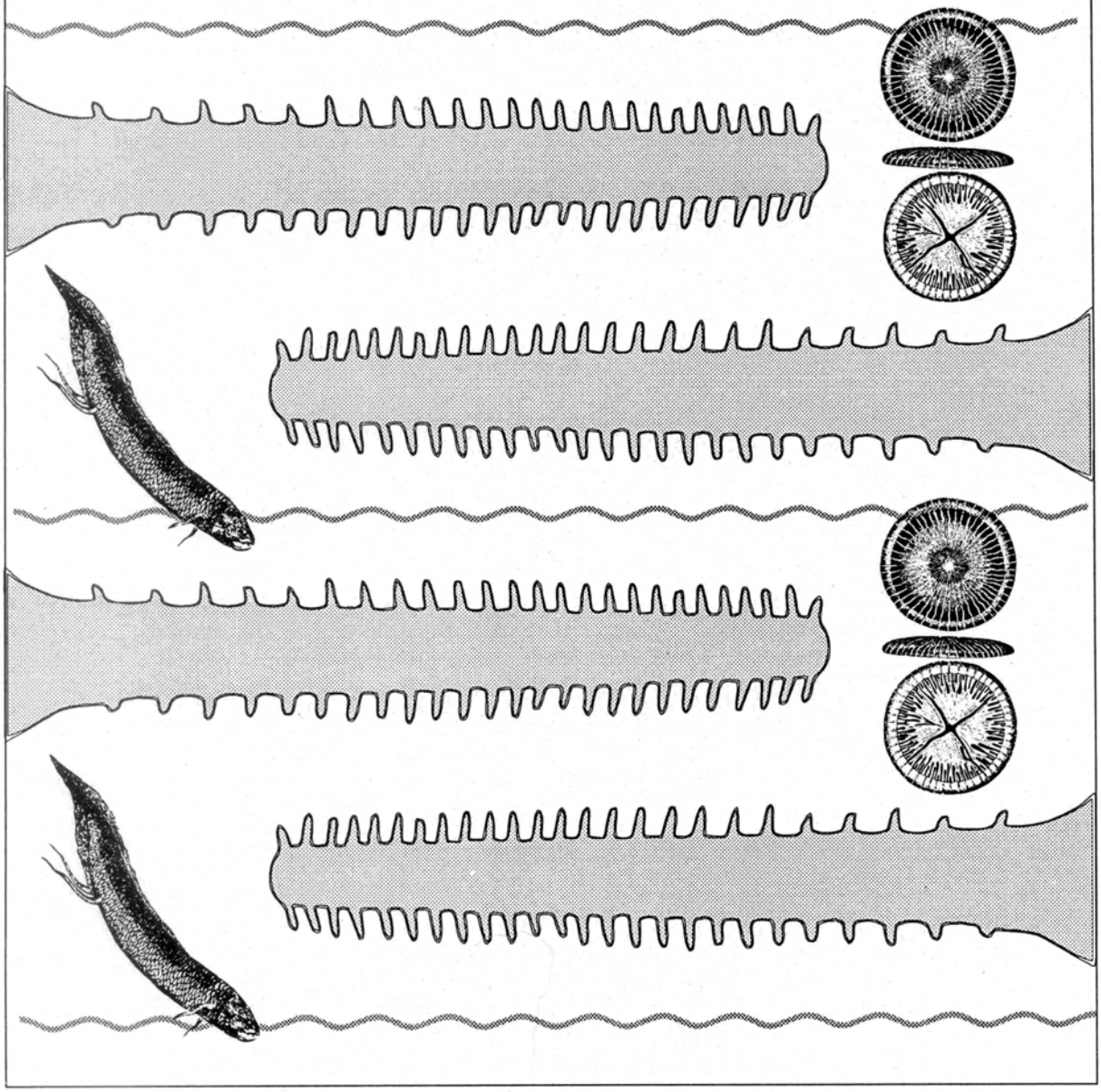
DRUM and CROAKER

A Highly Irregular Journal for the Public Aquarist

Volume 24 *Number 1* *Jan. 1993*



A BRIEF GUIDE TO AUTHORS:

1. As always, Drum & Croaker contributions are not peer reviewed and will not be edited.

2. Where possible, all contributions should be submitted in letter quality Times 12pt (the type style I've used here). If this is not available, please send your document in disk form to the individuals listed below. Send typed manuscripts directly to Pete Mohan (address below).

   a. Files created using Apple software:
   Rick Segedi, Cleveland Metroparks Zoo
   1212 E. 167th St. - Cleveland, OH 44110

   b. Word Perfect: Jay Hemdal, Toledo Zoo
   2700 Broadway - Toledo, OH 43609

   c. MicroSoft Word: Pete Mohan, Sea World of Ohio
   WordStar 1100 Sea World Dr. - Aurora, OH 44202
   Write
   ASCII Files

   If submitting an ASCII file, please use the space bar to center and indent text. Also avoid boldfaced, underlined, or italicized text. (We will reconstruct any desired type faces, such as bold for titles, before printing.)

3. "Regular" articles should follow the following basic format:
   Title (boldface, capitals & centered) space Name & title (centered)
   space
   Affiliation (centered)
   space
   Text: single spacing with 1" margins section headings should be in bold (but not all caps) at the left margin.

4. "Ichthyological notes" (short contributions) include any article, observations, or point of interest substantially less than one page in length. A brief bold faced and capitalized title can be placed at the left margin (if desired), text should be single spaced, and author and affiliation should be placed at the end of the piece with the left end of the line at the center of the page.

5. Reviews of books or scientific articles are welcome, as are bibliographies, Napkin drawings will be printed "as is" - no crayon please.

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ACKNOWLEDGEMENTS

Many people have contributed thought or energy to the evolution of this issue of Drum & Croaker. Bruce Axelrod, Jay Hemdal, Russ McAndrews, Dan Moreno, Doug Warmolts, and others who have participated in recent Regional Aquatics Workshops have been especially helpful.

Aniko Namenyi typed and formatted much of this issue. Diane Gregg designed the cover with inspiration from Dave Clippinger's sawfish figure.

"NOT RESPONSIBLE"

The contents of manuscripts submitted to Drum and Croaker are not edited before printing. However, articles may be retyped as needed to accommodate a standard format and figures may be reduced to conserve paper.

Fellow Aquarist -

The 1980's and early 1990's have been busy years for many of us in the public aquarium field. New construction, expansions and facelifts have increased dramatically, as has our involvement in research and captive propagation.

While our schedules have made it increasingly difficult to function as a community, other developments have drawn us together. Unlike many mammal and bird departments, aquariums must still obtain the bulk of their display animals from the wild. Consequently, our success as public institutions increasingly depends on our ability to work together in the areas of wildlife education and captive propagation. The Lake Victorian haplochromine breeding program is a case in point.

As public scrutiny and regulation increase, our professional organizations have become more involved in policy and ethics questions. This has necessitated a decrease in their coverage of basic husbandry issues and small exhibit construction at meetings. **Drum and Croaker** is a logical outlet for such information.

Drum and Croaker has a long history of providing an informal forum for the exchange of basic information - and occasionally humor. It was conceived in the back seat of a car in 1957 and has remained erratic and irregular throughout most of it's life, characteristics it shares with a colleague or two. The original name, "Grunt and Crappie" was rejected for scatological reasons, even though the original call for papers heralded the periodical as "an irresponsible journal...by undedicated aquarists". More on the early history of **Drum and Croaker** can be found in contributions by Bill Hagan [70(1):3] and Rick Segedi [77(2):17-18].

There have been many periods where the influx of articles to **Drum and Croaker** has slowed to a trickle. The worst gap occurred in the mid 1980's, when the journal dropped out of sight altogether for almost five years, apparently due to a general lack of interest at a variety of levels. John Kuhns, the editor of the Journal of Aquariculture and Aquatic Sciences, rescued a few lost contributions in 1989 and with these again began to issue **Drum and Croaker** on a regular basis. In 1992, John graciously agreed to pass responsibility back to the public aquarium community through members of the Regional Aquatics Workshop (RAW). The current format reflects the thoughts of representatives from about a dozen facilities. By consensus, we have resurrected what I will call a "proceedings look", for lack of a better description. I consider my role to be more "hunter-gatherer" than editor.

The availability of articles is often inversely proportional to the number of meetings for which contributors must also prepare. Postage is also getting a bit pricy. We addressed both concerns by establishing a publication schedule of at least once (and no more than twice) a year.

This issue contains a variety of original articles. I have reprinted (with permission) a couple of key papers from conferences that may not have been widely attended. Sources for complete copies of the proceedings are included at the ends of these articles. I have also asked a couple of dozen aquarium societies to send their best articles to **Drum and Croaker** for review. I will print one or two of the most relevant in each issue. Home aquarists have much to offer the public aquarium community.

Do you have a small exhibit or custom-made tool of which you are particularly proud? Did you observe any unusual behavior (animal or otherwise) that would warrant a couple of paragraphs in **Drum and Croaker**? Do you have any wisdom, philosophy or slapstick you would like to share with (or inflict upon) your fellow aquarists? **Drum and Croaker** is an open forum.

A couple of articles have already been promised for the next **Drum and Croaker**. We look forward to hearing from your aquarium also!

Pete Mohan, Curator of Fishes
Sea World of Ohio

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September 2, 1992

Dear Peter,

It was nice to hear about your plans for Drum and Croaker - my students and I spend a lot of time in class reviewing past issues of the magazine. Right now our aquarium is up, running and looking quite nice and we hope to keep it going over the following school year! We've even had former students hired by other aquariums!

We have 13 students in our Beginning Aquarium class, two students in the Advanced Managerial class, and two more who are in the Aquarium Board of Trustees class. I look forward to the next issue of Drum and Croaker.

Dennis L. Kelly
Professor of Marine Biology
Marine Science Department
Orange Coast College
Costa Mesa, CA 92628-5005
(714) 432-5564

"*The Marine Science Department at Orange Coast College offers classes in introductory Marine Science, Coastal Oceanography, Marine Biology, Marine Mammology, Mariculture (sea farming), and opportunities for participation in one of the Department's research projects. OCC's Marine Science Department contains the largest marine science teaching program in the United States.*

The Department has its own "wet" marine laboratory, maintains a 2,000 gallon recirculating cooled seawater system, and has a seabase on Newport Bay at which the 55' research vessel R/V Marada is moored." *--OCC brochure.*

Dennis also enclosed a 09/03/92 article from the Orange County Register regarding his program.

Unfortunately the schools' display system, which is used as a teaching aid for the above courses, may close due to a possible loss of operating funds. The tanks have been a popular campus highlight for 20 years and serve 10,000 school children annually.

If anyone has any suggestions, they might contact Professor Kelly at the above address.
--Pete Mohan.

OBSERVATIONS OF ROSTRAL TOOTH REGROWTH IN SMALLTOOTH SAWFISH, PRISTIS PECTINATA

David H. Clippinger, Senior Aquarist
The Living Seas, EPCOT Center, Walt Disney World Resort

Sawfish are characterized by a distinctive rostrum armed with a row of slender blade-like teeth on each side. This weapon-like appendage is used to capture fish with side to side sweeps or to rake shellfish from the bottom. Unlike sawsharks whose rostral teeth are constantly replaced by developing teeth arranged in a regular sequence behind the primary tooth, sawfish are born with the number of rostral teeth they will have as adults (Slaughter and Springer, 1968). Sawfish teeth are attached within sockets which are connected to the circulatory canals of the rostrum. This socket arrangement allows for continuous growth of the tooth. (Schaeffer, 1963, Slaughter and Springer, 1968, Shellis and Berkovitz, 1980). There is no apparent means of replacing a tooth if it is totally lost (Schaeffer, 1963). Slaughter and Springer (1968), using preserved Pristis rostrums, observed that damaged teeth often retained a pointed tip but remained shorter than adjacent teeth.

The objective of this study was to observe and document changes in the rostral teeth of smalltooth sawfish to determine if damaged teeth regrow to normal size and shape. Previous studies have relied on dried museum specimens or one-time observations of capture-release animals which do not allow for observing changes that occur over time. The unique environment of The Living Seas reef aquarium provided the opportunity to study three Pristis pectinata in a large simulated habitat.

Methods

The three smalltooth sawfish (Pristis pectinata) used for this study were transported from the Florida Keys to The Living Seas at EPCOT Center in Lake Buena Vista, Florida. The three sawfish, two males and one female, are maintained as part of the Caribbean reef display, a twenty-two thousand cubic meter artificial sea water aquarium at The Living Seas. Observations of the rostral teeth were documented bi-monthly over a twelve month period using sketches and underwater photography. All observations were made using SCUBA to avoid handling the animals. The rostral teeth were not deliberately altered or broken.

