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The medical treatment of 3 stranded Harbour porpoises (*Phocoena phocoena*)

R. A. Kastelein, M. J. Bakker* and T. Dokter

Zeedierenpark Harderwijk (Harderwijk Marine Mammal Park), Strandboulevard-oost 1, 3841 AB, Harderwijk, Holland
** Veterinary practice, Verkeersweg 29, 3842 LD Harderwijk, Holland*

Summary

In March 1988 three Harbour porpoises (*Phocoena phocoena*) were stranded on the Dutch coast and sent to the Harderwijk Marine Mammal Park for rehabilitation. The following parameters were recorded during their stay at the park: blood parameters, medication, parasites, health changes, weight and length changes, wound healing, food consumption, digestion, respiration rate and behaviour. The possible cause of the stranding and the amount of labour needed for the rehabilitation are discussed. After treatment, in November 1988, two of the animals were released into the North sea.

Introduction

Every year cetaceans are stranded on the Dutch coast. Approximately 80% of these animals are Harbour porpoises, *Phocoena phocoena* (Table 1). The carcasses of animals which die at sea and are later washed up onto the beach, are sent to the Natural History Museum of Leiden where the cause of death is determined if possible, and parts of the body are preserved for further study.

Live stranded animals are reported to the Harderwijk Marine Mammal Park, which is the rehabilitation centre for stranded cetaceans on the Dutch coast. Several cetaceans stranded alive between 1971 and 1985, many of which died before or during transport to Harderwijk (Table 2). The survival chance of stranded cetaceans is small; often they have been out of the water for a long time and are dehydrated, and they are usually very sick. Additional stress is caused by contact with humans, by mechanical noises around them, and the total loss of control of their situation.

Because of these problems the Harderwijk Park's transport equipment was improved at the beginning of 1986. The equipment now consists of: stretchers that can be modified for cetaceans of different sizes; buckets; water containers; rope; a pocket-knife; a water spray system; towels, sponges; zinc oxide ointment; a stomach tube; a funnel; a first aid kit and overalls. All these items are packed in a polyesterized plywood transport box with a foam rubber lining. To improve comparisons between treatments, standardized forms have been designed which are filled in during the treatment and give detailed records. All this equipment is packed in such a way that it can be put into a transport van within minutes of a live stranding alarm.

For more than 2 years after this transport kit was assembled no live strandings were reported. Then 3 live Harbour porpoises stranded within a period of 17 days in March 1988. This article is about the treatment of these animals and contains additional information gathered during their stay at the Harderwijk Marine Mammal Park.

Table 1. Total number of strandings of Harbour porpoises on the Dutch coast between 1970 and 1986 (Husson & van Bree, 1972, 1976; van Bree & Husson, 1974; van Bree & Smeenk, 1978, 1982; Smeenk, 1986, 1988, 1989). *Live stranding treated at the Harderwijk Park. **Treated animals. †Live stranding treated at Zandvoort

Date	Number	Date	Number
1970	17	1979	15
1971	13*	1980	13*
1972	18*	1981	33*
1973	26	1982	20*†
1974	7	1983	26
1975	16	1984	19*
1976	14	1985	28**
1977	22†	1986	19
1978	26**		

Materials and methods

Study animals

This study was carried out during the rehabilitation of 3 Harbour porpoises (*Phocoena phocoena*) that were stranded on the Dutch coast in March 1988 (Table 3).

Table 2. Beached cetaceans treated at the Harderwijk Park between 1971 and 1985. H = coast of Holland, B = coast of Belgium, W.G. = coast of West Germany. Ph.ph = *Phocoena phocoena*; La.al = *Lagenorhynchus albirostris*; La.ac. = *Lagenorhynchus acutus*

Year	Location	Species	Date of arrival at the park	Date of death	Date of release	Total days treatment	Remarks
1971	H	Ph.ph	26 Feb	16 Mar	—	18	
1972	H	Ph.ph	—	22 Aug	—	0	Died during transportation
1973	B	Ph.ph	—	28 Nov	—	0	Died before transportation
1973	H	La.al	7 April	7 April	—	0	Died during transportation
1978	H	Ph.ph	11 June	7 Aug	—	57	
1978	H	Ph.ph	6 Nov 78	26 May 79	—	201	
1980	H	Ph.ph	27 Dec	30 Dec	—	3	
1981	H	Ph.ph	12 June	—	27 July	45	
1982	H	Ph.ph	27 Apr	28 June	—	62	
1982	H	La.al	13 Aug	22 Aug	—	9	
1984	W.G.	Ph.ph	28 June	2 July	—	5	
1985	H	Ph.ph	16 Mar	—	16 Mar	0	Direct release
1985	H	Ph.ph	17 July	18 July	—	2	
1985	H	La.ac	24 Dec	30 Dec	—	6	

Table 3. The date and place of stranding, and estimated age of the 3 Harbour porpoises which stranded on the Dutch coast

Code	Sex	Date of stranding	Place of stranding	Estimated year of birth
PpSH012	F	10-3-88	Ameland	1987
PpSH013	M	22-3-88	Moddergat	1973
PpSH014	M	27-3-88	Ternaard	1982

Study area

During the first period (between 10-3-88 and 16-6-88), the animals were kept in a circular pool (diameter: 6 m, depth: 1 m). The water of the pool was separated from the other pools in the park. The temperature of the chlorinated salt (2.4%) water varied between 17 and 20°C. The area around the pool was artificially lit 24 hours per day. Through a window in the ceiling additional daylight could enter the area. On 16-6-88 the animals were transferred into a rectangular pool (8 m × 3 m; depth: 1 m) which also had a separate water treatment system (Fig. 1). Shallow pools, preferably with sloping bottoms so that the animals can beach themselves, are very useful for rehabilitating stranded cetaceans, since they facilitate handling and treatment (Bain, 1981). Shallow pools seem to slow down the swimming speed of newly arrived Harbour porpoises and thus avoid possible collison with obstacles (Andersen, 1976).

Treatment

When stranded animals arrive at the park, they usually have to be put into a hammock. A hammock serves several purposes: (1) it keeps the blowhole above the water so that the animal cannot drown, (2) it still keeps most of the body submerged and so prevents overheating and dehydration (body parts that extend above the water line are treated with zinc oxide ointment to prevent dehydration) and (3) it prevents the animals from swimming against the sides of the pool. The animals should be kept in a hammock for as short a time as possible, since their muscles become stiff due to lack of exercise (Gage, 1982). When the animals are released from a hammock, round-the-clock observers are usually needed to intervene if necessary.

Weight and length recording

The animals were weighed in two ways: either they were held in the arms of a person who then stood on a domestic weighing machine, or the animals were placed on a professional digital weighing machine. The length of the animals was measured along the body surface, on the dorsal side, in a straight line from the tip of the upper jaw to the deepest part of the fluke notch. This way the length measurements were slightly influenced by the animal's movements.

Drugs

The trade name, producer, and generic name of drugs mentioned in the text are listed below. The dosages of these drugs are shown in Figures 3, 9 and 10.

Figure 1. The 3 Harbour porpoises in the rectangular pool.

Lacrybiotic (R) by Vetoquinol (chloramphenicol, neomycin, vit A); Synulox (R) by Beecham (amoxycillin and clavulanic acid); Stesolid (R) by Dumex (diazepam); Solu-delta-cortef (R) by Upjohn (prednisolone-Na-succinate); Aureomycin-spray by Cyanamid (chlortetracycline and gentian violet); Seavit (R) by Aesculaap (marine mammal vitamins); L-Ripercol (R) by Janssen (levamisole); O.R.S. (oral rehydration salts) (R) by Nutricia (Na, K, Cl, HCO_3 and glucose); Isogel (R) by Allen and Hanburys Ltd (Ispaghula Husk B.P.); Argentii nitras by Braun Melsungen AG; Duoderm (R) by Squibb (hydroactive wound-dressing); Droncit (R) by Bayer (praziquantel), Clamoxyl (R) by Beecham (amoxycillin); Aluspray (R) by Vetoquinol (micronised aluminium); Cortexilar 50 (R) by Syntex (flumethasone) and Decadron (R) by Frosst (dexamethasone); Zinc oxide ointment by Interstate Drug Exchange.

Results

Animal PpSH012

Health condition on arrival

Animal 012 had severe cuts on both sides of her tailstock and 3 shallow cuts in her rostrum. She was emaciated and dehydrated. She also had a large abdominal wound which was probably caused by pressure and overheating when lying on the beach. She had well developed marginal papillae on her tongue (Fig. 2), which is a sign of young age (Kastelein & Dubbeldam, 1990).

