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An Approach to the Rehabilitation of *Kogia* spp.

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Abstract

Pygmy (*Kogia breviceps*) and dwarf (*K. sima*) sperm whales are rarely seen in the wild, but often seem to live-strand, particularly in cow-calf pairs. The rehabilitation of live-stranded individuals of both species has proven to be exceedingly difficult. The few released animals might not have been completely healthy, an alternative chosen due to their poor survival in captivity. The rehabilitation challenges for *Kogia* are numerous because limited knowledge exists regarding even the basic biology of both species. This report provides information derived from the rehabilitation of 13 live-stranded *K. breviceps* and *K. sima* (including five calves) over the last decade at the Dolphin and Whale Hospital at Mote Marine Laboratory and Aquarium in Sarasota, Florida. One *K. breviceps* calf survived for almost 21 months in captivity and one *K. sima* survived for over 15 months, both apparent worldwide records. From these cases we learned that it is critical to provide supplemental fluids in addition to solid food to maintain continuous activity of the intestinal tract, especially if maintained in chlorine-treated water, and that digestibility of squid species typically fed to captive marine mammals was poor. Both species appear to be susceptible to adverse reactions to a number of the drugs commonly used during rehabilitation. In addition, an artificial calf formula was developed to provide adequate nutrition for young calves. Finally, gastric and intestinal stasis appears to lead to death in many of these whales in captivity.

Key Words: Rehabilitation, pygmy sperm whale, dwarf sperm whale, calf formula, orphan calves, survival, captivity, *Kogia breviceps*, *Kogia sima*

Introduction

The pygmy sperm whale, *Kogia breviceps*, and the dwarf sperm whale, *K. sima* (nomenclature after Rice, 1998, hereafter jointly referred to as kogias), are the only extant species of the second most common genus of stranded cetaceans in the southeastern United States (Odell, 1991). Likewise, these whales are found throughout the tropical and subtropical oceans of the world (Caldwell & Caldwell, 1989; McAlpine, 2002). The literature is confusing regarding these two species; they were not recognized as separate species until recently (Handley, 1966). To date, the proper identification of individuals is still problematic.

Although many kogias strand, most of the animals brought into captivity for rehabilitation died within a few days or weeks (Sylvestre, 1983). Most attempts to rehabilitate live-stranded kogias resulted in either death or premature release prior to their being completely healthy. One reason for this lack of success at rehabilitation comes from the fact that so little is known regarding the basic biology of these two species. Because both species occur over deep waters and are not prone to form large aggregations (Katona et al., 1983; Nagorsen, 1985; Ross, 1979), very few observations have been made of free-ranging animals. The few observations made of animals resting on the surface may be biased because they probably do not reflect other behaviors shown in their deep-water habitats. This has led to a number of false conclusions regarding their behavior such as suggestions that they are “slow, sluggish swimmers” (Handley, 1966; Watson, 1981). Those who have observed healthy individuals, especially calves, in captivity suggest that, although they occasionally bask at the surface, their underwater swimming is actually quite fast (Mörzer Bruyns, 1971; pers. obs.). Breaching activity rarely has been observed in free-swimming kogias, but captive healthy animals are prone to such behaviour (Caldwell & Caldwell, 1989).

This lack of information from normal healthy individuals means that the majority of the information about the basic biology of both *Kogia* spp. has been determined from dead-stranded or dying individuals. This fact, too, may have affected the accuracy of some of these observations. For instance, deep ocean squid beaks have been found in the stomachs of most dead kogias examined (Barros, pers. obs.; Candela, 1987; Ross, 1984). In the past, it was assumed that these beaks survived in the acid environment of the stomach for a few short days. Recent observations with adult *K. breviceps* in rehabilitation suggest that these beaks may remain unchanged in the stomach for more than 40 days (Barros et al., in prep). This means that squid may be overrepresented in the diet, and other prey items without hard parts, which remain in the stomach for only a few hours to a few days, were underrepresented in stomach content analysis.

Another possible area for erroneous conclusions is milk analysis. A number of milk samples have been collected from stranded lactating females with calves in an attempt to develop an artificial formula for rearing the calves. Because these samples were collected from sick or dying individuals, the resulting analyses represented a wide range of milk analytes (unpublished data). The lactating kogias likely were suffering from conditions present for a substantial amount of time, making it difficult to determine which values were "normal" and which were affected by illness. Consequently, any formula developed was tested by "trial and error" to determine which worked best. Ideally, this bias will be resolved with the collection of milk samples from healthy individuals at various stages of lactation.

Therefore, one must draw conclusions with caution when interpreting incomplete or biased data. In addition, every opportunity should be taken to make observations during and following rehabilitation that may either confirm or discount the "current state of knowledge" regarding these two species.

The information included here has been derived from experiences with 13 live-stranded pygmy and dwarf sperm whales, including five orphaned calves, kept at the Dolphin and Whale Hospital (DWH) at Mote Marine Laboratory and Aquarium, Sarasota, Florida, over the past nine years (Table 1). One *K. breviceps* calf was maintained at this facility for almost 21 months, and a *K. sima* was kept alive for over 15 months. These apparently represent records worldwide, a reflection of the tremendous progress to date. The approach to this successful effort is presented below.

At the Stranding Site

Stranded kogias should be offered the same care applicable to any stranded cetacean (Gage, 1990; Geraci & Lounsbury, 1993), such as maintaining a clear blowhole and protecting the animal from the elements (e.g., heat, sunburn, cold, rough surf, rocky shore); however, a few additional procedures may substantially improve the chances of survival in kogias.

