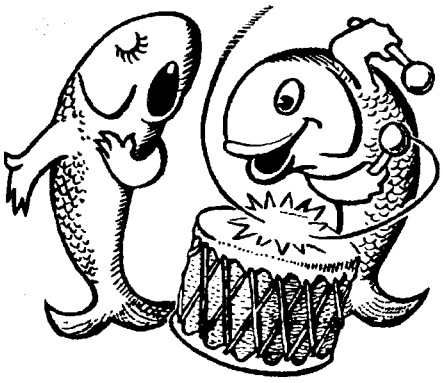
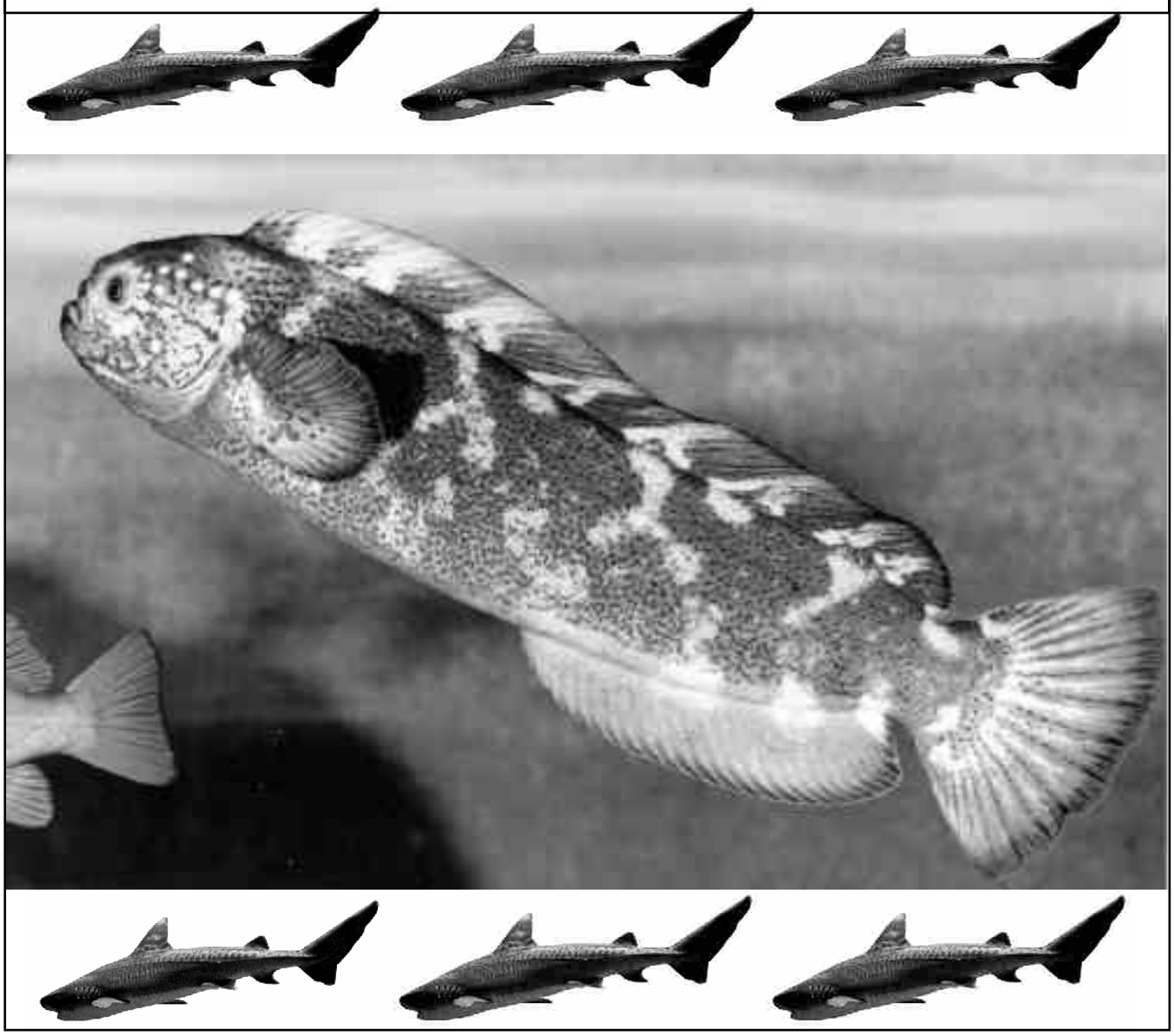
DRUM and CROAKER

A Highly Irregular Journal for the Public Aquarist



Volume 29 *Feb. 1998*



A BRIEF GUIDE TO AUTHORS

As always, Drum & Croaker articles are not peer reviewed and content will not be edited. Other types of contributions may be edited to meet space limitations.

Disks are preferred. DOS or Windows files can be sent directly to the Editor: Pete Mohan, Sea World of Ohio, 1100 Sea World Drive, Aurora, OH 44202. Send typed manuscripts directly to Pete Mohan in Times 12pt where possible. Please send Macintosh or other Apple files to: Rick Segedi, Cleveland Metroparks Zoo, 3900 Brookside Park Drive, Cleveland, OH 44109.

1. "Regular" style articles: should normally follow the following basic format:
   TITLE (boldface, capitals & centered)
   one and one half space
   Name & title (centered & boldfaced)
   one and one half space
   Affiliation (centered & boldfaced)
   double space
   Text: single spacing with 1" margins. Please indent five spaces at the beginning of each paragraph. Double space between paragraphs. Section headings should be in bold (but not all caps) at the left margin. Figures: we can print black & white photographs.

2. Optional "Journal" style articles: (provided by George Benz, Tennessee Aquarium) [also see "Morphology of the Fish Louse" in Volume 27]
   Font throughout paper: Times New Roman or some equivalent; Spacing: single throughout; Margins: 1" throughout. Page numbers: delete.
   Headers:
   Header top of title page: 10pt., bold, aligned left as following example: ***Drum and Croaker*, 1996, Vol. 27**
   Header second page of paper and every other page thereafter: 10pt., center aligned, bold as in following example:
   ***Drum and Croaker*, 1996, Vol. 27**
   Header third page of paper and every other page thereafter: 10pt., center aligned, bold, giving last names of author(s) and brief running title as in the following example: **Boons and Farm - How to Make Cheap Wine at Home**
   Title: center aligned, all caps., bold type with first letter of key words 16pt., all other letters 14pt.
   Use italics only where appropriate.
   2 line spaces after title
   Authors name(s): center aligned, all caps., bold type with first letter of each name/initial 12pt., all remaining letters 11pt.
   1 line space after author names
   Abstract: set off by bold "**Abstract:**". Entire abstract 10pt., 1 column text, left & right justified. Abstract set off from main text by thin centered line approximately 7cm long.
   Main body of text (including Acknowledgments and References sections): 2 column style, each column left & right justified. Use section headings as appropriate. Headings should be bold, all caps, with first letter of key words 11pt., all other letters 10pt. Rest of text should be standard paragraph style, 10pt.
   References: no empty lines between entries in list of reference citations. Use hanging indent style to set off beginning of each entry of reference list. Spell out entire names of journals.
   Figures and legends: may be formatted in 1 or 2 columns. Legends should begin boldly, for example as, "**Figure 1.**" Afterwards, use regular font. Legends are left & right justified. Pages with figures should be submitted camera ready (i.e., with legends in place and appropriate page headers at top). To conserve space, figures may be formatted to reside on pages that also contain main body text.
   Tables: similar to figures above. Please use accepted journal style for table format.
   Additional: refer to figures in text as "Fig." & italicizing scientific names.

3. "Ichthyological notes" (short communications) are any articles, observations, or point of interest that are less than 1½ pages in length. A brief bold faced and capitalized title should be centered, text should be single spaced, and author and affiliation should be placed at the end of the piece with the left end of each line at the center of the page.

4. Reviews, abstracts, translations and bibliographies are also welcome.

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DRUM AND CROAKER 35 YEARS AGO

Rick Segedi

Cleveland Metroparks Zoo

The following excerpts are from Issue 6, September 1962, published by New England Aquarium, Lee C. Finneran, editor

From the Editorial: ***What Is a good public aquarium?***

[I have] friends who are vitally interested in the welfare if the animals in their charge. They point with justifiable pride to the animal that is feeding well and to the other beastie that has been in captivity for yea odd years. Such public aquarists are the envy of the others in the profession because of their "special skill" in maintaining animals. These public aquarists will willingly cloud a tank or leave unsightly food in public view to keep their prize specimens going. I willingly concede that contributing to the sum total is of supreme importance and that the captive animal must be adequately maintained. But I worry about the public in public aquariums.

From: ***Octopus, Alive,*** **John Prescott; Marineland of the Pacific, & Cecil Brosseau; Pt. Defiance Aquarium**

Octopus have been kept at Marineland for a record 16 months. However, the average animal is normally kept for less than a year. We find that during Aug.-Sept. breeding season of animals they will go off their food and if a female lays eggs, she will guard them as long as three months, without eating, eventually dying herself.

. . . The Point Defiance Aquarium has kept octopus for various periods of time, up to two years.

From: ***Plastic Plumbing Can Mean Trouble;*** **James W. Atz; New York Aquarium**

Although I have known right along that some plastics are not suitable simply because they are toxic, I did not realize that all polyethylene, polyvinyl-chloride, or unplasticized [PVC] pipes are not the same. . . . On good authority, I have been informed that plastic products made with extenders, plasticizers, or used polyethylene should be avoided. . . .When a manufacturer claims that his product is completely non-toxic, he is usually speaking in terms of human beings, which are a lot tougher and better isolated form their environment than are most fishes and water-inhabiting invertebrates.

Aquarium Committee of American Society of Ichthyologists and Herpetologists

At the forty-second annual meeting, President Roger Conant, established and Aquarium Committee for the American Society of Ichthyologists and Herpetologists. The Committee members include the following people: Christopher Coates, New York Aquarium; William E. Kelley, Cleveland Aquarium; Earl S. Herald, Steinhart Aquarium; and F. G. Wood, Marine Studios. L. C. Finneran, New England Aquarium, is Chairman of the new group.

From: ***World's Fair Visitors Seeing Aquarium;*** **[probably by editor Lee Finneran]**

. . . My overall impression is that the Seattle Aquarium has a good location on the waterfront, near the Ferry departure pier (#52), and near restaurants and tourist souvenir shops, etc. [***1998 note****: This is* **NOT** *the present day facility. It was a commercial venture which opened in 1962 during the Seattle World's Fair. A few years later, it was the first aquarium to exhibit a killer whale with its acquisition of Namu. Namu was kept in a netted-off section of the harbor next to the aquarium.*] I know nothing of [its] filtration setup. I saw one other person there . . . (besides the busy ticket seller) a young boy who was feeding the baby seal at the outside. Incidentally, that to me was bad impression, being such a small tank with a small crab box stuck in it for the animals to crawl out of the water onto, and the water was filthy; but as I said, once inside, I was surprisingly impressed.

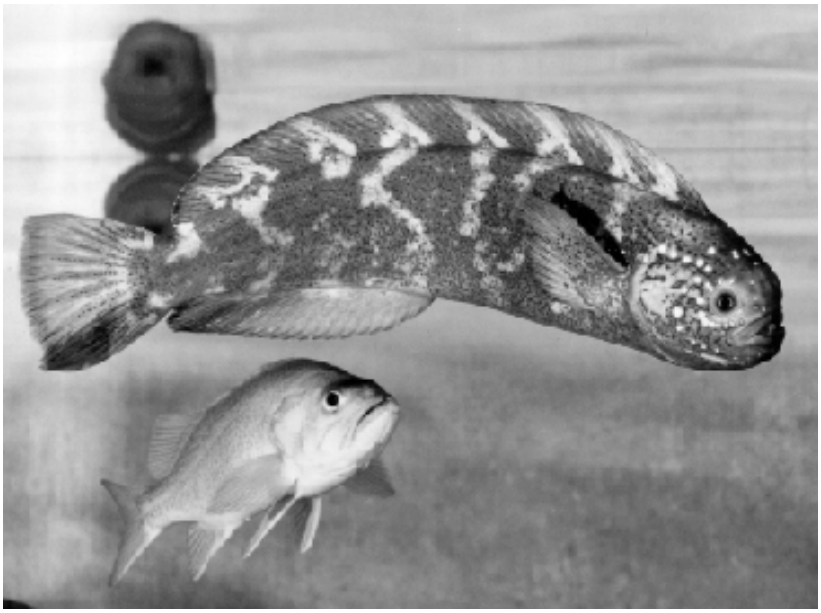
THE CARE AND DISPLAY OF THE PROWFISH, *ZAPRORA SILENUS*

Marty Carollo, Senior Aquarist
Polly Rankin, Curator of Fishes and Invertebrates

Oregon Coast Aquarium, Newport Oregon

Aquarists at the Oregon Coast Aquarium have had three opportunities to develop husbandry techniques for the care and display of the prowfish, *Zaprora silenus.* All three animals were collected by Glen Eason of the trawler *Limit Stalker*. Each specimen was in a different state of health at the time of collection, depending on the variables of the trawl. A 35-gallon bucket of sea water was used for transport. Mr. Eason constantly aerated and periodically changed the water throughout transportation. All animals received similar care upon arriving at our facility. Though we lost two to trawl injuries, we recently observed our 29-month anniversary with one of these rarely displayed animals.

Prowfish are a seldom displayed but not uncommon Pacific Northwest fish. These personable, beautifully colored fish are found in rocky habitats at depths of 16 to 195 fathoms, ranging from Orange County, California to the Bering Sea, Alaska (Hart 1973). A literature search revealed no dietary information for adult prowfish, although Scheffer (1940) noted juvenile association with cnidarians.



We learned a lot about prowfish from our first specimen, which was donated September 30, 1993. The available literature and a call to west coast aquariums and fisheries professionals revealed that little was known about these animals. We determined over several weeks that prowfish are powerful swimmers, have a benthic orientation and, much to our surprise, eat jellyfish. The ease of movement and residence of the animal in and around 12-inch PVC pipe led us to believe it was benthic in nature, and possibly a crevice dweller. The dietary discovery came after weeks of unsuccessfully trying every standard frozen food item, and then every live invertebrate we could think of, including anemones, worms, echinoderms, crustaceans, and mollusks. Fortuitously, three weeks after the prowfish's arrival, Mr. Eason provided us with a recently collected deceased prowfish. A gut analysis revealed gelatinous substances and exploration of the head revealed a single row of small teeth in a mouth that opens to a remarkable 180 degrees. These observations and the known association of juvenile prowfish with cnidarians pointed us in the direction of

jellies as a possible food source. The presentation of an egg yolk jelly, *Phacellophora camtschatica*, one month after acquisition resulted in a feeding response and a moon jelly, *Aurelia aurita*, was consumed shortly thereafter. This specimen ultimately died of trawl injuries, but provided us with a wealth of husbandry information, which we used with our current display animal.

Our current display prowfish was collected on May 12, 1995 in a trawl net set at 70 fathoms over a hard shale bottom. The catch consisted mostly of lingcod and yelloweye rockfish along with a large number of a small unidentified jelly. Upon receipt of the prowfish, we placed it in a 225-gallon quarantine tank measuring 24 x 28 x 48 inches. This tank is part of a semi-closed, filtered, chilled, and UV-sterilized system totaling 300 gallons. We began a standard two-week quarantine program, which predominantly consists of a seven to 14-day bath in a 10 ppm concentration of the antibiotic naldyxic acid. A skin scrape on the prowfish's reddened tail revealed the presence of multiple species of bacteria. No feeding was attempted during this period.

