SEAHORSE HUSBANDRY AND PROPAGATION

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INTRODUCTION

Seahorses have been known since ancient times, and throughout the ages some almost mystical powers have been attributed to them. Stories of enormous seahorses beneath the waves may have given rise to the legends of dragons. Many cultures believed that the waves breaking along the shoreline were created by seahorses pulling King Neptune's chariot. Early Polynesians thought Europeans on horseback were gods who had tamed seahorses and given them legs.

Man has always maintained a great interest in the seahorse. An unusual body shape and uncanny facial resemblance to terrestrial horses are two key reasons. That the male seahorse fertilizes and incubates the eggs in his pouch and goes through contractions, to give birth much like mammals, may be a subconscious tie. Additionally, seahorses are considered of medicinal benefit in many Asian communities and are heavily harvested for the alternative pharmaceutical trade (Lourie et al., 1999).

Seahorses have always been very popular display specimens. Their unique husbandry requirements make them quite difficult to maintain and display. For the past six years the BAS, with much input from aquarists throughout the world, has focused on these unique husbandry requirements as well as on seahorse propagation requirements. There have been many breakthroughs and many set-backs. Husbandry matters considered were collection/acquisition, water quality, food requirements, tank-mates, disease observations and treatments, propagation, and specimen shipping.

In 1994 the Birch Aquarium at Scripps (BAS) initiated a propagation project for the Pacific seahorse, *Hippocampus ingens*. In May ,1995 the our efforts were bolstered by a gift from Mrs. Dorothy Monro to construct a facility dedicated to seahorse propagation. Our goal was to raise a sufficient number of *H. ingens* to maintain our very popular local seahorse display. As propagation became more successful, we broadened our goals to include providing specimens to other aquaria, thus achieving an additional goal of conservation by reducing the need to collect display specimens from the wild populations. No efforts will be made to introduce captive-bred seahorses to the wild, has been postponed, and will be pursued only if the wild populations become endangered or extinct.

We have added eight additional species to the propagation program and now have raised a total of nine species to adulthood. To date we have shipped 1,428 seahorse specimens to 45 aquarium facilities worldwide (Table I). We regularly maintain approximately 500 juveniles in our grow-out tanks.

HUSBANDRY

Acqusition

The BAS breeding population of *Hippocampus ingens*, was collected from the waters of San Diego Bay, the northern extreme range for this species (Hubbs & Hinton, 1963). To supplement the breeding gene pool we acquired ten specimens from the Mazatlan Aquarium and collected two specimens during annual collecting trips to the Sea of Cortez. The other eight species of seahorse were acquired through purchase from marine fish wholesalers or trades with other aquarium facilities. It must be noted that wholesalers and retailers frequently misidentify seahorse species and do not accurately report collection locations. This information is an absolute necessity for the development of useful research programs on the propagation of individual species.

Newly acquired seahorses are quarantined for two-weeks in semi-open system tanks, which are easier to keep clean and control diseases. No medications are used during the quarantine unless disease symptoms are noted. Occasional copper and formalin treatments are done to prevent disease.

Sea Water Systems:

Sea water systems at the BAS are all semi-open systems. Water is supplied from the ocean by pumps located under the Scripps Institution of Oceanography (SIO) pier. There are two deep canyons off La Jolla. Natural up-wellings provide very clean water. All water is filtered through sand filters (20 gauge) and stored in 120,000 gallon settling tanks and pumped up to the aquarium, 242 feet above sea level.

The Monro Propagation Facility is part of a 1300 gallon warm-water loop supplied directly from the previously mentioned system. Water is quick heated, maintained at 23º C, and flows from the loop to each individual seahorse tank, which is maintained as a separate system. Over-flows from these tanks go to waste.