Dehydration is the most common finding in virtually all kogias that strand. Thus, it may be beneficial to administer fluids via a stomach tube to the animal at the stranding site. This is especially true for animals that may not be transported for an hour or more. This procedure should not be attempted by individuals who are not experienced in stomach tubing of cetaceans, however. When tubing a kogia, it is important to remember that the blowhole and goosebeak (larynx) are offset to the animal's left side, and there is not enough room to pass a tube to the left of the goosebeak. Therefore, the curve in the stomach tube should be turned up to get over the back of the tongue and then rotated 90° counter-clockwise to pass on the animal's right side. It is best to administer half-strength oral electrolyte solution (Table 2 presents a recipe to mix this solution) until the blood electrolyte concentrations are known. If half-strength oral electrolyte solution is unavailable, the use of drinking water is preferable to no fluids at all. The volume of fluids to be given is also of concern. If an animal is going to be transported soon, it is important not to completely fill the stomach prior to transport. One can usually give about 300-500 ml to a newborn calf and about 2 l to a full size, adult *K. breviceps*.

Another helpful procedure for a stranded kogia is to obtain a blood sample for electrolyte determinations. Often, the electrolyte concentrations will be either too high (possibly from dehydration or even drinking large amounts of salt water) or too low, and the choice of fluids to use will be determined by the measured concentrations. Since most of these animals are severely dehydrated, they will need to receive fluids multiple times during the first 48-72 h. If the wrong fluid is given relative to the blood electrolyte levels, death could quickly ensue. If electrolyte concentrations (esp. Na^+ and Cl^-) are unknown or are known to be near normal (Table 3), half-strength oral electrolyte solution is the best choice (Table 2). If electrolyte concentrations are highly elevated, fresh bottled water should be used. If electrolyte concentrations are below normal, a full-strength oral electrolyte solution should be used.

Collecting blood from kogias can be somewhat challenging. The main reason for that is the presence of small superficial vessels on the flukes that obscure the deeper sinus. One must ignore the obvious shallow vessels and palpate for the deeper sinus to be able to obtain adequate blood flow for a good blood sample. Another option is to use the

Table 1. Information regarding 10 *Kogia breviceps* and three *K. sima* rehabilitated at the Dolphin and Whale Hospital of Mote Marine Laboratory; additional information is available at <www.mote.org/~cmanire/patients.html>.

Animal ID number	Name	Sex	Age class	Total length (cm)	Weight (kg)	Days in rehab	Stranding condition	Cause of death
Kogia breviceps								
MML9413	Ritchie	Male	Adult	286	350	36	Fair body condition	Ulcerative colitis
MML9415	Juno	Female	Calf	153-182*	57-120*	146	Good body condition	GI rupture
MML9712AA	Vera	Female	Calf	146-176*	48-88*	109	Good body condition	Liver failure
MML0006	Hutch	Male	Adult	280	315	2	Very poor condition	Electrolyte imbalance, cardiomyopathy
MML0009	Dana	Male	Adult	310	355	<1	Very poor condition	Electrolyte imbalance, cardiomyopathy
MML0017	Jason	Male	Adult	295	405.5	40	Poor condition	Pulmonary embolism, GI rupture
MML0103	Mia	Female	Adult	288	371	3	Very poor condition	Electrolyte imbalance, cardiomyopathy
MML0103A	Ami	Female	Calf	138-245*	47-232.4*	631**	Good body condition	Intestinal volvulus, GI rupture
MML0108	Nemo	Male	Juvenile	178-191*	99-105.5*	101	Fair body condition	Intestinal blockage
MML0234	Armand	Male	Calf	137-151.5*	32.5-60*	91	Very poor condition	GI rupture
Kogia sima								
MML0232	Anna	Female	Juvenile	165.5	47.7	<1	Very poor condition	Pulmonary edema
MML0233	Maria	Female	Adult	227	66.8	<1	Very poor condition	Cardiomyopathy
MML0225A	Simone	Female	Calf	125.5-173*	27-74.6*	465**	Good body condition	Impacted colon

* Measurements taken at start and end of rehabilitation period
** Apparent world record

Table 2. Recipe for an oral electrolyte solution administered to cetaceans for electrolyte replacement therapy; as described, this yields full-strength electrolyte solution. For half-strength solution, mix this solution with equal parts boiled or bottled water.

2.5 cc (½ teaspoon) NaCl (table salt)
1.25 cc (¼ teaspoon) KCl (salt substitute)
2.5 cc (½ teaspoon) baking soda
60 cc (4 tablespoons) granular dextrose
1 liter boiled or bottled water

Mix all ingredients. This solution may be pasteurized at 60°C (140°F) for 30 minutes, if desired. Use within 24 hours.

mid-ventral approach on the fluke to obtain blood from the sinuses running along the ventral surface of the vertebra.

Transport

As with handling on the beach, the majority of activities that take place during transport will be the same with kogias as with other cetaceans (Antrim & McBain, 2001). Some adult kogias reportedly thrash violently in the back of a transport vehicle, enough to make the situation very dangerous. DWH staff also observed thrashing just after arrival before the animal could be removed from the vehicle. In one instance, an animal rolled onto its side when the ice chest that had been supporting it was removed. This set off a violent series of movements that were injurious to the animal and also could have been harmful to the handlers had they not been able to move away quickly. Extra care should be taken to avoid startling the animal with sudden movements or by removal of objects in their visual field. The crew transporting the animal should be prepared to react accordingly. If an animal does begin to thrash, it is best to cover it with large foam pads and subdue the animal through the pads. Once the animal is quieted, the foam pads may be removed and the animal properly secured prior to the transport to a holding pool.

First Critical Hours at the Rehabilitation Facility

The first 12 to 24 h in rehabilitation are the most critical for the survival of the animal. For that reason, it is essential that the animal be taken to a well-equipped rehabilitation facility where marine mammal veterinary care is readily available. Delaying medical attention in the first few days will dramatically decrease the animal's chances of survival.

Table 3. Blood values that are assumed to be normal for *Kogia breviceps* and *K. sima*; these values may vary depending on the laboratory performing the analysis. * values decrease with acclimation to shallow water.

