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Foreign bodies in the stomach of a female Harbour porpoise (*Phocoena phocoena*) from the North Sea

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Summary

The medical treatment of a 4-year-old female Harbour porpoise which was stranded on the Dutch coast is described. The animal was emaciated on arrival at Harderwijk, and survived for 3 days. During those days the animal regurgitated foreign objects including a large plastic bag, fishing line and algae. Necropsy showed that the animal had 2 large ulcers in the forestomach, and several organs were heavily infected with parasites. Several tissues were examined for heavy metal content, and high levels of mercury were found in the liver and kidneys, but these levels are probably not toxic for marine mammals. The concentrations of total PCB and DDT were relatively low, and these compounds could not have caused death. A virus neutralization antibody titer against a porpoise morbillivirus was found in the blood. Several possible events leading to the animal's death are discussed.

Key words: *Phocoena*, Cetacea, foreign bodies, polychlorinated hydrocarbons, heavy metals, cadmium, lead, mercury, stranding, porpoise morbillivirus, pollution.

Introduction

On 5 June 1991 an adult female Harbour porpoise (*Phocoena phocoena*) was stranded on the Dutch coast near Castricum. She was aged at 4 years by counting growth rings in the central teeth of the lower jaw (4 GLG's in the dentine but with many accessory lines; the cementum had 5–8 layers). The animal (code PpSH025) was transported to the Harderwijk Marine Mammal Park, which is the rehabilitation centre for cetaceans stranded on the Dutch coast (Kastelein *et al.*, 1990). On arrival (day 1) the animal was emaciated (standard length 163 cm; weight 45.9 kg), but had no external injuries other than old scars on the tail fluke and dorsal fin (Fig. 1). There was a healing wound on the tongue. A blood sample was taken. Compared to healthy porpoises the animal had low values of haemoglobin (7.2 mmol/l), haematocrit (0.34 l/l), leucocytes (4.3×10^9/l), and alkaline phosphatase (26 U/l). The animal was treated with antibiotics (Amikacine-sulphate) and, judging from the blood values, the animal seemed to have a reasonable chance of survival. She had to be force-fed, but showed little resistance to the procedure. On day 1 the animal defecated several times and the green colour and consistency were normal for Harbour porpoise faeces. To rest, the animal was placed in a hammock several times each day. She regurgitated a few times on days 2 and 3, releasing part of her food, some plastic and what appeared to be plant material. On day 3 the animal died. This report focuses on the regurgitated materials, the heavy metal and polychlorinated hydrocarbon levels in the tissues, the parasites and other necropsy findings.

Results

Regurgitated materials
The animal regurgitated the following materials (Fig. 2): the remains of a plastic bag (588 cm^2; 10.5 g), a mixture of hydroid polyps and nylon fishing line (4 g), a banana peel (6.5 g), sedentary polychaete tubes (*Chaetopterus variopedatus*; 7 g) and undigested parts of Bladder wrack (*Fucus vesiculosus*; 31 g).

Heavy metal and polychlorinated hydrocarbon concentrations
The heavy metal concentrations in several tissues are shown in Table 1. The most noticable figures are the high levels of mercury in the liver and kidney. The polychlorinated hydrocarbon concentrations in the body fat are shown in Table 2. PCBs were analysed as individual congeners with capillary gas chromatography. The 29 congeners found, are summed to get the total amount of PCB.

Parasites
The Harbour porpoise was heavily infested with parasites. Trematodes were found in the hepatic ducts (*Campula oblongata*) and in the wall of the pyloric stomach (*Braunina cordiformis*) (Fig. 3). The

