

# Biology, husbandry, and reproduction of freshwater stingrays.

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## Introduction

In the freshwater aquarium, stingrays are among the most desired of unusual pets. Although a couple species have been commercially available for some time, they remain relatively uncommon in home aquariums. They are often avoided by aquarists due to their reputation for being fragile and difficult to maintain. As with many fishes that share this reputation, it is partly undeserved. A healthy ray is a robust animal, and problems are often due to lack of a proper understanding of care requirements.

In the last few years many more species have been exported from South America on a regular basis. As a result, many are just recently being captive bred for the first time. These advances will be making additional species of freshwater stingray increasingly available in the near future. This article answers this newly expanded supply of wild-caught rays and an anticipated increased availability of captive-bred specimens by discussing their general biology, husbandry, and reproduction in order help ray owners have the best experience possible with these fascinating animals.

## General biology

Stingrays and sharks have cartilaginous skeletons, and are classified together in the class Chondrichthyes. This group includes around 1000 species in two subclasses: Elasmobranchii, sharks and rays, and Holocephali, the chimerae. Chondrichthyes arose in the Silurian period approximately 450 million years ago, around the same time as bony fishes. Within the Elasmobranchii, recognizably modern sharks had arisen by the Jurassic period, and rays and skates, the order Rajiformes, had evolved by the end of the Cretaceous period. Rajiformes contains about 456 species and differs from sharks by having their pectoral fins fused to the sides of their heads and by having ventral rather than lateral gill slits. Rajiformes contains two suborders. Rajoidei, the skates, inhabit deep water and high latitudes and reproduce by laying eggs. Myliobatoidei, the stingrays, generally inhabit tropical inshore waters, reproduce by giving birth, and usually have stingers attached to their tails. This barb is a modified placoid scale (the type of scale covering elasmobranchs), and is periodically shed. It is covered with toxic epidermal tissue and can be very dangerous.



**The underside is one of the most entertaining aspects of a stingray. In an aquarium it is possible to see the gill slits and watch it eat, as can be seen in this *Potamotrygon motoro*.**

Both sharks and rays are primarily marine. Only about 5% of all elasmobranchs are freshwater. Although bull sharks and sawfishes are well known for spending time in freshwater, some rays are completely adapted to it and spend their entire lives inland. Two families contain truly freshwater rays. One of these, Dasyatidae, contains



**A stingray will thrust its barb into the skin of whatever steps on it or otherwise molests it. The barb is not filled with venom, it is actually the skin surrounding it that is toxic.**

many species that are primarily marine, but a few species that have apparently independently invaded and adapted to freshwater. These include about four species from each of the genera *Dasyatis* and *Himantura*. The family of South American stingrays, Potamotrygonidae, contains 20

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known species and is the only elasmobranch family in which all species require freshwater.

Many dasyatids regularly enter and may reproduce in freshwater. Species restricted to freshwater include *Dasyatis garouaensis* and *D. ukpam* from Africa, *D. laosensis* from the Mekong River, one undescribed *Dasyatis* sp. from China, and a few *Himantura* species in Asia. *Himantura fluviatilis* can grow up to 600 kg and over 2 m across. One freshwater dasyatid population occurs in Florida. It is actually a landlocked population of the Atlantic stingray, *Dasyatis sabina*. The Atlantic stingray is very common in the southeastern U.S. and sometimes ventures into freshwater. In fact, some have been caught 200 miles up the Mississippi River. Individuals native to the St. John's river in Florida, however, spend their entire lives in freshwater. The Atlantic stingray is offered in pet shops somewhat frequently. I have never heard of one of these rays sold as a freshwater animal in the pet trade to do well after retail purchase. They seem to eat, but appear stressed and thin before eventually dying within a couple of weeks. It seems likely that these rays are not the freshwater animals of the St. Johns River, but are captured from other locations and are not completely adapted to freshwater.



