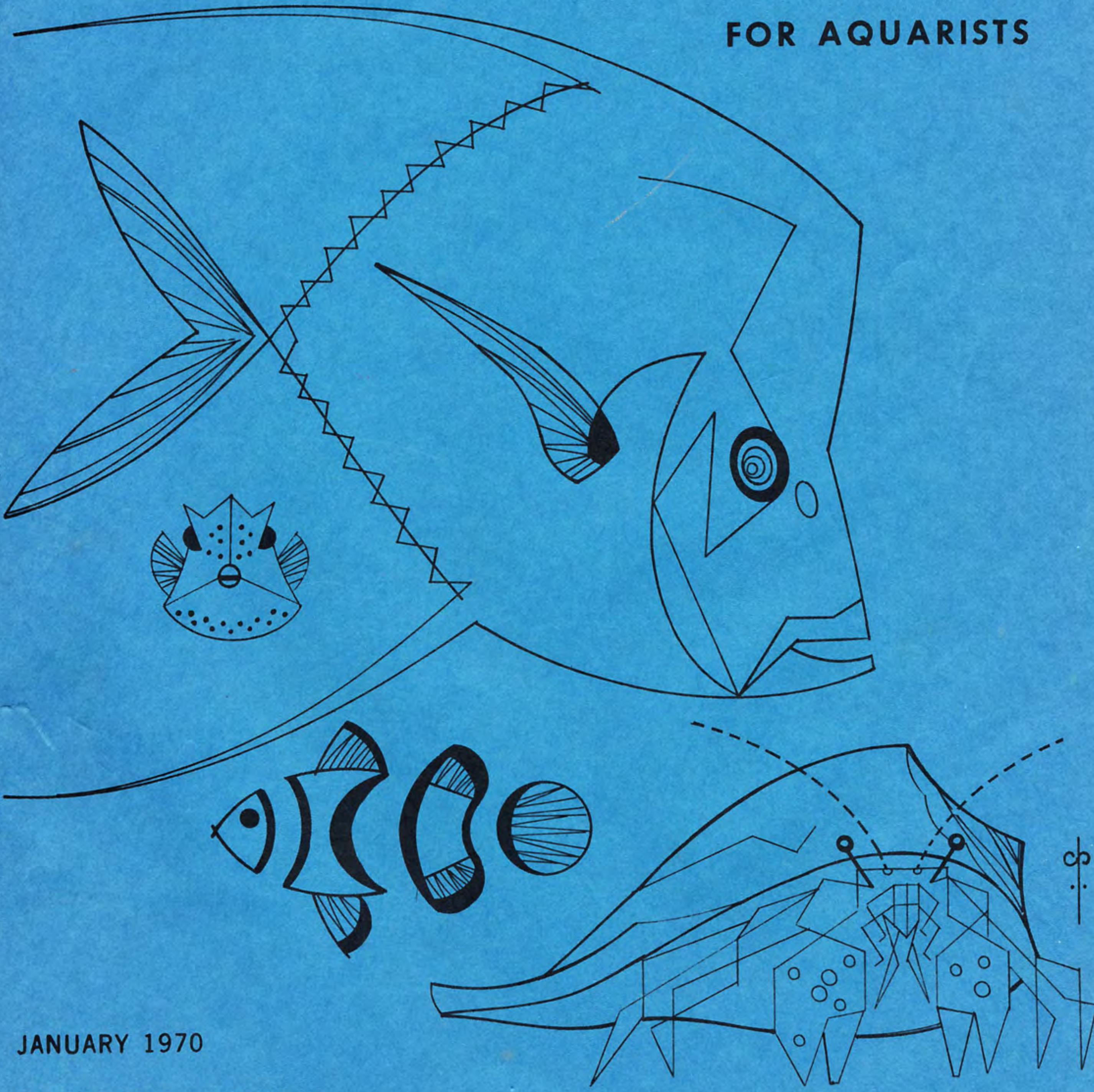
DRUM & CROAKER

THE INFORMAL ORGAN

FOR AQUARISTS



JANUARY 1970

VOLUME 70 NUMBER 1

VOLUME 70, NUMBER 1 JANUARY 1970

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

The Informal Organ

for

Aquarists

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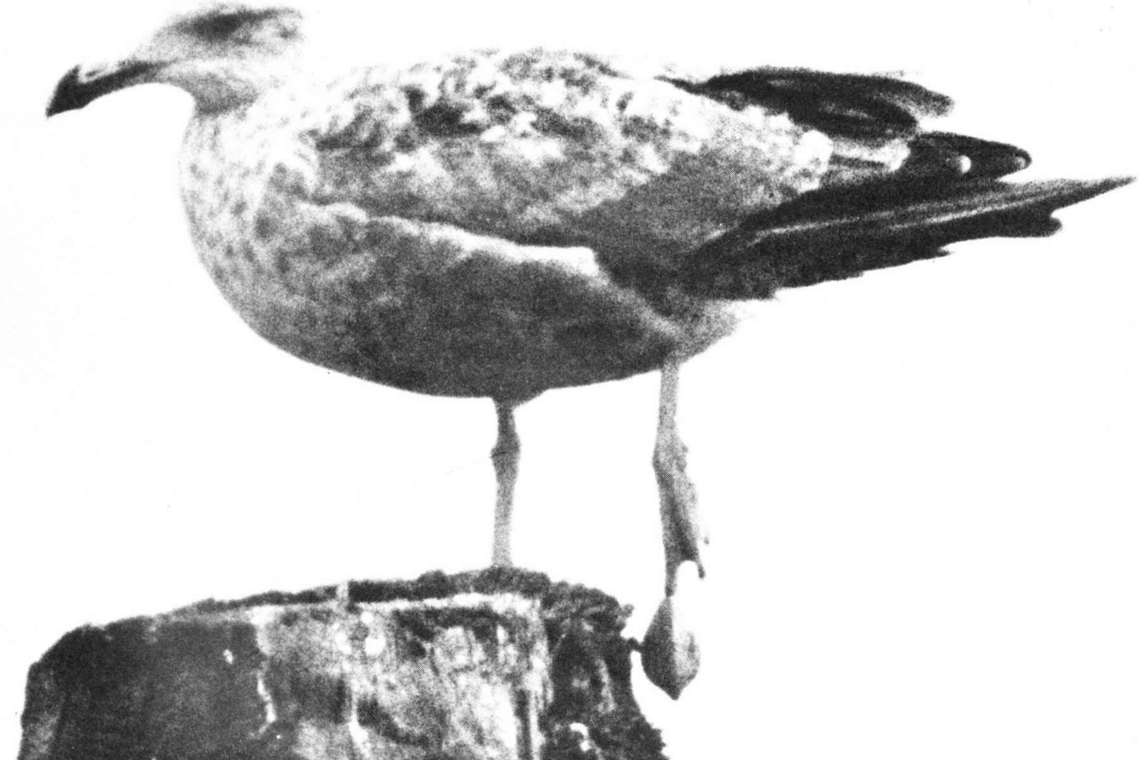
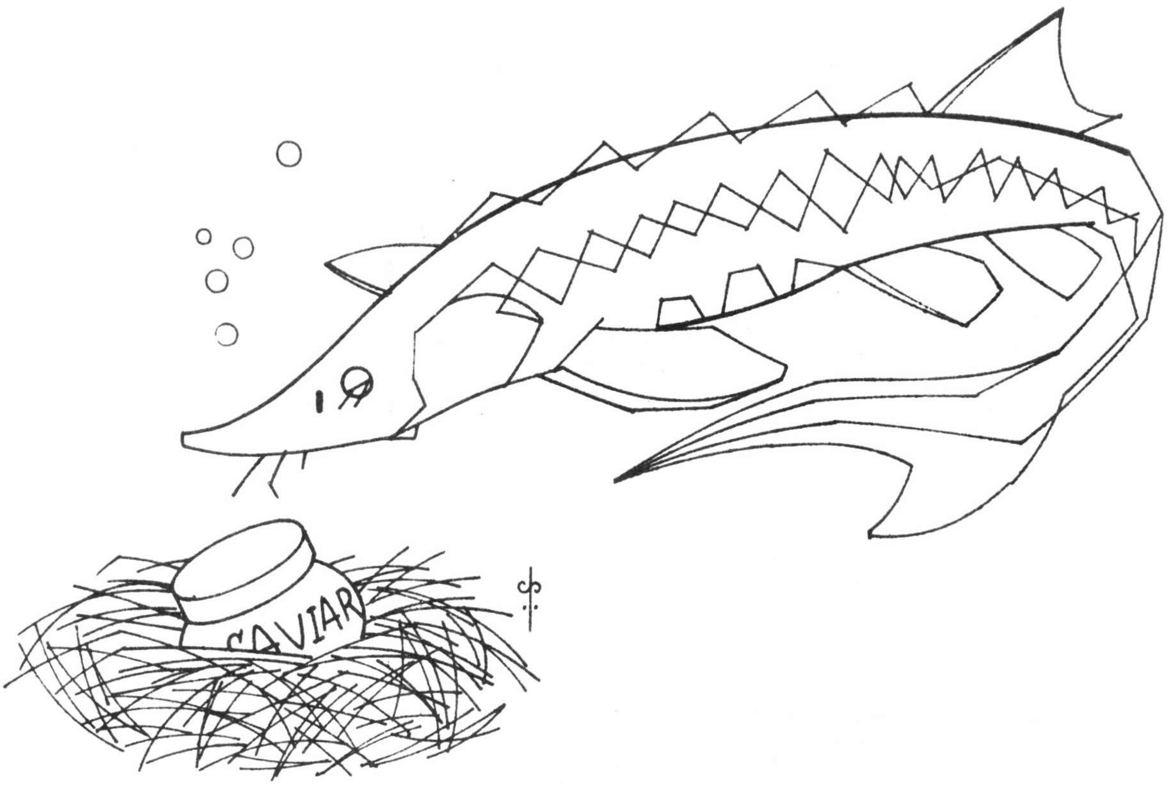
Art work by Craig Phillips, NFCA.

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

CLAM
BITES
BACK!

Herring Gull
and
traveling
companion
(FWS foto)





DRUM AND CROAKER
JANUARY 1970

CONTENTS

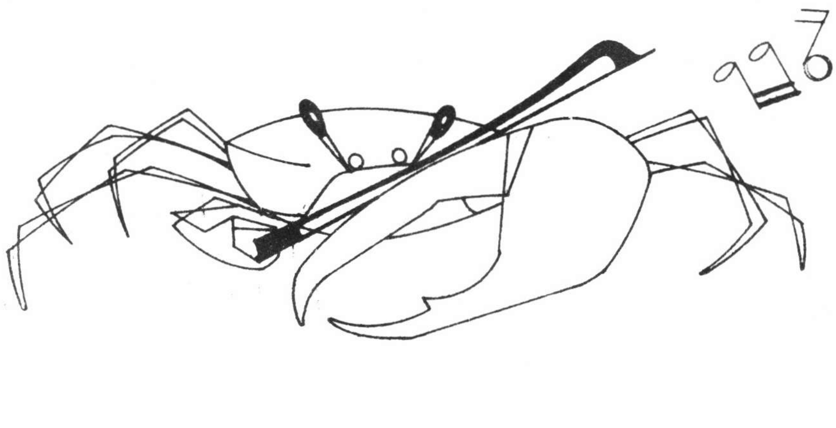
ALL OF US AT NFC&A
WISH FOR EACH OF YOU
A VERY PROSPEROUS
NEW YEAR.

May all of your gains

be of rare species

And your few losses

of common ones.



July 12, 1957

A CALL FOR MATERIAL

Announcement of Intent
To Foist Upon the World
of Professional Aquarists

THE DRUM AND CROAKER

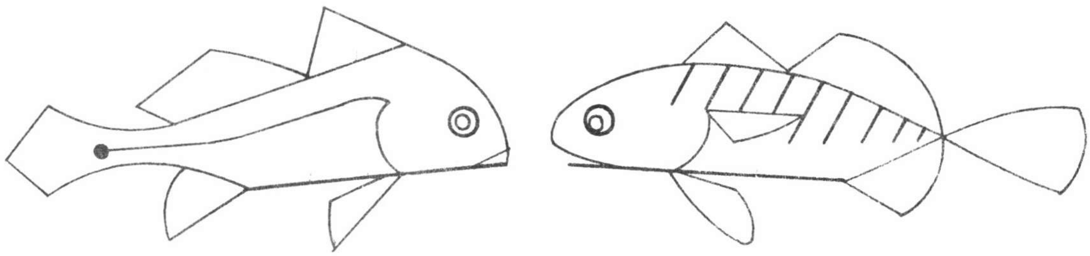
A Piscatorial Provoker -
A Revolving Poop-sheet -
An irresponsible journal
published at erratic intervals
by undedicated aquarists -

CONTENT: Each issue will contain a technical notes section and a general information section as well as other features. We would like to see something in the information section from each organization, but not more than 3/4 page single-spaced from each. Technical notes in the first issue will include a discourse by Craig Philipps on treatment method for injured eyes, and also some notes from MacFarland on the sources, cost and use of chemicals for collection of living animals from tidepools. We need more notes.

SCOPE: The DRUM AND CROAKER will be concerned with the problems of the aquarist working primarily with large tanks and secondarily with smaller tanks, and also with the problems of the marine and limnological station aquarist. The material covered adequately by the home aquarium journals will usually not be within the scope of DRUM AND CROAKER.

FORMAT: For the initial issues, DRUM AND CROAKER will be mimeographed, and quite unpretentious. If interest is sufficient, an attempt will be made at a later date to produce a more polished format.

DISTRIBUTION: As expected, distribution will be somewhat limited but will be gradually expanded. We hope to reach the majority of aquariums, marine stations and limnological stations in this country as well as some of those abroad. Please send in names of anyone we might have missed whom you think should be on the mailing list.



