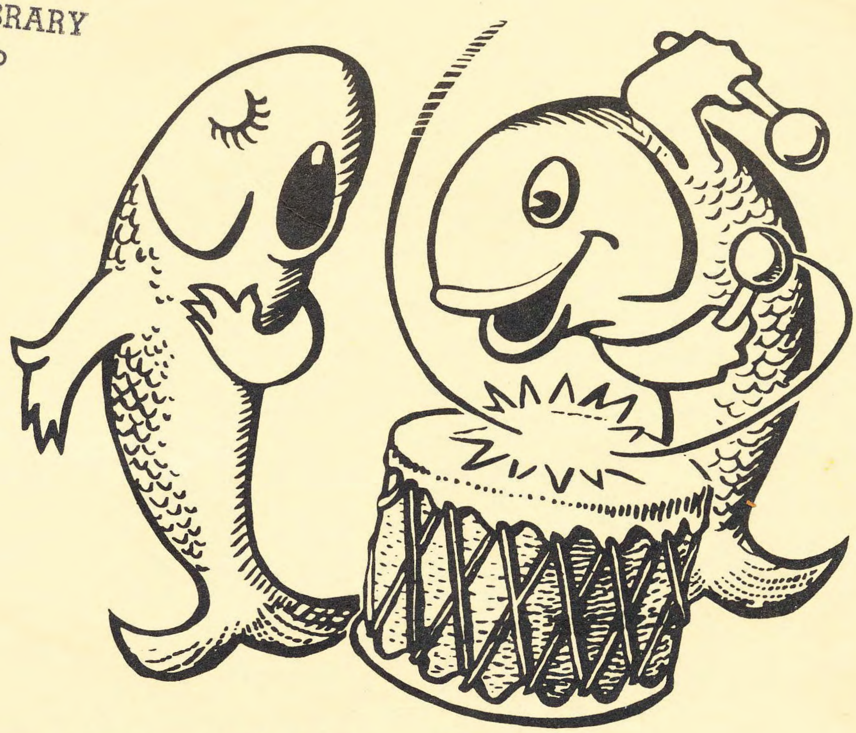


The DRUM and CROAKER

A Highly Irregular Journal for the Public Aquarist

Winter 1979
volume 19 (79), number 2

Volume 19 (79), Number 2 Winter 1979

DRUM AND CROAKER

The Informal Organ
for Aquarists

Manuscript material received is reproduced with a minimum of editing and is not returned unless requested.

We take credit for neither spelling nor classification.

Material herein may be reproduced unless specified otherwise. Please credit DRUM AND CROAKER, author, and photographer for material used.

This issue of DRUM AND CROAKER was prepared by the New England Aquarium, Central Wharf, Boston, Massachusetts, as a service to aquariums generally.

NOTICE

The New England Aquarium has the responsibility of editing, publishing, and distributing DRUM AND CROAKER. Copies are sent to those persons who contributed articles and to those working in the aquarium field and related aquatic sciences.

We are happy to have an opportunity to serve DRUM AND CROAKER readers. All future articles, inquiries, and complaints should be addressed to:

Jean Roberts, Editor
DRUM AND CROAKER
New England Aquarium
Central Wharf
Boston, MA 02110

Copy deadline for the next issue is April 1, 1980.

John H. Prescott
Executive Director
New England Aquarium

CONTENTS

CLEANING SYMBIOSES FOR TEMPERATE MARINE FISHES IN DISPLAY AQUARIA

Jeffrey B. Marliave and Victor J. Elderton
Vancouver Public Aquarium

Introduction: Cleaning sysmbiosis is perhaps best known among coral reef fishes, specifically the cleaner wrasse, *Labroides dimidiatus*, which was promoted for use in display aquaria by Earl Herald (1964). Although the usual concept of cleaning symbiosis seems easy to apply to the management of display aquaria, problems often arise in implementing "cleaner" associations in a display situation. Difficulities seem greatest with displays of temperate marine fishes, which are typically thought of as not having cleaning symbioses. This paper will review the subject and present some new observations, with the goals of clarifying the operational definition of cleaning symbiosis and promoting efforts to demonstrate useful cleaners for temperate marine fishes in display aquaria.

Wickler (1968) defines cleaning symbiosis as involving the "removal and eating of bacteria, ectoparasites, diseased and damaged tissue or excess food particles" from a "host" organism by a "cleaner" organism. Most known cases from the marine environment involve different species of fish as host and cleaner, with over forty known cleaner fish and many host species. (Feder, 1966). As shall be seen, scientists have tended to define strict "rules" for cleaning symbiosis on the basis of highly evolved relations among tropical reef fishes, whereas temperate cleaning symbioses tend to be less regular and more loosely defined. The less obvious cleaning relations among temperate species are not necessarily less valuable, however, for the maintenance of a healthy group of display fish.

As defined above, a cleaning symbiosis has obvious application to two related types of display problems: health and cosmetic. The health-related aspects of ectoparasite infestations or external tissue wounds and infections are actually relieved less by cleaner activity than are the cosmetic aspects, since extoparasite or external tissue problems are often symptoms of other, more insidious stressors (malnutrition, systemic infection, incorrect water chemistry, crowding, social conflicts, etc.) The cosmetic aspects, however, can be readily eliminated by cleaners. These cosmetic problems are obvious to the public and often arouse far more concern than more serious, but obscure, health problems.

Perhaps it is because of the public criticism of ectoparasites and other visible skin conditions that chemotherapeutics have been applied so readily to their control. Incorrect use of chemicals, however, can kill far more fish than the infecting parasites can. Concern is also growing over the chronic sublethal effects of dyes and chlorinated hydrocarbons, both on the fish and the aquarists treating them. Environmental controls such as salinity/temperature manipulations can sometimes eliminate parasites without seriously stressing the afflicted fish. Another safe alternative to chemotherapeutics is the use of a symbiotic cleaner species, the supposed "parasite panacea" for coral reef displays. Although not a panacea, a cleaner species can greatly assist in the control of ectoparasites, not only among tropical reef fishes, but also among temperate marine fishes.

Literature Review: As mentioned, general knowledge of cleaning symbiosis among marine fishes has emerged from studies of tropical species. Marine cleaning symbioses have been thoroughly reviewed by Feder (1966), who cites only six known temperate cleaner species, compared to forty-six known types of tropical cleaners. Hobson (1969) argues that this greater number of known tropical cleaners results from the proportionately greater amount of research conducted in tropical areas.

One general concept of cleaning is the use of a station where hosts come to a cleaner which is recognized by its signals. Limbaugh (1961, 1955) cites a cleaning station in the Bahamas which over 300 fish visited during a six-hour period. Both cleaner and host must recognize each other, and convey that recognition by postures and displays (Wickler, 1966). In combined field and laboratory studies, a goby cleaner which was immune to attack from piscivores showed no preferences for any type of host, whereas a wrasse cleaner (juvenile *Thallassoma* sp.), not immune to predation by piscivores, preferred nonpiscivorous hosts (Darcey, Maizel and Ogden, 1974). The evolution of cleaning symbiosis obviously involves problems of cleaner-host recognition, that is, the evolution of signals and timing factors which reduce risks of predation (Wickler, 1966).

Hobson (1971) argues against the necessity for genetically evolved relations, however, in that signal behaviors are not always species-, or even population-specific. Hobson regards the only preadaptation to, or requirement for, cleaning to be a small mouth and a "picking" mode of feeding.

Possibly the best known paper on cleaning symbiosis in marine fish is Limbaugh's (1961), in which the generalizations are made that cleaners occur primarily in clear tropical waters and that temperate cleaners are less specialized, less solitary and less obligate than the tropicals. Gotshall (1967) queries many of the generalizations about tropical versus temperate cleaners. He points out the occurrence of schooling tropical cleaners (as does Hobson, 1969) particularly the case of Phanerodon atripes, which occurs in small groups in the Gulf of California, but is solitary and in deeper water off the coast of California. Gotshall also notes that the greater diversity and specialized color patterns of tropical cleaners merely reflect the overall situation, with relatively more species and brighter color among tropicals than temperates. The specialization in display signals among tropicals may not be so great as presumed, in that only the Labroides species definitely use male mating displays to elicit postures for cleaning from host fishes. Finally, Gotshall argues that tropicals have been determined to be obligate cleaners only on the basis of subjective, observational studies, not from gut sample data. Wickler (1968) even maintains that cleaning in Labroides dimidiatus is always facultative, not obligate. Thus, although the most dramatic and sterotyped cleaner fishes are tropicals (Labroides spp.), modifiable and irregular cleaning associations undoubtedly also occur in the tropics as well as in temperate waters.

In more temperate waters, some of the cleaner species described in the literature are actually subtropical, as is the case with Oxyjulus californica or the gregarious, wandering shrimp Hippolysmata californica (Limbaugh, 1961). It should also be noted that not all individual Oxyjulus act as cleaners (Hobson, 1971). Among the truly temperate cleaners, the best documented cases seem to be among the embiotocid perches, including the kelp perch, Brachyistius frenatus (Hubbs and Hubbs, 1954; Limbaugh, 1955), walleye surfperch, Hyperprosopon argenteum, and juveniles of the pile perch, Rhacochilus vacca (Limbaugh, 1955). All of these embiotocids are facultative schoolers, so it seems understandable that group cleaning has been reported for them. Experimental demonstration of cleaning has been achieved with the temperate cyprinodontids Fundulus majalis, Cyprinodon variegatus and Lucania parva (Able, 1976), which ate trematodes and leeches in cleaning bouts lasting 10-15 seconds. A list of British (presumably temperate) cleaners observed in the aquarium of the Plymouth Laboratory has been compiled by Potts (1973), with the comment that displays tend to be more abbreviated than among tropical reef species.

The fact that a variety of cleaning associations has been identified solely on the basis of aquarium observations suggests that the captive situation enhances the establishment of a cleaner-host relation. Wickler (1968) observed "artificial" cleaning associations between mutually foreign species held together in captivity. Herald (1964) also observed this phenomenon, with Labroides dimidiatus instantly starting to clean non-cohabiting species upon introduction to them. More interesting than this instant response by a highly evolved cleaner is the observation that two temperate Atlantic species which do occur together naturally without any well-known symbiosis can learn a cleaner-host relation in the laboratory. McCutcheon and McCutcheon (1964) provided the topminnow Fundulus heteroclitus as food for the black sea bass Centropristes striatus, and found that after the bass preyed on the minnows during the first day, the minnows started producing "cleaner" displays which elicited quiescent postures from the bass, followed by cleaning behavior on the part of the minnows. That a process of conditioning or habituation may naturally occur within less obligate cleaner-host associations is suggested by Limbaugh's (1961) comment that Brachyistius are found in the gut contents of their hosts.

Observations at the Vancouver Aquarium: Experience at the Vancouver Aquarium suggests that established display groups of temperate marine fishes can develop and benefit from the more facultative type of cleaning symbiosis described above. Three types of association have been observed, involving three size classes of fish.

