First Rehabilitation Attempt of Pseudorca crassidens in the Maldives

Abstract

False killer whales (*Pseudorca crassidens)* are the third largest member of the oceanic dolphin (or *Delphindae)* family, after the Pilot Whale and the Orca, with an average size of 4.5 m (15ft.) for females and 5.3m (17.6 ft.) for males. *P. crassidens* is a tropical and temperate water species. It is one of the most common species of cetaceans that strands. Both individual and mass strandings have been reported globally. Here we report on an individual stranding and the attempted rescue of a juvenile *P. crassidens* in Baa Atoll, Maldives. This is the first documented cetacean rescue in the Maldives.

Introduction

False killer whales (*Pseudorca crassidens)* are the third largest member of the oceanic dolphin (or *Delphindae)* family, after the Pilot Whale and the Orca, The average size of a false killer whale is around 4.5 m (15ft.) in length for the females and 5.3m (17.6 ft.) for the males. Maximum known size for a female is 5.1m (17 ft.) in length and a weight of 1,200 kg (2,600 lb.), while the largest males can reach 5.9m (19 ft.) and weigh as much as 2,200 kg. Both males and females reach sexual maturity at lengths of 3.2-3.8 m (10.1- 13 ft.)*P. crassidens* is generally confined to tropical and temperate waters throughout the world, although they have been recorded at higher latitudes (Purves & Pilleri, 1978). This species appears to be uncommon throughout its distribution. Population size in the Indian Ocean is unknown. Pods of up to 300 individuals have been sighted in Baa atoll Maldives (personal communication).

A number of mass strandings of false killer whales have been reported from widely separated regions around the world and others in Sri Lanka, Zanzibar, Chatham Island, and Argentina (Dudok van Heel, 1962: 478; Brown *et al.*, 1966). Individual strandings of *P. crassidens* in the western North Atlantic have been reported from North Carolina (Brimley, 1937), South Carolina and Georgia (Caldwell and Golley, 1965), southeastern Florida (Bullis and Moore, 1956), Cuba (Aguayo, 1954) and Aves Island near Venezuela (Miller, 1920). (Caldwell, Caldwell, & Walker, 1970)

On the 9th of December 2012, a female sub-adult false killer whale was found stranding on the East side of Landaa Giraavaru Island, Baa atoll Maldives (Cf. Figure 1).

Figure 1: Landaa Giraavaru, Baa Atoll, Maldives, site of the stranding

The Pseudorca was drifting towards the beach carried by the dominant northeast winds and currents. The rescue team tried to push her back offshore but the whale was unable to keep herself upright and was too weak to swim. The whale was towed by boat to the island where she was kept in our rehabilitation center. Here we report on our attempt to rehabilitate her over 22 days.

Materials and Methods

Materials

Food

No.	Materials	Qty
1	Squids	±66kg
2	Tuna	±63kg
3	Herring	±20kg
4	Other Fish(Barracuda)	±6kg

Medication

No.	Materials	Qty
1	Dextrose(100mg/2Litres)	14 Packets
2	Ringer Lactate	6L
3	Baytril (5%)	125mL
4	Cefadroxil (500mg)	168 Tablets
5	Ciprofloxacin (500mg)	84 Tablets
6	Augmentin (258mg)	520mL
7	Vitamin E (400mg)	109 Tablets
8	Calcium/Vitamin C (1000mg)	30 Tablets
9	Vitamin B	400mL
10	Diaper Ointment (Zinc Oxide + Vitamin E)	100g

Daily Nutrition of the Pseudorca

Table 1: Amount of food, fluids and medication given from 10th till 31st December