Parameter	Units	Normal values
Glucose	mg/dl	75-160
Sodium	mEq/l	145-160
Potassium	mEq/l	4.0-4.8
Chloride	mEq/l	105-120
Carbon Dioxide	mEq/l	20-30
Blood Urea Nitrogen (BUN)	mg/dl	<80
Creatinine	mg/dl	<2.0
Uric Acid	mg/dl	<3.0
Calcium	mg/dl	9.0-11.0
Phosphorus	mg/dl	4.0-7.0
Cholesterol	mg/dl	150-300
Triglyceride	mg/dl	50-300
Bilirubin, Total	mg/dl	<0.5
Alkaline Phosphatase (AP)	U/l	150+
Lactate Dehydrogenase (LDH)	U/l	150+
Aspartine Transaminase (AST)	U/l	<300
Alanine Transaminase (ALT)	U/l	<30
Total Protein	g/dl	5.0-8.0
Albumin	g/dl	2.5+
Globulin	g/dl	2.5+
Iron	µg/dl	150+
Cortisol	ng/ml	<2.5
Corticosterone	pg/ml	<600
Creatine Kinase (CK)	U/l	150-400
GGT	U/l	7-30
Amylase	U/l	<400
Lipase	U/l	<30
Fibrinogen	mg/dl	<250
White Blood Cell Count (WBC)	10^3/µl	3.0-7.0
Red Blood Cell Count (RBC)*	10^6/µl	3.0+
Hemoglobin (HGB)*	g/dl	16.0-24.0
Hematocrit (HCT)*	%	48-62
MCV	fl	145-165
MCH	pg	50-70
MCHC	g/dl	35-45
Platelet Count	cells/µl	>100,000
Neutrophils (Segs)	cells/µl	2000-4999
Bands	cells/µl	<100
Lymphocytes	cells/µl	1000+
Monocytes	cells/µl	<500
Eosinophils	cells/µl	<2000
Basophils	cells/µl	<100
Reticulocytes	%	1-2
Nucleated RBCs	/100 WBC	0-2
ESR (std Westergren)	mm/hr	<10

Weight

During these first hours, it is important to obtain an accurate weight of the animal for accurate dosing of medications and as a reference point for the monitoring of weight fluctuations. Subsequently, weekly weighing (even twice weekly for young calves) of the animal is recommended so that caloric intake can be adjusted for appropriate weight gain.

Dehydration

There are a large number of other issues that must be dealt with as quickly as possible. Probably the most important is the initiation of, or the continuation of, rehydrating the animal. If blood electrolyte concentrations have not yet been obtained, they should be determined immediately. It is essential to the survival of the animal that the electrolyte concentrations be known before the second or third dose of oral fluids (which should generally be given at 3 and 6 h after the first oral fluids). Delaying 12 or 24 h for results of electrolyte determinations (or other blood values for that matter) can lead to disastrous consequences. Adult *K. breviceps* (3-4 m) should receive 16 to 24 l of fluids during the first 24 h and for smaller animals, a proportionately reduced amount. If fluid comes back out of the stomach tube at the start of tubings, the fluid is not passing through, probably due to intestinal blockage caused by constipation resulting from dehydration. If this occurs, allow as much of the previously administered fluid to come out the tube as possible and then administer the next amount. Generally, by the third or fourth dosage, fluids begin to move along into the intestine and are absorbed. It is important to continue to monitor blood electrolyte levels daily and to modify the fluid intake depending on indications of reduced dehydration and hemoconcentration (hematocrit, total serum protein) until fluid and electrolyte levels are stable.

Respiratory Issues

Another extremely important consideration during the first few hours is the condition of the lungs. Salt water in the lungs, pneumonia, and pulmonary edema are common and known to cause severe impairment to proper oxygen intake. Frequent auscultation of the entire lung field on both sides is important because the condition can change dramatically in a few short hours. If difficulty in breathing is encountered (as noted by rapid shallow respirations), one or two doses of furosemide about 8 h apart (1-2 mg/kg, either IV or IM or divided to both) can be given; however, this will certainly worsen the dehydration and should be used only if essential.

Diagnostics

Beyond these and other emergency measures, it is important to get as complete a diagnosis as possible in the first few hours. This involves collecting blood samples for complete blood counts (CBC) and chemistry profiles (again, the results should be available within the next 4 to 6 h, at the latest); collecting blowhole swabs for cytology; collecting feces (which is normally dark reddish-brown and very watery in kogias); and obtaining gastric contents for parasitology, cytology, and for gastric pH. A thorough physical exam should be performed as soon as possible in those first few hours to develop a treatment plan.

Antibiotics

If there is any evidence of pneumonia or fluid in the lungs or any other indication of infection, the animal should be given enrofloxacin intra-muscularly twice per day (2.5-5 mg/kg). Few adverse reactions have been seen in kogias with this antibiotic (Manire, pers. obs.). No oral medications should be administered until gastric contents are moving well, possibly two to three days or more after arrival. If use of an alternative injectable antibiotic is necessary, it should be administered with great care. One should note that both *Kogia* spp. are prone to adverse reactions with a wide variety of different medications, including other fluroquinolones, cephalosporins, and atropine (Manire et al., 2002). Some individuals had evidence of hepatic toxicity from the use of itraconazole (Manire, pers. obs.).

Environmental Issues

As with other sick animals, the environment in which the animal is maintained is very important. Although healthy kogia may inhabit temperate waters (and be exposed to much colder waters during deep dives), sick individuals do much better if they are maintained at a temperature at which they can readily retain body heat. At the DWH, 27^{o} C (80^{o} F) has been found to be the ideal water temperature for maintaining sick kogia, and it is also a comfortable temperature for them once they are healthy. The water in the environment should be well-filtered if it is not an open system because kogia will produce a lot of feces, and the water should be treated to suppress bacterial growth with ozone, UV light, or chlorine. Chlorine is probably the least desirable and should be maintained at less than 0.5 ppm (free chlorine). Finally, adequate space for the kogias to swim is critical. For a calf, a round tank of 6 to 9 m in diameter is minimal, and about 15 m is adequate for an adult *K. breviceps*.