The most difficult symbiotic relationship to identify, yet perhaps the only situation we have replicated, occurs between large rockfishes, Sebastes spp., or lingcod, Ophiodon elongatus, and large, thick-tentacled anemones (Tealia spp. or Anthopleura xanthogrammica). The host fish are individuals with heavy infestations of annelid leeches (Piscicola sp.) on the fin margins and the cleaners are anemones with strong nematocyst discharges. Typical of fish with ectoparasites, the hosts will glance their bodies against the tank substrate, perhaps in efforts to dislodge leeches or to alleviate discomfort. Brushing the anemones may either remove leeches at once, or render them moribund from nematocyst toxins so that they will be removed in subsequent contacts with the cleaner anemones. If the leeches actually remained on the tentacles, the anemones would benefit from feeding on the leeches, making this a true symbiosis. In any case, the establishment of a prominent cluster of large, healthy Tealia and A. xanthogrammica has repeatedly correlated with reductions in leech infestation on particular fishes. The finer-tentacled Metridium spp. do not appear to have this effect, possibly due to weaker or less numerous nematocyst discharges. Individual Sebastes which tend to hover in the water column away from the back walls and bottom appear not to learn the anemone cleaning association.

A cleaning relationship which was repeatedly observed in detail, but only in one tank, was between several juvenile dover soles, Microstomus pacificus, and a group of vermilion and greenstriped rockfish, Sebastes miniatus and S. elongatus, respectively. At the stage observed by the senior author, brief displays were occurring, with a dover sole rearing its anterior body off the substrate, fixating at the host greenstripe (a posture reminiscent of a king cobra's strike posture), followed by quiescent postures from the host rockfish. A heavily infected fin margin would be presented to the sole by means of the rockfish erecting that fin and rolling over to place the leeches in line with the sole's mouth. The sole would then strike at a leech, tug until it dislodged, swallow the leech and start on the next one, with the host rockfish quiescent all the time. Within a month of the first observation of this cleaning, the tank was devoid of leeches and has remained so for several years. An effort was made to "clean" a super-infested rockfish (S. caurinus) from a Tealia display tank, a "hoverer" which had never learned to rub the anemones, by placing it on reserve with juvenile dover soles. Perhaps because of its characteristic hovering near the surface, it was never cleaned by the soles, illustrating the possible importance of individual differences or circumstances of acclimation, tank array, etc.

Another temperate cleaner observed at the Vancouver Aquarium is the coonstripe shrimp, Pandalus danae. One observation involved an "instant" bout of cleaning between a coonstripe shrimp and a juvenile (one year old) dark-blotched rockfish, Sebastes crameri. The rockfish had long been in a display tank, gradually developing a heavy infestation of trematode flukes in the nape and pectoral regions of the body. A coonstripe shrimp was added and the rockfish immediately displayed a head-down posture in front of the shrimp, which first contacted the fish with its antennae, then started picking off flukes with its chelipeds. Within minutes a large sculpin attacked the shrimp, disrupting the cleaning association. Therefore, the rockfish was removed to a bare reserve aquarium with a dozen shrimp. After an initial reduction in the density of flukes, the fish started hovering in the middle of the tank and never fully acclimated to the tank or lost any more flukes in the following month before it died. The other observation of cleaning by coonstripe shrimp involved juvenile wolf eels (Anarrhichthys ocellatus) afflicted with superinfestations of the ciliate protozoan Trichodina sp.. The shrimp were always seen picking at the margin of areas of dermal erosion, which, upon microscopic examination of scrapings, proved to be the point of maximum density of these ectoparasites.

Observations at Sealand of the Pacific in Victoria (Angus Matthews, personal communication) support observations of symbiotic cleaning at the Vancouver Aquarium. Of the two fish displays at Sealand, one has both coonstripe shrimp and juvenile dover sole, and it has never had annelid leech eggs on the tank windows. The other tank has neither of these potential cleaners and requires frequent attention to a chronic leech problem.

Discussion: From our own observations and from information in the literature, it appears that cleaning symbioses can be established in a display of temperate fishes and that beneficial control of ectoparasites can be achieved. The possibilities for, and the effectiveness of, these temperate cleaning relations appear more limited than for more stereotyped tropical cleaning symbioses. These limits, however, do not argue against employing efforts to utilize cleaning assoications in managing temperate display aquaria. Several principles emerge for guiding these efforts, including the identification of chronic problems, identification of suitable cleaners, provision for acclimation or "learning," and controlled monitoring whenever possible.

The only justification for any serious effort at establishing a cleaning symbiosis would be in cases of tanks with chronic ectoparasite infestation, as typically occurs with leeches on flatfish, lingcod or rockfish. Caligoid copepods or trematodes may also present chronic problems. The type of parasite might affect the selection of the type of cleaner if available temperate cleaners should prove to have prey preferences, but size relationships between cleaner and host would likely bear more consideration. Since some fish may act as cleaners only during juvenile stages and shrimp are of limited size, large hosts like lingcod might predate heavily on potential cleaners, preventing habituation and conditioning to a cleaning association. Preliminary trials at the Vancouver Aquarium suggest that very large lingcod (Ophiodon elongatus), cabezon (Scorpaenichthys marmoratus), and rockfish (Sebastes spp.) will rapidly habituate to the presence of shrimp, whereas greenlings (Hexagrammos spp.), smaller both in overall size and relative mouth size, will predate relentlessly on shrimp. Provision of a bed of anemones involves no predation risks, so this might be a first choice for fish which would eat shrimp. Cleaner shrimps tend to have long antennae, used for tactile cleaning signals (Losey and Margules, 1975), so that medium-to-large fish might not react well to their signals. Alternatively, a large host might habituate more rapidly to the presence of cleaners smaller than a preferred prey size, reducing initial predation losses in the habituation/conditioning phase of establishing a cleaning association. So little work has been conducted in this field that all efforts at this time must be considered exploratory.

One indication from our own observation is that it is unreasonable to remove an afflicted fish from display and place it among potential cleaners. The shock of transfer is probably greater than usual to a heavily parasitized fish, so that acclimation and establishment of cleaning after transfer would be less likely than with the cleaners placed in the display tank with the afflicted fish. This again suggests that only long term establishment of potential cleaners should be attempted.

The long term aspect of establishing facultative cleaners of temperate marine fishes involves an advantage over the stereotyped tropical cleaner symbiosis. Displays of tropical fish with a cleaner wrasse can develop problems after all ectoparasites have been eliminated if the wrasse continues to attempt cleaning. The wrasse can become a source of harrassment to the fish trapped in its presence. Temperate cleaners, however, seem facultative enough that they would never "overdo" their job.

The only route to working out repeatable solutions to problems of ectoparasitism is to adopt a controlled, experimental approach with problem species. To test the permanence of a cleaning association in a particular tank, once the problem has been alleviated, one might attempt to reinfest that tank as well as a control group of fish without the supposed cleaners. When starting to establish potential cleaners, a control group of infested fish should be isolated on reserve, in order to provide a basis for comparing the effectiveness of the cleaners. A large group of infested fish might provide numbers adequate for a control group, a group provided with cleaners, a group provided with chemotherapy. Finally, efforts at replication are essential; observations at other institutions such as Sealand or the sort of facultative relations seen at the Vancouver Aquarium would lend greatly to their significance, both for aquarium management and toward an ultimate understanding of the phenomenon of cleaning.

Literature Cited

Able, K.W. 1976. Cleaning behavior in the cyprinodontid fishes: Fundulus majalis, Cyprinodon variegatus and Lucania parva. Chesapeake Sci. 17 (1): 35-39.

Darcey, H.G., Maizel, E. and J. Ogden. 1974. Cleaning preferences of the gobies Gobiosoma evelynae and G. prochilos and the juvenile wrasse Thallassoma bifasciatum. Copeia. 1974 (2): 375-379.

Feder, H.M. 1966. Cleaning symbiosis in the marine environment. pp. 327-280. In: Symbiosis, Vol. I. S.M. Henry (ed.), Academic Press, New York. 478 pp.

Gotshall, D.W. 1967. Cleaning symbiosis in Monterey Bay, California. Calif. Fish Game. 53 (2): 125-126.

Herald, E.S. 1964. Cleanerfish for a cleaner aquarium. Pac. Discovery. 17 (6): 28-29.

Hobson, E.S. 1969. Comments on certain recent generalizations regarding cleaning symbiosis in fishes. Pac. Sci. 23 (1): 35-39.

Hobson, E.S. 1971. Cleaning symbiosis among California inshore fishes. U.S. Fish. Bull. 69 (3): 491-523.

Hubbs, C.L. and L.C. Hubbs. 1954. Data on the life history, variation, ecology, and relationships of the kelp perch, Brachyistius frenatus, an embiotocid fish of the Californias. Calif. Fish Game. 40 (1): 183-198.

Limbaugh, C. 1955. Fish life in the kelp beds and the effects of kelp harvesting. Inst. Mar. Res., Univ. Calif. La Jolla Rep. (59). 155 pp.

Limbaugh, C. 1961. Cleaning symbiosis. Sci. Am. 205: 42-49.

Losey, G.S. Jr. and L. Margules. 1975. Cleaning symbiosis provides a positive reinforcer for fish. Science. 184: 179-180.

McCutcheon, F.H. and A.E. McCutcheon. 1964. Symbiotic behavior among fishes from temperate waters. Science. 145: 948-949.

Potts, G.W. 1973. Cleaning symbiosis among British fish with special reference to Crenilabrus melops (Labridae). J. Mar. Biol. Ass. U.K. 53:1-10.

Wickler, W. 1966. Mimicry and evolution of animal communication. Nature, Lond. 208: 519-521.

Wickler, W. 1968. Mimicry in Plants and Animals. World University Library, London. 256 pp.

WAVE TANK - SPLASH TANK - DUMP BUCKET
(Call It What You Will)
Here's One That Works

Paul L. Seiswerda
Assistant Curator
New England Aquarium
Boston, Mass.

The "wave" or splash tank is a particularly popular display at the New England Aquarium. This exhibit represents a West Coast tidepool and contains a carpet of Anthropleura anemones and some surf perch and opal eye.