Treatment

Before transport from the beach to the Harderwijk Park, the animal was given Stesolid (R) per rectum to reduce the stress of transport, and an injection of Solu-delta-cortef (R) to suppress shock effects (Fig. 3A). After arrival at the park, the animal was given an antibiotic injection and luke warm water with O.R.S. (R) (oral rehydration salts) to rehydrate the animal. When the animal arrived she had to be kept in a hammock for 3 days before she was able to swim by herself (Fig. 4). Blood was taken from the tail fluke and analysed. The PCV, haemoglobin, and erythrocyte levels were low (Table 4). This could have been caused by a loss of blood through her wounds. Her sodium and potassium levels were high which was probably due to dehydration. To improve these blood values, the animal was given water with O.R.S. (R), vitamins and fish. Most of the liver enzyme levels were high (SGOT, SGPT and LDH), but her AP level was normal which was a strong indication of a liver fluke infection. The animal was first given the antibiotic Clamoxyl (R), later

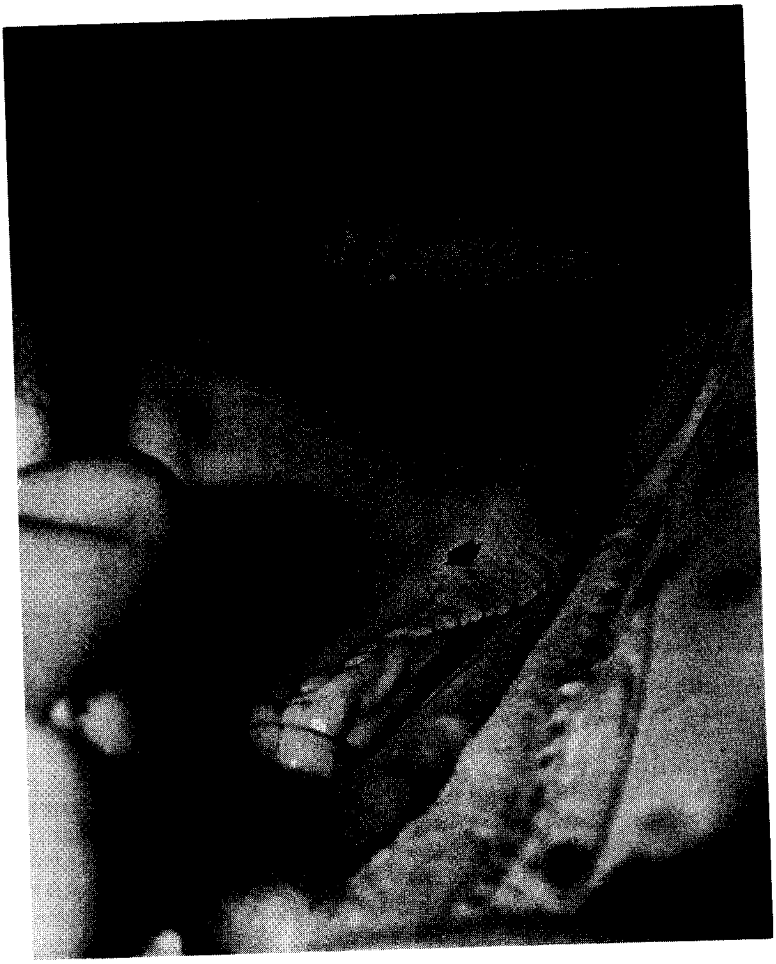

Figure 2. The mouth cavity of Harbour porpoise 012. The arrow indicates the marginal papillae on the tongue.

gentamicin, which was finally replaced by Synulox (R) which could be administered orally (Fig. 3A).

Parasites
Floating faeces were found in the pool and were sent to the laboratory for analysis. They contained lung worms and their eggs (*Pseudalius inflexus*), unidentified round worms (*Ascaridae sp.*), and liver fluke eggs (*Campula oblongata*). Because it was impossible to determine from which animal the faeces came, all three animals were treated in the same way for parasites. The round worms were treated with piperazine. The liver fluke was treated with Droncit (R) which is not the medicine of choice, but we relied on the self-curing capacity of the animals, as they became stronger. The lungworms were treated with L-Ripercol (R). To reduce the reaction of the Harbour porpoise to the remains of dead worms in the lungs, the animal was given the hormone prednisolone and the antibiotic Synulox (R). Some days after the treatment, dead (dried) lungworms were found against the edge of the pool just above the water level.

Wound healing
The skin wound on the abdomen was treated by taking the animal out of the water and by superficially drying the wound with a hair dryer. Then the wound was treated with Aluspray (R) to increase epithelial growth (Fig. 5). Later in the treatment the Aluspray (R) was replaced by Aureomycin-spray (R), an antibiotic which adhered better to the wound. The wound healed perfectly, and very few scars could be seen afterwards (Fig. 6).

DRUGS	METHOD OF ADMINISTRATION	DOSAGE	PERIOD
ANTIBIOTICS			A
Synulox ®	PO	2dd/8mg/kg	
Gentamicin	I	2dd/4mg/kg	
Clamoxyl ®	I	2dd/5mg/kg	
HORMONES			
Flumethasone	I	0.03mg/kg once	
Solu-delta-cortef ®	I	3mg/kg once	
Prednisolon	PO	2dd/0.5-1 mg/kg	
ANTI-PARASITICA			
Piperazine	PO	100mg/kg once	
Droncit ®	PO	3+6mg/kg	
L-Ripercol ®	PO	1.8+3.6+5mg/kg	
WOUND TREATMENT			
Duoderm ®	TOP		
Aluspray ®	TOP		
Cod liver ointment	TOP		
Argentii nitras	TOP		
Aureomycin spray ®	TOP		
OTHERS			
Zinc ointment	TOP		
Stesolid ®	A	0.3mg/kg	
Seavit ®	PO	2dd/1 tablet	
Paraffin oil	PO	1-3dd/10ml	
O.r.s. ®	PO	2dd/16 gr/0.6l	
Isogel ®	PO	2dd/1-2 gr	
Ferrosi-fumaraat	PO	2dd/5mg/kg	

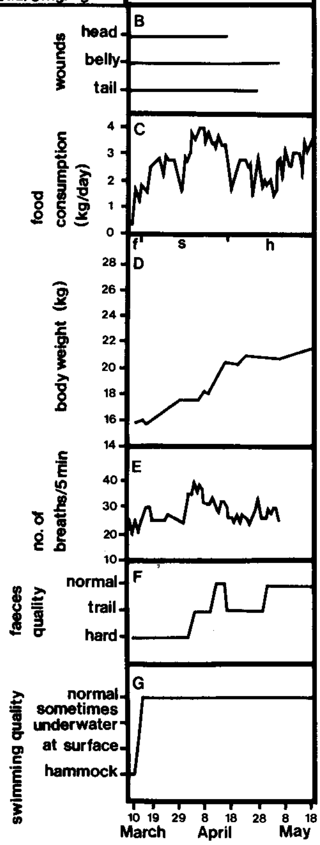

Figure 3. Harbour porpoise 012.
(A) Medication (PO = oral; A = anal; TOP = topical; I = injected in muscles).
(B) Healing of wounds.
(C) Daily food consumption (f = force-feeding; s = free-feeding; h = hand-feeding).
(D) Body weight.
(E) Respiration rate.
(F) Faeces quality.
(G) Swimming quality.

Table 4. The blood parameters of Harbour porpoise 012

Parameter	Unit	Date 11-03 arrival	18-03	05-04	28-04
Hematology:					
Sedimentation in 10 min	mm	0	0	0	0.5
Sedimentation in 20 min	mm	0	1	1	1
Sedimentation in 30 min	mm	1	2	1	2
Sedimentation in 60 min	mm	1	4	2	2
PVC	l/l	0.35	0.36	0.48	0.52
Haemoglobin	mmol/l	7.1	7.9	9.7	10.3
Erythrocytes	$\times 10^{12}$/l	4.1	4.4	4.8	5.1
Leucocytes	$\times 10^{9}$/l	8.2	11.0	5.1	11.3
Bas.	%	0	0	0	0
Eos.	%	12	2	6	8
Band cells	%	1	0	1	0
Seg.	%	76	86	64	76
Lym.	%	9	11	29	16
Mon.	%	2	1	0	0
Serum chemistry:					
Na	mmol/l	161	152	153	155
K	mmol/l	4.1	3.0	3.7	3.4
Ca	mmol/l	2.33	2.70	2.58	2.41
Fe	µmol/l	—	11	—	—
Fe binding cap.	µmol/l	—	130	—	—
Phosphate	mmol/l	2.14	—	2.60	—
y GT	U/l	—	48	50	27
AP	U/l	—	—	140	245
SGOT	U/l	—	693	310	299
SGPT	U/l	—	242	180	304
LDH	U/l	—	1135	800	—
CPK	U/l	—	425	577	279
Total Bilirubin	µmol/l	—	1	1	—
Uric acid	mmol/l	—	—	0.03	—
Urea	mmol/l	12.3	15.3	18.7	21.0
Creatinin	µmol/l	37	22	35	34
Total protein	g/l	69	71	75	72

The tailstock wounds and rostrum wounds were treated in the same way, but because granular tissue started to grow through the skin lesions of the tail-stock, this was temporarily wrapped in Duoderm (R) to restrict the formation of granular tissue. Although the Duoderm (R) was beneficial to the healing process, it started to cause small skin abrasions on the dorsal side of the tailstock, so this treatment was replaced by treating the granular tissue with an etching reagent (Silver nitrate). Care was taken to only cauterize the overgrowth of flesh, and not to touch the surrounding skin. The tail-stock healed perfectly, but the pigment did not return to the skin over the scars (Figs. 3B and 7).