THE ORIGINS OF DRUM AND CROAKER

(See facing page - Earl Herald's appeal)

Having had a number of inquiries regarding early issues and the origins of D&C, we undertook to secure clarifying information. This was not easy.

Initially, D&C was a newsletter, started at Steinhart in 1957, to provide a method for a number of professional aquarists to keep advised--to communicate. Gradually the letter grew, so it was stapled.

Various aquariums assumed responsibility for issuance of D&C--one or two years here, a year there, etc. Thus, D&C was issued quite irregularly. The National Fisheries Center and Aquarium accepted responsibility in late 1967, and has, during 1968 and 1969, prepared three issues each year.

D&C, as conceived, was to be very informal, and was, in fact, considerably less than serious. Thus, the volume number was merely the year of issue, even as this issue is Volume 70. To a librarian this could be most confusing and misleading.

The title, too-DRUM AND CROAKER--was in a way an attempt at humor, but it represents well known American species of fresh and salt water. A single species of the river-drum, *Aplodinotus grunniens* Rafinesque, is found in North American lakes and sluggish rivers. The common Atlantic croaker, *Micropogon undulatus* (Linnaeus), is very abundant on the east coast of the United States.

The aquarists who conceived and were present at the birth of D&C included Earl Herald, Sam Hinton, Bill Kelley, F.G. Wood, and probably one or two more.

The foregoing includes all we were able to glean.

There is one more item. D&C has been shifted from aquarium to aquarium. This is the start of the third year for us and we do not wish to deprive others of the joys of being editor and publisher. Therefore, we will be glad to send the files and mailing-list plates to any public aquarium upon approval of the Aquarium Committee.

Also, our mailing list is above 200 now, so don't suggest to others that they be placed on the list. Except aquariums.

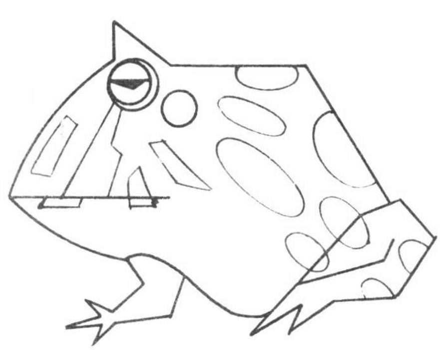
Bill

Wm. Hagen
Asst. Director-Operations, NFCA

And

Part-time Editor-in-Chief

X The title DRUM AND CROAKER originally started as Grunt and Croaker, but then the simon-pure fresh water aquarists objected--pointing out that we had two salt water fishes in the title - thus, slowly by evolution through many bourbons and scotches the title became DRUM (fresh water) and CROAKER (salt water).



RD3
East Stroudsburg
Pa

CHRISTOPHER W. COATES
587 THIRD STREET
BROOKLYN, NEW YORK 11215

Sept 21-69

Drum & Croaker

Vol 69 #3. Sept 1969

A damn fine issue.
Makes me almost wish
I was wet again

Chris Coates

At noon, members and guests assembled for a group photograph on the steps of the Planetarium building. After lunch, the joint symposium on Aquaria was convened by DR. EARL S. HERALD and the following reports were given:

AQUARIUM DESIGN, CONSTRUCTION, AND MATERIALS

The Multisystem Aquarium: The New York Aquarium.—Christopher W. Coates, New York Aquarium, New York Zoological Society.

The Oceanarium: The First Six Months of Marineland of the Pacific.—Kenneth S. Norris, Marineland of the Pacific.

The Marine Station Aquarium: T. Wayland Vaughan Aquarium-Museum.—Sam D. Hinton, Scripps Institution of Oceanography.

The Inland Aquarium: The New James R. Record Aquarium. Lawrence Curtis, Fort Worth Zoo and Aquarium.

The Use of Plastics in the Aquarium.—Ross McBride, Ocean Aquarium, Hermosa Beach, California.

General Discussion of Materials: Pumps, Pipes, Valves, Tanks, etc.—Leader: Earl S. Herald, Steinhart Aquarium, California Academy of Sciences.

BEHAVIOR OF FISH AND OTHER AQUATIC VERTEBRATES

Special Problems in the Maintenance of an Oceanarium Exhibit.—F. G. Wood, Jr., Marine Studios, Florida.

Behavior of Temperate Marine Fishes.—Earl S. Herald, Steinhart Aquarium, California Academy of Sciences.

Behavior of Tropical Freshwater Fishes.—George S. Myers, Stanford University.

Behavior of Trout and Salmon.—Murray A. Newman, University of British Columbia.

Collection and Confinement in Captivity of Two Species of Pacific Dolphins, Delphinus bairdi and Lagenorhynchus obliquidens.—David Brown, Marineland of the Pacific.

Arrival of Tursiops from Florida.—David Brown, Marineland of the Pacific.

The Symposium continued after dinner with DR. CHRISTOPHER W. COATES presiding. The following papers were heard:

Porpoises of the Atlantic Coast.—F. G. Wood, Jr., Marine Studios, Florida.

WATER IN THE AQUARIUM WORLD

Portable Salt Brine for Dilution by Inland Aquaria.—Maurice Rakowicz, San Francisco Aquarium Society.

DISEASES AND DISEASE CONTROL

Epizootics in California Freshwater Fishes.—Joseph H. Wales, California Department of Fish and Game.

Trout Hatchery Diseases vs. Hatchery Practice and Design. —Harold Wolf, California Department of Fish and Game.

Demonstration of Control for Oodinium ocellatum.—Robert F. Dempster, Steinhart Aquarium, California Academy of Sciences.

FOOD AND NUTRITION

Problems in the Use of the Brine Shrimp as a Fish Food.—Maurice Rakowicz, San Francisco Aquarium Society.

COLLECTION AND TRANSPORTATION OF FISHES

Salt-Water Fish Transportation Equipment.—Kenneth S. Norris, Marineland of the Pacific.

Demonstration of the Venturi Principle as Applied to the Circulation System of a Fish-Planting Truck.—Personnel of the California Department of Fish and Game.

The Use of Metabolism Inhibitors in Collecting and Transporting Fishes.—Wm. McFarland, University of California, Los Angeles.

The Aqualung in the Collection of Living Materials for Aquarium Display.—Conrad Limbaugh, Scripps Institution of Oceanography.

THE PHILOSOPHY AND PRACTICE OF AQUARIUM EXHIBITION

Aquascaping Small Display Tanks in Public Aquaria.—Donald A. Simpson, Steinhart Aquarium, California Academy of Sciences.

Legends and Labels.—Sam D. Hinton, Scripps Institution of Oceanography.

It appears to us that program quality has not continued as was initiated in this first aquarium symposium.

June 28, 1955

SAVE THESE DATES

AND

YOUR FUNDS

FOR THE

16th Annual Aquarium Symposium
of the
50th Annual Meeting
American Society of Ichthyologists and Herpetologists

Fontainebleau Motor Hotel
New Orleans

March 26-31, 1970

Sponsor: Tulane University

Titles (and abstracts, if possible) must be sent in promptly to meet the deadline for the printed program.

Send to: Dan Moreno
Cleveland Aquarium
601 E. 72nd Street
Cleveland, Ohio 44102

THE DOLPHINARIUM(1)

Walter Van den Bergh
Director
Royal Society of Antwerp

Plans for the first zoo building to emerge from the war ruins were drawn up in 1945. The dolphinarium was the first facility to be completed and was opened December 20, 1968.

The dolphinarium is functionally divided into five sections. The first of these is the public area where the animals are on display. Included are the major auditorium with the large kidney-shaped pool as well as the mezzanine where ten large windows in the pool walls make it possible to observe the animals under water. The second is the area containing two training pools interconnected by a channel which also provides access to the large pool in the auditorium. The third area is the quarantine section having its own pool and completely isolated from the other areas. The fourth consists of the filtration chambers located on the ground floor and containing the entire water purification installation. This installation has two sections in order to completely isolate the filtration system from the quarantine area. Lastly, the water is analyzed and this data recorded at the office-laboratory.

Inflow and outflow piping connecting the pools with the filters totals approximately 1,000 m in length and of diameters between 160 and 350 mm. Some of the piping is made of pvc (polyvinylchloride) capable of withstanding 10 k/m^2 of pressure and the remainder of metal covered on the inside with ebonite. This is also the case for the 115 cast Saunders cocks and the six filters also covered on the inside with ebonite. As such, all elements used in water filtration can thus withstand the action of the salt. Since it was indicated in the program that the dolphins should be visible under water, we had to solve the problem of the windows which we hoped would be as large as possible. The Splintex Belge Company

(1) Condensed from ZOO (Vol. 34, No. 4, April 1968) with permission. Photographs by Dr. A. Gijzen.

in Gilly carried out experiments and developed a bullet-proof glass window 7 cm thick, 1 m high and 2 m wide. We had to build a special aquarium to test this experimental window at a pressure of 8 tons or twice the pressure currently exerted on similar windows at the dolphinarium. Each of these windows weighs 400 kg. They were freely placed in concrete frames and are slightly inclined towards the public in order to prevent them from tilting when the pool is empty. Small pieces of neoprene (synthetic thermoplastic rubber) prevent the windows from contacting the concrete under any conditions. A protective window was installed to prevent the public from touching the windows.

This dolphinarium is located a long distance from the coast which meant that the seawater for our dolphins had to be artifically created and continually kept clean by filtration. The animals live in water whose sodium chloride (household salt) content is 2 percent or a sufficient concentration for them to swim without having to exert too much effort. This also prevents them from contracting skin edemas which might result from remaining too long in fresh water. However, for the entire facility this percentage represents 17 tons of salt. Water acidity has a pH of approximately 7.6 (hydrogen potential) and, following excursions to 7.2 or 7.8, it is returned to its original value by the addition of sodium carbonate or sodium bicarbonate.

The dolphin complex includes a large auditorium with rows of seats accommodating more than 800 people. The dolphins swim in a kidney-shaped pool 28 m long, 7 m wide, 3 m deep and with a capacity of approximately 600 m^3 equivalent to 600 tons of water. Ten 1 by 2 m windows on the mezzanine make it possible to view the dolphins under water.

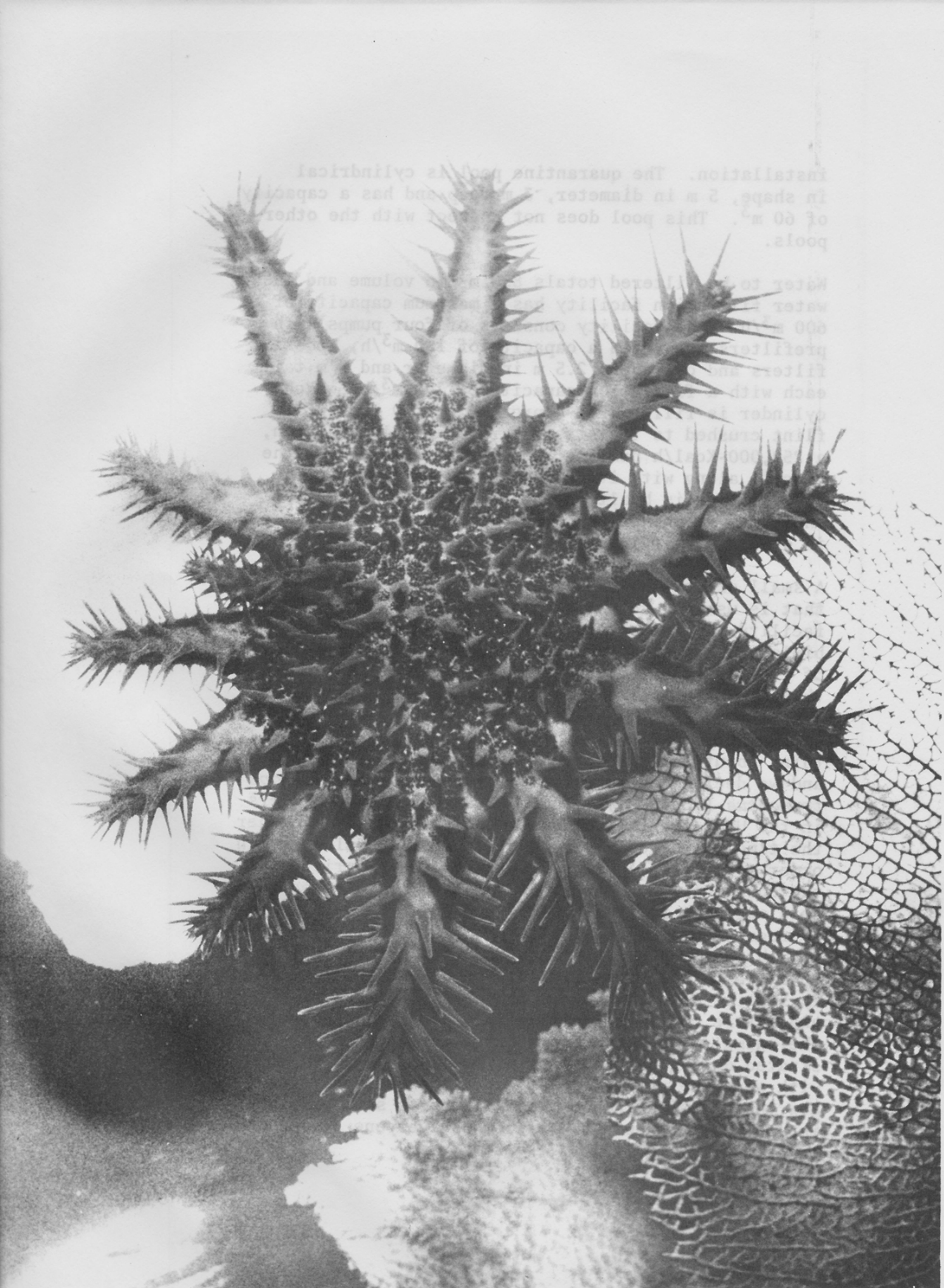
A channel or lock chamber connects the large display pool with the dolphins' training or rest pools. This behind-the-scenes room also contains two training or isolation pools, one circular or 5 m in diameter, 3 m deep, with a capacity of 60 m^3, and the other 5 m x 11 m x 3 m deep, capacity 150 m^3. Pools can be divided and gates permit easy passage of animals.