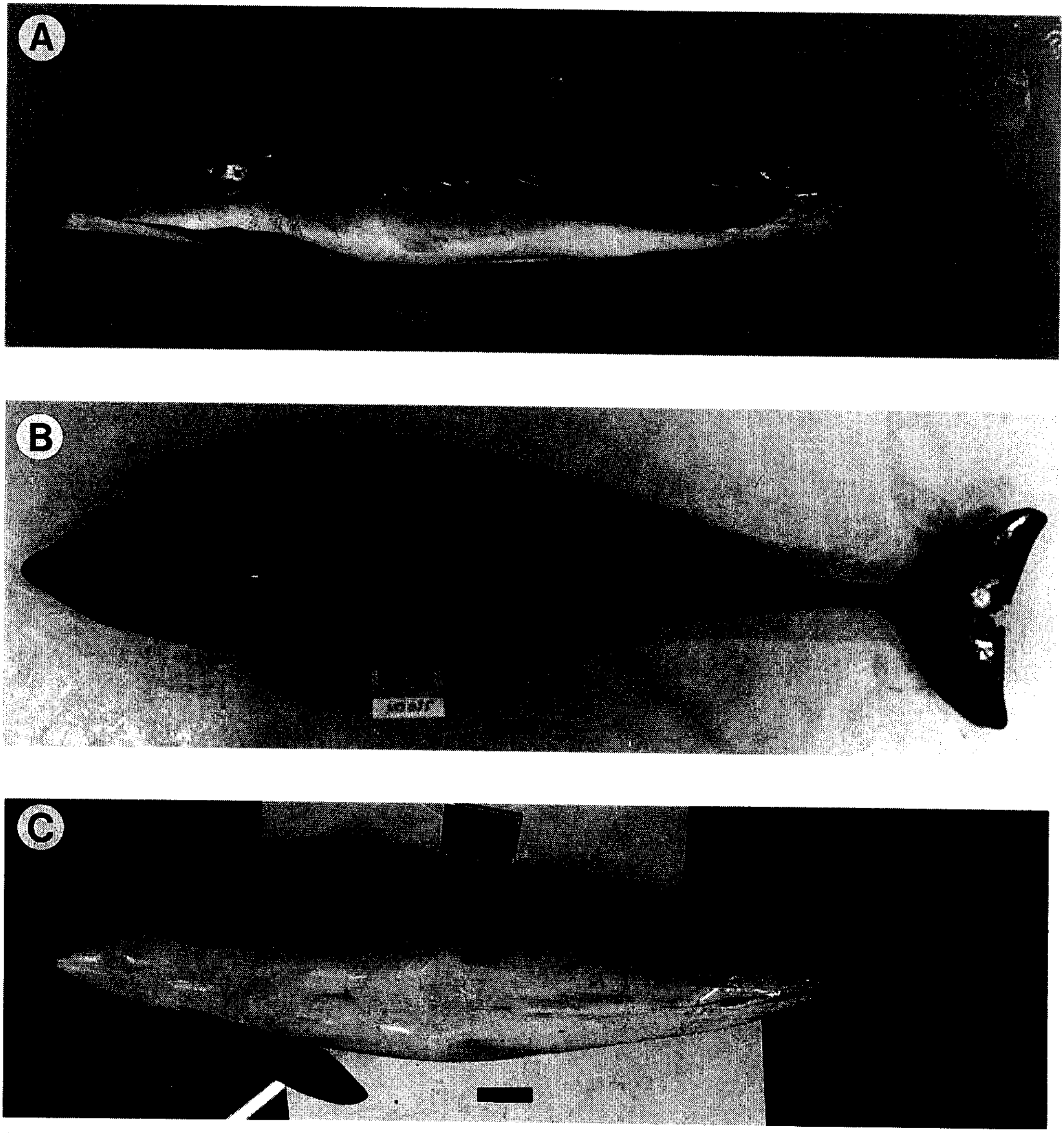

Figure 1. The 4-year-old female Harbour porpoise. A) Side view, B) dorsal view, C) ventral view. Note the scars on the dorsal fin and tail fluke. The bar indicates 10 cm (Photos: Ron Kastelein).

lumen of the forestomach contained Herring worms (*Anisakis simplex*). Nematodes were found in the trachea (*Pseudalius inflexus, Torynurus convolutus* and *Halocercus invaginatus*), lung (*Pseudalius inflexus*) (Fig. 4), arteria pulmonalis (*Pseudalius inflexus*), and in the right ventricle of the heart (*Pseudalius inflexus*).

Viruses

Presence of serum-specific antibodies against porpoise morbillivirus (PMV) was tested for in a virus neutralisation (VN) assay. In this assay, a VN antibody titer of 80 could be detected. A suspension of 10% lung homogenate was prepared and tested for the presence of morbillivirus antigen in an antigen capture enzyme linked immunosorbent assay (ELISA). In this system, the presence of morbillivirus antigen could not be demonstrated.

