

# The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays and their Relatives

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## Chapter 31

# Husbandry of Freshwater Stingrays of the Family Potamotrygonidae

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**Abstract:** Freshwater stingrays are often subjected to stressful conditions prior to importation and new specimens should be evaluated for signs of disease or stress. Recently transported specimens should be quarantined and appropriate medical treatments administered during this period. Once acclimatized, specimens can be maintained in communal aquariums with other fishes. In general, freshwater stingrays do not bother other fishes, if they cannot eat them, and they do not interact aggressively. Freshwater stingrays eat any kind of live food, and can be trained to eat a variety of fresh or freshly thawed dead foods. Frequent feedings of varied foods are necessary for optimal health. While many species of freshwater stingray can be maintained readily with basic husbandry techniques, some species have more specific needs and are less suitable for communal aquariums.

Tropical freshwater stingrays of the family Potamotrygonidae contain three genera (*Paratrygon*, *Plesiotrygon*, and *Potamotrygon*) and 18 species. These stingrays are endemic to South American rivers that drain into the Atlantic Ocean or Caribbean Sea. The range of many Potamotrygonid stingrays is restricted to a single basin or river system. Some species are even restricted to a single river. This high level of endemism means that Potamotrygonid stingrays are at high risk of endangerment through habitat destruction and over-harvesting.

This chapter examines the husbandry of freshwater stingrays of the family Potamotrygonidae; specifically, assessment of newly imported stingrays; their requirements for water quality, habitat, feeding, and general husbandry; and diseases of freshwater stingrays, showing possible medication regimes.

### ACQUISITION AND ACCLIMATIZATION

#### Importation

Commercially available freshwater stingrays are often larger than other ornamental fishes. While

medium-sized stingrays generally withstand shipping well, large specimens, of >35 cm disk width (DW), are more sensitive to the stresses of capture, handling, and shipping. Long flights, delays in making connections, and poor water quality are responsible for significant mortalities. Stingrays are initially stressed while being captured and held by villagers, by being roughly handled during transport to exporters' facilities, and finally, by being kept in inadequate conditions before exportation. Once they arrive at importer's facilities, they may be kept for as little as one or two days before being shipped again. By the time they reach their ultimate destination, stingrays may have been subjected to two to three weeks of substandard conditions. It is therefore important to examine new stingrays for signs of stress, disease, and poor condition.

#### Assessing new specimens

The most important sign to look for in a newly imported stingray is curling of the disc, or margin of the fin. A healthy stingray always keeps its disc-margin flat to the substrate, except when actively moving around. A stingray that consistently holds

the edges of its fin elevated (i.e., the fin edges “curl” upwards during rest) will almost inevitably die. There are two possible exceptions to this: a stingray may be resting in a current of water that causes the fin margin to be elevated; or a stingray in good condition, at rest, may slowly undulate the fin, or disc, on either side of its tail. If in doubt, the stingray can be gently encouraged to move and observed as it settles into a resting position again. If the fin margin remains elevated after the fish has settled to the substrate, this is indicative of a stressed fish that is likely to die. In the early stages of this sign the trailing edge of the disc-margin will be affected first, on either side of the tail. When this sign spreads around the disc towards the front, death will soon occur. Aquarists should always be aware of this sign and be prepared to identify it at its earliest stage. When it occurs in an acclimatized specimen or long-term captive it is an ominous sign, indicating an overlooked problem.

Other signs of poor health or disease include a cloudy or milky film covering the body, rapid breathing while at rest, open sores on the dorsal surface, red or bloody sores on the underside of the fish, and areas of fungal infection on the skin (see below). While these signs may indicate disease or stress, they are not necessarily indicative of imminent death; curling of the disc margin is a far more serious sign. Stingrays in good health should have clear skin, and an almost velvety appearance. Light-colored patches on the skin, or an overall cloudiness or milky discoloration, are a sign of disease, especially fungal infections.