To completely isolate sick or newly arrived animals, a quarantine area was built whose supply of water and heater unit could be kept completely independent from the major installation. The quarantine pool is cylindrical in shape, 5 m in diameter, 3 m deep and has a capacity of 60 m^3. This pool does not connect with the other pools.

Water to be filtered totals 850 m^3 in volume and the water filtration facility has a maximum capacity of 600 m^3/h. The facility consists of four pumps with prefilters each with a capacity of 150 m^3/h, and six filters and cylinders 2.5 m in diameter and 3 m tall each with a filtration capacity of 100 m^3/h. Each cylinder is filled with approximately 10 tons of flint crushed to the size of granules. In addition, a 250,000-Kcal/h heating element is installed in the circuit along with its own pump and prefilter. The installation is built in such a manner that each of the three dolphinarium pools can separately be placed in or out of service.

A small office is located above the auditorium entrance that is used by scientists temporarily working at the facility and interested in either psychological or biological problems related to dolphins. The staff of the dolphinarium consists of one chief handler, three dolphin trainers and four attendants.

As the dolphinarium was being completed, we had to think about the future inhabitants of this building, and we decided on so-called blower dolphins (*Tursiops truncatus* [Monague]). There are many dolphin dealers in the USA offering their services, and we had neither the time nor necessary means to spend several weeks in order to make a decision. Going on the experience of the dolphinarium in Brighton, England, we decided to go along with Jerry Mitchell, and we have no reason to regret our choice. We asked him to obtain one to five blower dolphins for us, and they arrived by Sebena air freight in Brussels on December 19, 1968. This quiet young man seems to be a true lover of animals and nature conservationist. The way he transported the animals and the concern and competence he demonstrated during the shipping as well as the devotion with which he patiently, amicably showed the trainers how they were to induce the dolphins to show off their innate qualities won the esteem of everyone coming in contact with him.



PROBLEM IN THE PACIFIC-*Acanthaster planci*

By

Craig Phillips
National Fisheries Center and Aquarium

During the final months of World War II, I came across a strange starfish while exploring the shallow reefs that fringe Guadalcanal Island in the South Pacific. The specimen had over a dozen arms in place of the usual five, was about the size of a man's hand, reddish-brown in color and covered thickly with 3/4-inch spines which caused it to remotely resemble some sort of sea-going hedgehog. As I pried the creature loose, one of its spines punctured the skin of my thumb resulting in intense pain, as if I had been stung by a hornet. My hand and arm swelled somewhat and the throbbing pain continued for about an hour, then gradually diminished as the swelling subsided. The starfish, which I had placed on a flat rock to dry in the tropical sun, broke into a number of pieces as it died, making it worthless as a specimen.

A number of years later I learned that my starfish was an *Acanthaster planci*, commonly known as the "Crown of Thorns," and the only starfish known to be dangerous to man. Some persons are particularly sensitive to its poisonous spines and can be made seriously ill fron its sting. Its range includes the tropical coral reefs of the Pacific and Indian Oceans, and the Red Sea.

Recently the crown of thorns has made worldwide news. *Acanthaster*, it seems, has a great appetite for the living polyps which are responsible for laying down the limy coral formations which comprise the reefs. Once an area of polyps is destroyed, the remaining coral skeletons are open to eventual destruction by waves and weathering, and the islands lose their protection. A new colony of polyps must take hold (a slow process) and start building the reef anew where the previous ones left off. By a quirk of biological happenstance, the polyps themselves have been the principal agents which have kept the starfishes under control in the past, since they capture and devour the free-swimming larvae of the starfish. It can be seen that the starfish-coral polyp balance has been a delicate one and potentially unstable were one or the other of the participants to gain the upper hand.

Apparently, this is what has occurred. At the present time the reefs in many areas are being ravaged by what appears to be a population explosion of the starfishes. In August 1969, it was announced by the U.S. Naval Oceanographic Office that a hundred square miles of Australia's Great Barrier Reef had already been destroyed and that the coral reefs near Guam are being eaten at the rate of half a mile per month. Ninety percent of Guam's coastal reefs have been destroyed to date, and the reefs of Palau, Saipan, and Rota are similarly being ravaged. As yet Polynesia has reported no *Acanthaster* problem, but since the starfishes are present there, a condition of potential danger is presumed to exist.

A predator on adult starfishes is a large Pacific triton--a shellfish which has been depleted in recent years by local shell collectors. Attempts are now being made to re-establish the mollusk in endangered areas where it has now become rare. Even if this effort should become successful, however, it would take a number of years to be effective, due to the slow growth rate of the triton.

On July 22, three *Acanthaster* measuring 7 to 8 inches in breadth were brought to the National Aquarium in Washington by Mr. Bernard Zahuranec of the Navy Oceanographic Office, who carried them from Guam in plastic bags. The specimens have proven to be quite hardy in captivity and are feeding at present on cut pieces of fresh shrimp. They are quite active as starfishes go and surprisingly flexible in view of their tough coating of thorny armor. When a dislodged specimen falls to the bottom of the tank, as sometimes happens, it will often momentarily curl into a ball, mimicking a large sea urchin to a remarkable degree.

A new measure currently in use on Guam against the "starfish explosion" is to send skindivers down on the reefs armed with hypodermic harpoons. When an *Acanthaster* is encountered, a jab from the harpoon automatically injects 5 cc of strong formaldehyde solution into its body, causing instantaneous death. If less volume is used, it has been learned from experimentation, the starfish will simply split in two, the uninjected half crawling away to eventually regenerate a whole new individual. Obviously, this method has its limitations.

What is the reason for the recent great increase in the numbers of *Acanthaster*? The natural ecological balance may have been upset in some way by harbor pollution, pesticides and other chemicals, atomic radiation, or the blasting of new channels and harbors. Or the present situation may be part of a long-term fluctuation in the population cycle that may have occurred before. In any event, to all observers, the situation at present appears to be serious, and no immediate solutions are in sight.

REPORT ON "CROWN OF THORNS" STARFISH INDICATES DANGER TO PACIFIC ECOLOGY

The "crown of thorns" starfish endangers life on reefs off some Pacific islands and may become a serious threat to others, a scientific task force reported to the Department of the Interior in a report released in December.

If current trends continue unchecked, the report said, results could include fish shortages for some islanders, who rely on fish for the protein in their diet; loss of tourist trade; and possibly erosion on some low-lying islands now protected by coral reefs.

The report suggested a three-phase control program:

1. Organize groups of divers to kill the creatures individually where infestations now are heavy. One method would be use of a hand-operated injector gun loaded with the chemical Formalin.

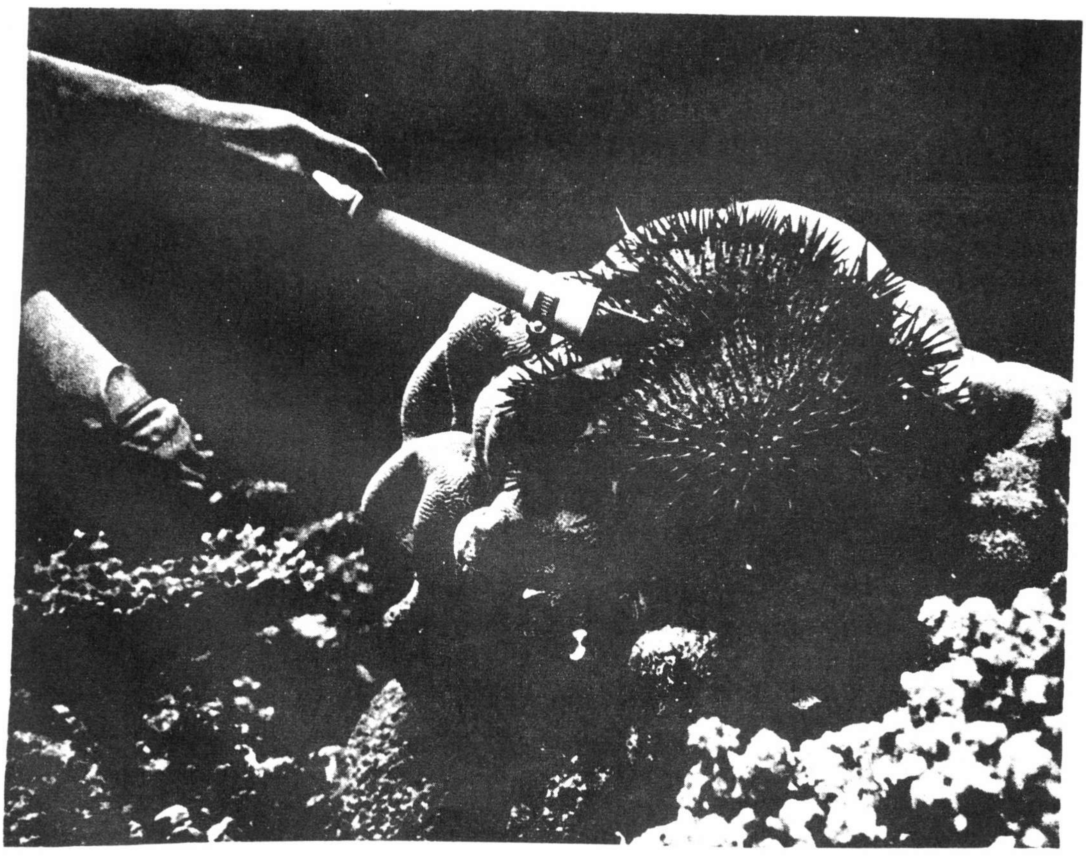
2. Further educate islanders to the problem and what they can do about it.

3. Increase scientific study of the biology of the starfish and of the creatures that prey upon it, and the way reefs degenerate and regenerate.

One diver with a formalin gun can kill up to 600 or 700 starfish a day, said the report, and six divers can clear about one mile of heavily infested reef daily.

Definite causes for the starfish population explosion were not established. The report suggests two possibilities: that dredging and blasting of reef areas have decimated creatures normally feeding on the starfish larvae; and that shell collectors have substantially reduced the number of triton snails, which prey on adult starfish.

Copies of the report "*Acanthaster planci* Impact on Pacific Coral Reefs" may be obtained from the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia 22151. Order the report by asking for PB No. 187631. The price is $3.00.



Diver Injecting A. planci Using Formalin Gun.

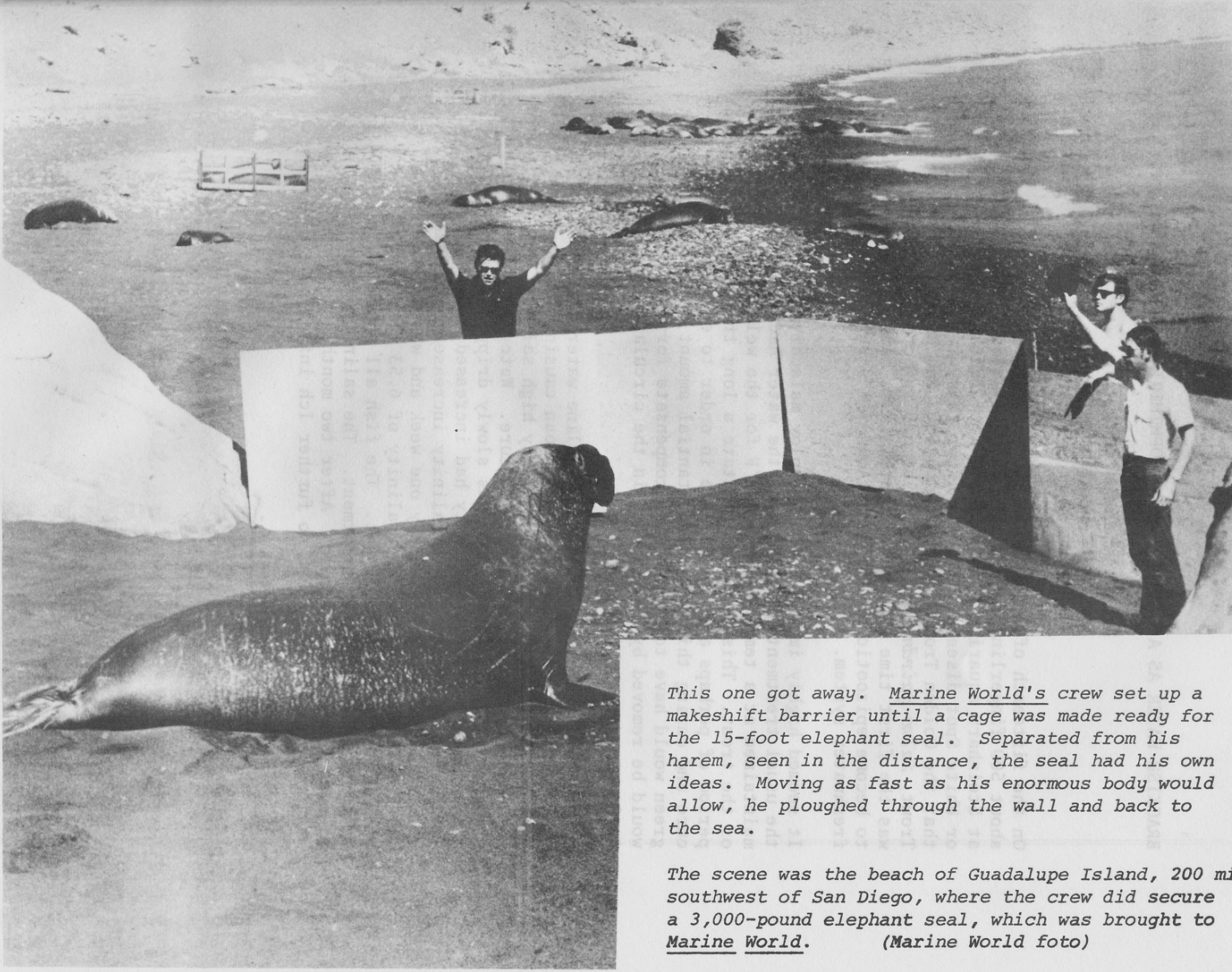
BRACKISH WATER AS A CURE FOR ICHTHYOPHTHIRIASIS IN TROUT

Robert P. Dempster
Steinhart Aquarium

On the fifteenth of August 1969, it was noticed that about 500 fingerling lake trout, *Salvelinus namaycush*, at Steinhart Aquarium were infected with Ichthyophthiriasis or White Spot disease. Shortly after this, it was noticed that the Golden Trout, *Salmo aguabonita*, and Rainbow Trout, *Salmo gairdneri*, had also become infected. This was the first time that Ichthyophthiriasis had been known to become epizootic in Steinhart Aquarium's refrigerated freshwater system.