Food consumption

First the animal had to be force-fed for 2 days (Fig. 3C). This involved taking the animal out of the water and opening the mouth, and pushing Sprats (*Sprattus sprattus*) deep into the throat (Fig. 8). On the third day after arrival the animal started to bite into 25 cms long Herring (*Clupea harengus*) that were presented in front of her mouth while the animal was held at the water surface. After biting the animal moved the fish around in the mouth and swallowed it. One day later (4 days after arrival) the animal started to eat Herring that was thrown into the pool. Her food intake increased from an average of around 2 kg a day during the first weeks to around 3.5 kg a

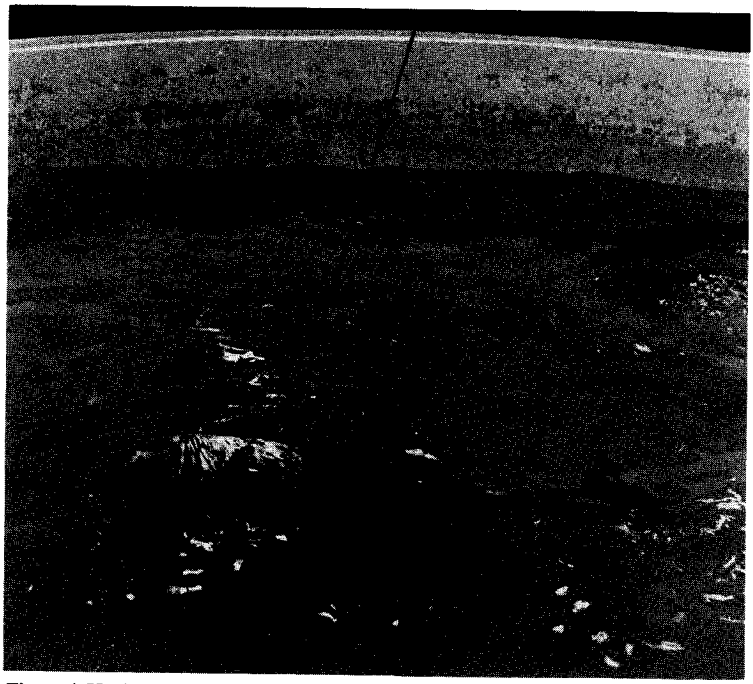

Figure 4. Harbour porpoise 012 in a hammock to prevent drowning. The white colour on the dorsal side is zinc ointment.

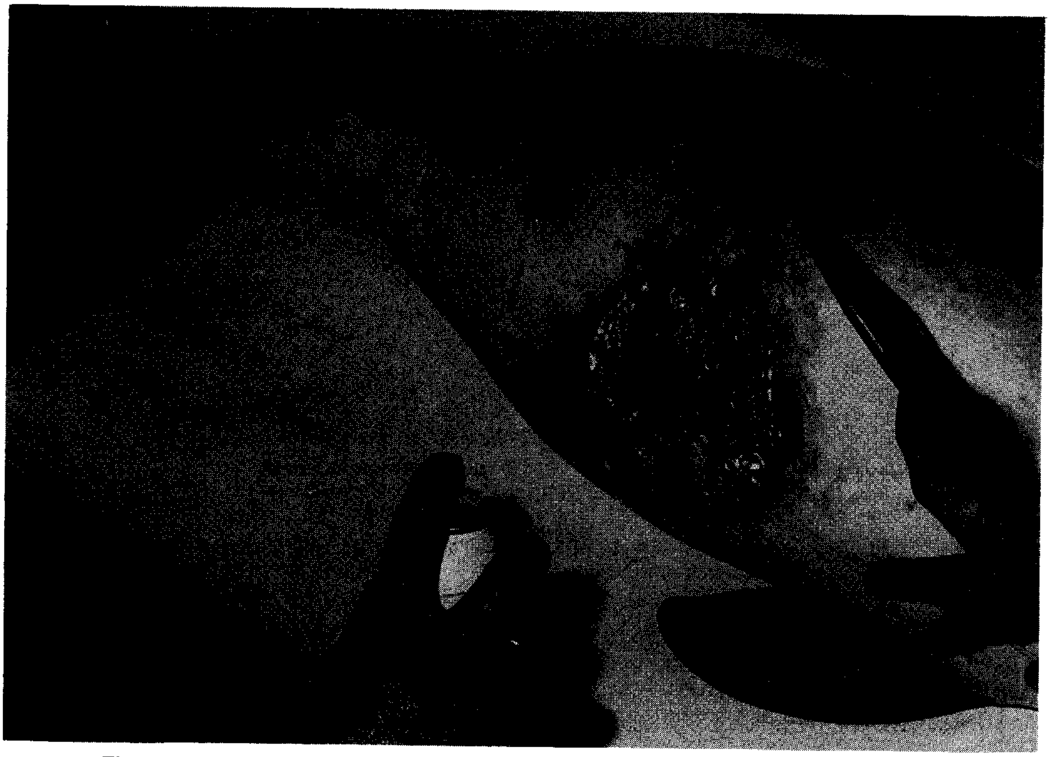

Figure 5. The treatment of the abdominal wound of Harbour porpoise 012 with Aluspray (R).

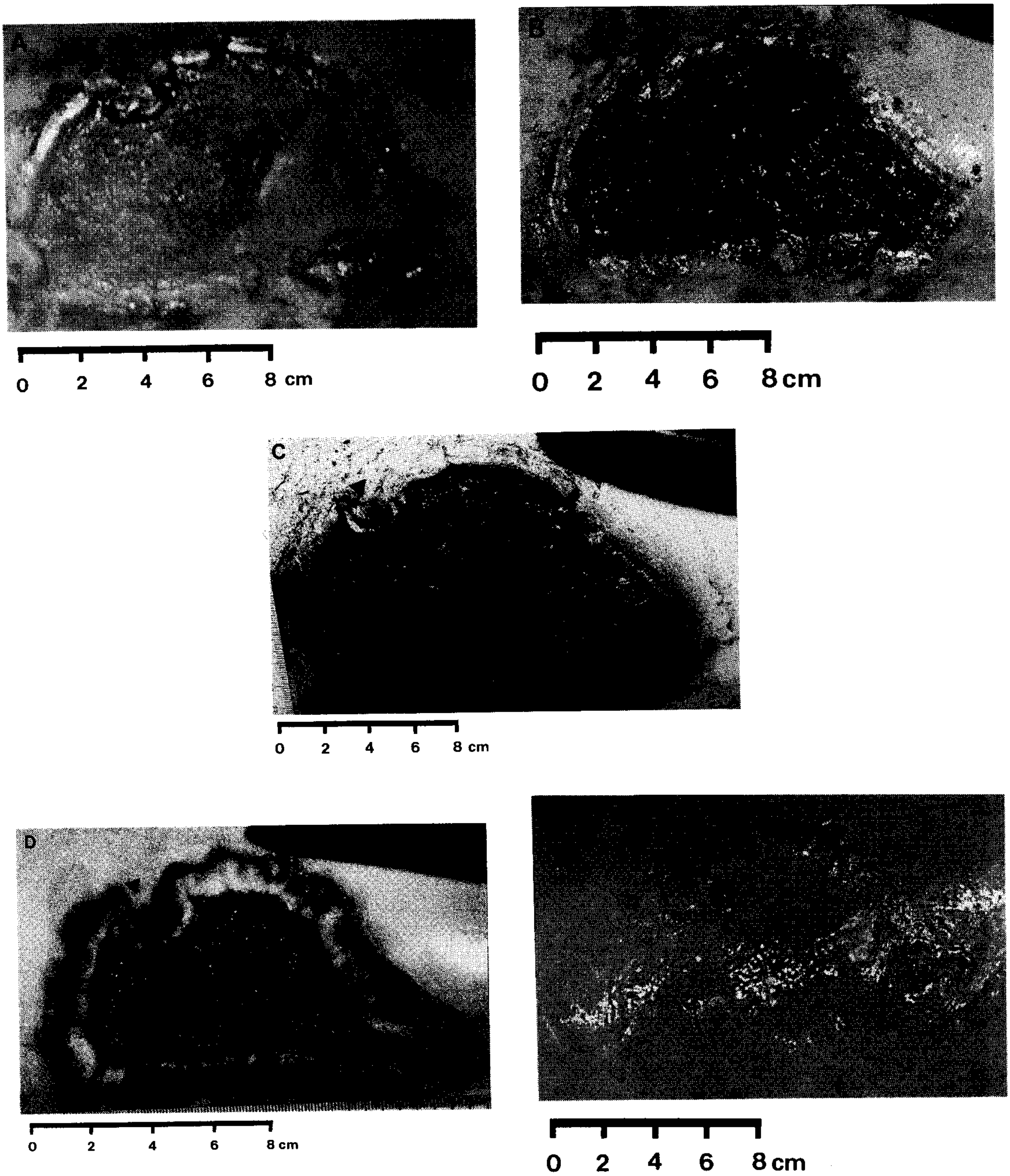

Figure 6. Several healing stages of the abdominal wound of Harbour porpoise 012.