By May 27, 1995, the end of the quarantine period, the prowfish showed an improved appearance and a decrease in the redness of its tail. We relocated it from the quarantine system to a holding tank eight feet in diameter. Transport was conducted using large plastic shipping bags, as this animal proved to be a strong and explosive vertical swimmer. The holding tank is a semi-closed, recirculated, filtered and chilled system 36 inches deep, divided in half by plastic netting. We placed the animal alone in one half of the tank and covered the lid with black plastic. Various *Sebastes* species inhabited the other half of the tank. The animal easily and calmly negotiated the holding tank and resided in or among the 12 inch diameter PVC pipes.

An *Aurelia aurita* was offered on May 29, and the prowfish consumed the gonads, along with parts of the bell. Concerned about the low nutritional value of jellies (which are 98 percent water) as well as their limited availability, we immediately began alternative feeding strategies. We started by offering frozen and defrosted sea nettles, *Chrysaora melanaster,* collected for this purpose. Once those were accepted, we began stuffing additional food items into the bell of the jellies. These included krill, shrimp, sandlance, clam, silverside smelt and a gel food which we prepare on site. The prowfish was initially wary, but soon began to accept the defrosted and stuffed jellies. Its typical feeding behavior was to come up near the surface, watch us place the food item in the water, study it, then suck it in. It usually ingested the gonads first, and consumption of the entire jelly often required two or more attempts. Other than the consistent feeding, we attempted no additional medical procedures.

The prowfish was transferred into our deep reef display on August 11, 1995. This is a chilled, filtered and recirculated system measuring approximately 200 x 100 x 90 inches, with a volume of 9,000 gallons. There is a large centrally located reef in the exhibit. Tankmates include four ratfish, eelpouts, several large rockfish and miscellaneous invertebrates.

Upon entering the display, the prowfish appeared disoriented and swam against the large acrylic viewing window. We offered a defrosted sea nettle the first day, which it accepted and consumed. However, starting the next day the prowfish refused to eat, even though we offered it

both defrosted and live jellies. Previously very aware and attentive, it began to show signs of stress, displaying behaviors such as head bobbing at the surface, and continued swimming against the acrylic viewing window. Water chemistries were stable, and all other animals exhibited normal behavior. We suspected this animal might be electrically sensitive, and we speculated about the potential function of the large white pores on the head. We even tried feeding it with all associated electrical apparatus turned off, including pumps, chillers and lights. The disoriented behavior continued until we moved the animal back to the 8-foot round holding tank on September 15. Two days later the prowfish began accepting food again. Soon the animal displayed behaviors consistent with those it exhibited before it was moved into the display, and it appeared healthy and responsive. No treatments were given to the animal while in holding, and food was offered and consumed daily to increase its overall health and weight.

Puzzled by the prowfish's apparent disorientation in the deep reef exhibit, we tested the electrical conductivity of the exhibit. A representative of our local power provider, along with our life support staff, found that there were significant electrical "hot spots," up to .11 volts, in our display. Testing was done by moving two submerged steel plates connected to a voltmeter around the exhibit. Possible sources for the electrical conductivity included the pumps, the chiller, and the metal halide transformer brackets, which were mounted to bolts screwed into the concrete superstructure of the display. Aquarists electrically insulated all bolts and metal-to-metal contact points in the lighting support, which decreased the electrical presence significantly. Additionally, the overall lighting was decreased in the belief that the brightness might be disconcerting to the deep-dwelling creature.

On November 8, 1995 we moved the prowfish back to the deep reef display. This time it appeared much more relaxed and at ease in the display. Live jellies were offered daily, and on the fifth day it ate the gonads out of a jelly. Though particular at first, soon it was again eating defrosted sea nettles stuffed with additional food sources, and it began to appear robust, showing the characteristic distention of the belly upon eating. Whatever the original source of discomfort, the prowfish has not shown negative behaviors similar to those exhibited upon its first entry into the display. Its normal behavior is to rest on or within the rockwork of the exhibit, or on the sand bottom, often right next to a large quillback rockfish. When anyone comes to the top of the exhibit, the animal immediately swims to the top of the exhibit and lingers attentively at the surface.

We continued feeding the frozen jellies stuffed with other food items until in January 1997, after 20 months in captivity, it began to eat the alternate food items outside of the bells of the jellies. We are now able to hand-feed it shrimp, clam, krill, fish and the occasional available jelly.

Since discovering the affinity of our prowfish for cnidarians as a food source, we have been in contact with field researchers, who have confirmed many of our original assumptions. Dr. Richard Brodeur of the National Marine Fisheries Service shared ROV footage of a juvenile prowfish swimming in close association with a lion's mane jelly, *Cyanea capillata*. Dr.Victoria M. O'Connell, a groundfish biologist for State of Alaska Fish and Game, provided us with video footage taken from a deep sea submersible of a pinnacle located off Kruzof Island, approximately

45 miles off Lituya Bay, Alaska. This footage shows numerous prowfish residing in a field of huge boulders at the base of the pinnacle. Her primary interest was in the lingcod, *Ophiodon elongotus*, and various *Sebastes* spp. populations on the reef, but many prowfish can be seen lying in the cracks, crevices and open areas of the reef. Perhaps just as intriguing is that multiple prowfishes are observed together, often even touching. Dr. O'Connell reports observing small schools of prowfish hovering over rocky pinnacles consuming gelatinous zooplankton as it drifts by. Photographer Emory Kristof provided us with ROV video footage taken at the Bowie Seamount on a trip sponsored by the National Geographic and Art Hall, the owner of the yacht SUM DUM. This incredible footage shows prowfish foraging on salps and a small school swimming directly up to and bumping into the ROV. In addition, underwater photographer Bill Curtsinger dove with these prowfish off the Bowie Seamount and reports their curiosity with his acrylic camera housing; he also observed them consuming a large jelly.

Another important contribution to our understanding of this animal comes from some unpublished research shared with us by Dr. David Somerton of the Alaska Fisheries Science Center. His research concerns prowfish population biology, stomach analysis and morphology. While taking samples along the southern portion of Alaska and along the Aleutian Islands, Dr. Somerton has had the opportunity to study many of these fascinating animals. Although he is planning to publish his reports soon, Dr. Somerton did give us permission to reveal one of his findings: the conspicuous pores on the head of the prowfish are definitely chemoreceptive in nature and not electrically associated, as we originally suspected.

Putting together the pieces of this intriguing puzzle has been extremely rewarding. We greatly appreciate the assistance of the enthusiastic field biologists and the photographers who have helped us confirm the natural history of these wonderful animals. We would also like to thank our colleagues at the Vancouver Aquarium who are now exhibiting a prowfish and have generously shared their experiences. A special thanks to the aquarists past and present who have creatively and diligently worked to understand and exhibit prowfish.

References

Hart, J.L. 1988. Pacific Fishes of Canada. Canadian Government Publishing Centre, Ottowa Canada: 359

Scheffer, V.B. 1940. Two recent records of *Zaprora silenus* from the Aleutian Islands. Copeia 1930(3):203

INTRODUCTION TO THE PROWFISH, *ZAPRORA SILENUS*

Akira Kanezaki, Aquarist

Vancouver Aquarium

It is not very often that an aquarium facility has the opportunity to obtain and display species of fish that are normally considered deeper water animals. One such creature is known as the prowfish (*Zaprora silenus*). To date, only two aquariums are known to have displayed this fish, first the Oregon Coast Aquarium and now also the Vancouver Aquarium, both located on the West Coast of North America. We at the Vancouver Aquarium were fortunate enough to not only obtain a prowfish but to have information obtained from Oregon Coast Aquarium as a foundation for our husbandry of this impressive animal.

The prowfish is a beautiful elongate, laterally-compressed fish lacking pelvic fins and having a dorsal fin that runs most of the length of its body. Imagine a blenny about two to three feet long and you have the general body plan. It is the lone species in its family having distinct orange patches on its face. The prowfish's most distinctive characteristic is the large (as in ~5-7mm), white pores spaced out in a semicircular fashion on its face. They start from under the mouth to up over the head. It is believed that they function as sensitive electrochemical receptors capable of detecting the pulsing of active jellyfish, a main part of their diet. Submersible video footage has shown numbers of prowfish at the top of deep pinnacles facing into the current waiting for jellyfish to float by and picking them off.

Prowfish are distributed along the Pacific coast of North America up to Kamchatka, Russia. They, as adults, are rarely found shallower than a couple of hundred feet deep, but I have seen one photo taken by a recreational diver of a prowfish found at about 80 feet in Saanich Inlet on Vancouver Island, west of Vancouver, B.C. Both Oregon Coast's and our individuals were obtained as donations from fishermen who had caught them as by-catch. Most prowfish specimens have been received from fishermen either trawling, long-lining, and occasionally purse seining near the bottom. Ours was caught on a long-line up around the northern end of Vancouver Island at approximately 400 feet deep using squid as bait. It was then shipped in a holding tank via truck to the Vancouver Aquarium.

Upon arrival, it was placed in a large, covered quarantine reserve tank and given lots of time to acclimate. We decided against any prophylactic treatments as we felt that they may be too stressful on the animal, but Oregon Coast Aquarium did perform such treatments without any adverse effects. However, we did run into a little problem after our individual was placed on display. It developed parasitic leeches, likely obtained from the display tank that it was initially placed in, all over its fins and face. We decided to subject it to a freshwater bath in an attempt to remove the leeches. The bath lasted for five minutes and the prowfish was monitored very closely. It remained calm, and the parasites were all removed, much to our relief. It has not shown any problems since that treatment.

The main problem that arose with both Oregon Coast's and our prowfish was trying to get them to feed. Initially, we tried a variety of foods for it while on reserve (squid, krill, fish) but to no avail. That's when we decided to contact Oregon Coast Aquarium. We learned that they too

had the same feeding problems. Eventually, they found something that worked. They used sea nettle (*Chrysaora sp.*) jellyfish. They starting packing them with various foods so that the prowfish would ingest those food items and get used to them. Eventually, their prowfish would eat just the food items as they sometimes fell out from the jellyfish. We did not have sea nettles, but moon jellyfish (*Aurelia aurita)* were available. So, we would try them as a vector for acclimatizing our prowfish to other frozen foods. Eventually, after two months, it began to eat the jellyfish. We started to pack them with krill and fish which it took without any problems. Trouble arose when we put it on display. It stopped eating. The display tank was well-lit and had rockfish (*Sebastes sp.*) as tankmates. It had developed the aforementioned leeches, but were not convinced that they would affect its appetite. Some of the rockfish had leeches as well, but no appetite problems. We were perplexed as to what the problem was. We gave our friends at Oregon Coast Aquarium another call. They discovered in their own investigation into the same problem that the lighting in their display generated strong enough electric fields to possibly disrupt the prowfish's sensory abilities. So, we put our animal back on reserve and waited for it to begin eating again. Then, we placed it in our deep-sea exhibit that is far more dimly-lit and with much less viewing window area. The results were positive. Our prowfish is eating regularly and interacting with the other animals without conflict.

If there is something we have learned from our experience with prowfish husbandry, it has been that it is very important and beneficial to network with other aquariums to share information about animals unique or not. We, as professional aquarists, are a unique breed, and must therefore use each other as resources. Seeing your animals get over that first major hurdle of starting to feed is one of the most satisfying feelings. We also learned that prowfish can go a couple of months without eating, and that they can be weaned off of normal diets onto food items that are readily available to us. They are an amazingly resilient creature.

THE AZA WESTERN REGIONAL CONFERENCE

The AZA Western Regional Conference is being hosted by the **Monterey Bay Aquarium** in Monterey, California, March 11-14, 1998. For further information contact Ginger Hopkins, Monterey Bay Aquarium, 886 Cannery Row, Monterey, CA 93940-1085, (408) 648-4925 or e-mail: GHopkins@mbayaq.org

THIRD INTERNATIONAL AQUARIUM CONGRESS PROCEEDINGS AVAILABLE

A few copies of these proceedings are still available. If anyone is interested in obtaining one or more copies please contact John Prescott. The price is $25.00 U.S. including shipping. John's current address is: 78 Possum Road, Weston, MA 02193-2318; Voice: (617) 894-7157; Fax: (617) 894-6461; E-mail: jprescot@neaq.org

HUSBANDRY OBSERVATIONS, AND TREATMENT OF FUNGAL INFECTION IN A TIGER SHARK, *GALEOCERDO CUVIER*

Andrew H. Dehart, Aquarist
Gary L. Stoops, Aquarist

Henry Doorly Zoo, 3701 South 10th Street, Omaha, Nebraska 68107

Introduction:

Tiger sharks, *Galeocerdo cuvier*, are rarely displayed in public aquariums and little is known about their behavior and health in the captive environment. Omaha's Henry Doorly Zoo had the opportunity to display this species for a year and a half, from March 1995 to August 1996. The purpose of this material is foremost to relay the information gained from the experience in regard to keeping tiger sharks in captivity. Secondly, to address a fairly successful treatment for fungal infections in elasmobranchs, which was used on this individual.

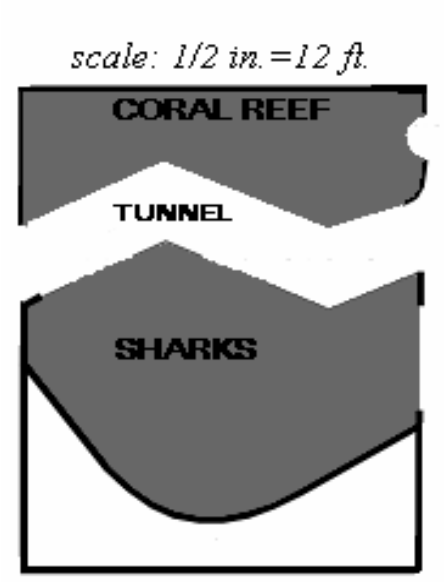
Transport:

A female tiger shark arrived in Omaha, via direct air transport, from Nomad Marine in the Florida Keys on March 15, 1995. Before shipping, the shark was kept in an oval shaped holding tank on an open system, for approximately nine months. In this holding tank the shark swam the perimeter constantly, due to the size and shape of the area. The transport went fairly well, except for the fact that the shark vomited en route. Total travel time from the Keys to Miami, and then to Omaha, was approximately six hours.

The most difficult part of the transport was the release of the shark. She was acclimated for about an hour and a half in her shipping box, which had a circulating pump, as well as an oxygen supply. When the temperatures were finally in equilibrium she was released into the 900,000 gallon closed system, display tank where she darted away, but then quickly became disoriented and sank to the bottom. Aquarists then had to pick her up off the bottom and swim her around the exhibit to ventilate her. This was a very slow process. After being pushed for several minutes the shark would take off on her own and swim for a short duration, but would then sink to the bottom again, apparently very disoriented and exhausted. Originally, there was some concern about the excessive handling removing her slime layer and compromising her health, but it did not seem to cause any complications. The swimming process took over two hours until she finally acclimated and began successfully navigating the tank by herself. The shark was watched all night, along with the six sandbar sharks, Carcharhinus plumbeus, that arrived. Due to the complicated manner of the transportation and acclimation, accurate measurements were not taken, but the tiger shark arrived at an approximate total length of 152 cm and an estimated weight of 35 kg.

Behavior:

Behaviorally, she quickly developed a pattern of swimming the perimeter of the tank, but seemed not to rub with her pectoral fins or ventral surface. She may have adapted quickly to this pattern due to the fact that she was kept in a rectangular holding pool with no structure for months before her arrival at the Henry Doorly Zoo. At the time when the sharks arrived to the facility, the aquarium was not yet open to the public and the shark exhibited fairly normal



swimming behavior, with times of swimming out in the middle of the display, as well as periods where she continually swam the perimeter. The Shark/Reef Exhibit at the Henry Doorly Zoo has a seventy-foot long tunnel, which zigzags, down the center of the tank. As soon as the aquarium opened to the public, the tunnel became filled with thousands of visitors per day, creating an extremely high amount of noise, which in turn reverberated off the acrylic tunnel. At this point in time the tiger shark's behavior changed, to the point that during visitor hours she would swim along the smooth perimeter wall, the farthest area from the tunnel. At night however, she was routinely noticed to come out and swim a lot in the middle of the display, even crossing over and around the tunnel. It was also noted that when the dissolved oxygen was elevated over 100% her behavior and swimming greatly improved. An elevated D.O. was possible by using a total dissolved gas meter to ensure gas bubble disease was not a problem. The shark would have benefited greatly if a D.O. of 105%-110% could have been maintained on a constant basis.

