S. We have also proven that Saprolegnia in the hatchery can be controlled.

During the past year we have expanded our work into the Aquaculture and Mariculture field, and have developed several new units specifically for these fields as well as the fish culture field.

The REFCO WATER PURIFICATION SYSTEM has been accepted and installed by just about all Federal and State Fisheries, as well as the Canadian Government and many Provinces there. We have installations with Sports Fish & Wildlife, National Marine Fisheries Service, and as mentioned, many States and Provinces.

The following article is reprinted from the Alameda Times-Star. It is about an installation we made two years ago for the State of California at their Feather River Hatchery, Oroville, California.

Also, we have a very wide spread (world-wide) mailing list which receives our Fish Cultural Newsletter. If any Drum & Croaker readers would like to receive our newsletter they can request this from our Berkeley Office (P.O. Box 2145, Berkeley, Calif. 94702).

* * * * * *

THE FEATHER RIVER HATCHERY

A fish hatchery -- even one as efficient as the Feather River Salmon and Steelhead Hatchery at Oroville -- is not something you can build and forget.

The hatchery, which was built by the Department of Water Resources to care for fish that were cut off from their spawning and nursery areas by Oroville Dam, is, financially speaking, a miniscule part of the giant multibillion dollar State Water Project.

But DWR and the Department of Fish and Game, which operates the

hatchery, are vitally concerned with the success of the operation that contributes more yearling king salmon to the Pacific Ocean catch than any other hatchery in California.

How well the two agencies are doing their jobs with the hatchery is indicated by the fact that the sports take of salmon for 1971 is one of the best on record -- at least as good as and probably better than the 184,000 salmon taken in 1970, third best year in history.

The total ocean catch off California, including 5.5 million pounds of king salmon and 1.5 million pounds of silvers, is close to the 20 year average for the fishery.

Nearly 3,700 salmon returned from the ocean to the Feather River Hatchery and were spawned during the year, and about nine million eggs were taken. The total number of spawners, which was well above the 1970 figure, included 480 spring run salmon, more than twice the number for the previous year.

In terms of spring run salmon eggs taken, the 1971 yield was twice that for 1970, and the mortality of spring run females was cut from about 50 per cent to less than one-half of one per cent.

Directors William R. Gianelli of the DWR and Ray Arnett of the DFG point to the significance of these accomplishments in view of the declining salmon-steelhead populations and habitat.

Because the DFG is unable to create extensive natural spawning areas in the remaining streams, it must rely on artificial means of re-building and increasing runs. Therefore, hatcheries such as Feather River must be made as efficient as possible.

But the accomplishment of restoring salmon and steelhead runs did not come as a natural consequence of construction of the hatchery. There were problems to tackle and solve.

Soon after the hatchery opened in 1967 king salmon fry began dying by the thousands because of a cold water virus. The virus attacked the juvenile fish in the rearing ponds where the water temperature was 45 degrees (F), a temperature at which the virus is particularly virulent.

The DWR and the DFG worked out an arrangement with the Thermalito Irrigation District to deliver TID well water--at 60 degrees (F)--so that the water could be mixed with hatchery water to produce a constant supply of 58 degree water in the rearing ponds.

The fry were kept in the 58 degree water for 27 days -- until they had reached weights of about 20 to the ounce -- and then, now less susceptible to the virus, were transferred to ponds with 45 degree water.

Used ever since, the system has effectively halted the virus, and now after two seasons the agencies are convinced that they have the problem solved.

There was a major problem with steelhead at the hatchery as well. Large numbers of steelhead were being lost to Ceratomyxa, an internal protozoan parasite.

At Fish and Game's request, the Department of Water Resources built a highly intricate complex of banks of ultraviolet light tubes through which water to the steelhead rearing ponds was channeled. The treated water has effectively killed the protozoan, and has saved many times over the $150,000 expenditure for the installation.

Steelhead that survived the protozoan have been placed in a separate pond and are being used as brookstock in an effort to develop a strain that will be resistant to the parasite.

Meanwhile, techniques in the handling, raising and planting of fish are being improved continually -- all to help accomplish the basic mission of the hatchery: the preservation and enhancement of salmon and steelhead runs.

Spring run king salmon are no longer being taken for spawning in June when they arrive at the hatchery. Experience has shown that taking the spawners this early results in high mortality among females.

During 1970, for example, half of the 82 spring run female spawners were lost.

Hatchery personnel during 1971 delayed the taking of spring run king spawners until September, and they lost only one of the 207 female spawners.

Diet improvements for king salmon are increasing survival and growth rates. The DWR-constructed 70,000-pound-capacity cold storage facility for dry fish food is credited in large part for the success of the diet improvement project.

Improvements in diet are resulting in the return of increasing numbers of three year old kings. The DFG knows this on the basis of data developed in a three-year marking and transportation program.

The project is designed to evaluate the effects of trucking 90-to-the pound (approximately three-inch-long) king salmon fingerlings downstream to Rio Vista for release rather than releasing them at the hatchery.

Although final data are not in on the contribution of the yearling kings to the fisheries, the DFG-marked kings consistently appeared in Bay Area sports catches during the 1971 season.

During the year 900,000 yearling kings -- 200,000 of them from the 1970 spring run -- were released from the Feather River Hatchery. The number of spring run kings planted was the largest in the hatchery's history.

One of the most advanced fish hatcheries and spawning channels in the world, the Feather River Hatchery is the result of the combined planning of the two agencies with the advice and assistance of the U.S. Fish and Wildlife Service and others.

The facility is a compact unit where a large number of adult fish can be trapped, held, artificially spawned or moved into the spawning channel. The water supply for handling adult fish has been arranged with flush gates, mechanical lifts and circular tanks so the fish are always moved in water.

Water currents through the spawning system can be manipulated to attract fish to any desired point. With the use of modern facilities, young fish are reared with a minimum of handling, thereby reducing cost and increasing survival.

The $2.3 billion State Water Project was the first large multi-purpose project to be built in which recreation and fish preservation and enhancement were given top priority. The DWR and the DFG both want to keep it that way.