It seemed highly impractical to employ malachite green, the usual treatment for Ich since the water had to be maintained at a temperature of 50°F for the well-being of the trout. This would necessitate a long treatment period of perhaps a month or more in order to effect a cure and during this time a substantial amount of malachite green would have to be added to compensate for that which would be removed by the filters in the circulating water system.

Since trout are known to tolerate saline water and *Ichthyophthirius multifilis* (the protozoan causing the disease) does not tolerate water of moderately high salinity, it was decided to use sea water as a cure. Water from the refrigerated saltwater system was slowly dripped into the trout system until the salinity had increased to 7.5‰ (parts per thousand). This salinity increase took place over a period of approximately one week and was maintained for two weeks at an average salinity of 6.53 with a high of 9.00 and a low of 5.79 ppt. The fish all appeared to be cured after the salt treatment. The salinity was gradually decreased to zero. After two months of observation, the trout have had no further Ich infection.



This one got away. Marine World's crew set up a makeshift barrier until a cage was made ready for the 15-foot elephant seal. Separated from his harem, seen in the distance, the seal had his own ideas. Moving as fast as his enormous body would allow, he ploughed through the wall and back to the sea.

The scene was the beach of Guadalupe Island, 200 mi. southwest of San Diego, where the crew did secure a 3,000-pound elephant seal, which was brought to Marine World. (Marine World foto)

ABC Marine World's 75-foot oceanographic vessel, the GOLDEN DOLPHIN, was at Guadalupe Island, during mid-September on a collection and filming expedition.

Marine World personnel, **BRADFORD G. BARUH**, General Manager, MICHAEL STAFFORD, Curator of Mammals, and LOU GARIBALDI, Fish Curator, were the team collecting mammals and fish. Assisting in collecting and doing the narrating were MARLIN PERKINS, Director, St. Louis Zoological Gardens, and STAN BROCK, co-hosts of the "Wild Kingdom" TV series.

Plans were to show the feature "The voyage of the Golden Dolphin" on NBC-TV on January 18.

J. THOMAS WHITMAN was appointed last November as Oceanarium Director of *ABC Marine World* in Redwood City (Calif.), where he assumed charge of the training, handling and health of all fish and mammals at the 60-acre marine park. Mr. Whitman has been Aquarium Director with *Sea World* in San Diego and spent four and a half years with *Sea-Arama* in Galveston, Texas, as Assistant General Manager and Curator of Fish and Mammals.

SPECIES OF DOLPHINS AND WHALES CURRENTLY (A) AND FORMERLY (X) HELD AS DISPLAY ANIMALS IN JAPAN (1)

Established	Aquaria	City \ Species	*Balaenoptera acutorostrata*	*Kogia breviceps*	*Globicephala macrorhyncha*	*Pseudorca crassidens*	*Feresa attenuata*	*Peponocephala electra*	*Grampus griseus*	*Tursiops gilli*	*Lagenorhynchus obliquidens*	*Delphinus delphis*	*Stenella caeruleo-alba*	*S. attenuata*	*Steno bredanensis*	*Phocaena phocoena*	*Neophocaena phocaenoides*
'28	Mito	Numazu	X						X	A	X		X		X		
'37	Hanshin Park	Nishinomiya			X												
'54	Yatsu Yuen	Narashino								X							
'56	Atami	Atami								X							
'57	Enoshima	Fujisawa			X			X	A	A	X	X	X	X	X		
'57	Shimonoseki	Shimonoseki				A			X	A	X						X
'57	Misaki	Osaka								X		X					
'57	Takeshima	Gamagori			X					X				X	X		X
'58	Ito	Ito					X		X	A	X	X	X	X	X		
'58	Saikaibashi	Saseho								X	X	X					
'58	Ohotsuku	Abashiri														X	
'58	Naruto	Tokushima															X
'59	Toba	Toba							X	A	X						A
'60	Irukajima Yuenchi	Toba							X	A							
'60	Miyajima	Hiroshima								X							X
'61	Ujina	Hiroshima															A
'63	Awashima Kaiyo Koen	Numazu						X		A							
'64	Yase Leisure Center	Kyoto															X
'67	Akashi Marine Pk.	Akashi								A							
'67	Shimoda	Shimoda			X								X		X		
'68	Terushima Land	Iwaki							A	X	A						
'68	Nagasaki	Nagasaki															X
'68	Bentenjima	Shizuoka		X													
'69	Echizen Matsushima	Fukui									A						

(1) Reprinted from "Animals and Zoos," Vol. 20, No. 7, 1968, with additions by the author, Dr. Masayuki Nakajima, Curator, Enoshima Marineland.

DOLPHINS IN JAPAN

In a personal communication to Dr. Earl Herald, Dr. Nakajima up-dated the table on the facing page. He also advised that a new aquarium will open this summer at Kamogawa, which will provide space for a porpoise show, two killer whales and two Amazon River dolphins, *Inia,* which are already on hand.

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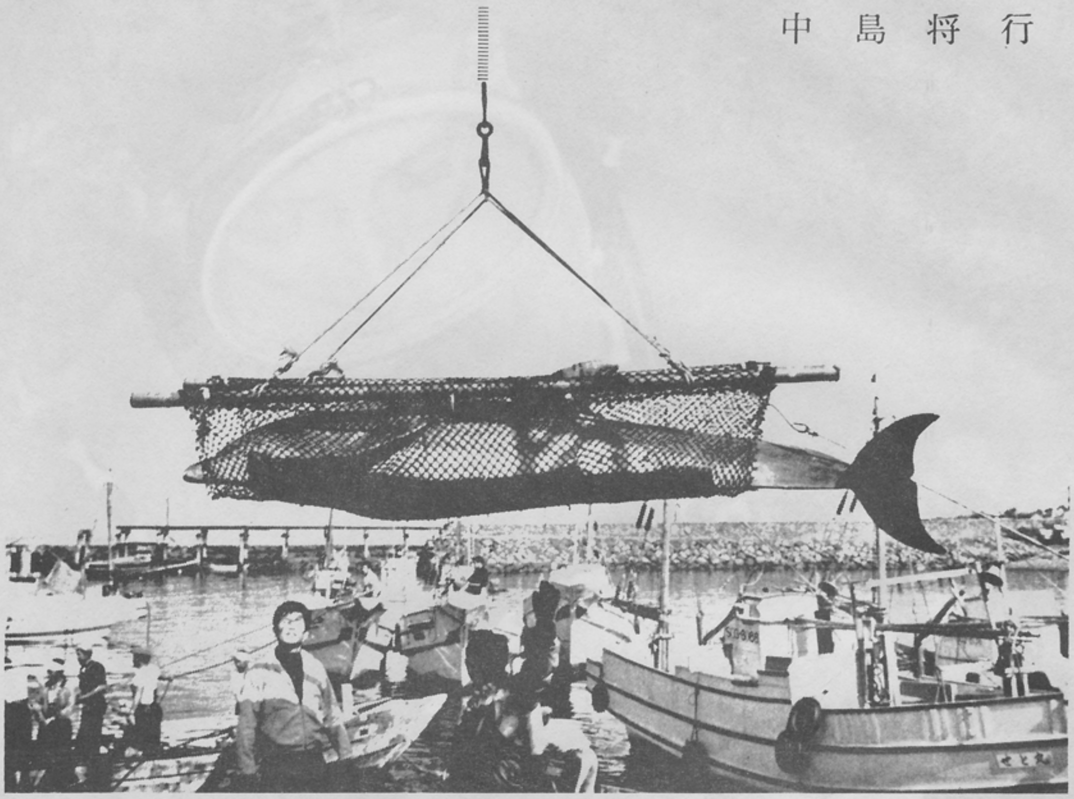


バンドウイルカの輸送 Transporting a porpoise(bottle-nosed dolphin)

湾に追いこまれたスジイルカの群 A school of blue-white dolphins was driven into the bay.

イルカに注射 A sick porpoise gets an injection.

ARTIFICIAL CORAL FOODS FOR REEF FISHES

W. Kymmerly Murphy
Sea World San Diego

The dietary specificity of many reef-dwelling fish often becomes a major stumbling block to the successful maintenance of these animals.

In our efforts to satisfy the dietary requirements of these finicky fish (e.g. scarids), we made some rather startling and very satisfying discoveries.

Our initial studies were pointed primarily toward the parrotfish. After studying the eating habits of these fish, we started searching for a food with a high calcium content. Very limited success was obtained with such delicacies as "mussel au natural" and cracked crab (in season).

Surprisingly enough the most successful food found during this search was "laying pellets." This picturesque designation refers to a pelletized food which is fed to (egg) laying chickens. An extension of this project led us to the production of "artificial coral."

We continued with the hypothesis that calcium may in some way stimulate certain fish to feed. With this in mind, we made five-pound blocks of fast-dry plaster of paris impregnated with such exotic ingredients as Purina Dog Chow, laying pellets, a liquid vitamin supplement, and an amino acid solution.

Our parrotfish eagerly attacked this "artificial coral," biting off pieces of plaster and consuming both the plaster and the exposed foods. Many other types of fish were attracted to this food as well. In fact, the reaction was so great that we had to place three or four of these blocks in our 55,000-gallon tropical fish tank per feeding to minimize the resulting hostilities.

An added feature of this food is the lack of clouding and little or no fouling occurs even after it has been in the tank for two or three days.

The following is a list of families, members of which show a keen interest and actively feed upon this food: BALISTIDAE; SCARIDAE; ANCANTHURIDAE; LABRIDAE; POMACANTHRIDAE; and others to lesser degrees.

As of this writing, we have not definitely isolated calcium, or calcium-containing compounds, as being directly related to the feeding responses of these fish. I feel, however, that further research will show that it is integrally related to this response.

COOPERATE

WITH

Spencer Tinker and his staff at Waikiki Aquarium

Public aquaria should return the questionnaires promptly for the Directory of the Public Aquaria of the World. This is a service to all of us.

SOME AQUARIUMS OF EUROPE

George B. Rabb
Associate Director
Chicago Zoological Park
Brookfield, Illinois

The first European zoo tour for AAZPA members took place in April 1969, and it seems appropriate that someone make note of it in DRUM AND CROAKER. Officially the tour covered 14 zoos, but some intrepid members took in 20 zoos. In contrast to the situation in the United States, zoos and aquaria are noticeably linked in Europe. Although the accommodations for tetrapods that we saw were various and interesting, I was most impressed with the aquaria.

Practically every zoo aquarium had two or three tanks that were superlative in terms of planting, rock formations, or specimens. Among the interesting display techniques seen were a shadow box front to a tank for anemones in the newly refurbished aquarium at Amsterdam. At West Berlin, Dr. Werner Schroeder has a tri-level fresh water tank, with cement rockwork rills fastened to the glass front in some mysterious fashion.

The Exotarium at Frankfurt is essentially an aquarium plus reptile house. Perhaps the best exhibit is one where a mountain brook comes down to a pool for a large giant salamander. The brook sides are well planted, and a few small birds flit about fallen logs. Upstairs a periodic misty thunderstorm set the alligators to roaring while we were visiting.

Basle Zoo had most of the basic structure of their new aquarium completed at the time of our visit. This $1.7 million venture will have a great many tanks, but is being built on a relatively small site (the whole zoo is wedged beside the railroad station). The winding public and work corridors appeared somewhat cramped, and most of the large tanks will be marred by a seam fitting two pieces of glass together.

Not on the official tour was the gem of the aquaria, at Stuttgart. A result of several years' thinking and building, it is obviously planned from the inside out. Failsafe and dual electronic controls abound behind the scenes. The filtration system for many tanks includes special bactericidal UV tubes built with condenser-type jackets for water to flow through. The compressor pump engines were of a novel ultra-compact design. The concrete aquatic tanks were set into the inside walls of the building as separate units: each had a molding between it and the building proper so that any settling of the structure would not ordinarily result in glass-cracking problems. The central section of the Stuttgart aquarium is a greenhouse area with sunken pits for large crocodilians and turtles. Lining the walls are cages for other reptiles. Though bright and well planted, it did not seem up to the standards achieved elsewhere in the building.

Stuttgart was originally a botanic garden, and the director, Dr. Schoctle, is a botanist. One sees a plasant reflection of this situation in the aquarium, for the plantings above the large Amazon River scene are live Amazonian plants! So too with a large East Asian pond tank. The animals, from living coral to anemone fish, appeared to be in great condition. The zoologist and assistant director responsible for the building is Dr. Neugebauer.