### **Unexplained mortalities**

Occasionally, specimens that appear in good health may refuse food and eventually die. Unfortunately, these unexplained deaths are puzzling for the aquarist as causes may not be obvious. The most likely explanation for these deaths is exposure to extreme stress during capture and transport. Failure to provide fresh transport water can result in the accumulation of excess nitrogenous wastes (i.e., ammonia) and cause permanent damage to the kidney. Although there are no obvious visible signs, renal failure will inevitably lead to death which may take place several weeks after transport. Another possible cause of unexplained death may be permanent neurological damage from elevated ammonia concentrations. Additionally, where water quality is poor, dissolved oxygen levels may be too low,

causing irreversible damage to the brain or other organs, and eventually resulting in death weeks later.

### **Acclimatization and quarantine**

Rays that are severely stressed for brief periods may not show abnormal physical signs for 7-10 days. Therefore, care during the period following shipping can be critical. Stingrays that appear healthy, with no abnormal signs, may initially do well, only to deteriorate days later. Whenever possible, newly received specimens should be kept in a quarantine or isolation tank during this period, at least until they have been feeding for several days. Early signs of poor health are listlessness, cessation of feeding, failure to begin feeding, and of course, fin curl. Stingrays with any of these signs should be kept in tanks with high water quality, good filtration and aeration, and should immediately be started on an antibiotic treatment program (see below). Since stingrays may stop feeding during treatment, specimens should be kept in isolation after treatment, and not placed in communal tanks, until feeding is well established.

Newly acquired stingrays should be examined for weight loss. The tail and pelvic bones are areas where weight loss will be most apparent. The pelvic bones are located on the stingray's dorsal surface, on either side of the tail, where the tail joins the body. When visible, they appear as small tent-like elevations of the skin. The pelvic bones should not be visible on a stingray in good nutritional condition. Similarly, the tail should be full and thick, with no bony structure visible through the skin. Stingrays kept without food for long periods, either by exporters or retail shops, may show signs of weight loss. Recently imported stingrays may have lost weight during the weeks in transit without food. Once in captivity, these stingrays should begin feeding and regain lost weight quickly. When in doubt about a new specimen's status (e.g., a specimen within a retail shop) it can be offered food—an acclimatized stingray, in good health and kept in suitable conditions, will almost never refuse food. A stingray in good health, but showing signs of weight loss, is likely to thrive once in a supportive environment, and should readily regain lost weight. Such specimens should be maintained in an isolation tank, if possible, to eliminate competition for food by other animals. Specimens with visible pelvic bones must be fed a lot of food to re-establish normal weight.

When specimens first arrive, small amounts of food, either blackworms (*Lumbriculus variegatus*) or tubifex worms (*Tubifex tubifex*), can be left in the isolation tank, while watching the stingrays to see if they begin feeding. Quantities can then be gradually increased in order to establish the appropriate amount for each feeding session. Stingrays are active fish, having high energy demands and food should be given two to three times each day. Many weeks may be necessary to re-establish the normal body weight of previously starved animals.

Although healthy specimens may be ready to begin feeding a day or two after arrival, the constant activity in an exhibit tank may delay or prevent a new specimen from becoming acclimatized, even one in good health. Newly acquired specimens may take time to accept unfamiliar foods offered in captivity, while acclimatized specimens search constantly and aggressively for food, leaving little for a new specimen to eat. There is always a risk of introducing infectious agents to acclimatized specimens if newly acquired animals are placed directly into a communal exhibit. Therefore, as previously mentioned, quarantining of new specimens is always recommended.

## HANDLING SPECIMENS

### The spine and venom

The spine, or barb, of a stingray is a defensive weapon. Stingrays rarely attempt to sting, even when netted or manipulated during treatments. However, some taxa are more aggressive than others. For example, ocellate river stingrays (*Potamotrygon motoro*) are more likely to sting when being netted. Stingray envenomation is uncommon. Individuals who have been stung report that the venom is extremely painful, but none suffered serious long-term consequences. The primary risk from a stingray barb appears to be secondary infection through wound contamination. The fleshy sheath surrounding a spine may contain toxins or other proteins that promote secondary infection. Stingrays shed their spine about two to three times per year. Shed spines will be found at the bottom of an exhibit. These spines may have residual toxins and should be handled with care. Envenomation has occurred from dead stingrays that have been kept frozen.

