DRUM *and* CROAKER

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DRUM AND CROAKER 35 YEARS AGO

Richard M. Segedi

(From the January 1970 issue, edited and published by the National Fisheries Center and Aquarium, Washington, D. C.)

New Year's greeting from the publisher of the January, 1970 issue

ALL OF US AT NFC&A WISH FOR EACH OF YOU A VERY PROSPEROUS NEW YEAR. May all of your gains be of rare species and your few losses of common ones.

Sea World of Ohio, W. Kymmerly Murphy, Curator, Sea World of Ohio

On the shores of spring-fed Geauga Lake, near Cleveland, Ohio, Sea World, Inc. is building a four million dollar oceanarium.

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

Other attractions will include a beautiful Japanese village, featuring lovely pearl divers, Koi ponds, a dove pavilion, and a deer feeding area.

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

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

The Seafloor Aquarium, R. A. Martin, Curator, Nassau, Bahamas

The 107-foot main aquarium building houses the main arena (35 feet in diameter by 12 feet deep, 80,000 gallons) and 12 gallery tanks. A coral grotto adorns the main arena, where native reef fishes are viewed in their natural setting. The gallery tank display encircles this tank and includes seven 500 gallon hexagonal fiberglass tanks and five large concrete tanks ranging from 2,500 gallons to 6,500 gallons. Walls are designed to fade into the background.

Sea water brought up from a 190-foot well is already pre-filtered underground through oolitic limestone. Water quality is quite constant and the temperature remains close to 75° F the year round. Water is pumped directly to a reservoir where it is aerated and flows (gravity) at a rate of 1800 gallons per minute to the system.

Some Aquariums of Europe, George B. Rabb, Associate Director, Chicago Zoological Park

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

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

Report on Crown of Thorns Starfish Indicates Danger to Pacific Ecology

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

OF SEA STARS AND JELLYFISH

Paul Sieswerda, Aquarium Curator

New York Aquarium

Starfish no longer exist. They have disappeared from the face of the earth without ever appearing on The Endangered Species List or even being listed in the IUCN Red Book. This has happened in an extraordinarily short time, in a shorter time than even the Dodo or the passenger pigeon. They were, of course, replaced by Sea Stars. Sea Stars are a voracious predator of starfish that are hatched in the minds of educators and zoologists who believe young people will be confused, and think starfish are, in fact, a species of fish. With great diffidence, and pedantic righteousness these arbiters of correctness proclaim – "They really are not **fish**, you know." And with that they exterminate not just a species, but the entire Class, Asteroidea. Comets have had less impact!

And speaking of comets –Sea Stars; "They really are not **stars**, you know."

The same threat is attacking jellyfish. There may still be time to save what's left of this immense group. More animals will be lost if conservationists, do not act and act quickly. Fortunately the threat, Sea Jellies, are only beginning to invade. There is still time to reach hearts and minds with reason. Sea Jellies cannot stand when the proponents use Captain Queeg-like "geometric" logic that would erroneously group them into the same Order as the Sea Jams. It is a distinction that will provoke the "lumpers" to claim that they are actually Sea Gelatins or the"splitters" to demand a new group of Sea Jell-o's. And what will be next?
The dogfish? Butterflyfish? Or Sea dragons?

Not the same, you say; they really **are** fish. Well, who knows how slippery the slope will be. The zoological world is slipping into political correctness. It has been claimed that "killer whales" do not deserve such a derogatory name, when many have never even stood trial. And the "great" of the great white shark is being omitted in many circles. A mouthful of 3 inch teeth on the end of two tons of muscle, cries out for a term like "Great". Give the other sharks something to look up to.

And the premise is flawed from the beginning. Young people are smarter than you think, and love to learn by exception. Teaching "they really aren't fish you know.", will lose its impact as soon as the common term becomes "sea star or jelly". It's more interesting to learn the contradiction or exception. Who doesn't remember, "i before e, **except** after c" or "**except** for February which has 28, **except** on leap year ,etc….." The effort to clarify jellyfish and starfish shoots itself in the foot by evoking new connections to stars and jellied preserves. Starfish and Jellyfish are perfectly good names. If clarification is needed, go to the scientific nomenclature. Kids love it in small doses. Ask any 10-year-old boy about *T.rex* or Velociraptors.

So save the Jellyfish before it's too late or we may find the Supreme Court deciding if Angelfish can be taught in public schools.

PRELIMINARY RESULTS OF GIANT PACIFIC OCTOPUS BEHAVIOR STUDY ON ENRICHMENT

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David Powell, Research Associate

Smithsonian's National Zoological Park, Invertebrate Exhibit, Washington, D.C.

Abstract

What impact does enrichment have on a Giant Pacific octopus? How do introduced objects and environmental changes affect octopus behavior? Where are the data? Can we determine the effectiveness of enrichment in invertebrates?

Behavioral data have been collected over three years on two Giant Pacific octopuses at the National Zoological Park's Invertebrate Exhibit. This is an effort to begin to measure the impact and effectiveness of enrichment through a rigorous collection of behavioral data. The collected data support much of the observations and impressions previously suspected of enrichment by octopus caretakers, yet some assumptions did not hold true with the two octopuses observed.

Introduction

Enrichment has become a catch-phrase for one more dynamic of caring for organisms. It refers to the psychological well-being of animals. In the case of an octopus, as in many animals, there's really no way to know what is going on in the animals' mind, however observers can get some indication by watching their behavior and their reactions to various stimuli in their environment. Good husbandry encompasses all aspects of caring for an animal. Life support parameters and diet do not stand alone. Enrichment is done best when incorporated in the planning and daily care of one's charges.

Duplicating the wild environment would be ideal but obviously not realistic. As a result people introduce objects into the octopus environment with the hope of stimulating activity and inducing behaviors that approximate wild behaviors. Many of these efforts have been effective in stimulating activity in the octopus. To date there have been very limited to no data resulting from rigorous behavioral observations. The question of how much activity is natural or healthy for an octopus that spends large portions of its time hidden in a den, is still unresolved. Three years of behavioral observations on two octopuses have been conducted at the National Zoo's Invertebrate Exhibit. What follows is a snapshot of select pieces of these data.

Enrichment is defined in many ways but our current working definition has been adopted by the Aquatic Invertebrate Taxon Advisory Group (AITAG) Enrichment Committee. It was taken from enrichment training materials developed by Disney's Animal Kingdoms' Jill Mellen and Marty McPhee. Environmental enrichment is a dynamic process of enhancing and improving zoo/aquarium animal environments within the context of their behavioral biology, natural history and individual history. Enrichment includes but is not limited to increasing behavioral choices available to animals, drawing out their species-appropriate behaviors and abilities, and reducing the development of aberrant behaviors, thus enhancing animal welfare. Methods include but are not limited to appropriate grouping, physical structures and substrates, water elements, food distribution, objects to manipulate, and inducing species appropriate activity and/or lack of

activity. An enrichment program is a formalized and dynamic plan that is integral to the care and management of a species.

Most of the enrichment that has been done to date has been recorded with anecdotal descriptions on the octopus reactions. This is helpful in determining possible enrichments to try. It is even more useful to have an analysis of octopus reactions and behaviors based on quantitative analysis of behavioral observations. This is a way to measure the impact of enrichment on an octopus.

The enrichment program at the Invertebrate Exhibit has two specific goals. One goal is to create the opportunity for the octopus to explore rather than just hang in the corner of the tank. The second goal is to reduce the frequency of the octopus jetting across the tank and slamming into its side.

Octopus Behaviors/Appearance/Location

In an effort to measure impact of enrichment on an octopus, the Invertebrate Exhibit staff identified six specific measurable behaviors that describe the octopus' level of activity: cling, arm move, arm walk, hang in the water, jet hop, jet slam. The lowest level of activity, cling, is when an octopus holds on to a surface with its suckers, and the only observable movement is its mantle and siphon moving due to respiration. The second behavior, arm move, constitutes something as simple as the tip of an arm moving in the water or the extension or pulling back of an arm. The octopus exhibits arm walk when it releases suckers from the larger two thirds of an arm, such that an arm comes off a surface and is placed in another location. This walk results in the movement of the entire octopus body. Hang in the water describes when the octopus is attached to a surface by the suckers on the last third of its arm but its body is extended out into the water column of the tank. The fifth behavior, jet hop, is when all arms are removed from a surface and water is expelled through the excurrent siphon as it jets or swims through the water. At the conclusion of a jet hop the octopus settles to the bottom of the tank or pulls up before hitting a tank wall. The jet slam resembles the jet hop except that the octopus slams into a surface with the posterior end of its mantle.

Octopus, like the extensively studied cuttlefish, has chromatophores that display a wide array of surface color stimulated neurally by the brain. The colors become a window into the animals' reaction to stimulus. The cuttlefish have been studied extensively such that its different patterns have been loosely described as a language. The octopus has not been studied as extensively. Even still we have used the octopus' color variations from primarily white, to mottled white and red, to primarily red, as an indicator of the animal's reaction to stimulus. The octopus also exhibits an extensive repertoire of textures. We have recorded the skin textures of smooth, bumpy, and highly accentuated papillae in observing the octopus' reaction to stimuli.

The six behaviors, the surface colors, and the location in the tank were selected because they not only demonstrated variations in the octopus but were also observable and distinguishable. This facilitates consistent observations.

Enrichment Tools

Two methods of changing the octopus' environment took place. One method was to change the tank or tank elements. The second method was to introduce an object for a limited period of time.

Both octopuses studied began in Tank #13. Tank #13 is 160 cm long, 100 cm deep, and 120 cm high. Both Tank #13 and Tank #9 have an acrylic front and side as well as two rock sculptured concrete backdrops and a smooth concrete floor. The second octopus was transferred to Tank #9 which is about twice the size of Tank #13 at 296 cm long, 113 cm deep, and 119 cm high. In Tank #9 we introduced first one, then a second large arch into the tank. In addition we introduced water flow that produces a water curtain around the inside perimeter of the tank. Water was circulated in the Tank #13 by airlift and pump, and by pump in tank #9. Both tanks have protein skimmers.

A wide variety of enrichment objects was used through this data collection. They included dog toys, balls, squeeze toys, PVC tubes, filter parts, and plastic jars. Each of these objects was initially introduced on its own and later combined with food, either inside or alongside it.

Data Collection Procedures

Each data collection cycle lasted one month. For the first three weeks data was collected each week day. Following these fifteen days of data collection, one week of no enrichment broke the enriched state and started the octopus fresh for a new cycle of data collection.

First baseline data were collected to determine what the unenriched behaviors looked like in these two octopuses. The baseline data were collected in the same intervals as the enriched data but without any object introduction or tank change. Periodically throughout the three years baseline data were collected again to determine if the octopus baseline had changed.

Data collection was done by scanning. This process involves sampling by noting a specific behavior at one point in time. For the first ten minutes of an observation session, the octopus' behavior was noted every 30 seconds. The enrichment was then introduced. For the following 1/2 hour, the behavior was again noted every 30 seconds. After the first half hour, observations were taken every ten minutes for the next one and one-half hours in order to capture long term effects of an object's impact on the octopus.

The data were collected by staff and volunteers. They were trained to consistently identify specific behaviors, color, texture, and tank positions. Training was done in three sessions. First we conducted a one and a half hour group meeting. This meeting was followed by an on-site, half hour of group data collection. Thirdly each observer collected data with somebody else for 1 to 3 sessions, varying according to the observer's comfort, confidence and competence. Oversight was done periodically by staff allowing for ongoing clarification in the data collection process. Consistency is always a challenge. Incomplete observation sessions and uncertain notations were not included in the analysis.

During each one month cycle only one enrichment element was introduced. This could be objects, a tank move, or a tank change such as an arch or water curtain addition. These elements varied from month to month. In later months, the objects were reintroduced with a food association.

Findings

The first octopus was observed in 2002-2003. Its observations provided unexpected results. We had expected that any introduced object would be immediately and thoroughly explored. Preliminary findings suggested that objects were more likely to be interacted with after a previous experience with them. In addition objects were interacted with longer after previous experience with them. Objects associated with food were more likely to be manipulated than others.

The second octopus, observed in 2003-2004, was in the larger of the two tanks. The animal exhibited similar behaviors to the first octopus. The tank arches were only initially explored and then ignored. The water curtain was interacted with initially extensively and then later produced no reaction. Overall the octopus demonstrated more movement and less wall clinging when in an enriched state.

During the months of enrichment introductions, the octopuses moved more, not just during the observation times, but more overall. As a result the data collected during the ten minutes prior to adding enrichment were too similar to the post-enrichment introduction to clearly distinguish two time periods. The pre and post introduction data were combined to refer to an enriched state. These data were then compared to the baseline data to identify variations between an enriched and an unenriched state.

During the enriched state, the octopuses moved more around the tank, traveling to the bottom and middle of the tanks more than during the baseline state. During baseline observations the data suggested that the octopuses had preferred spots in each tank. In Tank #9 the preferred spot was at the top rear of the tank on the left side. In this corner the clear acrylic and the rocky concrete backdrop join. In Tank #13, the preferred spot was also at the top but this time in the front of the tank on the right where the two clear acrylic walls meet.

The octopus texture and color differed between the enriched and unenriched state. During baseline observations the octopus tended to be mottled and bumpy. When in an enriched state their texture became smoother and their color more red.

Adding a food element to the enrichment greatly increased the degree of behavior changes. The octopus moved more which included moving in more areas around the tank, and traveling more to the front and top portions of the tank than previously.

Another unexpected finding was the tendency of the octopus to mimic the texture of an enrichment object. An octopus' color and texture response relative to substrates and rocks has long been understood as a camouflage technique. A similar response to an object much smaller than the animal does not yet have an identified purpose.

These findings continue to suggest that enrichment is good for the Giant Pacific octopus. Because direct observations of octopus in the wild are rare, it continues to be important to proceed with enrichment with caution in order not to over-stimulate the octopus. Further study will determine how much and when enrichment should be done.

Our preliminary finding is that previous experience with an object increases the likelihood and degree of reaction thus resulting in more activity. Initial data suggest that for an octopus, being in an enriched state may be more important than the specific type of enrichment done. This is not to suggest that anything and everything can be done in terms of enrichment. It is still important to be safe and purposeful in an octopus enrichment program.

Next Steps

From here our plans are to continue a graphical analysis of the data collected from these two octopuses. We will continue to increase our sample size by conducting a behavior study on each octopus entering the Invertebrate Exhibit and conducting a statistical analysis once a valid sample size has been achieved. We hope to merge the findings of other institutions and groups such that the data collected can be appropriately analyzed together. We hope to develop shorter-term research methods than what we have used to date so that each enrichment introduction would not require as rigorous a behavior study.

Conclusion

Enrichment needs to be applied with special attention to the impact on the specific species and animal. It is important not to do enrichment based on too broad a generalization across species or individuals. Much can be learned from other's experience and other species. Nothing will replace the discerning eye of an animal caretaker and real time observations of an individual animal. Species specific data will provide a jump start to the development of an enrichment program. Individually developed goals and a recorded measure of impact are building blocks for an effective enrichment program.

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NOTES FROM A SWORDFISH (*Xiphias gladius*) TRANSPORT

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Abstract

2004 has been an exciting year for L'Oceanogràfic and its attempts to expand its collection of pelagic species of fishes for its exhibits. One particular species that has generated equal amounts of excitement and humility is the swordfish, *Xiphias gladius* Linnaeus, 1758. Earlier this year, L'Oceanogràfic made attempts to successfully collect and transport swordfish. The experience of those efforts was valuable and enriching, but alas, the final result was not as was hoped for. The following is a discussion of the experience and a written summary of a presentation made on the same topic at Regional Aquatics Workshop 2004 at Mote Marine Lab in Sarasota, Florida.

Introduction

Swordfish are one of the billfishes, popular amongst the sport fishing community and essential for many commercial fisheries, holding high market value. Swordfish are monospecific to the family Xiphiidae. All other known billfishes such as marlin (*Makaira spp.*) and sailfish (*Istiophorus spp.*) belong to the family Istiophoridae. Swordfish are most easily distinguishable morphologically from other billfishes by the shape of their bill. An extension of their upper jaw, swordfish bills are dorsal-ventrally flattened, making them oval in cross-section, where as other species of billfishes have bills that are round in cross-section. Swordfish are cosmopolitan in tropical, temperate, and sometimes cold waters of all oceans (Nakamura 1985). They feed on mainly fishes, but also on crustaceans and squids (fishbase.org). They can reach 445cm (14.6ft) and 540kg (1,190lbs).