The AAZPA is planning another European tour next year and, judging from the first, I believe it would be well worth an aquarist's time.

THE USE OF HYDROGEN PEROXIDE IN THE CONTROL OF FISH DISEASE

Robert P. Dempster
Steinhart Aquarium

and

William H. Shipman
Naval Undersea Research and Development Center

Hydrogen peroxide may be employed as a prophylactic measure for the control of disease in both fresh- and saltwater aquariums and is of value for the treatment of a newly arrived shipment of fish. When it is used at the proper concentration, it will not injure most fish, but will prevent the spread of an indigenous disease by destroying the majority of the bacteria and parasites in the system. Experience at Steinhart Aquarium has shown that at a peroxide concentration of 28 $\pm$ 2 ppm there is no deleterious effect on the various species of fishes tested. Fishes that were infected externally with parasitic trematodes were found to be free of these parasites after a 24- to 48-hour treatment with hydrogen peroxide at a concentration of 30 ppm. This same treatment has been found effective against fin rot and related external problems.

In an attempt to measure the bactericidal characteristics of a 30 ppm hydrogen peroxide solution, simple thioglycollate infusions were used. In order to create the necessary concentrations of peroxide, either 3.8 ml of a 3% or 0.35 ml of a 35% hydrogen peroxide solution was added to each gallon of aquarium water. The final concentration was measured by reacting the peroxide in one ml of **aquarium** water with one ml of 1.4 X 10^{-3}M titanium sulfate **dis**solved in IN sulfuric acid. The absorbance of **the** chromogen was measured at 410 mu and the concen**tration** calculated from a calibration curve (Fig. 1).

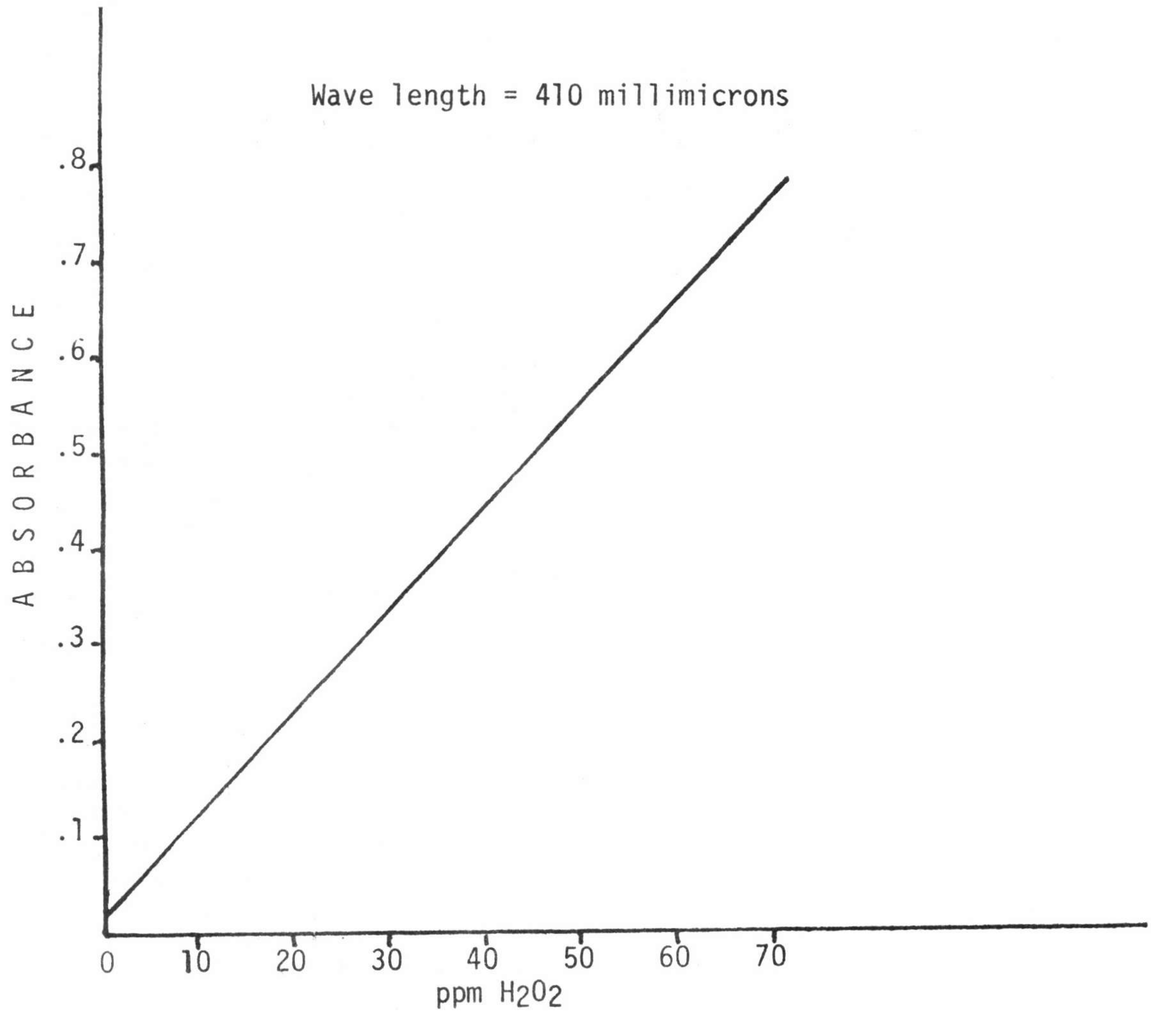
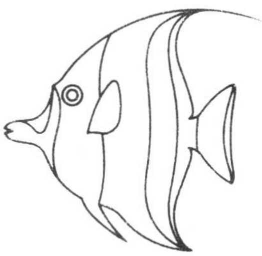


Figure 1. Graph for determing peroxide concentrations in known volumes of water.

$$\text{ppm } H_2O_2 = \frac{\text{absorbance} - 0.028}{0.0104}$$

Once the desired concentration of peroxide had been attained a 0.1 ml aliquot was removed from the test aquarium and introduced into the fluid thioglycollate culture medium. A 0.1 ml aliquot from the same aquarium taken prior to the introduction of the hydrogen peroxide served as a control. Both the sample and control were incubated at 25°C for 24 hours. At the end of this period, the culture tubes were visually compared and it was found that the control tube was extremely cloudy while the sample from the treated tank was completely clear. After 48 hours of incubation there was a visible growth in the previously clear tube indicating that all the bacteria had not been killed. It is clear however that a very high percentage was destroyed. There was no attempt made to identify the surviving bacteria.

Since the hydrogen peroxide is a strong oxidizing agent, bacteria and organic matter consumes it. This loss of peroxide necessitates analytical surveillance with frequent additions in order to maintain the concentration. At Steinhart Aquarium only clear glass or concrete tanks are used. It was found that the peroxide concentration decays quite rapidly in certain fiberglass tanks. It was also found that sand biological filters removed the peroxide completely. There was no effect on the concentration by aeration.



LOU GARIBALDI, formerly with Steinhart Aquarium, and until recently Curator of Fishes, ABC Marine World, Redwood City, (Calif.) joined the staff of the National Fisheries Center and Aquarium in mid-November as assistant to CRAIG PHILLIPS, who is in charge of the National Aquarium in Washington, D.C.

KEEP THEM MOVING

Don Fuhrman
Aquarium of Niagara Falls, Inc.

We're just like any other educational, recreational or tourist oriented facility - one of our first concerns is - how can we attract more visitors? Increasing your level of public awareness is, of course, the standard answer. To raise this important factor of awareness, the basic marketing tools of exciting publicity releases, stimulating advertising (magazines, radio, TV and billboards), and favorable word of mouth are united to produce "positive interest." Such a so-called public relations approach cannot be produced in a vacuum. It requires a combination of education, excitement and entertainment. No one will visit you twice if he's merely going to see the "same old thing" all over again, so you are constantly conscious of the necessity to change and improve your exhibits, upgrade and add to your demonstrations, and develop and maintain pleasant, esthetic and comfortable surroundings.

Fine - you've done all this and then what happens - the people come. Great - except that you only have 250 parking spaces supplemented by about fifty spaces in the street bordering your building. Not only do the people come, but so do the complaints: "It was too crowded. We couldn't see the dolphin show." "I couldn't see the octopus - no one would move away from the glass." "Why don't you limit your admissions so those of us in the building can enjoy ourselves without fighting this situation of wall-to-wall people."

This challenging situation was presented to us at the Aquarium of Niagara Falls during the summer season of 1968, but the solving of this challenge was hampered by our strong capitalistic urge to welcome all the patrons that can be attracted, fully realizing that those feeling "hemmed in" and crowded will certainly not be favorable ambassadors of good will.

What's to be done? How could we have our cake and eat it too? Our Staff - Steve Spotte, General Curator; Ralph Scarrow, Public Relations Director; and Ed Soja, Controller, tossed the problem around at brainstorming sessions - back and forth, up and down. There seemed to be one common denominator - the hourly dolphin and sea lion demonstrations. Casual observation confirmed that there was a "surge" of people exiting after the hourly shows, and further that an impressive number of visitors stayed to see two shows. What would happen if the shows during the busy period of the day were "speeded up" - scheduled every forty-five minutes rather than every hour? There was only one way to find out - try it!

On two consecutive Sundays last April we conducted our experiment. Incidentally, attendance on both Sundays was typical, when compared with experiences over the past four years, and further the daily total was within 7% for the two days. The first Sunday was used as the control and our shows were maintained at the normal hourly schedule. On the second Sunday from twelve noon to 7:00 p.m., we scheduled demonstrations every forty-five minutes. To develop meaningful figures, the first three rows of our parking lot were surveyed every fifteen minutes, recording the cars by license number. We only counted cars that arrived after our survey began and consequently the results below can be considered accurate to within fifteen minutes. The following is what we recorded:

Time at Aquarium	1st Sunday Normal Shows (Percent)		2nd Sunday Fast Shows (Percent)	
1/2 hour or less	15		9	
3/4	20		21	
1	16	51	35	65
1 1/4	22		17	
1 1/2	9		9	
1 3/4	9		7	
2	2		1	
2 1/4	2		--	
2 1/2 hrs. or more	5		1	
	100		100	

Two things seemed obvious: First, more people were able to stay and see our dolphin and sea lion demonstrations. This alone should result in additional word-of-mouth advertising. Secondly, we were able to move 14% more people through the Aquarium in a one-hour period. This not only made available valuable parking spaces, but improved the crowded conditions.

With the survey under our belt, we put the information to use by establishing a policy of commencing "fast" shows, in three-hour groupings (i.e., 12 noon - 12:45 p.m.- 1:30 p.m. - 2:15 p.m. and 3:00 p.m.), whenever our hourly attendance exceeded five hundred. It worked - there were only six recorded complaints this past summer and on only three occasions was it necessary for us to direct our patrons to other neighborhood parking facilities.

One question that always comes up when I talk to others in our industry is - "Don't work your dolphins so hard. No one has more than six shows a day - you'll just work them to death." As that famous presidential candidate would say, "Horsefeathers." Our animals put on eleven shows a day in the summer - hourly on the hour from 10:00 a.m. to 10:00 p.m., and two more shows have never adversely affected them. In fact, we think the extra activities are a positive benefit in that they reduce boredom. What do you think?

Golden orfe, yellow bass and black crappies look at visitors to the National Aquarium, Washington, D.C. (Washington Post foto)

SEA WORLD OF OHIO

RICHARD GEORGE WHEELER AIA & ASSOCIATES, ARCHITECTS • MOFFATT & NICHOL, ENGINEERS

SEA WORLD OF OHIO

W. Kymmerly Murphy(1)

On the shores of spring-fed Geauga Lake, near Cleveland, Ohio, Sea World, Inc. is building a four million dollar oceanarium. Thirty acres of beautiful woodland form the setting for this new park.

Two major stadiums, each seating three thousand people, will form the heart of the show facilities. One stadium will house the killer whale and dolphin production; while the other will be home for a seal and penguin show.

Other attractions will include a beautiful Japanese village, featuring lovely pearl divers, Koi ponds, a dove pavilion, and a deer feeding area. A trout fishing pond, complete with a cascading waterfall, will add to the natural setting of the picnic grounds and playground.

Four specially designed pools will allow people to feed and actually pet the seals and dolphins.

Next season a large aquarium will be added to enhance the existing facilities.

A variety of gift shops, snackbars and an arcade will complement the shows and displays of this new oceanarium.

Sea World of Ohio will open its doors on May 29, 1970.

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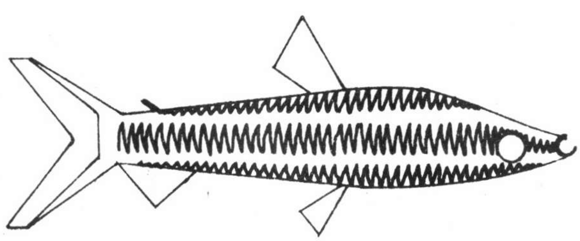
(1) Kym has been appointed Assistant General Manager and Curator of this new facility.




NASSAU SEAFLOOR AQUARIUM
(1967 photograph by
International Film Productions)
Reservoir
Gift Shop-Shell Factory
Main Aquarium Bldg.
Dolphin-Sea Lion Stadium
Snack Shop
Bahamian Lagoon

THE SEAFLOOR AQUARIUM

R. A. MARTIN, CURATOR
NASSAU, BAHAMAS

Nassau's Seafloor Aquarium which opened to the public on March 18, 1967, is shown on the facing page (photograph taken during final construction).