	Food				Fluids			Medications						
Date	Squids (Kg)	Tuna (kg)	other fish	Herring (kg)	Dextrose (100mg/2l)	Ringer lactate	Fresh water (l)	Baytril (5%)	Cefadroxil (500mg)	Ciprofloxacin (500mg)	Augmentin (258mg)	Vitamin E (400mg)	Calcium/ vitamin C (1000mg)	Vitamin B
12/10	1.2				2		1							100
12/11	1.5				2		4	25ml						100
12/12	1.5				2	1	4	25ml						100
12/13	1.5	1.5			2	1	4	25ml			30 ml	6		100
12/14	1.5	1.5			2	1	4	25ml			30 ml	6		
12/15	1.5	1.5			2	1	4	25ml			30 ml	6		
12/16	1.5	1.5			2	1	4				30 ml	6		
12/17	1.7	4.5			2		4		24		30 ml	6	4	
12/18	1.7	4.5			2		4		24		30 ml	6	4	
12/19	3	4.5			2		2		24		30 ml	6	4	
12/20	4	4.5			2		2		24		30 ml	6	4	
12/21	5	6		2	2		2		24		30 ml	6	4	
12/22	3	4		8					24		15ml	6	4	
12/23	4.5	6		4					24		30ml	6	4	
12/24	4.5	5		3						6	6 Tablets	6	2	
12/25	3	4		3						12	12 Tablets	6		
12/26	3	6		4						12	12 Tablets	6		
12/27	4	8	2	2	2.5					12	30 ml	4		
12/28	3	8	2	4						12	-	-		
12/29	3	8	2	4						12	-	3		
12/30	2	4.5	2		2.5					6	20ml	3		
12/31	1	2			2.5	1	2			6		3		

The table above shows the nutrition for the Pseudorca from 10th December, to the 31st December including the amount of food, medications, vitamins and fluids containing electrolytes provided daily.

Blood Collection

No.	Materials	Qty
1	5ml Syringe	10
2	21G needle	10
3	Alcohol Swab	10

Wound Cleaning

No.	Materials	Qty
1	Iodine Solution (5%)	10 Bottles(100mL)
2	Sterile Gauze	2 Rolls
3	Gloves	1 Boxes
4	Alcohol Swab	10

Sling Support

No.	Materials	Qty
1	Large Wet Suit	2
2	Ropes(1meter)	4

Floatation Device

No.	Materials	Qty
1	X Large Life Jacket	1
2	Fender(15 x 64cm)	2

Rehabilitation Centre

Materials	
Rehabilitation Pool	7 m Long, 1 m wide, 60 cm deep
Lagoon's enclosure	12 m Diameter, Depth ranging from 1 to 4m

Stretcher

No.	Materials	Qty
1	Canvas(4 m Long, 1 m Wide)	1
2	2 Galvanized Pipes (6 m long, 50.8 mm Diameter)	2

Methods

Rescue

A small boat and two windsurf boards were used to tow the whale back to the Marine Center on the island over a total distance of about a 1 km. Ten employees from the resort helped to carry the Pseudorca to the centre's turtle rehabilitation pool on a tarpaulin used as an emergency stretcher. The pool normally used for sea turtle rehabilitation was 7 m long, 2 m wide and 0.6 m deep (Cf.Figure 2).

Figure 2: Turtle Rehabilitation Pool

Figure 3: alternative water supply creating a minimum circulation in the pool

Due to the pool outlet's inability to drain the water out at the same rate as the inlet pumped water in, the pump supplying sea water from the resort's house reef was switched off and on manually. A vacuum cleaner operated by the same pump was used to ensure regular (twice daily) water changes. In addition, a low flow rate sea water supply, delivered through a hose of 2 cm diameter, was used to create a small circulation of water in the pool (Cf. Figure 3).

Maintaining the whale upright in the water

A sling, made of a neoprene wet suit hung on a transversal beam at the top of the pool, was used to maintain the Pseudorca in an upright position until the 20th of December. Later, a life vest and two plastic fenders were used instead of the sling (Cf. Figure 4).

Figure 4: The two different systems used to maintain the position of the Pseudorca upright in the water

Tube feeding

1. Three people were involved in restraining the Pseudorca: two at the rostrum and one at the neck to minimize movement of the head during feeding.
2. The Pseudorca was approached slowly with one person holding onto the tube to be inserted in the throat and one person opening the mouth.
3. A reinforced flexible hose of 20 mm diameter and 3 mm thickness (Cf. figure 5) was inserted near the throat swiftly while the mouth was opened
4. Fluids containing electrolytes, antibiotics and blended squids and fish were poured into the tube steadily.
5. Not more than 400ml of liquids were administered in between each breath taken by the Pseudorca.
6. During the period of tube feeding, the person who was restraining the mouth kept the tube in place, the second person checked regularly for any spillage of fluid from the mouth, and the third person restrained the neck of the Pseudorca by lifting it up slightly above the surface.