Physical condition

Due perhaps to the large number of lung worms, the lung tissue was tougher than usual. Thrombosis had

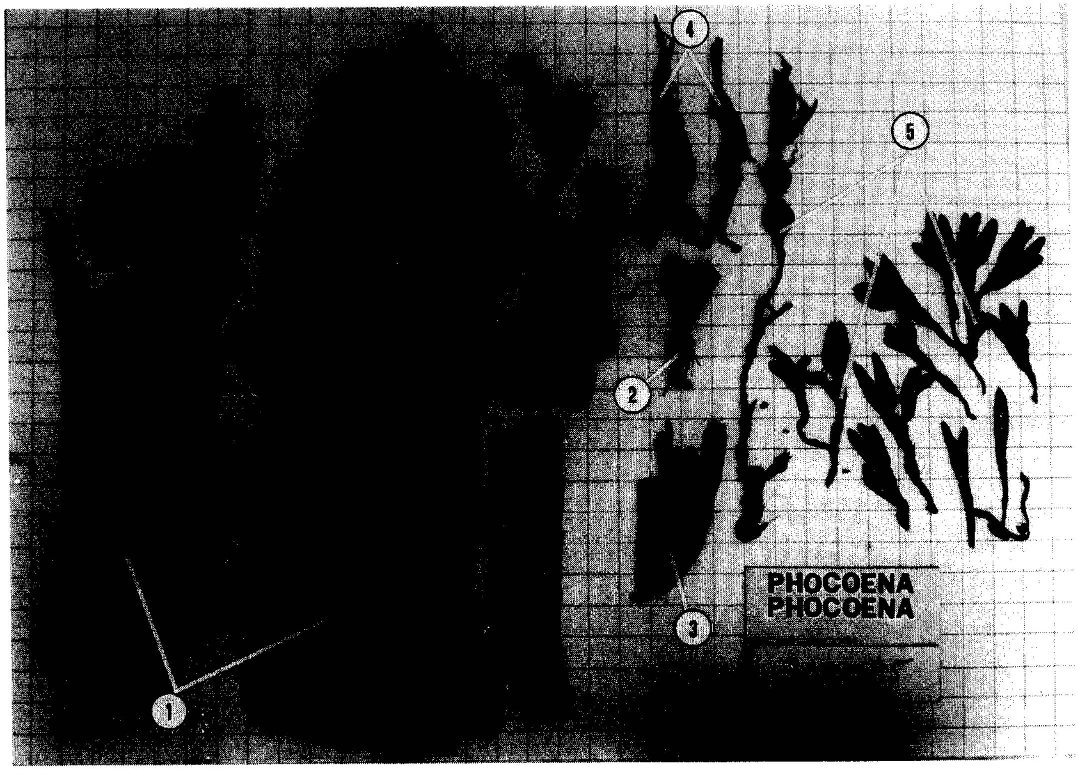

Figure 2. The regurgitated contents of the forestomach. 1) Remains of a plastic bag, 2) hydroid polyps and nylon fish line, 3) banana peel, 4) sedentary polychaete tubes (*Chaetopterus variopedatus*), 5) Bladder wrack (*Fucus vesiculosus*). Background grid: 2 x 2 cm (Photo: Ron Kastelein).

Table 1. Heavy metal concentrations in tissue samples from the 4-year-old female Harbour porpoise and the lawful maximum heavy metal levels for edible parts of animals produced by the Dutch food industry in 1991. In the vertebrates, the muscle is the part eaten.

Harbour porpoise tissues:	Cd (mg/kg)	Pb (mg/kg)	Hg (mg/kg)
Adipose tissue	0.010	<0.05	0.076
Liver	0.10	0.26	19.3
Kidney	0.032	<0.05	2.1
Food industry limits:			
Cow, pig and chicken	0.05	0.3	0.05
Predatory fish	0.05	0.5	1.0
Herring, Mackerel and Sprat	0.05	0.5	0.5
Crustaceans	0.3	0.5	1.0
Molluscs	1.0	2.0	0.5

Table 2. The polychlorinated hydrocarbon concentrations in the body fat of the 4-year-old female Harbour porpoise. o = orto, p = para.

Chemical	Concentration (ppm on lipid base)
Total PCB	8.96
Total DDT	5.17
DDT components:	
pp DDE	2.43
pp DDD	1.08
op DDT	0.32
pp DDT	0.96
HexaChloroBenzene	0.18
Trans Nonachlor.	0.66
Dieldrin	0.91

occurred in the large lung arteries, and the animal had pulmonary pneumonia. Due to the liver flukes, the bile ducts in the liver were dilated and their walls were thickened. The forestomach had 2 large ulcers (Fig. 3B). The ovaries were unequal in size, and the single rupture point indicated that the animal had ovulated once (Marsh & Kasuya, 1984).