day after 20 days. After 36 days she started to take hand-fed fish. From that moment on her food consumption dropped to 2.5 kg a day, probably because she had to overcome her fear of humans. Later, her food intake increased to around 3 kg a day (Fig. 3C). Although her main diet consisted of Herring she also accepted 30 cms long Mackerel (*Scomber scombrus*). During all feeding stages the animal was fed 3 to 4 times a day.

Digestion

A few days after arrival the animal showed signs of

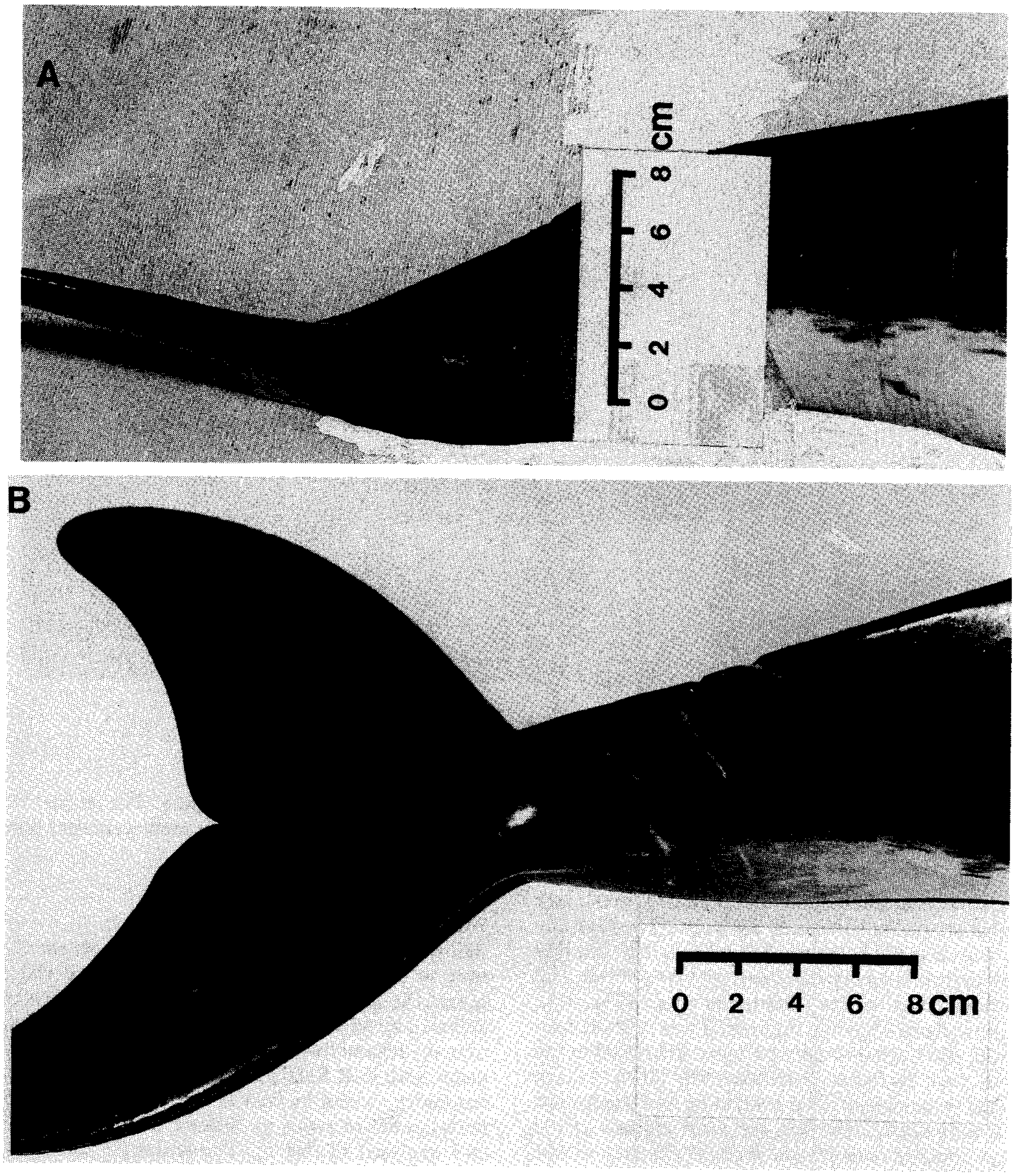

Figure 7. The tailstock wounds of Harbour porpoise 012 on arrival (A) and after healing (B).

constipation (Fig. 3F). She regularly stopped swimming and bent her tail towards the bottom of the pool. As a laxative, paraffin oil was given orally by injecting it into the food. Later during the treatment the paraffin oil was replaced by Isogel (R) capsules which were inserted into the gills of the fish. This treatment had to be continued until release (Fig. 3A).

Body weight and body measurements

When the animal arrived on March 10 she weighed 16.0 kg and had a body length of 107 cm. By July 6 her weight had increased to 24.5 kg and she measured 117 cm (Fig. 3D).

Respiration rate

The respiration rate was monitored 3 times a day for 5 minutes each time. At first the respiration rate of the animal was stable at around 25 inhalations per 5 minutes. From March 30 on it increased to around 35 inhalations per 5 minutes (Fig. 3E). This coincided

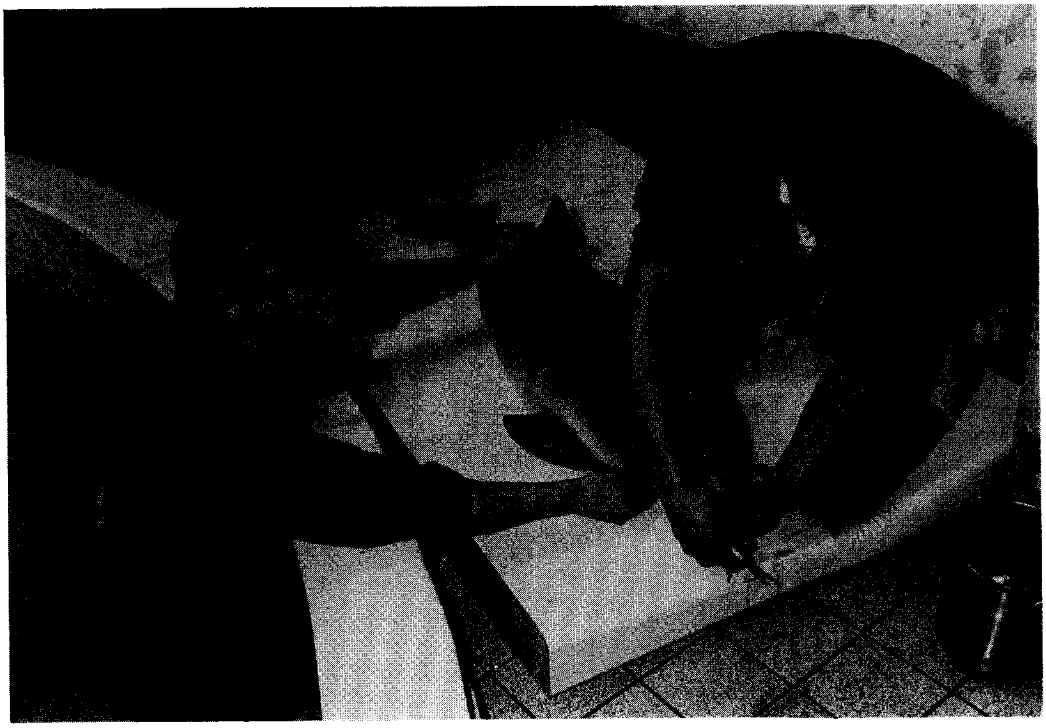

Figure 8. The force-feeding of a Harbour porpoise.

with an increase in food consumption followed by an extremely rapid growth (Figs. 3C and 3D).