CHEMOTHERAPY OF FISH DISEASES: A REVIEW

Roger Lee Herman
Eastern Fish Disease Laboratory,
Bureau of Sport Fisheries and Wildlife

Introduction

Fish suffer from environmental, nutritional, viral, bacterial, parasitic, and neoplastic diseases, many of which are similar to those of higher animals. The prevention and treatment of these diseases follow the same principles as diseases of other animals.

Fish culture is similar to poultry husbandry in that large numbers of animals are crowded into relatively small areas, feeding is free choice, and medication for systemic infections is usually oral. External treatment of fishes is more common than of poultry, due to a higher frequency of external diseases.

Many of the drugs and chemicals used in chemotherapy of fishes are the same as for higher animals. The following is a brief review of the more important drugs and their methods of administration.

External Treatments

External treatments usually are added to the water although direct application may be useful with aquarium or experimental fish.

The following types of baths, varying primarily in strength of therapeutic agent and time of exposure, are used for administering external treatments:

Dip - fish are dipped into a concentrated solution of chemical for up to one (1) minute.

Short bath - water flow is shut off, and chemical is added to the chamber at high concentrations, relative to toxicity, and allowed to remain up to an hour. The flow is then turned on and the chemical flushed out.

Long bath - low concentrations of chemical are added to ponds or aquaria and allowed to dissipate naturally.

Flush - the entire dose is added at the flowing inlet and allowed to spread through and out of the container. Water flow is continuous, and dose rates are about the same as for short baths.

Constant flow - a metering device is used to introduce concentrated chemical into the water flow to give a constant, continuous dose.

Fin and tail rots of aquarium fishes and bait minnows are treated with antibiotics or sulfonamides dissolved in the water. Antibiotics appear to be more effective and are usually used at a rate of 50-250 mg/gal.

The agent(s) involved in these "rot" diseases vary, thus it is advisable to identify the bacteria and determine drug sensitivity in each case. If facilities are not available for this, a mixture of drugs may give best results.

External myxobacterial infections in the early stages usually respond to treatment with disinfectants such as quaternary ammonium compounds (Roccal, Hyamines)[7] or ethylmercuric phosphate.[8]

Formalin baths are effective against the common protozoans, Ichthyophthirius, Costia, Chilodonella, and Trichodina.[2] Malachite green (zinc free) is also effective, however, it is more toxic than formalin and cannot be used on the tetra group of aquarium fishes. Acriflavine (Trypaflavine) and methylene blue also are used to remove protozoa infesting aquarium fish and may be used on other fish species.

Monogenetic trematodes infesting the gills and skin of fish are removed with a short bath of formalin.[2] Acetic acid and potassium permanganate have been used, but formalin seems to be preferred.

DDT and benzene hexachloride (BHC) have been found effective for removing parasitic copepods but they are highly toxic, have adverse effects on zooplankton and bottom fauna, and are persistant. Dylox*, an organophosphate lacking many of the disadvantages of the chlorinated hydrocarbons, has been reported recently as effective. Four weekly pond applications control the parasite.[3]

Internal Treatment

Medicated feeds are used for treatment of systemic infections or intestinal parasites. Suitable chemicals can be incorporated into dry, pelleted feeds or coated on them with gelatin-water, methyl cellulose, or feeding oil. For wet diets, the drugs are mixed in the dry meal portion prior to the addition of meat. We have a unique situation with medicated fish feeds. Dose rates of systemic drugs are calculated per kilogram of total body weight without regard for individual size or temperature.

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*Dylox (0,0-Dimethyl, 1,2,2,2 trichloro-1-hydroxethyl phosphonate) Chemagro Corp., Kansas City, Missouri.

TABLE 1. Fish Therapeutics

Chemical	Dose	Disease
Acriflavine	10 ppm bath, 3-20 days	external protozoans of aquarium fishes
	2-4 ppm 24-48 hours	of catfish (Ictalurus)
Chloramphenicol	2.5-3.5 gm/100 lb. fish/ day in feed, 7-10 days	bacterial infections
	3 mg i.p. single injection	prevent A. liquefaciens
Dylox	0.25 ppm active in ponds 4 weekly applications	parasitic copepods
Enheptin	0.2% in feed 3-5 days	Hexamita
Erythromycin	10 gm/100 lb fish/ day in feed, 21 days	Corynebacterium
Ethylmercuric phosphate (Timsan)	1-2 ppm bath for 1 hour	gill disease
Formalin	250 ppm bath for 1 hour; in ponds, 25 ppm indefinitely	external protozoans, monogenetic trematodes, fungus
Furazolidone	1.2 gm/100 lb fish/ day in feed, 20 days	furunculosis
Malachite green	1 ppm bath 1/2-1 hour; in ponds, 0.1 ppm indefinitely	external protozoans, fungus
Methylene blue	2 ppm daily in aquaria	external protozoans
Oxytetracycline	2.5-3.5 gm/100 lb fish/ day in feed, 10 days	bacterial infections
Quaternary ammonium compounds (Roccal, Hyamine)	2 ppm active, bath for 1 hour	gill disease
Sulfonamides	10 gm/100 lb fish/ day in feed, 14 days	furunculosis systemic myxobacteria
Tin oxide di-n-butyl	Total of 11.5 gm/100 lb fish given over 3 days	intestinal helminths

On the other hand, the amound of food given fish, particularly salmonids, does vary with size and temperature.[4] Thus the concentration of a drug in feed varies with temperature and fish size. In addition, the size of pellets varies with the size of fish. These variations make it necessary to order medicated fish feed as custom mixes to meet the requirements of a particular situation.

Injection of drugs into fish can be done intraperitoneally or intramuscularly with ease, while some skill is required for intravenous injections. Parenteral treatment is limited by use to control of diseases caused by Aeromonas and Pseudomonas. It may also be used for

treatment of valuable aquarium or experimental fishes.