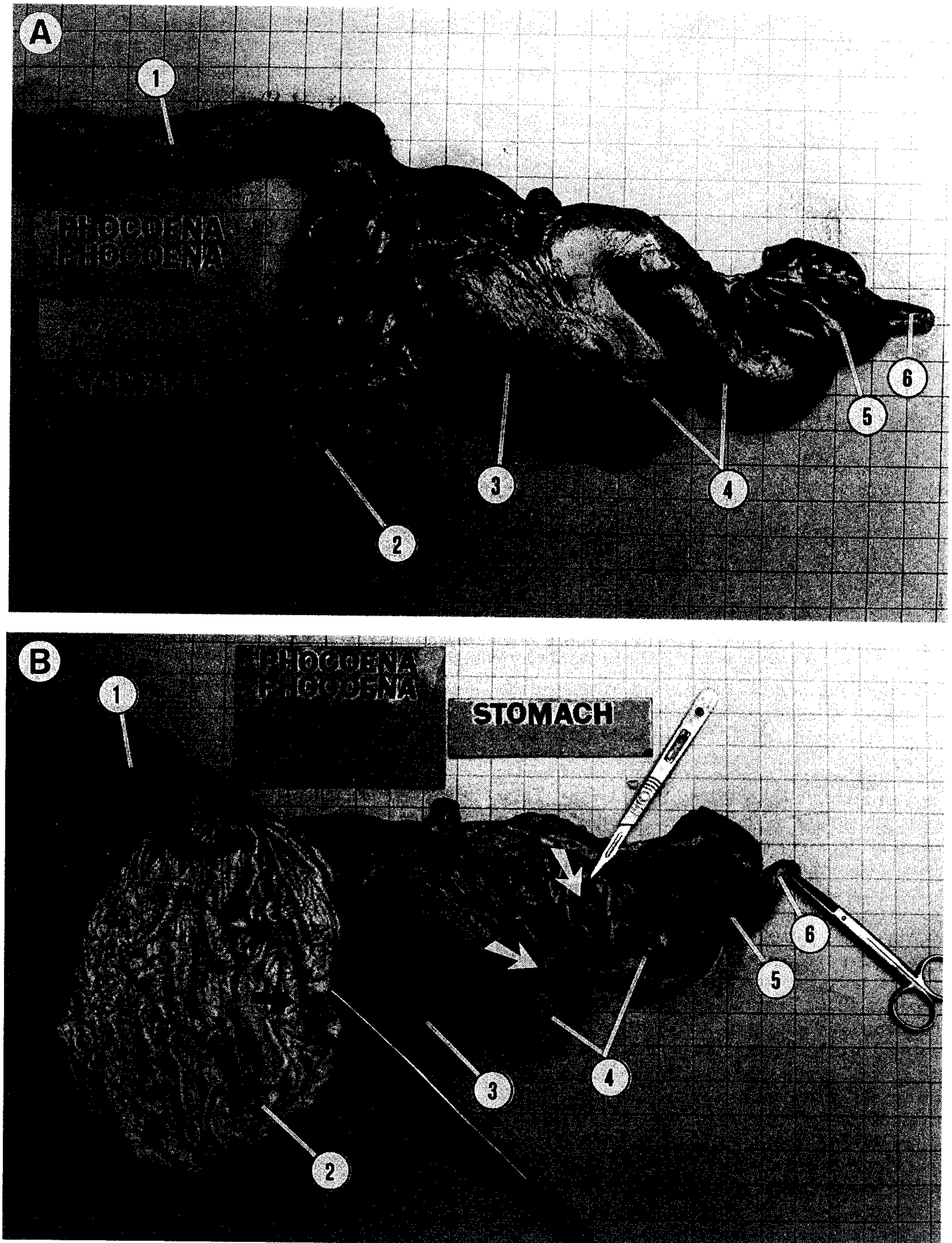

Figure 3. Side view of part of the digestive tract of the 4-year-old female Harbour porpoise. A) Intact stomachs. B) Dissected stomachs. 1) Oesophagus, 2) Forestomach, 3) Fundic (main) stomach, 4) Pyloric (connecting) stomach, 5) Duodenal ampulla, 6) Duodenum. The black arrows indicate ulcers in the forestomach. The white arrows indicate trematodes (*Braunina cordiformis*) in the pyloric stomach. Background grid: 2 × 2 cm (Photos: Ron Kastelein).