The 107-foot main aquarium building houses our main arena (35 feet in diameter by 12 feet deep, 80,000 gallons) and 12 gallery tanks. A coral grotto adorns the main arena, where native reef fishes are viewed in their natural setting. The gallery tank display encircles this tank and includes seven 500-gallon hexagonal fiberglass tanks and five large concrete tanks ranging from 2,500 gallons to 6,500 gallons. Walls are designed to fade into the background. Diurnal and nocturnal sections provide the visitor with a synoptic tour of the many zones of the sea floor (e.g. shallow reef, deep reef, tropical lagoon, details of the cliff, harbor bottom, etc.). Predator and prey are often seen together with live corals and other invertebrates.

Sea water brought up from a 190-foot well is already pre-filtered underground through oolitic limestone. Water quality is quite constant and the temperature remains close to 75°F year round. Water is pumped directly to a reservoir where it is aerated and flows (gravity) at a rate of 1,800 gallons per minute to the system. This ultimately drains to a 110-foot underground channel and is returned to the sea.

The dolphin tank (60 feet by 30 feet, 80,000 gallons) is similar to Montreal's oval performance tank enabling spectators to view the animals both above and below the surface during the course of the show. Maximum depth near the jump stand is 14 1/2 feet grading to 7 feet near the far end of the tank. Show animals include bottlenose dolphins and California sea lions. Dolphins are currently being trained in our adjoining holding tank (25 feet by 15 feet by 8 feet).

Sea turtles and lagoon fishes are displayed in the oval channel (14 1/2 feet maximum depth) that comprises our Bahamian lagoon tank. Lagoon shows feature turtle catching by native fishermen and gear. The central island is a miniature San Salvadore with a diminutive replica of the Santa Maria moored nearby.

Current problems include (1) lack of holding facilities on the premises, (2) limited lab space and equipment, and (3) limited staff. Aquarium staff members include the curator, two divers, two trainers, and a parttime truck driver-maintenance man. Holding facilities for incoming fishes are now being completed. A chemical treatment system is being developed for the fish exhibit.

This million dollar complex was built by Cavalier Construction and Bahamas Gunite Corporation. Mr. G. Curtis Johnson is principal owner and general manager of the operation. Dr. Carlton Ray, formerly with the New York Aquarium served as consultant.

WERNER SCHRODER, Director, Berlin Aquarium, was in the country in October, attending the International Convention of Zoo Directors in New York, and visited aquariums at Coney Island, Philadelphia, Washington, D.C., Vancouver, B.C., San Francisco, Los Angeles, and San Diego. For diversion he hunted rattlesnakes in the desert of southern California, returning to Berlin on October 24th by way of London and Edinburgh.

Captain Bill Grey and Craig Phillips bottle-feed spear-damaged manatee at Seaquarium, 1953.

The Port Elizabeth Oceanarium, South Africa, was severely damaged by floods on September 1, 1968, when 18 inches of rain fell. The Museum and Snake Park behind the pools.

OCEANARIUM WATER INTAKE AND FILTRATION PROBLEMS(1)

C.K. Tayler, Curator
Port Elizabeth Oceanarium
South Africa

The special requirements of a water intake system and the difficulties in installing and operating such an installation, together with factors that bring about failure or poor operation of a filtered water intake system, are little understood by members of the public and give rise to complaints when water conditions are cloudy in the aquarium tanks.

It is therefore intended that the following notes will give an explanation on some of the technical problems that arise with oceanariums and aquariums in all parts of the world, and more especially local conditions that cause difficulties at Port Elizabeth.

The water in a pool where marine mammals, birds or fish are kept becomes contaminated with faecal material and urine, dust and debris blown in by the wind, and remnants of uneaten food, etc. If the water is not changed frequently, certain marine microorganisms will appear, algae will grow on the pool sides and bottom, bacterial and fungoid cultures soon build up and the whole pool will become a filthy unhealthy environment. The process of recirculating the same water through a filtration plant will cleanse it of all undissolved material, but the urine and soluble nutrients continue to build up, since they pass through the filter medium.

These nutrients in the now clear water give rise to Diatom blooms, most of which are unfilterable by ordinary means, and we are then back to discolored water rendered opaque by the millions of diatoms. The diatom-infested water however is generally clinically clean as the nutrients are completely absorbed by them.

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(1) From a Report to the Board of Trustees.

A method of purifying water after filtration is to treat it chemically. Sea water can be treated, but the animals that live permanently in and drink this water, will in time show side effects of the chemicals used, e.g., chlorine, and can bring about the early death of the inmates and reduce the possibilities of breeding. Chemicals such as copper sulphate in very mild doses will control the growth of algae without ill effects.

These are the problems facing aquariums and oceanariums situated away from the sea. We are in the position where we are able to change over contaminated water with fresh sea water drawn directly from the sea. The sea water unfortunately is seldom clear enough to meet the requirements of an oceanarium and is usually so dirty that visibility particularly in our area, is only a few feet. During strong south-westerly winds the visibility can be as little as three inches. It is obvious then that water drawn from the sea must be filtered before entering the tanks and pools and this brings us to the design and installation of a filtering system.

The method of filtration is simple enough. Well points, well screens and various combinations of porous materials inserted under the sea sand will provide clear water when connected to a suitable pump. The well point, whether it is a pipe drilled with a number of tiny holes, or fine slits cut in it; or a large box structure with tiny holes, operates by merely preventing the sea sand (filter medium) from passing into the pipe and pump and into the pools. Water is thus drawn through the sand by the sucking action of the pump and on the way all the fine particles are left behind in the sand. This is a process of particle attraction just as in the Solar System - a sort of gravity attraction of the minute particles in the water to the grains of sand. The heavier particles, bits of seaweed, etc., are well strained out and left on the top of the sea bed. The well point just strains the sand particles - they cannot pass through it.

We chose to use two fiber glass well point units for the installation, completed in two sections in June 1967. These units, constructed to our specifications, and micro-drilled by our staff, have proved very satisfactory. They take the form of four cylinders, each 33 feet long and 18 inches in diameter (D). The ends are blocked with fiber glass plates and two cylinders are connected together by means of two 12-inch diameter by 3-feet stubs. The two units thus formed are connected individually by two 7-inch D fiber glass pipes each 225 feet in length, to the pumping station.

We have, then, two units each consisting of two elements (four cylinders altogether) sited 100 feet apart. Each unit is drilled with approximately 450,000 tiny holes each 3/64 of an inch in diameter, right through the 3/8 of an inch thick fiber glass. The holes are spaced about 1/2 inch apart, and drilled in all surfaces including the interconnecting stubs.

The continuance water yield is 700 gallons per minute for each unit provided they can be backwashed thoroughly and with sufficient pressure to dislodge any material that may block the tiny holes. A better continuance yield would be obtained if the cylinders were not interconnected into pairs, but rather four connecting pipes brought up the beach for more thorough backwashing. This, however, doubles the piping costs.

The material (fiber glass) has a theoretical life of 100 years in sea water. P.V.C. plastic has a comparatively short life. It becomes brittle in a few years and may collapse. Rubber, stainless steel, asbestos cement, bronze and copper, are all unsuitable due to their short life and/or rigidity. The commercially manufactured well points are of this type and intended for fresh water use where rapid electrolytic or chemical failure does not arise. Our Oceanarium commenced its long history of water intake problems with metal well points which lasted ten months. Plastic types were tried but they were washed out by wave action in heavy easterly winds. We finally licked the problem in 1967 by installing these units (of the most suitable material - fiber glass) and burying them under beach pebble, well beyond the low tide mark, by first making a cofferdam of sea sand with two bulldozers and then excavating 4-foot deep pits to contain the units. Trenches to contain the two connecting pipes were also buried under beach pebble in this manner, the whole distance up the beach to the pumpstation.

This system is completely safe in any sea and under any conditions and has been completely satisfactory and performed all its functions.

In view of the tremendous cost of fiber glass, units of the smallest possible dimensions were used, to give only the minimum water requirements.

This type of installation, unlike a well providing drinking water, has to be backwashed. The sea sand above the well points becomes saturated with debris and eventually will not pass the required amount of water. It is cleaned by stopping the pump and allowing water to flow by gravity from the Dolphin pool back through the system and through the sea sand. The upward flow of water through the sand lifts each grain of sand slightly and washes out the debris. About 30 minutes per day of backwashing time is required.

Pumps working on high vacuums such as in this case, normally give short service. Through the corrosive action of sea water worsened by high vacuum conditions, special pumps are required. The very small quantity of highly abrasive sand that does in fact creep through the well points does untold damage to pump parts, particularly the gland sleeve which is generally of a special abrasive resistant metal. We use a rubber lined pump with a stellite sleeve which we find gives excellent service and requires little maintenance.

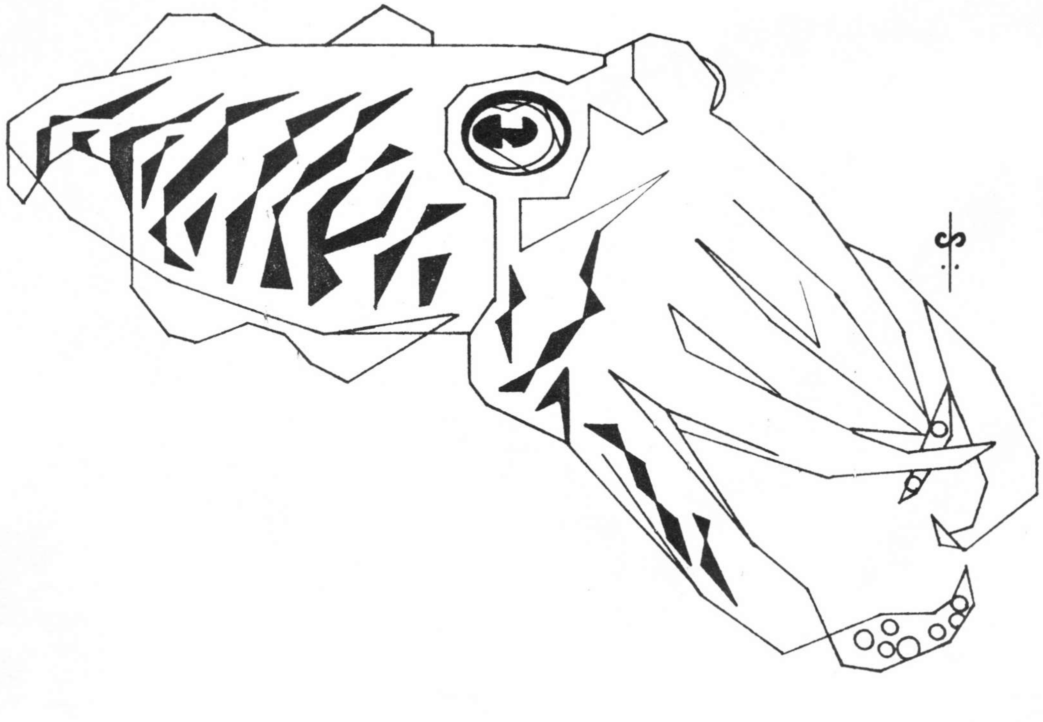
Failure of System

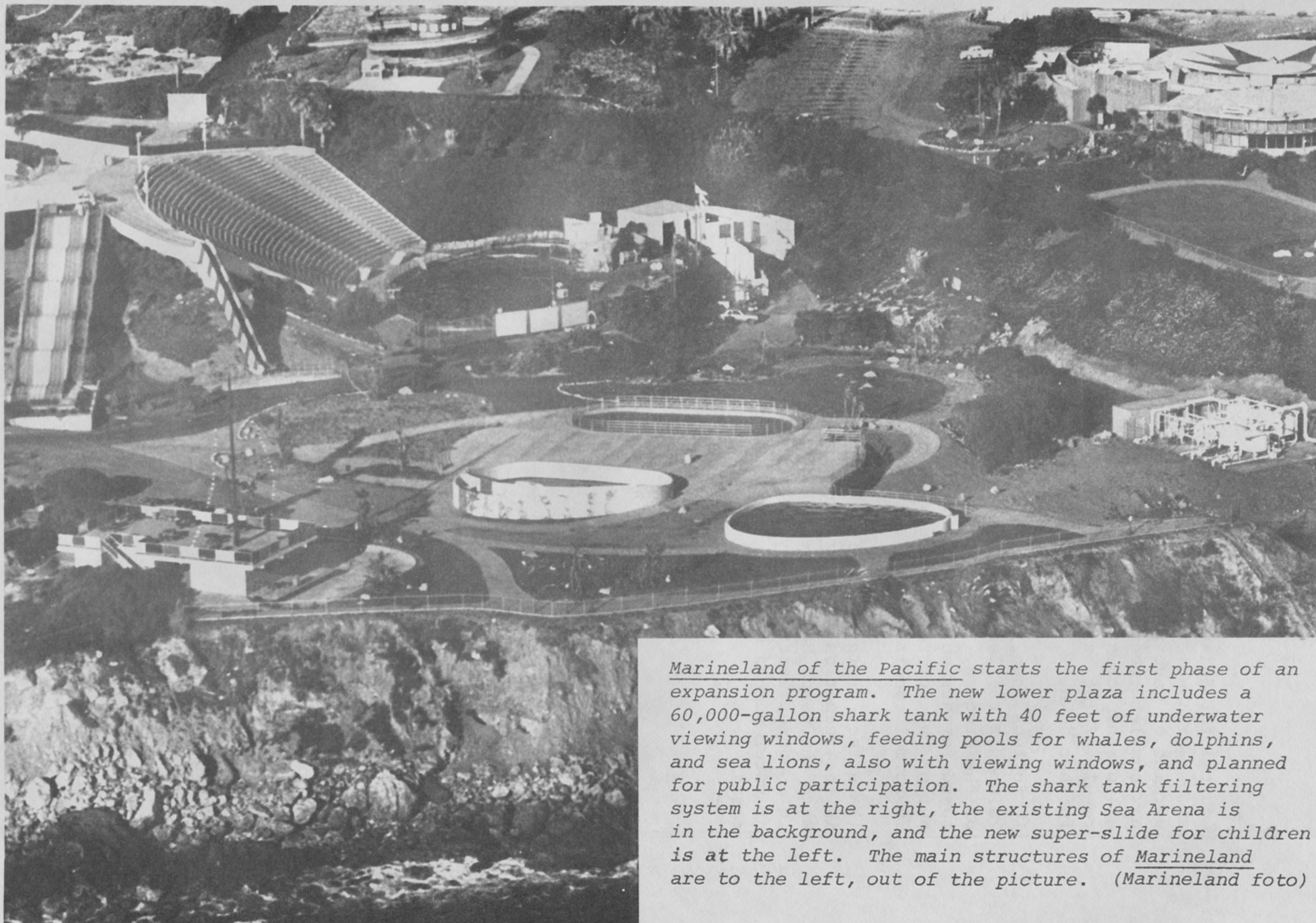
The system is now failing for a reason which has arisen partly out of the tremendous amount of sand that was released in Algoa Bay during the September 1968 floods. This sand was washed out to sea into banks which will eventually be deposited back onto beaches and blown back once again inland to form sand hills from where it originally came. But with the onset of the south-westerly (off-shore) winds, some of this sand piles up on the beaches in larger than normal amounts and has caused our intake system to be on dry land during low spring tides. The main factor, however, is the gradual forming process of Kings Beach which we are told by the

Council for Scientific and Industrial Research, has almost reached equilibrium. A specialist who has been working on wave profiles and currents for some years, has complete records and can give reliable predictions as to sand formations. This beach is forming as a result of the building of an oil tanker berth 1/2 mile further down.