Systemic myxobacterial infections (e.g. columnaris, cold-water disease) do not respond to external treatments. Oral administration of sulfamerazine, sulfamethazine, sulfisoxazole or oxytetracycline is necessary to control these disearse.[13] Systemic infections due to Aeromonas, Pseudomonas, and Vibrio usually can be controlled by feeding oxytetracycline or chloramphenicol. Various sulfonamide drugs may be effective but drug resistance is an important problem. Some of the nitrofurans have been found to be effective against systemic infections.[5,10] Drug resistance to nitrofurans seems to be rare. Furazolidone (NF-180) has been successfully used for treating furunculosis (A. salmonicida) on a hatchery scale.

Antibiotics injected intraperitoneally can be effective in the prevention of A. liquefaciens infections in warm-water fishes as the water warms in the spring. This method is used extensively in Europe to protect carp against bacterial hemorrhagic septicemia. Chloramphenicol is the drug of choice, but oxytetracycline, tetracycline, and streptomycin are also used.[9]

Ulcer disease (Hemophilus piscium) is relatively rare today. However, when it is encountered, oxytetracycline or chloramphenicol are drugs of choice. This disease does not respond to sulfonamide therapy.[11]

Kidney disease (Corynebacterium) usually is treated with one of the sulfonamide drugs mentioned above. Erythromycin is the most effective drug tested,[12] but it is too expensive for general use. The value of drug therapy of kidney disease is questionable except in acute cases.

Because some bacteria (e.g. Streptococcus, Flavobacterium) which are uncommon fish pathogens are isolated occasionally and because some common pathogenic bacteria, especially A. salmonicida, readily develop drug resistance, positive identification and drug sensitivity tests are essential to proper therapy.

Hexamita salmonis is an intestinal protozoan which can be detrimental under certain circumstances. For Hexamita treatment, Enheptin** has been suggested as a replacement therapeutic agent for carbarsone and calomel, which are highly toxic.[6]

Helminths, both cestodes and nematodes, are the intestinal parasites of prime importance of hatchery fishes. Many of these can be removed by feeding di-n-butyl tin oxide.[1]

**2 - amino - 5 - nitrothiazole (American Cyanamid).

The drug uses mentioned above and the dose rates listed in Table 1 have been reported in the literature. It should be noted, however, that only sulfamerazine currently has the approval of the Federal Food and Drug Administration (F.D.A.) for use in food fishes and only under the following conditions:

Sulfamerazine: Control furunculosis in rainbow, brook and brown trout: 10 gm/100 lb/day for up to 14 days: withdraw 21 days prior to stocking or marketing: a zero tolerance (no detectable residues at time of marketing) is established for the muscle.

Oxytetracycline is now being processed by F.D.A. for clearance.

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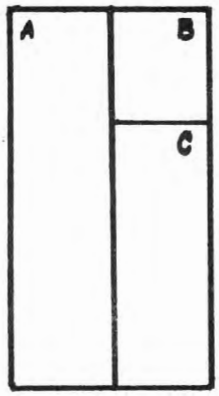
FISH CENSUS

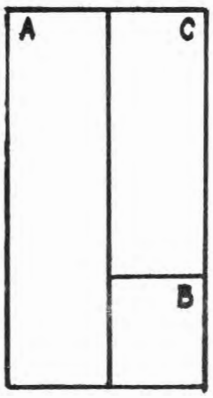
Craig Phillips
National Fisheries Center and Aquarium

Directions:

1. Cut the portions of the drawing on page

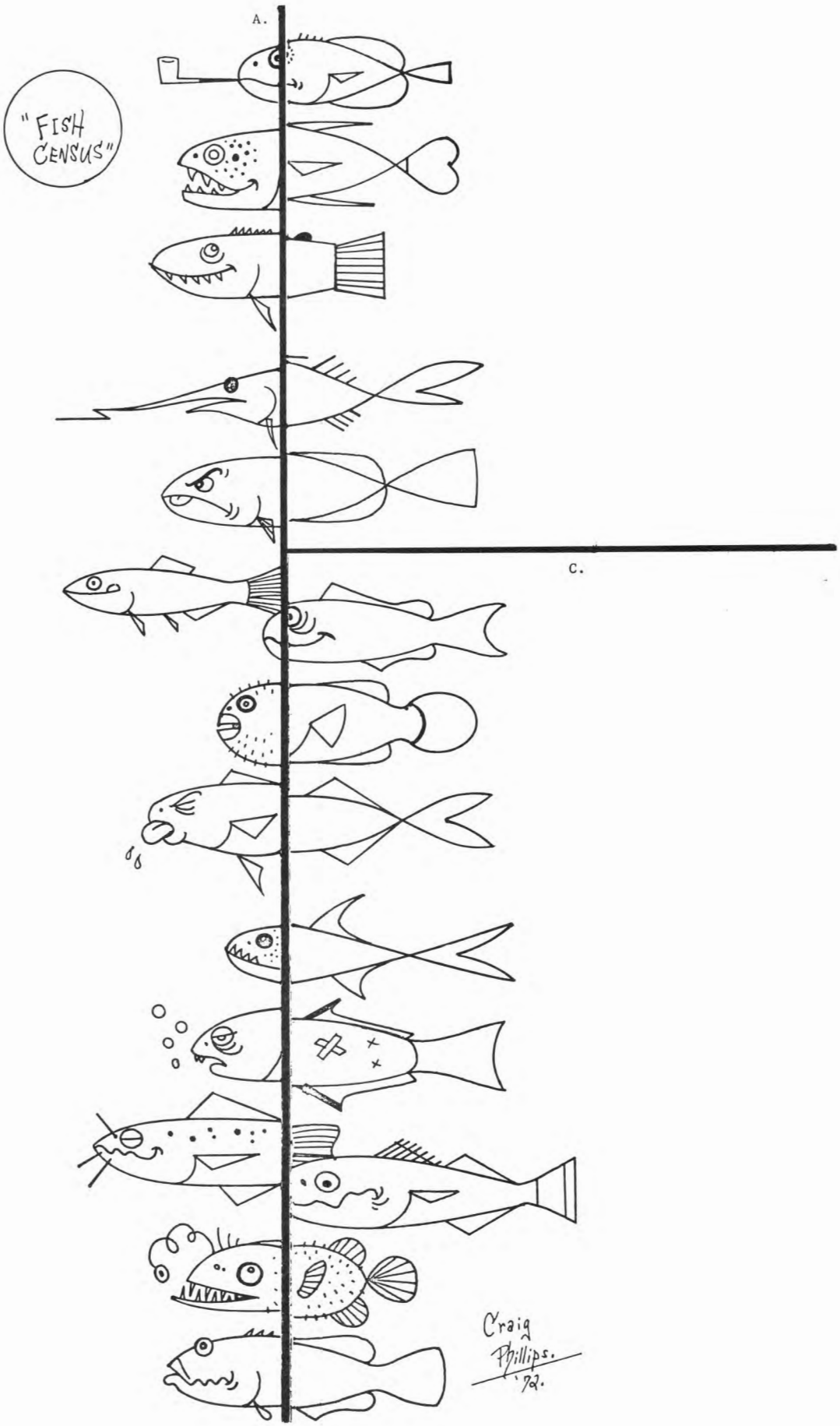
2. The drawing may then be put together in two different ways, as indicated:





3. Count the total number of fish in each case.

4. Which fish disappears, and where does he go?


A.
"FISH CENSUS"
C.
Craig Phillips. '72.

AN ANTIDOTAL STUDY ON THE SKIN EXTRACT OF THE PUFFER FISH *Spheroides maculatus*

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Abstract--A composite skin extract was prepared from the puffer fish *Spheroides maculatus* and the LD_{50} determined. It was found that the toxin does not affect the acetylcholinesterase of the erythrocyte as others have concluded. Alteration of the sex hormones or use of 100 per cent oxygen increased the lethality of the toxin. Picrotoxin, methylene blue, pentobarbital or sodium succinate did not alter the LD_{50}. Pentobarbital with sodium succinate decreases lethality. Strychnine or pralidoxime with atropine were the most effective antidotes (90 per cent).

INTRODUCTION

Tetraodon poisoning is a minor public health problem in Japan where the average mortality has remained stable at approximately 100 persons each year since 1886 (Kao, 1966). In the United States, two fatal cases have been reported (Benson, 1956). Banner (1967) and Halstead (1959) report there is no specific antidote nor specific treatment for puffer fish poisoning, although certain symptomatic measures have been suggested. Murtha et al. (1958) found that pentylenetetrazol (Metrazol) in cats shortened the time required for artificial respiration; while Larson et al. (1967a) have shown that pentobarbital sodium, sodium succinate, atropine, ephedrine or pentylenetetrazol did not increase the survival rate in mice receiving an LD_{50} of extract.

MATERIALS AND METHODS

A composite skin extract was prepared from *Spheroides maculatus* caught at the Banana and Indian Rivers near Cocoa and Titusville, Florida, by a previously reported method (Lalone et al., 1963). The extract was assayed on male and female white mice weighing 25-40 g. The LD_{50} of this extract was 0.087 ml per 20 g of body weight.

Male mice were first castrated under aseptic procedures. Then 2 weeks after castration they were tested with the extract. Male and female mice were injected intramuscularly with their corresponding sex hormone, testosterone propionate (Perandren)* diethylstilbestrol** in sesame oil respectively each week for 3 weeks. Then 12 days after the last injection, they were tested with the extract.

*Supplied by CIBA Pharmaceutical Co., Summit, N.J., USA
**Supplied by Eli Lilly & Co., Indianapolis, Ind., USA

In the experiments with 100 per cent O_2, either at atmospheric or at 2 atm absolute pressure, the mice were injected with the extract and immediately put in an Emerson hyperbaric chamber.

The determination of acetylcholinesterase inhibition by the method of Frawley et al. (1952) was made on the erythrocytes of albino rats of 250-270 g. Blood was obtained by cardiac puncture before and after the administration of a 0·75 LD_{50} of extract, hence each animal served as its own control.

Other groups of mice were first injected with a possible antidote (Table 1). After 10 min the mice were injected i.p. with the LD_{50} of extract and observed for 72 hr. Controls for procedures and antidotes were obtained.

RESULTS

TABLE 1. EFFECT OF PHYSIOLOGICAL PROCEDURE OR DRUG ADMINISTRATION (mg per kg) ON AN LD_{50} OF *Spheroides maculatus* SKIN EXTRACT IN MICE

Procedure or drug	Dose	Method of administration	No. mice	No. survived	Per cent survival
Diethylstilbestrol	15/wk	i.m.	15	2	13·3
Castration (male)	—	—	19	3	15·7
Physostigmine	0·25	s.c.	10	2	20·0
Oxygen 100%	1 atm	—	20	5	25·0
Oxygen 100%	2 atm	—	20	6	30·0
Testosterone	37·5/wk	i.m.	13	4	30·7
Atropine	5	i.p.	24	9	37·5
Serotonin	50	i.p.	20	8	40·0
Pralidoxime	20	i.p.	22	9	40·9
SKF 6333-A_2	25	s.c.	20	9	45·0
Picrotoxin	3	i.p.	20	10	50·0
Methylene blue	20	i.p.	20	11	55·0
Sodium succinate	13·5	s.c.	20	11	55·0
Pentobarbital Na	25	i.p.	20	11	55·0
ATP	5	s.c.	20	14	70·0
Methylene blue + pralidoxime	20 20	s.c. i.p.	20	14	70·0
Isocarboxazid	25	i.p.	24	19	79·1
Pilocarpine	5	i.p.	20	16	80·0
Methocarbamol	25	i.p.	25	21	84·0
Sodium succinate + pentobarbital Na	13·5 25	s.c. i.p.	29	25	86·2
Atropine + pralidoxime	5 20	i.p. i.p.	30	27	90·0
Strychnine	0·25	i.p.	20	18	90·0

DISCUSSION

Alteration of the normal concentration of appropriate sex hormone notably increases the lethality. Injection of diethylstilbestrol in female mice and castration of male mice produce essentially the same effect. Testosterone also increased the lethality but to a lesser extent. Testosterone is a powerful inhibitor of histamine (Trethewie, 1966). Both Li (1963) and Larson et al. (1967a) have reported that antihistamines can prevent or reduce the hypotensive action of the toxin.