Behaviour

After 3 days in a hammock, the animal spent one day swimming at the surface of the water. The next day she occasionally submerged her head. The 5th day after arrival her swimming pattern was normal, and she spent most of the time under water (Fig. 3G). Around April 23, when the animal was in good condition, she started to become more interested in the other two Harbour porpoises. On April 25 she started to synchronize her swimming and respiration with animal 013. She was the most curious of the three animals, which was probably linked to her young age. She often rotated 360° along her axis when swimming close to the edge of the pool where observers were standing.

The animal was declared healthy on May 18 and medical treatment was stopped.

Animal PpSH013

Health condition on arrival

Animal 013 had small skin wounds rostral of the dorsal fin. He also had more severe skin lesions around his tailstock. The latter wounds were similar to those seen on animal 012. He was very emaciated and weak and coughed frequently. The animal was considered to be aged, since the teeth were very blunt (Møhl-Hansen, 1954).

Treatment

Before transport the animal was given dexamethasone to suppress stress effects and Stesolid (R) to sedate the animal for the trip (Fig. 9A). When the animal arrived at the park he was given another injection of dexamethasone and was given luke warm water with O.R.S. (R) before he was placed into a hammock, where he had to stay for 2 days before he was able to swim by himself. Blood was taken and analysed (Table 5). The leucocyte count was relatively high, which indicated an infection. A blowhole culture revealed 4 bacteria (*Achromobacter; Pseudomonas luteola; Enterobacter agglomerans; Staphylococcus sp.*) which were sensitive to the antibiotic gentamicin. Later, Synulox (R) was administered orally. The iron level was low which could have been caused by a loss of blood from the tailstock (Table 5). The animal was given food and vitamins to restore this deficiency. On May 6, some foaming blood came out the blowhole which was probably due to a mild bleeding somewhere in the respiratory system.

DRUGS	METHOD OF ADMINISTRATION	DOSAGE	PERIOD
ANTIBIOTICS			A
Synulox ®	PO	2 dd/8 mg/kg	
Clamoxyl ®	I	2dd/5mg/kg	
HORMONES			
Prednisolon	PO	2dd/0.5-1 mg/kg	
Dexamethason	I	0.1 mg/kg	
ANTI-PARASITICA			
Piperazine	PO	100 mg/kg once	
Droncit ®	PO	3+6 mg/kg	
L-Ripercol ®	PO	1.8+3.6+5 mg/kg	
WOUND TREATMENT			
OTHERS			
Zinc ointment	TOP		
Stesolid ®	A	0.3 mg/kg	
Seavit ®	PO	2dd/1 tablet	
Paraffin oil	PO	1-3 dd/10 ml	
O.r.s. ®	PO	2dd/16 gr/0.6l	
Isogel ®	PO	2dd/1-2 gr	

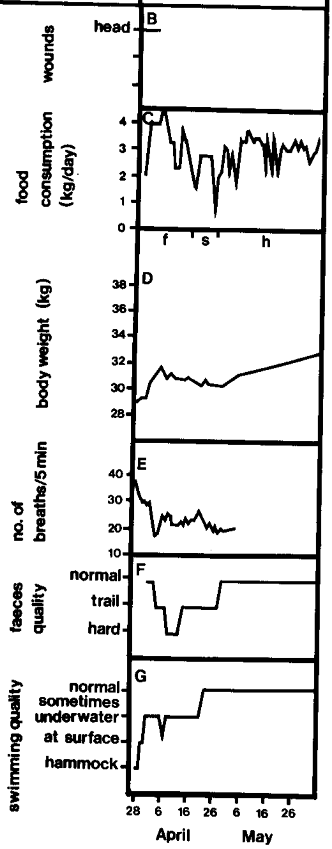

Figure 9. Harbour porpoise 013.
(A) Medication (PO = oral; A = anal; TOP = topical; I = injected in muscles).
(B) Healing of wounds.
(C) Daily food consumption (f = force-feeding; s = free-feeding; h = hand-feeding).
(D) Body weight.
(E) Respiration rate.
(F) Faeces quality.
(G) Swimming quality.

Table 5. The blood parameters of Harbour porpoise 013

Parameter	Unit	Date			
		22-03 arrival	28-03	05-04	28-04
Haematology:					
Sedimentation in 10 min	mm	0	0	0	0
Sedimentation in 20 min	mm	1	1	1	0
Sedimentation in 30 min	mm	2	2	1	0
Sedimentation in 60 min	mm	3	3	2	0
PVC	l/l	0.47	0.46	0.49	0.56
Haemoglobin	mmol/l	10.1	10.1	10.4	11.8
Erythrocytes	$\times 10^{12}$/l	5.6	5.6	5.6	6.5
Leucocytes	$\times 10^{9}$/l	13.6	13.9	8.2	8.8
Bas.	%	0	0	0	0
Eos.	%	4	15	12	2
Band cells	%	0	3	0	0
Seg.	%	88	56	55	73
Lym.	%	4	26	33	24
Mon.	%	4	0	0	1
Serum chemistry:					
Na	mmol/l	146	153	150	157
K	mmol/l	4.7	3.9	3.7	3.0
Ca	mmol/l	2.07	2.50	2.60	2.56
Fe	µmol/l	6	39	60	97
Fe-binding cap.	µmol/l	117	129	186	143
Phosphate	mmol/l	1.46	—	2.65	—
y GT	U/l	23	29	36	44
AP	U/l	67	57	91	147
SGOT	U/l	290	425	380	300
SGPT	U/l	154	160	241	276
LDH	U/l	940	770	766	668
CPK	U/l	146	100	182	120
Total Bilirubin	µmol/l	—	5	2	—
Uric acid	mmol/l	0.04	0.02	0.02	—
Urea	mmol/l	12.6	15.6	19.5	11.4
Creatinin	µmol/l	63	70	68	61
Total protein	g/l	—	74	82	77

Parasites
Because it was impossible to say from which animal the faeces with parasites and parasite eggs came, all three animals were treated for these parasites. Lung worms were seen often crawling out of the blowhole of this animal after treatment with L-Ripercol (R). Concurrent with this treatment prednisolon and Synulox (R) were given (Fig. 9A).

Wound healing
The wounds on the back were treated with Aureomycin-spray (R). The skin lesions around the tailstock healed quickly without medical assistance (Fig. 9B). In contrast to animal 012 no visual scars remained. Around May 23, an eye infection (keratitis) appeared which was treated with Lacrybiotic (R), an antibiotic ointment, until June 15 when the infection had disappeared.

Food consumption
The animal had problems with eating (Fig. 9C). He had to be force-fed for 69 days after arrival despite many different feeding techniques that were used, such as: decreasing the amount of food fed in order to make the animal hungry (April 20 to May 5); moving dead fish in front of the mouth by hand; moving dead fish on a fishing line through the water; and finally feeding live fish. All attempts failed, but on June 1 the animal suddenly started to eat fish that was thrown into the water to feed the other two animals.

During the first 30 days the animal was fed approximately 3.5 kg a day (Fig. 9C). After that period the food intake was deliberately reduced to 1.5 kg a day in the hope that this would induce the animal to start to eat by itself. Because this attempt was not successful, the food intake was increased to around 2.5 kg a day. After he started to feed himself, the food intake stabilized at around 3 kg a day. During all feeding stages the animal was fed 3 to 4 times a day.

Digestion
After a few days the animal showed signs of constipation. The symptoms were the same as seen in animal 012. The animal was given paraffin oil in addition to food. This oil was soon replaced by Isogel (R) which gave better results (Fig. 9A and F).

Body weight and body measurements
The animal weighed 35 kg and measured 145 cm when it arrived on March 22. By August 11 his weight had increased to 38.2 kg and the length was the same (Fig. 9D).

Respiration rate
The respiration rate of this animal was very high during the first 5 days after arrival (Fig. 8E). This was probably due to respiratory problems caused by lung worms. Later during the treatment period the breathing rate decreased to around 25 inhalations per 5 minutes.

Behaviour
The animal had to stay in the hammock during the first 2 days at the park. After that there was a period of 9 days during which he swam or floated at the water surface without diving (Fig. 9G). Then for a period of 26 days he sometimes dived, but still spent a large proportion of the time at the surface. It took 37 days for the animal to show a normal swimming pattern in which only a little time was spent at the surface. This animal was the calmest of the three.

From 14 April 1988 this animal was approached sexually by the other male (PpSH 014) in the pool. From 23 April 1988 onwards he sometimes showed his reaction in an erection.

The animal was declared healthy on 15 June 1988 when medical treatment was stopped.