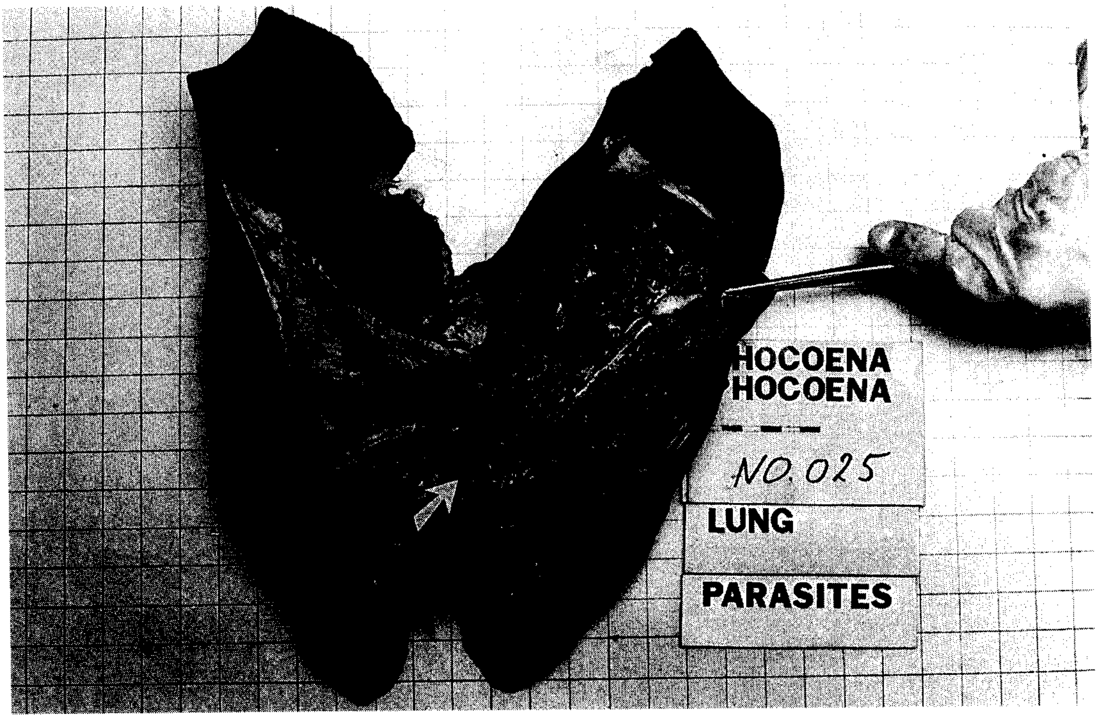

Figure 4. Ventral view of the lungs of the 4-year-old female Harbour porpoise. The arrow indicates large numbers of lung worms (*Pseudalius inflexus*) in the right bronchus. Background grid: 2 x 2 cm (Photo: Ron Kastelein).

Discussion

The highest concentrations of mercury were found in the liver and to a lesser extent in the kidney. These levels are similar to those found in Harbour porpoises of the same age class in the Bay of Fundy, Canada (Gaskin *et al.*, 1979) and to those found in 1- to 3-year-old Harbour porpoises in Danish waters (Andersen & Rebdorff, 1976). However, the mercury level in the blubber of the animal in the present study is lower than concentrations found in 1- to 3-year-old Harbour porpoises from Danish waters (Andersen & Rebdorff, 1976). The relatively low mercury levels in the animal of the present study compared to levels reported in other studies (Wagemann & Muir, 1984) are at least partly explained by the young age of the animal. When animals grow older, they start to accumulate more mercury in their tissues (Gaskin *et al.*, 1979). The liver is a storage and detoxification organ for mercury, and the level in the liver was much higher than the lawful maximum in animal products for human consumption in The Netherlands (Table 1). However, mercury in the livers of marine mammals is probably stored in such a way that its toxicity to the animals is low. Mercury found in marine mammals may not only come from human pollution, since high mercury levels are also found in pinnipeds from the Antarctic. The presence of mercury in their natural environment may explain why marine mammals are better adapted than terrestrial mammals to cope with high mercury levels in their tissues.