Observations

There were eighty-one recorded broken teeth over the twelve month study. Most of the breaks occurred at the back of the crown without damaging the pulp cavity. When only a small portion of the tooth was broken with the remaining tooth half retaining a pointed shape, regrowth of the crown took as little as one month. A broken tooth begins to regenerate itself by first forming a new tip. The progression of tooth regrowth can be observed in Figure 1. The broken end of the tooth thickens and lengthens from the pulp cavity. If the crown is missing, a new crown is generated from the pulp center. The new crown and base lengthen until the size of the repaired tooth is comparable to an adjacent tooth. Only nineteen of the 81 recorded breaks involved the pulp cavity portion of the tooth. Crown formation was delayed in this case until the

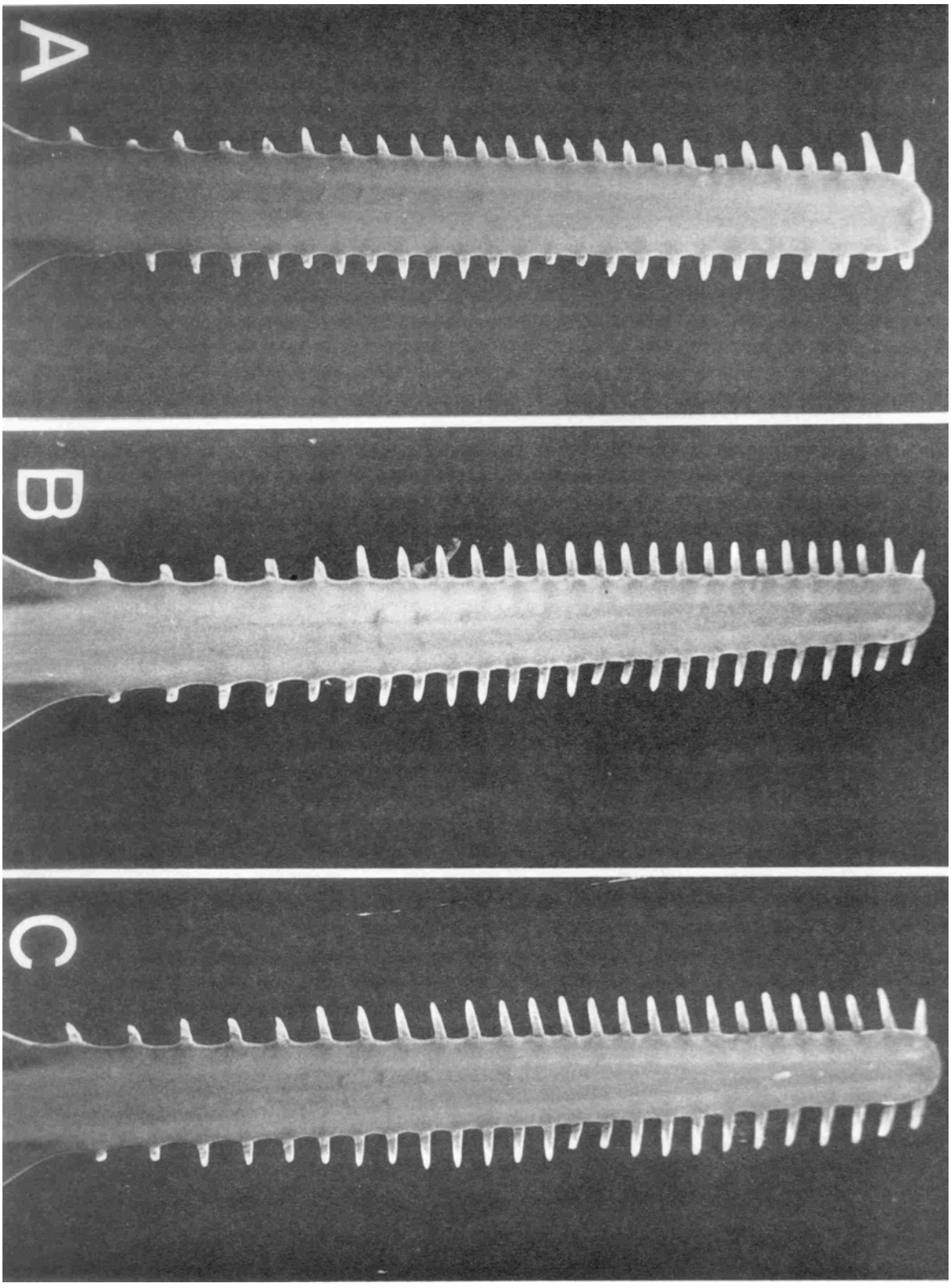

Figure 1: Photographs of smalltooth sawfish (Pristis pectinata) rostral teeth. A: April, B: October, C: December. Actual rostrum length approximately 65-71 cm.

base sufficiently lengthened to re-establish the pulp cavity. The base portion of the tooth lengthens more slowly than the crown. Regrowth of a damaged tooth appeared faster than the continuous growth of undamaged neighboring teeth.

The rate of regrowth was not uniform. Teeth on the anterior of the rostrum grew faster and to a greater length than posterior teeth. Regrowth was slower if many teeth in one area were broken. Injury to the rostrum or tooth socket also delayed tooth regrowth.
Although very slow in some cases, no damage occurred that was severe enough to prohibit tooth regrowth. It is not known if regrowth is possible if the entire tooth is lost.

Conclusions

In sawfish, continuous tooth growth and regrowth of damaged teeth takes the place of successional tooth replacement found in sawsharks. Growth may be reduced as a tooth reaches an optimum size, partially explaining how a damaged tooth can grow to the length of a neighboring tooth. Older, longer teeth that are prone to breaking tend to fracture at a point above the pulp cavity where the crown can be regrown in a short period of time. Damage to the tooth base, to the extent that regrowth is not possible, is probably so rare that true tooth replacement is not necessary.

Acknowledgements

I am grateful to the technical staff of The Living Seas, Dr. L. Brooks and C. Davis for their assistance and support.

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RECENT AUSTRALIAN LUNGFISH BREEDING STUDIES AND EFFORTS: HAVE WE MADE A DIFFERENCE?

Dan Moreno, Supervisor RainForest & Aquatics

Cleveland Metroparks, Zoo

My minimal effort at rekindling interest in breeding programs in controlled environments by making a modest presentation, "Thoughts on Captive Propagation of the Australian Lungfish Neoceratodus forsteri," at the Annual Conference of the American Association of Zoological Parks and Aquariums held in Pittsburgh, Pennsylvania September 24-28, 1989 produced results far beyond expectations. Upon the urging of Vancouver Aquarium Director, Murray Newman, and with wholehearted endorsement of Zoo Director, Steve Taylor, Cleveland Metroparks Zoo was successful in obtaining an Institute of Museum Services " 1990 Conservation Support Grant" for the purpose of gathering, organizing and interpreting pertinent information pertaining to the Australian, or Queensland, lungfish (Neoceratodus forsteri).

The International Australian Lungfish Breeding Workshop was held May 9, 10, and 11, 1991, at Cleveland Metroparks Zoo and included seven key presenters who had traveled to Cleveland from the breadth of the North American continent, Europe and Australia.

The audience consisted predominantly of professional aquarists from U.S. and Canadian aquariums coast to coast. Their combined specialties included animal medicine, morphology, ethology, physiology, ecology, taxonomy, histology, endocrinology, sociobiology, evolution/paleontology, freshwater fish husbandry/propagation, etc. The workshop program consisted of formal presentations by the key presenters as well as the readings of papers submitted by two scientists who were invited to participate but were unable to attend. Four panel discussions were held, with the key presenters exchanging information, ideas and suggestions among themselves and with workshop participants in the audience.

Also, as part of the IMS/CMZ conservation project support grant effort, I was able to travel to Australia in July of 1991 to visit libraries, museums, zoos and aquariums in and around Sydney, (NSW) and Brisbane (Qld.) and to talk with lungfish experts at those institutions and elsewhere. I was able to inspect a number of known breeding sites in the Brisbane, Mary, and Burnett River systems. Unfortunately, because of drought conditions, most of the usual spawning areas were above water during that year's normal spawning season, and I saw no signs of lungfish spawning activity.

However, due to the extraordinary and universal cooperation of people there, I accumulated many bits of interesting and potentially useful husbandry/breeding information about Queensland lungfish in Australia ... under tank, outdoor pond, and completely wild conditions ... much of it firsthand.

I inspected the outdoor lungfish tanks of the late Lionel Lambkin on his farm, in the

company of members of his family. I believe this to be the site of the only recorded instance of Australian lungfish breeding under controlled conditions in that country. Lionel's family presented me with a videotape showing the final draining of his ponds (shortly after his death) to capture the dozen-odd Queensland lungfish specimens he had, in order to transport them to the aquarium at the Taronga Park Zoo in Sydney. (Lionel had willed his lungfish to Dr. Jean Joss, and she arranged for their transfer.)

Early in the month of September, 1991 1 returned from Australia, and later that month presented a paper during the 1991 American Association of Zoological Parks and Aquariums' conference in San Diego entitled, "1991 Australian Lungfish Breeding Workshop and Field Studies".

The publication of the Proceedings from the International Australian Lungfish Breeding Workshop was delayed many months due to unanticipated difficulties in transcribing verbatim, the panelists, due to acoustical reverberation problems in recording. Still, the publication of the workshop Proceedings, addenda and Australian lungfish census held in North America was achieved before the September, 1992, grant's-end deadline.

Since the lungfish. workshop in the spring of 1991, and especially since my return from Australia that September, I have kept up a lively correspondence with a number of new friends down under as well as keeping in contact with fellow Neoceratodiphiles on this continent and Europe. From some of these communications I intend to glean and distill lungfish related information for publications such as Drum & Croaker and/or a Lungfish Newsletter which will (at least initially) emanate from Cleveland Metroparks Zoo.

Judging from letters and conversations I have had on the subject of lungfish over the past months, I am convinced that our efforts have made a difference. Although all our attempts at breeding Neoceratodus in our tanks, pools, and ponds have so far not met with success, I anticipate it will not be long before we witness a breakthrough, and the species will be bred with increasing frequency.

For example, in the very month following the Cleveland workshop, key presenter, Dr. Jean Joss, launched a campaign to raise money for breeding lungfish back in Sydney. Four months later Dr. Joss wrote, "The interview that I had not long after we last met has born fruit beyond my wildest dreams. The Australian Research Council is going to fund a National Centre for lungfish research at Macquarie... Next year I will get the money to start building the aquarium and laboratory facility for rearing larvae, carrying out many other research projects, and collaborating with all those who wish to study the lungfish ... I am also grateful for all the circumstances that have led to this success and I'm sure that your invitation to me to participate in the IMS/CMZ Lungfish Breeding Workshop was a significant contributor. The workshop certainly provided invaluable information to help in designing the breeding program that is now made possible..."

Two months later workshop key presenter, Dr. Frank Kirschbaum wrote, "I have been

offered a position as head of a department (Biology and Ecology of Fishes) in a newly founded institute in formerly East Berlin. Your invitation in the beginning of this year had renewed my interest in the ecology of fishes and this, in part at least, has contributed to the new possibilities, which have been offered to me...

"This new situation together with the stimulating atmosphere of the workshop has increased my interest in the reproductive behavior of Neoceratodus. Together with the Berlin Aquarium (you should know the head, Dr. Lange) we are planning a breeding program with Neoceratodus, too... There are so many interesting things which can be done with these fascinating animals."

Since my return from Australia, armed with information gained from participants at the Cleveland Lungfish Breeding Workshop held months earlier, plus what I learned during my six weeks down under, we set to work designing an "optimum" controlled environment for breeding Australian lungfish.

Our earliest plans to simply double the capacity of our Australian lungfish tank were not given further serious consideration as a result of the near unanimous consensus of the workshop presenters and participants and recommendations from lungfish experts with whom I spoke in Australia.

Instead, we began by designing a facility which would incorporate most of the features which we considered important for success in propagating Australian lungfish. (Plans available upon request.)

What we came up with was, essentially, a 55 foot long greenhouse, 30 feet wide, containing two octagonal 20 foot reinforced poured concrete tanks, five feet in depth, joined by a shared wall which would rise to within a foot or two of the water's surface. This would allow for the movement of the tanks' occupants without handling whenever it might be necessary to drain or otherwise service either one of the tanks. Each tank would have three viewing windows (3' x 5' long) which would provide excellent visual coverage of the tanks' occupants. A 5' x 30' area at one end of the 30' x 65' room would hold nursery and filter tanks, and an adjacent 10' x 30' utility room would house additional filtration and other water management equipment. A similar-size room would contain the heating plant for this operation plus a proposed Zoo/RainForest support greenhouse. The entire structure was not designed for general public access.

Regrettably, time and funding limitations put a halt to these ambitious plans, so the aquatics personnel spent the next months developing ideas for a smaller lungfish breeding system which could be accommodated within the area currently occupied by the Australian lungfish exhibit, filters, chiller tanks and service area.

What evolved was a system containing approximately four times the volume of their current 1,000 gallon exhibit tank (which itself is twice the volume of the tank in which they originally spawned) with most of the features we thought important such as a "shallows",

provisions for rooted plants for spawning and forage, increased natural light, a water chiller and an air heater above the water's surface, a largely unobstructed bottom with a sand substrate, "hiding" areas, shadows/light gradient, etc.

Zoo Director, Steve Taylor, expressed wholehearted approval of these plans too, but explained that we would have to be patient for a year to two before we might go forward with either of the above two major lungfish proposals.

Determined to continue doing everything in our power to enhance the possibilities of our proven breeders spawning once again before the end of October, 1992, we removed the obstructing rockwork in the tank. This provides more swimming area and a clear bottom for a proper sand substrate which I witnessed lungfish in Australia utilizing with obvious delight, which will, in turn, encourage us to try them on a wider variety of foods due to the ease with which uneaten morsels can be removed. Artificial light levels were reduced in response to recommendations of some panelists, plans to set water chiller temperatures lower than in past winters--as urged by the late Lionel Lambkin-- and other, more subtle efforts to trigger spawning, were agreed upon.

Any questions, comments, information or further recommendations concerning the propagation of Australian lungfish will be more than welcome, and I will do what I can to share it all with any interested fellow Neoceratodophiles.

HABITAT AND NATURAL BREEDING CONDITIONS OF THE AUSTRALIAN LUNGFISH

Dr. Jean Joss, School of Biological Sciences

Macquarie University,Sydney, NSW 2109, Australia

Lungfish were once widely distributed across Australia. Since their discovery by Science, however their distribution has been confined to a few coastal river systems in South-eastern Queensland. It is generally believed that they only occur naturally in the Mary and Burnett River systems and that they were introduced into a few other waterways, such as the Brisbane River and Enoggera Reservoir, by O'Connor in 1989. Fig 1 is a map of Northeastern Australia, showing present day drainage systems for naturally occurring and introduced populations of Neoceratodus.

Almost from their discovery, there was interest in their breeding. Fig 2 shows some of the records of finding *Neoceratodus* eggs, with comments on where they were found.

The most comprehensive study of stimuli responsible for initiation of spawning was carried out by Anne Kemp on the Brisbane River and Enoggera Reservoir (Kemp, 1984). I will present her findings to you and then follow them up with my own unpublished observations in the quite different locality of a coastal creek, running into the Mary River.

Both the Brisbane River and Enoggera Reservoir are permanent water supplies. The Brisbane River is a rich environment for lungfish. It was once a large meandering system but is now mostly converted into two reservoirs, Somerset and Wivenhoe Dams. Both have large populations of lungfish. The river between the 2 dams is also permanent - it floods several times/year but never runs dry. The water is normally clear, except after heavy rain and the pH is slightly alkaline around 8.0.