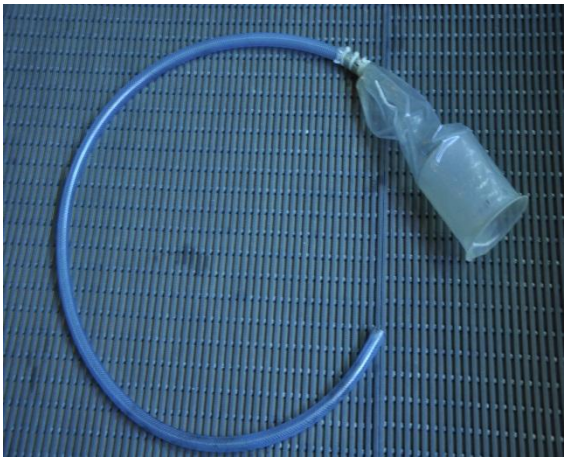

Figure 5: Hose used for the tube feeding process

Transition to solid food

1. Whole squids were introduced manually into the whale's mouth in order to get her habituated to hold the food she was offered.
2. Using the same approach previously described in the tube feeding technique, squids were thrown into the mouth after one person opened the jaws.
3. The same person kept the Pseudorca's jaws closed until the squid was swallowed.
4. After the whale was observed swallowing the food on her own, squids were offered again until they got taken deliberately.

Wound Cleaning

1. Water in the pool was drained out to minimize movement of the Pseudorca
2. Any raw lesions observed were flushed with fresh water.
3. 5% Iodine solution was applied to the area using sterile gauze to rub off necrotic debris
4. The pool was cleaned, scrubbed and filled with filtered seawater

Blood collection

1. Water in the pool was drained out to minimize movement of the Pseudorca
2. Restraining was insured by two persons: one at the peduncle and the other at the fluke, while a third person collected the blood sample
3. The fluke was stabilized by one person allowing access to the dorsal surface.
4. The fluke was lifted out of the water and twisted at an angle of about 60 degrees to expose its ventral side.
5. The long axis of the side of the fluke was used as a reference to locate the main blood vessel.
6. 70% alcohol was applied on the site of venipuncture along the main blood vessel.
7. Venipuncture was done on the middle 1/3 of the fluke by stabilizing the needle (bevel side up) on the side of the fluke and needle was inserted at a 60 degree angle to the plane of the fluke.
8. Needle was inserted by feeling for the penetration through the firm skin and then kind of a "pop" was felt as the needle enters the vessel.
9. Blood sample was obtained and sent to the hospital via seaplane immediately after the collection.

Observations

While towed back to the island on the rescue's day, the whale was observed vomiting several times, notably squid beaks. During this time, her movements were limited, her breathing was shallow and sporadic and her eyes remained closed most of the time.

During the first 18 days, the Pseudorca was unable to keep herself upright. Her movements were extremely limited during the first couple of days following her admission to the center. Signs of responsiveness, such as up and down fluke movements, were first observed on December 15th. The Pseudorca was force fed twice daily with a mixture of squid, fish, broad spectrum antibiotics, vitamin E and calcium supplements, and fluids containing electrolytes for the first seven days (December 10th to 17th). On the 18th of December, she started to take solid food by herself. Fluids, vitamins and calcium supplements (provided via tubing) continued to be administered until the 22nd of December. Fluids were also given via tubing on the 30thand 31stof December. Day by day improvements of the Pseudorca's conditions and activity were observed after solid food was accepted. During this period, an average 10kg of food including herring, tuna and squids was offered to the whale daily.

On the 12th December, she was observed to have a blister (approximately 20cm diameter) growing above her right pectoral fin. After having been flushed, the dead skin was removed to reveal the presence of a major wound in the same area. The wound was cleaned daily with an antiseptic solution in order to limit the risk of bacterial infection.