It is common practice for exporters to place a piece of air hose or other plastic tubing over the

barb to prevent injuries to workers and to prevent the spine from becoming caught in nets or perforating plastic shipping bags. If left over the spine this tubing can catch on objects in the tank, twisting the barb and putting stress on the tail. The spine may even be torn free, leaving an open wound at the barb insertion site. In some extreme cases, exporters have even been known to cut off the barb tip, which may cause damage to the spine sheath or tail. When plastic tubing is placed over the spine, it is often forced over the spine's protective sheath, damaging the tissue. Purulent necrotic material can accumulate in the tubing promoting infection and in some cases result in sepsis and premature shedding of the barb. It is recommended that plastic tubes be removed from barbs as soon as specimens are received. Removal of barbs can be done prior to removing the stingray from the shipping bag, or while it is in the quarantine tank. Brief anesthesia with MS-222 (e.g., Finquel<sup>®</sup>, Argent Laboratories, USA) can be helpful in removing tubing.

Plastic tubing is difficult to remove from the barb due to the backward-pointing teeth of the spine. The easiest way to remove tubing is to hold it with a forceps at one end, while cutting off the top of the tube with a razor or scalpel, starting from the end closest to the body. When the top has been cut away, the rest of the tubing can be spread apart and removed. After removing tubing, the area around the spine should be examined for signs of infection or bleeding. If such signs are present, the stingray should be given an antibiotic treatment (see below) and kept in an isolation tank until signs of infection have disappeared.

### Catching and moving specimens

Catching and moving a stingray is complicated by two factors: stingrays are venomous, and the spine readily catches in the mesh of most nets. The easiest method to catch stingrays is to guide the specimen into a plastic bag. The bag is then raised, allowing most of the water to drain out. Another technique, used in open-top holding tanks, is to guide the stingray into a submerged tub, which is then gently raised out of the water. This method causes little stress to the stingray and is certainly less traumatic than netting. Once in a bag or tub the stingray can be readily transferred to another tank.

When a stingray must be captured and restrained for treatment, it is usually necessary to use a net. In this case, a fine mesh net must be used as this

reduces (but does not eliminate) the risk of catching the spine in the mesh. Chasing a stingray around the tank should be avoided. Stingrays are not agile swimmers and can be gently guided into a net. Once caught, stingrays can be raised to the surface for treatment. It is best not to remove the stingray from the water entirely, as this causes them to panic and thrash around in the net, risking entanglement of the spine.

If a stingray's spine becomes caught in the mesh of a net, it is sometimes possible to free the barb by gently pushing the mesh backwards toward the stingray's body. If this procedure fails, it is best to cut the entangled tip of the spine free using high-quality heavy duty scissors (or wire cutters). When the spine becomes caught, the fleshy sheath does not penetrate the net. This means that the tip of the spine is exposed and easily visible. Usually only the tip of the spine becomes caught in the net, so cutting off 6-12 mm of the barb will release the stingray. The net should be raised to just below the surface of the water and the spine should be cut as close as possible to the inside of the net. Cutting the tip of the spine does not injure the stingray. If it is not possible to cut the spine free, a piece of the net can be cut free to release the stingray. Never try to pull the net free, as this will only entangle it further. When a stingray feels itself restrained by the net, it will swim away vigorously, which will embed the net more tightly. Therefore, the net should be cut away as quickly as possible, leaving a small piece of mesh attached to the spine. This will not bother the stingray, and will fall off when the spine is shed. Forcefully pulling on the net may cause the entire spine to be torn from the tail. This action will leave an open wound in the tail, which will usually heal spontaneously, but must be monitored for signs of infection. The fleshy sheath and spine will re-grow in about six months.

## WATER QUALITY

Water quality guidelines for freshwater stingrays do not differ greatly from the requirements of other South American fishes.

### pH

The majority of freshwater ray species prefer water that is soft, and slightly acid. Stingrays thrive in a pH of 6.25-6.75, but most will tolerate a pH range of 5.0-8.0, if changes occur gradually. Newly imported specimens are more sensitive to

inappropriate pH than acclimatized specimens. For example, new specimens that were listless and refused to feed suddenly became active and began feeding when pH was lowered from a range of 7.3-7.4 to 6.25 (personal observation).