Problems:

By swimming the back perimeter wall the shark began to develop abrasions on her pectoral fins and her mandible. As noticed previously this behavior is somewhat common and frequently leads to pathogen entry (Crow and Hewitt, 1998). These abrasions were successfully treated with enrofloxacin (Baytril) orally in food at an original dose of 10 mg/kg every other day for three treatments, and then later treatments at 5 mg/kg daily for five days. These abrasions routinely reappeared due to the rubbing, but were all treated with enrofloxacin and improved.

The only other medication used for these abrasions was an oral treatment for ten days of trimethoprim and sulfadiazine (Di-Trim) at a dose of 10 mg/kg. Di-Trim was used so that a resistance would not build up towards enrofloxacin, and also the shark's swimming became very sluggish. By the sixth day of this treatment there was a marked improvement in the animal's swimming and her appetite greatly increased.

Observations:

Initially the diet was 3.4 kg of blue runner *(Caranx crysos)* and mackerel, fed weekly in two feedings, but that was periodically increased as the shark grew. The food was supplemented with Mazuri shark and ray multi-vitamins, at a dose of one tablet per half pound of food.

During this time frame the shark was very inquisitive, and would always come over to investigate divers while they were in the water. The shark never exhibited any aggressive behavior. Baffles and bumpers were used to try to modify the tiger shark's swim pattern, but none of these worked for very long. A curtain of air bubbles was even tried along the back wall, which kept her away for about two days, but then later she began to swim in and out of the bubbles unaffected. The shark continued to do well in this environment, with the exception of the occasional skin abrasions, until February of 1996, when a white cottony fungus was noticed on the lower section of the caudal fin.

Fungal infection:

The fungal infection was believed to be of the genus *Fusarium* (Stoskopf, 1993). Along with the fungal infection a decline in the shark's swimming behavior was observed, as she began swimming with her tail slouched downwards. Skin abrasions were also noticed in conjunction with the fungus, so enrofloxacin was again prescribed to prevent any secondary infections. Again the enrofloxacin was effective against the skin abrasions, but as expected did nothing to combat the fungus. By April 13 the fungal infection had worsened with the area on the caudal fin getting larger, and the appearance of the fungal infection spreading to the abraded margins of the pectoral fins. A treatment of ketaconizol at a dose of 5 mg/kg was given daily for 41 days orally in the food. During this treatment the affected areas seemed to reduce greatly in size, and disappear completely from the pectoral fins. In addition to the visual decrease in size of the affected area, the shark also began to display greatly improved swimming behavior and an increased appetite.

New diet:

On June 1 it was decided to greatly increase the shark's food intake, because she was starting to look quite thin and was clearly expending more caloric energy than she was bringing in. Food intake was increased to 6.3 kg per week, and later 7.6 kg per week, in daily feedings. The diet was supplemented with 100 mg vitamin B1, 400 IU vitamin E, and ten to fifteen fish oil gel tabs daily, in addition to the normal Mazuri vitamins, to improve the nutritional and energy content. This improved feeding regiment was used for about a month with remarkable success. The shark filled out in size and her swimming improved greatly, with the most noted improvement being less tail drag swimming. At this point the shark appeared healthier than she had ever looked, with the exception of the remnants of the fungal infection on her caudal fin.

Complications:

On July 2 however, this all took a drastic change for the worse. The shark exhibited very labored and exaggerated tail dragging, with frequent periods where she would stop and sink to the bottom, then she would gill very hard for a short while and get back up and repeat the cycle. After observing this a few times, the shark was caught up in a stretcher and brought to the surface. Blood was drawn and there was an attempt to get a fungal scrape, which later showed no results. As precautionary measures, injections of amikacin and later rocephin (50 mg/kg) were administered. During this procedure the shark vomited. She did not actively swim by herself after this, and after failed attempts to swim start her, she was moved to the reserve tank where ram ventilation was possible on the effluent return of the display pumps. The ram ventilation process lasted about two hours until she regained enough energy to be re-released into the display. Once back in the display the shark seemed somewhat lethargic, but was managing to swim all right.

Hypothesis:

The first probable cause that was examined was a *Vibrio carchariae* (Stoskopf, 1993) infection due to the manner in which she was seeming to have equilibrium problems and how the shark repeatedly crashed to the bottom of the exhibit. Secondly, was the thought that this might be a complication of the fungal infection becoming systemic. And thirdly, the question arose of a possible vitamin overdose from the increased feeding schedule.

Treatment:

The director and the veterinary staff decided to address the possible *Vibrio* infection first, and began an IM treatment with rocephin at a dose of 50 mg/kg given with a pole syringe daily for seven days. These rocephin injections frequently caused the shark to stall and roll violently then sink to the bottom, and then take off again normally. This seven-day treatment was given twice with very little noticeable improvement.

By August 5 there was no significant improvement, and the shark had basically quit eating during this period. Attempts to treat the fungal infection were thus totally ineffective. A second type of treatment was administered at this time to combat the possible *Vibrio* infection. Florfenical was applied at a dose of 20 mg/kg with an IM injection via pole syringe for five consecutive days. Again nominal improvement was noticed.

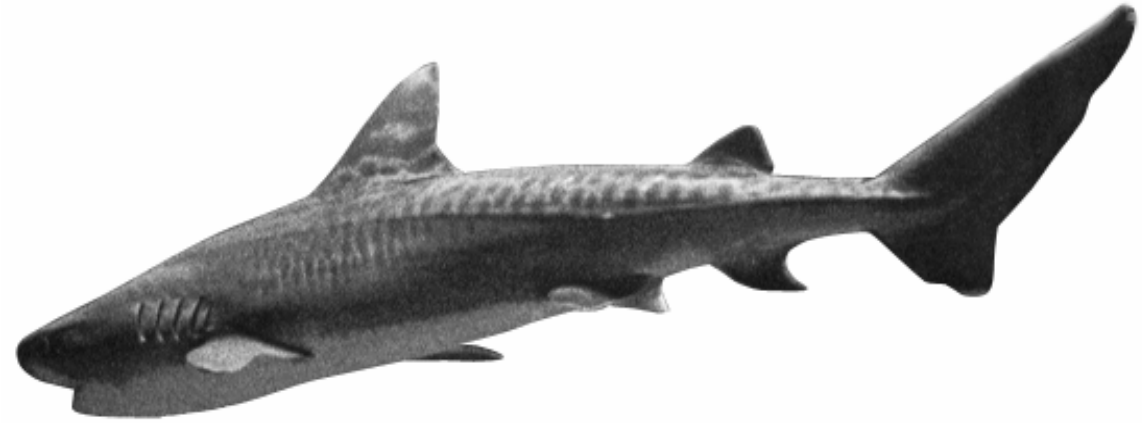
Further complications:

On August 22 the shark was seen on the bottom of the tank struggling to get up and swim. Again she was caught up and blood samples were taken and she was treated with enrofloxacin. She was moved to the back holding area once again to be ram ventilated. Several attempts were made to tube feed the shark, but she vomited the food within a half-hour of each feeding. The shark was held in the back over strong current for over 48 hours when the decision was made to euthanize her, due to the decrease in her activity and her lack of responsiveness.

Necropsy results:

Initial necropsy revealed a large fold in the posterior section of the stomach, with multiple gastric ulcers, which did not perforate the stomach. Multiple mucosal ulcerations were also noticed around the entrance to the spiral valve. Many of the ulcers were quite large.

Upon histopathology, large numbers of fungal hyphae were found in the gastric lesions and in multiple blood vessels. No lesions were found on the brain or spinal cord, and no fungal or bacterial organisms were isolated from the cerebrospinal fluid.



Conclusion:

At the time of the tiger shark's death, her total length was 241 cm with an estimated weight of 100 kg, which was far less than she had been a month before. Based upon necropsy results, the hypotheses for these events were primarily that the fungal infection led to the initial crash of the shark. During the time of this first episode the shark vomited while being restrained, and it is believed that this could have caused the stomach to fold on itself after being everted. It is

thought that this fold caused, or complicated, the ulcerations. From this point, due to lack of eating from these complications, the shark was severely compromised and became weaker. Vibrio infection was thus ruled out due to the lack of bacterial or viral organisms in the cerebrospinal fluid. Even though vitamin overdose could not be totally ruled out, it was considered to be not a factor due to normal blood values. Although the fungal infection was not fully eliminated with the treatment, it is believed that clinically, it greatly improved the external infection as well as improved the swimming and feeding behavior of the shark.

The staff at the Henry Doorly Zoo firmly believes that tiger sharks can be kept successfully in captivity. Currently, Atlantis Resort in Nassau, Bahamas has had one for approximately two and a half years. Evidence observed at the Henry Doorly Zoo and information obtained from consulting with other facilities that have kept tiger sharks, points to the benefits of obtaining these animals at a small size of about 122 cm. It also appears that there is advantage to keeping these animals in displays with uneven rockwork on the walls, rather than smooth surfaces. Another important factor is an increased diet, because these sharks tend to exhibit binge and starve eating behaviors. Although this shark is a very difficult species to maintain, the future looks hopeful for long-term captivity of the tiger shark, *Galeocerdo cuvier*.

References:

Stoskopf, Michael K. Fish Medicine. Philadelphia, PA, W.B. Saunders Company, 1993.

AQUATIC INVERTEBRATE TAG ANNOUNCEMENT

Institutional Representative Appointment Forms were mailed to AZA facilities' directors in December 1997. Those interested in their organizations being represented on the TAG were asked to appoint a representative. In the event that the occasional form may have been mislaid, you might wish to make a gentle inquiry to the appropriate person in your organization. Contact me should you have questions regarding the AITAG. Warren Pryor (Fort Wayne Children's Zoo, 219/427-6807)

SHARK MYTHS - A PROBLEM FOR MARINE EDUCATION.

Gordon S. Croft, Displays Curator

St. Andrews Sea Life Centre, The Scores, St. Andrews, Fife, Scotland, UK

Most people would agree that music has and incredible ability to stimulate a huge variety of emotions, ranging from acute sadness to joyful rapture. There are however a few bars of a well-known film score which has the ability, almost without exception, to strike fear into the hearts of most people. It is probably on a par with the "shower scene" clip from Hitchcock's "Psycho" - it is of course the first few notes of "Jaws". This is quite an incredibly powerful piece of music and although appears simple it has the ability to render the listener almost breathless with terror.

The unfortunate long-term result of the phenomenal box office success of this film has been an overall massive negative portrayal of shark imagery in an almost global basis, and this problem is one in which we as marine educators have a constant battle with trying to persuade members of the public to accept the truth rather than Hollywood generated stereotypes.

As the (Sea Life) Centre here in St. Andrews we keep four species of shark native to the waters around our coasts. The Common Dogfish, *Scyliorhinus canicula,* grows to around 75 centimetres in length, the Greater-spotted Dogfish, *Scyliorhinus stellaris* grows to 1.25 metres, and our two Smooth-hound species, *Mustelus asterias* and *M. mustelus* are no longer than around 80 centimetres. It is obvious from this then that we do not keep anything approaching the size (or apparent temperament!) of our friend *Carchardon carcharias*. Unfortunately however, we are continually besieged by an army of people demanding to know where the "sharks" are. The reaction given upon being told that our specimens are in fact sharks ranges from surprise to outright disbelief. Several years ago I spoke to a woman from California who emphatically stated to me that our species could not possibly be sharks as she came from a country where (and I quote) "sharks eat people all the time and are much larger than these". No earthly amount of explaining by myself would sway her from her convictions, and she marched off, happy that her perception of the Jaws mythos remained irrevocably intact.

Why do we encounter this problem? Are we alone in this country with regard to this failing by members of the general public to accept the scientific truth? Over the years we have armed ourselves with statistics which emphasize the benign side of sharks, such as the fact that 300 people die in the UK every day from smoking related diseases, which equates to around ten times the number of people killed annually by sharks, and the fact that only around 20% of living sharks attain a body length in excess of two metres. On a more positive side many people *do* accept what we tell them and go away with a more realistic image, but there are still many people who are content with their media generated preconceptions. Even as I type this I can hear several people at our reception area who are studying the Talks Programme board and are whispering the words "shark talk" in a state bordering on almost reverential awe. Sharks are blessed by 400 million years of evolution which has honed them into apex predators unrivaled in marine ecosystems, but the trade off has been to be cursed by an appearance which is perceived by the lay person as being not "cuddly". There is global condemnation of the ivory trade yet any eradication

programme initiated against sharks can go largely unchallenged. If this state of affairs is left unchecked and uncontrolled it is ultimately ourselves who will pay the price in marine ecological catastrophe. It is our job as marine biologists to *educate* people into the importance of all marine organisms, not just sharks, and especially target children who will ultimately be left to cope with our mistakes.

It's R.A.W.!

The twelfth Regional Aquatics Workshop (R.A.W.) will be held at the Texas State Aquarium this coming April 8 through 11, 1998. We'll kick off on Wednesday evening April 8 with an ice breaker at the Aquarium.

As always, there will be presentations and round table discussions. Topics will include: parasitology, marine fish propagation, acquisition and disposition of specimens, conservation issues, husbandry techniques, etc.

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There is no registration fee, lodging at the Sandy Shores Beach Hotel is a very reasonable $55 per night, and transportation to and from the airport can be arranged. The hotel is within walking distance of the aquarium and the USS Lexington Museum. Please join us for this terrific opportunity to exchange ideas, information, and fellowship with your peers.

Our tentative schedule is as follows:

Wednesday, April 8, 1998 ……. 6:30 PM ICE BREAKER AT THE AQUARIUM

Thursday, April 9, 1998 ……AM PAPER SESSIONS
LUNCH AT THE HOTEL
PM PAPER SESSIONS
DINNER ON YOUR OWN
Friday, April 10, 1998…….AM PAPER SESSIONS
LUNCH AT THE HOTEL
PM PAPER SESSIONS
BARBEQUE/COCKTAILS

Saturday, April 11, 1998……FIG AND TAG MEETINGS

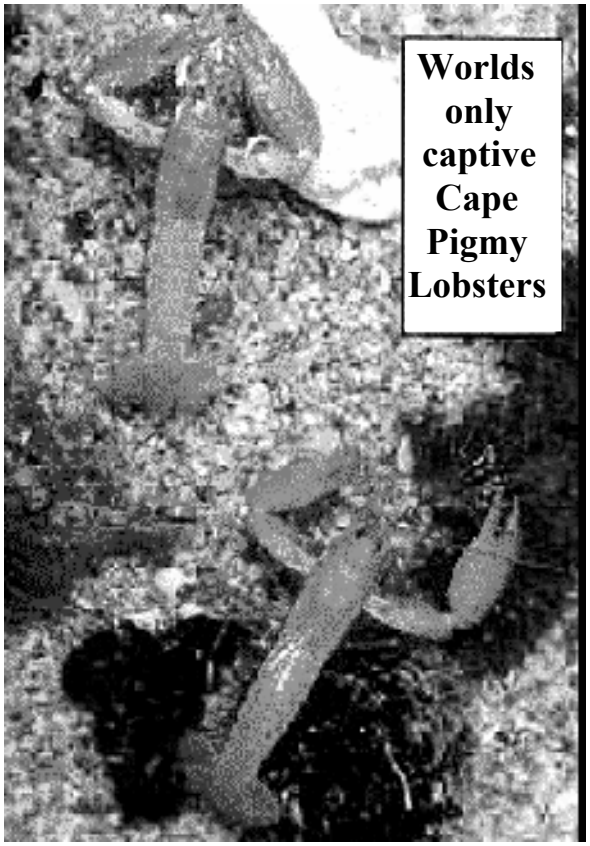
For more information contact Chuck Smith (512) 881-1218 or Tom Schmid (512) 881-1256. Fax: (512) 881-1257.