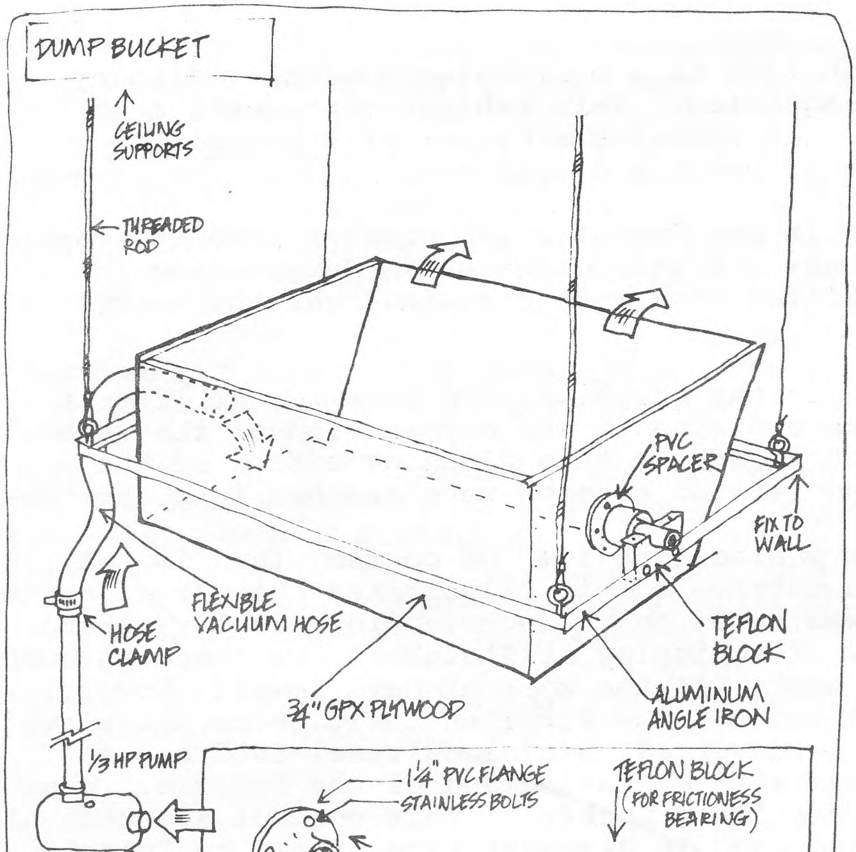
The real attraction is the "wave" which crashes into the tank about every 20 seconds. A wall of water is dumped into the tank creating the effect of a wave crashing over the rocks into a tidepool.

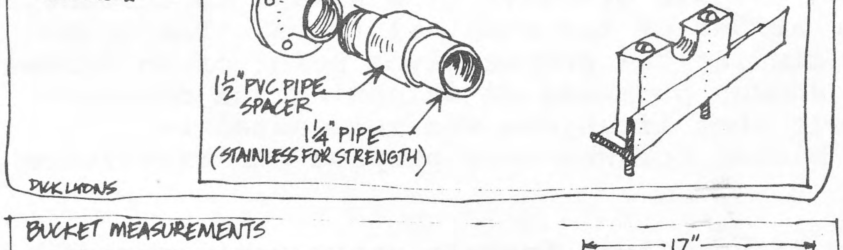
Through explanation in the graphics, the dynamics of life in such a surf zone are explained. The oxygenation of the water, the transport of nutriments to this flushing effect of the wave is vividly demonstrated as each wave crashes into the tank.

The animals and the public love it! Of course, this is not exactly as it is in nature, but it illustrates the effect quite well. Our design was based on a long-standing display at the Steinhart Aquarium. The display at Steinhart, we found through a little detective work, was the work of Dave Powell. However, the Steinhart model was not the first one. It seems that Dave's original model was a converted, stainless steel food bucket which he experimented with at Marineland of the Pacific. Thus the origin of the name "Dump Bucket." This concept and mechanical approach is now being used in displays from Hawaii to Cologne, Germany, in many variations of the original theme. The trial and error method of finding the proper pivot point of an eccentric "bucket" posed enough problems of weighting and counterweighting that we felt that if anyone was interested in constructing such a bucket for whatever purpose our experience might be helpful.

I suppose there is a mathematical formula which would prescribe the proper dimensions, but it certainly is not simple arithmetic. Therefore, the description of our bucket is given with our experience that similar designs can be constructed on proportional dimensions. Larger and smaller buckets should work. These machines are useful for other purposes than wave displays. Corals and filter feeders often respond to such water motions which probably stimulate them by the currents, saturating the water with oxygen and maintaining food particles in suspension.

Variations could be constructed to provide the mechanics for any display in which the intermittent rush of water is desired. The flow could be channeled to provide tidal effects, rheotaxis demonstrations, or other hydrodynamic effects. Certainly, such a design would revolutionize the "old bucket over the door" trick.





JULIDOCHROMIS REGANI

A BAP ARTICLE

Paul. D. Harvey

Two years ago, I had the good fortune to obtain five juveniles of this species. They were caught in Lake Tanganyika. All five Julidochromis regani were placed in a twenty-six gallon tank containing fifteen small pieces of petrified wood arranged to form caves. The water temperature was kept at 80 F. The local water conditions (with a pH of around 7.8 and a hardness approaching liquid rock) nearly duplicated the julies natural habitat. Every month I changed ten percent of the water in the tank and added three tablespoons of non-iodized salt.

The julies were seen swimming forwards, backwards and upside down among the rocks. I realized they were happy as flake food, frozen daphnia and frozen brine shrimp were readily consumed. The Julidochromis regani doubled their original size of three-quaters of an inch (standard length) during the first year. The two largest julies established territories and constantly displayed their best to each other. Unfortunately, no breeding pairs developed.

A thoughtful analysis of the situation resulted in moving the five Julidochromis regani to a forty gallon tank containing three very large rocks. One month passed with no signs of breeding behavior. I decided to rebuild the rockwork by creating two distinct piles of rock. Each of the two largest immediately claimed one pile of rocks. One of the remaining three lost favor with the other four and was relegated to live behind the heater. Except for eating with the other four julies, he remains in this territory even today. The other four seemed to chase each other all the time. Then, at the end of one week since creating two rockpiles, I saw one pair of julies per rockpile.

The largest and most aggressive pair of Julidochromis regani became very secretive. They spent most of the time out of my sight. Upon coming out to feed, they both were very aggressive toward the other pair. While viewing the tank one evening, I noticed a fry one-eighth of an inch long. Soon, I spotted several others. Then, I counted a total of nine fry. The fry grew rapidly to one inch.

No to be outdone, the smaller pair of Julidochromis regani became very secretive. Three days later, I saw one fry.

After one week, I saw a total of four. After eighteen months, I had two breeding pairs of Julidochromis regani.

A month went by peacefully before I noticed the smaller pair surrounded by two sizes of fry. The larger pair of julies were raising a second group of at least fifteen. During the following months, I saw each pair take turns breeding by first chasing the fry away to the neighbors. Then, the various sizes of fry were accepted back as the newest fry matured so the other pair could spawn. Today, I have over sixty Julidochromis regani in the tank. Because of the population explosion, both pairs of julies have halted the breeding program.

I plan to sell the fry. Then, I will sit back and watch five Julidochromis regani. Wait a minute! I only see three. I wonder......

TILEFISH IN CAPTIVITY

Jack Schneider
Natural History Associates, Inc.
P.O. Box 362
Mystic, Connecticut 06355

Introduction: This paper reports aspects of the capture and husbandry of two tilefish (Lopholatilus chamaeleonticeps Goode and Bean) and one blackline tilefish (Caulolatilus cyanops Poey) kept at the Mystic Marinelife Aquarium, Mystic, Connecticut, during 1976-1978.

Tilefish, unknown to science until 1879, are bottom dwelling fish of the North Atlantic continental shelf. Because they live at great depths, they have not been well-observed in the wild and never in captivity. Freeman and Turner (1977) report observations from submersibles of tilefish behavior in the wild.

There is no experimental evidence of tilefish thermal tolerance, but general agreement is that the acceptable range is narrow (Freeman and Turner, 1977; Bigelow and Shcroeder, 1953). This hypothesis is substantiated by the year-round distribution of tilefish along a narrow band of nearly isothermal water at the edge of the continental shelf, approximately 90 to 160 kilometers offshore. Investigators (Freeman and Turner, 1977; Freeman, 1976) state that between Cape Cod and Cape Hatteras these temperatures range from 9.4°C to 14.4°C and that most tilefish occur in depths of 110 m to 238 m. The great numbers harvested annually attest to their successful survival in that limited habitat.

Collection: Since no Aquarium boat trips, and relatively few research vessel cruises were available for this collection, arrangements were made with the captains of commercial fishing vessels from Rhode Island and Connecticut. Unfortunately, tilfish collection was secondary to the commercial fishing effort. Limitations imposed upon space, water condtions, specimen selectivity, and collection techniques precluded most experimentation and satisfactory record keeping.

Five collecting trips were made in all. One lasted one day and the other four lasted three to four days. Tilefish were caught by three methods: rod and reel, longline and otter trawl. These methods are discribed by Freeman and Turner (1977).

Specimens collected using rod and reel and longline incurred little damage from the method or from physical contact with the rest of the catch. Specimens could be rapidly unhooked without handling by first cutting the line and then disengaging the hook while the fish was immersed in the holding tank. Specimens collected by otter trawl suffered serious stresses that included floating en masse at the surface while the vessel maneuvered to lift the catch on deck, being squeezed with the rest of the catch and being coated in mucus and debris and perhaps mechanically damaged.

Tilefish specimens were selectively culled using the criteria appearing in Chart I.

Since fish weighing beyond the .5 to 1.0 kg (1 to 2 lbs) range consistently failed the criteria, there was a high selectivity for samller size fish. All fish larger then 61 cm (24") were moribund, showing signs of air embolism and eye and internal organ protrusion.

Acclimation: Shipboard holding facilities consisted of a series of plastic 208 l (55 gal.) trash barrels lashed to ship's rail and covered with netting. The use of such narrow containers prevented the acclimating fish from being damaged by water slosh. Each barrel contained a rate adjustable flow-through sea water delivery system. Flow ranged close to 38 lpm (10 gpm) but varied depending upon water condition and desired temperature.

Generally, when fish undergo abrupt temperature changes, they become stressed and die. This seems especially true of tilefish; and, therefore, necessitated their acclimation in 9.2°C- 11.2°C (48°F- 55°F) water.

Each new group of arrivals was sepatated from previously captured specimens. Once isolated, their holding container was copiously flushed with sea water to remove excess mucus and debris. This procedure took five to twenty-five minutes. This was followed by a reduction in the water turnover rate. One of two acclimation procedures, varying with the administration of pure oxygen, were followed. Oxygen was not administered in most cases and the water flow rate was adjusted to about 38 lpm (10 gpm). When oxygen was utilized, the gas was bubbled into a plastic trash barrel liner containing the fish and 94.5 l (25 gal.) of water. No additional water was added. After one minute of oxygenation, the pressurized bag was sealed and left for .25- .50 hour. Interspersed with 75% water changes, this procedure was repeated four to six times before returning to an open system.

Alternately, a closed system, used when ambient water temperature exceeded 9.2°C - 11.2°C (48°F - 55°F), required insulated fish shipping containers with sealable plastic bags. This closed system required that the fish first be purged of excess mucus and wastes as described above. Individual fish were placed in oxygenated, sealable, plastic shipping bags. Pure oxygen was then bubbled into the constricted bag, then the bag was sealed and placed in an insulated shipping box. One hundred percent of the water was changed every two to three hours with water of comparable temperature to insure favorable water quality. If the water exceeded 11.2°C (55°F) it was cooled with ice, or if it declined below 9.2°C (48°F) it was warmed with heaters. This second process would not be needed if collecting were limited to times of the year when the inshore and offshore surface water temperatures fell within the required range. When the inshore water temperature was higher or lower than the offshore water remperature as it was during fall and spring, this procedure was utilized only during the return trip.

Lesions Associated With Capture: Most specimens exhibited grossly inflated swimbladders caused by the expansion of gas resulting from the rapid reduction in environmental pressure. The over inflated swimbladders usually forced the organs out of the animals' mouths or anuses. In other cases, the swimbladder burst like a balloon when a fish was hauled to within approximately 9.4 m (30') of the surface (observed during longlining).