With the exception of temperature water parameters reflect local ambient conditions:

pH:	8.2
Salinity:	33.5 ppm
Ammonia:	0 mg/l
Nitrite:	<0.01ppm
Nitrate:	<0.15ppm
Dissolved O_2	97% saturation

Food Requirements:

Seahorses were initially offered only adult *Artemia* and juvenile guppies. Although guppies are an adequate food source, these are difficult to maintain the quantities required for even a modest number of adult seahorses. *Artemia,* although consumed, require enrichment treatments to make them nutritionally beneficial. We found that seahorse propagation was greatest when live *Mysis* shrimp were used to feed the brood stock. Best results were obtained by feedings two to three times daily.

Large schools of *Mysis* occur under the SIO pie and divers can regularly collect 5,000 live shrimp on one dive. During periods of rough ocean conditions, we may collect grass shrimp, *Hippolyte californiensis*, from the local bays. These two types of shrimp have been observed to be taken by *H. ingens*. However, there are drawbacks to using natural food sources. Staff time is always at a premium and there is the danger associated with the potential pathogens and other hitchhikers that may be brought in with wild-caught foods. As per the recommendation of the head veterinarian at the University of California, San Diego, we treat wild-collected mysids with a 10-ppm chloramphenicol bath before introducing them into the seahorse tanks.

We have had great success acclimatizing our adult seahorses to feeding on whole frozen *Mysis* shrimp. Chopped frozen *Mysis* shrimp are added to the juvenile grow out tanks to pre-condition the juvenile seahorses to this future food source (Garrick-Maidment, 1997). Wild-caught specimens may not initially take the frozen foods, but in the company of previously acclimated specimens, they usually learn to accept it very quickly. Frozen *Mysis* shrimp with a high oil content are not readily accepted. We have had great success with the “Gamma” brand from England.

Tank-Mates:

At the BAS we maintain seahorses in displays with invertebrates and other members of the *Syngnathidae* family. Common tank-mates in temperate waters are various algae, snails, seastars, tunicates, pipefish, seadragons, and other seahorses. Tank-mates in coral reef habitats tend to be invertebrates such as hard and soft coral, snails, cucumbers, shrimp, scallops, and hermit crabs.

It is best to maintain seahorses in tanks that closely simulate their natural environment. (Michael, 1998). However, nature does not present controlled feeding opportunities; the seahorses must forage for themselves using specialized feeding strategies. The specific techniques which have evolved to help the seahorse find shrimp in rocky coral rubble or sea-grass beds may place the seahorse at a disadvantage in the confines of the display or research tank. The relatively sedentary seahorse does not compete well with the fleeter and more agile finned fishes. Seahorses should be kept with similarly passive tank-mates. Even small arrow gobies, *Clevlandia ios*, and other more active syngnathids may out-compete the seahorse for food.

Disease Observations and Treatments:

Gas bubble disease, fungal infections, and ecto-parasites (trematodes and copepods) are some of the more common health concerns in maintaining adult seahorses. Gas bubble disease may be caused by UV-light intensity, supersaturation, or bacterial infections. Epidermal blisters may appear, usually originating in the tail region. In some cases the bubbles appear on the head and in the mouth region. UCSD veterinarians have not isolated the cause. *Vibrio* bacteria have been found in association with all affected areas. Most specimens continue to feed until the enlarged gas bubbles begin affecting their buoyancy. Trauma from the resulting buoyancy difficulties may cause the fish to stop feeding. Antibiotic treatments have been only marginally successful. The most successful treatment has been placing the affected specimens into a flo-trol (modified bait bucket) and submerging them in deeper display tanks (6 to 8 feet). Once the bubbles diminish, the specimen is either returned to its original tank or moved to a treatment tank for further observation. Although this type of decompression appears to be effective, it is still very early in the experimentation stage.

Fungal infections may result in tanks that are poorly filtered or maintained with poor water motion. These infections are indicated by hairy filaments covering the seahorse and associated plants and other substrate. We have had success in treating fungal outbreaks with a dose of 0.3ppm copper sulfate, for a two-week period. Specimens appear to have had no adverse effect from the copper sulfate. Limited success was obtained using fresh water baths. Betadine treatments and methylene blue treatments proved to be unsuccessful.