THE STORY OF THE CAPE PIGMY CLAWED LOBSTER *(HOMARUS* CAPENSIS)*

Willie Maritz, Curator

East London Aquarium, South Africa

Homarus capensis was described way back in 1792. It is related to the American clawed lobster *Homarus americanus* and the European clawed lobster *Homarus gammarus*. Both these species are being exploited extensively on a commercial basis. *H. capensis* is known to occur along a 900km stretch of coastline between Dassen Island near Cape Town and Haga Haga near East London. The species is regarded as being extremely rare, and most of the specimens were regurgitated by fish when caught on hook and line. During the first 200 years after being described, (1792; 1992) only 14 specimens were known to exist in scientific collections worldwide. (13 males and 1 female).



During 1992 a live specimen was found at Dassen Island, and a dead one was found near East London. The publicity generated by these finds resulted in a couple more reported. During April and May 1997 three live specimens washed up near East London, apparently dead. The lobsters were revived in rockpools and taken to the East London Aquarium, where they were placed in a suitable quarantine tank. The two males and one female have adapted well to tank life, are eating well and like to burrow in the gravel next to rocks. Like the American and European cousins, the Cape pygmy clawed lobster has differentiated knippers; a sharp cutter, and a crusher.

We are proud to say that we have the only Cape pigmy clawed lobsters in captivity in the world. Imagine if we manage to breed these elusive creatures! A 20 minute video of *H. capensis* moving about in a rock pool is obtainable from: FELA, P.O. Box 984, East London, 5200 South Africa at a cost of $US 30 plus postage.

About the Aquarium *(condensed from http://196.7.177.40/ela/)* **:**

East London is situated on the Southeast coast of South Africa between the former homelands of the Transkei and the Ciskei. The Aquarium was officially opened on the 2nd of December 1931, which makes it the oldest public aquarium in the country. The aquarium plays an active role in conserving the coastline and the estuaries in the local area. Our marine animal rehabilitation program treats and releases hundreds of seals, penguins, gannets and other seabirds, turtles and dolphins. The Friends of the East London Aquarium are raising funds for the establishment of a new marine mammal treatment facility at the aquarium.

The aquarium is the only source for marine biological information in the area. It is unthinkable, but true, that 90% of the largely rural local population have never seen a seal, penguin or live fish! The aquarium plays a vital role in educating the left-behind sector of the community in all maters relating to the ocean and it's conservation.

[* Editors note: Stan Cobb of the University of Rhode Island notes that the genus name has recently been changed to *Homarinus* for this lobster.]

Information regarding the symposium can be accessed electronically at the following web site:

http://research.umbc.edu/~tankersl/sympos

The Columbus Zoo, the Ohio Biological Survey, and the Ohio Division of Wildlife are hosting a special symposium on the propagation of freshwater unionid mussels. The purpose of the meeting is to provide a forum for the discussion and dissemination of information on the rearing, maintenance and long-term care of juvenile and adult mussel populations under artificial conditions. Registration and hotel information can be accessed electronically at the web site listed
above, or you may contact Doug Warmolts at the Columbus Zoo via e-mail (dwarmolt@colszoo.org) or phone [(614) 645-3524 (FAX: 614-645-3465)] for a copy by mail.

CURAÇAO SEAQUARIUM INITIATES DEEP-REEF EXPLORATION PROGRAM

Paul Hoetjes, Curator

Curaçao Seaquarium, Netherlands Antilles

The Curaçao Sea Aquarium is located on the island of Curaçao, one of the Dutch Caribbean islands in the southern Caribbean just off the north coast of Venezuela. It opened in 1984 with over 40 aquaria ranging in size between 300 and 2500 gallons, plus a number of outdoor pools and basins. A few years ago a lagoon-sized body of water was enclosed and now houses our "Animal Encounter" where divers can go down with a guide to swim among and feed many of the fishes ranging from tarpons and stingrays to angelfish, grunts and doctor fish. Behind a wire fence, 7-8 feet lemon sharks and nurse sharks are housed which can also be fed by the divers through holes in large acrylic windows, a unique yet safe experience. The Curaçao Sea Aquarium features what is probably the world's largest live collection of exclusively Wider Caribbean Area species, including a large collection of invertebrates ranging from sponges and corals to sea-cucumbers and crinoids. The aquaria are constantly supplied with unfiltered natural seawater drawn right off a lush coral reef directly in front of the Curaçao Sea Aquarium, from a depth of 20 ft. Natural sunlight provides lighting for the aquaria.

Last year we started a deep-reef exploration program, hoping to collect rare, and possibly even new, species for the aquaria.

It all started with a video of an unknown fish—unknown to us here at the Curaçao Seaquarium that is. The video was taken during a routine collecting dive in search of the colorful but exclusive candy basslets *(Liopropoma carmabi)* and threeline basslets *(Lipogramma trilineatum)*. Well…, not exactly routine of course at 220 feet deep; the dive had been very carefully planned. Gordy Cox, underwater photographer at the Curaçao Seaquarium, had gone along to film the collecting. During that dive he suddenly noticed an unusual fish and he followed it with his camera. After the dive, when he showed us the video, I knew right away that I had never before seen this fish. It was definitely one of the small basses *(Serraninae)*. It behaved more or less like a tobaccofish, swimming along just off the bottom; its color pattern reminded me of the harlequin bass, however, it was neither of those fish. It was time to start digging in the literature.

Below 200 feet

It tured out to be a walleye basslet *(Serranus luciopercanus),* which had been recorded on Curaçao in 1963 by John Randall, who collected several dead specimens below 200 feet. So, although it was not an unknown fish, it had rarely, if ever, been collected alive. This got our attention. It made us realize that there were more fish down there, below safe diving depths, that we did not know yet. Practically nothing was known about the deep reef environment below 200 feet. Some fish and invertebrates from those depths were known from specimens brought up by dredging nets, and I found a few reports of deep-reef observations from submersibles. What little was known about it was tantalizing though. A number of small but very beautiful basslets, related to the well known fairy basslet *(Gramma loreto)* were known to live at those depths. Those would be perfect for an aquarium!

"Dutch" Schrier, the director of the Curaçao Seaquarium, right then decided to embark on an exploration program of this deep reef. After all, he reasoned, Curaçao is the ideal spot for it, rising steeply from the deep sea bottom more than 5000 feet down. Right in front of the Curaçao Seaquarium, not 200 yards from the shore, the bottom drops precipitously to great depths, in a series of vertical drop-offs and very narrow ledges.

Deep Diving

Of course there were some minor problems with exploring the deep reef, such as the fact that below 200 ft nitrogen narcosis is so strong as to be almost debilitating for most people. A little deeper and the oxygen in SCUBA tanks filled with normal air starts becoming poisonous, and at 280-300 ft the normally life-giving oxygen can cause convulsions and death. Plus of course that at those depths with each breath you take you suck in some five gallons of air, making short work of a standard air tank containing some 500 gallons of air. That means 100 breaths, or not very long. Coming right up from those depths, even after staying only 5 minutes or so, would cause your blood to actually start foaming in your veins and arteries and you would be quite dead. In short, there is a reason why even reckless divers don't go much deeper than 200 feet.

But then there is a way to avoid these problems. It is variously known as tri-mix or heliox diving. The SCUBA tanks are not filled with ordinary air, but with mixtures of oxygen, helium, and nitrogen, specially designed for those depths. And there are more courses to train divers to safely use these techniques, although there is always risk in descending to these depths.

A team of divers was formed and trained by Billy Dean, a well known and highly qualified technical diving instructor from Florida. The team included two fish collectors, "Dutch" himself with more than 20 years collecting experience, and Arjan Siersma, dive instructor and manager of the Curaçao Seaquarium's Animal Encounters operation. Kees van Bueren and Rocklin Spenser joined the team as safety and support divers to help out with the up to four tanks per diver needed for the required two to three hours decompression time after a twenty minute dive. It was my job as curator of the Curaçao Seaquarium to identify the specimens brought up by the divers and to compile their data into a report. Now everything was ready to start going down as deep as 350 feet.

Fish Decompression Chamber

There was one more problem to solve. When you bring up fish collected in deep water, they too need decompression just like people, only much longer since they have not spent only a short time at those depths, but their whole lives. We constructed a special fish decompression chamber. The fish can be put into this container at say 300 feet and then be brought up to the surface while remaining under the same pressure! Once close to the surface, pressure can be gradually reduced. The whole process can take up to two days.

Finally after some three months of preparation, the team could really start diving. The results were not disappointing. Within a month we had not only a live walleye basslet swimming in the aquarium, but half a dozen other fishes never before recorded in Curaçao, including two species that had never before been brought up alive anywhere before. The pugnose basslet *(Bullisichthys caribbaeus)* had until then only been known from a handful of dead specimens

brought up by trawl nets. The very attractive banded basslet *(Lipogramma evides),* with its striking black and white bands had only been collected in the Northern parts of the Caribbean by submersibles at depths greater than 350 feet. They can now be seen in our aquarium together with the red hogfish *(Decodon puellaris),* Spanish flag *(Gonioplectrus hispanus), Parasphyraenops incisus* (no common name), bicolor basslets *(Lipogramma klayi),* ridgeback basslets *(Lioproma mowbrayi),* and yellowtail chromis *(Chromis enchrysura)* to name some og the other deep reef fishes collected.

New Fish Species

To top it all, the dive team collected a number of gorgeous gobies that turned out to represent a new species. Although this fish was not completely unknown—it had been observed and collected from a submersible some twenty years before—it had never been officially named and described. Dr. Patrick L. Colin had collected it in the seventies in the Bahamas and Puerto Rico. He gave the specimens to the well known fish expert Dr. James Böhlke to be described. Regretfully, Dr. Böhlke died before he could do so and the specimens remained shelved and forgotten for he next twenty years, although they went from one fish specialist to another. So now, after twenty years, our dive team had rediscovered the fish and brought a number of them up alive, which are at the moment swimming around in our aquarium. Together with Colombian fish expert Dr. Arturo Acero, now at the University of Arizona, I am in the process of preparing a scientific description of this fish as well as giving it a Latin name. For now we are referring to it by the English name "saber goby", bestowed on it by Dr. Colin twenty years ago.

Meanwhile our dive team is still going down regularly and we expect to find more new species as they explore more localities. Their findings, including deep reef gorgonians lobsters and other animals, are on display at the Curaçao Seaquarium, one of the very few public aquariums in the world where deep reef species can be seen.

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AQUATIC SPECIMEN ACQUISITION AND INVENTORY METHODS: A SURVEY OF AZA ACCREDITED ZOOS AND AQUARIUMS

Jay Hemdal, Curator of Fishes

The Toledo Zoo

Abstract

A survey of AZA accredited public aquarium facilities in the United States was undertaken in an attempt to identify current methods and future trends in aquatic specimen acquisition and inventory methods.

Methods

The curators (or equivalent staff members) of the fifty largest AZA accredited institutions housing fishes and invertebrates were mailed surveys. Non-accredited aquariums and those outside the United States were not polled. 32 facilities responded to the first mailing, 7 to a second reminder, for a total response of 78%. The survey consisted of seven questions about specimen acquisition methods and inventory protocols. The query was designed so that a curator, senior aquarist, or director of husbandry could answer the questions, without additional research, in under ten minutes.

Results

The surveys were mailed out on September 27, 1996. Long, complicated surveys obviously have a lower rate of return than do shorter ones such as this. Survey returns dropped to zero a month after the first mailing took place. A second, reminder mailing resulted in a few more responses. Not used in this report were two responses that arrived more than 3 months after the deadline for the second mailing. Another response (also not included) arrived from a non-AZA facility to which no survey had been sent. Of the 11 individuals who did not respond to either mailing, three were later determined to have left the employ of the facility to which the survey had been mailed.

Table #1 - Commercial livestock dealers utilized during the past year

Type of firm	Reported number	
Local wholesale firms:	**25**	**(64%)**
Scientific supply Co.:	**21**	**(54%)**
Free-lance US collectors:	**26**	**(67%)**
Retail pet stores:	**25**	**(64%)**
Transship service:	**5**	**(13%)**
National wholesale:	**24**	**(62%)**
Direct from overseas:	**3**	**(8%)**
Aquaculture firm:	**16**	**(41%)**

Table 1 outlines the categories of commercial livestock dealers reported to have been utilized during the past year. As expected, all respondents had purchased specimens from either a national or local wholesale firm, or both. Direct importation from overseas was the least common commercial source for livestock, used by only 8% of the respondents.

Table 2 lists those national dealers reported to have supplied specimens in the past year to more than 5% of the institutions surveyed.

Table 3 reports non-commercial sources for livestock utilized during the past year. Donations of specimens from private

individuals were reported to have been accepted by 87% of the respondents. Trades and donations with other AZA facilities were clearly the second most often used type of non-commercial transactions.

Table #2 - Dealers reported to be supplying specimens to more than 5% of the institutions surveyed		
Name of firm	Reported number	
Dynasty Marine:	**11**	**(28%)**
Quality Marine:	**11**	**(28%)**
Reef Displays:	**7**	**(18%)**
Beldt's Aquarium:	**7**	**(18%)**
JCA Int.:	**7**	**(18%)**
Gulf Specimen Co.:	**6**	**(15%)**
Sea Critters:	**6**	**(15%)**
Aqua Marines:	**4**	**(10%)**
Seacology:	**4**	**(10%)**
Segrest Farms:	**3**	**(8%)**

Table 4 lists the reported inventory control methods for both fishes and invertebrates. Some facilities employed more than one method. Flat field databases written in-house were used by the majority of aquariums(54%). A simple pen and paper tally was used by 41% of the institutions. The only difference between the fish and invertebrate inventory methods was the lack of use of the SIMS and ARKS3 software in the latter case.

Seven facilities (18%) reported that they have a formal dealer review process in place. Of the aquariums reporting that they have no formal review process, 10% indicated that they are planning to implement such a process in the future. Therefore, 72% of the facilities polled do not expect to use a formal screening process for their aquatic livestock dealers.

Table #3 - Non-commercial sources of livestock utilized		
Specimen source	Reported number	
Trade with other AZA facilities:	**26**	**(67%)**
Purchase from AZA facilities:	**17**	**(44%)**
Donations from AZA facilities:	**26**	**(67%)**
Donations from private individuals:	**34**	**(87%)**
Collect own specimens:	**29**	**(74%)**
Captive bred at own facility:	**32**	**(82%)**
State FWS:	**2**	**(5%)**
USFWS:	**3**	**(8%)**
Non-AZA aquariums:	**1**	**(3%)**

Discussion

Virtually every conceivable source of livestock was reported to be utilized to one degree or another. Specimen cost did not seem to be the main criteria for choosing one type of supply over another. Trans-ship services and direct importation offer specimens at the lowest cost, but were the least often used. The most common method of acquiring animals were through "cash and carry" sources; local wholesalers and retail pet stores. In these cases, the specimens cost more, but the aquarist has the luxury of being able to "hand select" the specimens. Between these two extremes was the utilization of national suppliers, where the shipper selects the specimens to be sent. In this instance, the facility relies on the expertise of the dealer to supply them with high quality specimens.

There was surprisingly little variation in the national firms reported being used to supply specimens to aquariums. This may again be a factor of quality rather than lower cost. The company names listed do not necessarily constitute an endorsement by the surveyed aquariums.

The survey did not ask if the facility was pleased with a dealer, only which ones were being utilized.

A wide variety of non-commercial sources of specimens were utilized. Purchases from other aquariums was a less common practice than were trades and donations. This indicates that most aquariums understand what zoos have long known, that by cooperatively sharing specimens, everyone benefits. An aquarium which will only relinquish their surplus specimens by selling them at a premium price soon discovers that other aquariums will no longer be inclined to trade or donate animals with them.