In considering new species to attempt to display at L'Oceanogràfic, four justifying criteria were considered when it was decided that swordfish would be a target species:

1. *Swordfish present a new, challenging husbandry and are just really, really cool.* To our knowledge, no facility is displaying any species of live billfishes, with previous attempts being that of juveniles only. There have been attempts made to collect young sailfish (Young, personal communication). Without question, every aquarium is searching for a signature animal that can often define its reputation. A swordfish, in L'Oceanogràfic's opinion, would be one such animal. In addition to their uniqueness, swordfish also prompt a lot of fisheries conservation issues, ones that could be addressed with the successful display of a live specimen. In addition, there exists a solid foundation for husbandry techniques for swordfish to be built on from the transport techniques of other pelagics such as tuna (*Thunnus spp.*) (Farwell 2001), dolphinfish (*Coryphaena hippurus*) (Cripe 2002), and scalloped hammerheads (*Sphyrna lewini*) (Young et al. 1998).

2. *Swordfish are obtainable, and from a source existing at a reasonable distance away from the aquarium*. L'Oceanogràfic has pursued a relationship with a local fishing company that maintains a seasonal set-net operation in the Mediterranean near the southern Spanish fishing village of La Azohía, just over 350km (217 miles) from Valencia, where L'Oceanogràfic is located. Situated a few kilometres off the coast, this set-net, called an 'almadraba', is effective in capturing pelagics and semi-pelagics while causing significantly less physical damage. This fishing method becomes an ideal opportunity for L'Oceanogràfic to collect species of fishes normally unavailable or easily injured by other methods such as trolling, long-lining, or trapping.

3. *L'Oceanogràfic has a place to hold the fish for an intermediary period after capture*. In addition to the relationship with the aforementioned fishing company, L'Oceanogràfic has developed an agreement with a marine institute belonging directly to the Ministry of the Environment called Instituto Español de Oceanografía (IEO) de Murcia, a few kilometres from where the almadraba is located. This institute conducts research mainly on reproduction, and especially on commercially valuable species or those with potential for aquaculture. Their building includes numerous holding tanks and raceway systems both for maintaining brood stock and for rearing larvae. As part of the agreement, L'Oceanogràfic is able to utilize holding space for animals captured live from the set-net in exchange for some of the animals that are captured, to be used as brood stock. This intermediary holding gives L'Oceanogràfic the advantage of providing the animals time to recuperate from their capture and having time to evaluate their health and hardiness before sending them on another transport to the aquarium. Also, this eliminates the need for L'Oceanogràfic to construct its own holding systems close to the fishing site.

4. *L'Oceanogràfic has an exhibit appropriate for exhibiting swordfish*. The intended exhibit for the swordfish would be the Oceans tank (fig. 1a and 1b) here at L'Oceanogràfic. It is a fantastic multi-specific exhibit that is themed on the Atlantic Ocean, stretching from the Bermudas on one end to the Canary Islands on the other. There are nearly 60 species of fish, many of them pelagic or semi-pelagic and many of them predatory. The exhibit is 80m long by 35m wide by 5.5m deep (262ft x 115ft x 18ft) and contains 6,900,000L (1.82 million gallons) of seawater. It is in the shape of a main rectangle with circular towers on either end. A 31m (102ft) long tunnel bisects the exhibit longitudinally down the middle, connecting the circular towers.

Materials and Methods

The most critical component in making the swordfish collection feasible is the almadraba set-net (fig. 2) that L'Oceanogràfic is able to utilize. The fishing season is open from March to July and is focused on small scombrids, the principal species targeted being bullet tuna (*Auxis rochei rochei*), little tunny (*Euthynnus alletteratus*), and Atlantic bonito (*Sarda sarda*). Many other species are caught as well, and most have market value such as amberjack (*Seriola dumerili*). Of course, swordfish are included on this list.

The set-net acts like something of a funnel. A long, straight barrier net channels animals into the first holding area. Fish can still freely move in and out of the first part, but many remain due to the shape of this area designed to direct fish in a swimming pattern that keeps them within. Eventually, many animals will swim through another opening into a smaller holding pen, called the 'copo'. It is here that the boats close the opening, and then proceed to raise the bottom

of the pen, slowly reducing the size of the pen by reducing its depth. Eventually, the fish trapped in this pen are forced to the surface where they can be seen and captured. It is at this point that L'Oceanogràfic staff divers are able to pick out specific animals that are desired and handle them in a manner less harmful to their often delicate bodies, using equipment specially selected for their less abrasive properties (vinyl stretchers, plastic bags or rubber pole nets, depending on the size of the animal to handle).

Fig. 1a. View of the Oceans exhibit from central tunnel.

Fig. 1b. View from service catwalks above the Oceans exhibit.

Fig. 2. Typical model of an ‘almadraba’ set-net.

In the spring of 2004, a targeted effort was made to capture and transport swordfish (*Xiphias gladius*) to L’Oceanogràfic for display in its large Oceans exhibit. We proceeded to capture a swordfish on two separate attempts that we felt were of a suitable size and in good condition despite the process of capture. The first animal was caught on April 7th, 2004 with a total length of 129cm and 3.9kg. This animal suffered a few abrasions and was heavily parasitized with what appeared to be copepods, but was swimming well and was surprisingly calm. The animal was handled within a vinyl stretcher before it had a chance to get caught in the net of the ‘copo’ that had been raised. It was kept in a horizontal position as best as possible during the move, looking forward so as not to damage its cervical region (note: it is anecdotal, but swordfish are believed to be very delicate at the cervical vertebrae). Firstly, the swordfish was transferred by boat from the almadraba to the shore in a circular tank of approximately 1500 litres, recirculated by a bilge pump, powered by a 12V battery and oxygenated by an oxygen bottle on brought on board. Then it was transferred to the same transport tank set-up by van to the holding tank at the marine institute. The total time for this movement was approximately 30 minutes.

The holding tank is 40,000L (10,600gal) and square in shape. This tank is supplied by an open system using ambient water from the Mediterranean, not far from the institute. The individual was not alone in the holding tank. Other fish that were also collected and held there included ocean sunfish (*Mola mola*), bonito (*Sarda sarda*), mackerel (*Scomber scombrus*), and common dentex (*Dentex dentex*). The swordfish swam very well for a couple of days (fig. 3), negotiating the walls and other animals without problems. It was quite amazing how well it knew the length of its bill and would turn at just the right time before reaching the walls. The decision was made to try and transport it to L’Oceanogràfic while it appeared to be in good condition.

Fig. 3. Swordfish swimming well in holding tank at Instituto Español de Oceanografía de Murcia.

Fig. 4. Preparation of transportation tanks for move of swordfish.

The animal went on April 9th, 2004 via semi-trailer truck in its own transport tank which was round with a 2m diameter at the bottom (fig. 4). The water was filled to approximately 1.2m in height. The tank was equipped with two bilge pumps, one for circulation and the other for running a cartridge filter containing a filter sock of activated carbon. Each pump was run by its own 12V battery. An oxygen bottle was held to the side of the tank with a bracket to help maintain sufficient dissolved oxygen (DO). Chemical snap lights (one in white and one in red with 12 hour burn times) were attached in the middle of the tank off the bilge pumps that hung

centrally from the lid in the water. The idea was to give the animal a point of reference for swimming as the tank was completely covered by the fibreglass lid and normally kept completely dark.

What follows is an outline and comments discussing transport time and some water quality parameters taken (Table 1) during the trip from the Institute to L'Oceanogràfic:

Table 1. Various water quality parameters taken during transport of the swordfish.

Time	Temp (ºC)	Dissolved oxygen (% saturation)	Salinity (‰)	pH	Ammonia	Redox (mV)
Ambient	15.5	95-100	37			
16:00	15.6	150				
17:40	15.7	153				
18:55	16.4	150				
22:30	15.7	140				
22:00	15.6			8.01	0	286

16:00 The swordfish is loaded into the transport tank.

16:55 *Departure.* The transport truck leaves IEO.

17:40 *First stop.* System check and temperature (temp.) and dissolved oxygen (DO) measured.

18:05 Swordfish appears to be struggling a little bit with its swimming. Circulation pump is turned OFF to reduce current. Filtration pump remains ON.

18:55 *Second stop.* System check, temp., DO.
Swordfish appears to worsen, swimming with difficulty on the bottom of the tank on its right side going with the current.

20:30 *Third stop.* System check, temp., DO.
Swordfish is now barely swimming. It is injected with 2ml dexamethasone to help cope with the stress and 1ml of doxapram, a respiratory stimulant, to assist in recovery.

22:00 *Arrival at L'Oceanogràfic.*

22:30 Swordfish is again injected with dexamethasone and doxapram and removed from the transport tank to a quarantine tank; then injected with 20ml of a 5% glucose saline solution with sodium bicarbonate to lower blood pH and counteract acidosis; swordfish placed in front of direct flow of water over gills (fig. 5).

23:15 Efforts to revive the swordfish are ceased.

Fig. 5. Swordfish placed in front of inflow in attempt to assist recovery.

A necropsy was performed without finding conclusive evidence for its death. It was at necropsy that total length and weight were determined. The specimen appeared to be on the thin side. However, of most interest were the parasites found attached to the animal. The most obvious ones found were of the *Pennella* genus. These elongated copepods, commonly found on other pelagic fish and even whales, are thought to attach to the skin in a free-swimming phase, then burrow their mouths deep into the host animal. There bodies hand outside from the body of the host with frilly breathing structures fanned out like a feather duster tubeworm at the end. Numerous *Pennella*, measuring up to 30cm long, were found attached to the heart, liver, and kidneys of this individual (fig. 6).

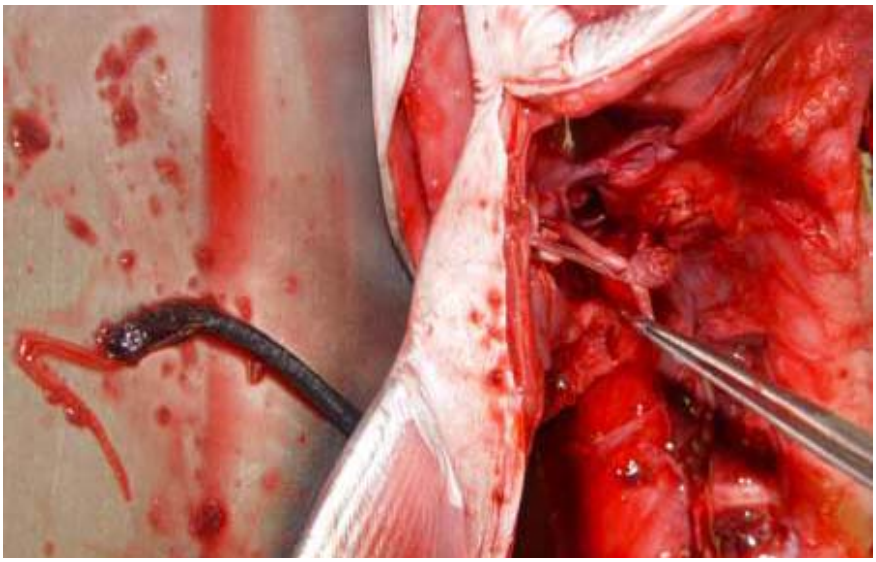

Fig. 6. *Pennella* sp. copepod can be seen penetrating body wall of swordfish. Note darker main body on left, outside of animal, and feeding and attachment appendages to the right, being held by forceps.

A second animal was captured in early May 2004, but it did not survive the transport from the set-net to the holding tank at the marine institute. This animal was bigger, less parasitized, and more robust. It measured a total length of 138cm and 9.12kg upon necropsy (fig. 7).

Fig. 7. Second specimen of swordfish captured, pre-necropsy, less parasitized and without abrasions.

Discussion

It is difficult to pinpoint the exact factors, or lack thereof, that may have prevented the success of this transport. With so many variables to consider, one can only come up with more questions as to how to improve the process:

If swordfish are pelagic ram ventilators with large gill slits, what levels of dissolved oxygen do they need in their transport tank to satisfy their respiratory needs? A level of 150% DO was maintained throughout the journey, as has been done before for other pelagic fishes we have transported. Maybe it needs to be higher?

Swordfish are adapted to making big changes in depth. They have the ability to heat their eyes and brain even in deeper, colder waters. Also, they have relatively large eyes with a significant *tapetum lucidum,* the reflecting layer behind the retina that allows better vision in the dark. Do they need a deeper tank for transport? Could there time acclimating at IEO where there was more light (although it was not overly bright) cause more stress? It is probably unlikely, as it was still swimming very well in the holding tank and often near the surface.

It is quite obvious to say that the larger a transport tank is, the better it should be for a large fish. So, is a tank of 2m diameter simply not big enough? What was noticed at the beginning, once the swordfish was placed in the tank was that it was banging its bill quite a lot against the side of the tank, behaviour that we did not witness while it was in the holding tank in

the institute. Could this banging have caused irreparable damage and stress to the animal? It has been suggested that a narrow, elongated transport tank be used next time, like those used for sharks. In this way, the animals would not be able to turn and would stay oriented in the direction of the current provided by the pumps. Perhaps this would discourage the banging of its 'sword' against the sides. Or perhaps a custom tank integrated into a trailer, as other facilities use, for more volume.

In addition, the tank set-up used has the two bilge pumps hanging in the middle of the tank at about mid-level. Could this have caused some stress by creating an obstacle to its swimming? It was noted that the swordfish began to swim along the bottom on its side part way through the transport. Was this an attempt to avoid the pumps?

The swordfish, as previously mentioned, was apparently doing well in the holding tank at the institute, swimming confidently within the space. No attempt had been made to feed any of the animals because the original plan was to move them shortly. Perhaps the plan should have been to leave the animals in the holding tank for a longer period of time, perhaps even to attempt feeding first. The option exists, and L'Oceanogràfic has subsequently done so with bonito (*Sarda sarda*). The only issue is that because IEO is on an open system with very few controls, water quality can, at times, be unstable. We have lost dolphinfish (*Coryphaena hippurus*) to temperature spikes in this system, for example.

What is interesting to consider is that the second specimen that was captured appeared to be in much better initial health, having less obvious external parasites and being much more robust in appearance. Yet, could it be that its seemingly superior condition may have made it more challenging to move it calmly? Was it able to struggle and fight more intensively than the first animal we attempted causing more injury to itself during its movement.

Swordfish are also known to have scales as juveniles, but lose them once they attain over 1m in length (fig. 8). Our specimens appeared to have had very little in the way of scales. Do we need to wait to capture a smaller animal that would theoretically be better protected against handling procedures?

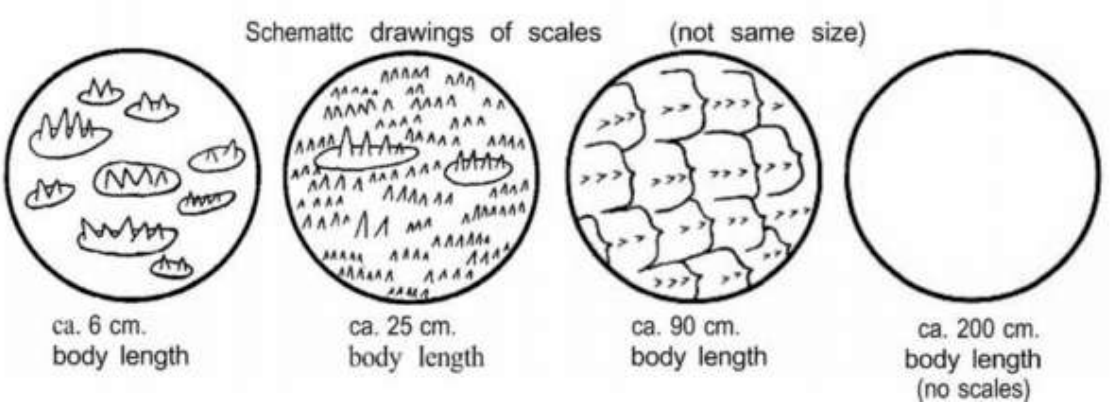

Fig. 8 Taken from Nakamura 1985, this shows the eventual loss of scales as swordfish grow.

Conclusions

There are many well-documented reports and publications of the transport of pelagic species of fishes. However, those of billfishes are unusual and unique. There is, of course, a balance between the costs of conducting such trials and the return of information gained, but the logistics are in place to continue this research in a reasonable and responsible manner. Maintenance of swordfish in captivity should be part of an education and conservation programme that outlines the critical situation of the fisheries of this species and their relatives.