Trematodes often infect both juvenile and adult seahorses. We begin treating juvenile seahorses prophylactically with formalin, (1cc/gal) at the age of two months. A prophylactic treatment is performed on adults once a month.

A shipment of *H. erectus* (previously Identified as *H. kuda*) sent to the Toronto Zoo was diagnosed to have fish Tb. All specimens were sacrificed. The UCSD veterinary staff were unable to detect any signs of fish Tb in our specimen stock and no other facilities have reported this condition.

Propagation Efforts:

In the Dorothy Monro Seahorse Propagation Facility each tank is maintained with a single species. There are 15 breeding tanks, 150 liters in volume. These tanks are two feet deep to allow room for the seahorses to perform their mating dance. After birth, juveniles are held in five, 15 liter and four 25 liter specially constructed kreisels (Figs. 1&2). As the juveniles grow they are transferred into one of five, 75-liter grow-out tanks. The only habitat in these tanks is artificial eelgrass. The tank bottoms are maintained without substrate to allow siphoning of waste products and reduce biological growth.

Raising *Hippocampus ingens* and *H. reidi* has proven to be quite difficult. Babies are only four to five mm in length at birth. The fish have very small mouths and have a difficult time swallowing most *Artemia* nauplii. Our initial efforts, starting in 1994, were to raise rotifers as their primary food source. To provide an adequate number of rotifers for the babies to consume we kept 25 rotifers per ml in the grow-out tanks (Moe, 1992). A 24-hour light, which induces constant feeding, was also deemed imperative. Water flows to the tank were kept at a minimum to prevent the out-flow loss of rotifers. The increased bio-load in the tank leads to water quality problems. A very delicate balance must be maintained to ensure seahorse survival. Toxic tank syndrome was a constant concern. Using plankton cultures we had only a 2-percent survival rate. Obviously there is much room for improvement.

In 1997, our success rates improved dramatically with two major changes to our propagation protocol. First, we followed the example from our jellyfish culturing and began using kreisels. We quickly found that the juvenile seahorses were unable to swim against the water current used to keep them away from the drain. Air stones are now used to move the water through the kreisels and provide water turbulence simulating a more planktonic environment for the juvenile seahorses. Specimens are prevented from accumulating at the surface and food sources are more evenly dispersed throughout the water column. The second major change was to go back to feeding newly hatched *Artemia* to the juvenile seahorses, but to hatch out the *Artemia* after only 18 hours. Although there is a lower percentage of overall hatching, the 18-hours hatched *Artemia* are smaller and can be swallowed by the juvenile seahorses. As specimens become non-planktonic (settle out) we switch to Selco enriched *Artemia*, small *Mysis* shrimp, chopped frozen *Mysis* shrimp, Selco enriched adult *Artemia*, and amphipods are the main food sources.

The nine species of seahorse we are raising can be divided into categories based on the ease of culturing. *H. abdominalis, H. capensis, H. whitei,* and *H. zosterae* are classified as easy to culture. Identified as more difficult to culture are *H. barbouri, H. erectus, H. hippocampus, H. ingens*, and *H. reidi* (Scarratt, 1999).

It is interesting to note that the *H. kuda* (Scripps), recently identified as *H. erectus* by DNA tests, is easy to culture, although categorized as harder to culture. We have suspected that there may be two potential strains of *H. erectus* found on the east coast of North America. Further DNA testing was conducted by Dr. Ron Burton of the Scripps Institution of Oceanography. We had acquired *H. erectus* from two different facilities. In the *H. erectus* (Scripps kuda) population, all DNA sequences obtained were completely identical to the previously reported DNA sequences of *H. erectus.* All DNA sequences obtained from *H. erectus* (Ocean Rider, HI) were also completely identical to those previously reported in *H. erectus.* The *H. erectus* (Mote Marine Lab, FL), sequences contained four positions (nucleotides) which did not match. Out of 697 positions (nucleotides), this discrepancy does not represent enough difference to make them a separate species, but certainly suggests a separation of breeding populations.