On the 28th of December, the whale was transported out of the pool using a stretcher and the help of 10 persons. The stretcher broke while lifting her out of the pool and she fell onto compact sand from a meter height. The transportation was continued using towels to lift the whale up to a trolley. She was placed on 3 windsurf boards joined together (Cf. Figure 6) towed by a small boat to an enclosure built in the island's lagoon located ~2km west from the Marine Centre (Cf. Figure 7). Upon reaching the enclosure, the Pseudorca was observed to be very weak with very minimal movements.

Figure 6: The Pseudorca transferred to the lagoon's enclosure on windsurf boards

Figure 7: The Pseudorca in the lagoon's enclosure

On the 29th December, the Pseudorca's condition appeared to be much improved. She was very active, swimming and whistling, and taking food by herself. At the same time, the inflammation present above the right pectoral fin seemed to reduce.

On the 30th December, she appeared very weak, with little to no movements. She was found biting two sea cucumbers, which had become stuck on her mouth. Some undigested prawns, which had been fed to the Pseudorca the previous day, were also found on the sea bed of the enclosure. Administering of fluids was resumed thereafter and continued the next day.

31st December, the whale died drowning herself while convulsing underwater.

Results

Blood sample analyses performed respectively on 26 December, 28 December and 31 December:

Table 2: Chemistry Panel Results performed on 26 December

Biochemical Analysis	Results
Alkaline Phosphates	63 U/L
S.Cholestrol	129 mg/dl
AST [SGOT]	27.7 U/L
ALT [SGPT]	493 U/L
S.Triglycerides	53 mg/dl
S.Iron Fe	39.63 ug/dl

Cholesterol and triglycerides obtained from the blood tests performed on December 26 did not reveal any anomaly, with respective levels of 129mg/dl and 53mg/dl. The enzymes fall in the normal range values, while the Iron displayed lower levels than the normal range. The Alkaline Phosphate levels were observed to be extremely low, especially for a juvenile animal. The aspartate aminotransferase (AST) displayed on the chemistry panel was normal, while alanine aminotransferase (ALT) was elevated and Serum Iron was low.

Table 3: Hematological and Biochemical Analyses performed on 28 December

Hematological Analysis		Result
Haemoglobin		10.3 g/dl
Total Leucocyte Count		10,000 cells/ul
Diferential Leucocyte Count		
	Neutrophils	71%
	Lymphocytes	20%
	Eosinophils	8%
	Monocytes	0.1%
	Basophil	--
ESR		45 mm/hour
Erythrocyte Count		3.44 * 10^6/ul
MCV		94.2 fl
MCH		29.2 Pg
MCHC		31.8 g/dl
Platelet count		424*10^9/l
RDW - SD		60.7 fl
RDW - CV		0.189

Biochemical Analysis	Result
S. Total Ptoteins	7.91 g/dl
S. Albumin	2.68 g/dl
Alkaline Phosphates	63 U/L
S. Urea	98 mg/dl
BUN	45.1 mg/dl
S. Creatine	0.39 mg/dl
S. Sodium	146 mmol/L
S. Potassium	3.7 mmol/L
S. Chloride	110 mmol/L
S. Calcium	8.0 mg/dl
Blood glucose Random	98 mg/dl

The hematology and chemistry panel of the blood samples collected on 29 December 2012, displayed on table 4, were also processed in a human laboratory. As interpreted by Dr. Robert C. Braun, (appreciating the varying differences in laboratories and their methodologies) hemoglobin levels were low, as an expected range would have been between approximately 15-18 g/dl. The Erythrocyte sedimentation rate (ESR) at 45 was considered significantly elevated above normal, but consistent with the exudative pectoral fin lesion and potential respiratory disease. White Blood Cells' (WBC) count was relatively high at 10,000 cells/ul compare to mean values commonly read in False Killer Whale's blood analyses. In a hematological study carried out at Nihon University School of Veterinary Medicine, Fujisawa, Japan, on 5 captive false killer whales, the average WBC count was 7,921 cells/ul (Shirai & Sakai, 1997).