Table 4. Fish and Invertebrate Inventory Methods

Fish inventory methods

# used	System used	# planning to change
2(5%)	ARKS2	1
2 (5%)	ARKS3	1
2 (5%)	AQUAPRO	1
1 (3%)	SIMS	1
21 (54%)	Own database	5
7 (18%)	Spreadsheet	4
16 (41%)	Pen / paper	10

Invertebrate inventory methods

# used	System used	# planning to change
2 (5%)	ARKS2	1
2 (5%)	AQUAPRO	1
21 (54%)	Own database	5
7 (18%)	Spreadsheet	4
16 (41%)	Pen / paper	10

When considering all the various sources for livestock which were reported in this survey, one must bear in mind that this data only reports the number of facilities using the various methods and not the degree upon which they rely on that source. For example, 87% of the facilities reported accepting donations of animals from private individuals. It is doubtful that the quantity of animals acquired in this manner ever approaches the number of specimens acquired through purchases from dealers, self-collected or are captive bred.

A relatively new term in aquariums is the "dealer review" or "dealer reference" process. Already adopted by many zoos, these various protocols attempt to insure that all animal transactions with which a facility becomes involved are with more ethical companies. Over 70% of the responding aquariums indicated that not only did they not utilize a formal dealer review process but that they were not planning on doing so in the future. All of the aquariums which utilize a review process were "zoo-aquariums". The use of these protocols for fish was most likely a "trickle-down" from their zoo's mammal and bird departments. Those aquariums already using a review process know that getting approval prior to purchasing livestock from a dealer takes quite a bit of extra time and effort. As a result of these efforts, they do know more about the dealers they are purchasing their animals from, and may have identified other dealers which do not meet their standards. On the other hand, the aquarist who is required to complete a dealer profile in order to acquire specimens from a new company may "lose out" on rare specimens that are more rapidly acquired by private individuals or aquariums which do not utilize such a protocol.

The survey showed there is a very strong tendency for aquariums to use a single inventory system for both their fish and invertebrates. There was also a strong degree of loyalty to the "own database" category. It may be that many of these facilities developed their own custom databases, and are now loathe to give them up. Where as ARKS (Animal Record Keeping System) is the

standard computer inventory system for zoological collections, it has not yet been wholly embraced by the aquarium community. Part of this may be a result of older versions of ARKS not being able to handle invertebrates collections as it can with fishes.

Perhaps the single most important issue shown by this survey was the lack of an inter-connected specimen inventory system between aquariums. While a zoo can utilize ISIS abstracts to identify other facilities housing a particular species of mammal, reptile or bird, aquariums have no similar resource. In fact, some aquariums which use a pen and paper census of their animals once a year cannot (except for at that time) produce an accurate specimen inventory at all. As SSP's continue to be developed for fishes and invertebrates, better aquarium inventory methods will become mandatory.

SEAHORSE PROPAGATION UPDATE

The seahorse propagation program here at the Birch Aquarium at Scripps has been a tremendous success since its initiation back in November of 1995. Our seahorses, specifically the giant seahorse, *Hippocampus ingens*, are found in our local waters and as far south as South America. The *H. ingens* have currently found new homes at the Monterey Bay Aquarium, Sea World of California, Chula Vista Nature Center, Vancouver Aquarium, Steinhart Aquarium, and the Berlin Zoo. Future destinations include the Long Beach Aquarium of the Pacific, Seattle Aquarium, and the Dallas World Aquarium.

In addition to the *H. ingens*, other species of seahorses have been raised. The *Hippocampus kuda* has shared equal breeding successes. This particular species is found in the warmer tropical waters of the Pacific Ocean. The *H. kuda* have been sent to the Waikiki Aquarium and Texas State Aquarium.

Our big-bellied seahorses, *Hippocampus abdominalis*, have been giving birth to healthy babies since October of 1997. These babies have eaten enriched brine shrimp nauplii since leaving their father's pouch. The *H. abdominalis* are found in the cooler waters of Australia.

Feeding the young seahorses is a delicate task. Newly born seahorses, with the exception of the *H. abdominalis*, have been fed rotifers and green algae water. As the seahorses continue to grow, enriched day-old brine shrimp nauplii is fed along with the rotifers and green algae water. This feeding combination of rotifers, green algae water, and enriched day-old nauplii allows for a smooth transition into feeding the enriched nauplii. Smaller juveniles will continue to feed on the enriched brine shrimp nauplii. Larger juveniles feed on live copepods. The adults feed on live mysid shrimp that are collected by the aquarists on a weekly basis at various locations. Adults also feed on enriched live adult brine shrimp. Our enrichment source comes from adding Selco nutritional additives directly to the nauplii cultures. Adult brine are kept in a large bucket under heavy aeration with Selco additions prior to feeding.

Aside from raising the seahorses, studies on the gas bubble disease and supersaturation within seahorses are also being conducted. Our work on the seahorse propagation as well as other efforts will continue to support conservation and ensure a promising future for the animals here at the Birch Aquarium at Scripps.

Julie Wang, Student Aquarist
Birch Aquarium / Scripps Inst. Oceanog.

A NEW AQUARIUM IN THE NORWEGIAN FORESTRY MUSEUM WITH FOCUS ON SPREADING OF UNWANTED FISH SPECIES IN NORWAY

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(Presented at: EUAC [European Union of Aquarium Curators] MEETING AT BASEL, SWITZERLAND, OCTOBER 18-21, 1997)

The importance of zoological gardens and public aquaria as interpretation and research institutions has gradually changed character during the last years. Showing as many species as possible form all over the world has become of more secondary importance, compared to exhibiting typical representatives of the species. Even more important is to help species that are threatened by extermination through research and breeding programs by re-introduction into areas where the species is threatened or extinct, but where its existence is still a possibility.

Interpretation of knowledge of this activity has been of ever-increasing importance, and the collaboration between the institutions who participate in such activities considerably strengthened. In this connection EUAC (European Union of Aquarium Curators) plays a major part.

Those of us working at a small aquarium like the one at the Norwegian Forestry museum have also realized our responsibility and found a platform in interpretation of knowledge, where we, by pinpointing the unwanted effects caused by human activities within the scope of our job, can create a better attitude and understanding in these issues. As a part of a larger national museum within forestry, hunting and fishing it is not possible within the aquarium to show more than 25 of the 42 total species that are recorded in our watercourses. The chosen species reflect the occurrence of them in nature, regarding both the practical and biological problems with keeping these species in captivity.

However, we have close collaboration with the veterinary authorities by making fish available for their research activities, as well as with other research institutions and management agencies in this sector.

A very important task is to focus on the fish as a resource and its exploitation, and also interpret knowledge about its immigration history, distribution and environmental demands. The maintenance of the balance in nature and the protection of the biological diversity has high priority all over the world. When this balance is changing, it is important to find the causes so that the balance if possible can be restored, or soften the extent of damage. This approach was the starting point for the building of an aquarium which was officially opened in connection with the Nordic Hunting and Fishing Festival August 7-10 this year (1997). This was brought about by a dispersal by humans of a freshwater organism which was thought to have a positive effect on the environment, but instead has become a serious threat against the biological diversity. However,

when an imported species is established in an environment, some effect will be the result. By being very conscientious when introducing species to a new environment, one may obtain the wanted effect, but in many cases the effect turns out to be a negative one and completely different from the one sought.

A condition for making an imported species a permanent member of the flora or fauna into which it is introduced is that it establishes itself and reproduces. Replacement and dispersal of Norwegian species into other parts of Norway has sometimes caused somewhat large effects on the local environment. The coast is long, and there are large areas with arctic and subarctic ecosystems where the diversity of species is low. The probability for imported and introduced species to be able to establish themselves is considered high in environments which are strongly influenced by humans and in some types of ecosystems poor in species.

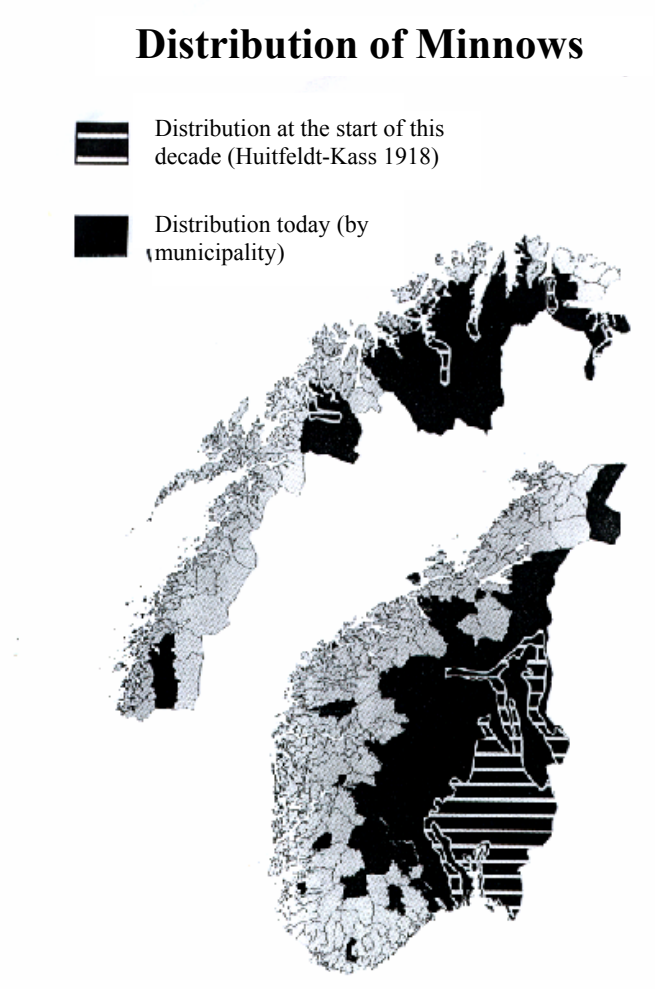
During the last hundred years humans have spread fish and other organisms to new areas in a steadily increasing tempo. Such spreading takes place both consciously and unconsciously. An example of conscious spreading is using fish as food for other fish. This happens with the best intentions, but can have catastrophic results.

Since the last Ice Age 10,000 years ago people have increased the dispersal of fish species in Norway in order to ensure the supply of food when settling in new areas. This has been done by moving fish from lakes rich in fish to lake with no fish at all, or by supplying the lakes with fry and roe from aquaculture activity. The official management has during the years also to a large extent taken part in this activity, mainly with salmon *(Salmo salar)* and trout *(Salmo trutta).*

Another way of spreading fish from one watercourse to another is by using living fish and small animals as bait. Transportation of water between watercourses can also have contributed to spreading of freshwater organisms and diseases. This can occur in connection with transport or import of fish and other aquarium organisms. Emptying aquaria into nature may spread unknown diseases which can survive on Norwegian species, and at the same time the aquarium organisms may establish themselves. The American water plant *Elodea canadensis* has in this way spread to the largest watercourses in Southern Norway where it causes overgrowth in some lakes.

The natural immigration of plants and animals in Norway after the last Ice Age started when the ice withdrew 10,000 years ago, and is still going on. Biological invasion is therefor common in nature and thus must in general not be thought of as abnormal or harmful. A consequence of this is, however, that it is important to prevent creation of new barriers for natural spreading, as well and establishing new ways of spreading.

Then to the problem species and the heart of the matter, the minnow *(Phoxinus phoxinus).* This species belongs to the carp family, and in Norway it reaches a maximum size of 12-15cm. It is distributed throughout greater parts of Europe and eastwards to Asia



At the turn of the century, the minnow had a limited distribution in lower-lying regions in the southeastern parts of Norway, and also in the northeastern part of the country (Troms and Finnmark). Today, the minnow is located in all our counties except for the most southern areas (Vest-Agder). The most extensive spreading of the minnow is in Eastern Norway up to Hardangervidda and larger parts of Western Norway. In the last few years the changes in spreading have been dramatic and are linked to human activities such as fishing with live bait, which in addition is strictly forbidden. In may lakes where the trout previously was the only fish species, there has been a decline in the trout stock after the minnow was introduced. many of the finest trout fishing lakes in Norway e.g. on the Hardangervidda are threatened - as are also the salmon watercourses of Western Norway. The risk of further spreading is impending, also because of fish being set out by people who still believe this will benefit the trout, or have mistaken it for trout fry. The result will be more or less the same. This hardy carp fish often eats the same food as the trout. It occurs in large shoals along the shore, and thus becomes a strong nutritional competitor to the young trout. In a brook the minnow can dominate completely, and thereby crowd out the trout from its spawning and growing areas. In addition, the minnow eats the fry and roe of the trout.

The challenges for the fish management are large in order to prevent further spreading of the minnow. An information campaign has been started, information material prepared and distributed, seminars and courses held for important interest groups all with the same objective: fighting down the minnow.

Having Norway's only special aquarium for freshwater species and 130,000 visitors a year, it was natural to involve ourselves in the endeavor to stop the spreading of the minnow. The Directorate for Nature Management, which has also been strongly engaged in this field, was contacted for a possible collaboration with the Norwegian Forestry Museum and the aquarium in this matter. Plans for building a special aquarium for minnows accompanied by relevant

information for the public were launched. NOK 55,000 (equivalent to 5500 pounds or $7500. U.S.) was after application immediately put at our disposal, equivalent to about 40% of the total costs of the project.

The aquarium (c. 2,500 litres) has the minnow as the only fish species, together with pondweed *(Elodea canadensis),* a plant commonly used in aquaria.

The information related to the aquarium tries to catch the visitors' attention by playing on the ignorance of the fisherman («Me - a criminal?») related to unconscious spreading of minnow by the use of living bait, or in connection with fish being put out in the areas where the species has not previously been established. Information about the minnow's biology, way of life and environmental demands is given, and to which extent it was spread by the turn of the century as compared to today. It is pointed out that it is easily mistaken for trout fry, but also that the difference is clearly seen as the trout fry has a fat fin and belongs to the salmon family, whereas the minnow lacks this special fin.

Visitors to the aquarium will also be informed on:

- How the minnow is spread, consciously or unconsciously
- That it is a treat against the trout stock
- about the consequence of uncontrolled import and moving of fish which will involve a transference of parasites and other fish diseases.

In that connection it is particularly focused on the salmon parasite *Gyrodactylus salaris* which came to Norway from Sweden through fish imports (smolt). Its spreading has increased dramatically by the dispersal of infected fish. About 38 Norwegian salmon watercourses are already strongly threatened, and some have been treated with the plant poison rotenone. Treated watercourses lie fallow for many years before a new fishable stock can be built up. The bacterial disease furunculosis *(Aeromonas salmonicida)* was introduced into the country after an import of rainbow trout *(Oncorhynchus mykiss)* in 1964. The tapeworm *Ligula intestinalis* is particularly common in minnows. It has its larval stadium inside the abdominal cavity of the fish until the abdominal wall bursts and the fish dies. The final hosts are birds, for instance seagulls or ducks.

In order to preserve the qualities found in Norwegian watercourses a set of rules has been prepared, whose aim first of all is to consider the fish and the ecological system it is a part of. The rules state clearly that fishing with living bait is strictly forbidden, that importing live fish, roe or fry is prohibited, and that the introduction of fish is generally forbidden without a special license in areas where the species is not established. The realization of the minnow project emphasizes the valuable collaboration between the Norwegian Forestry Museum and the authorities and research institutions. Through economical and professional support we have been able to give priority to this project, which we at the moment could not have done on our own. The need to bring out the information from the Directorate and the research institutions is large in many areas. We on our side have merging interests, in addition to a large and interested audience as well as professional knowledge which will benefit all parties

The Norwegian Forestry Museum and the aquarium has, by seeking collaborative partners in several areas, been able to benefit from external resources, and has thereby been able to realize some of the leading issues which most likely would not have been solved without this method of approach.