Specimen Shipping:

The BAS has shipped seahorses throughout North America and many other continents. Typical protocol requires raising the seahorse to a minimum of two inches in length before shipping (dwarf species being the exceptions). The relatively inactive seahorse tolerates long distance shipping well. Six-inch specimens of *H. ingens* spent over forty hours in their shipping bags without incident.

Our shipping protocol is to use double backs with a black nylon liner to keep the specimens as calm as possible. The shipping bag is filled with 1/3 sea water and 2/3 oxygen. The size of the shipping bag is chosen to match the requirements of the specimens to be shipped so that the specimen is comfortably covered by water. Oxygen is bubbled into the water for one minute to completely oxygen-saturate the water. The specimen is then placed into the bag and the remainder of the bag is filled with oxygen. All prepared bags are placed inside two larger sealed box shipping bags to prevent water loss. Air filled bags are used to fill up excess space and an ice filled bag is placed on top of the box bags to help maintain temperature during transit.

CONCLUSION:

Seahorses are over-collected, threatened by habitat destruction, and taken for food, medicinal treatments and many other purposes, and their wild populations are being affected. Seahorse propagation techniques developed at the Birch Aquarium at Scripps are part of a worldwide conservation program for these unusual animals. Additional benefits in having this type of a facility will be to open up research possibilities on the care, diets, growth, disease control, and behaviors of these astonishing creatures. In conjunction with “Project Seahorse” many AZA facilities are involved in organizing working groups to develop husbandry manuals for each seahorse species commonly maintained in captivity. The objective of these working groups is to guide and support the MFTAG in decision making about facilities and exhibit design, captive management, and participation in field conservation programs. It is also hoped that we can develop viable captive populations and thus reduce demand on wild populations.

Acknowledgements

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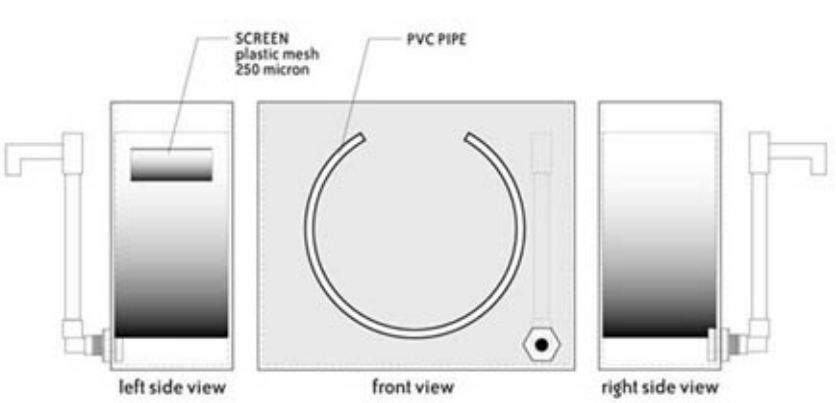
Table 1
Birch Aquarium Seahorse Travels