If excess gas was present, it was reduced or the animal floated uncontrollably at the surface and the internal organs were squeezed. A pathologically expanded swimbladder was deflated by introducing a hypodermic needle into the organ through the body wall underlying the end of the pectoral fin. Squeezing the sides of the animal resulted in gas being forced through the needle. Holding the end of the hypodermic needle under water helped to visually estimate the amount of gas eliminated. The fishes ability to regulate bouyancy was lost if too much gas was expelled. Adjusting the fish to near neutral bouyancy was estimated by releasing it in the holding container and observing whether it sank or floated.

Occasionally, a few specimens were selected in spite of proturding internal organs because they behaved normally. Such cases were treated by relieving the excess swimbladder gas and then using a probe to force the organs back into the body cavity.

A condition related to the expanded swimbladder is air embolism. This is analagous to the release of bubbles when a soda container is opened. Reduced environmental pressure causes gasses dissolved in the fish's blood to form bubbles which may occlude small blood vessels and result in the animal's death. Observable signs in severe cases included bubbles in the body surface, fins and eyes; hemorrhage in the eyes; and distention or protrusion of the eyes and other organs. These conditions occured with the reduction in water pressure during the animals' ascent. Air embolism was probably a greater cause of fish mortality than swimbladder enlargement. The effects of this air embolism may show immediately or within a week of capture, perhaps dependent upon brain or vital organ damage.

Abnormal behavior in non-moribund animals included continuously repeated bobbing locomotion from the bottom of the container to the surface. This activity may have resulted from excessive removal of swimbladder gases or from physiological damage due to air embolism.

The eye lesions of dead specimens included missing epithelium and edema of the corneal stroma. This latter lesion may have been an artifact of preservation (Bellhorn, 1977). The fact that the specimens developing bilateral corneal opacities within 24 hours of capture died, suggests its association with a lethal condition. Schaeffer (1977) related corneal opacity to diving disease in humans.

The differential rates of survival between the various acclimation techniques or disease conditions could not be studied in depth due to collecting conditions, small survivorship and lack of individual recognition without tags.

Survivorship and collection results appear in Chart II.

Captive Husbandry: After being transported to the Aquarium, fish no. 1 (*C. cyanops* - .7 kg) was held in a 1,512 l (400 gal.) Aquarium Systems, Inc. cylindrical tank having a seperate refrigeration unit. Oxygen was at or near saturation. Instant Ocean^{R}, synthetic sea water, was chilled to 9.2°C-11.2°C (48°F - 55°F). Ionized ammonia-[N] and nitrite-[N] measured less than .001 ppm and .01 ppm respectively. Nitrate [N] was maintained at less than 30 ppm. pH ranged from 8.0 to 8.3. A ten percent water change was made biweekly. The subgravel filter utilized airlifts and a dolomite and crushed oyster shell substrate. A black plastic cover that allowed indirect illumination through the side viewing ports, kept the tank dim.

Fishes no. 2 and 3 (*L. chamaeleonticeps*- .35 kg and .7 kg respectively) were held in a 3,780 l (1,000 gal.) tank having a fiberglass rock back drop with an oyster chip, dolomite and crushed silica rock subgravel filter substrate. The tank was lit by a single 75 watt blue-white bulb. Instant Ocean[R] was circulated to an outside refrigeration unit using airlifts. Water quality conditions were maintained as specified for fish no. 1.

After acclimation, tilefish fed readily on pieces of capelin, smelt or other fish, on clams, or on gelatin-based food. Feedings were daily. Multiple vitamins were applied on the food and fed weekly. Initially food was presented by hand or through use of a wire to place food at the animal's mouth.

The tilefish were usually observed moving slowly at mid-water in the approximately 122 cm (48") deep tank as described in Freeman and Turner (1977). They used their dorsal and anal fins in opposition to regulate movement. No interanimal behavior was observed.

The tank community included chain dogfish (*Syliorhinus retifer*), redfish (*Sebastes marinus*), red crabs (*Geryon quinquedens*), and various anemones.

Refer to the "Summary of Captive Husbandry" for additional information.

Discussion and Suggestions for Controlled Study: Each surviving tilefish was exposed to pure oxygen during early acclimation. Theoretically, a high O_2 tension encourages the diffusion of excess gases, presumably N_2 from the system. This therapy is used on humans experiencing diver's disease (Schaeffer, 1977). There seems to be a difference in survival between leaving the animals in running sea water and treating them with pure oxygen. However, controlled testing should determine the therapeutic significance of this exposure in fishes.

Certain attractive alternate acclimation and collection methods were not tried. These include resubmerging the animal and returning it slowly to the surface, or using a decompression tank without resubmergence. Use of traps or pots may be an effective capture method, given tilefish burrowing habits. Though this technique might result in the collection of fewer fish compared with trawl or longline, fish could be retrieved in stages and slowly recompressed. This would enable the fish to naturally expell excess gas from the swimbladder and would presumably result in fewer mortalities.

CHART I

Specimen Selection Criteria

Eyes:	Free of swelling or distension Gas bubbles absent Hemorrhage absent
Fins:	Gas bubbles absent
Body Surface:	Free of excess mucus Free of abrasions, or lacerations Scales flat against body with no indication of trapped gas
Organs:	Generally, no inner organ protrusion from mouth or anus
Behavior:	Active
Muscle Tone:	Firm

CHART II

Results of Collection Effort

Cruise No.	Date	Depth (Fathoms)	Capture Method	Numbers of Specimens Selected	Specimens Returned to Aquarium	Specimens Surving to Two Weeks	O_2 Administered (Hrs. After Capture)
1	4/76	55 - 75	Trawl	20	12	0	None
2	5/76	55 - 75	Trawl	25	15	0	None
3	10/76	75	Rod & Reel	3	1	Fish No. 1	Immediate
4	4/77	55	Trawl	15	12	Fish No. 2	Six
5	5/77	75 -100	Longline	16	9	0	Ten
6	5/77	55 - 55	Trawl	15	4	Fish No. 3	Immediate

Summary of Captive Husbandry
Tilefish Nos. 1, 2, 3

Tilefish No. 1

Date	Comments
10/5/76	Arrival
10/10/76	Very alert; color good
10/11/76	Left eye puffy; has occupied 4" diameter PVC pipe
10/22/76	Puffy left eye continues. Added Furanace $2X^R$ to .2 ppm
10/27/76	Lesion developing on left operculum. Swollen left eye continues.
10/31/76	Furanace $2X^R$ added to .2 ppm
11/8/76	Eating capelin fillets
11/9/76	Jumped out during the night and died

Tilefish No. 2

Date	Comments
4/28/77	Arrival
5/12/77	Eating capelin & continued to eat through 12/22/78
6/9/77	Scrape mark on right side, not reported again
10/2/77	Bobbing on the surface, continued through 10/4/77
12/22/77	White mark 1.24-1.91 cm (1/2"-3/4")on dorsal fin
12/22/77	Began swimming with less ease. Gradually became bouyant. Effort to stay down, mouth open, belly bloated
1/31/78	Small white area, probably a missing scale
2/5/78	Fin deterioration
3/7/78	Head and tail out of the water; thin
3/15/78	Punctured swimbladder; administered ¼ cc gentocin into swimmbladder

Summary of Captive Husbandry cont.

Tilefish No. 2 continued

Date	Comments
3/17/78	Nodular growths on right pectoral fin & left operculum
3/22/78	Dead

Tilefish No. 3

Date	Comments
6/7/77	Arrival
6/13/77	Hides behind decor
7/3/77	Eating capelin & continued to eat through 11/27/77
7/12/77	Left, rear, midline of body experiences a condition that starts with raised scales that develops into hemorrhagic lesion that clears up by 7/7/77
7/29/77	Dark spot on belly, visible through 8/11/77
10/17/77	Darted and hit door. No movement for three to four minutes, then returned to normal behavior
10/27/77	Observed remianing at the surface more & more frequently
11/8/77	Animal stays down in the water only with great effort Head out of water to eye level. Condition continues through 12/16/77. ¼ cc of gentocin administered intramuscular (dorsal) on 12/2 and 12/6
12/10/77	Observed at the bottom
12/12/77	Small raised spots all over the body, condition continues through 12/16/77
12/15/77	Observed at the surface, dorsal fin erect, body bowed to the left
12/16/77	Dead

References

Bellhorn, R. 1977. Personal communication

Freeman, B.L. 1976. Personal communication

Freeman, B.L. and S.C. Turner. 1977 Biological and Fisheries Data on tilefish, _Lopholatilus chamaeleonticeps_ Goode and Bean. Highlands, NJ, N.M.F.S., Northeast Fisheries Center, Tech. Rpt. No. 5.

Schaeffer, K. 1977. Personal communication

FISHING FOR PADDLEFISH

Ray Robinson
National Aquarium
Washington, D. C.

Paddlefish (Polyodon spathula)

Description: Long, paddle-shaped snout which is longer than remainder of head. No scales, hundreds of long gill-rakers on each gill arch. Coloration: Bluish gray, bluish-white, or bluish-olive dorsally, lighter beneath. Habitat: The paddlefish is an inhabitant of the sluggish pools, back-water bayous, and oxbows of larger rivers, where the gradient is low. Although apparently highly migratory, it rarely seems to move upstream during floods as do many other species, but migrates during lower stages of water when the currents are weaker.

The fish: The fish are usually captured in gill nets, presumably while feeding near the surface on the light-loving plankton (which consists mainly of small crustaceans). On exhibit at the National Aquarium are several specimens of the paddlefish. These fish were obtained by the Aquarium in October of 1977 from the Blind Pony Fish Hatchery in Montana. At the time of their arrival they exhibited a very thin body and measured between ten and twelve inches in total length.

Paddle fish are difficult to maintain in captivity because they must filter-strain particles from the water in order to entrap food in their gill rakers. In the wild, they feed primarily on plankton. We substituted live adult brine shrimp, as plankton is currently impractical to raise and maintain in sufficient numbers in captivity.

The live adult brine shrimp are purchased from a local wholesaler at a cost of eleven dollars per quart; two quarts per week being normally required to feed the fish. We also tried dried fish flakes, but none of these enabled them to grow very fast, if at all. After the death of several of our paddlefish, aquarist Ron Suden and I were standing in front of their display tank discussing some other food we might try, when suddenly one of the paddlefish which had strayed away from the other, came close to the bottom of the tank, and not near the surface where they are normally found. I could not believe my eyes. The paddlefish was trying to eat the small artificial cabomba plants that decorate the bottom of the tank. The fish was turning his body sideways and pulling on the plant. This singular bizarre behavior led to an experiment: attaching food to a string or wire, then submerging both in the water, with the hope that the paddlefish would try to feed from the string in the same manner we had just observed. I discussed my idea with Ron, who suggested that a board with holes drilled into it be used as a flotation device for suspending the string or wire. We suspended string from our flotation device (similar to the one described) and attached the food to the string. Unfortunately, the fish quickly became entangled in the string, sending us "back to the drawing board."

