Rupture of a Dissecting Aneurysm of the Pulmonary Trunk in a Beluga Whale (Delphinapterus leucas)

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and total nasal length (abnormal = 28.3 mm; normal = 34.1 mm) were considerably shorter for the abnormal fawn and indicated decreased rostral length. P_1 (first premolar) to occipital condyle also was shorter for the abnormal skull (85.6 mm vs. 90.4 mm). Rostral breadth at P_1, a measure of the swollen frontal bone, was wider for the abnormal skull (41.0 mm vs. 28.2 mm).

The curved rostrum and dentaries may have developed from a nutritional deficiency. Twisted rostrums are characteristic of calcium deficiency, phosphorus toxicity, or atrophic rhinitis (Church and Pond, 1974, Basic Animal Nutrition and Feeding, O and B Books, Corvallis, Oregon, 300 pp.). However, we examined the nasal turbinates and found no evidence of bone resorption. Therefore, we suspect that these anomalies were congenital.

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Rupture of a Dissecting Aneurysm of the Pulmonary Trunk in a Beluga Whale (*Delphinapterus leucas*)

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Aneurysm of the pulmonary trunk is uncommon in mammals and has not been described in cetaceans. In man, it is associated with chronic pulmonary hypertension (Deterling and Clagett, 1947, Am. Heart J. 34: 471–499), bacterial endocarditis, mycotic aneurysm, trauma, Marfan's syndrome and syphilis (Spencer, 1977, Pathology of the Lung, Vol. 2, W. B. Saunders, Philadelphia, Pennsylvania, pp. 579–649). Ruptured aneurysms also occur in primary (idiopathic) pulmonary hypertension (Spencer, 1977, op. cit.). This report describes the rupture of a dissecting aneurysm of the pulmonary artery associated with verminous pneumonia in a beluga whale.

A male beluga whale was found dead and drifting in the St. Lawrence River at 69°20′18″W, 48°21′N on 15 August 1983. It was 4.0 m long. The dorsal blubber was 6.8 cm thick. Based on the presence of 24 concentric dentine layers in the teeth, it was judged to be a young animal (Sergeant, 1973, J. Fish. Res. Board Can. 30: 1065–1090). Blubber, liver and kidney samples were collected in aluminum foil previously rinsed with acetone and they were kept frozen for subsequent determination of residues of chlorinated hydrocarbons.

Tissue specimens were placed in neutral buffered 10% formalin for histologic examination and stained with hematoxy-

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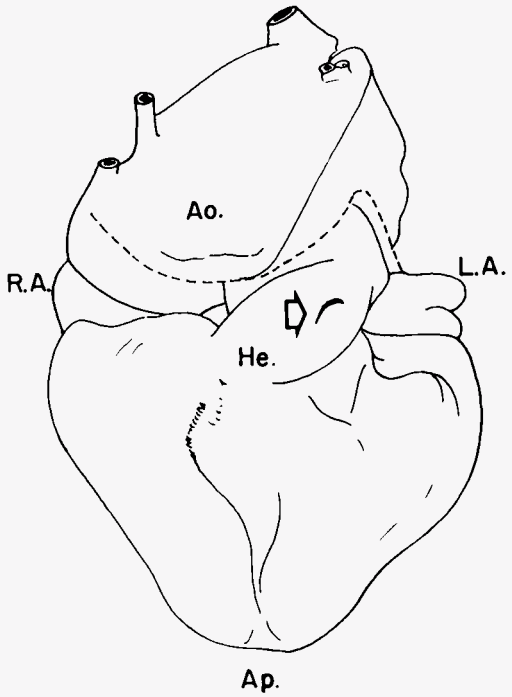

FIGURE 1. Sternocostal drawing of the heart of a beluga whale showing: hematoma (He.) at the base of the pulmonary trunk. The thin distal part of the hematoma was ruptured (arrow). R.A. = right atrium; L.A. = left atrium; Ap. = apex; Ao. = aorta. Line of reflection of serous pericardium is dotted.

lin-phloxine-saffron (HPS). Additionally, lung samples were stained with Verhoeff, Masson's trichrome, Prussian blue and oil red O. The walls of the aneurysm were also stained with Gomori's silver impregnation, Alcian blue, resorcin-fuchsin, picric acid-fuchsin and periodic acid-Schiff (PAS). The atheromatous lesion was stained with oil red O and Verhoeff. Helminths were preserved for identification in a standard formalin-ethanol-acetic acid mixture (AFA) (Manter, 1956, A Laboratory Manual in Animal Parasitology, Burgess Pub. Co., Minneapolis, Minnesota, 121 pp.). Pulmonary tissues were obtained also from seven killed adult normal beluga whales from Nastapooka, Eastern Hudson Bay, Quebec, Canada, as controls. These samples also were placed in neutral buffered 10% formalin and stained with HPS.