**The Atlantic stingray, *Dasyatis sabina*, is generally a saltwater ray, although some regularly enter freshwater. Those in the St. John's River in Florida spend their entire lives in freshwater.**

Potamotrygonidae currently contains 18 species of *Potamotrygon* and also *Paratrygon aiereba* and *Plesioptrygon iwamae*. In addition, undescribed species have reached the aquarium trade, being referred to by common name only, like 'pearl ray' and 'P-14'. Unfortunately, the misapplication of species names is a real problem. De Carvalho has described how even the most complete book on freshwater rays, *Freshwater Rays*, is wrought with misidentifications and he has pointed out the need for more work on their systematics in order to better understand their evolutionary relationships and assign appropriate taxonomy. Compagno and Cook have

discussed Potamotrygonid distributions and body sizes. *Potamotrygon motoro*, one of the most common freshwater stingrays in the aquarium hobby, has the broadest distribution, occurring in six countries and 7 river systems in South America. Four species, *P. ocellata*, *P. magdalenae*, *P. schuemacheri* and the popular *P. leopoldi* from the Xingu River drainage in Brazil have small distributions and are restricted to one country or river system. Six are 'dwarf' species with maximum sizes between 23 and 29 cm disk width (DW). These include *P. humerosa*, *P. magdalenae*, *P. orbignyi*, *P. schuemacheri*, *P. yepezi*, and *P. signata*. The others get a little larger, generally around 40 cm, with only two species, *Paratrygon aiereba* and *Potamotrygon brachyura*, being exceptionally large (80-90 cm). All are incapable of living in saltwater. They have lost the ability to concentrate urea in the blood like other elasmobranchs do to counteract the high concentration of ions in saltwater, and they lack rectal glands, another elasmobranch osmoregulatory adaptation. The maximum salinity they can withstand is 15 ppt (parts per thousand). Pure seawater is 35 ppt.



***Potamotrygon leopoldi* might be the most striking of all the potamotrygonids.**

Most freshwater rays available in the pet trade are potamotrygonids, and in the remainder of this article I will relate two experiences I have had keeping them.

### General husbandry: 'tea-cup ray' case study

Some people believe that rays need to be kept on sand, or in bare bottom tanks. This was the impression that I was under when I was managing the aquarium room of a pet shop in 1991. At that point I had never kept a ray, and decided to order one for the store. I got the cheapest, most readily available ray, a small tan 'tea-cup' ray. Considering the uncertainty regarding potamotrygonid taxonomy, I am unsure of the true identity of this animal. I believe it was *P. magdalenae*, often incorrectly called *P. reticulatus* (another species entirely, and now

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synonymized with *P. orbignyi*) in the pet trade. I housed it on white sand, alone in a 110 l (29 gallon) tank equipped with a sponge filter. Although rays are common in sandy areas in the wild it is important to note that Ross reported that sand may actually be too sharp and irritate some rays.



**The white sand beaches of Alter do Chao on the Rio Tapajos in Brazil are crawling with stingrays. *Potamotrygon humerosa*, P-14, and the pearl rays come from this river.**

The aquarium room was kept at 26° C (78° F), so an aquarium heater was not necessary. Heaters must be employed only with plastic heater guards or be restricted to the sump of an external filter. There are no intensely hot objects in a ray's natural environment, and they tend not to react immediately to the touch of a hot heater. Rays can become seriously burned by remaining contact with heaters. Plastic heater guards are available commercially, and although they will reduce the efficiency of a heater by approximately 1° C, it is a small price to pay for the ray's safety. Another option is to make one yourself by drilling holes into a piece of PVC pipe.

In the wild stingrays generally eat snails and other invertebrates. I fed the *P. magdalenae* live ghost shrimp, which were eagerly consumed, but can be very costly when purchased in small quantities at local pet shops. Being obtained in this manner they might only be suitable for occasional treats. It may require a special arrangement with a pet shop or a connection to a distributor to provide the quantities necessary for ghost shrimp to become a primary ingredient in the diet of a captive stingray. I was successful at keeping this animal under these conditions for a few months until it sold, and the customer that purchased it was successful in maintaining it for a long period (final disposition unknown).

### Breeding: background

Saltwater rays are common in, and have reproduced in, zoos and public aquariums. Southern stingrays, *Dasyatis americana*, common in tropical and subtropical waters of

the western Atlantic, produced 47 litters and a total of 199 pups at the National Aquarium in Baltimore between March 1994 and March 1999. As in potamotrygonids, females grow larger than males; males mature at 51 cm DW, females at 75-80 cm. Females were chased and copulated with by males immediately to within hours after giving birth. The North Carolina Aquarium at Fort Fisher and the College of Veterinary Medicine at North Carolina State University recently bred yellow stingrays, *Urobatis jamaicensis*, native to the southern East coast of the United States. In captivity, live delivery is rare in this species, as females usually resorb the pups. The aquarium injected an inducing hormone into a pregnant female to stimulate live delivery of pups, and on November 18, 2003 five pups were born.