The Enoggera Reservoir is a relatively poor environment for lungfish. It is a large man-made reservoir, created by convict labour in 1868. It is a permanent body of water covering approx. 60 hectares, filled by springs and overflowing into Enoggera Creek. It is up to 60 ft. deep, with steeply sloping sides of clay. The bottom is covered thickly with detritus from overhanging eucalyptus, which stains the water darkly with tannins and lowers pH to around 5.0. Except for occasional algal blooms, plants survive only at the edges.

Anne's results for spawning conditions are shown in Fig. 3, which gives the hours of daylight, daily rainfall and duration of oviposition in the 2 environments. In the Lake, breeding began in mid-September in 1971 and early August in 1972, when it lasted only about 1 week, recommencing in early October. In the River, breeding began earlier and lasted longer than the Lake - mid-late August to November - oviposition was continuous throughout this time.

The start of oviposition in either area did not appear to be related to rainfall. In the Lake during 1971 and 1972, oviposition began after a dry winter, but before heavy rains. In 1973, spawning followed a heavy rainfall in the previous month, stopped after 2 dry months and started

again after a month of moderate rainfall. On the River, rainfall was generally lower than on the Lake, and the commencement of oviposition appeared to be unassociated with significant rainfall. In 1981, the start of spawning followed a dry month and ended before much rain had fallen.

Temperatures are moderate initially and fairly steady but influenced by cold water released from the Somerset Dam in the River - no marked rise until mid-October. Oxygen tension and pH also vary little at time of spawning.

In every year, in both areas, lungfish begin to breed at a time of increasing daylength, approx. 10 weeks after the winter solstice. They do so in areas of some water flow, ie. not stagnant, and where suitable weeds are available for spawning. The weeds that Anne found lungfish using as spawning sites are shown in Fig. 4.

Lungfish are specific in their choice of spawning site. Weeds that they could use for spawning occur all along the river banks. The choice of the actual site is governed by unknown factors. Eggs are found on weeds rooted in sand or in gravel, in slow or shaded or in full sun, on clean weed or on weed with masses of algae attached. They are never found in stagnant slimy algae-infested water or where there is loose debris on the surface of the water. The specificity of the plants used for spawning is towards those that form dense masses of vegetation situated against a bank.

A summary of the conclusions from Anne's study of lungfish spawning at the two study sites is as follows:

Neoceratodus forsteri breeds annually between mid-August and December. Oviposition is not related to rainfall, temperature, pH or dissolved oxygen content of the water. Oviposition is related to increasing daylength (occurs 6-11 weeks following the winter solstice). Availability of suitable weeds in flowing water may affect the site chosen for spawning.

Spawning behaviour has been observed in the field by several people and in captivity by Lionel Lambkin. Most of the field observations describe quite complex noisy breathing and pursuing rituals followed by the fish intertwining, lying on their sides, the eggs being deposited singly or in pairs and the male fertilizing each as it emerges. Lambkin (personal communication) found that his fish behaved somewhat differently, in that the male appeared to deposit milt on the surface of the spawning site after which the female took up the males position and "sucked in" the milt. However, his fish then swam to another part of the pond where they also engaged in the intertwining behaviour as eggs were laid.

Now to my own observations. Since I am based in Sydney, some 1,300 km from the Mary River, I cannot sample lungfish in the wild as frequently as would be desirable to ascertain their habits but with 1-3 trips/year since 1984, I am slowly building up a picture. The geographic location of my study site is shown in Fig. 6. As can be seen it is near the head of the Tinana Creek system, one of the several creek systems that feed into the Mary River. At the head of these creeks, the waters are quite narrow and shallow, interspersed with deepish (2-4 metres deep) pools.

(Several slides shown [at International Lungfish Breeding Workshop] to illustrate the type of locality of my study site.)

The water in these creeks can dry up to extremely shallow between pools during dry months and can flood up to 20 metres during torrential rains. Fig. 7 shows the rainfall in Tinana Creek area over the last ten years.

Thus this locality is much more like the classic description of lungfish habitat, ie. "dries out to a chain of waterholes". As can be seen from Fig. 6, this creek system is very extensive. It contains very large numbers of lungfish. Over the 6 years I have been sampling lungfish, I have tagged some 200 fish and have only recaptured 2, both in November last year - 1 that had been tagged 12 months previously and the other 3 years previously.

As far as spawning is concerned, regrettably I have not yet found an ovulated female. I do not at any time see large weed beds along the banks of this creek. In some areas, there are significant root masses from trees growing along the banks and in others, stretches of grass that would be covered under mild flooding conditions.

Fig. 8 is a repeat of the rainfall data for my study site, indicating the times of my collecting trips. As you can see, I have collected fish in August, September, October and November of different years. As I will be explaining in my second talk, male fish from October to December have ripe sperm packed into the tubules of the kidney, presumably ready for spawning. Female fish have large yolky eggs in their ovaries but I have never found ovulated eggs in the oviducts ready for spawning.

And here I embark into the realms of speculation. Unlike the lungfish in the permanent waterways of Enoggera and the Brisbane River, these lungfish, inhabiting their more natural waterholes, may indeed require the stimulus of rising water levels to initiate ovulation and spawning behaviour. Many of the Australian freshwater fish have been found to require such a stimulus as have the other two genera of lungfish. If this is so, however it also shows that the stimulus may no longer be required for fish inhabiting permanent water supplies and therefore may not need to be considered in the captive breeding programs.

Originally presented at the International Australian Lungfish Breeding Workshop (May 9-11, 1991).

Contact Dan Moreno at the Cleveland Metroparks Zoo regarding the availability of conference proceedings, (216) 661-6500 - extension 272.

Fig. 1 (from Kemp, 1987)

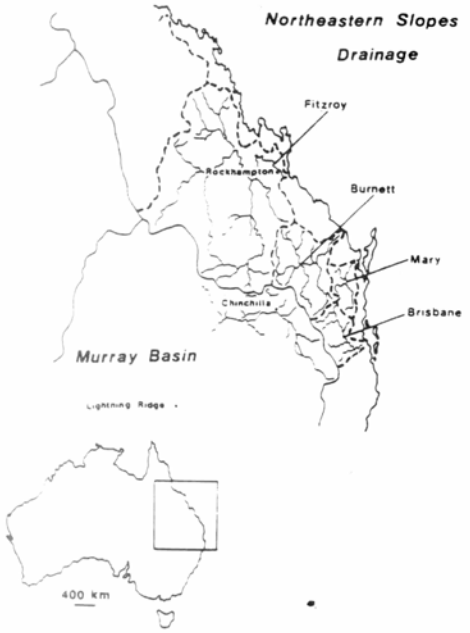


Fig. 2 (from Kemp, 1984)

SIGHTINGS of Neoceratodus EGGS

1884	Caldwell	Burnett R.
1892	Illidge	Deposited among growing water weeds or on sides and bottom of submerged logs
1893	Semon	Boyne R.(tributary of Burnett) - shallow water amongst weeds
1911	Bancroft	Burnett R. - found amongst *Hydrilla verticillata* *Vallisneria spiralis* *Nitella sp.*
1925	Spencer	Separately amongst vegetation but not attached so that they finally lie on the mud
1965	Grigg	Burnett R. - among weeds
1969	Bleakley	Enoggera Reservoir - attached to roots of water hyacinth
1977	Kelly	Brisbane R. - attached to submerged roots of *Callistemon saligna*

Fig. 4 (from Kemp, 1984)

Fig. 3 (from Kemp, 1984)

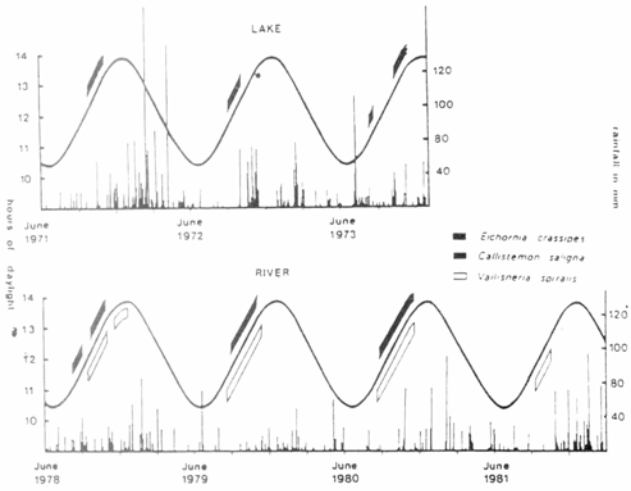


FIGURE 1. Hours of daylight, daily rainfall and duration of oviposition in Enoggera Reservoir (1971–73) and the Brisbane River (1978–1981). first day of each third month is marked; rainfalls of less than 3 mm are not included; the start of oviposition is calculated by subtracting the of the oldest eggs found from the date of collection, and the end from the last day on which new laid eggs were found.

WEEDS USED for SPAWNING
(from Kemp, 1984)

Eichornia crassipes (Water hyacinth)	roots
Hydrilla verticillata	
Vallisneria spiralis	
Callistemon saligna	submerged roots
Nitella sp.	
Potamogeton perfoliatus	

WEEDS PRESENT BUT NOT USED for SPAWNING

Potamogeton crispus	deep water species
Potamogeton javanicus	used for mating behaviour but not for spawning
Ceratophyllum sp.	
Nymphoides indica	
Nymphaea flava	
Ludwigia peploides	
Brachiaria mutica	
Rumex bidens	
Sedge	

Fig. 5

CONCLUSIONS from
STUDY of SPAWNING in
BRISBANE RIVER
and ENOGGERA RESERVOIR
Kemp, 1984

Neocetatodus forsteri

Breeds annually between mid-August and December

Oviposition is not related to
rainfall, temperature, pH or
dissolved O_2 content of water

Oviposition is related to increasing daylength
(occurs 6-11 weeks following winter solstice)

Suitable weeds in flowing water may affect
site chosen for spawning

Fig. 6

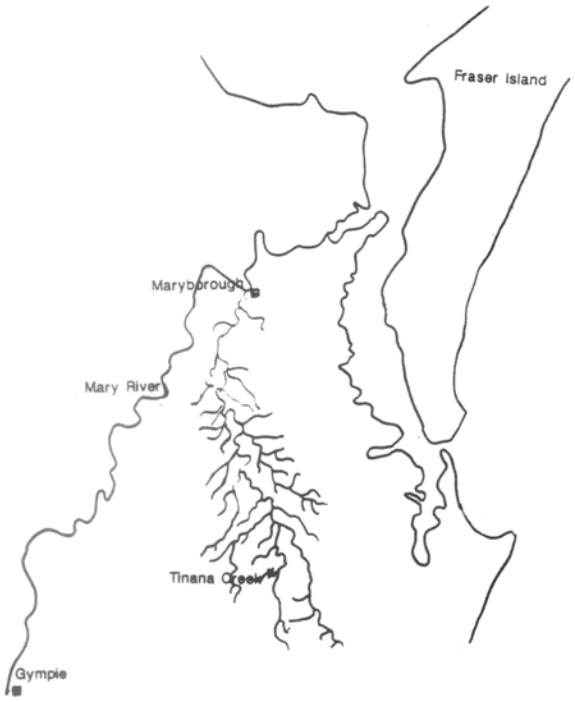


Fig. 7

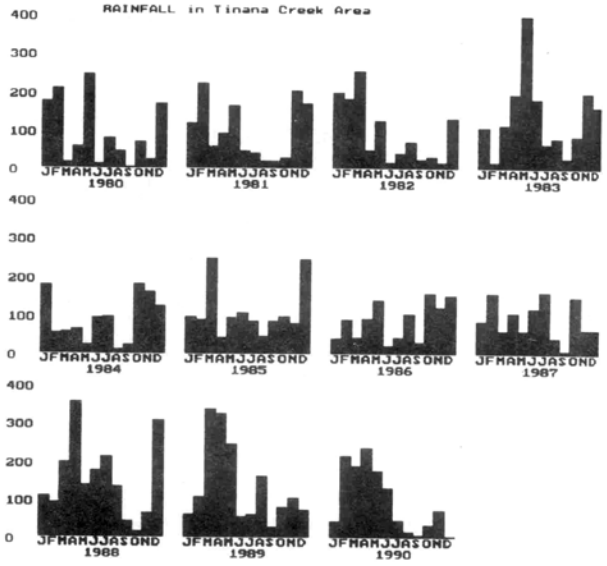


Fig. 8 * - Field Trips

RAINFALL in Tinana Creek Area

									SPRING			
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	172	206	14	54	241	11	75	44	0	66	22	166
1981	116	218	54	88	159	42	37	17	15	25	199	167
1982	192	178	250	45	122	14	37	68	21	29	14	127
1983	104	13	108	191	393	179	61	76	24	82	193	156
1984	175	53	54	62	23	91	95	9	* 23	177	156	120
1985	* 94	85	243	40	* 91	102	82	44	82	95	75	240
1986	37	86	* 41	89	*136	20	41	100	* 28	154	117	148
1987	82	153	59	*103	57	115	156	40	8	*145	62	61
1988	105	87	194	352	134	172	208	130	* 39	12	60	304
1989	59	104	334	323	242	53	59	157	26	* 76	100	69
1990	39	211	183	231	172	128	42	13	5	32	* 69	

SIMPLE AQUARIUM WATER ANALYSIS FOR TOTAL AEROBIC BACTERIA

Jay Hemdal Curator of Fishes Toledo Zoological Society

Lisa Scafidi Bowling Green State University

Routine analysis of aquarium water for total bacteria in smaller public and private aquariums is rarely performed. However, many large aquariums monitor their fish and invertebrate water systems for this parameter, especially if they already have the required techniques in place due to government mandated monitoring requirements for marine mammals. The information from these analyses can be used to judge the efficacy of various filtration systems and appropriateness of feeding regimes. These data are also useful as an adjunct water quality parameter for use in formal and informal studies.

The generally accepted technique for monitoring total aerobic bacteria in water is a time-consuming process and requires fairly extensive laboratory equipment, including an autoclave and incubator (Pelczar and Chan, 1981). Comprehensive training in aseptic technique may be required for the technicians. Above an, the costs may be higher than smaller public aquariums can absorb.