AIR: A SIMPLE SOLUTION

The Clearwater Marine Aquarium is a non-profit facility which rescues and rehabilitates sick and injured marine mammals, sea turtles, and otters. We frequently care for green sea turtles *(Chelonia mydas)* afflicted with the papilloma virus, which manifests in large, cauliflower-like tumors in the turtles' soft tissues. Because papillomas are very contagious, these turtles must be kept in a quarantine area which consists of three, 250-gallon tanks, each capable of housing four or five 10 pound turtles.

A problem arose from having this number of sea turtles in a relatively small space. To maintain water quality, we initially backwashed and changed 75% of the water in each tank five times a week. The makeup water was chlorinated saltwater with a free chlorine level of 0.3 and a total of 0.6. The water in each tank was recirculated at 60 gpm.

Unfortunately, even after conducting these procedures, after 4 weeks, the tanks turned cloudy and emitted a strong odor. To combat these problem, we manually rinsed the sand pressure filter with freshwater every four weeks, then added 2½ gallons of chlorine to soak in the filter for three hours before being backwashed. This procedure would temporarily correct the problem, but the odor still reoccurred in four weeks. What appeared to be happening was that the filter was going completely anaerobic We thought of two possible solutions: we could either maintain a higher chlorine level, or we could aerate the filter.

Our choice was to raise the dissolved oxygen level primarily in the filter by aeration. We did this by adding an air valve to the suction side of the recirculating pump. Our goal was to allow a small yet steady volume of air to be taken up by the suction pipe and become agitated by the pump without causing undue cavitation.

We started by opening the air valve for 10 hours the first day. The next morning we noticed a significant improvement in water clarity and a virtual elimination of the odor. We repeated the same procedure the next day with similar success. In the ensuing months, we have established a maintenance schedule of opening the air valve three hours, twice a week to maintain proper water quality. Our simple solution made the sand pressure a more efficient biological filter by meeting its limiting factor of dissolved oxygen. Since we have added air into the filter, the system has been able to handle the high bio-load of the papilloma sea turtles without any problem.

Chris Koberna, Head of Animal Care/Marine Systems

Clearwater Marine Aquarium

THE ALLIANCE FOR AQUATIC CONSERVATION (ACONS)

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[This is an abridged version of a paper originally presented at the 1997 American Zoo and Aquarium Association (AZA) national meeting in Albuquerque, NM. For more information on ACONS and the ACONS' "wish list" of projects, or a full length version of this paper with references, contact Doug Warmolts at dwarmolt@colszoo.org or the above address[8]]

Introduction

Over 100 species of North American freshwater fishes which have gone extinct in the past 100 years. An assessment of the status of freshwater mussels in the United estimated that as many as 10 percent of the total North American mussel fauna, the most diverse in the world, has gone extinct. As of 1 August 1997, the U.S. Fish and Wildlife Service had listed 108 fishes and 62 freshwater mussels native to the United States as endangered or threatened under the Endangered Species Act of 1973 (as amended).

Though the number of fishes and other aquatic species protected under the ESA may seem high, the list of federally protected species becomes quite conservative when compared against aquatic species imperilment and "at risk" determinations of state Heritage Programs, and other creditable sources.

To those concerned with the status of native fishes and other aquatic wildlife, the causes of species decline, imperilment, and extinction are familiar. Habitat loss is the number one impact affecting virtually all aquatic species whose populations are in decline. It encompasses a host of impacts such as impoundments, altered water flows and thermal regimes, agricultural, urban, and industrial pollutants, erosion and sedimentation. New causes contributing to species decline and impoverishment are being identified and examined such as loss of natural community integrity and the potential role of endocrine disrupters. There are also threats with direct anthropomorphic or biological origins such as resource overutilization, competition and predation from introduced non-native species including pathogens, and loss of species' genetic integrity due to diminished population size and population fragmentation. The challenges facing the conservation community involved in efforts to halt and reverse the imperilment of native North American fishes and other aquatic wildlife are substantial. They involve not only the removal or mitigation of abiotic and biotic threats, but must frequently surmount administrative, institutional, economic, sociological, political and cultural hurdles as well. However, over the past ten years there has been significant

change within the cultures of the conservation communities involved in this task. Change which can, and it is hoped will, ultimately enhance the conservation and recovery of aquatic resources within North America, and elsewhere. One of the most significant of these has to do with the evolving role of, and increasing support for partnerships. This is a positive change made in recognition of the fact that no single institution or organization has the resources to undertake conservation and recovery tasks in isolation. Amid the shift toward increased partnership development are several examples which involve task sharing and information exchange both within the federal conservation and resource management communities, and between government organizations and The American Zoo & Aquarium Association. The following discussion describes some of the few recent and exciting developments in this emerging conservation paradigm.

Role of Aquariums and Zoos in Aquatic Conservation

Representatives of the American Zoo and Aquarium Association (AZA), the AZA Freshwater Fishes Advisory Group (FFTAG) and five federal agencies signed a Memorandum of Understanding in December 1995 to cooperate on aquatic conservation in the United States and its associated territories. The AZA represents 180 accredited aquariums and zoos in North America and nearly 7,000 zoological professionals. AZA's federal partners include the U.S. Fish and Wildlife Services (USFWS), National Park Service (NPS), Forest Service (FS), Bureau of Land Management (BLM) and National Marine Fisheries Services (NMFS). The participants in this effort have since decided to call themselves the "Alliance for Aquatic Conservation" or "ACONS." ACONS members initially agreed to focus their attention on freshwater aquatic conservation issues. The Nature Conservancy recently identified freshwater aquatic ecosystems as the most endangered habitats in North America. Of particular concern are native freshwater fish and mussels that have been impacted by dams, pollution and the introduction of non-native organisms.

AZA's federal partners have recognized the important role that professionally-managed aquariums and zoos can play in aquatic conservation through public education, scientific research, technology development and transfer, professional training, field conservation, planning, captive breeding for reintroduction, and fund-raising to support such activities.

Several planning meetings have been held and many projects are under development. One of the primary goals of ACONS is to promote partnerships between AZA member institutions and federal agencies. To help identify opportunities for cooperative action, the federal agencies have developed a "wish list" of 38 projects for which they have requested assistance from AZA members. A directory should be completed by the end of 1997 which will list key individuals in aquariums, zoos and federal agencies, along with a description of their current interests and expertise in freshwater aquatic conservation. This tool should also be useful to facilitate communication and develop productive working relationships.

Progress to Date

The evolving partnership, although young, is already bearing fruit. For example, the AZA Aquatic Invertebrate Taxon Advisory Group (AITAG) is working with the USFWS and various state wildlife agencies in efforts to conserve endangered freshwater mussels. AITAG members

have assisted in the Ohio River Valley Freshwater Mussel Subgroup in developing a conservation plan, and a national conference on the captive breeding and husbandry of freshwater mussels is to be hosted by the Columbus Zoo in 1998. In addition, the FWS Freshwater Mussel Recovery Plan's newsletter has now been combined with the AZA AITAG's newsletter (The Heelsplitter) in an effort to improve interagency communication.

Several examples of cooperation between AZA institutions and federal and state agencies are currently underway. These feature the Phoenix Zoo, USFWS and Arizona Game and Fish Department's head start program for endangered desert fishes, the Columbus Zoo and Ohio Division of Wildlife's work to conserve the Western Banded Killifish, the Tennessee Aquarium and the USFS to implement a Brook Trout recovery program in the Cherokee National Forest, and the New England Aquarium's Freshwater Biodiversity Project. Such projects represent the growing power of public/private partnerships to contribute to wildlife conservation.

Phoenix Zoo

Within the boundaries of The Phoenix Zoo is a series of cascading lakes built in 1932 for the Arizona Game and Fish Department (AZGF) by the federal Works Project Administration. In the fall of 1995, Phoenix Zoo staff proposed to convert these lakes into a much needed refugium for endangered native fishes. But staff realized to ensure the success of this project, it would need extensive input and cooperation from individuals and organizations outside the zoo. The partners in this project included: AZA FFTAG, USFWS and AZGF, Dexter National Fish Hatchery, Willow Beach Fish Hatchery, Arizona State University, City of Phoenix Parks, Recreation, and Library Department, and Salt River Project (a local utility company). The objectives of this diverse team were twofold: to provide a long-term refugium for endangered native fishes and to "head-start" juvenile fishes to "naturalistic" conditions in preparation for release to native waters.

Having secured support and funding from the Phoenix Zoo's conservation committee, the next step was to solidify USFWS interest in using the lakes as a refugium for endangered native fishes. Their biological assessment determined the 15 acre-foot (5 million gallon) lake to be suitable habitat and agreed to place endangered bonytail chub (*Gila elegans*) and the razorback sucker (*Xyrauchen texanus*) in the lakes once exotic game fishes were removed. Native fishes are displaced by exotics through direct or indirect competition for resources and predation.

In August and November 1996, approximately 200 bonytail chubs and 5,000 razorback suckers were introduced into the lake after it was drained, rotenoned, and cured. The Dexter National Fish Hatchery in New Mexico supplied captive stock of the bonytail chub. The razorback suckers were wild caught as larvae at Lake Mojave and temporarily reared at Willow Beach Fish Hatchery in Parker, Arizona before shipment to The Phoenix Zoo.

The final step in the establishment of this refugium was the installation of permanent interpretive stations around the lake where visitors can read about our endangered fishes project and the reasons these fishes and their habitats are declining. Each interpretive station displays two life-size cement sculptures of the adult fishes species for visitors to touch and better visualize.

Columbus Zoo

The western banded killifish, *Fundulus diaphanus menona*, is distributed across the north-central United States and south-central Canada. This subspecies has been found at sites in Michigan, Illinois, Minnesota, Pennsylvania, Indiana, Iowa, South Dakota, North Dakota, Ohio, and southeastern Ontario .

In Ohio, the western banded killifish has been recorded from Lake Erie, the western Ohio tributaries to Lake Erie and very few small lakes, notably Miller Blue Hole in Sandusky County. Since 1980, the species has only been seen in Miller Blue Hole, Bull Creek, and the Portage River in Wood County. Miller Blue Hole, currently owned by the Ohio Division of Wildlife, Ohio Department of Natural Resources (ODNR), likely has the strongest remaining population of the killifish in Ohio. The tenuous existence of the western banded killifish in Ohio led to its being designated endangered by the Chief of Wildlife in 1974, the first year wildlife species could be declared endangered under Section 1531.25 of the Ohio Revised. The principle cause of the decline of this subspecies undoubtedly has been the destruction of habitat, much the result of agricultural practices in northwest Ohio.

In 1990, the Ohio Division of Wildlife (ODW) and the Columbus Zoological Gardens joined in a cooperative effort to institute a ten year recovery plan for the western banded killifish for the State of Ohio. This unique partnership focuses on two broad objectives: 1) To improve the status of the endangered fish; and, 2) To increase awareness and appreciation of the endangered fish. The former objective involves the protection of existing populations and the establishment of 3 additional self-sustaining populations in protected habitats through captive propagation at the zoo. The latter involves acquainting 10,000 intermediate school children with this species and its management. To complement this effort, the Columbus Zoo and the ODW collaborated on the design and construction of an Ohio Wetlands exhibit on the zoo's grounds. Representative aquatic habitats from around the state, the killifish program, and other threatened and endangered aquatic life are highlighted. The Columbus Zoo's 1.3 million annual visitors were exposed to the zoo and ODW's shared message of conserving the state's diminishing aquatic habitats and species.

Studies regarding early life history and spawning site preferences continue at the Columbus Zoo, as well as captive propagation. As of this writing, the program is in its seventh and final year. This summer, the Columbus Zoo and the ODW, as well as several other AZA institutions in Ohio have begun discussions on future aquatic conservation initiatives. Proposed projects include pirate perch culture and reintroduction, Brook trout culture and holding, freshwater mussel host identification and refugia establishment, Lake Sturgeon culture and reintroduction, and additional public information exhibits to name a few.

New England Aquarium

Massachusetts is experiencing a dramatic shift in species composition of fishes just as many other states are. The ichthyofauna historically comprised of 39 native freshwater species, but recently, 27 species of introduced fishes were reported as reproducing. Given that in North America, 68% of fish extinctions are associated with the introduction of exotic species, many feel that the native state ichthyofauna is imperiled. The New England Aquarium (NEAQ) is

responding in a number of ways to this crisis including partnering with state and local groups in conservation projects and educating the public through exhibitry. The Freshwater Fishes Biodiversity Project which focuses on the bridle shiner, *Notropis bifrenatus*, is one such example.

A minnow whose range extends from Maine to North Carolina, bridle shiner populations are threatened in North Carolina, Pennsylvania, New Jersey, Virginia and Massachusetts. This coastal plain lakes dweller is associated with healthy native freshwater ecosystems as are other species of minnow. The abundance of this species is therefore an indicator of the integrity of state freshwaters. This species was once abundant throughout the state's lakes and ponds. It is now reported in only 23% of locations in eastern Massachusetts that historically supported it,. The primary threats are believed to be introduced species, eutrophication and acid rain.

The NEAQ has undertaken bridle shiner survey projects to assess distribution and abundance since 1993 in conjunction with the MDFW. and the Sweet Water Trust of the Environmental Action Grant Program. The partnership's aim was to reactivate the survey projects and communicate the findings through a number of venues including exhibitry at the NEAQ.

By resurveying historically documented locations in eastern Massachusetts through the use of seine nets and snorkeling, the project has helped to focus attention on the plight of native freshwater fishes species and has led to specific management recommendations. Some of these recommendations include: guarding against excessive plant proliferation, viewing cautiously destructive aquatic plant management, preventing the introduction of non-native species and the study of a series of lakes with no exotic species. The last recommendation is especially important because little is known about the natural biology of bridle shiners in the absence of introduced species. With additional surveys planned for the central and western regions of the state it is hoped that such a lake or pond could be found.

A special exhibit entitled "Ponds: The Earth's Eyes" was created in 1996 in order to communicate concepts related to the Freshwater Fishes Biodiversity Project. Through the use of live exhibitry, creative graphics and interactives, 1.3 million visitors received a healthy dose of local freshwater education for the year long run of the exhibit. Parts of the exhibit have enjoyed a life beyond the whole such as the unique software called "How's <u>Your</u> Pond Doing?" This interactive through the use of GPS technology now allows school children to find a pond near their house anywhere in the state and learn a lot about that pond's health. Developed with the help of the MDFW and the Massachusetts Institute of Technology, the software is being distributed to schools state-wide.

Additional local and international cooperative projects are underway at the NEAQ. The North American right whale project with the NMFS (now in its seventeenth year) is having a positive impact on right whale management along the entire east coast. Hector's dolphin research in New Zealand hopes to provide insight into a fisheries crisis involving one of the world's most endangered dolphins through a collaborative with the New Zealand government. Additional projects include Bluefin tuna aerial surveys and an Eel grass restoration study in Boston Harbor.

Tennessee Aquarium

The Southern Appalachians are considered by some ecologists to be the center of North American biodiversity. The region's diverse aquatic fauna is represented by an increasing number of imperiled fishes and invertebrates. The Aquarium is currently involved in several regional conservation efforts with a variety of partners. One such effort is the recovery of brook trout, *Salvelinus fontinalis*, in Cherokee National Forest in east Tennessee.

The only salmonid native to Tennessee, brook trout were once common in cold water streams above 2,000 feet in elevation. However, widespread clear-cutting of Southern Appalachian forests from the 1880's through the turn of the century resulted in serious habitat destruction. This caused heavy siltation which probably interfered with reproduction. Further decline may be due to the introduction of rainbow trout, sportfishing pressure and acid rain.