Respiratory depression (Mosher et al., 1964) and decreased oxygen consumption (Larson et al., 1967a) are characteristic of tetraodon poisoning. Oxygen of 100 per cent concentration at atmospheric pressure and at a hyperbaric 2 atm absolute increased the mortality of test mice, whereas controls with saline injections resulted in no deaths.

Neither serotonin, a neural transmitter (Weight and Salmoiraghi, 1966) nor sodium succinate which relieves respiratory depression (Soskin and Taubenhaus, 1943) and increases oxygen consumption in the rat medulla (Larson et al., 1954), showed an antagonistic effect. Methylene blue used in photodetoxification of venoms (Kocholaty, 1966) and earlier in cyanide poisoning (Smith et al., 1940) had no effect. The use of a potent tranquilizer SKF 6333-A_2* likewise had little effect.

Larson et al. (1959) believed pentobarbital sodium offered some hope as an antidote. Using tarichatoxin (TTX), Kao and Fuhrman (1963) found that pentobarbital at 10 and 15 mg per kg did not show any significant protection. Our experiment corroborates this finding. However, combination of pentobarbital with sodium succinate decidedly increases the survival rate, than either of them alone.

Combination of methylene blue with pralidoxime provided some antidotal response as did adenosine triphosphate (ATP). Isocarboxazid (Marplan),** an MAO inhibitor, showed a positive antidotal effect as did methocarbamol (Robaxin).*** Robaxin in the injectable form with polyethylene glycol-300 as part of the vehicle increased the toxicity while the pure drug has an antidotal property.

Betti (1967) has shown that an oxime can effectively interfere with the curare activity of succinylcholine. It has been shown that tetrodotoxin (TTX) blockade (Kao, 1966) is potentiated by tubocurarine or succinylcholine, but is not antagonized by neostigmine, edrophonium or decamethonium. This lack of antagonism is also exhibited by physostigmine in our experiment. The explanation is that TTX affects the neuromuscular transmission at the motor axons (Kao and Fuhrman, 1963; Cheymol et al., 1962) and on muscle membranes (Matsumotu and Yamamoto, 1954), not at the endplate. Furukawa et al. (1959) and Katz and Miledi (1967) have shown that TTX while blocking electrical excitation in nerve and muscle does not interfere with the release of acetylcholine from nerve endings nor with its local action on the muscle fiber, though Fleisher et al. (1961) believed that TTX inhibited the release of acetylcholine.

*Supplied by Smith Kline and French, Philadelphia, Pa., USA
**Supplied by Hoffmann-LaRoche Inc., Nutley, N.J., USA
***Supplied by A.H. Robins, Richmond, Va., USA

Pralidoxime (2-PAM Cl) in a dosage of 20 mg per kg was found to be an ineffective antidote in mice. However, when in combination with atropine (5mg per kg), it acts as an effective antidote to an LD_{50} of skin extract (Larson et al., 1967b). Our belief that this indicated involvement of acetylcholinesterase was based on this combination's antidotal effectiveness in organophosphate poisoning (Goodman and Gilman, 1965) and its then reported effectiveness in ciguatera poisoning (Li, 1965), both of which inhibit acetylcholinesterase. We have found as others (Dettbarn et al., 1965) that this enzyme system is seemingly unaffected in the erythrocyte.

The administration of atropine with PAM indicates a decided increase in survival as compared to either PAM or atropine alone. Atropine may have a mild cerebral stimulatory effect as well as ameliorating muscarine-like effects of the toxin (sweating, increased salivation and bronchial secretion). Tremor and convulsions are associated with lethal doses of the toxin. These may be abolished or significantly reduced by atropine. If atropine (5 mg per kg) is given before or after a tremorgenic agent it can abolish the tremor (Holmstedt and Lundgren, 1966).

We used several antagonistic drugs in vivo which we felt might elucidate further the action of the toxin. As shown in Table 1, atropine increased the lethality of the toxin. Pilocarpine, an atropine antagonist, significantly decreased lethality. Our data would tend to confirm the response seen by Fleisher et al. (1961) in the rabbit eye.

Kao and Fuhrman (1963) concluded from their experiments that the action of tarichatoxin (TTX) was due to the blockade of the preganglionic cholinergic and somatic motor nerves. Picrotoxin inhibits presynaptic inhibition and therefore might improve survival. The results indicate a lack of action for picrotoxin with respect to per cent survival. Somewhat surprising was the action of strychnine, a specific inhibitor of postsynaptic inhibition. Strychnine provided a 90 per cent effectiveness as an antidote. Although some spinal neurons are resistant to strychnine (Green and Kellerth, 1966) those neurons do respond to picrotoxin. Fujii and Novales (1968) found the presynaptic membrane to be resistant to TTX and still remained responsive in the fish melanophore nervous system.

CONCLUSIONS

The results indicate that antidotes providing 90 per cent effectiveness against an LD_{50} of extract are ones that are involved with neural transmission. Strychnine or pralidoxime with atropine were the most effective antidotes. Our results suggest several parameters may be involved.

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DIETARY DEFICIENCY IN LION FISH (PTEROIS VOLITANS)

Sylvan Cohen, M.D.*

In February, 1961, Mr. John Prescott, Curator of Marineland of the Pacific, received a group of nine Lion fish (Pterois volitans) from the Philippine Islands. The fish had been caught by hand nets and were about 3 inches long when admitted to the holding tank. They were in good condition and were placed in display tanks a month later. They were fed exclusively on frozen white bait smelt (Allosmerus elongatus), and grew well, reaching a length of about 6 inches in a year. About nine months after their receipt, however, they began exhibiting erratic behavior with loss of equilibrium and often swam in spirals and upside down. The fish were all affected to varying degrees of severity, with three deaths. An additional obviously dying fish was placed in formalin solution and was examined grossly and microscopically. The gross examination revealed nothing remarkable, but the microscopic examination showed significant findings. The liver was very fatty, but the most striking finding was in the brain where sections revealed marked degenerative changes in the parenchyma with prominent histiocytic infiltrates mixed with the degenerating brain substance. Without knowledge of the dietary history, a Vitamin B Complex deficiency was suspected based on the microscopic findings. This belief was reinforced when the history was obtained, and the diet was altered, but unfortunately no controlled experiment was done, partly because of the small number of fish remaining (5), and partly because of the strong desire to preserve as many of the specimens as possible. No individual substitution feeding was done but the diets of all the fish were changed to 50% frozen food (Allosmerus elongatus), 25% live gold fish, and 25% live Fundulus.