The collection, transport, and husbandry of such fascinating species continue to be a developing science, and information sharing is critical for the improvement of such techniques. It is the hope of the authors that this report will help form a foundation for future attempts to exhibit swordfish and billfishes in general. What has been achieved is significant to the knowledge of general physiology and behaviour of this species and has gone a long way to inspire the people involved.

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Acknowledgements

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Also, please note that a short video clip (in AVI format) of the first swordfish individual swimming in the holding tank at IEO is available from the authors for viewing upon request.

ADVANCED TECHNIQUES FOR QUARANTINING BLUE SPOTTED STINGRAYS, *Taeniura lymma* AND *Dasyatis kuhlii*

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Abstract

Blue-spotted stingrays, *D. kuhlii* and *T. lymma,* are some of the most common stingrays found throughout the Indo-Pacific (Hennemann, 255 & 260). However, captive animals are seldom seen in aquaria, and attempts to keep these stingrays alive in captivity have been met with limited success (Michael, 158; Firchau, 16). Because of this issue, the Shedd Aquarium has worked toward getting these animals through their most critical periods—post shipment and quarantine. For the most part, the animals arrive emaciated and, prior to our procedure, weight loss ensues quickly. Staff realized that the key to raising these animals in captivity successfully is to bring them past the point of emaciation and thinness by getting them to aggressively eat on their own. Together with the veterinarian staff, quarantine aquarists set up a rigorous schedule of assist feeds and taking weights for the stingrays. Since this new technique has been implemented, the aquarium has suffered no losses of *D. kuhlii* and *T. lymma* due to anorexia. Most of the animals are on exhibit and eating well. Their food intake is still monitored very carefully and they receive biannual physicals.

Introduction

The animals were acquired in March of 2003 for a stingray pool in the new Wild Reef exhibit at the Shedd. They were purchased from numerous sources including wholesalers and one retail store. All of the animals were quarantined in four 230-gallon circular vats on a 1200-gallon system. The salinity was between 32-34 parts per thousand and the temperature was between 77-78 degrees Fahrenheit.

The conditions of the incoming animals were similar: they were all in a thin or emaciated state. Their incoming weights ranged from 79-942g and on rare occasions they would eat ghost shrimp. All of the animals lost weight when they went through quarantine. Traditionally, they died within 1-21 days of arrival at the Shedd.

Materials and Methods

Shedd staff decided that in order to keep these animals alive they would need to be very aggressive with the approach they used to treat the animals. They decided to monitor the incoming weight of the animals, acclimate them for 24 hours, and then assist feed at day two with gruel. The animals would be assist-fed daily until their weight was stable or rising, if they began to gain weight the feedings would be lessened to every other day.

For all interventions the animals were anesthetized in a ten-gallon transport with 75-100ppm of MS-222. The weights were taken with the animal in the water. A plastic tube was placed over the stinger to prevent any injury to vet staff or aquarist.

While using this method staff learned that the animals were not gaining weight. So, they took many things into consideration when contemplating the next step. Things to consider were:

1. The metabolic requirements (caloric needs) of stingrays are largely unknown. 2. Most of the animals were growing, so additional calories needed to be accounted for.
3. Entering quarantine is more stressful and animals require more energy (Fowler and Miller, 164).
4. Calories of the gruel were not analyzed.
5. Sick animals require more energy (some had bacterial infections at the time of treatment) (Fowler and Miller, 14).
6. There is a limit on the volume of the stomach (a 100g ray can only take about 7-10cc's of gruel)(N. Mylniczenko, personal communication, March 2004).

The first thing done was to re-evaluate the gruel that was used and it's contents. Gruel one contained:

1. Hill's Canine and Feline A/D Diet®
2. Nutrical®

They were mixed in equal proportions and cod liver oil and pedialyte were added until the mixture became easy to pass through the syringe. The advantage to this gruel was that it is easy to store, mix and push through the syringe. The disadvantage is that the animals did not gain any weight and continued in their anorexic state.

Gruel two was concocted and evaluated with vet staff and aquarists keeping in mind the need for a higher calorie count. It contained:

1. Hill's Canine and Feline A/D Diet ®
2. Nutrical®
3. Emeraid®
4. Cod Liver Oil
5. Pedialyte

The Hill's Diet® and Emeraid® were mixed in equal proportions and the nutrical, cod liver oil and pedialyte were added until the mixture passed through a syringe. Animals gained weight, but it was artificial. Constipation occurred most likely because Emeraid® is higher in carbohydrates.

Another gruel was made, gruel three, which contains:

1. Hill's N/D® (Neoplasia diet)
2. Hill's A/D®
3. Less Nutrical® (empty calories, but liquid)
4. Cod Liver Oil
5. Pedialyte

This was ground in the blender. The advantage is the higher calorie count; unfortunately, this gruel was too thick to pass through the gavage tube and could not be used for the rays.

Finally, the last gruel, gruel four was the mixture that helped the rays to gain weight and keep it on. This last concoction contained:

1. 800g of Pacific and Spanish mackerel fillets
2. 100g of shrimp/shellfish (with shells, without tails)
3. 2 sheets of nori seaweed
4. 20g of Nutrical®
5. 1 Vitazoo®
6. 100ml of STAT®
7. Cod Liver Oil-add enough to push gruel through gavage tube (added calories and to reduce thickness of mixture)

Preparation time takes about one hour. The food must be ground exceptionally well with a blender. Freeze the food in small packets and thaw the day of use. The mixture is thick, but it can pass through the tube. The ingredients in it are very high in calories and viscous enough to pass through the gavage tube. The STAT® is a high lipids liquid from PRN pharmaceuticals, Vitazoo® is the elasmobranch vitamin variety from Mazuri, Nutrical® is a high nutrient liquid from EVSCO pharmaceuticals, and the cod liver oil is a high lipids liquid from a local pharmacy.

To administer the food we used a large red rubber catheter and a 60cc syringe. The food is back-loaded into the syringe and the end of the catheter is cut off and melted down to create a smooth surface. When administering gruel to stingrays be sure to go gently, they have a large esophageal sphincter, but the food should not be forced. Make sure the catheter is fully in the stomach; as tip can be palpated. Regurgitation can occur, clear gills immediately with water otherwise animals will stop breathing. If an animal stops breathing within an hour of feeding pump water over gills to clear possible food entrapment.

As the animals were assist-fed regularly they began to acquire an appetite on their own. Once this occurred, vet staff and aquarists decreased with assist-feeds and continued to weigh them every third or fourth day. The amount of fatty foods offered to the animals like herring fillets, mackerel fillets, and capelin were increased.

Once the animals' weight stabilized and they were eating, standard elasmobranch quarantine was started. Animals received a low dose bath of praziquantel at 1ppm, dimilin at

0.03ppm, and a thirty-day observational ensued. When the animals were done with their standard quarantine they were moved onto exhibit and weighed weekly, bi-weekly, and then on a monthly basis.

Discussion and Conclusion

Perhaps the biggest case for improvement was a *T. lymma* named "Rae West" that arrived at the Shedd weighing approximately 942g. Over the course of her first couple of months she dropped about 165g leaving her at 777g. Once vet staff and aquarists developed the final gruel concoction to assist feed the animals, "Rae West" began to turn around. Within a month's time the stingray started to gain weight and eat fatty foods on her own. She now weighs 1.4kg and is doing well on exhibit.

Overall, the statistics at the Shedd have been extremely encouraging. So far, this technique has been used on seven *D. kuhlii* and seven *T. lymma*. There have been no animal losses since the Shedd started using this method of quarantining blue-spotted stingrays. All of the animals gained weight using this method and continue to thrive on exhibit. Today, animals receive bi-annual physicals to keep track of growth rates, acquire blood values and assess overall health.

Acknowledgements

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USE OF CONTRAST RADIOGRAPH TO DETERMINE TRAUMA TO THE VALVULAR INTESTINE IN THE BLACKTIP REEF SHARK (*Carcharhinus melanopterus*)

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Abstract

A female Blacktip reef shark (*Cacharhinus melanopterus*) was found to have an intestinal prolapse on January 10, 2002. It was suspected that another shark bit the cloacal area during intestinal eversion which resulted in the animal being unable to retract the intestines. A six week treatment included hydrocortisone suppositories, mineral oil enema, antibiotic injections and purse-string suturing of the prolapsed tissue. Contrast radiographs were taken to confirm internal rupture or tear. With apparent reduction of weight, failure to respond to treatment and leakage of contrast into the coelomic cavity, euthanasia was chosen. Upon gross necropsy, trauma and prolapse of the scroll valve was apparent with accompanying liver and rectal gland trauma. There was adhesion of the epigonal organs to the traumatized liver and rectal gland and suspected damage to the right uterus. Histopath of tissues submitted showed the prolapsed intestinal tissue was formed of normal intestinal mucosa with a segmental area of ulceration and mucosa replaced by fibrosis and fibrinohemorrhagic membrane. Diagnosis was a prolapsed colon with segmental, chronic, colonic ulceration. The contrast radiographs taken during diagnostic investigation of internal damage were reaffirmed by necropsy and subsequent histopathology.

Case Report

A female Blacktip reef shark (*Carcharhinus melanopterus*) was maintained at the Steinhart Aquarium in a 242,000 liter recirculated marine system at 25.6 degree Celsius, with a pH of 8.16-8.25 and salinity of 32.7-32.9 ppt. The water was tested weekly for ammonia, nitrite and nitrate with no trace amounts detected. The female shark shared this exhibit with 2.1 Blacktip reef sharks, 2.2 Whitetip reef sharks (*Triaendon obesus*) and 4.0 Nurse sharks (*Gingylomostoma cirratum*). Her significant medical history included successful parturition on January 20, 2000, isolation to determine hormone levels and possible pregnancy on May 4, 2000, trauma to left eye on November 20, 2000 and reintroduction to exhibit tank on March 5, 2001. Her weight fluctuated between 18.1 Kg and 23.2 Kg and her length was 127 centimeters. She was offered a diet of thawed, previously frozen Mackerel, Herring, Capelin, Silversides and Squid at approximately 5-8 percent of body weight per week. Sea Tabs (Pacific Research Laboratories, Inc., El Cajon, California, 92019, USA) and B-1 Vitamin Supplements (ADH Health Products, Inc., Congers, New York, 10920, USA) were offered by pole feeding two times per week. With the exception of a slight change in swim pattern due to eye trauma there was no noticeable behavioral or health problems.

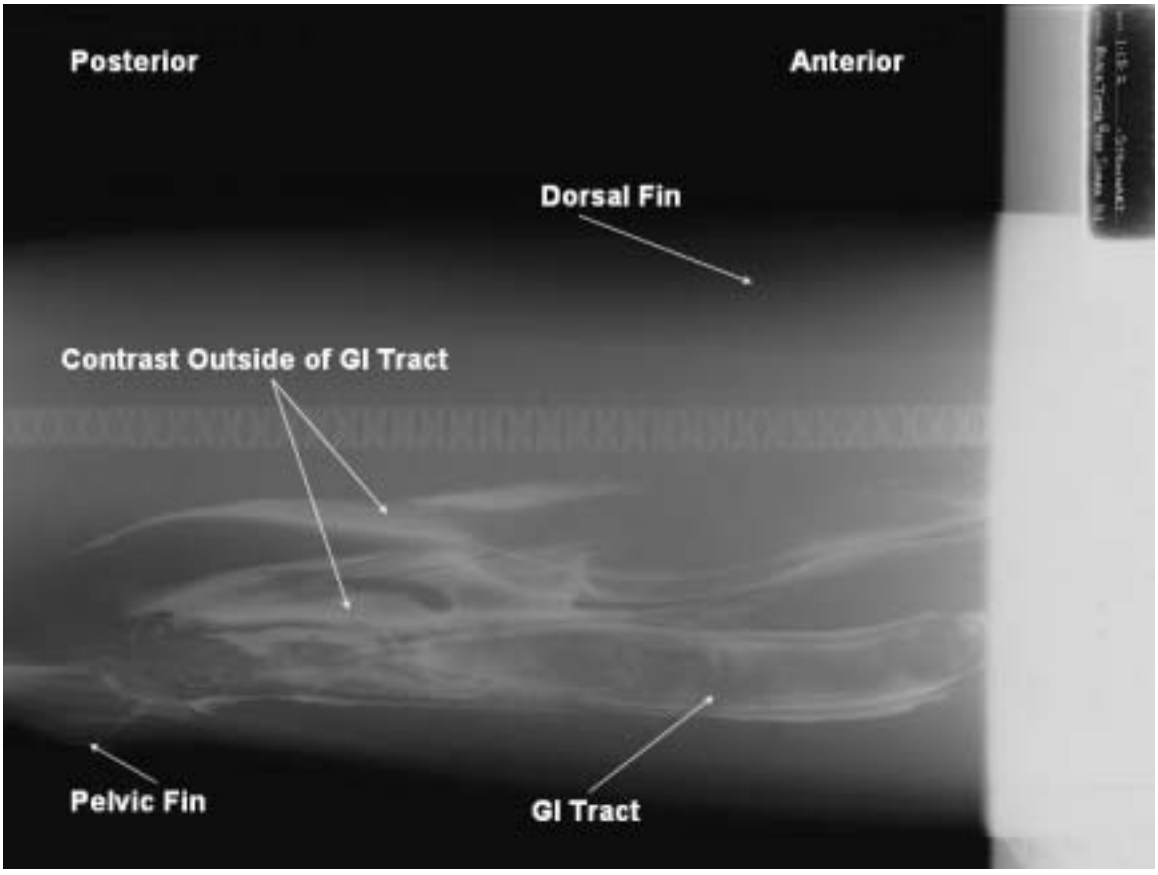
On January 10, 2002 this ten year old female Blacktip reef shark was found swimming abnormally in a tight circular pattern with a swollen cloaca and intestinal prolapse. The female was removed from the exhibit tank for physical examination and restrained through the use of tonic immobility as described by Henningsen (Henningsen, 1994). The cloaca was examined and an inability of the animal to close the cloaca recorded; vascular tissue was observed protruding from the cloaca. The abdomen was palpated and no obvious obstruction or hardening of the abdomen was felt. Blood was taken by caudal venipuncture (Stoskopf et al.,1984), she was given an injection of 91mg of Enrofloxacin (Baytril, Bayer Corporation, Shawnee Mission, Kansas 86201, USA) IM, a 50ml mineral oil (Certified Grocers of California, LTD., Los Angeles, California 90040, USA) intracolonic enema was performed, a 25mg hydrocortisone acetate suppository (Paddock Laboratories, Minneapolis, Minnesota 55427, USA) was inserted and she was subsequently returned to main exhibit for observation.

The female did not attempt to eat or respond to food for five days, her cloaca remained open and the intestinal prolapse was still observed. On January 15, 2002 she was removed from the exhibit for further diagnostics and treatment. The female was placed under anesthesia with the administration of 30ppm of MS-222 (Tricaine Methanesulfonate, Argent Chemical Laboratories, Inc., Redmond, Washington, 98052, USA) to a 265 liter salt water restraint tank (Stoskopf, 1990 and Dunn, 1990). A biopsy of the prolapsed tissue was taken and on close inspection it appeared as though the intestinal material had torn and was beginning to become necrotic. Contrast radiographs were taken to determine if there was internal rupture or tear. The shark was briefly removed from the water for administration of contrast and radiograph. The administration of an upper GI contrast and lower GI contrast enema used 40cc of 50% Hypaque 76 (Diatrizoate Meglumine and Diatrizoate Sodium Inject, USP, Nycomed Inc Princeton, New Jersey 08540, USA) and 50% water. The radiograph was performed and the shark was returned to the restraint tank. The prolapsed tissue was reduced back into the cloaca and the cloaca was partially closed with a purse-string suture using 2.0 Dexon thread (Davis and Geck, American Cyanamid Co., Manati, Puerto Rico 00701) to prevent prolapse yet to allow for defecation, 125mg of Enrofloxacin was given IM. Her weight at the time of exam was 18.1 Kg. The recovery from anesthesia and return to the exhibit was uneventful. The radiograph was reviewed and confirmed leakage of the contrast into the coelomic cavity (See Film One). The diagnosis was probable internal rupture or tear. The biopsy results were returned on January 21, 2002 stating cloacal epithelium with minimum amount of associative inflammation. Due to the lack of appropriate post operative holding, surgery was not an option.