First Critical Week

Once the animal is somewhat stabilized, it is important to complete the diagnosis, as many of these animals will have multiple concurrent conditions requiring treatment. Additional diagnostic work-ups should include echocardiography and electrocardiogram (for adult kogias), gastroscopy, chest and abdominal ultrasound, broncho-alveolar lavage (if pneumonia is present and may not be responding), culture and sensitivities from any infections that do not appear to be responding to treatment, radiographs if indicated, urinalysis (although catheterization of a male kogia can be extremely difficult), and any other indicated diagnostics. Depending on the results of these diagnostics, the treatment regimen should be changed as appropriate. It should be noted that when doing gastroscopy on both *Kogia* spp., the opening between the first and second stomach compartments is normally quite large and, unlike most dolphins, it is as easy to visualize the second stomach (glandular) compartment as the first.

Gastric Function

Prior to beginning solid food (or formula in young calves), it is important that gastric function be assessed. If the gastric pH is well above normal in older calves or adults (1.5-2.5 in animals > 6 months old being normal), one should assume some degree of gastric stasis or blockage. In this case, only clear fluids should be administered. Even if the gastric pH is normal, we recommend that only clear fluids be given for the first 24 to 72 h to correct the dehydration and to reduce the effects of constipation on blockage of the intestinal tract. Then, once it is certain that things are moving well through the stomach, one can begin offering/administering solid food (or formula) at a very low level. Usually one should begin with about 10% of what is estimated to be a full daily ration for the first day of solid food (or formula), then increase it by an additional 10% each day until a full ration is attained nine days later. At the point when solid food is moving through the stomach, oral medications should be given. (It is important to note that the gastric pH in young calves may run much higher than in older calves and adults.)

Food Digestibility

Kogias are unable to digest many prey items that are easily digested by other species of cetaceans (Manire, pers. obs.). Several *K. breviceps* rehabilitated at DWH could digest only about 3 kg of coastal squid (*Loligo* spp.) and *Illex* spp. daily. Obviously, there are inadequate calories in 3 kg of squid to maintain any kogia. In those cases, the additional calories must come from another source. We found that those same animals cannot digest fish skin or bones; however, boneless and skinless fish fillets (Atlantic herring, *Clupea harengus*) are digested well. When using herring in the diet, one must monitor the whale's uric acid and creatinine levels as these may be affected.

Resolving Medical Issues

Blood Samples and Exams

It is important to determine CBCs and chemistry profiles on a daily basis for the first full week. Blood values can change rapidly during this time period, and it is critical to the survival of the animal that treatments change as rapidly. As blood values begin to stabilize, one can reduce the frequency of blood collection to every other day, then twice weekly, and finally once per week. It is important that weekly blood collections and exams take place, even though an animal is apparently completely stable. Changes in the medical condition are not always accompanied by behavioral changes, and the sooner a medical change is observed, the better the outcome. These weekly exams should include a full physical exam; weight; routine hematology and blood chemistries; and cytology from the blowhole, gastric contents, and feces.

Cardiomyopathy

If cardiomyopathy (a very common condition in older adult kogias of both species; Bossart et al., 1985) is present, the animal is unlikely to survive. This condition is irreversible and is cause for euthanasia of the animal (Bossart, pers. comm.). There are a number of thoughts regarding the cause of the cardiomyopathy (e.g., dietary deficiency), and data are being gathered by several researchers to determine the possible etiology.

Parasites

Parasites are present in virtually every kogia that strands (Caldwell & Caldwell, 1989; McAlpine et al., 1997). Many different types of parasites are found, especially in adult kogias (e.g., nematodes or roundworms in the gastrointestinal tract; cestodes in blubber and muscle). It is unnecessary, however, to attempt to completely eliminate parasites, especially from kogias that will be returned to the wild. It is better to reduce the parasite burden in compromised animals only if the parasites appear to contribute to the disease condition of the animal. Only in unreleasable animals is it advisable to eliminate all parasites.

Superficial Wounds

The skin of kogias is extremely delicate, even more delicate than that of bottlenose dolphins, and most stranded animals will arrive with many open wounds and bruises, especially on the flukes, peduncle, pectoral fins, and head. Also, cookie cutter shark (*Isistius* spp.) bite wounds are common and have been observed as fresh, healing, or healed scars. Fortunately, most of these wounds heal well with minimal care. One method of treatment is to utilize gauze sponges (3x3 or 4x4 in^2) soaked in povidone iodine solution to debride loose necrotic tissue. It is best to allow the povidone iodine to dry on the wounds for 20 to 30 s after it is applied. For deeper wounds, it may be beneficial to apply an antibiotic ointment in a petroleum base. Occasionally, tags of nonviable tissue must be removed from these wounds using scissors. Daily treatment will heal most superficial wounds in about one week and deeper wounds in two to three weeks. For wounds that do not appear to be granulating, a dilute acetic acid spray (0.25% acetic acid) should be applied after the povidone iodine and allowed to dry for 20 to 30 s. This is very effective against pseudomonads that may secondarily infect these wounds.

Constipation

Constipation due to inadequate fluid intake was present in virtually every kogia examined at DWH, dead or alive. The normal consistency of kogia feces should be watery. If there is any substance to the feces, constipation is present. The amount of fluid intake is critical to maintaining normal fecal consistency. Normally, every kogia should be expected to have a very large defecation ("inking") every seven to ten days, with a number of smaller defecations in between. We extracted almost 50 l of fecal material from the colon of a 295 cm male *K. breviceps* undergoing rehabilitation. Due to this large capacity of the lower colon or "ink sac," it is possible for an animal to be constipated in the upper intestine (where most of the blockage seems to take place) and still be defecating fairly normal feces for a period of time.