For our next effort, we suspended heavy fishing line (120 lb. test) and burned the ends, which gave us small, rounded tips which would secure chunks of food to the line, keeping it in place, while enabling the fish to pick at it. (Fig. 1)

The paddlefish's long snout makes it cumbersome for it to feed on large food chunks or scavenge about the tank bottom for food. We had previously experimented with a wide range of food: flaked, chopped clams, fish, and meat, none of which would float long enough to enable the fish to feed, before it fell to the bottom of the tank. We attached cut smelt (1/4 inch squares) to the ends of the plastic line, and observed two of the fish twisting their bodies in an attempt to pick at the "bait." Shortly, all were feeding in this unusual manner from the suspended lines. In the last six months our paddlefish have substantially increased their size and weight, adding six inches to their length, and will now accept almost anything **which is attached to our suspended "<u>fishing line</u>."**

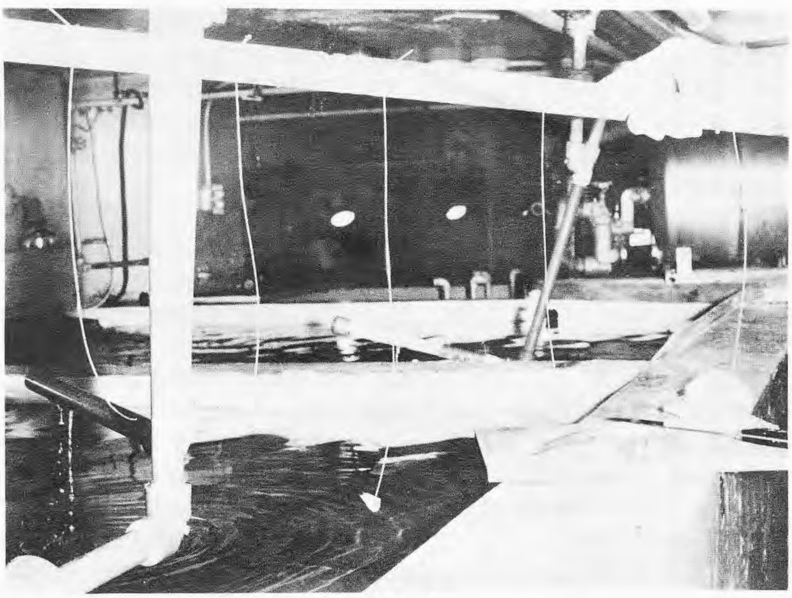


Fig.1

A NEW FOOD SOURCE FOR FUSSY INVERTEBRATES

Frank L. Murru
Sea World of Ohio

The Aquarium staff of Sea World of Ohio has, for some time now, been literally giving a part of themselves for the well-being of their animals. In a continuous effort to discover new means to keep some of our very fussy animals alive, primarily invertebrates, a discovery was made which has proven, thus far, extremely successful. Fussy feeders such as corals, sponges, bryazoa, tunicates, etc., seem to be thriving on fresh blood! These, along with many other invertebrates, have flourished for the past year on daily feedings.

Because the bloody juices of thawed beef heart proved somewhat successful as a food source, but not adequate, we progressed to whole blood; obtained initially from a local chemical supply company. The animals responded to the fresh blood by totally engulfing it as it was placed into the polyps, in the case of anemones and corals, and by the expansion of the mantle in the case of bivalves. The animals did quite well on the same blood for the first eighteen to twenty-four days, however, on the eighteenth day the animals, one by one over several days, began rejecting it. This was quite evident: the polyped animals actively withdrew from the liquid and the bivalves began the common coughing reflex, blowing the blood away. Water chemistry was thoroughly checked and found to be in good order. The blood was cultured for contaminants and found to be clean.

It was at this point, that our first volunteer stepped forward to donate fresh blood to determine if the age of the blood was a factor. The animals immediately accepted the fresh offering and have thrived on it ever since, with one exception. It was noted on several occasions that during periods of excessively high temperatures, exceeding 27.7°C, the invertebrates totally rejected the blood, regardless of its freshness. As the temperature was lowered, feeding activity resumed once again.

Fortunately, because of the routine blood work which takes place in our park on various animals, the Aquarium personnel now infrequently find themselves as the donor.

Drawn blood is stored in the refrigerator after mixing with EDTA, a natural anticoagulating agent. Daily an appropriate amount of blood is withdrawn and mixed with sea water at approximately a 1:10 ratio and slowly fed to each animal with a small transfer pipett. All filtration is temporarily stopped to allow the blood to settle onto the animals.

Thus far, we have found that freshly drawn blood will last in a refrigerated state three and one-half to four weeks. At the first signs of rejection from any animal, the supply is renewed.

Since whole blood contains tremendous quantities of protein, carbohydrates, fats, and starches, what could serve as a better food source? The red blood cell alone is very high in its protein make-up (80-90 percent) and its small filterable size (7-15 microns) makes it ideal for filter feeders.

A number of notable changes have taken place in several animals being fed this diet. Conjugation in the Rock Anemone Bartholomea annulata, is proceeding at an increased rate; increased growth rates of both soft and stony corals, and an increase in their overall polyp size; increased nematocyst production in anemones, as noted by their increased ability to capture live food, and a significant increase in longevity of almost all filter feeders.

We are now experimenting with new animals and new methods for delivery of the blood to the animals, and hope to refine our methods even further.

SNIPEFISH IN CAPTIVITY
Macrorhamphosus scolopax

Jack Schneider
Natural History Associations, Inc.
P.O. Box 362
Mystic, Connecticut 06355

This is a report on the capture and husbandry of snipefish, *Macrorhamphosus scolopax*, currently on display at Mystic Marinelife Aquarium, Mystic, Connecticut. The snipefish is an unusual looking species; the orange colored dorsal region shading gradually to a pale cream ventral region. It's characteristic shape has led it to being named "bellows fish". Their requirements in captivity lack documentation and the little existing literature about the species primarily relates to distribution. (Appendix).

Capture and Acclimation: A school of three to four hundred snipefish was caught in the nets of a commercial side trawler about ninety miles south southeast of Point Judith, Rhode Island, on 5 June 1977. The net was being fished at a depth of 145 meters along the edge of the continental shelf.

Though the snipefish were probably caught at the surface during the end of the tow, most of the fish captured were dead or moribund. Thirty living specimens, removed from the net or from the deck, were placed in a 55-gallon (208 l) drum of running (3.78 l/min.) ambient temperature (55°F-13°C) sea water.

Eighteen of these animals floated at the surface, showing movement of the pectoral fins, but lacking ability to properly orient themselves. The body surfaces overlying the swimbladders of the stressed fish were enlarged compared to those of the fish which were swimming normally, near the bottom of the drum. Such abnormalities suggested swimbladder distention; perhaps, caused by the sudden reduction in water pressure associated with rapid ascent in the net. However, the captain had observed a school alongside the boat shortly before the net was retrieved. It is likely that many of the animals had been in the net no longer than ten minutes and that at least some specimens had been caught at the surface.

Excess air was relieved from the swimbladders of the eighteen floating fish by inserting a hypodermic needle into the expanded swimbladder. These then sank to the bottom but died within 12 hours of capture.

Twelve fish were returned to the Aquarium on 7 June and placed in an Aquarium Systems, Inc. 284-gallon (1073 l) cylindrical tank having a separate chiller box holding 128 gallons (484 l). The system was filled with Instant Ocean^{R} chilled to 55°F (13 C). The tank was covered with black plastic sheeting; side illumination kept it dimly lit.

These fish behaved well; swimming strongly and being alert, but because the fish showed skin and corneal abrasions, a 0.2 ppm Furanace 2X^{R} was added on June 8 and no water changes were made for five days. In addition, the fish were also placed in a Furan II^{R} dip (1 capsule/gallon) on 11 June. By 19 June, four animals had died. These showed exopthalmus, or a loss of equilibrium, possibly caused by surface abrasions or by the continuing effects of air embolism. Two animals died without showing any apparent disease symptoms.

The surviving six snipefish began eating live adult brine shrimp by 16 June. By 22 June, 2.5 cm krill were taken into the mouth, but were rejected. By 27 June, frozen adult brine shrimp were being eagerly consumed.

Husbandry: Since 9 October 1977, the fish have been kept in an Aquarium Systems, Inc. CS-225^{R} fiberglass display tank. The unit in which they are kept is a closed system aquarium using Instant Ocean^{R}. It uses a subgravel filter plate supporting a dolomite-sand mixture that filters and buffers the water. Ten percent partial water changes administered biweekly keep nitrate levels below 12 ppm nitrate N and pH within the range of 8.0- 8.3. Ammonia and nitrite levels apporach 0.0 ppm. Normal water temperature is 55 F (13 C) but fish have experienced brief exposure to temperatures ranging from 45°F - 66°F (7.2°C- 18.9°C) without ill effects. The tank is lit by a single blue-white spot 75-watt incandescent bulb placed 24" (.61 m) above the water.

The fish are fed twice daily live adult brine shrimp, frozen brine shrimp, 2.4 cm krill or mashed gelatin diet, mashed fish, clams and shrimp (in order of preference). Feeding sessions are terminated when the feeding rate slows, usually within five minutes. This is usually accompanied by a visibly swollen stomach.

The snipefish sizes ranged from 5.5 cm to 10 cm total length.

Their behavior and morphology influences their tank design. Snipefish normally behave quietly, moving slowly in the middle of the 18" (45.7 cm) water column. Their normal posture is head down and approximately 50° horizontal. Frequently, however, when the animals are suddenly disturbed, by such acts as turning on bright lights, tapping excessively on the glass, or thrusting a net abruptly into the tank, the animals dart about rapidly and sharply. During this behavior, they frequently jump from the water, or swim up the sides of the tank. These observations support the captive behavior described for the banded bellows-fish, Centriscops obliquus, (Whitley and Allan, 1958). The tank should, therefore, have a tight-fitting top or inward sloping sides to prevent damage or mortality resulting from this behavior.

The snipefish are strong swimmers, having swum down the tank's airlifts and under the filter bed. On one occasion, a single fish survived under the filter plate for a month before its live removal. Six months later, 24 June 1978, two were found under the filter bed. One swam out the airlift after removal of the air-conducting tubing and the airstone. The second, however, was damaged due to its snout being trapped in the subgravel filter plate. Airlifts should be covered to prevent such occurrences.

On at least four occasions, animals were trapped by getting their snouts wedged between the tank walls and the fibergalss decor. Two died. These areas of the tank were modified by placing rocks in the corners. The surfaces of the tank and the decor should expose rounded surfaces to the fish.

The pointed snout and seahorse-like food-capturing behavior also make snipefish poorly adapted to feeding on the stone-like fiberglass decor or on the dolomite "dryer chip" substrate covering the exhibit bottom. One fish that repeatedly ate off this bottom developed an upturned snout, presumably due to the impact during feeding. Covering the bottom with a .4 cm layer of sand (.4 mm grain size) corrected this condition.

The snipefish seem fairly resistant to disease, though they sometimes display unidentified white spots on the fins and a dark body surface discoloration. Of particular interest was the appearance on 3 July 1977 of a jelly-like lump on the distal end of the dorsal spine of one specimen. By 8 July, two other fish showed similar lumps. These growths continued to enlarge and were removed from three animals by amputating the affected portion of the spine on 26 July 1977. This disease organism was identified as a roundworm. Subsequent reappearance of the lumps by 2 August 1977 indicated that the disease was still present. This condition, however, gradually disappeared without further treatment.