### Hardness

Although sensitivity to water hardness does vary between species, most stingrays tolerate moderate hardness levels. Conductivity, as measured by TDS (total dissolved solids), can be used as a guideline. TDS measurements in the range of 350-450 mg l<sup>-1</sup> (=ppm) are usually acceptable; however, stingrays generally prefer softer water, in the range of 150-200 mg l<sup>-1</sup>. Discus (=ceja and =manzana) (*Paratrygon aiereba*) and China stingrays (undescribed) will not generally tolerate hard water, requiring water that has a TDS <200 mg l<sup>-1</sup>. However, once acclimatized, even these species will tolerate harder water.

### Temperature

Water temperature for stingrays should normally be maintained in the range of 24.0-26.5 °C. Stingrays seem comfortable up to temperatures of 29.5 °C and appear to tolerate brief exposure to colder temperatures of 15.5-18.5 °C (as may occur during shipping) without permanent harm. However, chronic exposure to temperatures below 22.0 °C may cause anorexia and illness. Largespot river stingrays (=tiger) (*Potamotrygon falkneri*) require a higher temperature than other species (i.e., 25.5-26.5 °C). If the temperature falls below this range, anorexia will soon develop in this group. Since all other husbandry aspects will appear normal, in such cases, it is easy to overlook a drop in temperature as the cause of anorexia in largespot river stingrays, especially in a communal or mixed-species aquarium.

## SUBSTRATE

In the wild, freshwater stingrays are found in areas where river bottoms are composed primarily of mud, silt, or extremely fine sand. Substrates composed of particles that are sharp or abrasive (e.g., angular sand particles) may damage the skin of stingrays and result in fungal or bacterial infections. Substrate should therefore be chosen carefully. Smooth gravel, such as medium or coarse aquarium gravel, is suitable. Stingrays will do well in bare-bottom tanks, although they

appear to be uncomfortable for a short period of time before becoming acclimatized to the lack of substrate. Stingrays use their pectoral fins to move slowly over the bottom. Without substrate they are unable to gain traction and slip when trying to use their pectoral fins. Eventually, however, stingrays in bare-bottomed tanks seem to adjust to these unusual circumstances.

Stingrays will bury themselves in substrate, especially when startled. Occasionally stingrays will bury themselves while inactive and lie with their eyes protruding. As stingrays become fully acclimatized they spend less and less time buried in the substrate, and eventually spend most of their time looking for food or exploring their surroundings. In general, delicate species, such as the discus, China, and largespot river stingrays do not do well on coarser substrate that is suitable for other taxa. This is probably due to their tendency to bury themselves more frequently, resulting in abrasions of the skin.

Substrate should not be too deep when used in aquarium systems without under-gravel filters, as anaerobic areas may develop where substrate becomes compacted. Additionally, uneaten food can accumulate in thick layers of gravel; although active stingrays will turn over shallow substrate while searching for food items and keep it relatively free of debris (i.e., if the substrate is not more than 35 mm deep).

## FOOD AND FEEDING

Stingrays eat a wide variety of foods. Maintaining a varied diet is extremely important in captive animals, both for environmental enrichment and minimizing the risk of nutritional deficiencies. Stingrays are active and should be fed at least once a day, and preferably two to three times daily. The following are considered to be suitable food items:

1. Goldfish (*Carassius auratus*) or other small fishes.
2. Ghost shrimp (*Callinassa californiensis*), small crayfish (e.g., *Orconectes* spp., *Procambarus* spp., etc.), or grass shrimp (*Palaemonetes* spp.).
3. Californian blackworms (*Lumbriculus variegatus*) or other tubificid worms.
4. Nightcrawlers (*Lumbricus terrestris*), redworms (*Lumbricus rubellus*), or other commercially-raised earthworms.
5. Chopped pieces of raw fish and shrimp.