The female appeared to mouth food on January 18, 2002, but no consumption of food was observed. By January 19, 2002 the sutures had failed and the prolapsed material was easily observed, although the female's swimming and ability to navigate the tank continually improved. On January 30, 2002 the female was removed for reevaluation. She was anesthetized with 30ppm of MS-222 and blood was drawn by caudal venipuncture. She was examined externally and appeared slightly dehydrated. A contrast radiograph was performed to determine if the internal injury had healed or sealed off from the coelomic cavity. A contrast enema was administered with 40cc of 50% Renographin 76 (Diatrizoate Meglumine and diatrizoate sodium inject USP, Solvay Animal Health, Inc., 1202 Northland Drive, Mendota Heights, Minnesota 55120-1139) and 50% water and the radiograph was taken. The prolapsed tissue was physically manipulated inside the cloaca and purse-string sutured partially closed, 113.5mg Enrofloxacin was injected IM and she weighed 16.3 Kg (a

loss of 1.8 Kg). The radiograph confirmed leakage of contrast material into the coelomic cavity although to a lesser degree.

By February 2, 2002 the purse-string suture had failed and the intestinal material was apparent. For the next three weeks, the shark actively responded to food, but ingestion of fish was questionable. Her swimming ability had improved to normal. However, she appeared to be losing considerable weight and the decision was made to euthanize her. On February 25, 2002 she was captured and restrained in a cooler and anesthetized with 30ppm of MS-222. Under anesthesia she was weighed, her weight was 10.9 Kg, a 40% weight loss in 6 weeks. Radiographs were taken; survey film was completed with Renographin 76 contrast administered into her lower GI tract (See Photo One). She was then euthanized with 4cc IV and 1cc IC of Beuthanasia D Special (Schering-Plough Animal Health Corp., Kenilworth, New Jersey 07033).



Film One: Contrast Radiograph, note leakage of contrast into ceolomic cavity.

At necropsy the animal was found to be thin and dehydrated. The cloaca was swollen and prolapsed tissue was everted through the cloaca. Upon internal examination, the scroll valve trauma was evident (See Photo Two). Additionally, the distal end of the left liver lobe was found to be traumatized with associated granulation tissue scarring. The distal end of the left epigonal organ was adhered to the traumatized area of the liver (See Photo Three). The right uterus was distended with

clear mucus. Summary of the findings include: prolapse, liver trauma, adhesions suggesting peritonitis within the coelomic cavity and trauma to the scroll valve.

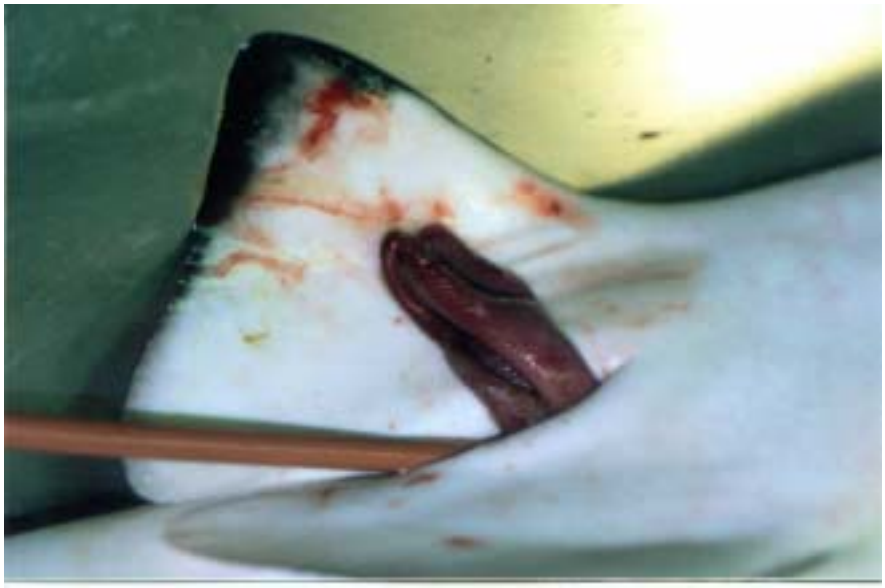


Photo One: February 25, 2002, Insertion of Renographin for contrast radiograph. Prolapse is evident. Photo is postmortem. Photo Credit: Pat Morales

Photo Two: February 25, 2002 Necropsy, Scroll Valve Trauma. Photo Credit: Pat Morales

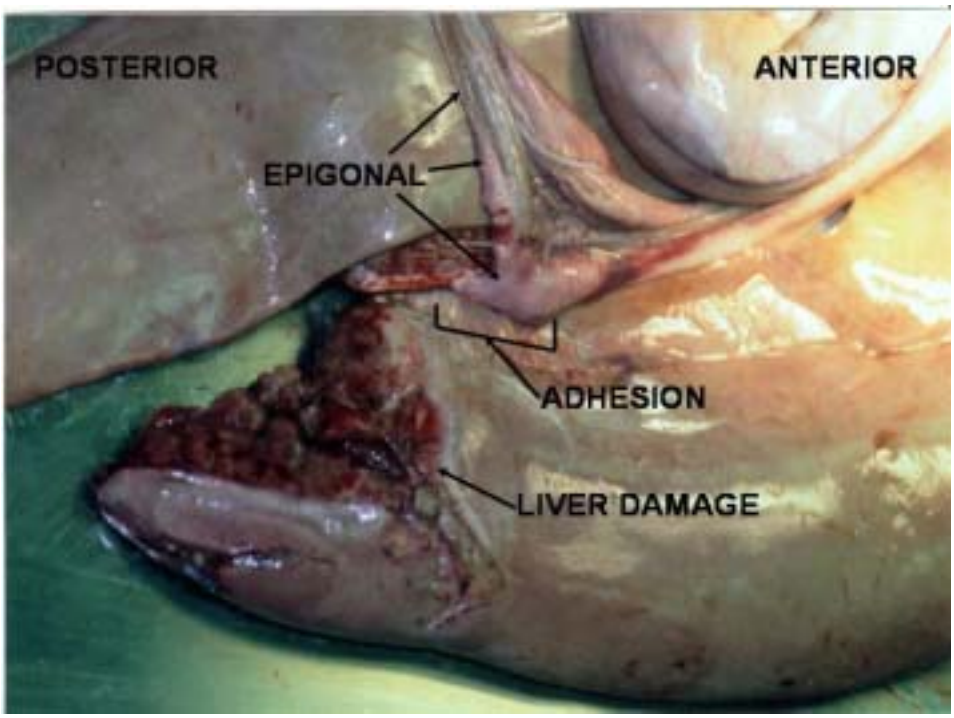


Photo Three: February 25, 2002 Necropsy, Liver Damage and Organ Adhesion.
Photo Credit: Pat Morales

Samples for histopathology were fixed in a 10% phosphate-buffered formalin, pH 6.8-7.2 (Fisher Diagnostics, Middletown, Virginia 22645, USA). Samples from the intestine, rectal gland, colon-cloacal junction, proximal spiral colon, spleen, kidney, liver and gills were taken aseptically for microbiological examination. Histological findings confirmed trauma with the diagnosis of prolapsed intestinal tissue with segmental, chronic and colonic ulceration. The prolapsed intestinal tissue results stated that the tissue was formed by normal intestinal mucosa with a segmental area of ulceration and mucosa replaced by fibrosis and fibrinohemorrhagic membrane. There was no apparent histological explanation for the prolapse of the intestine. The necropsy and diagnosis reaffirmed the results of the contrast radiographs.

Discussion

Intestinal eversion is a common observation in captive held Blacktip reef sharks (Crow et al., 1991) and has been linked to several shark mortalities (Crow et al., 1991) Eversion of the intestines is thought to be a usual physiological function in the Blacktip reef shark and may serve as a natural "flushing action" to remove undigested food or intestinal parasites (Crow et al., 1990). Intestinal Biting Syndrome is described as the biting of exposed intestinal tissue by tankmates and can result in "severe laceration to complete amputation of large sections of, or the entire, scroll valve intestines" (Crow et al., 1991). Under circumstances where the intestines do not completely retract it is possible to consider the intestines may have been bitten by tankmates with resulting internal injury (Crow et al., 1991, Morales, 1999). However, close evaluation including complete medical history, physical examination, suturing and careful observation of the shark and their environment may not allow the staff to recognize ultimately fatal internal trauma. It is also possible for a shark to outwardly appear

as though it is recovering, with improved swim patterns and return of appetite, yet be suffering from internal damage (Crow et al., 1991, Morales, 1999).

In the reviewed case, the shark had initially shown agonal signs including occasional weak swimming and inappetance, however outwardly appeared to be improving after a week. A summary of the blood results taken at the physicals and treatments showed a drop in total protein possibly indicating blood loss and/or inadequate caloric intake. The blood results also revealed a drop in hematocrit possibly indicating blood loss and/or anemia of chronic inflammation. However, the total white blood cell count remained within an acceptable range for this animal. From January 18, 2002 to February 25, 2002, the shark progressively seemed to have improved appetite towards food, even appearing to bite or consume fish. Her behavior was more consistent with a recuperating animal, returning to a swim pattern of a healthy shark. Although she was losing weight, which could be observed, an assumption could have been made that she may improve over time and regain her appetite, caloric ingestion and weight. A determination of the severity of internal injury would have been difficult based on bloodwork alone. The shark might have been assumed to be recuperating without the additional use of contrast radiography. The use of contrast radiography as a diagnostic for confirmation of internal injury is suggested for suspected Intestinal Biting Syndrome cases.

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We would like to thank the California Academy of Sciences, Steinhart Aquarium husbandry staff and Steinhart Aquarium laboratory staff, especially Pat Morales.

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THE EFFECTS OF REARING VESSELS AND LABORATORY DIETS ON GROWTH OF NORTHEAST PACIFIC JELLYFISH EPHYRAE (CNIDARIA: SCYPHOZOA)

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Abstract

Due to their importance in nature and general crowd appeal jellyfish are becoming increasingly more popular as display animals at public aquariums and zoos. Each stage in the life history of a jellyfish requires assorted husbandry techniques including using different rearing vessels and laboratory diets. This paper reports on results of experiments testing the effects of rearing vessels and laboratory diets on growth of four species of scyphozoan jellyfish ephyrae. Three of the species grew well in the tested vessels and one did not. 8" diameter glass dishes are generally good rearing vessels for ephyra development, producing jellyfish similar in size and health condition. *Aurelia labiata* and *Aurelia aurita* grew best when fed rotifers for days 1-7 and a mixture of Selco-enriched *Artemia* nauplii and rotifers for days 7-14. *Phacellophora camptschatica* grew best when fed a diet of *Artemia* nauplii for the first seven days and then fed *Aurelia labiata* ephyrae thereafter.

Introduction

Due to their importance in nature and general crowd appeal jellyfish are becoming increasingly more popular as display animals at public zoos and aquariums. As a result we aquarist-types have been charged with the mission of figuring out how to acquire, grow and display them. Jellyfish can be delicate and difficult to grow under laboratory conditions. There are relatively few studies looking at effects of various factors on growth of jellyfish. Most work concerning growth of scyphomedusae has been limited to only a few hardy "lab rat" species such as *Chrysaora quinquecirrha*, *Aurelia aurita* and *Cyanea capillata* (Olesen et al., 1996; Bamstedt et al., 2001; Bamstedt et al., 1997, respectively).

Each stage in the life history of a jellyfish requires different husbandry techniques, including using progressively larger rearing vessels and changing laboratory diet requirements. Raskoff et al. (2003) described rearing vessels and techniques used at the Monterey Bay Aquarium for growing cnidarian medusae. However, the type of vessel used for each jelly species at each stage of development for optimal growth remained to be discerned. Some work regarding wild diets of the abovementioned jellies has been addressed but how jellyfish medusae grow on commonly available live foods remains to be discerned.

Jellyfish undergo an alternation of generations that includes a benthic polyp stage and a pelagic medusa stage (Figure 1). Each stage in the developmental life history of jellyfish requires different husbandry techniques. Appropriate foods and rearing vessels are critical for good growth and development of newly released scyphomedusa ephyrae. The purpose of this paper is to report on the effects of rearing vessels and laboratory diets on growth for four species of scyphozoan jellyfish ephyrae commonly grown in aquarium facilities.

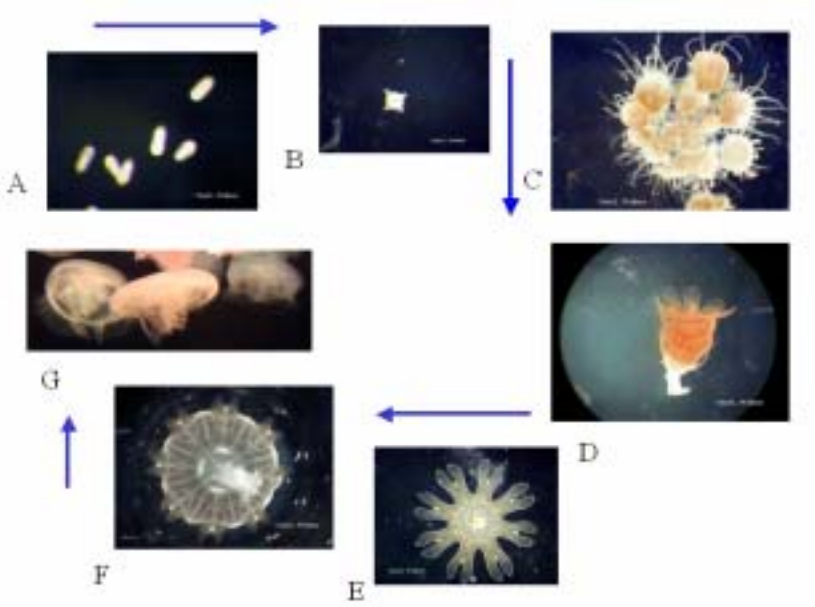

Figure 1. Life cycle of *Aurelia labiata* (A planulae, B 4 tentacles stage polyp, C developing colony of polyps, D strobila, E ephyra, F immature medusa, G mature medusae).

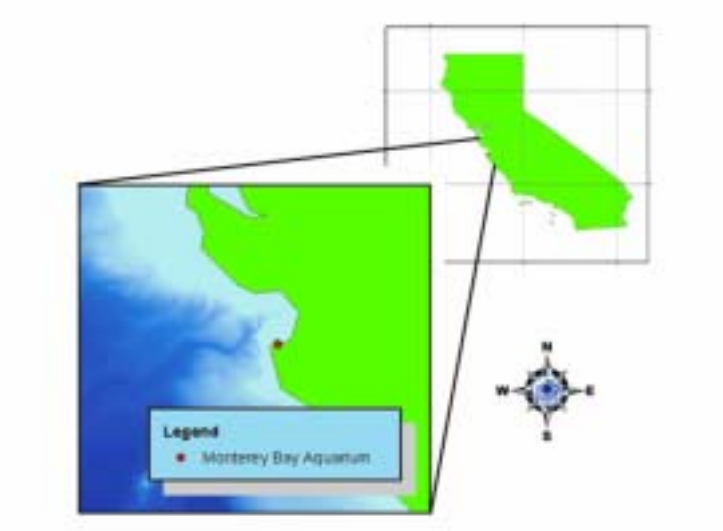

Figure 2. Monterey Bay, California.

Methods and Materials

Polyp cultures:

Three species of scyphomedusae native to the Monterey Bay, California (Figure 2) *Aurelia labiata*, *Chyrsaora colorata* and *Phacellophora camtschatica*, and one non-native species, *Aurelia aurita* (used for comparison), were tested. In order to obtain scyphistomae for the three species native to the Monterey Bay new polyp cultures were started. Using the R/V Plankton Boat, mature medusae were collected from the surface waters of Monterey Bay with a dip net and transported back to the jelly culture laboratory at the Monterey Bay Aquarium within two hours. In vitro techniques were used to obtain gametes for each of the three species. Zygotes for all three species developed into planulae that settled and metamorphosed into scyphistomae. Resultant scyphistomae were fed Selco-enriched *Artemia* nauplii daily. Polyps of *Aurelia aurita* were obtained from a collection of scyphistomae originally started in Japan.

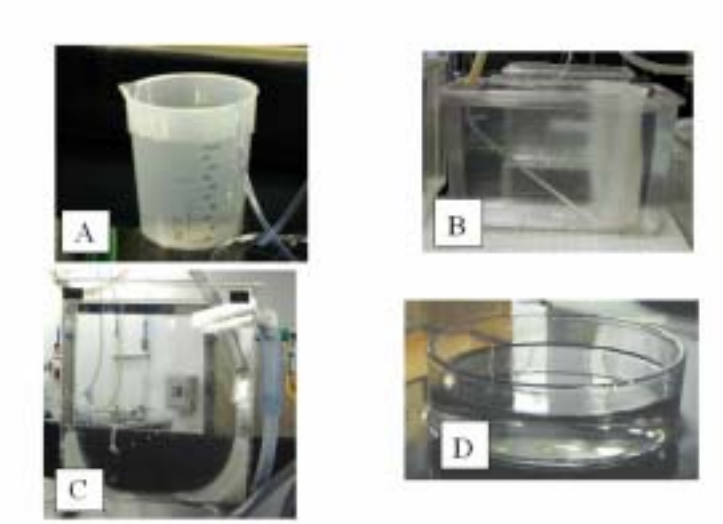

Figure 3. Tested rearing vessels (A 2-liter beaker, B 5”x5”x7” screened in flow through tank, C 1’ pseudo kreisel, D 8” diameter glass dish).