Capturing snipefish in our area is an unusual event and the replacement of these fish would be unlikely. Fortunately, once acclimated, the fish prove to be hardy and are a popular, interesting display animal.

APPENDIX

Ehrich, S. 1975. Investigations on *Macrorhamphosus scolopax* (Linnaeus, 1758) (Pisces, *Syngnathiformes*) from the sub-tropical N.E. Atlantic. Inter. Counc. Explor. Sea. Contrib. to statutory meeting. C.M. 1975/G:13 pp. 11

Erich, S. and H.C. John, 1973. Zur Biologie and Okology der Schnepfenfische (Gattung *Macrorhamphosus*) vor Nordwest Afrika and Uberlegungen Zum Altersaufbau der adulten Bestande der Gro Ben Meteorbank "Meteor" Forsch-Ergebn, D, #14 87-98

Fitch, J.E. and R. J. Lavenberg, 1968. *Deep-water Fishes of California*. University of California Press, Berkeley and Los Angeles, 155 pp.

Holgersen, H., 1950. Fra Stavanger Museum. III. *Fauna*, 3: 37-41. Oslo

Miller, D., 1959. A pelagic record of the snipefish *Macrorhamphosus scolopax* (L.) in the Gulf of Maine. *Copeia* 1959:160

Mohr, E., 1937. Revision der Centriscidae (Acanthopterygii, Centrisciformes). *Dana Rept.* (13): 70 pp.

Whitley, and Allan. 1958. "The Sea-horse and its Relatives". IX + 84 pp., illus., Georgian House, Melbourne; Chas. T. Branford Co., Boston.

HUSBANDRY OF FRESHWATER STINGRAYS

James K. Langhammer, Curator of Fishes
Belle Isle Aquarium, Detroit Zoological Park

As professional animal exhibitors, you are all aware of the need to establish exhibits which subjectively provide intrigue and titillation for the viewer while simultaneously offering educational and, when possible, recreational outlets. At the Belle Isle Aquarium, we have found the South American freshwater stingrays (*Potamotrygon motoro*) to be perhaps the best all-round exhibit which we have.

Among the positive features of their exhibition are:

1. The family Potamotrygonidae contains the only truly freshwater elasmobranchs in the world.

2. The representative species are the most feared and dangerous freshwater fishes in South America - and perhaps the world.

3. They are large - females being slightly in excess of 70 centimeters in disc diameter as adults - and are very active on exhibit. (A frequent and apparently independently derived observation of viewers is that "they look like flying saucers.")

4. Lastly, we can capitalize on local pride in that Belle Isle has the only captive-bred colony in the world.

The only detraction in their exhibition is that the species are notoriously difficult to maintain in captivity. Which is the purpose of this presentation - to share the experiences which we have had with these rays.

Freshwater rays are very sensitive to the buildup of nitrogenous metabolites in solution. Much failure with them is directly attributable to inadequate water changes. Attention to water changes of no less than 25 percent once per week is perhaps the most important element in the management of freshwater systems for fishes and amphibians. Such water changes are far easier and more economical than reliance on adsorptive materials for contaminant removal. Most adsorptive materials are usually effectively nonfunctional long before they are replaced or reactivated in common practice.

I believe our practice of regular water changes has been the basis of our success with these rays. Our major setback occurred when a new low-pressure blower system was installed to replace our air compressors. Apparently an organic evaporate--either from the PVC tubing or the linkage sealants--poisoned the rays in three different areas of the building. The adult breeders died overnight, and two tanks of juveniles were seriously distressed until massive water changes were made.

These rays are easily sexed, even at birth. Males have the inner edge of the pelvic fins rolled into copulatory claspers. In juveniles, these claspers can be seen in ventral view, but in adults they are enlarged sufficiently to be seen from lateraland even dorsal views.

Copulation has never been observed and recorded in this family, but the onset of breeding is usually evidenced by prominent bite marks around the edges of the female's disc. Breeding activity has usually been during the months of October and November with births following in the spring. Gestation appears to be between four and five months' duration. There have been six litters born at Belle Isle, consisting of 20 offspring. Litters have ranged from two to five in number, with the most frequent number being three (i.e., 2,3,4,3,5,3).

These rays can be difficult to induce to feed. Acclimated individuals eagerly eat redworms, nightcrawlers, and fish either alive or dead. Newborn and recently imported specimens pose special problems. The only food our newborns have initially accepted has been mashed minnows. Oddly enough, dead whole or chopped minnows are not accepted until they have been mashed. Once feeding begins, new items are quickly accepted by the babies. Larger rays usually begin feeding on diced whole fish. Established rays are quite proficient at catching live fish between their disc and the tank walls. Interestingly, stomach analysis of wild rays give no indication that fish are ever eaten.

Captive rays are gluttonous fedders, and care must be exercised that all rays are satiated. The slightest hint of the pelvic girdle protruding on the dorsal surface signals trouble. As a precaution, water changes should be increased and the ray watched closely to be sure it receives its share of the food. Rays quickly become tame and will beg for food by splashing at the tank surface. Many rays accept food offered by hand.

Although the bony sting or barb is a formidable weapon, its utilization in captivity probably would require considerable provocation. Most human injuries occur when rays are stepped on by waders. Occasionally, though, while being netted, a frantic ray has been known to imbed its barb deeply into a wooden net handle. The force of imbedment, the serrated edges of the barb, and the associated venom make resultant human injuries of serious medical concern. Without expert medical care, many deaths have occurred in remote parts of South America due to shock and associated infections.

All things considered, the freshwater stingrays can be important display animals in any aquatic menagerie. However, emphasis must be again placed on the importance of regular water changes to reduce the effect of organic pollution and nitrogenous metabolites on these delicate fish.

THE END

SPECIAL NOTICE

Addendum from the Seattle Aquarium in regard to the following article:

"A Review of Larval Fish Rearing Techniques Used
In Obtaining a Larval Series For Descriptive Purposes:
The Seattle Aquarium Technical Report No. 2"
by Janet M. Ilg, Steven F. Borton, John W. Nightingale
Published in DRUM AND CROAKER, Volume 19 (79), Number 1.

The Seattle Aquarium and the Vancouver Public Aquarium have been cooperating over the past year on studies of larval fish and octopus rearing techniques. Through an oversight, an article published in the last issue of DRUM AND CROAKER by The Seattle Aquarium (Ilg, J.M., S.F. Borton, J.W. Nightingale, 1979: A Review of Larval Fish Rearing Techniques Used in Obtaining a Larval Series for Descriptive Purposes), neglected to give appropriate credit to Jeff Marliave of the Vancouver Aquarium for the design of various tanks and equipment used in our study. For a discussion of Jeff Marliave's larval rearing techniques and apparatus, please see his article: Marliave, J.B., 1976: Laboratory Rearing of Marine Fish Larvae, DRUM AND CROAKER, 16(2): 15-20. The Seattle Aquarium wishes to apologize to Jeff Marliave and the Vancouver Aquarium for this oversight. Their information, assistance and cooperation have been invaluable.

OCEANARIUM FACT SHEET

Mark Suiso
Oceanarium Curator
Pacific Beach Hotel
Honolulu, Hawaii

Our Oceanarium was conceived and planned by Mr. H. T. Hayashi after visiting several aquaria in the orient. Construction began by digging the salt water well for the Oceanarium. It is 270 feet deep, that is, almost as deep as the Oceanarium Tower is high. It is one of the deepest oceanariums in the world at 26 feet. It is 52 feet long and 32 feet wide and holds 280,000 gallons of salt water.

The Oceanarium is constructed of steel-reinforced concrete. The windows are made of acrylic and each one is 12 feet long and 6 feet high. The bottom windows are almost 7 inches thick and weigh 1 1/2 tons each. Each bottom window is subject to 47 tons of water pressure. The upper windows are 4 inches thick, weigh 1 ton and subject to 14 tons of water pressure. The concrete walls and floor are coated with a special epoxy and then covered with a blue vinyl on the walls.

The salt water from the well cascades at the waterfall on the third floor. The pump is capable of filling the Oceanarium in 3 hours if flowing at its maximum rate. The water flows 24 hours a day and can be bubbled for effect or aeration when desired.

The fishes in the Oceanarium are caught by local fishermen in Hawaiian waters. They are currently fed at 9:00, 12 noon, and 3:30 p.m. We are contemplating an evening feeding as well.

The surgeon fish are identified by a spine at their tail and have very small scales. Fish such as the tangs, manini, palani, kala, and moorish idols are surgeon fish. In the Oceanarium they are fed green vegatables, seaweed, and bits of crab and fish as well as koi food and our special mix.

The trumpet fish is a long and unusual fish. In the Oceanarium we are feeding our trumpet fish live baitfish.

The trigger fish or humu humus, as well as the file fish, have a very rough skin and swim without using their tail very much. The humuhumu-nukunuku-a-pua'a is a famous example of this group of fish. In the Oceanarium they are fed squid, crab, and our special mix.

The jacks or papio are popular game fish. We have several examples of these fish. Any fisherman can point them out. In the Oceanarium they are fed squid and pieces of fish.

The mahi mahi and tunas (ahi and kawa kawa) are not normally seen in oceanariums. The mahi mahi will always be near the surface. This is normal for them. The tunas are fast swimmers and will roam throughout the Oceanarium. In the Oceanarium, they are fed squid and fish.

The octopus is usually a shy animal and needs a hole and rocks to hide in and protect itself from papios and eels. We are feeding it crab.

The butterfly fish and colorful yellow fish, of which we have many types, are being fed koi food, tiny shrimps, pieces of fish and live corals.

The lobsters, crabs and other animals such as star fish are scavengers and clean the Oceanarium of leftover food. They are occasionally given portions of fish and squid.

The menpachi are also called (u'u or soldier fish). They are most active at night. Most red fish are active at night. We are feeding them squid, shrimp and our special gel mix.

The hinaleas or wrasses are slimy fish, but many of them are very colorful. They also are very similar to the parrot fish or uhus. These fish are fed a variety of foods.

The goat fish are identified by the two whisker-like barbels under their mouth. The kumu, moana and weke are all goat fish. They are fed tiny shrimps, fish pieces, koi food and our special gel mix.

The eels are vicious-looking and have sharp teeth but are really very shy. They are most active at night and will occasionally catch a sleeping fish. We feed them pieces of fish and squid.

The puffers and box fish are also unusual fish that enjoy resting on a ledge or rock. They have sharp beaks and are fed crabs, sea urchins and squid.

Moi, or threadfish, was a favorite food fish of the ancient Hawaiians, as it is today. It is a silver-grey fish with a series of whiskers under its chin. In the Oceanarium we feed them shrimp, squid, and our special gel mix.

The damsel fish or mamos are a small fish, usually about 3 inches long. They are usually in schools. We have several types of damsel fish and they are fed koi food, our gel mix and tiny shrimps.

The sharks are called mano in Hawaiian. They are graceful swimmers and we feed them in the evenings with pieces of fish and squid.