De Carvalho pointed out the need for captive breeding of potamotrygonids. It is unknown what effects threats like collecting for the pet trade and environmental degradation might be having on natural populations because they are not monitored. Although captive bred *P. motoro* are frequently available, other species are just recently reproducing in captivity.

Potamotrygonids also have a history of breeding in zoos. The motoro stingray was first bred in captivity in 1969 at the Belle Isle Aquarium in Detroit, Michigan. Six batches of pups were produced from the original pair between 1969 and 1977. Sibling pups went on to reproduce in 1981. Fertilization occurred at 43 months, and birth at 46 months of age. Size at maturity for males was estimated to be 20-25 cm DW and for females 24-32 cm DW. Gestation was thought to be a little over 3 months. Males would mate with more than one female, but only with one at a time. Litter size of captive motoros averaged 3.3 (ranging between 2 and 5), and was less than that of wild motoros (6.3, 6-7), and wild *P. constellata* (then identified as *P. circularis*: 5.8, 4-11). In captivity, 9 of ten conceptions occurred between September and March, when the water temperature was at its lowest (24° C). Captive born pups' disks measured between 83 mm and 107.5 mm wide.

Breeding of other South American rays has progressed at a surprisingly slow rate, and only in the last few years have many other species begun to reproduce in public aquariums. In 1999, Ross summarized some cases of captive breeding that had occurred up to that time, including three species bred in public aquariums: *P. magdalenae* (Belle Isle Aquarium), *P. leopoldi* (Aquarium of the Americas), and *P. motoro* (Exotarium Frankfurt), and three by an independent aquarist: *P. motoro*, *P. leopoldi*, and *P. hystrix*.

Zoos have since been breeding more species in captivity. The Audubon Aquarium of the Americas began a breeding program in 1993 and has produced 275 pups from four of the five different species it maintains, including *P. leopoldi*, *P. castexi* (otorongo ray), and the reportedly first captive breeding of *P. henleii*. Breeding behavior was observed in *P. menchacai* (tiger ray), which

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had never bred in captivity. The Smithsonian National Zoological Park is also breeding *P. castexi*. In the spring of 2001 they acquired four wild-caught individuals. In three years, one pair produced 28 offspring. One of the offspring then hybridized with an unidentified *Potamotrygon* sp. also in the exhibit.



**The otorongo ray *Potamotrygon castexi* is relatively rare and expensive, yet beautiful.**

Independent aquarists are also proving successful at breeding potamotrygonids. A. J. and Bobby Town recently produced nine pups in five batches from a breeding trio of *P. magdalenae*. One female was around 3 years old and 25.4 cm DW and 53 cm total length (TL). The other female and the male were both approximately two and a half years old; the female 28 cm DW and 58 cm TL and the male 20 cm DW and 43 cm TL. As in *P. motoro*, gestation was approximately 90 days. There were 1-3 pups per batch, each about 8 cm DW, 18 cm TL. The pair was fed almost exclusively Canadian night crawlers

with occasional live minnows, frozen shrimp, and live ghost shrimp. The pups would not eat anything but live blackworms or ghost shrimp, except one which took frozen bloodworms. Hobbyists have also been successful with other species. As recently as late 2004, European aquarists had reproduced exotic rays like *P. scobina*, the undescribed P-14: *P. 'Itaituba'*, and the 'pearl ray'.

### Breeding: *Potamotrygon motoro* case study

The motoro is still the ray most often bred in captivity. I know of at least half a dozen independent aquarists that have bred this species. Here I will relate the breeding activities of my pair.