Rearing vessel experiments:

In order to determine the effects of rearing vessel on growth of ephyrae four potential rearing vessels were tested (Figure 3). The vessels used were a 2-liter beaker with the experimental beakers gently mixed using an aeration system consisting of a single airline tube with a small lead weight affixed per beaker, a 5”x5”x7” screened in flow through tank, a 1’ pseudo kreisel, and an 8” diameter glass culture dish. Each of the treatments consisted of two replicate treatments filled with 15 ephyrae of each species and 5 µm filtered seawater (34 ppt.) at 15ºC. Ephyrae in the two replicates were statistically treated as one group in all treatments, due to a lack of significant differences between replicates (ANOVA $P > 0.05$). Selco-enriched *Artemia* nauplii were provided in excess (~ 410 nauplii ml^{-1} x 20 ml d^{-1}) so that food availability was not a limiting factor. Where appropriate (8” dish and 2-liter beaker treatments) food and water were changed every day for 14 days. In the case of the flow through rearing vessels (5”x5”x7” screened in tank and 1’ pseudo kreisel) food was added in excess.

Laboratory diets:

Effects of laboratory diets on growth of ephyrae were tested for *Aurelia labiata*, *Phacellophora camtschatica* and *Aurelia aurita*. In order to test effects of diet on growth of ephyrae, specimens of each jellyfish species were reared in 8" diameter glass dishes maintained at 15ºC with 5 µm filtered seawater (34 ppt.). Each treatment consisted of two replicates that were statistically treated as one group, due to a lack of significant differences between replicate dishes (ANOVA $P > 0.05$). Each dish received daily water changes every day for 14 days. Laboratory diets were tested in various combinations for each species of jellyfish. All foods were fed in excess so that food availability was not a limiting factor. The laboratory diets tested for *Aurelia labiata* included Selco-enriched *Artemia* nauplii, rotifers *Brachionus plicatilis*, and the phytoplankton *Nannocloropsis oculata*. The laboratory diets tested for *Phacellophora camtschatica* included Selco-enriched *Artemia* nauplii, rotifers *Brachionus plicatilis* and ephyrae of *Aurelia labiata*. The laboratory diets tested for *Aurelia aurita* included Selco-enriched *Artemia* nauplii and rotifers *Brachionus plicatilis*.

Statistical analysis:

Ephyrae were measured from lappet tip to lappet tip to determine bell diameter size. Individual ephyrae were placed on a glass dish using a wide-mouthed pipette, allowed to relax and then measured using a dissecting stereomicroscope and a grid with 1 mm gradations. Measurements for each ephyra were completed in less than one minute. Ephyrae were measured three times, on days one, seven and 14. The growth rate was calculated (% d^{-1}) with the following equation using increments of diameter after Bamstedt et al. (1997) where D1 and D2 are the mean diameters from each treatment group, measured from lappet tip to lappet tip, at two consecutive analyses, t1 and t2 (days), respectively. $\underline{\%\ \text{growth}\ d^{-1} = \ln[(D_2/D_1)^3]/(t_2 - t_1) \times 100}$ This equation was used rather than ones based on ash free dry weight, as it takes into account the gradual development from ephyra to medusa (Bamstedt et al., 1997) and does not require destruction of the specimen (Widmer, 2005).

All statistical tests were performed using SPSS 12.0 for Windows. One-way analysis of variance tests were carried out to determine the significance of the treatments on growth of ephyrae. Assumptions for ANOVA tests were checked and verified. In some cases it was necessary to transform data with the natural log to meet the assumption of homoscedasticity.

Results

Rearing vessel experiments:

By day seven, the effects of rearing vessel were visible and significant for all four tested species (ANOVA $P < 0.01$). The effect was also significant (ANOVA $P < 0.01$) and further magnified by day 14. For ephyrae of *Phacellophora camtschatica*, 8" diameter glass dishes proved best for growth. Ephyrae of *Aurelia labiata* grew well in all tested vessels but optimal growth was achieved in a 5"x5"x7" screened in flow through tank. *Chrysaora colorata* ephyrae did not grow well in any of the tested rearing vessels and ephyrae of *Aurelia aurita* grew well in most tested vessels, however grew poorly in 5"x5"x7" screened in flow through tanks. The general effects of rearing vessel on growth of tested ephyrae may be seen in Figure 4. Growth rate data is provided in Table 1.

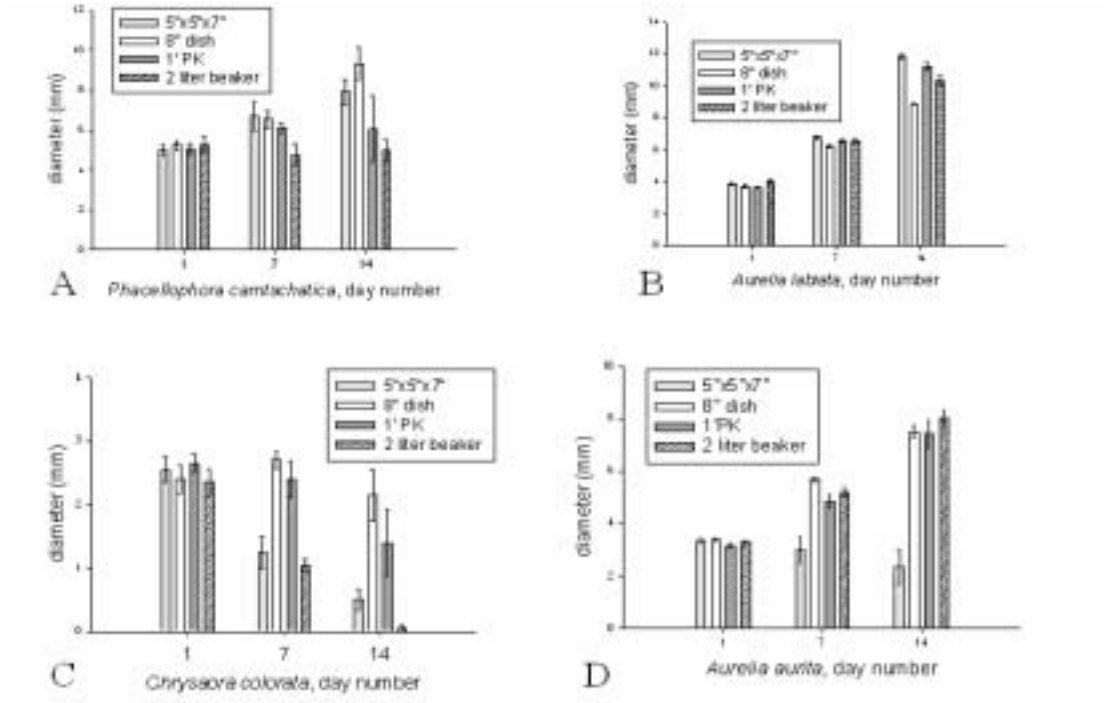

Figure 4. The general effects of rearing vessels on growth of ephyrae (A *Phacellophora camtschatica*, B *Aurelia labiata*, C *Chrysaora colorata*, D *Aurelia aurita*).

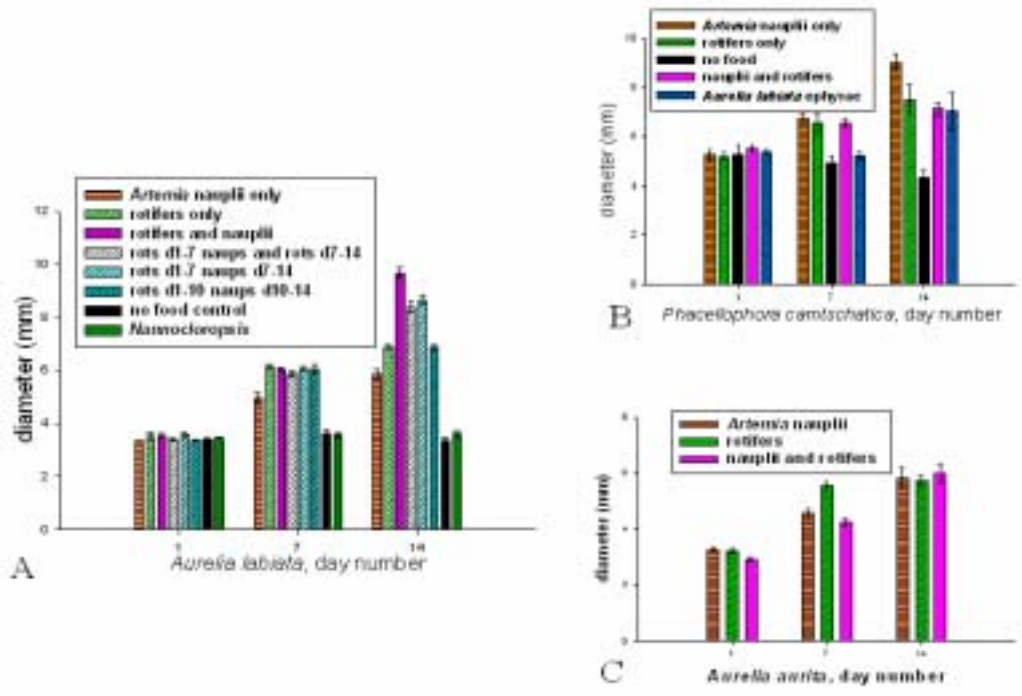

Figure 5. The general effects of laboratory diets on growth of ephyrae (A *Aurelia labiata*, B *Phacellophora camtschatica*, C *Aurelia aurita*).

Table 1. Growth rate (% day^{-1}) of ephyrae in experimental rearing vessels. N = 30 in all treatments.

Rearing vessels	**Days 1-7**	**days 7-14**	**days 1-14**
Phacellophora camtschatica			
5”x5”x7”	14.83%	7.06%	10.64%
8” dish	11.78%	15.10%	13.54%
1’ PK	9.50%	-0.28%	4.25%
2 Liter Beaker	-2.70%	-5.30%	-4.09%
Aurelia labiata			
5”x5”x7”	28.27%	24.05%	26%
8” dish	25.54%	15.29%	20.02%
1’ PK	29.51%	22.83%	25.91%
2 Liter Beaker	24.36%	19.45%	21.72%
Chrysaora colorata			
5”x5”x7”	-24.57%	-19.05%	-21.6%
8” dish	6.72%	-0.31%	2.93%
1’ PK	-6.86%	-17.09%	-12.37%
2 Liter Beaker	-40.28%	100%mortality	100%mortality
Aurelia aurita			
5”x5”x7”	-5.79%	-10.12%	-8.55%
8” dish	25.52%	12.03%	18.43%
1’ PK	21.28%	18.18%	20.07%
2 Liter Beaker	23.14%	18.55%	20.67%

Table 2. Growth rate (% day^{-1}) of ephyrae maintained with tested diets. N = 30 in all treatments.

Laboratory diets	**Days 1-7**	**days 7-14**	**days 1-14**
Aurelia labiata			
Artemia nauplii	19.76%	7.59%	13%
rotifers only	27.62%	4.98%	15.43%
rotifers & nauplii	26.9%	20.1%	23.2%
rotifers d1-7/nauplii&rotifers 7-14	27.34%	15.35%	20.59%
rotifers d1-7/ nauplii 7-14	27.19%	15.5%	20.33%
rotifers d1-10/ nauplii 10-14	29.55%	5.50%	16.6%
Control, no food	3.57%	-3.38%	-0.17%
Nannocloropsis oculata	1.99%	0.17%	1.01%
Phacellophora camtschatica			
Artemia nauplii	12.6%	10.8%	12.47%
rotifers only	11.78%	5.67%	8.49%
Control, no food	-3.32%	-5.54%	-4.5%
nauplii and rotifers	8.73%	3.6%	5.98%
Aurelia labiata ephyrae	-0.95%	12.9%	6.17%
Aurelia aurita			
Artemia nauplii	16.68%	10.44%	13.32%
rotifers only	26.88%	1.44%	13.18%
nauplii and rotifers	18.76%	14.77%	16.57%

Laboratory diets:

By day seven, the effects of laboratory diets were visible and significant for all three tested species (ANOVA $P < 0.01$). The effect was also significant (ANOVA $P < 0.01$) and further magnified by day 14 for the species *Aurelia labiata* and *Phacellophora camtschatica*. However on day 14 the effects of laboratory diets on growth of *Aurelia aurita* was not significant (ANOVA $P = 0.21$). The general effect of diet on growth of tested ephyrae may be seen in Figure 5.

Ephyrae of *Aurelia labiata* and *A. aurita* fed rotifers only for the first seven days had significantly higher growth rates (ANOVA $P < 0.05$) than ephyrae grown with other diets (Table 2). However, growth of *Aurelia* species fed only rotifers dramatically slowed during days 7-14. Ephyrae of *Phacellophora camtschatica* grew best (ANOVA $P < 0.05$) on a diet of *Artemia* nauplii only for the first seven days but grew best on a diet of *Aurelia labiata* ephyrae for last seven.

Discussion

The general effect of rearing vessel on growth of ephyrae was that different species grew best in different rearing vessels. With the exception of *Chyrsaora colorata*, most species grew well in at least two of the four tested vessels. For all species, ephyrae grown in 8" glass dishes had the least amount of variation in final size. Ephyrae grown in 8" dishes were usually similar in size and health condition (e.g. if one was healthy they all were and if one was in bad shape the others were too.). Ephyrae grown in the other three tested rearing vessels showed considerably more variation in final size. The sources of variation for each vessel are probably produced by the various means used to stir the water. For example, 2-liter beakers use an airline with gently flowing bubbles to keep ephyrae up and off the bottom of the beaker. Most ephyrae are delicate and may be damaged by suddenly encountering a bubble and rapidly ascending to the air/water interface. Similar damage may be encountered by ephyrae grown in 1' pseudo kreisels with manifolds that can spray an ephyra onto a screen with a poorly aimed jet of water.

Ephyrae of *Chrysaora colorata* did not grow well in any of the rearing vessels tested. This may be partly due to insufficient diet and/or appropriate vessel. Which as it turns out is the case. When we wish to rear *C. colorata* for display at MBA we feed them *Artemia* nauplii, rotifers and diced moon jellies daily and raise them in an 8" dish stirred with an air/water driven magnetic stirrer (Kartell). Ephyrae in this study were fed only *Artemia* nauplii and were not raised in an 8" dish stirred by a magnetic stirrer. We did not test 8" stirred dishes because it is difficult to adjust the exact rpm of the stirring magnet. Adjusting to the appropriate rpm is a trial and error process.

The effect of laboratory diets on growth of ephyrae was that different species of jellyfish had different diets that produced optimal growth. It seems that initial ephyra size may play a role in determining what type and how much food can be effectively captured and put towards growth. The two species of *Aurelia*, which are similar in initial size (~ 3.5 – 4.0 mm in diameter), grew best when fed rotifers for days 1-7 and then grew best on a diet of mixed rotifers and *Artemia* nauplii for days 7-14. Rotifers are smaller than nauplii and easier to catch. The downside to rotifers is that they are not as nutritious as nauplii. *Phacellophora camtschatica* grew best for the first seven days when fed nauplii. Mature *P. camtschatica* are medusivorous so

we fed ephyrae of *A. labiata* to ephyrae of *P. camtschatica*. Ephyrae of *P. camtschatica* are ~ 5.7 mm in diameter when released from the strobila. Ephyrae *P. camtschatica* seemed to have trouble catching *A. labiata* ephyrae until the *A. labiata* ephyrae shrank to a manageable size. As soon as *P. camtschatica* ephyrae were able to consume a single ephyrae of *A. labiata* growth of the *P. camtschatica* took off.

Conclusions and recommendations

Rearing vessels:

1. Three of the species grew well in the tested vessels and one did not. Different species of jellyfish have different husbandry requirements.
2. 8" diameter glass dishes are generally good rearing vessels for at least the first 14 days of ephyra development, producing jellyfish similar in size and health condition.