The following is an outline of the spread plate bacteria analysis routine used by the Toledo Zoo in an attempt to circumvent these drawbacks. Although the process is still fairly time-consuming, the equipment cost as well as the degree of skill needed by the technician have been substantially lowered. Accuracy may be reduced to some degree, and the resulting data should probably not be used in official reports. Nevertheless, with a little effort, smaller public aquariums can utilize these techniques to gain a better understanding of the water quality in their aquarium systems.

Materials list:

4"x 4" piece of tinfoil
2"x 2" open pore foam block
20 sterile plastic petri dishes - 100 mm X 15 mm
1 500 ml Pyrex Erlenmeyer flask
10 grams of Tryptic Soy Agar powder (TSA media, Difco)
1 graduate cylinder
250 ml hot tapwater
9 g of synthetic sea salt (for marine sampling)
Bunsen burner or alcohol lamp
Hot plate or stove Betadine disinfectant or equivalent product
Autoclave gloves or hot pads
150 mm glass rod with heat flattened tip Felt tip marker
0.2 ml glass pipette

Pouring the media plates:

1) Pre-heat the hot plate and wipe the counter top with Betadine or other disinfectant, Set the closed petri dishes upright on the counter.

2) Add the agar to the bottom of the dry flask. Add 250 ml of very hot tapwater (If the plates are to be used to monitor marine aquariums, also add 9 g of synthetic sea salt). Swirl to dissolve the agar. Place piece of foam in mouth of flask, and cover with tinfoil. Set the flask on the hot plate and heat to a full boil.

3) Boil for 20 minutes, swirling the flask occasionally. Note: overheating will result in the agar boiling over. Do not allow this step to proceed unattended.

4) Turn the hot plate off. Allow the agar solution to cool to approximately 55 degrees centigrade.

5) Remove plug and tinfoil from flask. Pass mouth of flask quickly through the Bunsen burner flame. Lift the lid of one petri dish and add a small portion of liquid agar, (so that the bottom of the plate is covered with the agar) and replace lid quickly. Repeat this on a total of 5 plates then re-flame the mouth of the flask. Continue until an 20 plates have a thin layer of liquid agar in them. Pour the agar very sparingly, or else there will not be enough for the full 20 plates. Shaking the plates slightly as the agar is being poured will help level the agar against its inherent surface tension, requiring less to be used.

6) Allow plates to cool for at least two hours. Remove the lid from a plate and place it open side down on the counter top. Invert the bottom of the plate and rest it on the edge of its respective lid. Continue for all plates. Once the plates have dried, (as evidenced by the evaporation of any condensation which formed on the inside of the lid) replace the lids.

7) The finished plates can now be stacked, placed in a plastic bag and refrigerated, Do not store plates longer than 14 days.

8) As a test, select two plates at random and incubate them for 24 to 48 hours at room temperature. The presence of any colonies of bacteria or fungus after this time may indicate a flaw in the technique used, and the remainder of the plates become suspect.

Sampling water for total aerobic bacteria:

1) Remove the required number of TSA plates from the refrigerator and allow to warm to room temperature. Sterilize a serological pipette by flaming with alcohol, or use a sterile disposable pipette.

2) Draw a water sample into the pipette. Drain pipette, repeat twice, on the third time, retain sample. Quickly continue to step 3.

3) In a draft-free area, on a sterile counter as described above, open the cover of a TSA plate, hold it above the bottom of the plate, a little to one side. Drop by drop, allow the proper volume of the sample to fall onto the media (usually 0.05 to 0.1 ml), It helps to move the pipette so that each drop falls on a new portion of the plate.

4) Use the flattened end of flame sterilized glass rod to gently smear the water sample evenly across the surface of the agar. Touching the possibly hot rod to a dry portion of the surface of the agar will cool it before it to comes in contact with any of the sample (Jim Anderson, John G. Shedd Aquarium; Personal Communication). If the sample forms pools, the media may have too much liquid in it. Try re-smearing the sample with a sterile glass rod.

Take care not to smear the sample near the sides of the petri dish. Any colonies of bacteria subsequently forming near the edge of the dish win be difficult to count. If too much pressure is used, the glass rod may crack the agar. If this happens, discard the plate and take a new sample. As soon as this step is completed, replace the cover of the plate.

5) For increased accuracy, the same glass rod may then be used to spread any inoculum still adhering to it onto a second plate. The colonies from both plates would then be combined for the total count (Pelczar and Chan, 1981).

6) Label the bottom of the plate(s) with the date, sample source, and sample volume Store the exposed plates inverted for 36 to 48 hours at 22 to 25 degrees centigrade to incubate the sample.

7) Count the number of colonies (If colonies are small and difficult to see, incubate for a longer period of time, or use a dissecting microscope). A felt tip pen applied to the back of the plate just above each colony as it is counted win help avoid miscounts. If the second plate method is used, combine the counts from both plates.

8) Divide the number of colonies counted by the sample volume This will give an approximate number of bacteria per milliliter.

9) If the bacteria colonies are "too numerous to count" subsequent samples should be smaller in volume. Diluting a sample with a known volume of sterile water is another possibility (Anderson, per. com.).

10) Dispose of the used petri dish and media in a safe manner. Exposing the used materials to ethylene oxide is one technique which can be used. The normal method is to run the used material through an autoclave cycle. Since the culture technique outlined here was designed for use in labs without an autoclave, an alternative method of covering the media with 70% ethanol for 24 h can be used.

Interpretation of the bacteria numbers can be difficult. They are most useful in showing trends in a given water system over time. The following general guidelines apply to many aquarium systems:

0-10 colonies / ml sterile
10-100 pristine
100-1000 excellent to good
1000-5000 good to adequate
5000-20,000 adequate to poor
> 20,000 corrective action may be required

The primary drawback to the method described above is that some bacteria and fungal spores are not de-activated at temperatures reached by simply boiling the agar. This means that if spores are present in the media, they may grow and form colonies on the media mixed in with colonies produced by the sample. Use the control plates to monitor any colonies that might be forming from spores.

Multiple plates of the same sample on the same date may improve the accuracy of this technique when averaged together. Factors which affect the relative bacteria numbers in a given system over time may not always be easily identified. Certainly, if the specimens are on a set feeding schedule, taking samples at the same time from one week to the next is mandatory. Free floating particulate matter will tend to increase the number of bacteria in a given sample. The point at which the sample is taken from the system will also have a bearing on the number of bacteria present. Even the differences in the technique of one technician over another may change the results some what.

Weekly monitoring of the main water systems of The Toledo Zoo aquarium using these techniques has proven helpful in our attempt to better understand many of the parameters which can affect water quality, such as overfeeding, overcrowding, and lack of proper water changes. Effectiveness of ultraviolet sterilizers, micron filters, and ozone generators can also be more easily assessed.

Reference

Pelczar, Michael J., and Chan, E.C.S, Elements of Microbiology 1981 McGraw-Hill, Inc. New York

MAINTAINING MOONJELLYS, AURELIA AURITA, IN A MODIFIED CLOSED KREISEL SYSTEM AT THE ST. LOUIS ZOOLOGICAL PARK

Joseph Norton, Zoologist

St. Louis Zoological Park

Early in 1991, my staff of aquarists, along with myself, decided we wanted to take upon the task of displaying jellyfish at our institution. We specifically wanted to display the Moonjelly, Aurelia aurita, in our new education facility known as The Living World. This is a high tech facility combining animal exhibits with computer interactives and videos. Since the animal exhibits are found among the high tech equipment, we had to, from the onset of this endeavor, overcome obstacles in our path to display the Moonjelly.

I began my research on this project at the Monterey Bay Aquarium, who from information I had gathered, were making great progress with these planktonic creatures. I started my design by visiting the aquarium, and gathering data on their systems and design. Theirs is a more traditional kreisel which takes fresh seawater from the bay and circulates it in a kreisel pattern, creating an overlapping circular current within the exhibit. This same theory is present within the holding areas for the jellys. Since the water entering the kreisel is of a constant fresh source, I came to my first obstacle. The water must be circulated slowly or the jellys can be torn or held against the suction of water exiting the tank. How was I to circulate this water at a slow pace, in a closed system, (artificial seawater), and still maintain high water quality?

Our final design for the exhibit and filtration is as follows; the tank had to be build in a tall and narrow configuration due to constraints placed upon us by the building design. The tank measures 70 cm wide x 90 cm high x 70 cm front to back. This tank is constructed of 3/4" acrylic with black back and sides. The tank has a false bottom angled at approximately 35 degrees with the slope toward the front of the exhibit. The back of the tank is a false back with a sump contained behind the viewing area. The area directly above the incline on the back wall of the exhibit has an area of perforations for water intake to the sump. This perforated area measures approximately 12 cm high and extends the width of the tank. Directly above the perforated area is the water input into the tank. This consists of a narrow box which allows the water to fill behind the viewing area in the sump and then flow gently into the tank, dropping parallel to the perforated area. This keeps the moonjellys from being sucked into the perforations, and with the inclined bottom, I've created a kreisel of sorts circulating water from the bottom of the tank to the top and back down, similar to a ferris wheel, (see fig.1). Also note that the water flow into the tank must be free of air bubbles. This is critical as the jellys tend to get air bubbles within the bell which can be fatal.

The filtration of the tank was not as complicated as I first felt it would be. The filter is a standard biological filter supplied with bio balls. The major difference is that the tank operates with 2 pumps. Both of these pumps are piped directly into the sump for the bio filter. One pump is to maintain a flow from the sump over the bio media. The second pump is utilized for the current into the exhibit. This pump is valve regulated, first passing through a chiller, cooling the water to 15 degrees C., then dropping the water into the tank. The volume of water in the exhibit is passed through the filter at the rate of 1x per hour. This would be inadequate if it were the source of water passing over the bio media. The pump utilized for the bio media passed the water through the tower at a rate of 480 gal. per hour. Both pumps are prefiltered through a sponge. For a more complete detail, see fig. 2. Even though we are maintaining a high water quality with this system, we will be incorporating a sterilizer and protein skimmer in our future designs.

This tank has been in operation for almost 2 years now with great success. We have raised one group of jellys to adulthood feeding them freshly hatched artemia daily, which as been enriched with Selco. We recently collected our first polyps from the filter area and are maintaining them off display for the present.

At this time I would like to extend our thanks to Mark Furgeson and Freya Sommer at the Monterey Bay Aquarium for their design input and for our first stock of moonjellys and to Mike Helton, formerly of Summit Aquatics, for the final construction.

This tank was a prototype for a closed plankton system and we will continue to make improvements in our design. The basic design is broken down in fig. 1 and fig. 2. The only further recommendation I have is to make sure the output of the filter into the tank fully covers the perforations. Any spots not protected by the output will be a sure trap for the jellys. We tested the system out with diatomaceous earth to check for current and suction before introducing the jellys. This proved to be an effective test aid.