Only one additional fish died after the dietary change, while the remainder rapidly improved and lived for several years.

Vitamin deficiencies in hatchery trout have long been recognized. Wolf[1] showed that Thiamin deficiencies can occur in trout fed raw herring (Clupea harengus), smelt (Osmerus moidax), and buckeye shiners (Notropus atherinoides), resulting in numerous varied symptoms, especially central nervous system symptoms. Wolf also demonstrated that the raw fish food contains a thiamin destroying substance that would eliminate thiamin in other foods added to the raw fish food and even would destroy added thiamin hydrochloride to some extent. Additional authors have confirmed these findings and have also discussed

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other vitamin and dietary deficiencies in trout, but I have not been able to find any specific reference to Lion fish. It seems probable, however, that the findings regarding hatchery trout would be applicable to other fish in captivity.

SUMMARY

Young Lion fish fed an exclusive diet of frozen smelt developed severe symptoms of central nervous system disease as they grew over the course of a year. The symptoms strongly resembled those associated with thiamin deficiency in hatchery trout and were alleviated when a more varied diet was provided.

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QUINALDINE: A RAY OF HOPE FOR AN OLD ENIGMA

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Managing Curator, Miami Seaquarium

During the past few years I have been definitely anti-quinaldine, having suffered specimen losses as high as 100% among fishes captured with this tranquilizing agent. The story behind these mortalities often went something like this...

A large collection of apparently healthy specimens; perhaps rock beauties, angelfishes, royal grammas, and golden-browed jawfishes, were offered for sale by a collector. They were purchased, quarantined for evidence of disease or parasites, and then distributed to various aquaria for public display. They appeared to eat and behave normally, at least for fishes newly introduced into an artificial environment. In about two weeks all died without warning, often within minutes or hours of each other.

Such occurrences, for a short time, became commonplace. Therefore I was forced to refuse specimens from the collectors involved. Lengthy discussions with them revealed their specimens had been taken with the aid of quinaldine. Although the collectors were well-intentioned businessmen or enthusiastic hobbyists, we could no longer come to terms under these conditions. Other aquarists soon followed suit, while private fanciers of marine tropicals unwittingly expended large sums on "doomed" fishes.

Arguments raged in favor of the use of quinaldine (after all, Steinhart Aquarium in San Francisco has used it for years as a tranquilizer for specimen movement and care without ill effects) and against its use. Others argued the merits of its solvents, 95% alcohol vs. acetone. Some swore by it; others, like myself, swore at it for the havoc we envisioned being wreaked upon the ocean's reefs by untutored collectors. I have spent many hours in hot debate with staff members of other large aquariums. I always was opposed to its use for any reason! When a collector called and reeled off a long list of fish species, each available in large numbers, I would interrupt and say "wonderful collection -- must have taken them with quinaldine?" The collector's enthusiasm generally would result in an affirmative reply before he had time to think. My answer, of course, was "No, thanks". In good conscience I could not even offer the names of other potential buyers.

A brief respite came during the Dominican Republic crisis. Quinaldine is a derivative of quinine, a main source of which is that small Caribbean nation. It was not long, however, before my arch enemy was with us again. Some of the personnel of the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, had persisted in use of the drup despite my vociferous arguments. One, in particular, utilized it in order to tranquilize specimens for photographic study. At my urging and under his meticulous care we went through his entire procedure with specimens from Seaquarium collections. Thereafter, they were returned to their

various display tanks. Observations of the drugged fishes for two weeks recorded them as "normal". Well into the third week I was prepared to concede defeat. On the seventh day of week three -- all died! This worker repeated the experiments with his own specimens, to the same disheartening end. Thus, in the hands of a highly competent professional we had gained one week of life for our unfortunate subjects.

Robert Stevenson, Ph.D., of Rosenstiel School of Marine and Atmospheric Sciences, took special interest in the problem. He noted that most collectors capture a fish and place it in an aerated container of sea water on their boat. Dr. Stevenson found that fishes placed in a perforated container in the water over the side of the boat seemed to "flush the drug from their system" and did not suffer from its lingering ill effects.

I telephoned one of the collectors who persisted in the use of quinaldine and told him of these findings. This particular man has always been honest in our dealings and vowed to follow through on our experiment. He captured a fine collection of royal grammas and yellowhead jawfishes with the drug and placed them in slotted bait containers over the side of the boat below the water surface for an hour or two. He utilized that time to take more sedentary creatures for which tranquilization was unnecessary. The procedure was repeated on three separate collecting trips and the fishes were brought to Seaquarium after each trip and placed on display. Months passed and all survived. Additional work in this vein has been accomplished by others with identical positive results.

Thus, flushing in running water specimen holding facilities or perforated containers in the ocean will alleviate the distressing mortalities among fishes taken with quinaldine.