The most effective treatment for constipation is administration of oral fluids. A kogia placed on solid food, because they are not normally fed the same prey items that they obtain in the wild, may require 4 to 10 l of oral fluids daily to maintain normal feces. It is possible that if deep-sea squid were fed to the kogia instead of coastal squid, that this fluid requirement would be met through the diet rather than through supplementation; however, until a source for deep-sea squid is found, the supplementation will be necessary. If an animal becomes constipated and increasing the fluid intake does not help, it may be necessary to administer mineral oil orally six times per day (30-50 ml) until the situation is resolved. In general, if a kogia behaves abnormally, it should be assumed that constipation is the problem unless otherwise noted. Unfortunately, most common treatments for constipation have little effect on kogias. When a kogia first arrives in rehabilitation, it should be assumed to be constipated until it has a large voluntary defecation.

One possible cause for the constipation in kogias maintained in captivity (considered for investigation at DWH) is the chlorination of the water that may prevent these animals from drinking it. We have indirect evidence from milk composition analysis that *Kogia* spp. calves may drink seawater while nursing in the wild, but chlorination of the water may prevent them from drinking in captivity. Kogias housed in pools maintained on ozone do not seem to have the constipation problems, but conclusions are reserved until more data are gathered. Fasting common dolphins (*Delphinus delphis*), Pacific bottlenose dolphins (*Tursiops gilli*), and pilot whales (*Globicephala* spp.) have been shown to drink seawater (Hui, 1981; Telfer et al., 1970). An unpublished study of Atlantic bottlenose dolphins showed that about 70% of their fluid intake must come from either absorption through the skin or from drinking seawater (Costa, 2002).

Ingested Foreign Materials

Another digestive problem observed in *Kogia* spp. is stomach blockage due to ingestion of plastics or debris prior to stranding (Barros et al., 1990; Scott et al., 2001; Tarpley & Marwitz, 1993). This sometimes can be removed via a gastroscope. If not, it may be possible to induce vomiting through the administration of hydrogen peroxide orally. If such items are found, they should be saved for proper documentation.

Ulcers

Chronic gastric and/or esophageal ulcers are common in kogias undergoing rehabilitation. Until the cause of such ulcers can be determined, it is important to monitor gastric cytology to determine the appearance of basal cells and sometimes erythrocytes, common indicators of ulcers (Figure 1). In treating gastric ulcers, it is wise to use acid blockers with great caution. A number of the acid blockers have been observed to cause a neutral gastric pH and associated "sour stomach" or even gastric stasis, and others may induce behavioral changes. It may be advisable to try sucralfate (1 g twice per day orally on an empty stomach) for two to three weeks to determine if that treatment alone cures the ulcer(s). If it does not, try administering ranitidine orally four times per day (0.5-2.0 mg/kg), but begin at a low dose, slowly increasing and monitoring the gastric pH frequently. For extended gastric ulcer treatment with ranitidine, it may be necessary to slowly adjust the dosage up (even up to 4.0 mg/kg three times per day) to maintain an adequately therapeutic pH. For esophageal ulcers, a tube can be constructed from a short stomach tube, just long enough to reach beyond the goosebeak (larynx), and a small tygon tube siliconed inside it, so that sucralfate liquid (1 g twice per day) can be flushed directly into the esophagus (Figure 2). Treatment for *Helicobacter* spp. infections have not appeared to be of much benefit in most of these cases.

Normal Blood Values

As with any animal, normal blood values will differ, depending on the laboratory that runs the analyses. Blood values obtained from a local laboratory (considered normal at DWH) are found in Table 3. These values were derived from a small number of both species and are included for reference values only. Interlaboratory differences in blood values are expected, especially regarding enzyme concentrations such as alkaline phosphatase, lactate dehydrogenase, creatine kinase, aspartate aminotransferase, and alanine aminotransferase. Alkaline phosphatase concentrations are consistently higher in younger calves, and hematocrit, hemoglobin, and red blood cell count decrease as the whale acclimates to being restricted to shallow waters in captivity. These three hematological parameters also have been used to infer diving capabilities. Long-term collection of these types of data from live-stranded animals may allow investigators to examine whether or not the two species have different diving adaptations (Barros et al., 1998).

Orphan Calves

Treatment

In the southeastern United States, cow/calf pairs of kogias strand frequently (Odell, 1991). Most kogia calves are thought to strand because of primary disease in their mothers, which leads to secondary issues with the calf such as starvation, dehydration, and constipation. If the calf's immune system has not been seriously impacted, there is a relatively good chance that the calf will be healthy within a short period of time; however, maintaining the healthy condition of that calf may pose a great challenge.

Figure 1. Photomicrograph of gastric contents of *Kogia* stained with methylene blue demonstrating basal cells (center of photo) that indicate gastric or esophageal ulceration; erythrocytes rarely are seen if the gastric pH is at normal levels.