Table 4: Hematological and Biochemical Analyses performed on 31 December (post-mortem)

Hematological Analysis		Results
Haemoglobin		**14.9 g/dl**
Total Leucocyte Count		**5 800 cells/ul**
Diferential Leucocyte Count		
	Neutrophils	**65%**
	Lymphocytes	**32%**
	Eosinophils	**1%**
	Monocytes	**2.00%**
	Basophil	**--**
ESR		
Erythrocyte Count		**5.02 * 10^6/ul**
MCV		**99.0 fl**
MCH		**29.7 Pg**
MCHC		**30.0 g/dl**
Platelet count		**246*10^9/l**
RDW - SD		
RDW - CV		

Biochemical Amalysis	
S. Total Ptoteins	**7.98 g/dl**
S. Albumin	**2.68 g/dl**
Alkaline Phosphates	**71 U/L**
S. Urea	**124.1 mg/dl**
BUN	**57.6 mg/dl**
S. Creatine	**0.60 mg/dl**
S.Cholestrol	**126.3 mg/dl**
S.Triglycerides	**87.7 mg/dl**
S.Iron Fe	**19.75 mg/dl**
Blood glucose Random	**45.2 mg/dl**

In table 4, the post-mortem Hematological and Biochemical Analyses performed on 31 December revealed an improvement in levels of Red Blood Cells (RBC) and Hemoglobin relative to previous analyses performed on 28 December. WBC count appeared normal, improved from the previous elevation of 10,000 in Table 3. The differential count of the WBCs also appeared to be normalizing. In the Biochemical analysis, the Blood glucose level was low. Serum Iron was however very low and had declined. An ESR was not available and alkaline phosphates had not improved.

Discussion

Normal AST and high ALT, displayed in the blood test results from December 26 may indicate hepatic influences of insufficient diet, microbial insults and/or toxins prior stranding. The low level of Serum iron (Fe) can generally be associated with blood loss and inflammation, which may indicate that the gastrointestinal tract or respiratory system was infected. Low levels of Alkaline Phosphate were likely strongly influenced with the gross inflammation of the pectoral fin, a potential respiratory disease and certainly low dietary protein intake and insufficient calories provided daily. Based on an estimated weight of 300kg for the Pseudorca and a recommended daily diet of 5% of the body weight, the Pseudorca should have been provided with 15-20kg of food per day. Due to logistical difficulties to supply this requirement, the marine team was only able to provide her with 10kg of food daily. Therefore, the Pseudorca displayed gradual visible loss of weight throughout the 3 weeks of rehabilitation.

In the Hematological and Biochemical Analyses performed on 28 December displayed on Table 3, the WBC count of 10,000 was as one would expect and consistent with what was grossly evident, considering the infection on the pectoral fin and also the possible diagnosis of lung infection. The ESR at 45 was high, even considering the pectoral fin lesion, and may represent other not apparent influences.

The normalization of both the WBC count and differential count in the post-mortem blood sample analysis seemed to reflect a reduction in systemic inflammation's reaction. At this stage, any infection present was being controlled. Signs of hydration were indicated by serum proteins and creatinine levels. The low blood glucose observed was likely a result of time between collection and separation of the serum from the cells, allowing consumption of the available glucose by the cells.

The Pseudorca's inability to maintain her position upright in the water was undetermined but was most likely to be related to either respiratory disease (inflammation/infection, inhalation of water, injury), or perhaps a central neurological problem. (E.g. balance center of her inner ears) (Personal communication, Robert C. Braun DVM MS, 2012).

The severity of the circumferential wound observed above the right pectoral fin may be attributed to a possible entanglement in fishing line/net prior stranding, leading to a subsequent struggle to cause the injury which then opened and developed a secondary infection. Ghost nets and more precisely gill nets originating from India and Sri Lanka are known as a regular source of Olive Ridley sea turtles' entanglements observed in the Maldives at this period of the year (personal observation).
Incidental captures of false killer whales in various fisheries are reported.
Following this hypothesis, the Pseudorca, near drowning could have developed respiratory distress leading to an inability to feed or/and swim, and resulting to a stranding eventually.