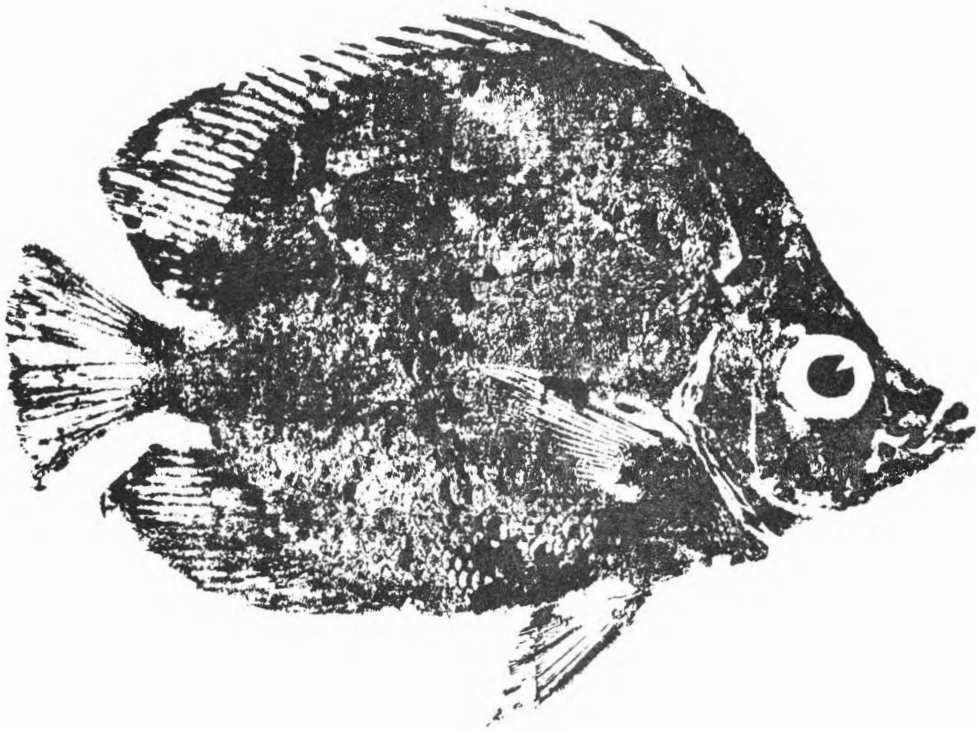
One final point requires clarification. Although enlightened by the above, I continue to refuse information to anyone regarding the use of tranquilizing agents. An excerpt from a letter from Randolph Hodges, Director, Florida Board of Conservation, will enlighten all collectors, professionals and hobbyists, as to my stubborn attitude.

> The Florida Board of Conservation "may issue special permits to individuals to collect fish that are on the protected list, or under legal size limit, or those that must be captured by other methods, Our permits state the means by which fish may be collected, where, how many, and for what purpose. Any deviation from the conditions of the permit is strictly illegal. Usually, permits are issued to those desiring to augment their private aquariums. However, we have issued permits for individuals or firms to capture marine life for scientific purposes. So far as commercial ventures are concerned, we issue permits only to qualified and licensed wholesale dealers. We do not issue permits to anyone take marine fishes by chemical means unless under exceptional circumstances."

In short, unless protected by special permit from the Florida Board of

QUINALDINE - Zeiller

Conservation, the use of quinaldine or any other chemical agent is unlawful -- and rightly so. Reflect on this possibility for a moment. A prized specimen lurks in a niche in the reef. No amount of prodding or persuasion can force it from its haven. Squirt in enough drug to capture this single prize and the myriad of life left within that niche that could not escape or be removed is lost forever.



AN UNUSUAL CASE OF TETRODOTOXICATION

Merritt S. Keasey, III
Curator of Small Animals, Arizona-Sonora Desert Museum

At the Arizona-Sonora Desert Museum near Tucson, Arizona, we have a 1200 gal. salt-water system wherein we display a number of small fishes of the Gulf of California. At the time of this strange occurrence this system contained approximately one hundred fishes, representing nineteen species, the largest being no more than four inches in length.

We had received a shipment of fish from Dave Powell of Sea World, consisting of seven specimens. Two of these were too large to put into the display tank, so they were placed into the reservoir section of this system to await further disposition. Unfortunately, one of these specimens, due to its slowness, managed to get itself caught in the pump intake tube. This was a six-inch long specimen of spotted puffer, Arothron setosus. The resulting stoppage eventually shut down the entire circulation system, but in the meantime the puffer was pulled clear into the tube, with the resultant suction tearing out pieces of skin and viscera. These particles passed through the impellers of the two pumps and were blown through the main return line into the display tank itself.

How many of the fish actually ate pieces of the deadly flesh no one knows, but the tetrodotoxin which it contains seemed to effect most of the tank's residents. Oddly enough, only two species of fish died, although many others seemed to be ailing for up to forty-eight hours after this accident. The fish which succumbed were three Barber Fish, Heniochus nigrirostris, and five Blue Damsels, Eupomacentrus rectifraenum. The remaining number of these two species and the dozen or so Pacific Sergeant Majors, Abudefduf troschelii, seemed to be the most effected, huddling on the bottom and gilling rapidly. Many of the other species were somewhat less active than normal.

All but one of the eight dead fish died within an estimated four to eight hours after the incident and within forty-eight hours all effects seemed to have vanished. No other losses have occurred since that time.

Reference

Halstead, Bruce W. Poisonous and Venomous Marine Animals of the World. Vol. Two, 679-844.

MARINE ZOOPLANKTON AS FOOD FOR THE AQUARIUM

K. G. Hewlett
Curator, Vancouver Public Aquarium

For many years, brine shrimp (Artemia salina) has been used substantially for the feeding of both saltwater and freshwater fish and invertebrates. This product is available in a number of forms: as dried eggs or frozen or freeze-dried adults. The industry is estimated to be worth approximately five million dollars per year.

Despite its popularity, brine shrimp is not an ideal food item. Hatchery-raised brine shrimp may not have the nutritional value of wild harvested Artemia as the only food available to it is that of its own yolk sac.

In recent years, brine shrimp from some areas has been found to contain unacceptably high levels of D.D.T. Researchers Dr. C. G. Bookhout and Dr. J. D. Costlow of Dukes University, Beaufort, have found that brine shrimp collected for commercial sale contained enough D.D.T. so that its cumulative effect on fishes reared in captivity can interrupt normal developmental processes even to the point of causing death.

The abnormalities that appeared in the early developmental stages of crabs reared on brine shrimp were typical of D.D.T. poisoning, according to the researchers' report. Tests were undertaken on Utah's Salt Lake brine shrimp and specimens from saltwater ponds near San Francisco - both high producers of commercial brine shrimp. It was found that the Utah brine shrimp contained three times as much D.D.T. (7,050 parts per billion) as the California product (2,300 parts per billion).

With these drawbacks in mind, the Fisheries Research Board of Canada postulated that an alternative food source could be harvested right in Georgia Strait. This area has always been a high producer of zooplankton, as is illustrated by the number of baleen whales that could be found in the area up until a decade ago. These primary consumers who each year ate tons of this food item have been drastically reduced in the eastern North Pacific as a result of overwhaling. Dr. T. Parsons postulated that the tonnage of zooplankton has increased proportionally to the decrease in the number of whales.