The first food for newly acquired stingrays should be tubificid worms as these seem to be most readily accepted and are small enough to be inadvertently ingested through the mouth or spiracle, thereby giving the stingray an opportunity to taste this unfamiliar food by chance. Once a stingray is observed to be readily feeding on tubificid worms, finely chopped night crawlers can be introduced in small quantities. Once recognized as food, these will be readily eaten by nearly all stingrays. Other types of food can then be tried.

Live foods, including blackworms or tubifex worms, may be fed in quantities sufficient to leave a small amount in the tank after a feeding session, allowing the stingrays to browse at leisure. However, when cleaning the substrate, note whether a significant amount of living worms are present as they may colonize the substrate, if left uneaten, and add to the tank's biomass. Chopped redworms or nightcrawlers, and any non-live, non-aquatic foods should be fed in smaller quantities, in order to avoid overlooked detritus decomposing in the tank.

Stingrays have relatively small mouths (e.g., a stingray of 25 cm DW would typically have a mouth of only 13-19 mm diameter) and food items must be chopped into small pieces so they can be readily ingested. If a stingray ingests a piece of food and repeatedly spits it out and ingests it again, this usually indicates that the food item is too large. Some stingray species, such as the antenna stingrays (*Plesiotrygon* spp.), have even smaller mouths, relative to their body size. Once acclimatized, stingrays can develop techniques for eating larger food items. For example, newly imported stingrays may have difficulty consuming small pieces of chopped nightcrawler, but over time they will learn to eat an entire worm by sucking it into their oral cavity. Additionally, newly acquired stingrays may ignore "feeder" goldfish. However, they quickly learn to chase down and consume "feeder" goldfish, even learning where they hide within the exhibit.

When feeding large quantities of "feeder" goldfish to obligate fish-eating species, such as the discus and China stingrays, it is wise to supplement with vitamin B1 every one to two weeks, at a dosage rate of 0.125 mg l<sup>-1</sup> week<sup>-1</sup> (personal observation).

Stingrays will grow in proportion to the quantity of food given. Most imported species can grow to a large size (i.e., 120-150 cm DW). However, like most aquarium fishes, if fed small amounts of food regularly, their growth rate will be slower.

## SPECIES-SPECIFIC HUSBANDRY REQUIREMENTS

Although stingrays are not aggressive fishes, keeping them in a communal aquarium can present problems. Any fish small enough to fit into a stingray's mouth may eventually become prey. Stingrays are otherwise tranquil animals. Keeping more than one specimen in the same tank generally does not present problems, even when size or species differences are a factor. Except for species requiring special conditions (see below), numbers of stingrays of different species and sizes may be kept together without difficulty as long as there is adequate food. Under these conditions, the aquarist should provide food at least twice a day and observe each specimen to be certain that all are obtaining sufficient food.

### Large-eyed stingrays

The large-eyed stingrays include more commonly available species such as the ocellate river, Magdalena river (*Potamotrygon magdalenae*), porcupine river (*Potamotrygon histrrix*), and the smooth back river (=teacup) (*Potamotrygon orbignyi*) stingrays, as well as the less common white-blotched river (*Potamotrygon leopoldi*) and bigtooth river (*Potamotrygon henlei*) stingrays.

The large-eyed stingrays are active, aggressive fishes that hunt for food and constantly move around an exhibit. For this group, the water temperature range should be 22-24 °C, nitrate levels should be <100 mg l<sup>-1</sup>, and pH should be 6.25-6.75. The large-eyed stingrays should be fed two to three times daily with a variety of foods. In a community tank, all specimens should be observed carefully while feeding. Specimens not getting sufficient food can be fed directly with tongs.

The large-eyed stingrays make good display species as they are constantly active and are aggressive feeders. Adult specimens generally do well in display aquariums with catfish of the family Pimelodidae, or other predatory fish. On occasion, conflict can arise between stingrays and arawanas (*Osteoglossum bicirrhosum*), or large species such as redtail (*Phractocephalus hemiliopterus*) or gilded (*Zungaro zungaro*) catfish. These fishes have been known to chew the tails of stingrays.

Small-eyed stingrays include obligate fish eaters such as the discus, China, and coly (undescribed)

stingrays. This group includes the long-tailed (=common) river stingray (*Plesiotrygon iwamae*) and black-tailed (=dwarf) river stingray (undescribed), collectively called the antenna stingrays. For husbandry purposes the small-eyed stingrays can be divided into two sub-groups: the antenna stingrays, and discus and China stingrays.