It follows then that the 40 feet which our beach has gained in the last four years is probably at the end of the process. These units will therefore have to be moved further out beyond the new spring low tide mark out of the intertidal zone. This would not be necessary in normal conditions.

The effect of this sand-forming process to the Oceanarium is the reduction in water turnover during spring tides when the pumps have to be switched off. This gives rise to a poorer water clarity in the tanks, as the quantity of water pumped during a day is then less than that required.





Marineland of the Pacific starts the first phase of an expansion program. The new lower plaza includes a 60,000-gallon shark tank with 40 feet of underwater viewing windows, feeding pools for whales, dolphins, and sea lions, also with viewing windows, and planned for public participation. The shark tank filtering system is at the right, the existing Sea Arena is in the background, and the new super-slide for children is at the left. The main structures of *Marineland* are to the left, out of the picture. (Marineland foto)

COMMENTS ON EYE DAMAGE TO A WHITE-SIDED DOLPHIN
Lagenorhynchus obliquidens

Richard Shopen(1)
Steinhart Aquarium

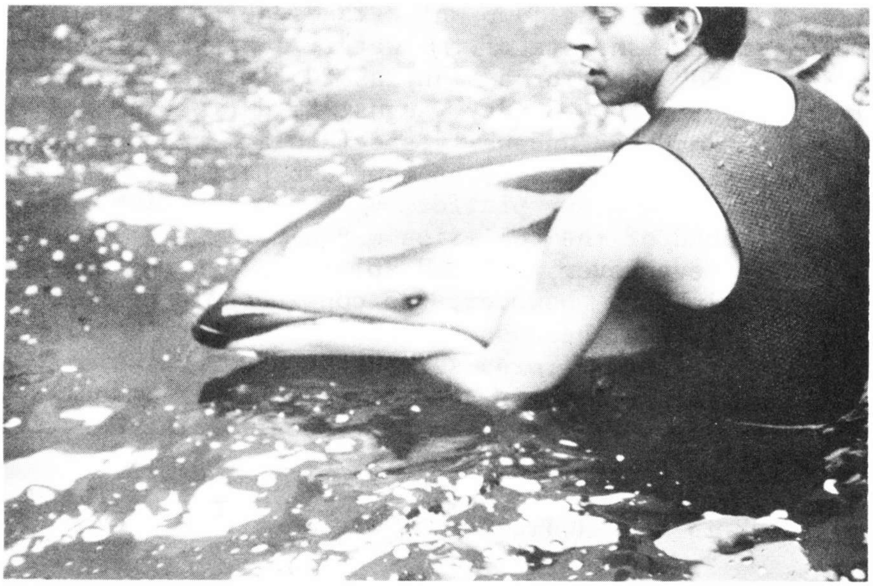
The marine dolphin tank at Steinhart Aquarium houses five dolphins and one harbor seal. Four of the five dolphins are *Lagenorhynchus obliquidens*, more commonly known as the Pacific white-sided dolphin. The fifth dolphin is an Atlantic bottlenose dolphin, *Tursiops truncatus*. These animals are fed four times a day at two-hour intervals, beginning at 10:30 a.m. During the feedings the dolphins are required to jump, tail walk, etc. However, the structure of the show is relatively loose, and the dolphins have to a certain extent developed their own tricks. Dolphin-initiated variants of "shaped," i.e., trained, behaviors are encouraged and reinforced. After initial training one animal may prefer (or has inadvertently been reinforced for) tail walking while another may prefer high arching jumps, culminating in a tremendous splash or belly flop.

Spot, one of our female white-sided dolphins, specializes in a high leap of the type mentioned above. She will often make a gliding jump which takes her more than eight feet above the surface of the water. She will repeat this "shaped" behavior as many as 20 times during a five-minute feeding. On Sunday, August 8, during the 2:30 p.m. show, Spot made an unusually spectacular leap and struck the left side of her head on the jump platform while still ascending. The heavy platform vibrated from the impact, and the sound of the collision was clearly audible 25 feet away, even over the loud splashing made by the other leaping dolphins. However, she continued to perform and feed. I assumed, because she had not stopped working that she had not suffered serious injury, but as a precautionary measure, attempted to examine her immediately after the show. She refused to respond to the hand signal

(1) Dick is Mammal Trainer at Steinhart.

used to call her to the side of the tank, but otherwise continued to behave in a normal fashion. Later, we managed to get a closer look at the dolphin through the viewing glass. Due to the recent addition of chlorine into the dolphin water system, the water was cloudy. This, in addition to the large Sunday crowd, prevented our getting more than a rudimentary idea as to the extent of the damage. The wound seemed to involve the eye which, from our vantage point, appeared rather cloudy. We could see no blood, and the dolphin appeared to be able to move the eye. As the days passed, the eye became increasingly opaque. At no time during this period did the dolphin show any visible signs of distress. Her feed, play, and sexual activity all appeared to be quite normal. She continued to perform effectively at all shows. It soon became apparent, however, that she had difficulty picking up fish thrown to her left side.

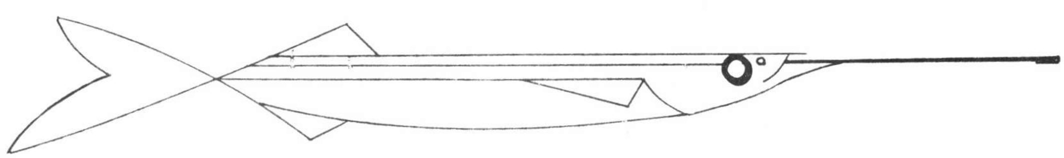
On September 16, the water in the marine dolphin tank was lowered in order to record the weights of all four white-sided dolphins. After capturing Spot and placing her in the large sling used to lift the dolphins from the water, we had our first opportunity to carefully examine the eye. The cornea was milky white, and no pupil was visible. The eye muscles were still functional (i.e., they had not atrophied), but it seemed quite apparent that the dolphin was blind.



The next week we again lowered the tank. Dr. Fredric L. Frye, veterinary surgeon for the Aquarium, was on hand to examine the wound. He diagnosed the injury as a lenticular cataract; the damage was irreversible, and the dolphin was indeed blind in the left eye.

As of this writing the dolphin has shown no distress that can be directly attributed to the damaged receptor. She has not gone off feed, and her performance during daily shows has not deteriorated. We cannot explain this, as it would be expected that trauma and shock would follow an injury of this magnitude. The incident becomes especially puzzling when one considers the temperament of white-sided dolphins in general. When, for example, compared with the more tractable bottlenose dolphin, white sides often appear inordinately sensitive. They are prone to stop feeding as a result of relatively insignificant incidents, often refusing food for several days after merely being weighed.

By mid-October Spot had learned to pick up fish thrown to her blind side. The sound of the fish striking the water may be the new critical stimulus; however, other sense modalities that we are unaware of could be involved in this response. We do know that she has effectively compensated for the injury and seems only slightly hampered by her handicap.



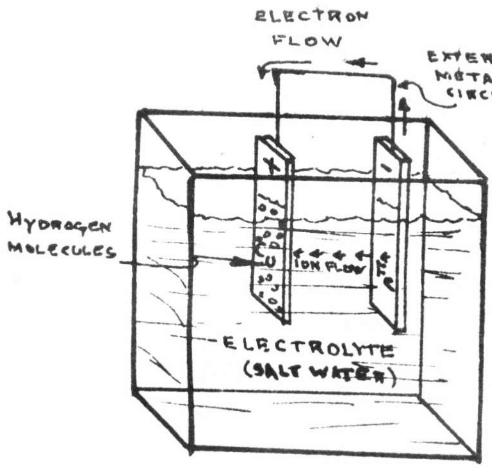


FIG. 1

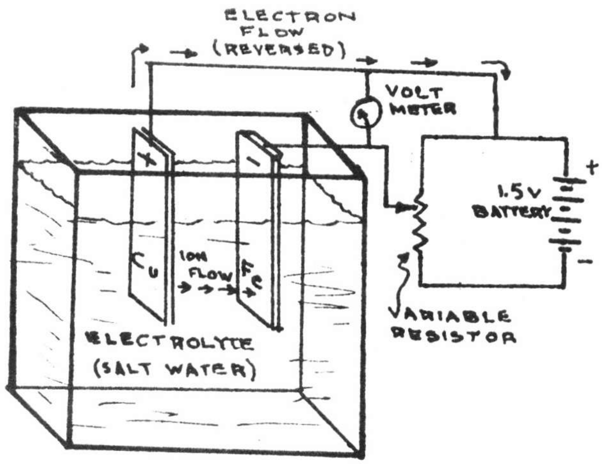


FIG. 2

Figure 1: Corrosion Cell.

Figure 2: Impressed Current Cathodic Protection. Voltage developed by the cell in Fig. 1 is approximately 0.4 volts. If the variable resistor is adjusted so that the battery voltage exceeds 0.4 volts, the direction of current flow is reversed as indicated. This will cause a surplus of electrons on the iron, which will attract hydrogen ions from the electrolyte, thereby changing the iron from anode to cathode.

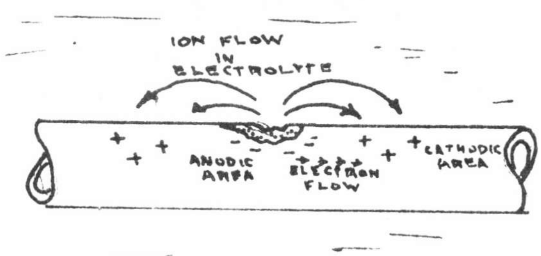


FIG. 3

LOCAL CELL ACTION

CORROSION CONTROL

Billie M. Bevan
Miami Seaquarium

The direct losses due to corrosion run into the millions of dollars every year in the United States. The marine aquarium, with its harsh saline water environment, is a classic example of the losses that can occur.

Pipe failure, pump breakdown, and tank rupture are often the direct result of corrosive forces.

Resultant losses due to shutdown of facilities, cost of replacement parts, and labor costs can be sharply curtailed by applying the concepts of corrosion control. Economically, the optimum time to consider corrosion control is in the planning and design stages of a facility. However, in all but the most advanced stages of deterioration corrosion control will be of value. In order to incorporate a corrosion control program of value, one must understand the corrosive process as well as preventative measures.

The basic illustration of corrosive processes is the simple (battery) cell (Fig. 1). This cell is comprised of an electrolyte (salt water), an anode (iron), and a cathode (copper). The two electrodes (iron and copper) are connected externally by a metallic circuit.

For our purposes the anode will always be considered the active and positive element and the cathode the negative and passive element of this cell. Current flow in the external circuit will be from negative to positive by means of electrons. In the electrolyte, ionic current flow is from positive to negative.

Iron tends to ionize more readily than copper; therefore, it is more active. At the instant a molecule of iron loses an electron it becomes an ion and enters the electrolyte. The electron travels through the external circuit to the anode where it is neutralized.

In the electrolyte, certain chemical processes take place. Normally there is some dissociation of H_2O into hydrogen ions (H^+) and hydroxyl ions (OH^-). The negative hydroxyl ions combine with the positive ferrous ions (Fe^{++})forming ferrous hydroxide, thus maintaining the chemical and electrical stability of the electrolyte. The positive hydrogen ions migrate to the copper cathode where they combine with the electrons from the anode to form stable atoms of Hydrogen.

The anodic reaction (oxidation process) is:

$$Fe + 2\ OH = Fe\ (OH)_2 + 2e^-$$

The cathode reaction (reduction process):

$$2\ H_2O + 2e^- = H_2 + 2\ OH$$

Overall reaction:

$$Fe + 2\ H_2O = Fe\ (OH)_2 + H_2$$

Free hydrogen molecules plate the cathode in a monatomic layer. Excess molecules gradually combine with oxygen to form water.

Thus, metals corrode when their ions enter solution.

In the example, different metals served as cathode and anode. However, any metal will have impurities which produce areas of dissimulation (Fig. 3). A difference of potential will exist between these areas and the pure metal surrounding them. In effect, we will have thousands of minute voltaic cells over the surface, each contributing to the overall corrosive action. This activity is referred to as "local cell action."