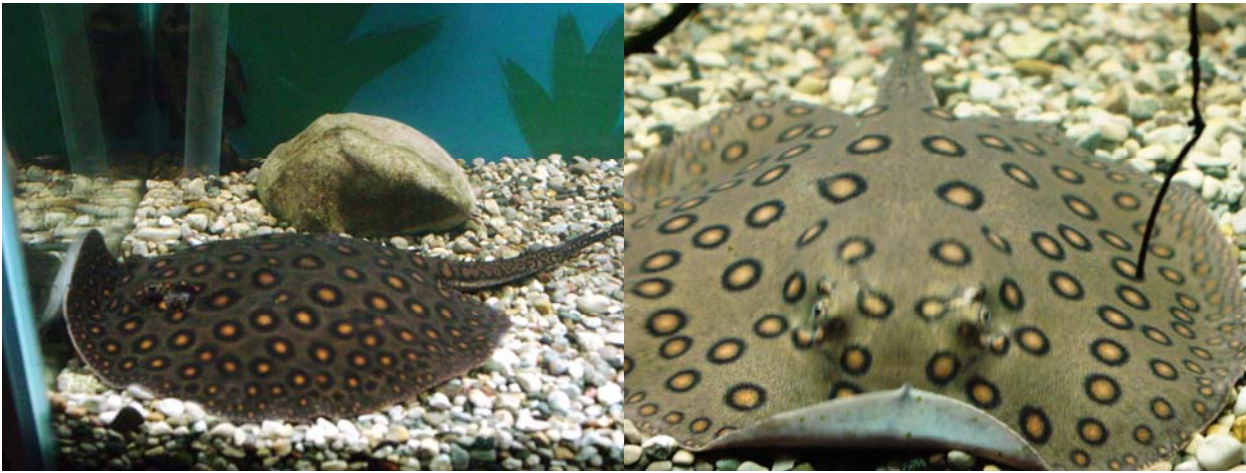
In November, 2002 I received two wild-caught Peruvian motoro stingrays from a commercial importer. One was female and the other male – easily identified by the presence of claspers. Claspers are special structures on the pelvic fins that are used to inseminate females. Also, as adults, males tend to be a light tan color, whereas females are darker brown. I placed the pair into a 454 l aquarium, with the water temperature kept at 26° C. Water quality was maintained with a partial undergravel filter powered by a powerhead, and three powerfilters. The gravel was vacuumed and partial water changes done weekly. Rays must be given special attention when first imported to ensure successful acclimation to captivity. Most important of the differences between their wild and captive conditions will be the types of food available to them. Starving fish before transcontinental shipment to reduce the production of waste during transport is common practice, so getting an animal eating as soon as possible is very important to make sure that it remains (or becomes) healthy. Accomplishing this can be a problem if it does not recognize the offered items as food. The best food to offer immediately after receipt is live

**Reproduction data for some potamotrygonids. Superscripts indicate references. DW = disk width (cm) at first reproduction for females (f), and males (m). # pups = the mean number of pups per litter, with the range of litter sizes observed in parentheses.**

Species	Environment	DW(f)	DW(m)	Gestation	# pups	Pup DW, cm
'P-14' (Itaituba) <sup>1</sup>	captive	?	?	>2.5 mon.	3	10-11
<i>P. aiereba</i> <sup>2</sup>	wild	37	>41	?	1-2	?
<i>P. constellata</i> <sup>3</sup>	wild	35-45	32-42	?	5.8 (4-11)	10-12
<i>P. hystrix</i> <sup>6</sup>	captive	38	15	?	5	6
<i>P. magdalenae</i> <sup>4</sup>	wild	17-21	17-19	?	2	10
<i>P. magdalenae</i> <sup>5</sup>	captive	25-28	20	90 days	1.8 (1-3)	8
<i>P. motoro</i> <sup>3</sup>	wild	24-32	?	?	6.3 (6-7)	?
<i>P. motoro</i> <sup>3</sup>	captive	33-35	20-25	>3 mon.	3.3 (2-5)	8-11
<i>P. orbignyi</i> <sup>2</sup>	wild	19	23	?	1-2	10

References: <sup>1</sup>Zilman 2005, <sup>2</sup>Lasso et al. 1997, <sup>3</sup>Thorson et al. 1983, <sup>4</sup>Teshima and Takeshita 1992, <sup>5</sup>A.J. Town personal communication, <sup>6</sup>Katie Birkett personal communication.

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These wild-caught Peruvian *Potamotrygon motoro* produced several litters of pups. The female is the darker colored individual (left) and the male is lighter (right).

blackworms. A ray will usually recognize these worms as food and begin eating immediately. The worms can be expensive through local pet shops (up to \$3 per 'ounce', which is often an arbitrary measure, largely dependent on which employee is helping you). However, it may be worth it for the convenience if you are lucky enough to be near a store that regularly carries them. Another option is to order them directly from a producer. This can be much easier than it sounds. The price will be about \$25 for one pound, including next day delivery 2000 miles away. This is about the right amount to order if you have stingrays. You will be amazed at how many worms are in one pound.



When *Potamotrygon motoro* pups are first born their coloration has a washed-out appearance, but it becomes very distinct within a few months and remains so for several years. The color then fades again as the rays grow old.