Date	Facility	H. abdo	H. kuda (H. erectus)	H. ingens	H. zostera	H. capensis	H. whitei
2/2/96	Monterey Bay Aq.			6			
5/9/96	Rainbow seascapes		20				
6/10/96	Chula Vista Nature			2			
12/3/96	Waikiki Aquarium		10				
3/10/97	Berlin Zoo		10	12			
4/23/97	Texas State Aquarium		9				
7/1/97	Vancouver Aquarium		10	12			
1/15/98	Ca. Academy of Sci.			6			
1/20/98	Aquarium of Americas			3			
3/25/98	Pittsburgh Zoo	5					
3/25/98	Columbus Zoo	20					
4/10/98	Long Beach Aquarium		6				
4/14/98	Sea World, Ohio		10				
5/7/98	Vancouver Aquarium	16					
5/13/98	Toronto Zoo		12				
8/27/98	Aquarium of Americas	25					
9/2/98	UnderwaterWorld, Mn	73	18	6			
9/22/98	Long Beach Aquarium		32				
9/30/98	New York Aquarium	24					
10/2/98	Sea World, Ca.			8			
10/2/98	Seattle Aquarium	16	4				
10/14/98	Ca. Academy of Sci.			10			
10/21/98	New England Aq.	6	12				
10/21/98	UnderwaterWorld, Ca	16					
10/27/98	Ca. Academy of Sci.		12				
10/29/98	Toledo Zoo/Aquarium	16					
10/29/98	Omaha Zoo	12					
11/11/98	Mystic Aquarium		14				
11/18/98	UnderwaterWorld, Ca	16					
12/8/98	Pittsburgh Sci. Center		6				
12/9/98	Ripley's Aq., SC	15					
12/9/98	Fort Worth Zoo		6				
1/12/99	Ca. Academy of Sci.	30	8	14			
1/19/99	National Aq., England	50	20	5			
1/26/99	Aquarium of Americas			3			
12699	Mystic Aquarium		14				
2/9/99	Virginia Sci. Center	10					
2/9/99	Brookfield Zoo			2			
4/15/99	UnderwaterWorld, CA	10					
4/15/99	Mirage Hotel, NV.	6					
4/20/99	Mystic Aquarium	14					
4/20/99	Ocean Rider, HI	20					
5/12/99	Newport Aq., KY	30					
5/19/99	Colorado Aquarium		5	5			
6/9/99	Colorado Aquarium		30	30			

Table 1 continued

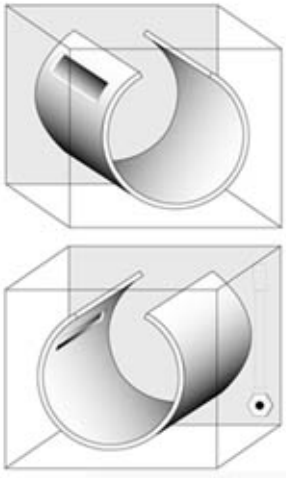
Date	Facility	H. abdo	H. kuda (H. erectus)	H. ingens	H. zostera	H. capensis	H. whitei
6/22/99	Colorado Aquarium		50				
7/6/99	Denver Zoo		12				
7/6/99	Cabrillo Marine Aq.			2			
8/31/99	Oceanario de Lisbon	20					
9/1/99	London Aquarium		30	23			
9/8/99	Ocean Rider, HI	20	20	12			
10/2/99	UnderwaterWld,Guam	30					
10/13/99	Mirage Hotel , NV		4		12		
11/2/99	Colorado Aquarium		31				
11/9/99	Albuquerque Aq.		10				
12/20/99	Sea World, Ca.		8				
1/26/00	Sea World, Ohio	10					
2/1/00	Sea World, Texas	9					
2/1/00	Aquarium of Americas					6	6
2/8/00	Ca. Science Center		9				
3/1/00	New York Aq.						12
3/7/00	Carnigie Sci Center		4			18	
3/22/00	Atlantis Marine World				6	6	
3/28/00	Seattle Aquarium				30	12	12
4/11/00	Aquarium of Americas					6	
4/18/00	UnderwaterWorld, MN					24	
5/2/00	National Aq., Baltimore					10	
5/2/00	Cal Academy of Sci					12	
5/9/00	Seattle Aquarium	16					
5/16/00	Colorado Aquarium					24	
7/11/00	Seven Seas Marine Lab	10	10				
7/18/00	Sea World, Florida	50					
8/1/00	Aquarium of Americas	15					
8/9/00	Cabrillo Marine Aq.			1			
TOTAL	45 facilities / 1426	610	456	158	48	124	30

Figure 1



Seahorse kreisel • 4 gallon

Figure 2



Seahorse kreisel • 4 gallon