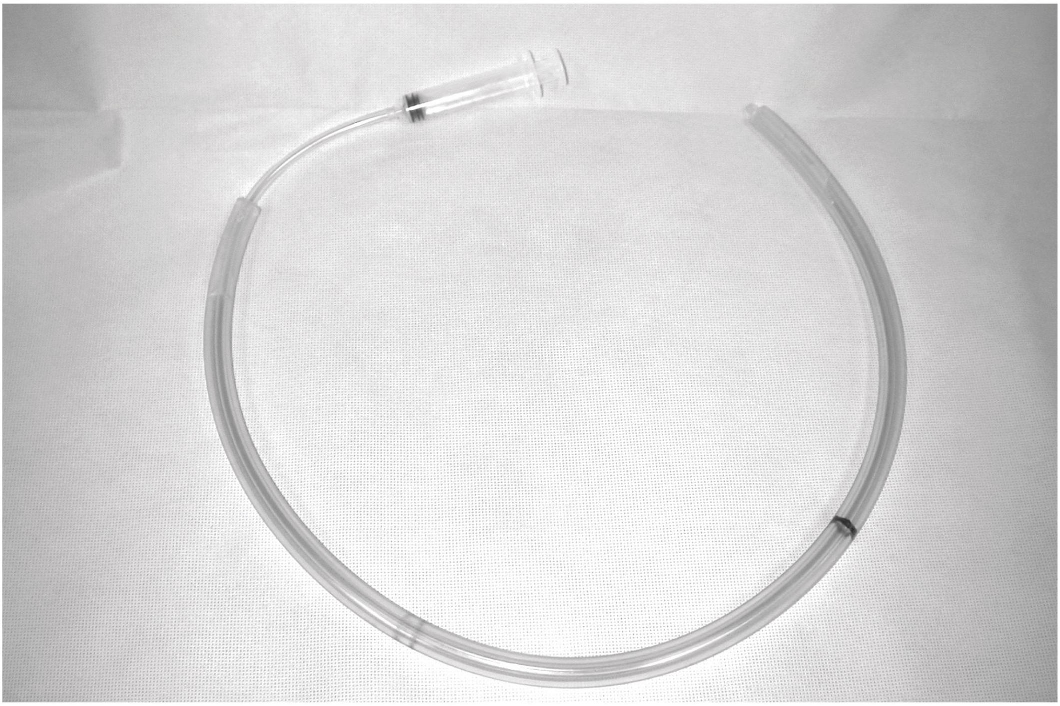

Figure 2. Tube developed to administer liquid sucralfate into the esophagus of *Kogia* for treatment of esophageal ulcers

The initial treatment during the first few days will be the same for a calf as for an adult. Rehydration and the elimination of constipation are even more critical in a very young calf than in an older animal. Beyond this initial treatment, nutrition will be the major concern for the next weeks and months (Townsend & Gage, 2001).

Feeding

A modified formula based on the SeaWorld dolphin formula (Townsend, 1999) is used at the DWH for kogia calves (Table 4). Similar to older animals being placed on solid food, the amount of formula given to a calf should start low and gradually increase over a 10-day period. For *K. breviceps* calves, calories should increase to about 60 kcal/kg/day during the first few weeks or months and gradually decrease to about 35-40 kcal/kg/day. These should be modified depending on the weight gain each week. The target weight gain for the first six to eight months used at the DWH is about 1.5-2.0 kg/week for *K. breviceps* and about 1.0-1.25 kg/week for *K. sima*. It may take more calories for *K. sima* to achieve and maintain this weight gain; however, such observations are based on a very small sample size (n=1) and should be followed with caution.

Initially, the formula shown in Table 4 is mixed with the fluids given to hydrate the calf. This

Table 4. Recipe for artificial formula for use with *Kogia breviceps* and *K. sima* calves before their electrolyte levels are stable; this formula should be diluted with half-strength oral electrolyte solution or other solution used to obtain electrolyte balance.

6.25 cc (1¼ teaspoon) table salt
790 cc (3⅓ cups) Zoologic Milk Matrix 33/40 (Pet-Ag, Inc., Hampshire, IL)
400 cc (1⅔ cups) Zoologic Milk Matrix 30/55
15 cc (1 tablespoon) lecithin
50 ml safflower oil
250 mg taurine
250 mg arginine
1 multivitamin plus iron
8,000 IU vitamin A
500 mg vitamin C
400 IU vitamin E
30 cc (2 tablespoons) Osteoform (Veta-Mix, Shenandoah, IA)
Bottled water to make 2 l of mixture

Blend all ingredients, pasteurize in water bath at 60° C (140° F) for 30 min, refrigerate, and use within 36 h. The caloric content of this formula base is approximately 1.09 kcal/ml.

fluid composition is determined from the blood electrolyte values as above. Once the calf is on full ration, gaining weight, and the electrolyte and blood glucose values are stable, the formula can be diluted with drinking water (adequate to prevent constipation) as shown in Table 5. The salt and salt substitute levels in the formula can be modified so that the calf has adequate intake to maintain blood electrolyte levels. If blood glucose levels fall when switching formulas, a small amount of dextrose can be added to the formula for a short adjustment period and then eliminated.

Newborn calves that are tube-fed should be fed once every three hours, around-the-clock. This can be reduced to once every four hours, around-the-clock, when a calf is about three months of age.

A number of different nipples were tried to allow a kogia calf to suckle, but using a short tube inserted into the stomach and pouring fluids and/or formula through an attached funnel worked best (Figures 3a-b). Calves can prevent small tubes from being passed, and it may be better to use a larger tube (about 16 mm in outer diameter), even for very young calves. Calves quickly learn to approach the handler at feeding time and open their mouth to receive the tube, with little or no handling.

As a calf grows, it may experience lactose intolerance and produce excessive intestinal gas. This can be reversed by giving lactase with each formula feed. This calf formula also can be used in much older animals as a source of quick calories as long as lactase is administered with each feed or is added to the formula prior to feeding. Another option for older animals is blended herring fillets instead of the milk matrix.

Table 5. Recipe for artificial formula for use with *Kogia breviceps* and *K. sima* calves once their electrolyte levels are stable; this formula should be diluted with water.