The Fisheries Research Board of Canada harvested two species of plankton on an experimental basis in the spring of 1970 - a copepod (Calanus plumchrus) which is about the size of a grain of rice and a euphausid (Euphausia pacifica) which grows up to about an inch in length. Dr. R. J. LeBrasseur carried out feeding experiments comparing growth rates of juvenile chum and sockeye salmon fed diets of Oregon pellets (a moist hatchery food), copepods, frozen euphausids and a mixture of

frozen copepods and Oregon pellets. Although results were highly variable, all fish fed frozen zooplankton showed weight gains substantially higher than those fed Oregon pellets. Dr. LeBrasseur also found that the fish (young salmon) fed zooplankton were far more alert and active than those fed pellets. Biochemical analysis indicates that some marine zooplankton have an exceptionally high fat to protein ratio which makes them an ideal dietary source for fast-growing fish.

The Fisheries Research Board carried out a pilot project during the spring and summer of 1970 when they distributed samples of frozen zooplankton to their own researchers and the Vancouver Aquarium. (Species fed were crayfish and adult and juvenile sockeye salmon). In general, it was found that the product was highly acceptable to both the feeder and the fed. With the help of the Fisheries Research Board, Mr. Don Bradley of Pacific Plankton (Box 145, Nanaimo, B.C.) has set up operations to harvest both species for sale. Briefly, the harvesting process is as follows:

> Plankton is taken from the water and put into holding bins where the seawater is drained off.
>
> Plankton is then put into plastic bags (1 lb. to 1 1/4 lb.) then sealed.
>
> These bags are then quick-frozen on the boat.

The actual time lapse between being removed from the water and frozen solid is less than one hour, so that in most cases, the organisms are still alive when frozen.

We have used Mr. Bradley's frozen euphausids for a year and have been more than satisfied with the product. Acceptability by the fish is higher than with any other food yet offered. We have had remarkably good success with fussy eaters like sailfin sculpins, windowtail poachers and Moorish idols. We have seen a much higher growth rate and tremendous colour retention in both freshwater and saltwater fish.

Frozen zooplankton has been used by several home aquarists (both freshwater and saltwater) who have expressed great satisfaction with the product.

AQUARIUM EXHIBITS AT THE GULF COAST RESEARCH LABORATORY

Gordon Gunter
Director Emeritus, Gulf Coast Research Laboratory

Over 1700 persons have visited the new Environmental Education Center (Marine Sciences) in Biloxi, Mississippi since its official opening last spring. The Center is a branch of the Gulf Coast Research Laboratory located in Ocean Springs. The Center site is seven acres of land just south of U.S. Highway 90. The visitors included elementary school students and their teachers, groups of high school and college students, pre-schoolers and individual adults.

The Center is operated by an aquarist who collects species for 14 twenty gallon and 3 fifty-five gallon glass tanks. Currently about forty-five species of marine animals are represented in the collection, both vertebrates and invertebrates. Preserved biological specimens and geological exhibits are arranged on shelves in wide display cases. Several marine fishes and invertebrates are exhibited. A collection of sea anemones collected over a period of nine months are thriving.

The Center is a metal structure about fifty by forty feet overall and designed to provide both public display area and work space in two small office laboratories for four graduate students doing research work. The public display area provides space to seat some thirty-five people in movable chairs. A movie screen mounted on one wall and a projector and stand remain in the area for the showing of films and the use of other visual aids in presenting programs to visitors.

NEW EXHIBIT AQUARIA AT THE VIRGINIA INSTITUTE OF MARINE SCIENCE

James Lanier
Education Program Director

The three exhibit aquaria at the Virginia Institute of Marine Science rose phoenix-like from the ashes of a fire which fortunately was limited to items already scheduled for replacement. A short-circuited power filter melted the plastic side on one of five 25-gallon tanks then in use, and a burning wooden partition severely damaged the others. A new, more exciting display was designed to replace the damaged one, which had been installed in 1950. These new aquaria were opened to the public in 1971.

The Virginia Institute of Marine Science (VIMS), at Gloucester Point, Virginia is a state agency engaged in research in biological, chemical, physical, and geological oceanography. The Institute also acts as an advisor on marine science affairs and has both graduate and public education programs.

A heavy emphasis on research at VIMS limited the availability of funds, time or space for the room. Careful planning was necessary in order to produce the best possible display using an abundance of interesting estuarine and freshwater animals.

The center tank is over six and one-half feet in diameter and three feet deep, and holds 720 gallons of water. It is made of molded fibreglass and 3/4 inch plate glass. The 212 gallon tanks to either side are constructed of GPX waterproof plywood and 3/4 inch plate glass.

The space available for the aquaria includes a display wall 16 feet long and work area of 144 square feet behind the tanks. Three large aquaria take up nearly the entire length of the display wall. Two contain brackish water pumped from the York River, and house turtles, fishes and invertebrates found locally. The third tank has a semi-closed freshwater system and also contains local turtles and fishes, including a large bowfin, Amia calva.

The center tank is circular in order to accommodate animals prone to damage themselves by repeatedly running into the sides of a rectangular tank. A circular flow is maintained at the top and bottom of the aquarium by a 900 gallon per hour submersible pump so that fishes may constantly swim against a current without encountering a barrier. A ridley turtly (Lepidochelys olivacea) has lived in this tank since early last fall.

A smaller brackish water aquarium is set up as an oyster rock community. Oyster shells form a large reef in the center of the tank and cover the back wall. Blennies (Chasmodes bosquianus and Hypsoblennius hentzi), gobies (Gobiosoma bosci), skilletfish (Gobiesox strumosus), and spider crabs (Libinia) live here much as they would in the nearby river.

The exhibit room is open to the public from 8:00 A.M. to 4:30 P.M. every day of the year and is free. In addition to the aquaria, it contains several educational exhibits on marine science, marine life and the sea. VIMS is about five minutes from the battlefield at Yorktown, Virginia, across the Coleman Memorial Bridge that spans the York River.