The PCB level found in the body fat of this animal was very low. Higher levels have been found in young Harbour porpoises in northern Norwegian waters (Elze de Ruiter-Dijkman, pers. comm.), and in the blubber of 1- to 3-year-old Harbour porpoises from Danish waters (Andersen & Rebdorff, 1976). The PCB concentration in the blubber of Harbour seals (*Phoca vitulina*) from the Dutch Wadden Sea is on average much higher (about 100 ppm). The levels of the other polychlorinated hydrocarbons found in the present study are also much lower than those found in the blubber of 1- to 3-year-old Harbour porpoises from Danish waters (Andersen & Rebdorff, 1976). The ratio of total PCB:total DDT is similar to that found in Harbour porpoises from Danish waters (Elze de Ruiter-Dijkman, pers. comm.).

The blood contained some antibodies against the porpoise morbillivirus, indicating contact with the virus at some time during the animal's life. However, there was no infection at the time of stranding.

The information above suggests that the animal in the present study did not succumb to high levels of toxic chemicals or a virus infection. There are at least two other explanations for the animal's poor physical condition and the presence of the foreign bodies in its stomach. One is that the animal swallowed a plastic bag, possibly because of its flavour. Toothed whales have a well-developed gustatory system (Nachtigall, 1986; Kuznetzov, 1990), and the presence of the banana peel suggests that the bag was a waste bag which may have contained more organic matter. Plastic bags may also be swallowed accidently simply due to dolphins' investigatory behaviour and are often found in stomachs of stranded dolphins. The plastic bag filled a large part of the forestomach (compare Fig. 2 with Fig. 3), and must have blocked the passage from the forestomach to the main stomach frequently, possibly causing stomach pain and eventually ulcers. The animal may then have eaten the algae in the same way that many terrestrial carnivores eat vegetation when their food supply is reduced or to induce vomiting (Beaver, 1981; Meyer, 1983). The fact that the algae were not digested at all after having been in the forestomach for at least 3 days suggests that they are not part of the normal diet of healthy Harbour porpoises. The stomach problems may have led to weight loss, weakening, proliferation of the parasites, and eventually stranding. This scenario is supported by the fact that the animal produced normal faeces on day 1, showing that she ate at least some food on the day before stranding.

It seems unlikely that the animal had misidentified the plastic bag as prey, unless it contained organic matter, since Harbour porpoises mainly eat fish. Plastic bags are often found in the stomachs of animals which eat jellyfish, such as some marine turtle species, and squid-eating toothed whales, such as Pilot whales (*Globicephala* sp.). It is presumed that these animals misidentify floating plastic bags as edible prey.

A second possible explanation is that the animal was weakened by lung parasites, and rendered incapable of catching enough fish. This stress may have caused ulcers in the forestomach. As a substitute for fish, the animal may have started to eat whatever it encountered; the waste bag, algae and the polychaete tubes (which perhaps contained worms).

Harbour porpoises are frequently seen along the Dutch coast, but also at and around the Frisian Front (Baptist *et al.*, 1990). This area is located between 53°30′N, 4°E and 54°N, 5°E and has an exceedingly rich benthic and bottomfish fauna (de Gee *et al.*, 1991). The presence of tubes of the polychaete *Chaetopterus variopedatus* in the stomach contents makes it highly probable that the porpoise visited the Frisian Front and Oyster Ground (54°30′N, 4°30′E) shortly before it stranded. This polychaete lives in large numbers at these areas, and is rare in the rest of the southern North Sea (Duineveld & Moodley, 1991). The sedentary polychaete, which can reach a length of 20 cm, lives in a parchment-like tube buried down to a depth of over 30 cm in muddy sediment. Although the tube may be visible on the sea bed and the worm can produce bioluminescence (Nicol, 1952), the porpoise probably did not attempt to feed on the worm *in situ*. However, because of fishery activity, these tubes could have been torn out of the sediment and released into the water. As the surface current flows north in this area of the North Sea (Eisma, 1987), it is unlikely that the tubes were swallowed near the Dutch coast.

The presence of the Bladder Wrack in the stomach does not give evidence for the porpoise visiting a certain part of the North Sea. Although this common brown algae is restricted to the tidal zone and hard substrate, it can easily become detached and may drift. It is therefore ubiquitous in the North Sea.

The findings of the present study indicate that large debris pollution may be a more directly lethal problem to individual marine mammals than chemical pollution. The latter reduces reproduction rate and longevity to some extent, but may only rarely lead to immediate death.

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