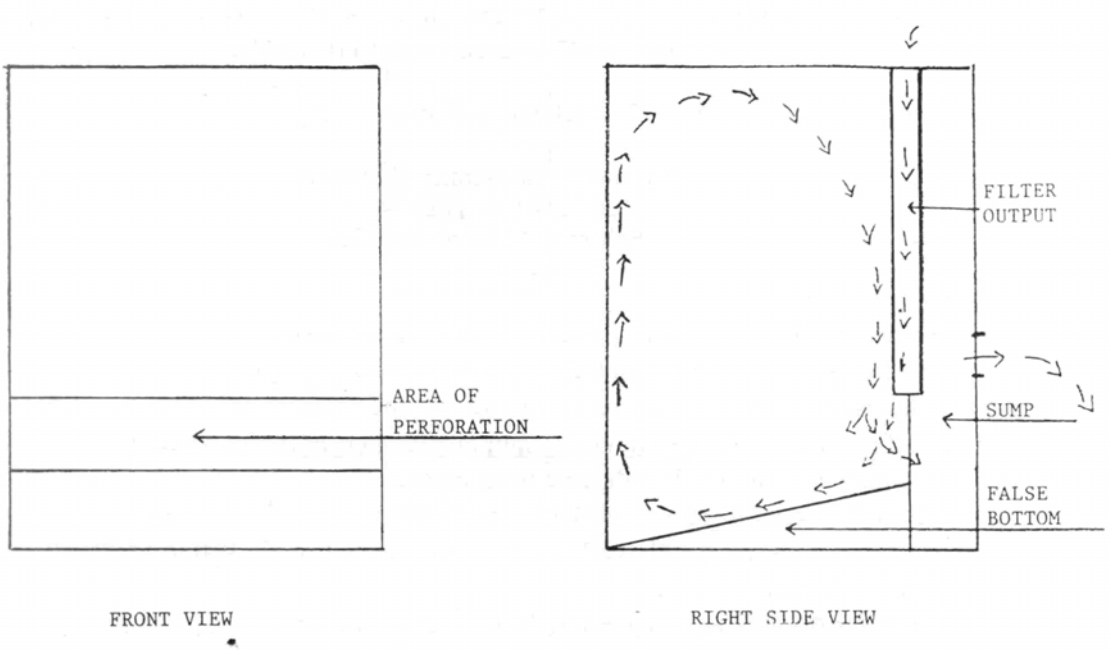

AREA OF
PERFORATION
FILTER
OUTPUT
SUMP
FALSE
BOTTOM
FRONT VIEW
RIGHT SIDE VIEW

FIG. 1

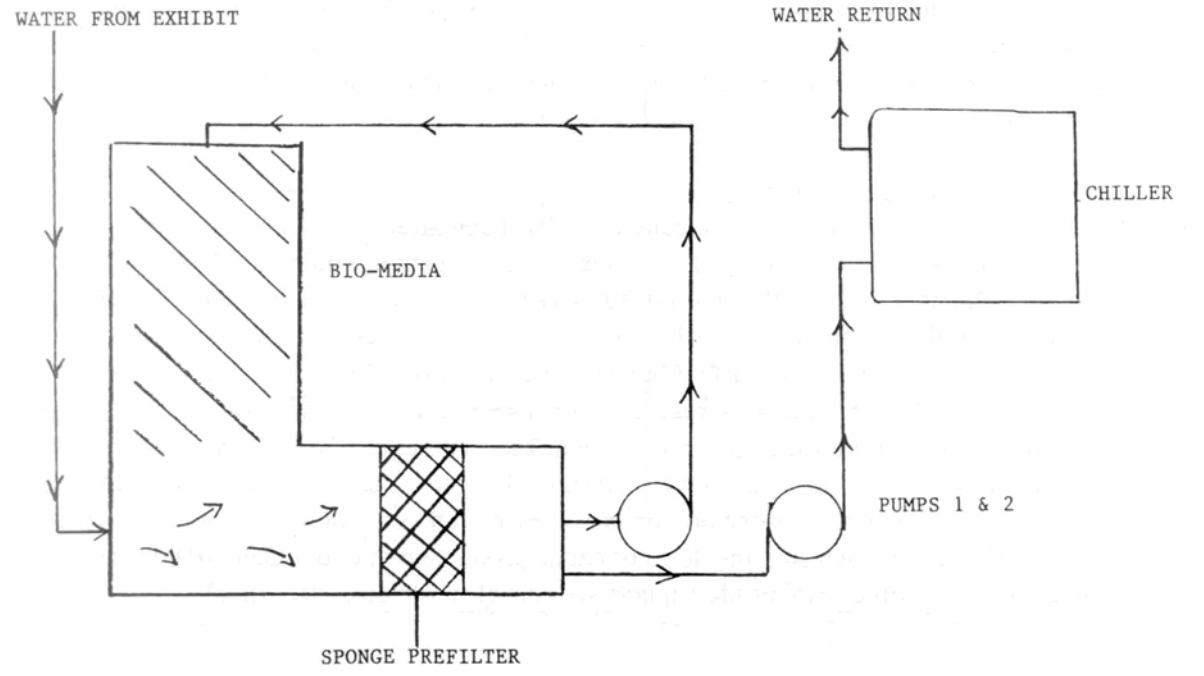

WATER FROM EXHIBIT
WATER RETURN
CHILLER
BIO-MEDIA
PUMPS 1 & 2
SPONGE PREFILTER

FIG. 2

DESIGN AND PRACTICAL APPLICATION OF A UNIQUE OZONE TREATMENT SYSTEM WITH MULTIPLE AQUATIC EXHIBITS

David L. LaBonne and Perry Hampton

National Aquarium in Baltimore, Pier 3, 501 E. Pratt Street, Baltimore, Maryland 21202

Introduction

Ozone has been applied to aquarium life support systems for almost two decades. As its chemistry has become more clearly understood, husbandry staff in the aquarium community have intensified their research into the effectiveness of ozone as a disinfectant and powerful oxidant. As system design and applications have improved, promising gains in water quality and animal health have been made.

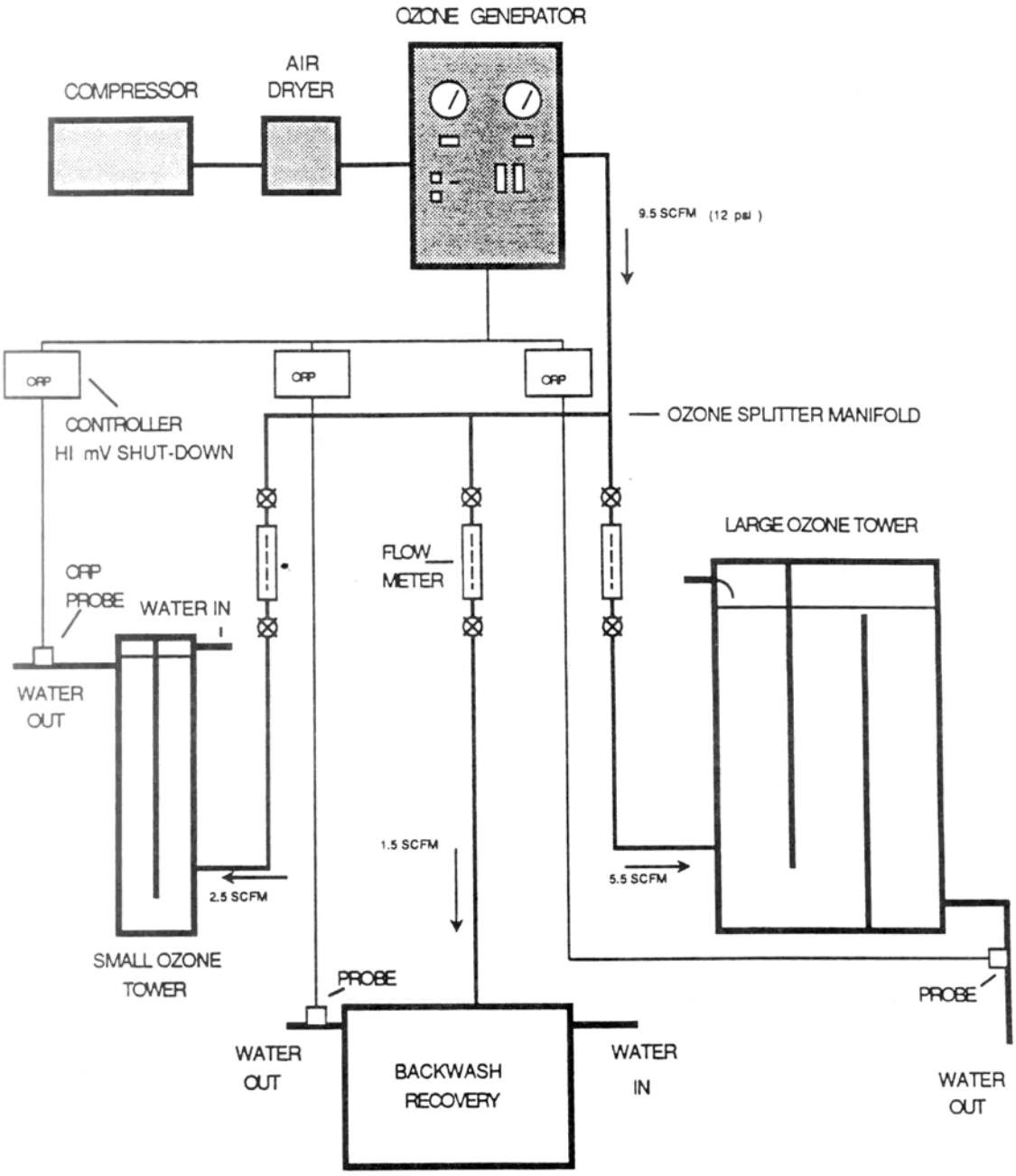
At the National Aquarium in Baltimore (NAIB), ozone has been applied to its larger exhibits for over eight years. These display volumes range from 75,000 to 1,500,000 gallons. In fact, for the aquarium industry as a whole, ozone use has been primarily reserved for aquatic displays of this size and greater. The logistics of operating exhibits of such volume have traditionally generated great demands on water and chemical use to maintain healthy environments. When ozone is applied successfully to these life support systems, good water quality can be sustained for longer periods. The cost savings in water and chemical use, as well as the more important benefit of a healthier exhibit, have encouraged facilities to pursue the larger applications. Also, as ozone technology has developed, the desire to automate systems has increased. Automated controls can also save on the operational cost of facilities.

Ozone Distribution and Control

Automated control of ozone generation has been attempted with varying degrees of success. The common technique of using Oxidation-Reduction Potential (ORP) probes to monitor oxidant residual within the life support loop or in the exhibit itself is beneficial. Connecting ORP probes to controller-monitors that feed back to ozone generators is a method that is used in the aquarium industry and the world of the fish hobbyist. When a present high millivolt reading is reached on these controllers, power is shut off of the generator. This is fine if that generator is dedicated to one exhibit. Operators, however, must monitor ORP before manually restarting the generator. This detracts from the principle of automation. If ozone production is distributed from one generator to more than one aquatic display, then shutting down of ozone production due to a high ORP reading in one deprives the other exhibit life support systems of treatment. (See Fig.1)

Another problem of multiple exhibit treatment from one ozone source is the distribution of the gas itself. Traditionally, fused glass diffusers or stones are used in large system applications. They require continuous air flow and pressure for good bubble size production. Manifolding the gas through splitters and flow meters is easy enough. (Fig.1). If a high ORP reading is received, the

TRADITIONAL OZONE DISTRIBUTION SYSTEM



Automated ozone distribution and control system with centralized shut-down capability.

Fig. 1

generator will shut down, creating the same problem as before. If the high ORP signal is instead sent to a solenoid air flow valve then ozone to that one exhibit would successfully be cut off. However, the other exhibits are dramatically affected. If, for instance, one-third of the total air flow is shut off by high ORP, then pressure increases in the generator when the total flow decreases. This results in a change of ozone concentration to the other life support systems. What might result is a domino effect with cut-off signals going to the other solenoid valves on the other systems when ORP values increase due to higher ozone doses. Once again automation would be disrupted with high pressured generator shut-down when most or all flow is cut off. An intensive hands-on approach is called for here, with operators adjusting gas flows and resetting generators. Automation suffers once again.

The NAIB, therefore, does not use automated ORP feedback control on ozone systems with diffuser stones. Ozone reaction chambers are monitored 24 hours a day. The doses applied are specific to each exhibit so shut-downs are almost non-existent. Years of testing and monitoring have given the staff a high level of confidence in the treatment of systems. The man-hours have piled up, however, and the desire for an automated system has increased.

The Gallery Ozone Project

The NAIB ha been so encouraged by its success in the ozone treatment of its major displays that in recent years this technology was transferred to smaller exhibits of 1,500 to 5,000 gallons. The doses and method of application require greater care and control of ozone systems due to the small system turnover times of less than one hour. This transfer of technology led us to what we believe is a big step in the right direction for automation of ozone control. An automated system was designed and then budgeted for the following gallery exhibit tanks. (Fig. 2).

Over the past five years the ozone application to the NAIB gallery exhibits followed the simple ORP feedback system described earlier, ie. one ozone generator, one ORP controller, dedicated to one exhibit. The generators were usually low in production (200 to 400 mg/hr.). The reactors were foam fractionators (Sanders Protein Skimmers). All the exhibits treated with these enhancements to life support benefited with superior water quality. Plants, corals and fish thrived. Bioloads on the systems naturally increased and the small generators were soon running at maximum, 24 hours a day. When breakdowns occurred, immediate effects on water quality were seen, initially in the areas of color and turbidity. A solution to this problem came with the gallery ozone project.

The greatest weakness to the old system was the inconsistent ozone output of the small generators. Air prep was limited to silica gel drying tubes which were rotated frequently. Some generators had no air prep and their output suffered.

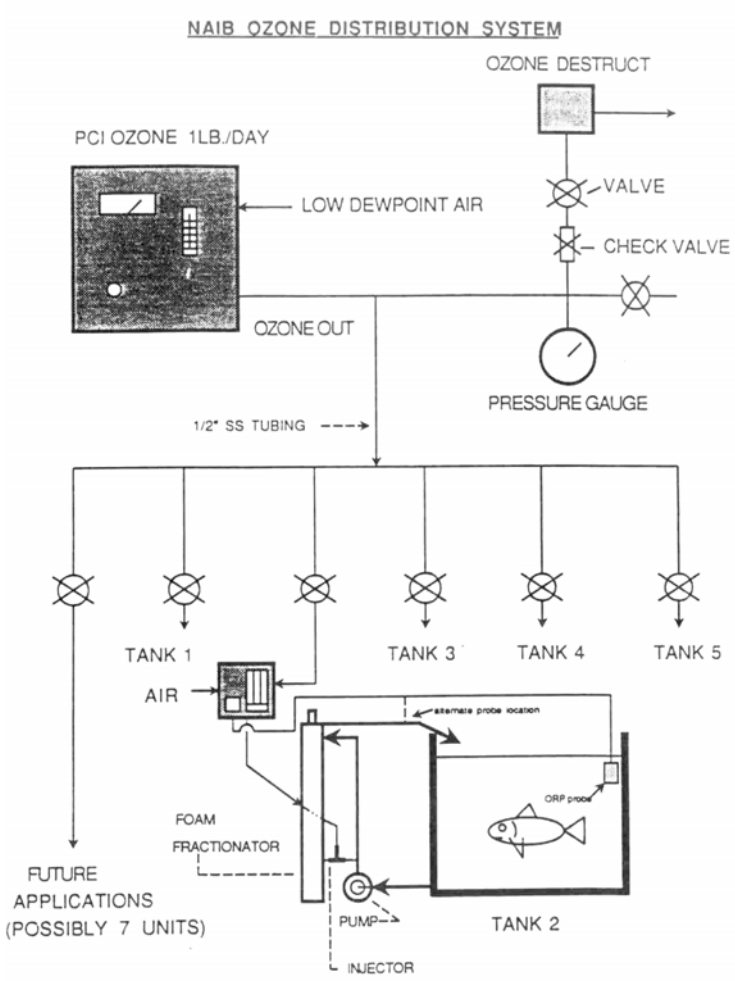
GALLERY EXHIBITS

Exhibit	gallons/liters	1/m flow through protein skimmer/reactor
Pacific Coral Reef (PCR)	4500/17000	45
Atlantic Tide Pool (ATP)	1500/5700	36
Pacific Tide Pool (PTP)	1500/5700	50
Live Coral Reef (LCR)	2000/7600	50
Migrating Exhibit	5500/20800	50

Fig.2

The only solution to consistent ozone generation with acceptable concentrations and air prep capability was to incorporate a true low frequency (50-60 Hz) water cooled ozone unit with low dewpoint air dryers. The lowest production models are usually 450 gm/day (1 lb./day). This was more than needed for the first five exhibit tanks to be upgraded, however, future budget allocations are approved for seven additional fish displays to be enhanced with ozone treatment.