Laboratory diets:

1. *Aurelia labiata* and *A. aurita* grew best when fed rotifers for days 1-7 and a mixture of Selco-enriched *Artemia* nauplii and rotifers for days 7-14.
2. *Phacellophora camptschatica* grew best when fed a diet of *Artemia* nauplii for the first seven days and then fed *A. labiata* ephyrae after that.

Acknowledgements

We wish to thank the animals for teaching us so much, and also A. Young, T. Love, S. Reid, A. Pereyra, M. Faulkner, T. Knowles, G. Peterson, E. Francis, B. Upton, S. Brorsen, T. Davies, J. Welch, J. Hoech, C. Slager, E. Seidel, R. Hamilton, the Widmer family, the white shark for being great, the Monterey Bay Aquarium, Harley Davidson Motorcycles, the US Army College Fund, Humboldt State University, L. Garden, K. Kurimura, the Anchor Steam Brewing Company, D. Lang, and to A. Barratt, thanks for all the water changes.

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RAW 2004 ABSTRACTS
Regional Aquatics Workshop, May 18-23
Mote Marine Laboratory Aquarium, Sarasota, FL

Hard copies compiled by 2004 organizer: Kevin Curlee
New email: **kcurlee@georgiaaquarium.org**

OCR and Editing by Pete Mohan
petemohan@aol.com

[Editors note: Abstracts were not submitted for all papers presented. However the titles, presenters, and email addresses (where available) are provided for each paper.]

Tuesday, May 18
Morning Sessions: AZA Conservation Group Meetings

For complete minutes of all AZA TAG meetings, and copies of any materials distributed, please contact Doug Warmolts (MFTAG, FFTAG), Steve Bailey (LVSSP), or Mike Brittsan (AITAG, CRCAP)

Afternoon Sessions:
Collaboration of Public Aquariums: Strategic Planing for the Future(Part 1)

While not scheduled during the formal RAW talk days (May 19-22), this session was intended as pre-work for sessions occurring of later days. Those in attendance listened to several introductory talks on the title topic, communication resources, and the role of aquariums in the AZA. This was followed by group exercises designed to identify important areas for future discussion.

Collaboration of Public Aquariums: Strategic Planing for the Future
(Introduction of topic by the moderators)
Doug Warmolts, Columbus Zoo and Aquarium
doug.warmolts@columbuszoo.org
Beth Firchau, Virginia Aquarium (Virginia Marine Science Museum
bfirchau@vbgov.com

Communicaton Resources
Pete Mohan, RAW Advisory Chair
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The presentation identified conferences, organizations, training opportunities, and online publications that are of particular interest to public aquarists. A detailed list including listserves, newsletters, AZA committees, and websites was also provided to the conference organizers and placed on Mote's RAW pages. As Kevin Curlee has now moved on to the Georgia Aquarium, the full document is also presented in this issue of Drum and Croaker.

The Role and Function of the AZA

Ruth Allard
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Wednesday, May 19
Conservation Science Papers

Sand Tiger Shark (Carcharias taurus) Reproduction and Conservation

Cheryl Nicholson, the University of Hull
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In 2003 I was funded to carry out a PhD on conservation and reproduction of captive Sand Tiger sharks. The study is divided in to 3 sections, aquaria questionnaires, behavioural observations and genetic analysis.

1.1 Aquaria Questionnaires

Two questionnaires were designed for aquaria, with the aim of gathering information on their Sand Tiger sharks, their tank and their feeding regimes. In particular reproductive success of their Sand Tiger sharks is discussed. The questionnaires were also designed to encourage aquaria to increase the involvement in this study, such as donating blood samples for genetic analysis.

1.2 Behavioral Study

The Sand Tiger sharks of The Blue Planet Aquarium, Ellesmere Port, U.K. have been observed for 300 hours to date. The variables include time of day, diver presence/absence, feeding/non-feeding days and season (mating/non-mating). The factors monitored are behaviors, nearest neighbor, voluntary swimming speeds, mating interactions, give-ways, depth and swimming patterns. Each shark was observed for a 15-minute period and every 15 seconds all of the factors were recorded. Then the following 15 -minute period a different focal shark was selected and so on.

1.3 Genetic Analysis

High quality genomic DNA is recommended for AFLP (amplified fragment length polymorphism) analyses (Vos et at, 1995; Mueller and Wolfenbarger, 1999). Correct sample collection and preservation is crucial in preventing DNA degradation. Obtaining genetic samples from aquaria sand tiger sharks has proven to be difficult.

After preliminary work, high quality genomic DNA was obtained from blood and fin samples. These protocols yielded enough DNA for AFLP or Microsatellite analyses.

Success of the genetic tests and determination of which test will be most viable will rely on gathering a relatively large sample numbers from a range of locations. The more blood/tissue samples we have the more accurate the test will be. At present we believe microsatellite isolation is the most viable option. Other possibilities include AFLPs and mitochondrial DNA. Until we know how many samples we have from each location we cannot definitely confirm which techniques will be used or which genetic questions can be answered.

1.4 Regional Aquatic Workshop

By taking part in R.A.W, I hope to encourage curators from the North American Aquaria to donate blood samples from their Sand Tiger Sharks. Also if my aquaria would like to be included in the behavioural study this would also be an excellent opportunity to discuss that possibility. I would therefore like to give a talk or poster presentation on my work at the forthcoming R.A.W. conference.

Sawfish Conservation Research

Colin Simpfendorfer, Mote Marine Laboratory, Center for Shark Research
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Satellite Grey Nurse Sharks in Western Australia

Rory McAuley

Predator as Prey: The End of the Line for Sharks?

Stephan Bognar, WildAid
bognar@wildaid.org

WildAid is a San Francisco non profit dedicated to fighting the illegal trade in wildlife. WildAid's Shark Conservation Program fights for better protection of sharks and works to reduce the demand for shark fin globally. The Galapagos Forever Program aims to make the Galapagos Marine Reserve the best protected marine reserve in the world. Stephan will outline the threats facing sharks from overfishing and their ongoing education campaign to reduce consumption of shark fin in Asia, as well as the hands-on efforts to equip and train rangers in the Galapagos, where sharks are poached for their fins.

Aquaculture, Responsible Collecting and Captive Breeding: The Right Way to Go!

David Gross, Proaquatix
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A discussion of species which are now available captive-raised from Proaquatix, and ethical methods used to supply fish for Aquariums.

Sustainable seafood and animal diets

Sonja Tiegs, Conservation Programs Coordinator, Shedd Aquarium
stiegs@sheddaquarium.org

Generally, we've thought of the oceans as a limitless source of food. We are now discovering limitations and seeing a decline in fish populations. However, the demand for seafood is only increasing. The Food and Agriculture Organization of the United Nations reports that 60% of the world's 200 most commercially important marine fish stocks are overfished. The seafood consuming animals in our care depend on the availability of these food products. Through a partnership between Shedd Aquarium's Right Bite program, Monterey Bay Aquarium's Seafood Watch program and Brookfield Zoo's Nutrition Department, we are beginning a baseline assessment of the types and amounts of seafood in animal diets at AZA facilities. The next step will be to identify alternate food choices, if necessary, that will meet both nutrition and sustainability needs. There are the additional complicating factors of cost and availability that must be taken into consideration. We don't have the answers yet, but hope to begin the thought process and have discussions about this important issue.

Status of Federal Shark EFPs (Exempted Fishing Permits)

Joe Choromanski
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Marine Aquarium Council (MAC) Update

Doug Warmolts
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Lake Victoria Species Survival Plan: Ten Years On

Lake Victoria Species Survival Plan: Ten Years On

Les Kaufman[1], Cindy Lee[2], Steve Bailey[3] Paul Fuerst[4]
[1]Boston University, Boston, MA 02215 USA , [2]Toronto Zoo, Scarborough, Ontario, Canada, [3]New England Aquarium, Boston MA 02215 USA, [4]Paul Fuerst, The Ohio State University, Columbus Ohio

In 1994, the AZA launched a risky experiment: the first fish Species Survival Plan (SSP) was officially recognized by the AZA for the haplochromine cichlids of Lake Victoria. During its first ten years, the LVSSP tackled the challenges of managing multiple, gravely endangered species with short generation times and high fecundity, while keeping one eye to the situation in the wild. Beyond the shaping and stewardship of a managed population of representative species, the products of ten years of work include: major contributions to the generation of a regional restoration project for Lake Victoria (funded by The World Bank and the EU); contributions to both funding and training of young African scientists for advanced degrees; field surveys that uncovered hosts of new species and provided a map of the remnant populations in the wild, a new understanding of the ecology, conservation genetics, and population biology of the

endangered cichlids and associated fish species; a major public exhibit and associated education programs, assisted by funding from the National Science Foundation; a successful combination of in situ educational programs - including exhibity, technical training and personnel exchanges with N. Americans and the National Museums of Kenya, the Entebbe Zoo and regional fishery research institutes; and recent research on the threats posed to fish conservation programs by chronic mycobacterial Infections. Success has come through dedicated teamwork, modest but long-term commitments, a true collaboration with East African partners, leverage of funds, and participation by the academic community. The LV-SSP has reached a critical juncture and is about to broaden its focus to include a number of in-situ conservation efforts, but new science is needed both on fish pathology, and on what happens when complex, multi-species assemblages of indigenous species are released in tropical fresh wafers that vary in limnology and human ecology. Planning has begun for a replicated field experiment, with careful follow-up study, in isolated satellite takes and impoundments lacking indigenous species of special concern. In addition to guiding subsequent LV-SSP efforts, this can be a landmark experiment in conservation, community, and evolutionary biology.

Mycobacterium **Studies and Updates**

Akinyi Nyoake, University of Connecticut
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An abridged version of Akinyi's scholarly talk for the Lake Victoria SSP, edited and presented by Pete Mohan. An introduction was added by PM regarding the history of the *Mycobacterium* issue in public aquaria, 1998 to present. He also reviews precautions to be used to protect staff and prevent the spread of the pathogen within collections.

The main paper begins by summarizing the clinical signs, gross pathology, histology, and diagnosis of *Mycobacterium* infections. The successful use of molecular techniques (PCR-RFLP and PCR-Direct sequencing) to identify Mycobacteria species and strains in several fishes is described. Molecular techniques prove to be sensitive and specific in the detection of paucibacillary (stain negative, culture positive) *Mycobacterium spp*. Infection.

Genetics and Captive Breeding

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Lake Victoria SSP Program Report, Lake Victoria Studbook, Master Plan, and State of the Lake

Steve Bailey, Jay Hemdal, and Cynthia Lee
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Thursday, May 20

Preliminary Results in Giant Pacific Octopus Behavior Studies on Enrichment

Alan Peters* and David Powell
*Smithsonian's National Zoological Park Invertebrate Exhibit.
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What impact does enrichment have on a Giant Pacific octopus? How do introduced objects and environmental changes affect octopus behavior? Where is the data? Can we determine the effectiveness of enrichment in invertebrates? Behavior data has been collected for three years on two Giant Pacific octopus at the National Zoological Park's Invertebrate Exhibit. This is an effort to begin to measure impact and effectiveness of enrichment through a rigorous collection of behavior data. The collected data supports much of the observations and impressions previously suspected of enrichment by octopus caretakers, yet some assumptions did not hold true with the two octopuses observed. The full paper is included in this issue of Drum and Croaker.

Rebuilding the Reef

Carrie Nelson Beauregard, Columbus Zoo and Aquarium
carrie.beauregard@columbuszoo.org

An overview of the process of refurbishing the 85,000 gallon Discovery Reef exhibit at the Columbus Zoo and Aquarium. Discussion will include fabricated coral selection, surface preparation, materials/equipment used and outline methods for underwater installation.

Sharks: Myth and Mystery

Andy Case, Monterey Bay Aquarium
New contact information: andycase@comcast.net

Themes, animals, and messages of the new show that opened at the Monterey Bay Aquarium in April.

Shark Reproduction in Aquariums

Jose Castro

Bioencapsulation of Metronidizaole in Adult Brine Shrimp -
Can Metro-Brine Really Work?

John Dickson
John.Dickson@Disney.com

Anesthesia and Surgery: Veterinary Assistance Device

Goncalo David Nunes, Oceanario de Lisboa
gdnunes@oceanario.pt

At Oceanario de lisboa, it was necessary to develop an apparatus that would help the veterinary staff to improve some of their operations. These operations mainly consist of: surgeries, treatments, observations, and complementary means for diagnosis. The apparatus will be described, as well as some anesthesia considerations. Some video examples will be shown of the apparatus during some of the veterinary procedures. In the end, a brief history of the results so far using this apparatus and the expected evolution for it will be presented.

The Aquatic Biology and Aquaculture Technician Program at Gadsden State Community College

Hugh S. Hammer, Aquaculture Education and Development Center
hhammer@gadsdenstate.edu

The Aquaculture Education and Development Center at Gadsden State Community College is a 40 acre facility with 13 bodies of water, 1,700 sq ft of indoor hatchery space, a modem classroom and wet/dry laboratory space. The program offers an Aquaculture Technician Certificate, Associate of Science Degree in Aquatic Biology and the opportunity to participate in a large number of unique internships with public aquariums, aquaculture farms, and research institutes all over the nation. Students graduating from the program pursue careers with public aquariums, aquaculture farms, pet stores, state fisheries units or transfer into 4-yr institutions such as USA, Auburn, UAB or JSU. Over 1,000 people from Gadsden and the surrounding areas come to the AEDC for children's fishing events, educational activities/labs, or tours of the facility each year. The AEDC is active in supporting Alabama's researchers and farmers by providing catfish, FW Shrimp, koi, and tilapia. The AEDC is supported by an appropriation from the Alabama legislature, GSCC and through grants from NSF, AACC, and ARC.

Aquarium Science Program of Oregon Coast Community College

David Beran, Student Coordinator/Instructor, Oregon Coast Community College

Friday, May 21

The Use of Closed Circuit Rebreathers as a Safe and Practical Diving Tool for Unobtrusive Observation and Study of *Latimeria*

Forrest A. Young, Dynasty Marine Associates
forrestyoung@bellsouth.net

Technical diving has been in existence for some time and for the majority of that time, it's use as a valid working dive method has been not universally accepted by the scientific and

commercial diving community. More recently, institutions, Including NOAA (USA's National Oceanic and Atmospheric Administration) have been looking at technical diving as a legitimate and relatively safe means for acquisition of biological life forms from the deep reef to depths in excess of 125m. Rebreather technology has shown it to be the best diving method from both a technical standpoint and from it's cost efficiency. It is the author's hypothesis that divers using rebreather gear, that is bubble free and inherently stealthy, will result in being able to gain a more intimate knowledge of the behaviour of this truly unique species.

Use of Regranix to Repair Lateral Line Disease Damage in an Ocean Surgeon

Alison Davidson, Curator of Fishes, National Aquarium in Baltimore
adavidson@aqua.org

Topical application of the drug Regranix is being used to repair tissue damage from lateral line disease in tropical fish. This talk reviews one medical case where severe erosion of tissue on the face of an ocean surgeon was completely reversed. Effects appear to be permanent.

Optimizing Jellyfish Growth

Chad L Widmer, Monterey Bay Aquarium
cwidmer@mbayaq.org

Jellyfish are popular display animals due to their charismatic nature and general crowd appeal, However, the relative fragility of jellies has been an obstacle to jelly keeping and so usually only the hardiest species appear in public aquariums. At present most species cultured have only achieved a level of 'enough-to-get-by maintenance' and very little attention has been spent focusing on optimizing jellyfish growth. The purpose of this talk will be to present results of experiments designed to optimize growth of commonly cultured scyphomedusae. I will present various results of experiments testing effects of rearing vessels, feeding frequency, stocking density and temperature on growth for *Aurelia labiata*, *A. aurita*, *Chrysaora fuscescens*, *C. colorata* and *Phacellophora camptschatica*. The end goal of these ongoing studies is to create optimal growth flow charts for these jellies to be used when practicing jelly culture. A related paper is presented in this issue of Drum and Croaker.

Advanced Techniques for Quarantining Blue-Spotted Stingrays: *Dasyatis kuhlii* and *Taeniura lymma*

Heather M. Thomas, John G. Shedd Aquarium
hthomas@sheddaquarium.org

Blue-spotted stingrays, *D. kuhlii* and *T. lymma*, are some of the most common stingrays found throughout the Indo-Pacific. However, captive animals are seldom seen in aquaria, and attempts to keep these stingrays alive in captivity have been met with very limited success. Because of this issue, the Shedd Aquarium has worked toward getting these animals through their most critical period, the first few weeks in captivity and quarantine. For the most part, the animals would arrive in such an emaciated state that they would starve very quickly. Staff

realized that the key to being successful is getting them past this point and having them aggressively eat on their own. Together with the vet staff, quarantine aquarists set up a rigorous schedule of assist feeds and taking weights for the stingrays.