Animal PpSH014

Health condition on arrival
Animal 014 had been on the beach for at least one day, since he was first seen the day before transport (but not recovered because he was not recognised as a Harbour porpoise). He was very emaciated and dehydrated. He had a small wound below each eye. These were probably caused by excoriation, since the lesions were next to the areas where the mucous ran from the eyes. The outer skin layer of the animal was sloughing. The teeth of this animal were very sharp.

Treatment
Prior to transport the animal was given Stesolid (R) per rectum to reduce stress. He was also given an injection of dexamethasone and Clamoxyl (R) before he was put into the hammock (Fig. 10A). Blood was taken from the tailstock and analysed. The blood had high PCV, haemoglobin and erythrocyte levels, which is consistent with dehydration (Table 6). The potassium level was also relatively high, which is indicative of muscle damage probably caused by the animal's long stay on the beach.

Parasites
The animal was treated for parasites in the same way as animals 012 and 013 (Fig. 10A).

Wound healing
The small skin lesions below the eyes healed within 6 days after arrival at the park without medical assistance. No scars remained (Fig. 10B).

Food consumption
When the animal did not respond to dead Herring which were thrown into the water in front of his head for 23 days, other measures had to be taken. First, live freshwater fish (Rudd, *Scardinius erythrophthalmus*) were put into the pool (26 April 1988). The Harbour porpoises hardly reacted to them, and the fish died within 5 minutes in the salt water. The same day two species of marine fish (3 Coalfish, *Pollachius virens* and 3 Plaice, *Pleuronectes platessa*) were released into the pool. Within a few minutes animal 014 started to chase the Coalfish and succeeded in catching 2. Then a dead Herring was thrown into the water, and the animal ate it. Even more remarkable was the fact that a second Herring was taken from the hand. Usually it takes a long time to make the transition from free-feeding to hand-feeding. The Plaice were not touched by the Harbour porpoises. On a second occasion (29 April 1988) another species of live marine fish was introduced. This time, Coalfish and Cod (*Gadus morhua*) (both 20 cms long) were released into the pool. Both species were taken by animal 012 and animal 014, while animal 013 did not react to live fish.

Animal 014 was force-fed approximately 3.5 kg a day during the first 10 days after arrival (Fig. 10C). Then the food intake was deliberately reduced to induce the animal to eat by itself. The food intake increased after the animal started to eat dead fish from the water (i.e. after introduction of live fish). Then the food intake dropped for a short period when the animal started to eat from the hand, and eventually stabilized at around 3 kg a day. During all feeding stages the animal was fed 3 to 4 times a day.

DRUGS	METHOD OF ADMINISTRATION	DOSAGE	PERIOD
ANTIBIOTICS			A
Synulox ®	PO	2 dd/8 mg/kg	
Gentamicin	I	2 dd/4 mg/kg	
Lacrybiotic ®	TOP		
HORMONES			
Prednisolon	PO	2 dd/0.5-1 mg/kg	
Dexamethason	I	0.1 mg/kg	
ANTI-PARASITICA			
Piperazine	PO	100 mg/kg once	
Droncit ®	PO	3+6 mg/kg	
L-Ripercol ®	PO	1.8+3.6+5 mg/kg	
WOUND TREATMENT			
Aureomycin spray ®	TOP		
OTHERS			
Zinc ointment	TOP		
Stesolid ®	A	0.3 mg/kg	
Seavit ®	PO	2 dd/1 tablet	
Paraffin oil	PO	1-3 dd/10 ml	
O.r.s. ®	PO	2 dd/16 gr/0.6 l	
Isogel ®	PO	2 dd/1-2 gr	

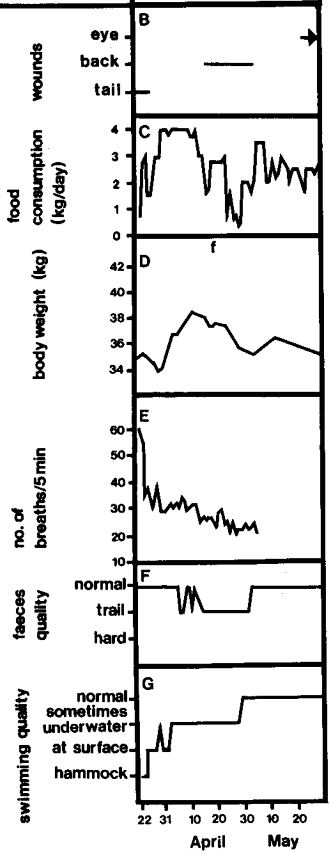

Figure 10. Harbour porpoise 014.
(A) Medication (PO = oral; A = anal; TOP = topical; I = injected in muscles).
(B) Healing of wounds.
(C) Daily food consumption (f = force-feeding).
(D) Body weight.
(E) Respiration rate.
(F) Faeces quality.
(G) Swimming quality.

Table 6. The blood parameters of Harbour porpoise 014

Parameter	Unit	Date		
		29-03 arrival	05-04	28-04
Haematology:				
Sedimentation in 10 min	mm	0	0	0
Sedimentation in 20 min	mm	0	0	0
Sedimentation in 30 min	mm	0	1	0
Sedimentation in 60 min	mm	0	2	0
PVC	l/l	0.69	0.53	0.62
Haemoglobin	mmol/l	14.2	11.6	12.4
Erythrocytes	$\times 10^{12}$/l	7.7	6.0	6.8
Leucocytes	$\times 10^{9}$/l	6.2	5.8	6.0
Bas.	%	—	0	0
Eos.	%	—	8	13
Band cells	%	—	0	0
Seg.	%	—	61	55
Lym.	%	—	30	32
Mon.	%	—	1	0
Serum chemistry:				
Na	mmol/l	154	154	155
K	mmol/l	8.3	3.0	3.2
Ca	mmol/l	1.37	2.55	2.31
Fe	µmol/l	—	—	36
Fe-binding cap.	µmol/l	—	—	109
Phosphate	mmol/l	1.61	1.54	—
yGT	U/l	—	290	131
AP	U/l	53	339	249
SGOT	U/l	244	1920	23
SGPT	U/l	157	970	270
LDH	U/l	1295	2470	1371
CPK	U/l	458	422	300
Total Bilirubin	µmol/l	—	7	—
Uric acid	mmol/l	—	0.02	—
Urea	mmol/l	277	144	166
Creatinin	µmol/l	107	55	40
Total protein	g/l	79	73	75

Digestion

Like animals 012 and 013, this animal developed constipation, and the problem was solved by administering paraffin oil and later by giving Isogel (R) in capsules in the fish (Fig. 10A and F).

Respiration rate

The respiration rate was high during the first 5 days after arrival (Fig. 10E), but decreased later and levelled off around 20 inhalations per 5 minutes.

Body weight and body measurements

The animal measured 139 cm and weighed 29.0 kg when it arrived on March 28. On May 17 his weight had increased to 32 kg and he had a body length of 139 cm (Fig. 10D).

Behaviour

The animal only had to stay in the hammock for 2 days after he arrived at the park (Fig. 10G). After that, he swam at the surface for 2 days and then started to dive periodically. His swimming behaviour was normal 26 days after arrival at the park.

Each time, when animal 013 had to be taken out of the water for treatment or weighing, animal 014 forcefully swam above his poolmate and showed, what looked like, sexual behaviour. A penis erection was also often observed when the animal was handled by the keepers (Fig. 11).

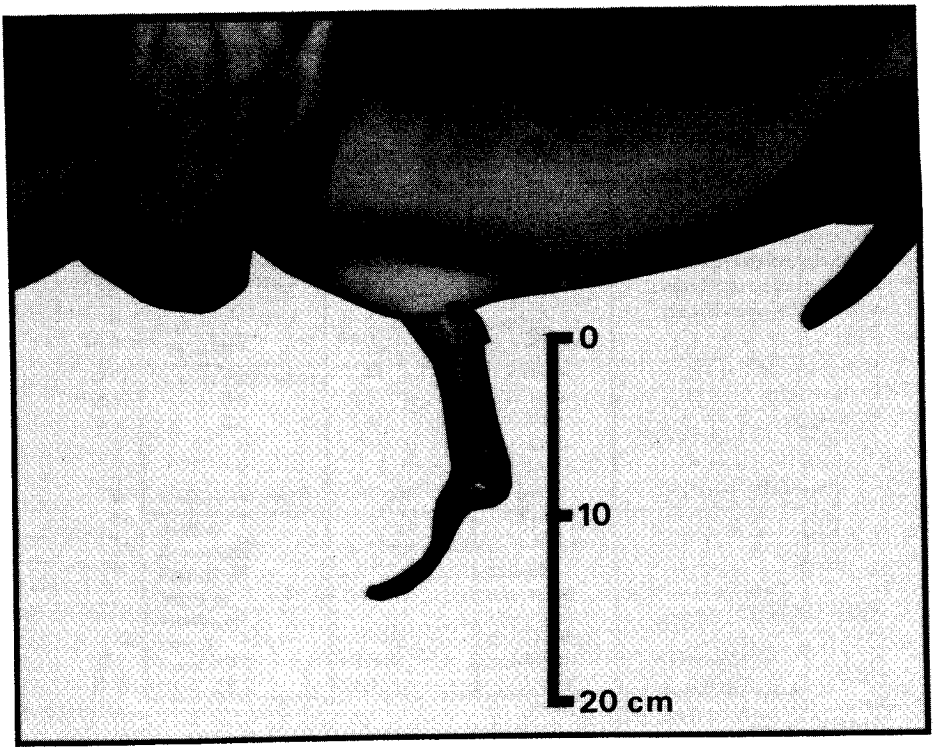

Figure 11. The penis erection of animal 014 during handling.