The biggest obstacle to overcome was splitting and distributing the gas to each system with ORP feedback control so that if one ozone reactor would shut down, the others would continue to operate. (Figs. 3 & 4). This was overcome by using "Normally open" solenoid valves activated by a 4-20 m-amp signal to close when a high ORP reading is detected by the monitor/probe. (Figs. 3 & 4). Pressures do not build up in the other exhibit feed gas lines because diffuser stones (which are operated with positive pressure) were not used to bubble the gas into the protein skimmer reactors. (Figs. 3 & 4). Venturi injectors were incorporated to deliver the gas because they function by operating under negative pressure. (Fig. 3). Their performance in frationator/skimmers is superior to that of stone diffusers by generation of smaller bubble size. The quantity of air, bubble diameter and water flow are critical to the process of coagulation that takes place in these units. When enhanced by the proper ozone dose, removal of organic material becomes more efficient.[1] Further, the precise dosing in each reactor is possible due to separate ozone feed gas and supplemental air flow meters. (Fig. 4). The husbandry staff can monitor the water quality of the exhibit and increase or decrease the ozone dose without affecting the total air flow to the protein skimmer. Efficiency is constantly maintained whether ozone is running or not. Adjustments such as those mentioned have no effect on the other life support systems since the gas flow through the main feed loop remains almost constant. If two units shut off due to high ORP then the unused gas vents off through the ozone destruct unit. (Fig. 3). There is no danger of domino effect shut-downs.



Automated ozone distribution and control system with individual shut-down capability.

Fig. 3

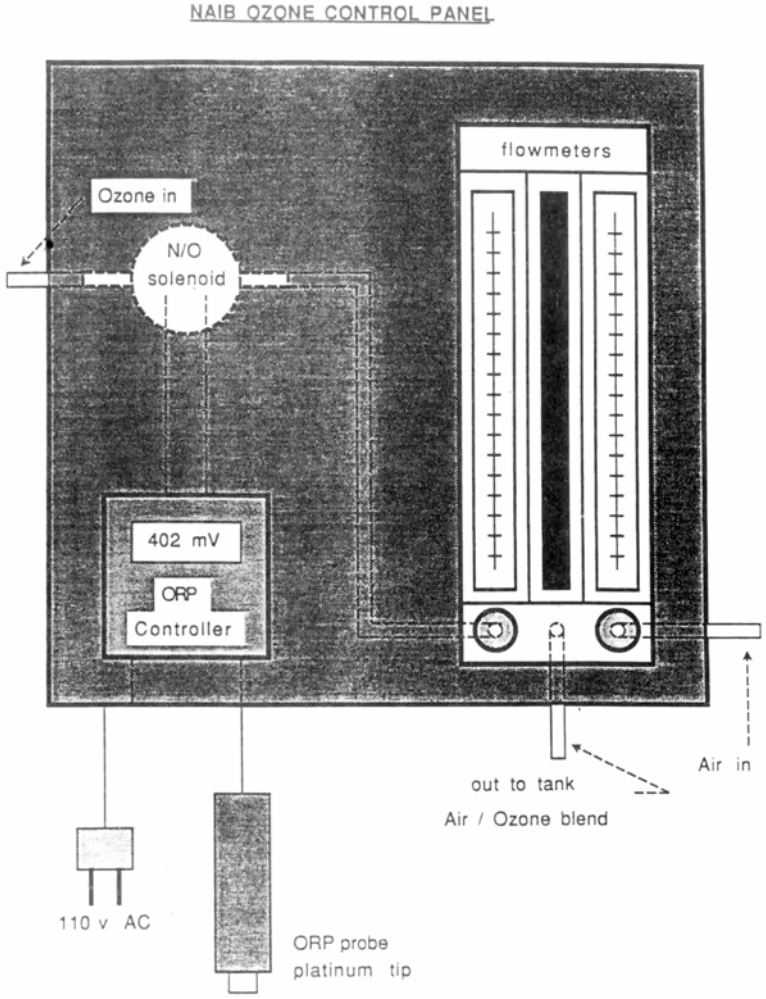


Fig. 4

Results and Summary

This system has operated continuously with two exhibits having reached shut-down ORP levels, without any malfunctions. (Fig. 5). All the displays connected have shown improved clarity and millivolt readings that are consistent with superior water quality. ORP (mv) values collected for NAIB artificial seawater plotted against ozone concentrations measured with indigo dye are shown in (Fig.6)[2]. No ozone residuals have been detected in any of the exhibits.

Initial studies of organic reduction, improved disinfection, pH stabilization, and animal health are being performed. It is too early in the process to present data that would be considered difinitive. However, if these ozone enhanced displays respond to this treatment as our larger exhibits have, then the NAIB will not only be pleased with this innovative design success but also a healthier environment for its animals in the galleries.

MATERIALS AND EQUIPMENT
LIST FOR THE NAIB OZONE CONTROL PANEL

COMPONENT	SPECIFICATIONS	SOURCE	COST
Janco pH/ORP Controller Model #3672	4-20 mA output Hi/Low With alarm	Cole Parmer Inst. Co. 7524 North Oak Park Ave. Chicago, IL 60648	$325
Furon Solenoid Valve MT2-122NOA1	Normally open	Cole Parmer Inst. Co.	$171
Gilmont Flowmeter	Direct reading A1, glass const. Customized parts	Gilmont Instruments 28W092 Commercial Ave. Barrington, IL 60010	$360
Corning Redox Electrode	Pt. tip. KC1 saturated	Curtin Matheson Scientific (CMS) Houston, TX 77251	$150
Tubing x Connector	1/8" NPT Stainless nipple	McMaster-Carr Supply Co. P.O. Box 440 New Brunswick, NJ 08903	$36
Teflon xx tubing	1/8" ID Heavy wall	McMaster-Carr Supply Co.	$18
PVC xxx	4' x 8' x ¼" Flat stock Sch. 80	Any local industrial plastics supplier	$10
			Approx. total cost per unit: $1,070

x = Approx. $6.00 each. Each unit requires 6.
xx = $1.50 / ft. Each unit requires about 12 ft.
xxx = Approx. $80.00 / sheet. 1 sheet makes about 8 units.

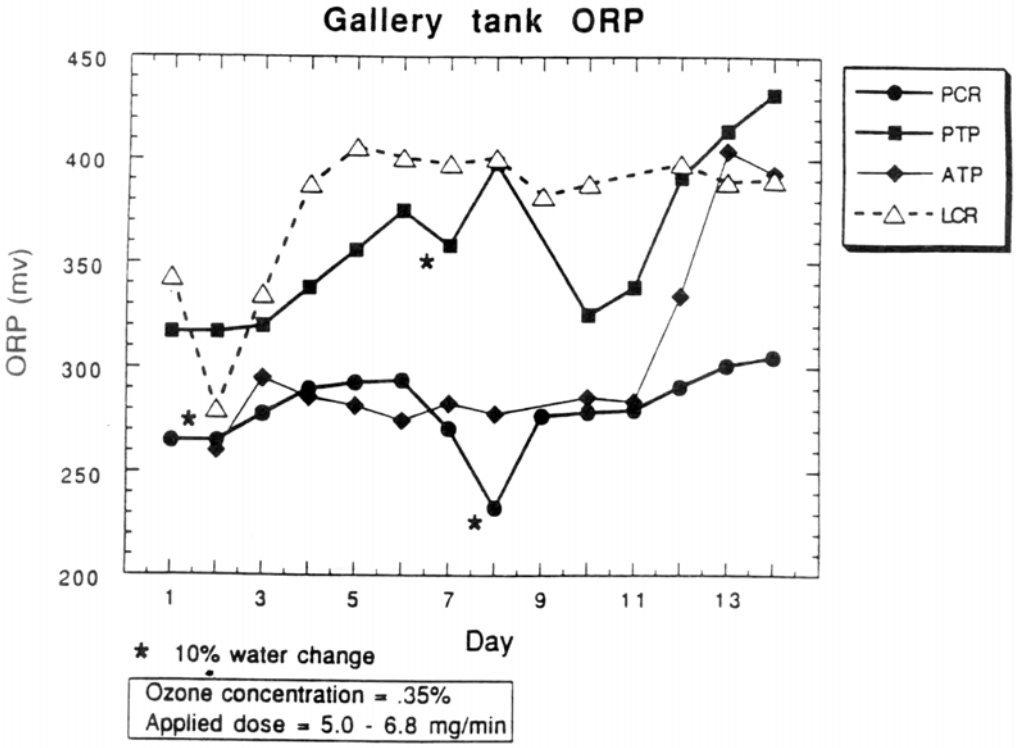

Gallery tank ORP
ORP (mv)
450
400
350
300
250
200
1
3
5
7
9
11
13
Day
PCR
PTP
ATP
LCR
* 10% water change
Ozone concentration = .35%
Applied dose = 5.0 - 6.8 mg/min

Fig. 5

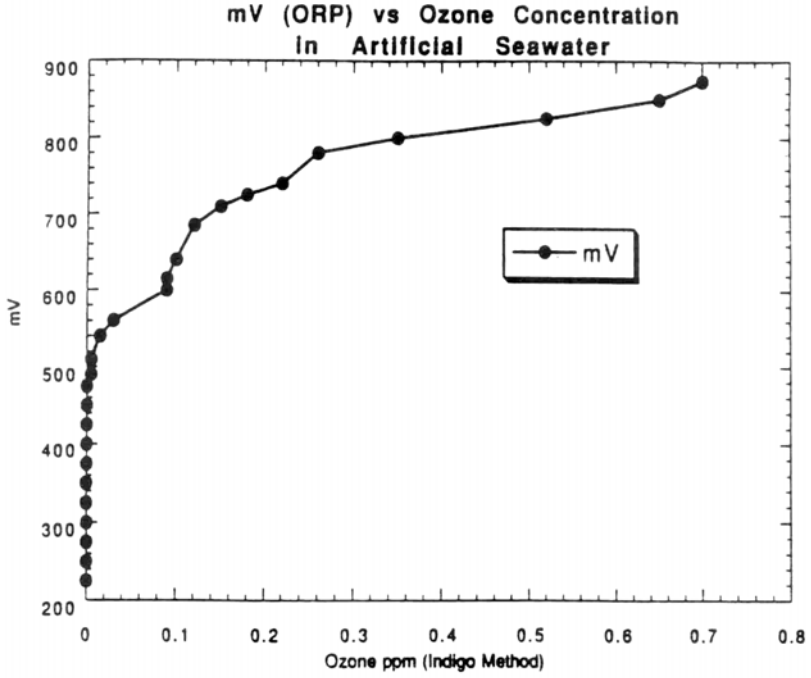

mV (ORP) vs Ozone Concentration
In Artificial Seawater
mV
900
800
700
600
500
400
300
200
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Ozone ppm (Indigo Method)
mV

Fig.

References

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2. David L. LaBonne. Analysis of Ozone in Aquatic Systems. AAZPA Annual Conference Proceedings, 1989, pp. 232-236.

Originally presented at the 3rd International Symposium on the Use of Ozone in Aquatic Systems. September 8-11, 1992.

Information on the availability of conference proceedings can be obtained through Walter Blogoslawski (203) 783-4235.

JORDANELLA FLORIDAE - AMERICAN FLAGFISH

Anna Stevenson

Calgary Aquarium Society BAP Report

The flagfish is an egg-laying toothcarp - family Cyprinodontidae and is largely found in southern Florida and the Yucatan.

These killifishes' habitat may be brackish marshes, ponds, and even shallow irrigation ditches and canals.

The American flagfish is often ignored by both the dealer and the aquarist since they do not show bold colours - as to behaviour they are most certainly a mono species tank fish. Although the colour pattern is variable these fishes are basically olive-green with a checkerboard pattern of dark stripes and reddish spots. Both sexes have a distinct black spot on the side, which is larger on the female. Sometimes the female sports a dark spot on the dorsal fin. During the breeding period they transform into an attractive fish covered with iridescent spots of all the colours of the rainbow. The female brightens up as well but the male is the peacock of the family.

Jordanella floridae males grow to approx. 2 1/2 inches (6 cm) while the female is slightly smaller but more robust body.

Conditioning

Being omnivorous the pair were fed a variety of live and home-made foods and heavy doses of spirulina. A five gallon tank was planted with temple plant since it grows nicely in brackish water, Java moss, gravel for digging a nest, coconut shells and a killie spawning mop to be used as a refuge for the female. The temperature ran about 75°F, pH 8 and a corner filter was added. Two teaspoons of salt per gallon was added to make the water brackish.

Spawning

The female began to dig small impressions in the gravel here and there for about a week. The American flagfish is known to use cichlid-fashion spawning procedures. The male is extremely rough although the female can turn the tables during the courtship. Once the spawning begins, they will lay eggs daily for several days to a week, usually in small batches of 20 eggs.

I observed the chase for about a week but did not see any eggs. The eggs are fairly large approx. 1 mm and clear. Once laid, the male will guard these by hovering over them, fanning with his fins. I did not see any such behaviour but the female was a lot thinner. Another spawning down the tubes! I could not be more wrong. Just to make sure I checked the killie spawning mop and, lo and behold, 75+ large eggs were deposited all singly in the strands of yarn.

I picked the eggs out of the mop and placed them in a large container - which floats on top of the surface of the tank - a usual procedure for my other killie eggs - and added Java moss.

In about 8 days the first fry began to hatch, and over several days, more than 50 fry of different sizes were swimming around.

Care of Fry

Microworms and finely powered spirulina were fed within a week to ten days the fry could easily be transferred to a five gallon tank set up similarly as the spawning tank.

One month later more than 20 fry no 1/4 inch made it past infancy. The larger fry do not hesitate to eat their brethren so be prepared for a much smaller batch than what was there originally. 10% water changes were done every two weeks. They fry grow and are sexually mature at three months.

Afterthoughts

1. Don't count on a rapid turn over to fellow hobbyists. The *Jordanella floridae* has a reputation of being pugnacious, classing it as a mono species fish and it is NOT super colourful.
2. The breeding male has departed hence (3 years old) and his partner is happily swimming in a 30 gallon brackish tank with puffer, scat, orange chromide and glassfish.
3. The 20 plus fry are set up in a 20 gallon tank and are now 1 1/2 inches or more. Again lots of plants, caves (coconut shells) gravel. The fry are growing like weeds.
4. Hope to spawn the flagfish again at a later date but without a mop so I can observe the pit with the male guarding the nest and the fry being led around by the male in `cichlid style'.