### Antenna stingrays

Antenna stingrays have smaller mouths than most stingrays and therefore feed primarily on blackworms or tubifex worms. Small specimens (i.e., <25 cm) are often incapable of eating small pieces of chopped nightcrawler. Finely chopped redworms or blackworms may be given as an alternative food. Larger specimens will eat finely chopped nightcrawlers, and even small "feeder" goldfish.

Gravel substrates are satisfactory for antenna stingrays. Due to the extreme length of the tail, which can be several times the length of the stingray's disk, antenna stingrays require a larger surface area than other species.

The tail of the antenna stingray is delicate and specimens with damaged tails often die. If the tail is kinked or damaged near the tip, it may break off (or even remain intact) and heal, leaving a small bump where the damage occurred. However, if the tail is damaged, bent, or kinked, close to the body (especially where it changes from all white to variegated), it rarely heals, eventually falls off, and the stingray will probably die. The cause of death is unknown but may be related to infectious agents entering the tail stub. Wild-caught specimens with healed tails (i.e., broken and healed in the wild) are not at risk. The tail can be easily damaged by objects in the tank. Rocks, driftwood, or even aquarium equipment can catch the tail, causing it to kink or break. Powerheads, air-lift tubes, or other equipment is equally dangerous. A specimen may have its tail drawn into a powerhead intake, resulting in the tail becoming entangled and damaged by the impeller. Therefore, antenna stingrays are best kept in a tank without ornamentation or equipment.

The long-tailed river stingray is a difficult species to display for several reasons: the long, delicate tail is at constant risk of being broken or damaged; new arrivals are delicate and may refuse food unless they are held in a quiet aquarium; and acclimatized specimens can become aggressive.

The black-tailed river stingray seems to be less sensitive to tail injuries than the long-tailed river stingray. Kinks in the tail are not as likely to cause the tail to fall off and specimens with broken tails are not at risk of dying. The black-tailed river stingray is the only species that may rest with its disc margin elevated above the substrate when in good health. The black-tailed river stingray is unable to eat foods larger than blackworms or tubifex worms, although small grass or ghost shrimp may be eaten. The black-tailed river stingray is not large enough to turn over gravel to search for worms and therefore uneaten worms will soon colonize exhibit substrate. Prior to feeding, the substrate should be disturbed to see if worms are present. If so, the substrate should be agitated to free worms so they can be eaten.

### **Discus and China stingrays**

The discus and China stingrays are generally more delicate than other stingrays. The China stingray was only recently described and the name seems to originate from the stingray's similarity to a Chinese coolie's hat. The discus, or ceja (eyebrow in Spanish), stingray gets its name from the dark markings over each eye. The manzana (apple in Spanish) stingray, which may be a morph of the discus stingray, has a shape reminiscent of an apple-half cut from top to bottom, the tail being the "stem" of the apple.

Discus and China stingrays require soft water. Their fin, or disc, is thinner and more delicate than those of large-eyed stingrays and seems to be sensitive to irritation from substrates. When maintained on substrate, China stingrays may thrive for short periods and then develop fungal infections and die. Discus stingrays survive on substrates, but may develop nicks and tears in their fin. Bare-bottom tanks work well for these species.

Discus and China stingrays have a habit of adhering to the side of an aquarium, making them interesting display species. However, they are ambush feeders and are poor competitors for food in displays with other fishes, making them difficult to display. Discus and China stingrays feed exclusively on "feeder" fishes and supplementation with B1 vitamins is therefore essential. These stingrays feed most effectively during the initial confusion when "feeders" are first dropped into an aquarium. If "feeders" escape the initial feeding frenzy, they may stay out of the range of the stingrays for days.

These stingrays rarely survive for more than one and a half years and may die suddenly, even when feeding well and appearing to be robust of health (personal observation).