The rays are also graceful swimmers. They are not aggressive feeders and must be hand fed crabs and squid by the divers.

The mullet and awa are large silver-grey fish that swim near the surface. In the Oceanarium they are fed koi food and our special gel mix.

The turtle is an endangered species and is protected by federal law. We feed the turtles our special gel mix and green vegetables.

The scenery was created by Rush Studios of Chicago. They have made several scenes in oceanariums around the world. The scenery made of fiberglass, with only a few real corals added.

We will be doing special underwater shows and may soon have a mermaid. We will announce up-coming shows.

EXOPHIALA-LIKE FUNGUS IN AN ALEWIFE
Alosa pseudoharengus

Dianne Lieberman, D.V.M.
Greg Early, Curatorial Biologist
New England Aquarium, Boston, MA

Abstract:

An alewife, *Alosa pseudoharengus*, from a captive school in a marine display tank at the New England Aquarium revealed an Exophiala-like fungus on histopathologic section of the cardiac tissue. Naturally-occurring cases of Exophiala, also from public aquarium display tanks, have been reported in eight genera of captive fish, and the infection has been experimentally reproduced in six genera of fish. Histologic techniques as an addition to standard aquarium postmortum procedures proved to help in obtaining information.

The alewife was obtained during a collection trip to the Bourne herring run in Bourne, Massachusetts, on May 21, 1979. All fish were removed from 17°C fresh water and transported via truck to the New England Aquarium. The fish were acclimated to 30 ppt salt water and introduced to the display tank after being given a formalin dip (250 ppm/1 hr) as prophylaxis against parasites. The display tank contained 2,500 gallons of salt water with a biological undergravel filter and consisted of a community of juvenile menhaden, alewife, and kingfish. During a three-month period, the average water temperature was 19.25°C (range 16°-23°C), the average pH was 7.8, the average ammonia was less than 100 ppb and the average salinity was 30 ppt. On November 11, 1979 the female alewife of this report was found dead in the tank and submitted to the curatorial laboratory for examination.

Externally the fish was in good flesh with no external signs of trauma. The fins were clear with no signs of hyperemia. The gills appeared slightly congested with no defects or parasites. Opening the body cavity revealed an unusually large amount of clotted blood. The body and musculature were firm and had good texture. The heart had a granular grey, slightly raised area occupying the dorsal/caudal one third of the ventricle. On cut surface the lesion appeared superficial with little or no invasion of the spongy layer of the heart. Impressions of organs and blood smears revealed no significant information. Tissue specimens of heart, liver, kidney, spleen, and gastrointestinal tract were fixed in buffered 10 percent formalin and submitted for histopathological examination.

Examination of the hemotoxylin and eosin stain section of the ventricle on low magnification revealed a dense cellular reaction in the cortical layer. On higher power examination, pale brown hyphae could be seen within a population of macrophages, lymphocytes and neutrophils. With a PAS stain the hyphae were easily visualized being branched and septate, measuring 1.5-2 microns with internal oval bodies. The hyphae were seen diffuse through the cortical and spongy layer of the ventricle and also the smooth muscle and elastic tissue of the bulbous arteriosus. Granulomatous tissue reactions and necrotic foci with occasional eosinophils and giant cells were seen predominantly in the cortical layer. No related lesions were seen in the gill, kidney, liver, spleen, or gastrointestinal tract.

Natural cases of Exophiala have been reported in cod <u>Gadus morhua</u>, scup <u>Stentotomus versicolor</u> Mitchell, seahorse <u>Hippocampus hudsonius</u> DeKay, sargassum triggerfish <u>Xanthichthys ringens</u> (L.), sebae clownfish <u>Amphiprion sebae</u> (Bleeker) (1); cutthroat trout <u>Salmo clarki</u> Richardson, lake trout <u>Salvelinus namaycush</u> (Walbaum) (2); and channel catfish <u>Ictalurus punctatus</u> (3). Experimental infections of the disease have been induced in channel catfish, white catfish <u>I. catus</u> (L.), bluegills <u>Lepomis macrochirus</u> Rafinesque (3); mummichog <u>Fundulus heteroclitus</u> (L.), winter flounder <u>Pseudopleuronectes americanus</u> (Walbaum), and cunner <u>Tautogolabrus adspersus</u> (Walbaum) (1).

Morphologic identification of the hyphae as Exophiala-like fungus was done by Dr. Richard Wolke of the University of Rhode Island, Department of Pathology (1). <u>Exophiala</u> sp. belongs to the Fungi Inperfecti, order Monilales, family Dermatiaceae (4,5). Culture and growth of the fungus was not done, therefore a definitive identification cannot be stated. Gross and microscopic lesions associated with natural cases of Exophiala fungus have been reported observed in piscine spleen, heart, lung, kidney, and swimbladder (1). In the alewife <u>Alosa pseudoharengus</u> of this report, the heart was the only major organ invaded by the fungus.

The relationship of a fungus to the pathologic process can be one of three: saprophytic, a primary pathogen, or simply an opportunist. A full answer may only be obtained by description, isolation, and identification of the organism, reinfection of fish of the same species and reisolation and identification of the organism, in addition to gross and histopathological examination (4). This is a research endeavor.

This case demonstrates the value of histologic techniques in addition to standard aquarium postmortum procedures. Even though a definitive diagnosis cannot be stated, the additional information obtained from histopathology adds value and perspective to the clinical history of the display tank system, and to the list of fish species in which this agent has been reported.

The authors add a special note of appreciation to the Department of Pathology at the Angell Memorial Animal Hospital for the generous use of their histology laboratory in the preparation of the specimens of this report.

1. Blazer, V.S. and Wolke, R.E., An Exophiala-like fungus as the cause of systemic mycoses of marine fish. Journal of Fish Diseases, 2, 145-152, 1979.

2. Carmichael, J.W., Cerebral mycetoma of trout due to a Phialophia-like fungus. Sabouraudia 5, 120-123, 1966.

3. Figan, N. Systemic mycoses in channel catfish. Bulletin of Wildfish Diseases Assoc. 5, 109-110, 1969.

4. Wolke, R., Pathology of bacterial and fungal diseases affecting fish, p. 33-117 in Fish Pathology, Ribelin and Magaki, edit., University of Wisconsin Press, 1975.

5. Reichenbach-Klinke, Fish pathology. p. 129. T.F.H. Publications, Neptune Park, N.J. 1964.

BABY FRESHWATER DOLPHIN BORN IN JAKARTA AQUARIUM

The following information was contained in a letter received by Louis E. Garibaldi, curator at the New England Aquarium, Boston, Mass., from Sukiman Hendrokusumo, general manager, Gelanggang Sumudra Ancol, Jakarta, Indonesia.

On July 4, 1979, a baby freshwater dolphin (*Orcaella sp.*) was born in the Jaya Ancol Oceanarium in Jakarta, Indonesia. It was a female about 65 cm long and weighed about 5 kg. The *Orcaella* baby was born in a tank with a volume of 605 m^3, a depth of 3.5 m and a diameter of 14.85 m.

The seven-year-old mother, Semayang, was caught from the Mahakam River in East Borneo (Kalimantan) in 1974. On October 15, 1974, she was transported to Jaya Ancol Oceanarium where she stayed for three months. Since 1976, Semayang has been training for her first underwater ballet show. In 1978 she was very active in the show, but in May of that year Semayang had her first mating with a male freshwater dolphin named Mahakam, also from East Borneo (Kalamantan). After the mating Semayang looked very sick, lazy, and wild and was not satisfactory in the public show.

In August 1978, Semayang looked about three months pregnant; she became "wild" and the show was closed. Semayang was observed 24 hours a day so that her progress could be watched. Results of the observation showed her genital slit was swollen, and she often bit the trainers. In March 1979, Semayang almost had an abortion after hurting herself by striking her abdomen on the wall or bottom of the tank. Often her abdomen looked as if there was some movement. On June 21, 1979, the first milk came from the mammary slit, and on July 3 Semayang looked very sick and restless.

At 12:02 a.m. on July 4, the first little freshwater dolphin was born. The first time the baby suckled on July 4 was at 12:32 p.m.

WHAT MAKES WATER RUN?

WELL, EVERYONE KNOWS THE ANSWER TO THAT. OR DO THEY?

George Henkel
Cleveland, Ohio

At the Cleveland (Ohio) Aquarium, where some trepidation is being felt about the adequacy of the central air supply as new display units are frequently being added, it was decided to investigate the possibility of increasing the efficiency of the air lifts. The alternative is to purchase a second air pump. At $7,000 a copy, this would obviously strain an already tight budget.

The said budget also dictated that our tests and experiments would have to be done by the armstrong method, as there were no funds for sophisticated measuring devices. Our only truly professional guage was a donated air pressure guage. (Although convenient, even this part was not essential.)

The first surprise for the staff was to find that the pressure guage showed only about 3.5 pounds per square inch. "But the pump's rating is 5 pounds. The guage must be wrong," was the immediate reaction. Can we depend on a water column to measure air pressure? Of course we can. And we did. Fortunately, one-quarter-inch plastic tubing was available in abundance, as were high-ceilinged work spaces, so we made and suspended a 12-foot-high "U" tube, which had first been filled with water. With air pressure applied we had a momentary fountain and then found that the water stabilized with a difference in level of eight feet. Ergo, the water pressure was indeed only 3.5 psi.

Many of the early experiments were carried out on a modest scale using one-and-one-quarter-inch or two-inch plastic pipe, these sizes being least expensive and most manageable. (Smaller sizes were deemed too prone to error because of the small units that would be measured.)

It was felt that a dynamic means of measuring air flow was a must and a water-filled "U" tube was again selected to do the job. The water level difference in inches was measured across a length of quarter-inch tubing through which the air lift was flowing. The readings obtained were only comparative, we realized, but good enough for our purpose. When a more accurate measure of standard cubic feet of air was desired, we used the Bronokowski method of timing the interval required to completely replace with air the water contained in an inverted receptacle of known capacity, hence the manometer could be calibrated without excessive error.

The amount of water moved by the various air-lift configurations was measured by weighing the amount of water collected in a plastic bucket over a specified time period, such as a half minute, full minute, or sometimes several minutes. It was a case of fill and lift to the scale, and lift again to dump the water back into the tank. (The armstrong method mentioned previously. A fine exercise, excellent for trimming the waist-line of those with sedentary occupations.) Let me thank in advance those who will write to point out our stupidity in not calibrating the receiving container. We merely wanted the greater accuracy to be obtained by weighing the water.

In these relatively small air lifts, the best results in the matter of air injection were obtained by using the commercially available air stones as air diffusers. The stones were located just below the lower opening of the water tube. At this location they had no appreciable effect on water flow. Inside of the tube they would, of course, be an obstruction to water flow.

To insure that the experimenter was not overtaxed by being obliged to lift the heavy containers at an awkward height, the tests were performed in a 36 inch tank filled to a height of 33 inches. The water pipe of the lift was kept at a constant 30 inch length, and data were taken with the top at various levels above the water surface, expressed in percentage lift to total pipe length. Thus, a three-inch lift was called 10%. We found none of the spectacular results we had read about. To be quite practical, the percent of lift had to be minimal, the amount of water being moved dropping off substantially as the lift was increased. At about five inches (17%), only a trickle of water was realized, but with the top of the pipe at the surface of the water, the amount of water pumped was spectacular.