References

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POSTER ABSTRACTS
"Conservation Genetics and Evolutionary Ecology: A Case study of the Cichlid Fauna of Lake Victoria"
Poster Session S. Columbus OH, Oct. 30 – Nov.2, 1992

Anki Larsson, Sue Allen, Chris Lutmerding, Columbus Zoo Docent Assoc., P.O. Box 400, Powell, OH. 43065.
"GETTING IN TOUCH": A PROACTIVE APPROACH TO CONSERVATION EDUCATION.

The TIDE POOL at the Johnson Aquatic Complex represents an 'in touch' program for conservation education. Staff and volunteers man a salt water touch pool providing visitors with a unique opportunity to "get up close and personal" with selected marine invertebrates. The use of constructed tide pool "trash" stimulates discussion of pollution and the general degradation of marine, estuarine and coastal environments. Visitors are encouraged to interact with living and preserved biofacts. This stimulates discussion of marine life processes and environmental interaction. School groups appreciate this gentle approach to conservation education, and teachers and visitors make a point of returning nearly to the tide pool.

S.L. Parker, V. Weaver, and K.L. Brown, Dept. of Biol. Sci., Wichita State University, Wichita, KS 67208.
EFFECTS OF URBAN POLLUTION ON GENETIC VARIATION OF N0TROPIS SPECIES

High levels of genetic variation have been shown to enhance fitness characters (eg., growth rate, survivorship) in a variety of aquatic organisms. Also, several hypotheses predict that relatively more heterozygous individuals have broader tolerance to environmental change. However, few studies have tested this. If pollutants lead to differential mortality of less heterozygous individuals, populations in perturbed habitats should exhibit greater levels of genetic variation. Our study was conducted to examine the effects of urban pollution on the genetic structure of two common minnow species.

The Arkansas River between Bentley and Oxford KS, includes areas of relatively high and low urban impact, particularly from sewage effluents. In both March and August 1990, approximately 50 sand shiners, *Notropis stramineus*, and 50 emerald shiners, *N. atherinoides*, were collected by random seining from seven locations along this section of the river. Standard measures of water chemistry were recorded at each location. Starch gel electrophoresis was used to assay phenotypes of 19 and 15 genetic loci of the sand and emerald shiner, respectively. For fish sampled at each site, estimates of average heterozygosity, population polymorphism, and allelic diversity were determined. Results for both species sampled in March indicate that values of allelic diversity and population polymorphism were higher at sites of comparatively greater levels of nitrate and phosphate. Preliminary results of the August data are suggestive of the same trend. These observations indicate an association between urban pollution and population genetic structure.

Swingle W.M., D.I. Warmolts, J.A. Keinath, and J.A. Musick. Virginia Marine Science Museum, 717 General Booth Blvd., Virginia Beach, VA. 23451., Columbus Zoo, P.O.Box 400.,Powell,OH. 43065.. Virginia Institute of Marine Science, Rte. 1208., Glousester Pt.,Va. 23062
LOGGERHEAD SEA TURTLE HEAD-START EVALUATION: CAPTIVE GROWTH RATES AND POST RELEASE MOVEMENTS AND BEHAVIOR.

In 1989, the Columbus Zoo and the Virginia Marine Science Museum (VMSM) joined in a cooperative research program with the Virginia Institute of Marine Science (VIMS) and the Back Bay National Wildlife Refuge (BBNWR) (U.S. Fish & Wildlife Service) to evaluate the effectiveness of head-starting loggerhead sea turtles. A total of 17 loggerhead hatchlings were collected from their nesting beach at Back Bay and distributed amongst the participants where they were reared for a 23 month period. During this period weekly measurements were made on each turtle consisting of 3 carapace, 3 plastron and measurements. In addition, the mass of food ingested daily per turtle was recorded. Comparisons of our growth rates with those from previous studies reveal extremely rapid development of our young turtles. This study constitutes one of the most detailed studies of captive loggerhead sea turtle growth rates to date.

In September 1991, the loggerhead sea turtles in this study were released to the wild at BBNWR. The 6 largest turtles were released outfitted with an ARGOS compatible satellite transmitter attached to their carapace and their post release movements and diving behavior was monitored. Transmitter position, diving/surfacing data, temperature, speed, and direction were among the data collected. This data was then compared to the post release movements of tracked wild loggerhead turtles and a captive raised loggerhead tracked by the Columbus Zoo and VIMS in 1989.

Henningsen, A.D., B. Hecker, and C. Andrews. National Aquarium in Baltimore, Pier 3, 501 E. Pratt St., Baltimore, MD 21202.

FISH BREEDING PROGRAM AT THE NATIONAL AQUARIUM IN BALTIMORE

The National Aquarium in Baltimore (NAIB) established a fish breeding program in 1989 with the neon goby, *Gobiosoma oceanops* as the pilot species. In 1992, the NAIB began collaborating with the University of Maryland's Center of Marine Biotechnology (COMB) in an effort to rear two additional species of tropical marine fishes, the high hat, *Equetus acuminatus*, and the smallmouth grunt, *Haemulon chrysargyreum*. The techniques being used include manipulation of environmental cues, routine biopsies, and intramuscular injection of hormones.

Hoelzer, G.A., P. Stacey, C. Stockwell, R. Gerhardt and A. Hodgson. University of Nevada Reno, Reno, NV 89557.

RAPD GENETIC ANALYSES OF ENDANGERED POPULATIONS

The PCR-based technique of random amplified polymorphic DNA (RAPD) is currently being used at the University of Nevada Reno to characterize the relative levels of genetic variability within, and divergence between, animal populations. Preliminary results from two such projects are presented here. The first project is aimed at assessing the genetic variability in a series of mosquitofish, *Gambusia affinis*, populations. The history of transplantation is known for these populations where each population was founded by a "small" number of individuals from the previous population. Thus we expect that each population will contain a subset of the genetic variability present in its donor population. The second study is designed to appraise the genetic variability within and between populations of the potentially endangered Mexican spotted owl, *Strix occidentalis mexicanus*. These data should also provide information about the rate of gene flow between populations. Our preliminary data demonstrate the promise RAPD holds for these purposes. We are currently optimizing the PCR protocol to consistently yield a small number of bands (2-6 per reaction) that can be repeatedly be scored with confidence.

Thompson, Todd N. and Dwight W. Moore. Emporia State University, Emporia, KS 66801.

CORRELATION BETWEEN GENETIC DIVERSITY IN THE NUCLEAR GENOME AND GENETIC DIVERSITY IN THE MITOCHONDRIAL GENOME.

The purpose of this study was to examine the correlation between genetic diversity in the nuclear genome and genetic diversity in the mitochondrial genome. Specifically, we tested the hypothesis that within populations there is a correlation between the mean number of alleles per locus, as determined by electrophoretic data, and the mean number of mitochondrial fragment patters,as determined by restriction digest data. We collected data on mean number of alleles and mean number of literature. These studies included data on five taxa, four fish and one mammal. There was a significant correlation ($r = 0.67$, $p < 0.001$) between diversity in the nuclear genome and diversity in the mitochondrial genome. These results indicate that either protein electrophoresis or restriction site data from mitochondrial DNA can be used to assess within population variation and that either technique yields valuable information concerning the relative amounts of genetic diversity within populations.

Booton, Gregory C., Mustafa Karl, and Paul A. Fuerst. Department of Molecular Genetics, The Ohio State University, Columbus, OH 43210.

ANALYSIS OF THE PRIMARY AND SECONDARY STRUCTURE OF THE 18S rDNA FROM A REPRESENTATIVE HAPLOCHROMINE SPECIES OF LAKE VICTORIA, Haplochromis simpsoni.

The small and large subunit (18S and 28S respectively) ribosomal RNA genes (rDNA) are among the most useful and phylogenetically informative molecules currently available for the analysis of evolutionary divergence. Many regions of these molecules are evolutionarily conserved across even distantly related taxa, while other regions rapidly diverge. This unique combination allows the alignment of sequences from diverse organisms using the nearly invariant areas, with the subsequent phylogenetic reconstruction of evolutionary history of this molecule being performed using the remaining variable regions. In our research we have begun an examination the phylogenetic relationships between portions of the African Great Lakes cichlid fauna by analysis of the 18S rDNA. DNA from this gene was obtained using PCR with a set of primers which flank virtually the entire (about 1800 base) gene. At this time, we have determined the primary sequence of the 18S rDNA of the Lake Victoria cichlid *Haplochromis simpsoni*, and compared our sequence with the primary sequence of the South African clawed frog *Xenopus laevis* The frog sequence was used for comparison because no 18S rDNA sequence is available from fish. In addition, we have constructed the proposed secondary sequence of this molecule in both *Haplochromis simpsoni* and *X laevis* based on the currently accepted model of eukaryotic secondary structure. Our future plans are to sequence the 18S rDNA from some other cichlid taxa of the Af rican Great Lakes and perform a phyloqenetic analysis base on this data. (This work is supported by a

Goertmiller, T.R., Smithsonian Institution, Washington, D.C. 20560.

CAPTIVE LIVING ECOSYSTEMS: JUST ANOTHER FISHTANK???

The development of captive living ecosystems requires duplication of certain environmental conditions that exist in the wild. Nutrient levels (NO2-NO3) daily photoperiod (light intensities), water temperature, salinity, pH, organic levels and tidal fluctuations are very important for growth and reproduction of plant and algal species and for many animals. Two ecosystems were modeled. The 135 gallon tropical coral reef and the 100 gallon temperate coast of Maine. Although parametrically similar, specific concentrations and fluctuations of conditions makes these systems extremely diverse. Coral reef water quality is maintained by the use of an algal turf scrubber at 0.3 to 2.0 umol; light levels between 700-1800 uE/m2; water temperature 24.0 to 30.0 °C; salinity 35.0 to 38.0 ppt; pH 8.2 to 8.3; tidal levels -4.0 to 4.0 feet. The Maine Coast Ecosystem is also maintained by an algal turf scrubber although nutrients are higher at 2.0 to 20.0 umol; light levels at 150 to 800 uE/m^2; water temperature 4.0 to 12.0 °C; salinity 28.0 to 32.0 ppt; pH 7.5 to 8.2; tidal levels -8.0 to 8.0 feet. Due to the sizes of the system the tidal parameter has been scaled down. These are totally living ecosystems functioning as they would in the wild. Species diversity and abundance are partially controlled by the aquarist. Ile systems approach to exhibiting aquatic environments provides both a research tool for understanding natural processes that occur and an educational resource for public involvement. Reproductive behavior may be enhanced since the plants and animals are associated with a habitat in which they normally live. Competitive interactions for food and space may also be compared to the wild environment. These self-contained ecosystems may provide a better understanding of the many ecosystems of the world.

John R. Benn (3901 Hatch Boulevard, Sheffield, AL 35660) and John Farrell Kuhns (AquaScience Research Group, Inc., 1100 Gentry Street, North Kansas City, MO 64116)

FISHNET, THE INTERNATIONAL COMPUTER NETWORK.

A historical perspective and a brief exposition of the current functioning, including brief descriptions of each of the message boards and data libraries, of the international computer network, FISHNET, is presented in this poster. FISHNET is a computer information exchange service for people interested in fish, aquaria, invertebrates and ponds. Its more than 6000 members are general aquarium hobbyists as well as public aquarium administrators, aquarium product manufacturers, fish farmers and breeders, retailers and wholesalers from all over the world. FISHNET is composed of two forums on CompuServe. The Aquarium Fish Forum (AFF) offers message boards for questions and problems, librariers of information on aquarium-related topics, and conferences for specialized topics or general get-togethers for fish enthusiasts. The Aquatic Data Center (ADC) is primarily a reference resource with technical research databases, aquarium product information and Customer Support Service with representatives of aquarium product vendors.

Booton, Gregory C., Heather M. Cooper, and Paul A. Fuerst. Department of Molecular Genetics, The Ohio State University, Columbus, OH 43210.

PRELIMINARY DETERMINATION OF SPECIES SPECIFIC GENETIC PROFILES (SSGP's) USING RANDOMLY AMPLIFIED POLYMORPHIC DNA (RAPD) PRIMERS IN LAKE VICTORIA CICHLIDS

The recent decimation of the cichlid fauna of Lake Victoria has led to the initiation of an international program to preserve a portion of this extraordinary fauna. Approximately 10% (or 40 species) of the original taxa of the lake have been selected for ex situ conservation for possible restoration into the wild. For this program to be successful, accurate and rapid determination of species designation is required. The Lake Victoria cichlid fauna contains a number of species which are similar phenotypically, as assessed by dentition, male coloration, and other minor morphological differences. For these reasons accurate and rapid species determination based solely on morphology is sometimes questionable and often relies on sacrificed individuals. in an attempt to remedy this situation, we are developing species specific genetic profiles (SSGP's) based on the automated Polymerase Chain Reaction (PCR) using Randomly Amplified Polymorphic DNA (RAPD) primers. RAPD primers are oligonucleotide decamers used to anonymously amplify amenable anonymous regions of genomic DNA which happen to be flanked by the primer sequence found in opposite orientation. Hundreds of RAPD primers are now commercially available. We have begun a preliminary screening of primers to determine which produce consistent, readily interpretable banding patterns when analyzed by gel electrophoresis. A set of primers which produce reliable patterns be combined to construct a SSGP. The "type" patterns can be compared with the patterns of fish to be introduced into the breeding program. In addition, RAPD's can be used in a nearly non-invasive manner, using DNA extracted from a small tissue sample, eg. a fin snip. Our preliminary studies have identified patterns which are specific for several taxa in the breeding program. Also, one species, *Psammochromis riponianis*, was previously in the program but dropped because it was suspected of being a hybrid, produces extraordinarily highly variable patterns between sampled individuals. Future studies will concentrate on expanding the number of primers screened so SSGP's may be produced for all species in the program. (Research supported by a grant from the Columbus Zoo).

Johnson, O.W., G.B. Milner and F.W. Waknitz. National Marine Fisheries Service, Coastal Zone and Estuarine Studies, 2725 Montlake Blvd. E., Seattle, WA 98112.

GENETIC CONSIDERATIONS IN THE STATUS REVIEW OF LOWER COLUM13IA RIVER COHO SALMON.