The animals were initially all fed on a daily basis, some twice a day, and were then tapered off as they gained more weight. All of the animals were anesthetized and fed gruel and fluids. Initially, the gruel was made up of blended fish, with a high lipid, carbohydrate mixture. After determining the animals were not gaining weight mother gruel was concocted. This one was made up only using the muscle tissue of the fish, not the organs, skin, etc., since it's higher in calories, but missing a lot of the roughage component.

When the animals were maintaining their weight and appeared to be eating well on their own, assist feedings were halted. The animals were eating anything from live food to frozen foods. All were still periodically weighed to be sure that they were gaining weight on their own. Since this new technique of assist feeds has been implemented, the aquarium has suffered no losses of D. kuhlii and T. lymma due to anorexia. Most of the animals are on exhibit, and eating well. Their food intake is still being monitored very carefully and they receive biannual physicals now. The full version of this paper is also presented in this issue of Drum and Croaker

Training Spotted Eagle Rays to Decrease Aggressive Behaviors towards Divers

Allen McDowell, The Living Seas, Animal Care
allen.g.mcdowell@disney.com

In 1999, the eagle rays at The Living Seas exhibited aggressive behaviors towards SCUBA divers such as biting, ramming facemasks and pulling regulator hoses. Over the years, divers had inadvertently reinforced aggressive behavior from the rays through indiscriminant feeding. The unwanted behaviors increased to the point that the rays harassed any diver that entered the water, regardless of the presence of food. A training program was implemented to address the aggression problems. Operant conditioning was used to train behaviors, such as targeting, that would be incompatible with expressing the aggressive behaviors. The aggression was greatly reduced due to the training. Also, the animals can be shifted and easily maneuvered for husbandry procedures and perform A to B's. Training has proven to be an effective management tool for these animals.

Evolution of Live Mysid Culture at Virginia Marine Science Museum

Jennifer Yost, Virginia Marine Science Museum (now known as the Virginia Aquarium)
jryost@vbgov.com

This presentation will follow the evolution of the live mysid culture at the Virginia Marine Science Museum. The husbandry techniques of the culture have morphed over time with changes in aquarists and ideas. However, the culture has been successful in providing a source of live food since its inception. The various techniques over the years will be highlighted and discussed.

Regulating the International Trade in Seahorses

Heather Hall, Zoological Society of London/Project Seahorse
heather.hall@zsl.org
Sarah Foster, Amanda Vincent, University of British Columbia/Project Seahorse

In November 2002 CITES (now totalling 165 nations) voted to implement trade controls for all seahorses (*Hippocampus spp*). Seahorses are among the first marine fish species of commercial importance to be listed on the Convention. The international community has now tacitly accepted that fishes are wildlife. The CITES listing has been deferred to come into effect in May 2004, the longest delay ever given to a listing implementation.

Of all wildlife trade issues under international conservation management, seahorses will represent the greatest volume when the listing takes effect on 15 May 2004: more than 24 million animals are traded each year among at least 77 nations. Traditional medicine accounts for the largest consumption of seahorses, and they are also fished in substantial numbers for the aquarium and curiosity trades. These direct threats, along with incidental catch in nonselective fishing gear and habitat loss and degradation, have led to severe population declines in many regions.

This paper will discuss the implications of CITES listing of seahorses on the aquarium community, including the global minimum size guideline that is both of considerable ecological value and enforceable by Customs officers.

Life Support Session Kickoff/Aquality Symposium Update and Report

Andy Aiken, National Aquarium in Baltimore
aaiken@aqua.org

Water Recovery at Oceanario De Lisboa: The Next Step

Joao Madureira, Oceanario de Lisboa
jmadureira@oceanario.pt

The technology of water treatment in aquariums and zoological parks has been evolving greatly over the last decades. Never the less, water recovery systems have not changed accordingly when it comes to their design. Environmental legislation in the future will be more restrictive in relation to dumping water in municipal sewages and water cost (particularly salt water) is getting more expensive. For those reasons. an efficient design on water recovery in closed systems is of great importance. The goal of this presentation is to introduce the original design at Oceanario de Lisboa and the changes applied to it since start-up in order to improve water quality, highlighting the approach to nitrate removal via a denitrification system.

What Do You Know About Ozone?

Kevin Curlee, John Overby, and John Gadaur
Mote Aquarium, Ozone Water Systems
rkskcurle@msn.com

Determining the Effects of a 37% Formaldehyde Solution on the Nitrification Process of a Closed Saltwater Biofiltration System

Allison L. Corwin, Scott Barrie A. Jeanene McCoy, M. Andy Stamper, Disney's Living Seas
Allison.X.Corwin.-ND@disney.com

Formalin is a. parasiticide used to treat many fish in saltwater systems; therefore, testing its effects on the biological filtration is important to ensure the continuation of proper nitrification kind to provide complete sanitization of the fish habitat.

In a pilot study, the biological filtration of two, 15 l closed saltwater systems were treated with one-hour, 250 ppm, 37% formaldehyde baths given every throe days for a total of six treatments to determine the formaldehyde solution's effect on the reduction potential of ammonia and nitrites. At the conclusion of the sixth treatment, the experimental biofilters were reducing daily one hundred percent of the allotted ammonia. They also increased throughout the treatments in percent reduction of ammonia by 27.11 +/- 2 .65% and nitrites by 64.32 +/- 22.63% compared to the control's increase of 29.04% and 40.11 %, respectively. Therefore, the 37% formaldehyde solution dosed at the highest suggested level of 250 ppm for one hour does not appear to negatively affect the nitrification process of a biological filter in a closed, saltwater system.

Incredible Isabel: Preparation, Impact, and Recovery from the 100-year flood at the National Aquarium in Baltimore.

Alison Davidson, Curator of Fishes, National Aquarium in Baltimore
adavidson@aqua.org

Hurricane Isabel brought a 7-foot storm surge into Baltimore's Inner Harbor, submerging the ground floor of the aquarium, as well as the off-site Animal Cue Center. All life-support and back-up generator systems at the aquarium were knocked out. The talk will review the measures taken to maintain the animal collection through the crisis, as well as some valuable lessons-learned.

Live Corals: Natural Water Quality Parameters and LSS Design Considerations

Mike Brittsan, Columbus Zoo and Aquarium
mike.brittsan@columbuszoo.org

On a geologic scale corals have been around for about 500 million years. Most of the genera we see today evolved about 25-35 million years ago. There are more than 2,000 species of living, corals presently classified. Over the past 25 years advances in keeping live corals has

grown tremendously. Multiple methods have been provided in the literature for successfully growing live corals. This paper highlights methods, natural water quality parameters and elements, and provides estimates of what those variables should be in closed systems. Parameters include: Salinity, temperature, pH, Alkalinity, Nitrogen (ammonia, nitrite, and nitrate), Phosphate, Calcium, Iodine, Strontium, lighting (intensity, photoperiod, and spectral quality). LSS design considerations, as well as make up water sources are discussed. Tailoring LSS methods of keeping corals, near natural physical and chemical parameters are encouraged. Methods need to consider the geographic origin and natural depth of the species.

Saturday, May 22

The Lunker Dilemma

Rich Terrell
richt@zoo.pgh.pa.us

Described Pittsburgh's efforts to dissuade the general public form purchasing species that grow too large for most home aquaria. Included a group discussion.

Bass in Our Midst

Frank C. Elia, Supervisor, Dallas Aquarium at Fair Park
dallasaq@airmail.net (general address for all staff)

Obese fish? You bet. Unnatural foods, odd feeding schedules, super-sized portions, too much Xbox and too little exercise all can lead to obese fish. As it turns out, our largemouth bass was a poster child for fish obesity. To prevent the heartbreak of fish obesity we needed to be able to identify its early warning signs. Donning my dive gear and loading my camera I set out to live with the bass ala Diane Fosse and document what healthy largemouth bass look like in the wild.

To Release or Not to Release - The Pros and Cons of Fish Re-Introduction Programmes

Heather Hall
Zoological Society of London/IUCN Re-introduction Specialist Group Fish Section Chair
heather.hall@zsl.org

Re-introduction of captive animals into the wild is more complicated than formerly thought and zoos and aquariums in the US and Europe are moving more and more towards a policy of not supporting random releases, unless the IUCN guidelines for re-introductions have been observed. However, some adaptation of these guidelines is required in some cases for fishes. At last years' RAW, there was a full debate on the release of elasmobranchs. The recommendations from these discussion were written up and published and will be summarized in this presentation.

While a precautionary approach to re-introduction programs is appropriate, one of the motivations for breeding critically endangered fishes in aquariums, and running our TAG

programs, is with the goal of re-introducing these fishes into the wild. This paper will explore the feasibility and approaches required for fish re-introduction programs, with both successful and unsuccessful examples.

Notes from a Swordfish Transport: *Xiphias galadius*

Akira Kanezaki, Valencia Aquarium
akanezaki@oceanografic.org

A full version of this paper is presented in this issue of Drum and Croaker.

Bi-annual Elasmobranch Physicals:
Capture and Handling Methods at The Shedd Aquarium

Rachel E. Wilborn, J.G. Shedd Aquarium,
rwilborn@sheddaquarium.org

In preparation for the opening of the Wild Reef exhibit (April 2003) creative techniques had to be developed to conduct elasmobranch physicals. As part of our health maintenance plan, we elected to perform ~30 individual physicals on 6 different species of elasmobranches, including a nine foot green sawfish (*Pristis zijsron*). The Fishes staff developed an efficient and effective method for handling our animals while imposing a minimal amount of stress. The results from our shark physicals have been quite impressive, with successful collection of blood (both dorsally and ventrally), fecal and oral cultures, gill clippings, morphometrics, heart rates, recovery times, body condition, and ultrasounds of the internal organs. Our team of veterinarians use the data collected as an important aid in preventative disease management. The fishes staff also use the data to accurately monitor growth and reproductive states of the animals. This allows us to make important dietary adjustments.

A Successful physical exam program requires significant forethought during initial exhibit design. In order for an exhibit to facilitate the performing of physicals, a large and easily accessible medical pool should be incorporated into the exhibit design, thus providing the area for animals to be corralled for easy capture and restraint. The Shedd Aquarium's Wild Reef incorporated a medical pool with a rolling bridge and seine net, similar to SeaWorld's (Ohio) design. Those tools along with the hard work and creativity of Fishes staff, have allowed all the sharks at Shedd to receive 2 physicals in the past year alone (many physicals were conducted prior to the opening of the exhibit).

Since, many of the sharks arrived as juveniles, we continue to adapt our protocols as they mature. Upon reaching sexual maturity, many of our animals will only undergo annual physicals; this is mainly due to their documented reduced growth rates. It is the firm belief of Shedd staff that detailed data collection, especially with sensitive elasmobranches, creates a better environment for these animals to thrive. While the shark physical program at the Shedd Aquarium is in its infancy, it has already made significant strides and advancements that could prove useful to other aquariums worldwide.

COMMUNICATIONS RESOURCES

Pete Mohan
petemohan@aol.com

(A companion document to a RAW presentation of the same name, this document was originally posted on the RAW 2004 web site, hosted by the Mote Marine Laboratory Aquarium. Much of the text used in this summary is pasted directly from the various web sites identified herein. The intent is to represent each site as self-advertised.)

NEWSLETTERS

FishNews
NOAA Fisheries
http://www.nmfs.noaa.gov/fishnews.htm
FishNews is an automated, e-mail-based newsletter that provides electronic notification of important actions, rules, policies and programs that may be of interest to you. The newsletter is coordinated by the National Marine Fisheries Service's Office of Constituent Services. Participation is entirely voluntary and free of charge. Has an Archive.

MAC Newsletter
Marine Aquarium Council
http://www.aquariumcouncil.org/
The Marine Aquarium Council (MAC) is an international, not-for-profit organization that brings marine aquarium animal collectors, exporters, importers and retailers together with aquarium keepers, public aquariums, conservation organizations and government agencies.
MAC's mission is to conserve coral reefs and other marine ecosystems by creating standards and certification for those engaged in the collection and care of ornamental marine life from reef to aquarium.

ONLINE PERIODICALS

Advanced Aquarist's Online Magazine
Published by Reefs.org, an online interactive community dedicated to the education of marine aquarists worldwide. Established in 1997, Reefs.org continues to pioneer the format for online marine aquarist communities.
http://www.advancedaquarist.com/index.htm

American Currents (at least some issues posted online)
North American Native Fishes Association (NANFA)
http://www.nanfa.org/ac/american_currents.htm

Aquarium Frontiers
Originally published in paper, then online, a small remnant archive of the online journal remains on the Aquarium Fish Magazine site.
http://www.aquariumfish.com/aquariumfish/home.aspx

Drum and Croaker
Published for public aquarists for 45 years. Over half of all issues published since 1958 are now online, including all from 1958-1968, 1993-2004, and a few key issues between these dates. Additional older issues are continually added as part of a historical archiving process.
http://www.colszoo.org/internal/drumcroaker.htm

ReefKeeping
...an online Magazine for the reef aquarist, brought to you by Reef Central
http://www.reefkeeping.com/index.htm

LISTSERVES

Aquaticinfo
aquaticinfo@neaq.org
Membership requirements: substantial involvement in the public display of aquatic life. Members include traditional public aquarium professionals, husbandrists working for museums or businesses that feature public displays, public aquarium alumni, and vendors that work closely with public aquariums either due to previous experience in the field or a business scope that substantially serves public aquariums.
List administrator: Brian D. Nelson, Senior Aquarist - Tropical Gallery, Fishes Dept.
New England Aquarium www.neaq.org
Central Wharf, Boston, MA 02110 USA
v-617.973.5242, f-617.723.6207
e-mail- bnelson@neaq.org

AZA "AQUATIC" TAG Listserves
See Joe Lankard's Table of 23 lists and contacts appended to end of this document.

Coral-List
Coral Health and Monitoring Program of the National Oceanic and Atmospheric Administration
Coral-List@coral.aoml.noaa.gov
http://coral.aoml.noaa.gov/mailman/listinfo/coral-list
The purpose of the Coral-List listserver is to provide a forum for Internet discussions and announcements among coral health researchers pertaining to coral reef health and monitoring throughout the world. The list is primarily for use by coral health researchers and scientists. Currently, over 2000 researchers are subscribed to the list. Appropriate subjects for discussion might include: bleaching events, outbreaks of coral diseases, high predation on coral reefs, environmental monitoring sites, incidences of coral spawnings, shipwrecks on reefs, international meetings and symposia, funding opportunities, marine sanctuary news, new coral-related publications, announcements of college courses in coral reef ecology, coral research

initiatives, new and historical data availability, controversial topics in coral reef ecology, and recent reports on coral research. Messages with solicitations of a commercial or political nature, inflammatory commentary and other messages not appropriate for the coral-list venue will not be approved for posting...

Shark-L
Sharks and Cartilaginous Fish Discussion
SHARK-L@RAVEN.UTC.EDU
signup page: http://raven.utc.edu/cgi-bin/WA.EXE?SUBED1=shark-l&A=1
SHARK-L is a general-interest forum for discussions about sharks (and other cartilaginous fishes, such as skates, rays, chimaeras). Topics on SHARK-L include shark biology, behavior and evolution, stories about diving with sharks, sharks in the media, shark folklore, sharks' relationship with human beings, shark conservation efforts, and resources for shark aficionados. SHARK-L is an informal, conversational list for both lay people and scientists.
Archives: http://raven.utc.edu/cgi-bin/WA.EXE?S1=shark-l

Elasmo-L
The Elasmobranch Discussion List
http://www.elasmo.org/elasmol.htm
The Elasmo-L discussion list is a forum for broad discussions of research, teaching, and conservation of Chondrichthyan fishes. The mailing list operates under the aegis of the American Elasmobranch Society (AES), and is dedicated to the concerns of its full, student, and affiliate members. Although this list is intended to promote communication among AES members, all serious students of chondrichthyan biology are invited to participate.