Really, no new ground (or water) was being plowed. We found that adhering to already established principles of water movement resulted in substantially increased efficiency. Unfortunately, these principles are not widely known outside of professional engineering offices. It is a pity that this is so, but then all men cannot be all things. Engineers are not biologists, and the reverse is also true. (Enough philosophy already.)

One seemingly minor detail that is sometimes overlooked is that the air lift pipe must be vertical. Even a modest slant will reduce the efficiency of the air lift. Also, turns in the water flow both before and after the lift must be minimized. Every turn uses up precious water pressure. Remember that in many cases you are working with a water "head" of only a foot or two, which translates to a water pressure of less than one pound per square inch. At this low pressure, all restrictions must be minimized if not eliminated completely. Abrupt changes in pipe sizes are also costly. It is best to choose one size of pipe for the air lift and the pipes to and from it. The greater the relative diameters of pipes that are mixed, the greater is the loss that will be experienced. This principle holds whether we are considering sudden contractions or sudden enlargements with effect from the latter being substantially more severe than in the former.

Consider for a moment the case of a four inch pipe discharging underwater directly into an aquarium tank. This appears to be a classic case of a sudden enlargement with the ratio of pipe sizes being practically infinity. At a desired flow rate of ten feet per second, the loss in head of water is almost one and one half feet or really, probably more head than planned or <u>possible</u> with a typical air lift. The system would not stop operating, of course, but the desired flow would be seriously compromised. A decided improvement could be effected by <u>flaring</u> the discharge end of the pipe.

Flaring the pipe at both the underwater exit and entrance is such a small thing to do and pays handsome dividends. Consider: the calculation for entrance <u>losses</u> is directly related to a factor "K" which is given a value of 0.78 for an inward projecting pipe. For a sharp cornered entrance at the wall of the aquarium "K" becomes 0.5, for an entrance with slightly rounded corners "K" is given as 0.23, and for a bell-mouthed entrance "K" becomes a startlingly low 0.04. The comparison of the worst and best case figures makes obvious the fact that just sawing off the pipe and putting it willy-nilly into the aquarium carries a substantial penalty. Our tests and observations bear this out.

Getting the water out of the pipe certainly is deserving of careful planning and execution. The manner of getting the water into the pipe is no less important. Much too often we see water flowing into a pipe which is just barely off the floor of the tank or water required to enter through a series of holes in the side of the pipe or a jaggedly cut pipe end that rests on the bottom. The loss of pressure occasioned by these unfortunate arrangements are dearly paid for in terms of reduced flow and air waste. Here, too, a bell flare is useful and clearance above the floor is essential.

For comparison, let us consider the price the hot-rodder pays for peeling away from a traffic signal; not in lost rubber but just in fuel. Conservationists plead "take it easy; fast acceleration has a price". The same holds true for water movements to enter a pipe. The water flows toward it in a leisurely fashion, but an abrupt change in velocity is required at the pipe entrance. This sudden acceleration costs money. A bell entrance assures a more gradual acceleration and hence uses less power. A correctly designed bell would have its cross section doubled for each unit of its length. That is, if the area one inch from the small end is "X", two inches away would require an area of 2 times "X", and at the three inch point, the area should be 4 times "X", etc. It should be noted, however, that any flare is probably better than none. Our method of flaring at the Cleveland Aquarium was a little less than scientific, and yet it payed dividends. We heated our plastic pipe over a gas flame until the plastic was quite pliable and then plunged the heated pipe over the neck of a quart size soft drink bottle, holding it in place until the pipe cooled. (Use precautions and protection in case the bottle should break.)

Before winding up our tests which would have gone on for weeks and months had we had the time and resources to build or obtain better measuring equipment and test jigs, we measured in our crude way the water and air being moved and consumed in the six inch pipe serving the large exhibit tanks and found that our measurements and conclusions obtained with the smaller pipes were equally applicable in the larger environments.

Since greater quantities of air were involved, a new manometer sensor was devised by the simple expedient of heating the center portion of an approximately eight inch length of one inch diameter plastic pipe and squeezing it slightly by means of two round objects, one on either side. A simple jig placed between the jaws of a vice deformed the pipe very nicely with just the right amount of restriction on the second try. The depressions in the sides of the pipe need be only very slight to provide useable readings. One side of the "U" tube was connected to the point where the air entered the pipe and the other right into the point of greatest restriction.

When our observations were just about completed, a kindly consultant pointed out that our "U" tube need not be a "U" at all; that greater reading accuracy could be easily obtained by slanting the tube and scale, thus making the scale longer. (Why didn't we think of that? Drat!)

All in all, despite the fatiguing lifting of water for hours on end and the lack of any new principles discovered, we found that we should not overlook or ignore the facts already in print, nor the timeless principles of basic physics, and the work was certainly not wasted. The existing aquariums, Cleveland included, will certainly not tear out any of their present air lift arrangements on the basis of these findings; they are really not all that bad at present, but you may be sure that greater care will be taken in future designs.

All formulas, charts, and tables referred to are from Cameron Hydraulic Data published by the Cameron Pump Division of Ingersoll-Rand to which we express our thanks.

Questions, comments, criticisms, etc. may be directed to the author at 9275 North Church Drive, Apartment 708, Cleveland, Ohio 44130 or to Mr. Ed Bronokowski, c/o The Cleveland Aquarium or to Mr. Dan Moreno, Director, 601 East 72nd Street, Cleveland, Ohio 44103. A S.A.S.E. would be appreciated if a reply is expected from the author.

BABY DOLPHIN BORN AT NEW ENGLAND AQUARIUM

Sue Miller Sinclair,
Trainer, New England
Aquarium, Boston, MA

At 8:37 p.m. on November 20, 1979, Spit, a fourteen-year-old bottlenose dolphin (Tursiops truncatus), gave birth to a male calf. It was the first live birth at the New England Aquarium. Two days previously, Cathy, a thirteen-year-old Tursiops, had given birth to a stillborn female. Because of an obvious weight gain (both animals had gained 116 pounds in a one-year period prior to the births) as well as a progesteron level check done in August, neither birth was totally unexpected.

Three months prior to calving, both animals were removed from shows and placed together in a holding pool measuring 30' x 23' x 6' deep because we suspected the pregnancies. They were together in that pool when Cathy delivered. Spit, however, appeared quite disinterested in the birth. Cathy, on the other hand, was very attentive to Spit during her delivery. Cathy stayed close by and at times seemed to be coaxing Spit into moving if Spit had been resting for a long period of time. Spit's delivery did take an unusually long time. Parturition began at 4:00 p.m. and at 8:15 p.m. little progress had been made in the delivery. Spit seemed quite calm at that point and was inactive. We took food out and began running Cathy through some behaviors to stir up activity in the pool. Spit never joined in the session, but did become more active. At 8:37, about 20 minutes later, she gave birth. Shortly after the calf was born, Cathy became extremely aggressive toward the baby and Cathy was removed to another holding pool.

Immediately following the birth, around the clock observation was established to monitor the animals' behavior. This regimen continued for four days. Spit spent all of her time eschelon swimming with her calf, always keeping him on the inside, away from the walls. At approximately midnight on the evening he was born, the calf was seen attempting to nurse. During the following days it was determined that he was nursing every twenty-five minutes on a regular basis.

On Wednesday, November 21, we began adding a brine solution to the holding pool to raise the salinity from 300 parts per thousand to 39 ppt. We also hooked up a steam line to increase the water temperature from a winter normal of 63°F to 74°F. These steps were taken to make the calf's environment a more natural one.

On December 11, Dixie, a seven-year-old female Tursiops, was introduced into the holding pool with Spit and the calf. We hoped that Dixie would assume the role of midwife/auntie, but Spit seemed unwilling to let Dixie get close to the calf. On November 26 we allowed Cathy in with the trio, and on November 28 she took the calf for a short period of time. As time passed, Cathy took the calf for increasingly longer periods. At present Spit and Cathy are alternating duties with the calf, although the calf does not, nor has he attempted to, nurse from Cathy.

Our show pool measures 35'x45'x15' deep and holds approximately 110,000 gallons of water. We felt it would be beneficial for the calf if he was in the larger pool. After several unsuccessful attempts to coax Spit and the calf through an underwater gate that connects the holding pool with the show pool, we made the decision to net them through the gate. On December 18, when the calf was 29 days old, we lowered the water level in the two pools to allow adequate breathing room for the animals while they swam through the gate. All went smoothly, and, after 15 minutes of slowly moving the net toward the gate, Spit and the calf went through it. Once in the deeper pool, Spit and the calf quickly assumed a pattern of diving, surfacing only for respiration.

Since Spit and the calf are now in our show pool and we must do regular performances, we have written a new show dialogue introducing the calf to the public. On January 4, Neptune, an eight-year-old, male bottlenose dolphin, was introduced into the show pool with the females and the calf only during showtime. On January 9 Apollo, also an eight-year-old male and the suspected father of the calf, was allowed in the show pool during showtime only. The two males have not been in the pool with the females and the calf at the same time. Neither male has presented any problem other than occasionally chasing Spit. Neither has shown any real interest in the calf.

Following the first four days of around-the-clock monitoring of Spit and the calf, we developed a schedule of observations alternating between a respiration count and a nursing and behavioral observation. Each "watch" is a sampling of ten minutes out of every hour.

The trainers spend at least half the day observing the calf and mother, and it appears that there are almost daily changes in growth and behavior. For example, after the first week and a half, Spit allowed the calf to wander away from her but moved quickly to his aid if it appeared that the calf was in any danger. The following is a list of the calf's more notable behaviors and the dates on which they occurred. It should be mentioned that behaviors always occurred with greater frequency after the initial observations were made.

BEHAVIOR		DATE	DAY
1)	Spyhop	Dec. 9	20
2)	Porpoising First seen porpoising with an adult; now does it on his own during period of high activity.	Dec. 14	25
3)	Spouting off Could not determine if it was just hard respiration, but he did it with an adult who was not demonstrating this behavior. Calf has repeated this several times in the last few weeks.	Dec. 16	27
4)	Rolling on side and slapping water with pectoral fins (a favorite)	Dec. 21	32
5)	Rollover	Dec. 21	32
6)	Slapping chin on water	Dec. 28	39
7)	Openmouth behaviors Doing any of above behaviors with mouth wide open	Dec. 28	39
8)	Breach	Jan. 3	45
9)	Adult female rolling on back while calf swims up and "beaches" himself on the adult's chest. Usually stayed in that position for 10 to 15 seconds.	Jan. 4	46

The calf seems to have put on a healthy amount of weight and is doing very well. His weight is estimated at 55 pounds and his length about 45 inches. As a result of a contest to name the baby dolphin, he is now called "Echo."

New England Aquarium

Central Wharf, Boston, Massachusetts 02110

Addressed Correction Requested

non-profit org.
U.S. POSTAGE
PAID
Boston, Mass.
permit no.1479

Frank Murru, Sr. Aquar.
Sea World of Ohio
1100 Sea World Drive
Aurora, OH 44202