In June 1990, Oregon Trout, Oregon Natural Resources Council, Northwest Environmental Defense Center, American Rivers, and the Oregon and Idaho Chapters of the American Fisheries Society petitioned the National Marine Fisheries Service (NMFS) to list coho salmon *(Oncorhynchus kisutch)* in the lower Columbia River (LCR) as an endangered species. NMFS conducted a status review of existing information to determine whether LCR coho salmon qualify as a "species" as defined by the U.S. Endangered Species Act (ESA). NMFS' policy is that for a population to qualify as a species under the ESA, it must represent an evolutionary significant unit (ESU) of the biological species. An ESU is defined as a population that is reproductively isolated from other conspecific populations and represents an important component in the evolutionary legacy of the biological species. The status review of biological information on LCR coho salmon covered life history, historical and current abundance, history of hatchery stocks and outplantings, effects of parasitism and biochemical genetics.

The genetic portion of the status review considered morphological and electrophoretic studies of coho salmon from the Pacific Northwest. To help evaluate the population structure of LCR coho salmon, NMFS also collected some fish samples from LCR streams and hatcheries for allozyme analysis. This provided data for genetic characters (gene loci) from 16 populations. These data were compared with published and unpublished genetic data from a variety of sources.

No clear evidence was found of the continued existence of a distinct population of naturally spawning coho salmon in the LCR that would qualify as an ESU. However, indications of possible genetic differences between the LCR and Washington or Oregon coastal coho salmon were seen in some analyses. While NMFS did not recommend listing, the decision did not exclude the possibility that a population that would qualify for ESA protection still exists, only that there was inadequate evidence at the time to make such a recommendation. Studies to clarify the population structure of coho salmon in the LCR and nearby coastal regions are discussed.

Klein, D.B., H. Ono, C. O'hUigin, V. Vincek, and J. Klein. Department of Microbiology and Immunology, University of Miami School of Medicine, Miami, FL 33101 and Max-Planck-Institut für Biologie, Abteilung Immungenetik, 7400 Tubingen, Germany.

EXTENSIVE Mhc VARIABILITY IN AFRICAN CICHLID FISHES

The major histocompatibility complex, Mhc, is a cluster of genes controlling the immune response of vertebrates to parasites. In mammals, the functional Mhc loci are characterized by high polymorphism and the Mhc alleles often differ by more than a hundred nucleotide substitutions. A collection of alleles is passed on from species to species during speciation in a trans-species manner. These characteristics make the Mhc polmorphism an ideal tool for studying phylogenetic relationships in flock species. We have cloned and sequenced the expressed class II Mhc genes of one cichlid species and on the basis of the sequence have designed oligonucleotide primers which enabled us to sequence the most variable region of these genes from different species very rapidly by the polymerase chain reaction (PCR). We have thus far obtained 35 sequences of Mhc class II genes from 12 species of African cichlids. The results suggest that the founding populations from which the cichlids of the African lakes radiated were highly polymorphic at their Mhc loci and that during radiation, different Mhc alleles were distributed into different species. It should therefore be possible to trace cichlid phylogenetic lineages through their Mhc polymorphism.

Schug, Malcolm D., Greg C. Booton*, and Paul A. Fuerst*, Department of Zoology and *Department of Molecular Genetics, Ohio State University, Columbus, OH 43210.

LACK OF POPULATION VARIATION FOR THE FIRST INTRON OF BETAGLOBIN BETWEEN BLUE HOLE POPULATIONS OF Gambusia hubbsi.

The distribution of *Gambusia hubbsi* on Andros Island, Commonwealth of the Bahamas, reflects the current and historical distribution of freshwater on the island. Vertical caves called blueholes which existed when sea levels were more than 100m lower than today filled with freshwater and became available for colonization by *G. hubbsi* as glaciers melted. Different depths of blueholes represent different dates of possible colonization events. Today, there are more than 50 blueholes, most of which contain isolated populations of *G, hubbsi*. In an attempt to construct a phylogeny which represents the history of colonization events among the blueholes, we sequenced the first intron of the beta-globin gene among individuals from several of the oldest blueholes. It was expected that this region would reveal sufficient allelic diversity to discriminate among the these populations. However, sequencing of four individuals each from five sites failed to reveal a single sequence difference. Furthermore, sequence of the same intron from a distantly related species, *G. affinis* revealed only two nucleotide differences. To determine whether genetic variability was completely absent from these populations, analysis of VNTR loci using Jeffreys probe 33.15 was performed. This study revealed significant differences among some of the sites. In *Gambusia* species, the beta globin intron may evolve more slowly than expected if we use an estimate based on the rate of evolution of introns in general.

Stephon, D., Rainbowfish Study Group of North America, 3185 Thornapple Drive, Lancaster, PA. 17601.

***MELANOTAENIA EACHAMENSIS* .... RESURRECTING A SPECIES FROM EXTINCTION.**

Melanotaenia eachamensis represents, as a "splendida type descendent, another example of the rapid rate of speciation of the family Melanotaeniidae. Evolving, presumably, from an ancient isolated population of rainbowfish of the splendida lineage, in Lake Eacham, Atherton Tablelands, Queensland, Australia, this species was proclaimed extinct in its native biotope in the late 1980s. What happened to this rainbowfish, left undisturbed for thousands of years, to allow it to vanish overnight from the wild? Fisheries biologists suspected and later confirmed the introduction of non-endemic predatory species which led to the demise of the Lake Eacham rainbowfish. A 1989 effort by the Australia New Guinea Fish Association to reintroduce the species to Lake Eacham has not been successful. A proposal has been made, but not yet implemented, which would utilize the overstocking of a secondary predator to eradicate non-endemic species, followed by another attempt at reintroduction of M. eachamensis. Meanwhile a captive breeding program is being coordinated through public aquariums to maintain the species.

Verheyen, E., Royal Belgian Institute of Natural Sciences, Brussels, Belgium & Snoeks, J., Royal Museum of Central Africa, Tervuren, Belgium.

ALPHA-TAXONOMICAL STUDIES ON TANGANYIKA CICHLIDAE USING mtDNA SEQUENCES

A recent study has shown high genetic divergence among geographic distinct populations of the endemic Tanganyika *Tropheus*-lineage [1]. One conclusion suggested by the results of that study is that the number of *Tropheus* species actually present in Lake Tanganyika may be considerably higher than six -which is the number of *Tropheus* species currently recognised based upon morphological and ethological criteria.

The answer to the question whether, or to what extent, the actually accepted number of species in *Tropheus* - and other Tanganyika cichlid -lineages underestimates the 'real' number of species would certainly have important consequences in light of the increasing concern about the species diversity in the endemic fauna of lake Tanganyika.

We propose to conduct an alpha-taxonomical study on the most important cichlid lineages of Lake Tanganyika. For this purpose we have started a sequencing project (D-loop and cytb of mtDNA) using tissue samples of the approximately 1500 cichlids we collected (41 genera, 85 species) over about 500 km of the eastern shores of Lake Tanganyika (May-June 1992).

[1]C. Sturmbauer & A. Meyer (1992) - Nature 358: 578-581

D.I. Warmolts, S.U. Andromeda, and D. Ross. Columbus Zoo, P.O. Box 400, Powell, OH 43065. Ohio Division of Wildlife, ODNR, Fountain Square, OH 43224.

RECOVERY OF THE WESTERN BANDED KILLIFISH: A UNIQUE PARTNERSHIP AND APPROACH

The western banded killifish has been recorded from Lake Erie, the western Ohio tributaries to Lake Erie and a very few small lakes, notably Miller Blue Hole in Sandusky county. Since 1980, the species has only been seen in Miller Blue Hole. 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 Code. 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 Columbus Zoological Gardens and the Ohio Division of Wildlife (ODNR) 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. 2) To increase awareness and appreciation of the endangered fish. The former objective involves the protection of existing populations and the establishment of three additional self-sustaining populations in protected habitats. The latter involves acquainting 10,000 intermediate school children with this species and its management.

In 1991, a small temperature controlled greenhouse was built on Zoo grounds containing 6-350 gallon pools. 36 wild killifish were collected from the Blue Hole and distributed amongst the pools. Our studies focused on documenting its early life history, determining spawning site preferences, and establishing breeding protocol for producing killifish in numbers required for translocation. On 3 December 1991, 365 killifish propagated at the Columbus Zoo were introduced to a protected pond near Xenia, Ohio. a visual survey of the pond the following spring suggests that the introduced population is thriving.

WATER VOLUME IN AQUARIUM GRAVEL
(or: how I spent my lunch hour)

Once a medication has been chosen to treat an aquarium for a disease, and the concentration to be used has been established, one needs to determine the total volume of water contained in the aquarium. For a bare, rectangular, quarantine tank, this is a simple matter. Calculating the volume of exhibit tanks, some with triangular edges or circular shapes can be more difficult. Still, most aquarists find this nothing more than a mathematical exercise. Usually, one measures the tank depth used in these calculations from the surface of the water to the top of the gravel. Careful aquarists will also estimate the volume of water displaced by the tank decorations, as well as water contained in the pipes and boxes of any attached filtration systems. Common sense tells us that there is also some water between the gravel grains, but most people ignore that volume. In giving that idea some thought, I realized that I was discounting this hidden volume because, "that's what most people do". In fact I had no idea how much water is actually contained within the interstices of aquarium gravel. I decided to perform a series of simple tests to estimate the volume of this water. A 500 ml graduate cylinder was filled with each of four varieties of gravel examined. Water was then added to fill the spaces between the gravel grains. This water was then drained off and the volume measured.

The amount of water contained between the gravel grains of these samples ranged from 33% to 40% by volume. The degree to which a gravel packed when added to the cylinder seemed to have more of an effect on the water volume than did gravel size or shape.

Based on these figures, I believe that the amount of water contained between the gravel grains of an aquarium should be considered in any aquarium volume calculation where there is either a thick gravel bed, or the dosage of the chosen medication is critical. In practical use, one might simply calculate the volume of the gravel bed and then estimate that 35% of this volume is water.

Jay Hemdal
Toledo Zoo

FishFAX

In February 1992, Dr. Paul Loiselle of the New York Aquarium initiated a FAX tree designed to expedite the distribution of surplus animals. "Member" institutions fax their lists to Paul, and these are promptly faxed to the first person on your "tree" and so on down the line.

If you are not already participating in this tree and would like more information, please fax Dr. Loiselle at (718) 365-3420.

1993 ELECTRONIC AQUARIUM CONFERENCE SET FEBRUARY 19-21 on FISHNET

The seventh annual Winter Weekend Workshop (W/W/W/7) has been scheduled for February 19 through 21, 1993.

The electronic conference will include lectures on aquarium-related topics with opportunities for questions and answers, games, prizes, "hospitality rooms", information about aquarium products and services and a chance to meet aquarists from around the country and abroad. One and two hour on-line lectures are expected to cover a variety of topics of interest to freshwater, saltwater and reef aquarists with information for beginners as well as advanced hobbyists.

Those attending lectures and participating in games and puzzles will be able to earn "Fishy Bucks" to spend at the "no-money" auction Sunday night on items donated by aquarium product vendors and other organizations. A full conference schedule will be available on FISHNET prior to the start of WWW7. This schedule will be in the Community Library (Library 7). Information updates on speakers, prizes donated, game rules and schedules will be available in Message Section 6, FISHNET Information Section. The access command on CompuServe is "GO Aquaforum."

FISHNET is a computer information exchange service on CompuServe for people interested in fish, aquaria, invertebrates and ponds. Its more than 6000 members are general aquarium hobbyists as well as public aquarium administrators, aquarium product manufacturers, fish farmers and breeders, retailers and wholesalers.

FISHNET is composed of two forums. The Aquarium Fish Forum (AFF) offers message boards for questions and problems, libraries of information on aquarium-related topics, and conferences for specialized topics or general get-togethers for fish enthusiasts. The Aqua Data Center (ADC) is primarily a reference resource with technical research databases, aquarium product information and a Customer Support Service with representatives of aquarium product vendors.

A free introductory membership on CompuServe with a $15 usage credit is available by calling 1-800-524-3388 and asking for Rep #164.

John R. Benn, FISHNET Director
205-381-4945, (Fax) 383-7615, (voice) 383-3009

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NEW ENGLAND AQUARIUM TO HOST 3RD INTERNATIONAL AQUARIUM CONGRESS

The New England Aquarium will host the 3rd International Aquarium Congress, Sunday, April 25-Thursday, April 29, 1993 at Boston's Park Plaza Hotel. The conference theme is "Aquarium 2000: The Next Generation."

The Aquarium Congress is an excellent forum for aquarium professionals from around the world to look toward the 21st Century. Conference sessions will focus on advances in biology, animal care, and aquaculture, as well as new directions in conservation and education.

For further information about abstract submissions, conference registration, and logistics such as discount airline and hotel rates, please call Kim Heywood, (617) 973-6587.

Andrea Conley, New England Aquarium (617) 973-5222.

THE REGIONAL AQUATICS WORKSHOP (RAW)

A few years ago a small group of public aquariums began to get together twice a year to discuss husbandry, exhibits and research. These extremely informal and inexpensive meetings include a tour of the host facility and a few low key presentations by participants. The typical RAW participant is from an inland aquarium in a Great Lakes or Mississippi River state, and eighteen public aquaria have participated in at least one Regional Aquatics Workshop to date.

The next meeting will be held at the Tennessee Aquarium this spring. Contact Chris Coco at (615) 265-0695 for more information.

-- Pete Mohan

FFTAG FAX

In 1991, Paul Loiselle of the New York Aquarium established a Fish Fax Tree to improve communications amongst public aquariums and aquarists in placing surplus animals and locating new animals. This program has proven itself to be very effective.

I would like to propose that a similar Fax Tree be established for Endangered Fishes Breeding Conservation Programs under the auspices of the forming Freshwater Fishes Taxon Advisory Group (FFTAG). Its purpose would be to improve communications amongst breeding program participants. Information, brief articles, announcements, and inventory updates could be circulated in a much faster and efficient manner.

As a member, you would be asked to receive FAXs and in turn FAX this information along to a designated receiver. If you are interested in participating, please fax your name, institution, and fax number to me at (614) 645-3465 by March 1, 1993.

-- Doug Warmolts