By 1900 brook trout occupied only 15% of the region's once suitable cold water habitat. After the timber companies abandoned vast tracts of barren land in east Tennessee, the Forest Service stepped in and commenced stewardship over what is now Cherokee National Forest. Improvements to stream habitats led to a sharp increase recreational fishing pressure with the Forest. To meet the demand, non-native rainbow and brown trout were stocked by the millions into Cherokee National Forest. Trout fishing became popular in the area and by 1950, the introduced trout occupied 90% of the area once inhabited by brook trout.

Watershed restoration continues to be a top priority in the Forest. A desire by anglers and the Forest Service to see brook trout flourish once again spurred efforts to restore the species to a greater percentage of its former range in Cherokee National Forest. What begin in the early 1980's as a project by dedicated fisheries biologists and members of Trout Unlimited has grown to a relatively high profile and successful restoration program. The Tennessee Aquarium joined this program in 1996 by contributing the use of a backpack electroshocker and staff labor.

Work consists primarily of removing rainbow trout and browns from streams where brook trout should flourish if competition with rainbow trout was eliminated. The exotic trout are collected via electrofishing and relocated to lower elevation downstream locations. Physical barriers such as waterfalls and log jams generally prevent large numbers of rainbow trout from migrating back upstream. Brook trout are then stocked in high elevation streams where rainbow trout have been removed. Streams are considered successfully reclaimed if 95% of the trout inhabiting them are brook trout. As recently as ten years ago, brook trout inhibited only 1% of the streams in Cherokee National Forest, whereas today they inhabit 15% of the streams in the Appalachian Mountains of Tennessee.

In 1997, the Tennessee Aquarium will expand its role in this program by assisting in the culture of pure Southern Appalachian strain brook trout and their subsequent stocking into a newly targeted stream. Prior to their autumnal spawning activity, native strain brook trout broodstock will be collected in the mountains of north Georgia. Assisted by the Georgia DNR, staff from the FS and the Aquarium will transfer broodstock to the University of Georgia's Cohutta Fisheries Center, where the Aquarium currently leases outdoor ponds and operates a

small aquaculture program. Aquarium and University staff will spawn the trout and soon thereafter transfer broodstock to Cherokee National Forest. Their offspring will be released into the same stream in the spring of 1998.

The Aquarium's involvement in brook trout restoration is a relatively low cost way to participate in a nearby conservation project that benefits an extremely popular fish species. Organizational commitment is minimal because the effort is managed by the FS and responsibilities are distributed amongst a variety of participants. The Aquarium, therefore, is able to make a long term contribution to this project due to its low capital expenditure and close proximity. In return, the FS has another reliable partner that shares its interest in pursuing conservation efforts of regional aquatic faunas.

Summary

These programs represent successful collaborations between AZA institutions and a governmental conservation agency in the recovery of threatened and endangered species. They represent classic examples of the role zoos and aquariums can play in the conservation of North America's aquatic fauna. Further, they illustrate the changing philosophy of AZA institutions from one of a Noah's Ark paradigm to one of active participation and partnerships in conservation and species recovery efforts. ACONS is in its early stages of development and will continue to evolve over the next few years. It is hoped that the frame work established through the ACONS initiative will continue serving as a catalyst for future collaborative partnerships between the AZA and its federal partners. The creation of a AZA North America Faunal Interest Group earlier this year will further enhance communication and organization of North American conservation programs. In a time of increasing threats to our natural world and dwindling resources directed towards its conservation, a pooling of resources and expertise between the AZA and federal/state agencies holds tremendous potential for the future of our shared interest of wildlife conservation in North America.

DRUM AND CROAKER ACKNOWLEDGEMENTS

Sandee Holod typed several of the articles not received on disk, and prepared this issue for mailing.

Once again, I'd like to extend my special thanks to all those who contributed articles to this issue. The response to my call for papers was as overwhelming as last year.

SPAWNING *ARIUS JORDANI*, THE "SEA CAT"

Jo Meade

Greater Iowa Aquarium Center, Des Moines, Iowa

My position at the Greater Iowa Aquarium Center, here in Des Moines, Iowa has given me unique opportunities. One of these is observations on the sea cat (bull shark and black-finned silver shark are other names common to the market).

Over the years we have observed a group of these fish and thought they were gravid, but had not generated any offspring. These particular fish were purchased as 3 inch "catlings" and raised in a 70 gallon brackish water aquarium with scats until they were 8 to 9 inches long. A female and two males were kept in 1.009 brackish water with an undergravel filter, rock and plastic plants. Cool white fluorescent lights were kept on 8-10 hours, and the fish were regularly fed Doramin, fish chunks (salmon or whitefish) or shrimp. They also had occasional feedings of broccoli, oatmeal and other vegetable staples. They aren't fussy eaters as with most cats. Water was changed bi-weekly (25-30%).

When I noticed the female becoming gravid and the inner margin of the ventral fins enlarging (some authorities feel these are used to hold the eggs after extrusion until the male can put them into his mouth), I began to make more frequent water changes (weekly) and added a heater to bring the temperature to a more constant level of 84 degrees. In making the water changes I decided to alternate the salinity from 1.009 - 1.004 [to simulate tidal variations]. I also increased water movement with an outside filter moving 300 gallons per hour, and turned up the air on the undergravel system. The first time a ripe female was observed I concluded nothing had happened as all fish activity remained constant. The female lost her gravid look and no guarding, seclusion or any other odd behavior was seen.

Some authorities say breeding occurs in May, some late fall, but I think only the fish know for sure. In August 1996 the fish again showed signs of ripening, so I starting making water changes again. I made a 50% fresh water change on a Thursday afternoon. I needed to check something at the aquarium on Sunday, and as I looked into the tank my heart stopped…there was the largest mouthful of eggs distending the male's jaws that I have ever seen. I decided to remove the female and other male from the tank.

Now to keep the male holding his charges… I did not feed him or make any more water changes during the incubation time, which from what information I could find was 2 - 6 weeks. Conflicting material was given in Burgess' catfish atlas and volume 3 of the Baensch Atlas. So, I just decided to wait.

I am always at the Center on Thursdays, so I anxiously returned to work to find the male resting on the bottom of the tank, with no sign of hidden eggs. He was very quiet, and as these fish are constant swimmers and seldom rest, I had hope that there might still be a few eggs in his mouth. My co-worker was convinced he had swallowed the eggs, but as the weeks passed I became convinced that he was still holding eggs. His behavior had definitely changed: he no longer "opened" his mouth while breathing, and he continued to lie on the bottom, moving only his eyes. I consulted with a few breeders of cichlids and they confirmed my suspicion that upon rearranging the eggs in his mouth, they became "invisible".

After four weeks I was beside myself and like any ardent fish breeder, I had to see for myself if fry were present , and at what stage of development. The foremost handling problem is the sharp spines on the pectoral and dorsal fins. I wasn't anxious to get spiked. After getting him into the bucket, my next task was to hold him so I could open his mouth and get a peek. I

got him into the net tail down and took my thumb and opened his lower jaw. Attached to the roof of his mouth were 6 - 10 marble-size eggs with yolk sacs and two little black eyes. The eggs are quite large, and a size of approximately 1.5 cm is noted in the texts. At 4 weeks the eyes were the only visible structures and I did not see any movement. I figured I'd give him three more weeks.

I was like a little kid waiting for Christmas…three more weeks seemed like forever. However, the appointed day arrived, and my husband and I took the video camera and filming equipment to the Aquarium Center. We brought a large styro because I knew a bucket would not afford the room I would need to both open his mouth underwater, and take pictures. We have footage of him holding the fry in the tank. He uses the sides of the tank to press his charges into his mouth, and their whiskers can be seen floating out from time to time. As I netted him into the styro six fry were released. They were actively swimming. I used a popsicle stick to hold open his mouth and 6 more fry were released along with one infertile egg which later exploded.

I measured the fry in a small plastic isolation box. Each was a two-inch miniature of it's parents. Their fins developed a black coloration a few hours after release. I placed them in a bare 20L aquarium with brackish water (1.004) at 80 degrees, and fed them small chunks of Caravoire dry food. They were not a bit shy about eating! Frozen blood worms and brine shrimp were also offered occasionally. I changed 30% of their water weekly and they are really growing well.

After a year, the cats are approximately 5 inches long and very vigorous. The only losses were from jumping. The parent fishes spawned again within a year, this time in June. The female appears to take 3-4 months to attain a gravid state, and the spawning point.

These fish are very popular in the hobby, and if we can spawn with regularity, wild populations will not need to be exploited.

(Ozone Discussion…Continued from page 48)

much lower dose is required and hence you do not need as large an ozone generator, and contact towers and destruct units can be eliminated. It was mentioned that some existing contact towers can be modified into large protein skimmers.

Misc. Discussion:

A brief review of the problems of ozone forming hypobromic acid was addressed. The conclusion was that it certainly is a relevant fear, but it is somewhat overdone. Bromine is usually found as an impurity in NaCl and thus every system has the potential build up of Bromic acid, but it can be removed by carbon filtration or denitrifiers if it becomes a problem.

TRANSFERRING GIANT OCTOPUSES

The giant Pacific octopus (*Octopus dofleini*) can easily grow to over a hundred pounds during a short lifespan of just three or four years. The Seattle Aquarium has had numerous octopuses over eighty pounds and one that was probably over a hundred. This latter animal was 97 pounds when it died after not eating for two months. Large octopuses can be difficult to move from tank to tank and even more difficult to get out of a tank if they don't want to move.

Since octopuses grow rapidly, up to 2 % of their body weight a day, they outgrow their tanks rapidly. Although larger octopuses appear healthy and contented and water quality is fine in the open system tanks, when they grow to over forty pounds the public starts to perceive that they are large animals in small tanks, and that they need to be replaced with smaller animals

One of the tanks that the Seattle Aquarium uses to display giant octopuses is a 800 gallon octagonal-shaped aquarium constructed of all glass (no frame). This tank has an aluminum and wood frame hood sitting on top with a small swing-up hatch providing access.. The hood requires at least four people to lift off the tank. In addition to the access door, access is also provided by four removable Plexiglas graphic panels measuring 12 inches by 30 inches on four sides of the hood. A sectioned Plexiglas lid normally keeps the octopus from crawling out. The Aquarium also displays giant octopuses in a smaller 400 gallon rectangular glass tank with a similar hood arrangement on top of it

Getting such large animals out of these tanks can be a challenge. Typically, the tank has been partially drained and a wet-suited or wader-clad worker has clambered onto the tank through the narrow access door. Then the octopus was wrestled into a large bucket or small barrel and laboriously lifted out to others who then poured the animal into a barrel with water on a wheeled cart. While such transfers are entertaining to the public they are usually time-consuming, laborious and hard on the octopus. Such transfers are necessary about every six months.

I have recently discovered an easier way to get large octopuses out of these tanks. I let them crawl out by themselves. I don't feed them for a day or two before attempting a transfer. Then I entice the octopus over to the side I want it to crawl out of with a large herring. I rub the herring on the lip of the tank (octopuses can taste with the surface of their suckers). This leaves a trail for them to follow out of the tank. Then while holding the herring firmly, I let the octopus grab it at the edge of the tank with one of its arms. At this point the octopus usually crawls right out after the herring. I usually have a barrel of water on a cart underneath. We use two people to catch the octopus as it drops, depending on its size. We have used this method to remove and transfer out octopuses as large as 65 pounds with efficacy, and I believe it would work with even larger animals. This method would probably only work for tanks that have a water level fairly close to the top of the tank. Any new octopus tanks we design for future exhibits will have an access designed for getting the octopuses in and out using this method.

Roland C. Anderson, Puget Sound Biologist

The Seattle Aquarium

FISH IN WOLVES' CLOTHING

Though neither wolves nor true eels, wolf-eels (Anarrichthys ocellatus) get their common name from their gray coloration, large canine teeth, and snakelike bodies. They have been found from the Sea of Japan and the Aleutian Islands throughout the north Pacific seacoast to San Diego. They are most frequently found in waters ranging in temperature around the mid 40°s (F), and are quite at home in the chilly waters of Washington State, or in the dark depths of our neighboring submarine canyons.

Like their wild canine namesakes, wolf-eels mate for life and they seldom leave the safety of their rocky dens. Adults spawn in winter months, so newly hatched juveniles can feast on spring plankton and other juvenile fishes. Our mated pair here at the Birch Aquarium at Scripps spawns once a year, a good sign that they are content.

In a highly ritualized mating dance, the male wraps its long body around the female's and fertilizes the eggs as she lays them. Squeezing and twisting together, they continuously mold the eggs into a sphere, producing a brilliant green egg mass about the size of a honeydew melon, and containing up to 10,000 individual eggs.

We remove the eggs from the display tank and incubate them artificially in the aquarium nursery to ensure a better chance of survival. The eggs are constantly flushed with chilled seawater and heavily aerated with a series of airstones in a specially designed tank. Months later, the babies are helped out of their egg cases with gentle massaging to imitate natural parental care. Next, they are immediately transferred to another tank specially designed to keep them in a constant current, like a circular tread-mill. This tank is designed to allow the animals to swim indefinitely without bumping into the sides, and to keep food in the water from settling to the bottom.

In the first few days of life, a baby wolf-eel's nutrition is supplied by its own yolk sac. For approximately one month, we then feed them fortified live adult brine shrimp. The young are then weaned to a more nutritious diet of frozen krill (a small, shrimp-like crustacean). Once it reaches adulthood, a wolf-eel's powerful jaws can crush clams, sea urchins, and crabs, their preferred prey.

As they grow, juveniles settle down and find a home, usually under a rock structure-something we provide for them in the aquarium. The rate at which wolf-eels grow is truly amazing. They emerge from their egg cases at an inch and a half in length, and within a month they are just under five inches. At this rate, they grow to be big denizens like their parents in no time!

We are quite proud to be able to share these animals with other aquarium's that exhibit cold-water fishes. Individuals from a recent brood are doing well at more than ten different aquaria across America. Our shared successes in the propagation of wolf-eels proves that conservation of all types of marine animals is a worthwhile effort that all aquarium's can participate in.

Eric Johnson, Aquarist
Birch Aquarium at Scripps

MINUTES OF THE 1997 REGIONAL AQUATICS WORKSHOP (RAW), HENRY DOORLY ZOO, OMAHA, NEBRASKA, USA, JUNE 12 - 14

(For more information contact Kathy Vires - see p. 45)

PET TRADE ISSUES (Moderator: Jay Hemdal)

Animal Donations:

Some zoo directors accept all donations. Is this reasonable?

Jay Hemdal, Paul Loiselle and Peter Mohan (referring to their "Tropical Lunkers" article for Aquarium fish Magazine -July issue): "People buy large fish species without knowing how large they really get - Ex: Pacus. Lemon Sharks are also becoming a problem." Perhaps partnerships can be formed with pet stores and dealers to increase awareness of this problem.

Should we prevent exotic fish from being released into the wild by accepting all fish, or would the trade in these species slow if zoos and aquariums stopped accepting all fish donations, thereby closing an escape hatch for those wishing to dump large fish?

Continue to produce articles for newsletters and magazines on this subject to increase awareness of this issue within the hobby and pet industry.

Is eco-labeling a valid way for aquariums to discourage hobbyists from purchasing problem species?

Gary Meyers - AZA should develop some kind of liaison with the pet trade groups. Should there be some kind of an accreditation process for pet stores? Try to work with store owners to inform the public about the fish they are buying.

Rumors of Philippines collecting ban:

Has anyone heard whether the Philippines is closed? There is rumored be a temporary ban on collecting in effect due to the use of cyanide.

Red Sea issues:

Is Cyanide collecting taking place in the Red Sea? Is another chemical agent in use…perhaps chlorine bleach?

Some breeders are producing Red Sea *Pseudochromis*. Breeders are having trouble staying in business - don't seem to be selling the fish. We need to help the word get out on captive-bred fishes. Can information on available hatchery raised marine fishes be distributed via FishFax/Flash?