The cause of the sudden deterioration of the whale on the 30th is unknown. The probability that the Pseudorca died due to a large loss of blood as in a ruptured blood vessel in the lungs, organ such as the liver etc. related to her fall and/or some prior cause of stranding was low if we refer to the post-mortem RBC count and Hemoglobin levels. As vomiting, loss of appetite and depressed behavior were observed, gastrointestinal (GI) problems would be high on the list of potential causes. These could include GI

stasis and bacterial complications, food poisoning or potentially ulcers in the gastrointestinal tract which could have been irritated by inappropriate food. Undigested prawns, offered on the 29th of December were vomited and the rest of two sea cucumbers along with their Cuvierian tubules (peculiar specialized defense system in present in several species of sea cucumbers) were found in the whale's mouth. This also could have been related to the undetermined respiratory disease.

Recommendations

Positive aspects of the rehabilitation	Limitations
Reporting daily undertaken actions and whale's progress to cetaceans 'experts was the most important part of the rehabilitation	No adequate water circulation in the pool
Re-assessing the situation, planning and organizing day by day was a requirement	Insufficient facilities to establish a decent diagnostic (absence of Ultrasound, X Ray or Blood test Machines)
Supporting the Pseudorca to stabilize her balancing issue was managed efficiently.	Daily required diets were difficult to supply
Force feeding was well handled	The marine biologists could have tried to pass a stomach tube down the esophagus when performing force feeding
Holding sea pen was built with regards to the environmental conditions (wind, wave and current pattern) and the animal's size and preferential configuration (dimension of the enclosure, oval shape and varying depths)	Material used in the stretcher's fabrication was inadequate

Retrospectively, both the rescue and the first phase of the whale's rehabilitation were approached effectively considering the available facilities, the difficult logistic and the global lack of experience of the marine biologists in dealing with stranded and sick cetacean. Transferring the pseudorca to the pool and maintaining her position upright as well as supplying required medications and daily diet of food and fluids counted among the most challenging parts of the rehabilitation. This holding was fortuitous given her condition. The wet suit sling was both effective in her support, not injurious to her skin and facilitated treatments and nutritional support. While the size, shape and depth was very helpful during the initial intensive care, water exchange for the pool was difficult and less than optimum. Additional sources of water could be explored and delivered, potentially, from periodic use of saltwater pumps, and extended siphon drainage.

The difficulty to provide sufficient and appropriate daily rations of fish was not optimal, but was the best use of what was available. As caloric dense oily fish (sardines, herrings, mackerels) commonly used in cetaceans' rehabilitation were not available at the resort, the marine biologist team was fortunate to be able to rely on local islands' sporadic catches of herrings (20 kg in total), Herklotsichthys *quadrimaculatus*, to supplement the daily supplies of squids and tuna's filets. A better strategy for the future might include Bonito, Sarda *sp*., perhaps more widely available, directly from the local fishermen.

Similarly the open water holding pen was excellent. It was well constructed for the site as well as for the animal in the assessed condition. The oval shape, varied depth, external supports and location relevant to ocean threats was very appropriate.

Finally, a post-mortem examination and necropsy could have been performed in order to obtain additional information relevant of the possible cause of death.

This experience taught us many things, which in the event of future stranding response and rehabilitation attempts, will serve us well. Our collective experience in support/floatation, restraint, force feeding, and use of a gastric tube in support of a cetacean have been documented in photos and video and this report. We can explore additional diagnostic resources in hematology, cytology, and perhaps ultrasound or even portable x-rays. Similarly, now that we are more familiar with sources of medications, both in availability and logistical considerations, we will be better prepared for future rehabilitation attempts.

Conclusion

As a first attempt to nurse a stranding cetacean back to health in the Maldives, this experience highlighted the main challenges encountered in the process of rehabilitation. With limited facilities and persons qualified in handling cetaceans, the rehabilitation of a relatively large marine mammal seemed to be realistic if well organized under the supervision of professional marine veterinarians. Though, some important considerations that have not been stressed in this report should have been taken into account in the perspective of a successful release: would the animal have been able to take care of its own welfare back into the wild? Could the released have interfered with human health and safety? Or, as a non-endangered species, could the False Killer Whale have represented a threat to the wild population?

Both the origin of the stranding and 3 weeks later, the sudden deterioration of the whale remained undetermined. Speculations on a possible entanglement in fishing gears corroborated with all the symptoms displayed by the Pseudorca post-rescue. Blood tests performed before and after the death of the individual have not permitted to obtain a clear diagnostic.

Acknowledgements

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