15 cc (1 tablespoon) table salt
5 cc (1 teaspoon) salt substitute
790 cc (3⅓ cups) Zoologic Milk Matrix 33/40 (Pet-Ag, Inc., Hampshire, IL)
400 cc (1⅔ cups) Zoologic Milk Matrix 30/55
15 cc (1 tablespoon) lecithin
50 ml safflower oil
250 mg taurine
250 mg arginine
1 multivitamin plus iron
8,000 IU vitamin A
500 mg vitamin C
400 IU vitamin E
30 cc (2 tablespoons) Osteoform (Veta-Mix, Shenandoah, IA)
Bottled water to make 2 l of mixture

Blend all ingredients, pasteurize in water bath at 60° C (140° F) for 30 min, refrigerate, and use within 36 h. The caloric content of this formula base is approximately 1.09 kcal/ml.

Calves can be offered solid food at about six months of age. Handlers should play with the calves with whole squid around the mouth until they learn to swallow them. Once the calf consumes squid, very small amounts can be slowly added to the diet. It is suggested that calves continue to receive formula until at least one year of age. Once a calf is taken off formula, it likely will need to receive oral fluids to prevent constipation, especially if maintained in chlorine-treated water.

Medical Issues in Calves

There are a couple of special medical issues when raising orphaned calves. Just as with older kogias, calves are prone to gastric and esophageal ulcers. The treatment for these ulcers is identical to that used for older animals. Secondary fungal infections are common in calves receiving antibiotics, so it also should be given acidophilus. In addition, any time a calf is on an antibiotic for more than one week, it also should be given a systemic antifungal such as itraconazole, fluconazole, or terbinafine. As with all drugs in kogias, one must be careful to monitor for side effects such as hepatic injury with these agents.

Releasability

In the United States, NOAA Fisheries, the agency regulating the rehabilitation of cetaceans, considers dependent kogia calves as unreleasable (T. Rowles, NOAA Fisheries, pers. comm.). It is assumed that they would be unable to survive because they have no experience finding prey and avoiding predators. In addition, because they are not prone to forming large aggregations, it would be difficult to place them in a social grouping in the wild at the time of release. Until more data on kogia distribution and social structure become available, it is advisable to consider all orphaned kogia calves that arrive in rehabilitation without any evidence of having fed well in the wild (i.e., having food matter or parasites in the stomach) as unreleasable. Due to the fact that these are high-maintenance animals, there may not be a large number of facilities willing to take long-term responsibility for them. This must be kept in mind when deciding whether to attempt to raise an orphaned kogia calf.

Husbandry Training

When raising an orphan kogia deemed unreleasable, the following behavioral modifications will

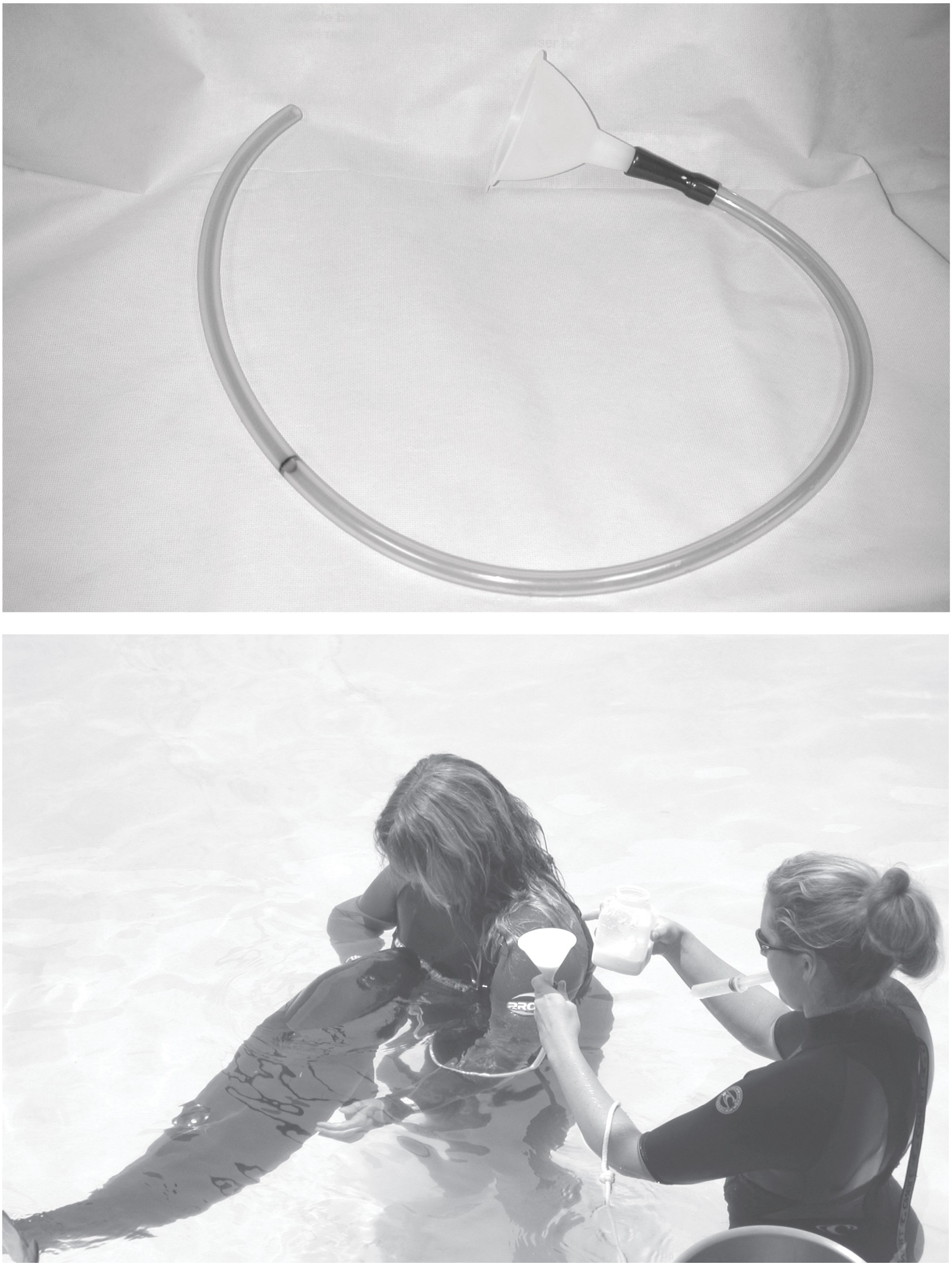

Figure 3. Feeding apparatus used to feed artificial formula to *Kogia breviceps* and *K. sima* calves: a. shortened stomach tube for administration of formula with funnel attached; b. feeding apparatus being used to tube-feed a *K. sima* calf.