After generously offering blackworms to the rays for a few days until they were eating well, I began to introduce more cost-effective foods like chopped pollock and shrimp from a local supermarket. I generally thawed

my frozen fish and shrimp through several soaks in water before feeding, which may have helped to remove excess oils or residues before placing them into the aquarium. Other frozen decapods like krill and mysids were also used, as were frozen bloodworms, and live leafworms and nightcrawlers. The rays seemed to prefer some of these foods over others, ranked from most to least favorite: live blackworms, live earthworms, frozen bloodworms, frozen mysis, frozen shrimp, frozen pollock, frozen krill, frozen whiting. Many people apparently train their rays to eat from their hands, however, I did not attempt this.

Quantity of feeding is another issue. I have heard of rays being maintained healthy on two feedings per week. However, Ross emphasized the need to feed rays often. He feeds his rays 2-3 times per day. My pair of motoros always appeared to be hungry, so I fed them between 1/3 and 1/2 pound of food once per day. I observed incredible growth under this diet. When I obtained the rays in November of 2002, the female was about 20 cm DW, and the male slightly smaller. By July of 2003, the female had grown to around 36-38 cm. At this time the pair were moved to a 596 l (157 gallon) steel vat (229 x 60 x 43 cm). By April of 2004 the female's disk was 46 cm wide and she was 60 cm in length, and the disk of the male was about 38 cm wide. Due to the hazard involved with obtaining accurate measures, these are only approximate. Even under this feeding regimen, the rays sometimes attacked fish that were housed with them, even if the target was obviously too large for them to eat. Once a large red hook silver dollar had its face chewed off and on another occasion a 15 cm long Midas cichlid had its operculum and gills scraped off of one side of its head after being newly admitted to the rays' vat.

The rays got along fine with other fish that were at least half their size. Ross stated that loricatorid catfishes have been known to chew on rays. However, after seeing them housed together in large public aquariums, I decided to try it myself. I maintained a large rhinoceros pleco and adonis pleco with these rays without incident. A large

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arowana, a red bellied pacu, and various large neotropical cichlids: chocolate, uaru, oscar, severum, and red devil and Midas cichlids also shared their aquarium or vat at various times. I have seen some cichlids behave aggressively toward them, biting the edge of the disk. Although tears will heal, careful observations should be made after choosing new tankmates.



**Newborn male pups have small claspers. As the animal reaches sexual maturity they will undergo considerable growth and development.**

It was after they were placed into the vat that the pair began breeding. On December 30, 2003 I found 2 small pups (2.5-4 cm DW) stillborn in the vat. Subsequent litters turned out much better. Five pups were born in each of the following two batches, occurring on April 12, 2004, and July 25, 2004, and were much larger (13-15 cm DW) than the stillborn pups. The second of these two batches produced a couple of abnormalities. One pup died a couple days after birth, although it appeared healthy. Another was born as a 'Batman' ray. The pectoral fins had failed to fuse together in front of its head in early development. Its snout was free, and its pectoral fins projected forward on each side. I was worried that without a complete disk the ray might not be able to create enough suction to pull worms out of the gravel. To my surprise, the ray did fantastic, eating healthily, growing rapidly, and developing a nice color pattern. Another batch of seven healthy, normal pups was born on November 17, 2004. The parents apparently mated at night for the few days immediately after the births, as evidenced from bite marks on the posterior margin of the female's disk. These bites usually caused no damage to the female, although once there was a notch in the disk that healed uneventfully.

I mentioned above that I housed these rays on gravel. I noticed that public aquariums employ gravel substrates in their ray tanks, and this is the approach I took. My rays did fine on the round 'river gravel' available at quarries and home-improvement stores. Ross does not recommend large, deep gravel for ray pups, because they will not have

the power to suck food out of it like larger individuals. This may be the case, but if you feed the pups often enough and periodically stir the gravel this will not be an issue. In fact, live blackworms may initially escape the rays and colonize the substrate. If rays are the right size in proportion to the size and depth of the gravel to only extract worms that are near the surface, this worm colony may serve as a continual food source from which the rays can freely forage. This constant food opportunity seems particularly suitable to behaviorally enrich rays, since they are often cruising the tank searching for food when they are not being fed.



**Newborn pups have a small structure on the underside of the disk, probably used in obtaining nutrients from the mother. In motoros it is lost after the first several days.**

Adult rays generally get along fine with their offspring. However, Bill Gillies of Detroit had one occurrence where a father apparently cannibalized 7 of his offspring from a 9-pup litter, after which he stopped eating and died as well. After each birth, I removed the pups from the pair within a day or two. Although I did not expect any real problems from the parents, there were other large fish in the vat. Plus, I wanted to closely monitor the pups' feeding. This required moving the pups, which can be quite a challenge considering the danger of the barb. It is possible to be stung and endure little harm. A Brazilian friend of mine has been stung by wild stingrays on two occasions and never even went to a doctor. However, in the aquarium literature there are frightening photographs of very serious injuries caused by stings. It is definitely a good idea to seek medical attention if stung.