### **Largespot river stingrays**

Largespot river stingrays are among the most challenging and delicate of the freshwater stingrays. They prefer acid pH in the range of 6.25-6.50. When pH rises to  $\geq 7.0$ , their behavior changes, becoming quieter, feeding less aggressively, and spending more time beneath the substrate. Largespot river stingrays require a warmer temperature than other species, preferring a range of 25.5-27.5 °C. If too cool, these stingrays will become inactive, stop feeding, and will eventually sicken and die.

When newly acquired, largespot river stingrays prefer to feed nocturnally and remain quiet during the day. They are rarely tempted by "feeder" goldfish and often reject chopped nightcrawlers for many months following acclimatization. Even when well-acclimatized, they do not do well with aggressive species of stingrays. This species is best kept alone or with other largespot river stingrays. Newly imported specimens are often large and severely stressed from transport.

## **CLINICAL CARE**

Healthy stingrays demonstrate typical patterns of activity, exploring the exhibit for food items, occasionally burying themselves in the substrate, and soon surfacing again to look for food. Discus stingrays often adhere to the side of the tank waiting for "feeder" fish, which they will trap against the tank wall. Although stingrays will periodically swim along the sides of an exhibit and the water surface, healthy stingrays rarely spend much time free-swimming. A stingray that spends most of its time swimming freely in the water, rather than along the substrate, may be demonstrating stress. Rapid breathing, decreases in activity, remaining under the substrate for long periods, and most importantly, inappetence, can all indicate stress and/or compromised health in a stingray.

### **Inappetence**

Most species, if received in good condition, will begin feeding in about two to three days, although some specimens may take as long as one to two

weeks (especially China and largespot river stingrays). Stingrays are normally active and inquisitive and should begin exploring a tank and searching for food almost immediately. Stingrays that remain quiet for more than a few days, or refuse food after this time, should be closely monitored for signs of injury, stress, or illness. Stingrays that otherwise appear to be in good health, but do not begin feeding immediately, should be kept in an isolation tank until feeding has become regular. Shy or stressed specimens can starve, in the midst of abundant food, if kept in a tank with too many active fishes.

Healthy stingrays eagerly accept food, and between feedings are almost always searching for more food. Stingrays will rarely refuse food when offered, even if they have been recently fed. Therefore, refusal of food is often the first sign of a health problem in stingrays. If a stingray refuses food, even once, it should be examined carefully for signs of disease and water quality parameters should be thoroughly checked.

### **Dominance interactions**

Intra- and interspecific dominance interactions may be responsible for loss of appetite. These interactions may be subtle or overt, and can be related to differences in species, size, and/or gender, etc.

Although uncommon, aggressive behavior can occur between stingrays. Adult males may bite each other, and males will bite females during courtship. Occasional bites of this nature are harmless. However, severe injuries to females have been known to occur, especially during courtship. Additionally, male-male interactions can sometime produce serious injuries. Such injuries usually occur around the disc margin and are characterized by abrasions or frayed fins. In the wild a subordinate stingray can escape a dominant specimen, but in an aquarium this is not possible. As a result, a subordinate specimen may be repeatedly injured and will eventually stop feeding and die. When aggression is present in an exhibit, the subordinate specimen must be watched closely to ensure it does not stop feeding or becomes listless and inactive. In addition to injuries around the disc margin, abrasions or bite marks may appear on the dorsal surface of a stingray. When such injuries appear with increasing frequency, specimens should be segregated. If intra-specific interactions are intense, they may result in loss of appetite and the eventual death of subordinate fish.

Catfishes (*Hypostomus spp.*) may chew on the dorsal surface of stingrays, causing serious abrasions and death. It is unknown whether catfish acquire some nutritional value from the skin or slime coat, or whether this is simply aggressive behavior. Although suckermouth catfish (*Hypostomus plecostomus*) can generally co-exist peacefully with stingrays, this group must be watched carefully for signs of aggression.