The animal was declared healthy on 17 May 1988 after which medical treatment was stopped on that date.

Discussion and conclusions

Cause of stranding
Although nothing can be said with certainty, the sharp cuts in the tail-stocks of animal 012 and 013 seem to indicate entanglement in fishing nets. Maybe the animals inhaled water during the entanglement and/or were afterwards unable to catch fish because of the pain in their tail-stock. The fact that màny Harbour porpoises are drowned or injured in fishing nets has been documented by several authors (Andersen, 1966, 1974*b*, 1978; Smith *et al.*, 1983; Gaskin, 1984). Such accidents are probably the main threat to this species.

Area of stranding
During the period in which these 3 Harbour porpoises were stranded, 5 more, but dead, Harbour porpoises were stranded on the Dutch coast (Smeenk, 1988). All animals in the present study came from the same area on the north coast of Holland. This is an area in which a relatively high density of Harbour porpoises is seen during aerial surveys (Baptist, 1988). The animals probably drifted towards the same area on the coast in a particular current. The idea of them passively drifting to the beach is supported by observations in the circular pool. In the beginning, when the animals were just fit enough to be taken out of the hammock, they could not swim against the weak circular current in this pool.

Treatment
Stress of capture and/or first contact with humans can cause illness to cetaceans in some cases (Dudok van Heel, 1962; Stuntz & Shay, 1979). Andersen (1974*b*) reports that many Harbour porpoises died during transport from the fishing nets to the holding facility. Therefore the animals in this study were given Stesolid (R) *per rectum* to reduce stress prior to transport. This drug was successfully used by Krabbe (1987) on Harbour porpoises that were accidentally caught in fishing gear in Danish waters. It is also important to be gentle with the animals during transport and treatment (Bain, 1981).

Animal 014 died of an infection of *Erysipelothrix rhusiopathiae*. This disease was previously suspected in Harbour porpoises by Andersen (1974*b*), and can be successfully treated with penicillin and semisynthetic penicillins if diagnosed soon enough (Ridgway, 1972).

However, animal 014 did not give any warning except for a reduction in food intake the day before death. The total PCB concentrations in the fat (8.99 ppm), liver (8.55 ppm), muscle (9.20 ppm) and kidney (7.22 ppm) tissue were very low, and could not have affected the health of the animal (Reijnders, 1989).

The fact that the 3 animals were treated in the same pool was probably a very positive factor that increased the chances of survival. It is our experience that dolphins are usually calmer when they are put into a new environment in pairs. Bain (1981) discussed the successful rehabilitation of 1 stranded Common dolphin (*Delphinus delphis*) and 2 Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and noted that the treatment of the animals in the same tank was probably the main factor in their recovery.

Parasites

Some lungworms were still present at the time of the necropsy on animal 014. In the future, Harbour porpoises carrying lungworms should be treated daily with Droncit (R) for at least 2 months (starting with 0.5 mg/kg during the first week, then 3 weeks 1 mg/kg, later 2 mg/kg) in order to remove all lung worms (Neurohr, 1988).

The lung nematode *Pseudalius inflexus*, and the liver trematode *Campula oblongata* seen in the present study were the same ones as found by Andersen (1966, 1974*b*) in Harbour porpoises from Danish waters and by Balbuena *et al.* (1987) in French waters.

Blood samples

Usually it is not difficult to obtain a blood sample from the ventral side of the tail fluke of Harbour porpoises. The sample is taken from the centre of a fluke where there are both arteries and veins (Elsner *et al.*, 1974). Usually, putting the animal back into the water is enough to stop bleeding after sampling. Through vasoconstriction the blood pressure then drops, and the bleeding stops.

The values of the blood parameters of the 3 recovered Harbour porpoises in the present study were within the ranges reported by Andersen (1966) and Nielsen & Andersen (1982).

Wound healing

This study showed that even severe wounds can heal well in Harbour porpoises. Even the large abdominal wound of the young animal 012 left virtually no scars after treatment. Often the wounds heal, but the pigmentation will usually not return. This lack of pigment will always remain an indicator of an old wound. Scars were mainly found on adult Harbour porpoises by van Utrecht (1959). Corkeron *et al.* (1987*a,b*) described large wounds and scars on Bottlenose dolphins (*Tursiops truncatus*) which were caused by sharks and by other dolphins. Greenwood *et al.* (1974) also noted that even deep wounds in cetacean skin heal remarkably quickly, provided the wound does not gape. The wound on the tailstock of animal 012 gaped, so the underlying tissue had to be cauterised daily to prevent granular overgrowth.

The skin of the stranded Harbour porpoises started to slough one day after arrival at the park. This was probably due to several factors: (1) on the beach the upper skin of the animals became dehydrated and over-heated, (2) the animals were put into an environment with perhaps a slightly different salt concentration from the North sea water (although the salt concentration also varies in different parts of the North sea), and (3) the animals were put into chlorinated water. Spotte *et al.* (1978) also noticed sloughing of the skin on the dorsal surface of a stranded Harbour porpoise that recently arrived at their facility. Harrison & Thurley (1974) showed that rapid drying of the surface of the skin causes a change in the superficial cells of the *stratum externum*, creating a denser layer which is the *stratum corneum*. They observed similar changes when a dolphin was put into fresh water for a few days. After a week the skin of the animals in the present study had sloughed and a new shiny skin had appeared.

Food consumption

Feeding was done in 4 stages:

(1) force-feeding out of the water,
(2) force-feeding while constrained in the water,
(3) free-feeding in the water, and
(4) feeding from the hand.

For the first few days, the animals were fed out of the water when they had to be investigated and medication had to be administered. However, feeding is usually easier for the animal in the water. After some practice one person can force-feed a Harbour porpoise in the water. The method becomes less stressful for the animal as it gets used to the process. In order to help the animal to make the transition from force-feeding to free-feeding, the food intake was reduced for several days. This technique was successfully used by Andersen (1974*a*) when he was rearing young (normally suckling) Harbour porpoises. Andersen & Dziedzic (1964) report that healthy Harbour porpoises started accepting fish from the hand one hour to a week after arrival in a pool.

In order to regain a normal body weight the animals ate more during the early stages of recovery. Later their food intake dropped and stabilized. This change in food intake was also observed by Bain (1981) during the rehabilitation period of a Common dolphin (*Delphinus delphis*) and 2 Pacific White-sided dolphins (*Lagenorhynchus obliquidens*). At the end of the recovery period the animals in the present study had the following food intake per day (expressed as percentages of the total body weight):

Animal 012 (young, still growing): 10.4%
Animal 013 (adult, not growing) : 7.8%
Animal 014 (adult, not growing) : 8.1%

The young female 012 which was still increasing in weight and length, had a relatively high food intake compared to the adult males. In the wild, this animal had probably just started to shift from mother's milk to solid food, since after its recovery it weighed around 25 kg. In the Baltic, Harbour porpoises begin to take solid food when they are about 5 months old and weigh around 25 kg (Møhl-Hansen, 1954). Myers *et al.* (1978) mention a growing female Harbour porpoise, kept in a 19°C pool, with a daily food consumption of 10.8% of the body weight. This corresponds well with the energy consumption of the female in the present study. Andersen (1965) reports on the food consumption of 8 Harbour porpoises that were kept in an indoor pool (no temperature reported) and that were fed Herring, as in the present study. He found that the adult animals consumed around 8% of their body weight a day, whereas the still growing animals ate around 13% of their body weight a day. Yasui & Gaskin (1987) suggest that a non-lactating adult Harbour porpoise would require about 3.5% of its total body weight per day. This does not seem to be correct, since the animals in the present study were housed in a small pool with relatively warm water (17–20°C) and were fed fish with a relatively high caloric content. Therefore, the daily food intake of adult animals in the wild, which can swim (energy costing) distances of up to 20 km per 24 hours (Read & Gaskin, 1985), should be higher than 8% of the total body weight.