make routine husbandry and care easier and less stressful. These include stretcher training, targeting, using a feeding signal, and body manipulations. Stretcher training allows for the weekly exams and weights with a minimum of personnel. Most calves learn to swim into a stretcher to receive a meal after only a few lessons. Target training is especially important if the calf is to be maintained with other animals, thereby allowing for separation of the animals. Using a feeding signal is helpful as a secondary re-enforcer for other training, and targeting may allow body manipulation to take place without restraint.

Breaching Behavior in Calves
Despite reports in the literature, healthy calves are active at times. Especially during rain storms, calves swim quickly around their tank and do extensive breaching. Small mesh, knotless nylon netting has been used to cover the tanks at DWH housing kogia calves to prevent them from breaching out of the tank. Some individuals breach with their entire bodies and should be allowed sufficient space so as not to become entangled or injured when presenting this behavior.

Long-Term Care

With many of these animals, long-term care appears to be just a continuation of short-term care over a long period of time. These animals must be monitored continually for the development of constipation and ulcers as well as for other medical conditions. This is the reason they are considered high-maintenance, although some individuals may require more maintenance than others. Once fluid intake is regulated to prevent constipation, the animal's defecation rate must be monitored. Currently, we are having some success giving sucralfate tablets (1 g) twice daily with food for long periods of time to prevent ulcers from developing.

Other Issues of Concern and Interest

Proper Species Identification
Two morphometric characteristics that separate these two species are the size of the dorsal fin and the position of the blowhole (Barros et al., 1998; Ross, 1984). In *K. sima*, the dorsal fin is taller and the blowhole is nearer the tip of the snout, when taken relative to total length. Thus, in *K. sima*, the ratio dorsal fin height/total length will be > 5% and the ratio tip of snout to center of blowhole/total length will be < 10%. These values were found to be diagnostic for animals of both sexes and all size classes (Barros et al., 1998). Other differences are the presence of throat grooves (primarily in *K. sima*) and tooth counts (12 to 16 for *K. breviceps* and 8 to 11 for *K. sima* per half lower jaw) (Caldwell & Caldwell, 1989; Jefferson et al., 1993; McAlpine, 2002).

Species-Specific Behavior
From limited experience with *K. sima*, we believe that individuals of this species may display behavioral patterns that are substantially different from those displayed by *K. breviceps*. Several *K. sima* individuals have been described as hyper-excitable and prone to sudden, panic-like behaviors when being handled (pers. obs. and pers. comm. from other rehabilitation facilities). We found this type of behavior to be very unusual in *K. breviceps*, only observed following a long transport or just prior to death.

Determination of Age of Calves
The determination of age in kogias has not been properly documented. The precise age determination of very young calves, crucial in the early days of rehabilitation, can thus be problematic. At DWH, fetal folds have never been observed on *Kogia* spp., but one *K. sima* female calf, 125 cm total length and 28.5 kg in weight (thought to be newborn), was admitted with dorsal fin and flukes completely curled and soft. This calf's umbilicus was inverted and was difficult to determine its stage of healing. The calf did not have teeth and did have rostral hairs that remained for about one month in captivity. One must be careful in placing too much emphasis on the rostral hairs to determine age as a *K. breviceps* was observed at DWH with a full set of fairly large teeth that still had rostral hairs, and the calf was thought to be two to three months old. These rostral hairs were present for approximately 45 days in captivity.

Saving Samples
There are a number of samples that can easily be saved from any *Kogia* spp. brought into rehabilitation that may be useful for a number of research projects. First, skin samples can be scooped out of the water, placed into a container with DMSO (dimethyl sulphoxide) solution or frozen, and used for DNA analysis that may help differentiate species and stocks. The same information may be available from whole heparinized blood that can be stored frozen (Duffield et al., 2003). If regurgitated material (e.g., squid beaks) is available, these should be saved for proper species identification. One should note the date and time materials were first seen and the species of squid fed to the animal in captivity so that subsequent differentiation of wild and captive diets can be made.

Recordkeeping

Because so little is known about both species, it may be beneficial in the long run to keep very good records regarding each animal that comes into rehabilitation. Records should include length, weight, blood values, amount of food given, food supplements, feeding behavior, all medications given and in what dosages, any unusual behaviors, and anything else out of the ordinary. This will be helpful when reviewing the cases to determine better methods of husbandry and treatments.

Conclusions

Clearly, there are many unanswered questions regarding these two species. The information presented here is far from complete, but it represents a great deal of effort and progress from the situation just a few short years ago. We believe that it is now possible to keep these animals alive long enough to fully diagnose their conditions and have time to address treatments. Unfortunately, most of the animals that strand are either orphan calves or adults suffering from cardiomyopathy. Even so, this information may make it easier to decide which animals are potentially releasable and to concentrate efforts on those individuals. It is hoped that this information will be helpful to others who attempt to rehabilitate pygmy and dwarf sperm whales. Rehabilitation with both species can be extremely challenging, but it can be accomplished with diligence and perseverance. We respect those who are willing to go the extra distance necessary to save these animals, and we hope that much can be learned along the way.

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