Legal Issues:

Regional interdiction efforts on coral shipments seem to vary. There appears to be some uncertainty among inspectors over what is legal. We should form "partnerships" with the U. S. Fish and Wildlife Service to help educate them regarding coral identification. We must also be willing to take (or place?) both desirable and undesirable animals when they are confiscated.

Ethical Issues:

Should institutions purchase specimens from dealers with questionable records, even if their current practices are legal? Some institutions will not deal with anyone if they have ever

had a conviction on a wildlife infraction. They also require a dealer to fill out a profile form before doing business with them. It is now becoming a policy at some facilities to get profiles on both dealers and recipents of animals (for lifestock leaving the public aquarium/zoo community). We may be losing opportunities to obtain unusual fish because of this paper trail. Jay Thinks this issue will start coming up at registrar conferences. More zoos may start to require all of these forms.

Some institutions also have a problem deaccessioning fish to the pet trade and or private sector.

AZA acquisition survey results:

Jay Hemdal has a list of national dealers being utilized *[See article in this issue of Drum and Croaker]*. Some people using Airborne Express to deliver to their doors. This is so much nicer than having to go to the airport. Federal Express appears to have a policy of not taking live fish shipments, but this is only enforced at some locations. The Toledo and LA offices are two that will not accept animals.

Cooperative exhibits between institutions and clubs:

Does anyone work with local aquarium clubs to help develop exhibits? Cleveland is going to try working with local organizations on a new display of corals. Pittsburgh tried a similar project, but the agreement fell through. Problems with these partnerships revolve around the fact that these "volunteer" organizations experience a regular turnover in membership. New England Aquarium is utilizing local divers to collect for them.

ROLE OF AQUARIUMS IN CONSERVATION (Moderator: Chris Coco)

1. The most efficient way to accomplish conservation mission is often for an institution to simply assume a leadership role on a specific project and do it.
2. Conservation takes many forms such as education outreach, beach clean-ups, member's programs, re-hab programs, and in- institutions efforts.
3. Aquariums need to get the word out and publicize their conservation efforts. This is necessary to illustrate the potential benefits that our facilities able to conservation efforts.
4. New Aquarium/ Zoo M.O.U. with federal resource agencies is major progress in facilitating cooperative efforts through federal agencies need: husbandry expertise, education supports, assistance with public relations and assistance with labor.

VOLUNTEERS

Aquariums have a variety of volunteer organizations ranging from formal procedures and structure to teams that are self operating.

There are differences in how volunteers are selected including passing diving skills in a pool and passing written tests and physical examinations.

The “Volunteer Coordinator” may be an aquarist who has larger displays or the head a separate department. Duties of volunteers also vary. Some aquariums have competency levels with check off lists that must be met before a volunteer can go to the next level. At some

institutions volunteers are involved in food preparation. Some divers are involved with educating the public and narrate their dives.

What do the volunteers receive? Benefits include free memberships, free shirts, red carpet nights, thank you dinners, employee discount, winter fun days and a volunteer newsletter.

Safety procedures were discussed, including the use of a buddy system, tenders, and an alarm button above each display.

Staff comes to depend on volunteers being there to do volunteers work that do free up staff for other interest not cleaning.

MULTI - TAXA DISPLAYS (Moderator: Lisa Cuevas-Jorgensen)

The main topic of discussion was how to coordinate the different crews/personalities needed to create successful displays. Some solutions/modes of action include conducting cross training (also helps ensure staff coverage during vacations, etc.) and the designation of primary & secondary species (the keeper for the primary species takes care of the exhibit with support from the secondary. Cross training allows people to cover many taxa (fish, birds, mammals, etc.) in one area/display but each team member is also able to have an area of specialization.

Encourage familiarity with all of the animals and the procedures involved in their care. Make sure that job descriptions are clear and that each person knows what is expected of them.

All agreed that team work and communication are the keys to good exhibit management and exhibit design. Communication can be improved through regular meetings, rotations through different areas, organized social activities. It is important to come up with ways to increase feelings of ownership for everyone involved in the exhibit and even the institution.

Safe methods of pest control and quarantine procedures both need special consideration when developing a multi-taxa display. Do biological control agents such as geckos introduce parasites?

Engineering concerns:

(*This group was a mix of LSS engineers and aquarium staffers*.)

- Engineers are by necessity conservative in their applications.
- Agreed that more follow up from the designers is needed to see if their applications are working.
- How do front line aquarists become more of a part of the design? Conversely, how do engineers access the front-line users through management?.
- Are engineering firms committed to learning about aquariums and zoos applications and is the research being done to improve the technology?
- Technology may be out there - but, the cost is a factor.
- Better results may be obtained when the aquarium and zoo hires the engineers directly and the engineer is then working for the zoo itself and not a third party.

Incorporating Humans into the Displays:

- Tunnels, multi- levels / step platforms, and kiosks are useful.
- Make architects get down on their knees to see the child's perspective.
- Try and see from both staff and visitor perspective (good for working, good for visiting)
- Incorporate divers - make them a star attraction - utilize talk back systems, presentations, scheduled feedings
- Build for kids - places only kids can get into "safe danger"

DENITRIFICATION WORKING GROUP
(Presented by Peter Hall, original notes by Rob Sparks)

This session was comprised of two major portions: 1). Presentation of Ecomat's denitrification technology; and 2). Related conversations about denitrification.

Presentation Notes:

- Denitrification follows the following chemical path. NO3-NO2-NO-N2O-N2.
- A carbon source is crucial to denitrification. Methanol provides a good source for the process.
- Denitrification requires anoxic (not anaerobic) conditions.
- Startup of a denitrification system can fail because of a number of reasons.
- Startup begins with O2 reduction then reversal of the nitrification process occurs (above chemical pathway).
- Crucial point in startup is creation of NO2 handling enzyme.
- Denitrification systems can be made from recycled sand filters but they are not real reliable or efficient.
- Formerly denitrification was done in batches, where each batch had a startup phase.
- Continuous loop carrier denitrification was developed in Japan. The carrier, or "bug house" accomplishes the denitrification.
- Final step in continuous loop denitrification is foam fractionation which removes any remaining methanol and reintroduces O2 into the water.
- The loop system only requires one successful start up and the phase is generally shorter than of the batch system.
- Economic data, including start up costs, show that the purchase and use of continuous loop denitrification is more cost effective than conducting water changes.

Conversation Notes:

(Compiled from various speakers in attendance in response to P. Hall's question: "What level of NO3-N is safe?".)

- Denitrification should be utilized because we know nitrates are generally bad. We are not trying to stay below a specific nitrate level but should provide the best care we can.
- Setting a "nitrates are bad at this level" number is practical because maintaining them at or close to zero PPM is impractical in some instances.
- Nitrates can be an indicator of overall water quality when other water quality tests are not available. Would denitrification remove this measurement tool?
- Denitrification can help balance other water quality parameters such as alkalinity.
- Other filtration methods can be employed, such as protein skimming, which will remove waste products before they become nitrates, thus limiting the need for denitrification.
- Nitrate levels that are too low in a coral tank setting could actually hamper coral growth.
- Denitrification not only saves in sewer disposal fees but it also saves an institutions' reputation as a conservation facility and not as a contributor to pollution.

QUARANTINE PROCEDURES

From the discussion, the most popular quarantine procedures seem to lie along these lines:

Salt Water Fish	Fresh Water Fish	Invertebrates
- Acclimate in new salt water quarantine. - Use Chelated CuSO4 at 0.2ppm for 20-30 days tested 5 times daily. - Use praziquantel bath at 2ppm for 24 hrs. - Release into system unless other problems occur.	- Acclimate in new fresh water quarantine. - Use malachite green at 0.2ppm for 20-30 days. - Use praziquantel bath at 2ppm for 24 hours. - Release into system unless other problems occur.	- It was noted that with the increasing amounts of corals and live rock being Used, unwanted animals and/or disease may be brought in. A quarantine period should be done to at least observe the specimens until more is learned on the subject.

These are not meant for every species. It had been stated that hawkfish, wrasses, some gobies and tilefish, and most elasmobranchs are intolerant of copper treatments (and I'm sure there are quite a few more). There has been some copper treatment testing with some species of rays, as well as lemon and sand tiger sharks. Centrarchids and ictalurids are not tolerant of the malachite treatments.

It should be noted that most in attendance did not believe in the use of prophylactic antibiotics. Many felt that a period of 45-60 days should be spent a quarantine area, but this may not be realistic for most institutions. It was stated that a bare bottom tank with external filtration would be best for treatment reasons, and only when animals incur abrasions should there be a fine silica layer applied to the base. For fish that are in need of adequate hiding places, various PVC pipes, shells, or shelves could be added for refuge.

A few in attendance thought the use of ozone was somehow inhibiting their copper levels during treatment. It would be interesting to hear if other institutions have this problem in the future as more and more of us are using ozone. At a high, pH, the CuSO4 has a tendency to be absorbed out of solution. So be aware that as the pH is lowered, the copper level may reach dangerous levels.

There was also a call for a more natural quarantine during the meeting. Some suggest that the chemicals added are more abusive than helpful to the fish. Randy Goodlett mentioned the existence of a non-chemical herbal treatment available through Sano Aqua Remedies. If interested, you will need to contact him at 1111 Winterton St., Pittsburgh, PA. 15206.

Drugs and doses discussed:

(A detailed list of drugs and doses was assembled by those attending the meeting. For a copy contact Kathy Vires, Omaha's Henry Doorly Zoo, 3701 South 10th St., Omaha NE 68107-2200, USA Voice: (402) 733-8401, Fax: (402) 733-4415, E-mail: kos@omahazoo.com)

INVERTEBRATE WORKSHOP
[Moderators: Sue Kenney (Omaha Zoo) & Warren Pryor (Fort Wayne Zoo)]

Announcements:

The AZA Aquatic Invertebrate Taxon Advisory Group's newsletter is the Heelsplitter. See Warren to get on mailing list.

"Freshwater Mussels: Conservation, Captive Care, & Propagation" will be held at the Columbus Zoo on March 6 - 8, 1998. *[Announcement on Page 17]*

Corals:

The group discussed the tracking of coral fragments, coral reef conservation education (parking meters, graphics, etc), the development of a husbandry manual, and the need for a survey of husbandry practices.

Unionids (Freshwater mussels):

More information will be available through the upcoming conference in Columbus.

Octopods:

Availability is still an issue. Sources were shared. Is behavioral enrichment an issue for these relatively intelligent critters?

Sea Anemones:

Discussion was a response to a recent report on the impact of collecting anemonefishes on host anemones left in the field.

PROTEIN SKIMMING DISCUSSION GROUP
(Moderated by Dave La Bonne and Andy Aiken)

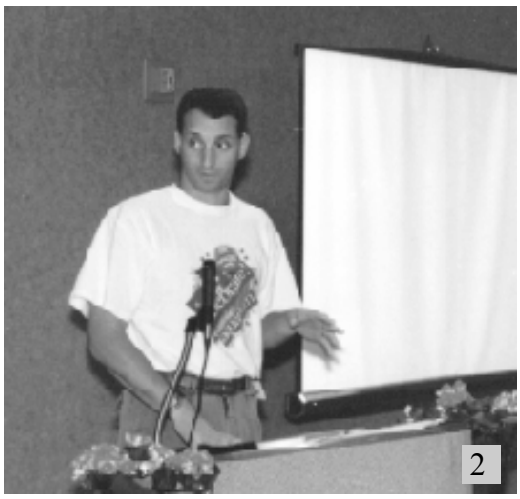
Opening Discussion:

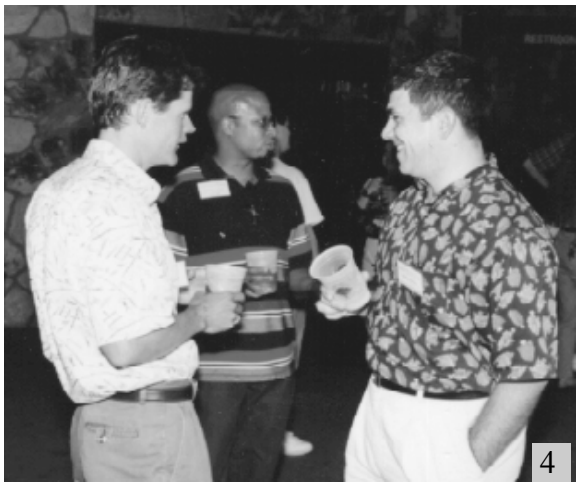
A brief overview was given about some new protein skimmer systems designed and used at the National Aquarium in Baltimore. This furthered the information given by Kirsten McCracken in her paper session. Several designs were talked about including the new Pacific Coral Reef Exhibit and the Seal Pool. All designs mentioned implemented the use of ozone in the skimmer. The major advantage to using ozone in protein skimmers is that you can use lower dosages and not use huge degas towers or destruct units.

The design discussion then diverted to a description of the new Seal Pool at the New England Aquarium. This system is driven by 4 large protein skimmers and sand filters. It has been observed that the protein skimmers do a great deal to extract a lot of the hair before going into the sand filters. Tthe skimmers did a great deal to eliminate the green water cycle commonly found in mammal exhibits that do not use chlorine.

Flowrate:

The issue of flow rate was brought up. One message of caution was to make sure that ozone bubbles do not get entrained back into the exhibit or reservoir. A healthy indicator of good flow rate is an area of clear water at the bottom of the skimmer where there are no bubbles.





Photos from the 1998 RAW meeting at the Henry Doorly Zoo in Omaha

1. **(L-R, T-B) Roger Klocek (Shedd), Gary Stoops (Omaha), Warren Pryor (Fort Wayne), Randy Goodlett**
2. **Chris Coco (Tennessee)**
3. **Sue Kenney (Omaha), Randy Goodlett, Jay Hemdal (Toledo)**
4. **Next Years Hosts: Chuck Smith [R] and Tom Schmid [L], Texas State Aquarium, with fellow Texan, Charles Yancy (Dallas)[center]**
5. **Sue Kenny (Omaha), Carol Farmer (Tennessee), and Linell Smith (Denver)**

There are different flow rates depending on whether air stones or injectors are being used. If stones are being used a rigorous maintenance schedule needs to be maintained so that the stones do not become clogged and change the flow rate.

Design:

Several comments were made about different design forms of the skimmers. There was some disagreement as to the actual necessity for a conical top to the skimmer. Many people felt a cylinder worked fine. The ETS skimmer was brought up as an effective use of the cylindrical top. The issue of pump driven level adjustment with valves versus gravity adjustment via a stand pipe was also argued. It appears that for large systems the protein skimmers driven by pump and regulated by valves is somewhat more practical.

Misc. Comments:

We should not forget that the pet trade has been working with these for many years and there is certainly information for us to use from that resource.

Too much ozone running into the skimmer will cause it not to foam.

Ozone and protein skimmers can be used in fresh water systems with some success, but it is far more difficult.

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OZONE DISCUSSION GROUP (Moderated by Jeff Kefabber and Dave La Bonne)

Opening Discussion:

The working group started out with a general discussion, and overview of how ozone was being used in most aquariums today. This tends to be many large contact and degas towers with very little ozone being run through them. It was also mentioned that many institutions are only running ozone during the day and not 24 hours a day. Another problem with the current use of ozone is that many facilities do not use pure oxygen as their feed gas.

Millivolt Readings:

Millivolt readings were discussed and it was determined that a value in the 300-400 range was average for a display running on ozone, and that the readings are about 800-1000 in the contact towers. This is keeping in mind that these readings can be high due to byproducts of ozonation and may not be a true reading. Again it was mentioned that it is incorrect to look for a target value, but rather it is better to observe trends.

Current Systems:

Through experiments and general operation of current ozone systems a new approach to efficient ozone use in aquariums was addressed. The new method involves the use of ozone in a side stream in conjunction with large scale protein skimmers. It was noted that protein skimming with air alone could remove 20%-25% of bacteria and by using ozone instead this could be dramatically increased. A major benefit to the use of ozone in protein skimmers is that a ***(continued on page 38)***