Because of the unfavourable body surface to volume ratio, Harbour porpoises lose much energy through radiation and conduction. To survive in a medium that conducts heat better than air, Harbour porpoises have a relatively thick blubber layer compared to other cetaceans, and a relatively high metabolism compared to other mammals of their size (Kanwisher & Sundnes, 1965). As a comparison: a 1900 kg female Killer whale (*Orcinus orca*) kept at the Harderwijk Marine Mammal Park on a diet with a lower caloric content than the Harbour porpoises in the present study, consumed only 2.3% of her body weight per day (Kastelein & Vaughan, 1989).

The introduction of live fish into the pool somehow triggered the feeding instincts of animal 014. Strangely, the animal suddenly accepted dead fish during the same feeding session. Spotte *et al.* (1978) had a very similar experience when feeding 5 cm long live Mummichogs (*Fundulus heteroclitus*) to a stranded Harbour porpoise. This animal also started to accept dead fish after an encounter with live prey. Andersen (1976) warns that feeding live fish may postpone the transition to eating thawed fish. This was possibly just a hypothesis unsupported by observations. The animals in the present study did not eat flatfish (Plaice). This has also been previously reported by Verwey (1975). Dudok van Heel (1962) offered freshly killed Eelpout (*Zoarces viviparus*) and Flounder (*Platichthus flesus*) to Harbour porpoises; both species were refused. Andersen & Dziedzic (1964) report on Harbour porpoises that ate live Herring and live Eel (*Anguilla anguilla*). Animals 012 and 014 accepted 20 cm long live Cod, whereas Andersen & Dziedzic (1964) report of Harbour porpoises that swam together with Cod for two months without touching them. Maybe these Codfish were too large to swallow for Harbour porpoises. The animals in the present study were mainly fed on dead Atlantic Herring, which is a major prey species of Harbour porpoises in the Atlantic (Dudok van Heel, 1962; Smith & Gaskin, 1974; Gaskin & Watson, 1985; Watts & Gaskin, 1985). Rae (1965, 1973) notes that the fish eaten by Harbour porpoises in Scottish waters was predominantly pelagic or semi-pelagic, and that most fish were less than 25 cm long.

Digestion

The fact that all three animals showed constipation was probably due to a lack of roughage of the fibres in the thawed fish. Isogel (R) solved the constipation problem much better than paraffin oil. It also made the pool surface, pool side and working area less slippery, since some of the oil-filled fish were regurgitated during force-feeding.

Body weight and body measurements

The males 013 and 014 increased in body weight during the recovery period. This was due to an increase of the fat layer thickness and not to a growth in length, since both animals were mature. That an adult animal can change dramatically in weight, was also observed by Spotte *et al.* (1978). They report on a stranded Harbour porpoise which increased in weight from 27 kg to 42 kg without changing in length (148 cm). Adult animals of the same length can have a weight difference of 25 kg (Møhl-Hansen, 1954). The blubber layer (the epidermis included) of Harbour porpoises from Danish waters can be 45% of the body weight (Slijper, 1958).

The young female 012 grew a great deal both in weight and in length. Her maximum growth rate was 0.24 kg a day during a period with an average food intake of 3.5 kg a day. According to van Utrecht (1978) female Harbour porposes have a slightly higher growth rate than the males. In the North sea, males reach their maximum length around the age of 10 years (average: 146 cm) and females (average:

170 cm) around the age of 14 years (van Utrecht, 1978; Gaskin *et al.*, 1984).

Respiration rate

The respiration rate of most odontocetes increases during illness (Bain, 1981). This was also the case with animals 013 and 014 in the present study. Their respiration rates shortly after arrival at the park were almost double the rate they showed after recovery. Animal 012 showed a respiratory rate increase during the period of extreme food intake followed by a fast growth. The average respiratory rate of the female was higher than that of the older males. This was probably due to her age.

A study on the heart rates of these animals (Kastelein & Meijler, 1989) showed respiratory arrhythmia and an increase in average heart rate during the recovery period of animals 012 and 014 as they became more alert. The heart rate of animal 013 was relatively low compared to the other two. This was probably due to his larger body weight. Andersen (1969*a*) also observed arrhythmia in the heart rates of Harbour porpoises due to respiration. So in dolphins, an irregular heart beat is not a sign of illness as was suggested by Dudock van Heel (1962).

An average respiration rate of around 4 breaths a minute for Harbour porpoises has been observed by several authors (Parker, 1932; Andersen & Dziedzic, 1964; Andersen, 1976; Spotte *et al.*, 1978 and Meyers *et al.*, 1978). These values are roughly the same as in the animals in the present study, after recovery. The breathing rate seems low compared to terrestrial mammals, however, the ventilation in cetaceans is more effective. The tidal volume of a 26 kg Harbour porpoise is 1.85 litres containing 9% oxygen after expiration, compared to 0.4 litres in a 100 kg man containing still 16% oxygen after expiration (Kanwisher & Sundnes, 1964).

Behaviour

A few weeks after the animals had been put into the rectangular pool, the dorsal fins of all 3 animals started to bend laterally to the left. This had not happened in the circular pool, and it was probably due to the shape of the pool. The animals usually swam anti-clockwise in both pools when they were not interacting. However, in the rectangular pool the animals could increase their speed on the long side of the pool and then had to make a relatively sharp bend to swim along the short side. The increased drag during this curve probably forced the dorsal fin to bend. Andersen & Dziedzic (1964) also report on the inclination of dorsal fins of Harbour porpoises after they have been in a pool for some time. This phenomenon was also observed in a lactating Bottlenose dolphin (*Tursiops truncatus*) by Neurohr (1989). The animal usually showed an irregular swimming pattern, but during lactation she swam anti-clockwise most of the time. During that period her dorsal fin started to bend to the left. The dorsal fin contains no bones, and gets its stiffness from connective tissue and probably also from blood pressure in the circulatory system (Elsner *et al.*, 1974). Changes in dorsal fin posture are probably temporary, and depend on the circumstances.

After the animals in this study had fully recovered from their illnesses, they started to interact with each other. Most of the interactions seemed to be sexual. Fisher & Harrison (1970) found a seasonal testicular activity, reaching a maximum during July and subsiding in late August. Because of these interactions the animals in the present study did not spend much time performing stereotyped motor patterns such as monotonous circle swimming. If stereotyped behaviour appears, it can be dealt with by increasing human attention (Kastelein & Wiepkema, 1988), by increasing the number of poolmates, or by introducing occupational therapies (Amundin, 1974; Markowitz, 1982; Kastelein & Wiepkema, 1989).

Animal 014 often started to swim above animal 013 when keepers went into the water to catch animal 013 for treatment or feeding. Whether this was succorant behaviour (care given to distressed individuals) was not clear, since animal 013 was pushed down. Anderson (1969*b*) reports of succorant behaviour of only one of 30 Harbour porpoises in his laboratory.

Acoustics

Although the social calls and most echolocation calls of Harbour porpoises are within the human hearing range (Busnel *et al.*, 1963; Busnel & Dziedzic, 1966), the sounds emitted underwater by the animals in the present study were never heard by the researchers in the air. This is in contrast with Bottlenose dolphins (*Tursiops truncatus*), Killer whales (*Orcinus orca*) and False Killer whales (*Pseudorca crassidens*). The underwater social and (the audible part of) the echolocation calls of these species are often heard in air at the Harderwijk Park. The sound pressure level of the social sounds of Harbour porpoises is probably lower than those of the formerly mentioned cetaceans. This has also been reported by Schevill *et al.* (1969) who estimate Harbour porpoises to have a weak source sound pressure level of less than 1 dyne per cm^2.

Labour

Because of the usually bad health condition of stranded cetaceans, treatment is often labour-intensive. In most cases it is necessary to have round-the-clock watches to observe the animals and to give medical treatment and intervene when necessary. Treatment took 14 man-hours a day during the first 6 weeks of the 3 Harbour porpoises in the present study (excluding night watches). Andersen (1974*a*) reported that it was a full time job for one man to take care of a suckling Harbour porpoise.

Reintroduction to the wild

The animals were first scheduled to be returned to the wild in June 1988. However, in that period many Harbour seals (*Phoca vitulina*) were dying in the North sea from a Phocine Distemper Virus infection (Osterhaus & Vedder, 1988). The Harderwijk Park was advised not to release the Harbour porpoises until a vaccine had been developed for the porpoises. In September the vaccine became available, and the animals were vaccinated twice in mid October. Unfortunately animal 014 died suddenly on 5 October 1988 before vaccination. The only warning sign of illness was one day of anorexia. The necropsy and bacterial culture showed that the animal was infected with *Erysipelothrix rhusiopathiae*. However, because this animal died of a disease which was not related to the cause of stranding, the medical treatment presented in the present study for the initial problems after stranding can be considered successful. On 16 November 1988 the remaining two animals were released in an area of the North sea with a relatively high density of Harbour porpoises (15 km north of the Dutch island Terschelling).

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