The above illustrates that a number of factors are involved in corrosion processes, control of which can be achieved with varying degrees of success in the following ways:

1. Breaking the external circuit will stop the interaction of the two metals, but would have no effect on "local cell action."

2. Coating one or both electrodes will prevent the reaction. The finest of available coatings are imperfect at best, however, and even a single break in their integrity can produce intense pitting.

3. Equalizing potentials to eliminate current flows.

Each corrosion control application is suited uniquely to specific corrosion problems due to variables and restrictions involved.

Environmental factors to be considered are:

1. Temperature - high temperature = increased corrosion.

2. Aeration - oxygen is required for corrosion.

3. pH - in general, acid conditions are more conducive to corrosion.

Physical factors:

1. Structural shape - numerous sharp angles increases difficulties of protection.

2. Size - determines protective current requirements.

3. Location - climatic conditions, soil conditions determine methods of protection required.

4. Material - selection of compatible materials and the protection of dissimilar material at one location.

Biological factors:

1. Algae growth - inhibited (by positive potential) and accelerated (by negative potential).

2. Open (running water) or closed (recirculating) water system.

3. Bacteria - certain bacteria cause rust.

Economic factors:

1. Type of protection system to be installed.

2. Cost of protection vs. cost of replacement.

3. Personnel to maintain installation.

Corrosion control may be broken down into three basic categories:

1. Materials

2. Coatings

3. Electrolytic

Electrolytic methods involve establishment of oxidation-reduction conditions in which hydrogen is deposited cathodically on the structure being protected, while oxidation takes place at an anode.

This is essentially the process occurring in our simple cell where the corroding iron anode was protecting the copper cathode.

Since we normally are concerned with protecting the iron, we can replace the copper with a metal such as zinc which is more active than iron. The iron now becomes the cathode and ceases to corrode.

This method of using a more active metal to protect a given structure is termed a <u>sacrificial anode system</u>, and is used extensively on boats, canal locks, pumps, and other isolated structures.

The second electrolytic method is termed <u>impressed current cathodic protection</u>.

In our original cell, inserting a battery and variable resistance in the external circuit in a manner to oppose or buck the normal flow of current, in effect, will make the copper become the anode. If the iron is made sufficiently negative with respect to the copper, it will also eliminate any local cell action (Fig. 2).

In practice the copper would be replaced with some substance which does not ionize readily, such as carbon.

Seaquarium utilizes the impressed current system to protect the large tanks, pipes (other than P.V.C. and fiberglass), pumps, pressure filters, and steel upright monorail supports. This, in conjunction with good coatings and proper material selections, has reduced losses due to corrosion.

Specific applications of cathodic protection at Seaquarium is illustrated in Diagram 1.

Diagram 1 is the system used to protect our 80-and 50-foot diameter tanks. These tanks have concrete bottoms and gunite coated cold rolled steel sides.

GENERAL READING LIST

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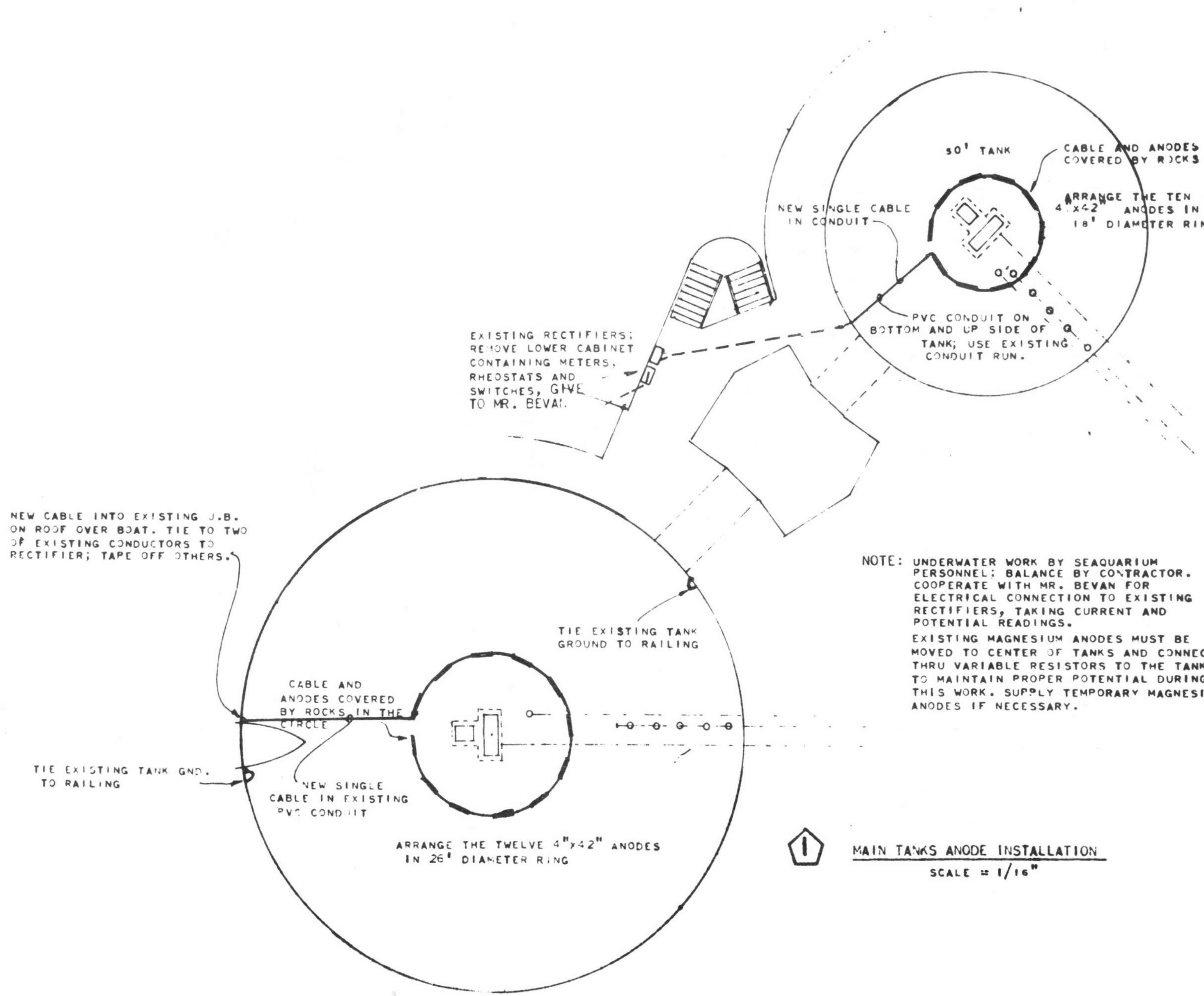


NOTE: UNDERWATER WORK BY SEAQUARIUM PERSONNEL; BALANCE BY CONTRACTOR. COOPERATE WITH MR. BEVAN FOR ELECTRICAL CONNECTION TO EXISTING RECTIFIERS, TAKING CURRENT AND POTENTIAL READINGS.

EXISTING MAGNESIUM ANODES MUST BE MOVED TO CENTER OF TANKS AND CONNECTED THRU VARIABLE RESISTORS TO THE TANKS TO MAINTAIN PROPER POTENTIAL DURING THIS WORK. SUPPLY TEMPORARY MAGNESIUM ANODES IF NECESSARY.

1 MAIN TANKS ANODE INSTALLATION

SCALE = 1/16"

MORE ON CORROSION

Walter L. West
National Fisheries Center and Aquarium

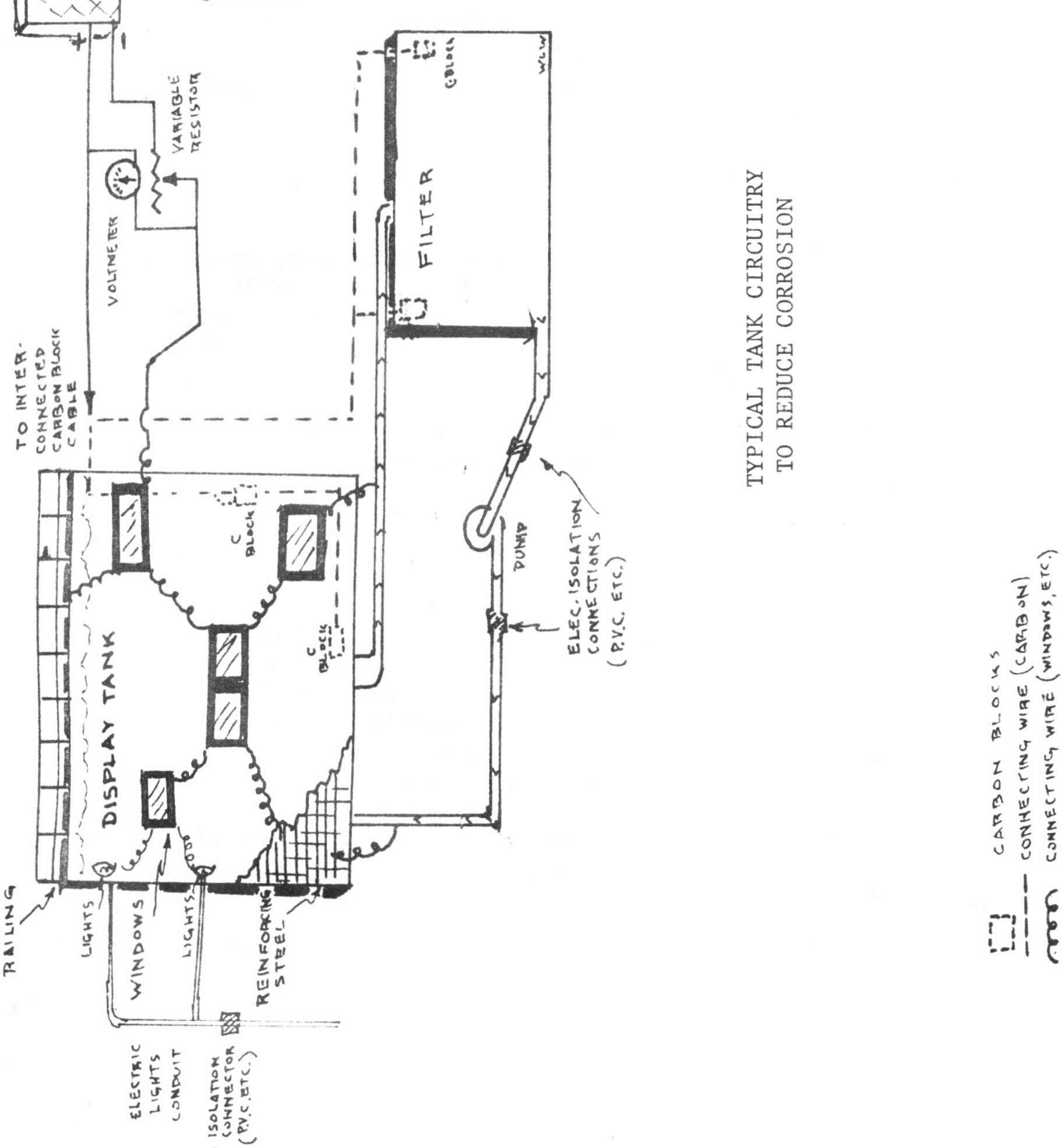
Although Billie Bevan's material is instantly clear to those technically oriented, I would like to associate it more closely, if I may, to the thinking of an aquarist as to how it is used within his aquarium. Billie has made it very clear that an external direct current source (EMF) such as a battery "plugged" into a "circuit" will reduce, stop, or reverse electro-chemical (corrosion) action. A typical aquarist would comment that no one designed a plug in the side of his tank.

All of the metal portions of a tank (window frames, railings, reinforcing rods, built-in lighting fixtures, etc.) should be interconnected or wired together, but should not be grounded. A ground is negative; therefore, grounding the interconnected metal is worse than no protection at all. The connecting wire is fed to the variable resistor (rheostat) in a system as shown in the accompanying sketch. Thence, to a series of inert conductors such as carbon blocks placed somewhere within the system--tank, piping, filter areas--the closer to the active corrosive area the more efficient. A series of blocks is generally most effective. The externally introduced current has made the steel the cathode (instead of the anode).

It is important to remember, as Billie indicated, if too much voltage is used in new concrete tanks, the concrete near the cathode metal (window frames, reinforcing, etc.) through which the current leaves the circuit becomes softened and remains brittle and friable after drying, destroying the bond between iron and concrete.

Although Billie mentioned a number of physical causes of corrosion, he did not mention a very interesting one, that of physical strain. Oxidation, or anodic areas, are created in a number of ways, but in forming a window frame from angle iron, as an example, in a cold state will put a strain concentration at that point. General practice is to cut a "wedge" from one leg of the angle and bend the other leg to 90° and weld the resultant angle. Also, the welding material, if made from a slightly dissimilar metal from the angle iron, is an invitation to corrosive pitting.

Ideally, all pipes and conduits entering and leaving a tank structure or the soil should have insulating joints.



TYPICAL TANK CIRCUITRY
TO REDUCE CORROSION

F.G. WOOD, appreciates our D&C work, and apologizes for failure to contribute saying that this "was supposed to be a requisite for remaining on the mailing list." Perhaps we should reinstate this requirement.

Woody has a new assignment with the Ocean Sciences Department, Naval Undersea R&D Center, San Diego, California 92132, where the Point Mugu work will be continued at Sea World.

SALT WATER AQUARIA

"The Marine Aquarium," by Robert F. O'Connell, Great Outdoors Publishing Co., 4747 28th St., North, St. Petersburg, Fla., 33714, 158 pp., illus., $6.95.

This is a comprehensive description of how to set up an ideal marine tank, and to create the conditions in which marine fish will thrive. It includes the latest techniques and equipment for filtration, heating, lighting, decoration, and feeding. Superb color photographs of many species are included.