### **Fish lice**

Stingrays in captivity are usually not susceptible to the common diseases of other tropical fishes. Occasionally, newly imported specimens may carry fish lice (*Argulus spp.*). These ectoparasites appear as small brown circular spots, about 2-3 mm in diameter, and are more readily seen on light-color stingrays. Fish lice are usually only observed in small numbers (i.e., 2-3) and if gently touched the parasite will skitter across the skin of the stingray. When on the dorsal surface, fish lice can be removed readily with forceps. When on the ventral surface, removal is more difficult as it is difficult to invert stingrays. In these circumstances, it is easier to pinch the parasite through a net, from underneath, in order to remove it. Sudden heavy outbreaks of fish lice may occur within an exhibit, without the addition of new stingray specimens. These outbreaks are probably caused by a few unobserved parasites successfully reproducing. Dimilin or diflubenzuron (e.g., Anchors Away®, Jungle Laboratories Corp., USA), a chitin inhibitor non-toxic to fishes, is effective at treating fish lice outbreaks at a dosage 2,650 mg l<sup>-1</sup>. This treatment should be repeated once after a two week period.

### **Fungus**

Fungal infection is the commonest disease of freshwater stingrays. The first obvious sign of an underlying health abnormality is often a fungal infection of the skin. Fungal infections appear to occur secondarily to external injuries, bacterial infections, or chronic stress. Fungal infections caused by the freshwater cotton wool fungus (*Saprolegnia spp.*) are often seen on the tail, especially where a piece of air tubing has been placed over the spine, or at the tip of the tail where minor injuries may have occurred during handling. These infections appear as small cotton-like tufts and generally are not difficult to cure. Treatment with antibiotics appears to be an effective means of eliminating fungal infections (see below). Since

fungi are generally not susceptible to antibiotics, it is likely that the successful treatment of fungal infections is a secondary effect of treating an underlying bacterial infection.

### Antibiotics

Furanace (e.g., Nitrofurazone, Novalek Inc., USA) may be added directly to aquarium water to treat minor infections; however, injectable antibiotics are generally more effective and preferable. Enrofloxacin (Baytril®, Bayer Corp., USA) at 0.25 mg kg<sup>-1</sup> (daily or every other day), or ceftazadime pentahydrate (Fortaz®, GlaxoSmithKline Inc., USA) at 10.0 mg kg<sup>-1</sup> (every other day), administered intramuscularly for 7-10 days, may be used to treat bacterial infections secondary to external injury.

Rays requiring injection should be netted and held just below the surface of the water, to prevent excessive struggling. The process is facilitated if the spiracles remain submerged. If two people are available, the body of the stingray can be supported from below with one hand, while the injection is being given with the other hand. The second person can hold the net. Injections should be given intramuscularly. The preferred injection site is slightly to the right or left of the spine, about halfway between the line of the eye and the base of the tail. The needle should be inserted to a depth of ~5.0 mm, at a low angle, rather than perpendicular to the body. Care should be taken to avoid being within range of the spine when giving injections. Before handling or administering any form of medication it is advisable to seek veterinary advice.

### SEX DETERMINATION AND REPRODUCTION

Stingrays, like other elasmobranchs, reproduce by internal fertilization. Male stingrays have claspers (modified pectoral fins located on either side of the tail) used to transfer sperm into the cloaca of the female during copulation. Gender can be readily determined in small or newborn specimens as claspers are present at birth. However, claspers remain small until stingrays become sexually mature, so it may be necessary to examine the ventral surface of a young specimen to verify clasper presence or absence.

While reproduction in freshwater stingrays has been accomplished in captive conditions, little is known about their reproductive strategies. Captive breeding has occurred primarily in the fall and

winter in the northern hemisphere, with courtship behavior from September through December, and births occurring from November through January. Little is known about environmental cues that may stimulate reproductive behavior in stingrays, although possibilities include changes in the water temperature, pH, and photoperiod.

All freshwater stingrays are believed to bear live young. When captive bred, gestation periods have been about three months and litter sizes ranged from 1-12 offspring. Newborn stingrays may begin feeding within 24 hours of birth. Only the smallest foods should be offered (e.g., blackworms, tubifex worms, or pieces of finely chopped redworm). No negative interactions have been reported between adult and newborn stingrays. Other than concern for food competition, there appears to be no reason to separate newborn stingrays from parent females or other adults. Allowing newborns to remain in the water in which they were born is preferable whenever possible. Care must be taken to ensure that newborns are getting sufficient food in large community exhibits.

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