Care must be taken not to get the barb caught in a net. The best method for moving rays is to scoop them up in plastic containers. If no appropriate containers are available and a net must be used, a very fine mesh (often white) aquarium net works best for small rays, and a large-mesh (3+ cm) landing net used for fishing works best for large rays. If the barb does get caught in a net, the best action to take is to calmly lay the net into the tank

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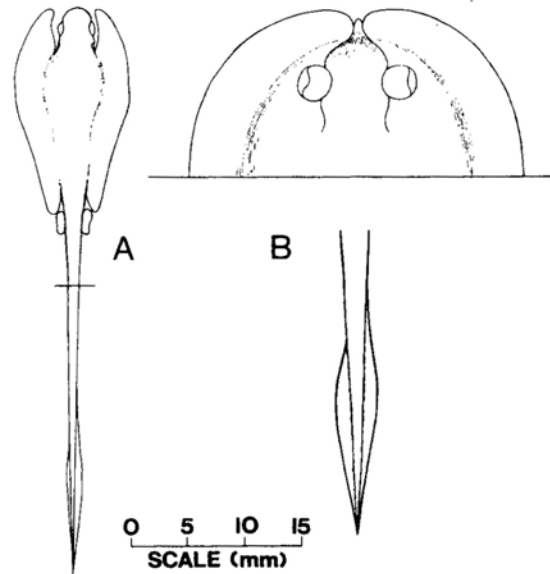
without hanging up the ray, and it might work itself loose. In November 2004 I displayed the breeding pair and three pups at America's Family Pet Expo in Detroit. When packing up for the return trip the barb of the male of the pair got caught in a thick net. I cut most of the net off so the ray was free. However, after a few days the remaining scrap of net was still attached. I suspected that it might have been irritating the tail. I scooped the ray into a shallow container and anesthetized it. Upon examining the tail I noticed that the area around the piece of net was a deep red. With the ray unresponsive I was able to remove the scrap. I think that the tail would probably have become infected had I not removed it.



The so-called 'Batman' stingray morphology. The disk failed to fuse in front of the head during embryonic development of this *Potamotrygon motoro*.

One final note must be made about water quality. Rays grow to be large animals, and have tremendous appetites. Even a large tank provides a small volume of water relative to the size of an adult ray. Add to this the fact that their main food is raw meat, and there is a recipe for poor water quality. The water in my ray vat always appeared clear and clean, never yellowish or cloudy. Water changes had continued on the weekly schedule after transfer to the vat. However, when I removed the pair and got them into the bare bottom tank at the Pet Expo it was easy to see large, red, open sores present on their undersides. Both the Ross book and Gillies indicated that the cause was high ammonia levels, although this seemed impossible to me. When the Expo was over I moved the rays to a 950 l bare bottom fiberglass tub. For two weeks I performed daily water changes and occasionally treated the water with commercial slime stimulator and ammonia remover. After this time the sores had healed. Although I do not have enough information to draw a strong conclusion, I am suspicious that although keeping rays on gravel may normally be harmless, it may have been a contributing factor in the development of the sores – adding mechanical irritation to chemical irritation. The bottom line is that special care

must be taken concerning water quality. The paradigm that I had developed after 26 years of keeping cichlids and other, smaller, bony fishes simply did not apply to the conditions under which I was keeping the rays.



A stingray's pectoral fins begin separate (A, early fetus) and then fuse in the front (B, medium fetus) before birth to form a disk. Reproduced from: *Environmental Biology of Fishes* Vol. 9, 1983, pg.18, Reproduction and development of the South American freshwater stingrays, *Potamotrygon circularis* and *P. motoro*, Thorson, T.B., Langhammer, J.K., and M.I. Oetinger, Fig. 3, © 1983 Dr. W. Junk Publishers, The Hague with kind permission of Springer Science and Business Media.

Freshwater rays make fascinating pets. However, maintenance practices must be slightly enhanced compared to those used in keeping typical freshwater fishes. A ray's eventual size must be considered before purchase, as a very large tank will be required. The cost of food and the intensive labor required for food preparation and water changes should also be thoughtfully considered. However, if you are ready to take on these responsibilities, a stingray may be one of the most rewarding pets you will ever own.

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