Aquatic Plants Mailing List
aquatic-plants@actwin.com
To subscribe, visit http://www.actwin.com/mailman/listinfo.cgi/aquatic-plants.
The aquatic plant mailing list is intended to be a medium for exchange of information about all aspects of growing aquatic plants as a hobby. Postings on both aquarium plants and pond plants are welcome. Topics of discussion include (but are not limited to): Individual plant species (identification, cultivation, propagation, etc), Aquascaping, Substrates - pros and cons of commercial substrate additives, potting soil, peat, etc., Water conditioners and fertilizers, Hardware - heaters, filters, surface skimmers, etc., Compatibility of fish and other organisms with aquatic plants, and Trades/exchanges between hobbyists. Advertisements from commercial-scale operations are not permitted.

NAW List
National Aquarium Workshop, UK
NAW@egroups.com
Colin Grist, Owner cgrist@neaq.org
Heather Hall, Moderator Heather.Hall@zsl.org
Primarily for people working in aquariums in the UK and Ireland, alhough interested USA and mainland European members are welcome.

Syngnathidae List
syngnathidae@egroups.com
Colin Grist, Owner and Moderator cgrist@neaq.org
For aquarium (and related) people working on syngnathid husbandry, education, etc.

Another Seahorse list (name?)
For people involved in more formal research on Syngnathids.
Moderated by Sarah Foster, Project Seahorse, University of British Columbia
s.foster@fisheries.ubc.ca
Project Seahorse www.projectseahorse.org also has a lot of refs and information available online.

Permit-L
http://www.lsoft.com/scripts/wl.exe?SL1=PERMIT-L&H=SI-LISTSERV.SI.EDU
Scientific permit issues...mostly museum oriented. An electronic forum to discuss state, Federal and international scientific permits issues, shipping, ownership and use of cultural and natural property.
Listowner is Sally Shelton, Collections Officer, NMNH, Shelton.Sally@NMNH.SI.EDU

CTURTLE
http://accstr.ufl.edu/cturtle.html
To improve communication among individuals around the world who are interested in sea turtle biology and conservation, the Archie Carr Center for Sea Turtle Research at the University of Florida has established CTURTLE -- a LISTSERV managed email network on the Internet. CTURTLE takes advantage of Internet technology to facilitate communication worldwide. Anyone who has access to an Internet email address can subscribe to CTURTLE.

Aqua-L
http://www.aquacultureassociation.ca/aqual.html
Owned by the Aquaculture Association of Canada and maintained by the Fisheries and Marine Institute of Memorial University of Newfoundland.

BRINE-L
Brine Shrimp Discussion List
Internet Subscribe to: listserv@uga.cc.uga.edu
Internet Mail to: brine-l@uga.cc.uga.edu
List Owners/Contact: Lamar Jackson ljackson@uga.cc.uga.edu, Mercer University, Phone: 912-752-4062; and Harold Pritchett harold@uga.cc.uga.edu

Algae-L
Forum for marine, freshwater and terrestrial algae.
http://www.lsoft.com/scripts/wl.exe?SL1=ALGAE-L&H=LISTSERV.HEANET.IE
Archives: http://listserv.heanet.ie/cgi-bin/wa?S1=algae-l

CRUST-L
Crustacean Biology List
Internet Subscribe to: listserv@sivm.si.edu
Internet Mail to: crust-l@sivm.si.edu
Description: CRUST-L is an unmoderated discussion list for scholars and students of Crustacean Biology, which, for our present purposes, comprises any matters related to the systematics, distribution, and ecology of members of the arthropod Subphylum Crustacea. Announcements will be made in English and subscribers may use the language of their choice. Translations, however, will not be provided.
List Owners/Contact: Jan Clark mnhiv002@sivm.si.edu, Bill Hart mnhiv008@sivm.si.edu, and Jim Thomas mnhiv040@sivm.si.edu

LIVESEA
A forum for seafood industry workers involved with the live holding and shipment of seafood, including aquatic plants, destined for markets worldwide. The forum is limited to technical and other practical challenges facing this developing industry.
The Livesea mail group is managed by Brian Paust (907-772-3381) and Brenda Kleinfelder of the University of Alaska. Both are located at Petersburg, Alaska.
If you would like to participate in this list-serve, please contact Kleinfelder or Paust via email at: TSBLK@ACAD1.ALASKA.EDU -or- FFBCP@ACAD1.ALASKA.EDU

MAR-FACIL
MAR-FACIL is a forum for the discussion of technical and business topics for managers, and technical staff at marine research facilities, aquaculture operations, public aquaria and other facilities supplying seawater for the support of marine life. Subscribe via mailserv@ac.dal.ca

DEEPSEA
A list for the discussion of deep sea and vent news. Its purpose is to serve the world's community of deep sea and hydrothermal vent biologists working in the areas of evolution, ecology, biogeography, paleontology, systematics, phylogenetics, and population genetics. It is maintained at the University of Victoria, British Columbia, Canada.
The list owner / contact is: Andrew McArthur amcarthu@uvvm.uvic.ca
To subscribe, send a message to: listserv@uvvm.uvic.ca with the following text in the body of the message: sub deepsea {Your Name}
To send mail to the list, the address is: deepsea@uvvm.uvic.ca

DFC-L - the Desert Fishes Council Listserv
Desert Fishes Council http://www.desertfishes.org/
An electronic forum for discussions among members of the Desert Fishes Council, though anyone interested in the mission of the DFC may subscribe. It was started in January, 1996 with the objective of facilitating communications of ideas and problems of DFC members to better help them and the DFC fulfill its mission.
E-mail to DFC-L@lists.cc.utexas.edu is circulated to all subscribed to the list.
Membership: DFC-L is now an open list. To subscribe, send e-mail with the command "***SUBSCRIBE DFC-L my name***" (without quotation marks and replacing "my name" with your own first and last names) to listproc@lists.cc.utexas.edu

Archives: E-mail the command "***INDEX DFC-L -ALL***" (without quotes) to listproc@lists.cc.utexas.edu, and an index of the archive will be e-mailed to you. Send the command "***SEARCH DFC-L -ALL pattern***" (where "pattern" is a word or text string you wish to search for) to the same address to find only those files containing specific text. Finally, when you've picked the file you want from the response to either of these commands, send e-mail to the same address with the command "***GET DFC-L file***" (where "file" is the name of the file you want.

MANGROVE (Mangrove Research Discussion List)
A new global e-mail discussion list devoted to all aspects of mangrove research. The purpose of MANGROVE is to provide a global forum for the discussion of all aspects of mangrove biology, the ecology and management of mangrove ecosystems. A major aim for the list is to provide a repository of "grey literature" (ie. non-primary literature) pertaining to mangrove research and management. This list arose out of a perceived need to improve communication between mangrove workers and avoid re-inventing the wheel with regard to mangrove research and management methods. This discussion list is not moderated. All discussion is automatically archived.
Owner: Eric Paling, Murdoch University, Western Australia;
paling@essun1.murdoch.edu.au
List manager: Mike van Keulen, Murdoch University, Western Australia;
keulen@murdoch.edu.au
To subscribe to the list, simply send a message to: majordomo@essun1.murdoch.edu.au
and in the body of the message, type the line: subscribe mangrove You will receive additional information on how to use the list on subscribing, including instructions on how to obtain help and extra information.

MPA-L (marine protected areas list)
Managed by Jon Lien at Memorial University Of Newfoundland.
To subscribe, send a message to: listserv@morgan.ucs.mun.ca
with the following text in the body of the message: subscribe mpa-l {Your Name}

SEAGRASS_FORUM
A global e-mail discussion list for the discussion of all aspects of seagrass research, biology and the ecology of seagrass ecosystems. Discussion on all aspects of seagrass ecosystems is encouraged, including: physiology, trophic ecology, taxonomy, pathology, geology and sedimentology, hydrodynamics, transplanting/restoration and human impacts. This discussion list is not moderated. All discussion is automatically archived. List owner: Mike van Keulen, Murdoch University, Western Australia; keulen@murdoch.edu.au
To subscribe to the list, send a message to: majordomo@essun1.murdoch.edu.au with the the following text (only) in the body of the message: subscribe seagrass_forum

SPECIES-ALERT
The World Wide Fund For Nature's (WWF) Endangered Species Alert Network
To subscribe to this list, send a message to: majordomo@panda.org with the following text in the body of the message: "subscribe species-alert"

Cichlid-L
Cichlid Systematics Discussion List
Cichlid-L@nrm.se
An electronic forum for the discussion of all issues related to the field of cichlid documentation, with emphasis on systematics, ecology, behavior and conservation. It is maintained primarily for scientists and advanced amateurs. Although it hopefully may serve as means of communication between scientists and hobbyists, it is not intended as a hobbyist's forum. It is also not intended for the discussion of general aquacultural topics. Subscribe by sending the single line message: SUBSCRIBE CICHLID-L firstname lastname where first and last name are your own, to mailserv@nrm.se.
Archives: http://biodiversity.uno.edu/mail_archives/cichlidl.html

Native Fishes Discussion List
North American Native Fishes Association (NANFA)
Do you have a question about native fishes? Would you like to know more about NANFA? To subscribe, unsubscribe, or get help, send the word subscribe, unsubscribe, or help in the body (not subject) of an email to nanfa-request@aquaria.net. For a digest version, send the command to nanfa-digest-request@aquaria.net instead.
list archives: http://www.nanfa.org/archive/nanfa/

EUAC Coral list
EUACCoralASP@yahoogroups.com
Practical public aquarium stuff on corals.
Although you have to be a curator or equivalent for EUAC membership www.euac.org (and it is individual membership so if you move institutions you have to reapply), biologists of various sorts may post to this list. Directors/biologists etc can become Associate members. You have 3 years of being a candidate member when you are required to give talks at the annual conference.

CONFERENCES

Advanced Fish Medicine
Next offered in Spring/Summer 2005
University of Florida
"Hands-on" approach to many of the latest techniques including anesthesia, hematology, nutritional therapy, imaging, histopathology and surgery. The primary goal is to encourage practitioners to increase their expertise in clinical fish medicine. The course is intended for the advanced student who has prior education in fish diagnostics and health management.
Outline of 2003 conference at http://conference.ifas.ufl.edu/fishmed/index.html

Aquatic Gardeners Association: Annual Convention
Washington, DC, Nov. 12-14, 2004
http://www.aquatic-gardeners.org/convention.html

American Zoo and Aquarium Association (AZA) Annual Conferences
Chicago (Shedd Aquarium), September 13-18, 2005
http://www.aza.org/ConfWork/AboutAnnualConf/

American Zoo and Aquarium Association (AZA) Regional Workshops
Vancouver Aquarium, Vancouver, BC, 2006
http://www.aza.org/ConfWork/AboutRegWork/

Diseases of Warmwater Fishes
Next offered June 2006
University of Florida
Diseases of Warmwater Fish has been offered as a summer course at the University of Florida since 1988. It is now offered every other year (even years). This course covers basic information on fish health assessment, water quality management, system design, and introduction to diagnosis and management of the most common fish diseases.
http://conference.ifas.ufl.edu/ame/wwf/index.html

European Union of Aquarium Curators (EUAC)
Lisbon, 2005
www.euac.org

International Aquarium Congress (IAC)
http://www.iac2004.org/

International Marine Aquarium Conference (IMAC)
Chicago, June 4-6, 2004
http://www.theimac.org/

Marine Aquarium Conference of North America (MACNA)
Boston, Sept. 10-12, 2004
www.macnaboston.com

National Aquarium Workshop (NAW), UK
Watch for information via the NAW listserve or contact the list Administrators
Founded 1999. Select the talks each year through a small committee made up of previous hosts and target practical issues and topics important for discussion for aquarists. It is a RAW analog for British and Irish aquariums primarily, though there are European and N.American members of the NAW listserve (a result of the 1st conference and set up by Colin Grist, now moderated by Heather (Hall) Koldeway, London Zoological Society).

Regional Aquatics Workshop
Spring 2005
Aquarium of the Pacific & Cabrillo Marine Aquarium, Long Beach/San Pedro (LA area)
Watch http://www.aquariumofpacific.org/ and http://www.cabrilloaq.org/ for details later in 2004

A LIST OF AZA "AQUATIC" TAGS

Provided by Joseph Lankard, AZA

This list does not include listservs dealing with snakes, lizards, reptiles, amphibians, crocs, water birds, etc.

Listserv Name	Open or Closed	Description	Moderator	Moderator's Email Address
aitagirs	Closed	Aquatic Invertebrate TAG IRs	George Stettner	lakehills1@juno.com
aitagsc	Closed	Aquatic Invertebrate TAG Steering Committee	George Stettner	lakehills1@juno.com
aquacomm	Closed	Aquatic Advisory Committee	Kris Vehrs	kvehrs@aza.org
aqua-ig	Open	Aquatic Interest Group	Doug Warmolts	doug.warmolts@columbuszoo.org
aquaprofdevotrain	Closed	Aquarium Training Opportunities	Ken Yates	kry@nyslivingmuseum.org
consortium	Closed	Dolphin Consortium	Kevin Willis	kwillis@mail.mnzoo.state.mn.us
coralreefcap	Closed	Coral Reef CAP	Mike Brittsan	mike.brittsan@columbuszoo.org
divers	Closed	Professional Zoo and Aquarium Divers	Marcus Cook	marcus@zoocats.org
enhydra	Open	Sea Otter Interest Group	Andrew Johnson	ajohnson@mbayaq.org
fftag	Closed	Freshwater Fish TAG	Chris Coco	csc@tennis.org
fftagexec	Closed	FFTAG Steering Committee	Chris Coco	csc@tennis.org
jellyfish	Open	Jellyfish	Mike Schaadt	mschaadt@rap.lacity.org
manatee	Open	Manatee Discussion Group	Jane Davis	jane.davis@disney.com
marinemammalirs	Closed	Marine Mammal TAG IRs	Brad Andrews	brad.andrews@anheuser-busch.com
mftag	Closed	Marine Fish TAG	Greg Charbeneau	gcharbeneau@njaquarium.org
mftagexec	Closed	Marine Fish TAG Executive Steering Committee	Doug Warmolts	doug.warmolts@columbuszoo.org
ocean	Closed	The OCEAN Project Steering Committee	Paul Boyle	pboyle@wcs.org
riverotters	Open	Feeding, Care, Enrichment and Breeding of River Otters	Jan Reed-Smith	jrsotter@iserv.net
seafoodwatch	Open	Seafood Watch Program	Jennifer Dianto	jdianto@mbayaq.org
seaturtle	Open	Sea Turtle Husbandry and Conservation	Mark Swingle	mswingle@vbgov.com
sharksc	Closed	Steering/Editorial Committee	Doug Warmolts	doug.warmolts@columbuszoo.org
WaterQuality	Closed	Discussion Group for Water Quality Issues	Mark Ryan	mryan@lbaop.org
wqssc	Closed	Water Quality Symposium Steering Committee	Andy Aiken	aaiken@aqua.org

Only those email addresses that are subscribed to a listserv may post a message to the listserv. This eliminates Spam from being posted to the listservs. AZA's listserv provider has also added virus protection software to the server that the listservs use. There have been occasions when inappropriate messages have been posted and it is at the discretion of the listserv's moderator to remove the member or not.

Schedule and Details Available at:
http://www.raw2005.org/main.htm

The Regional Aquatics Workshop for 2005 will be co-hosted by the Aquarium of the Pacific and Cabrillo Marine Aquarium in sunny Long Beach, California, welcoming RAW to the West Coast for the first time in its history. The conference will take place from **Monday, June 20th to Friday, June 24th 2005 at the Westin Long Beach Hotel**. The Regional Aquatics Workshop (RAW) is the only annual gathering of public aquarium facilities intended to give people an opportunity to share experiences and network with colleagues in an informal, laid-back environment (just as the above website is intended to be). This is a conference for people who get their hands wet, as well as for people who used to get their hands wet, but don't very much anymore, and sometimes wish they still did.

This year's schedule is streamlined to reduce conference costs for both the hosts and attendees. There will be the equivalent of 2.5 days of presentations, and we are promoting better use of poster sessions.

We're pleased to announce that we have arranged a fantastic room rate with the **Westin Long Beach** hotel for RAW 2005 attendees. The hotel will act as the site for the conference presentations and poster sessions. The secured rate for a single, double, triple, or even quadruple room is **$99 per night** (plus the usual taxes and stuff)!

CONTACTS

The main contact person for RAW 2005 will be **Paul Clarkson, Assistant Curator of Fishes and Invertebrates** at the Aquarium of the Pacific. If you have any questions, you can email him at: **pclarkson@lbaop.org.** If for some reason you are not getting a response from Paul, it could be that he is on vacation, on a collecting trip, is too darn busy, or is just plain old ignoring you. In that case, you can always try contacting **Jeff Landesmann, Chief Aquarist** at Cabrillo Marine Aquarium at: **jlandesman@rap.lacity.org**