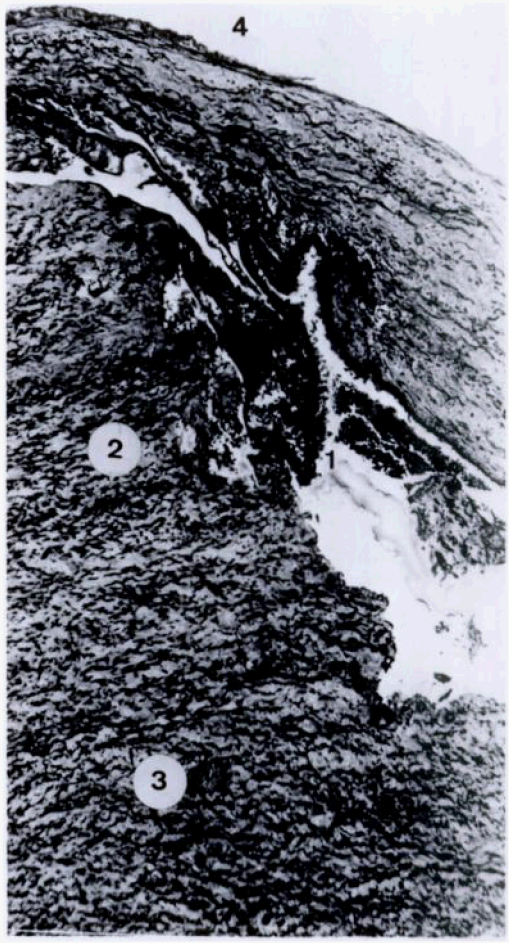

FIGURE 2. Dissection of the pulmonary trunk wall of a beluga whale from the St. Lawrence River: islands of red cells (1) dissect the media (2). The margins of the dissecting path are covered with fibrin. Foci of slight edema and collagen deposits, disorganized and fragmented elastic fibers can be observed in the media. Deep arteriole (3) of the vasa vasorum with thick and irregular media and with its lumen nearly occluded. The intima (4) is partly stripped. Hematoxylin-phloxine-saffron (HPS), ×88.

Various tissues were cultured on blood agar, incubated at 37 C in a 10% CO_2 atmosphere and examined after 48 hr.

The pericardial sac contained 3 liters of partially coagulated blood. The subepicardial tissue located at the base of the pulmonary trunk was distended by a hematoma extending from the annulus fibrosus of the pulmonary valve to 6.2 cm

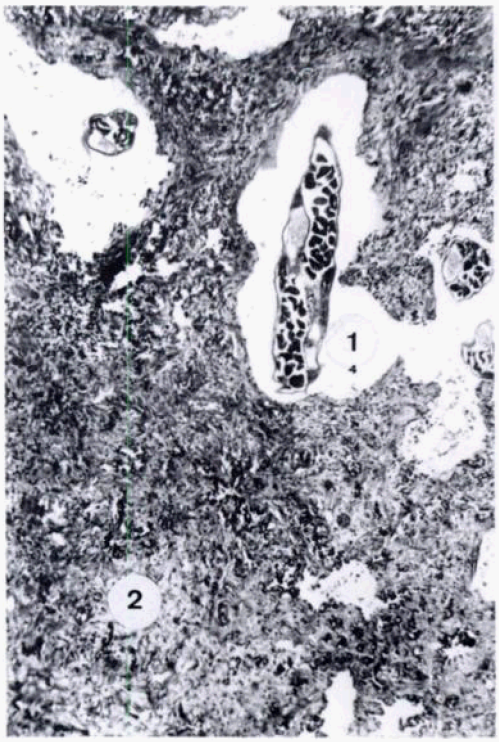

FIGURE 3. Adult female nematode, probably *Pharurus pallasii*, filled with larvae in a lacuna of the pulmonary parenchyma of a beluga whale from the St. Lawrence River (1); locally extensive pulmonary fibrosis (2). HPS, ×53.

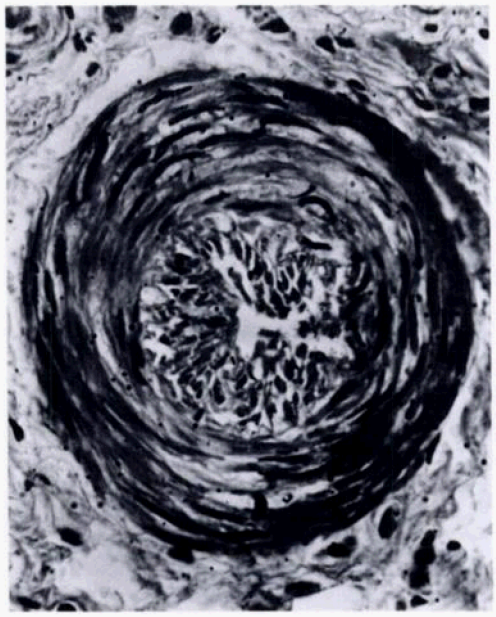

FIGURE 4. Diffuse fibrocellular intimal proliferation in a pulmonary arteriole of a beluga whale from the St. Lawrence River. HPS, ×1,390.

distally (Fig. 1). The distended tissue was ovoid in shape and it surrounded incompletely the pulmonary trunk. Its major part lay at the level of the commissure between the right and the anterior cusp of the pulmonary valve. The dilatation contained a roughly cone-shaped cavity: the tip of this cavity was located 1.5 mm proximally to the annulus fibrosus and its base 6 cm distally. The walls of the cavity were lined with a thick layer of clotted blood except in the very thin distal wall where a 1.5-cm-long transversal tear communicated with the pericardium. The lumen of the pulmonary trunk communicated with the cavity by an equal-sized transversal tear of the arterial wall, longitudinally 3.2 cm long and located at the level of the free margin of the right cusp of the pulmonary valve. No other abnormalities were found upon examination of the heart and cardiac valves. A circular plaque of 1 cm in diameter slightly raised the intima of the pulmonary trunk about 10 cm distally to the aneurysm.

Upon palpation the lungs were very firm. There were many scattered, irregular areas of purplish color and of large size in the grey pulmonary parenchyma. A brown liquid oozed from the bronchioles under a moderate pressure. Many tiny white nematodes, about 3 cm long, were found in bronchioles, bronchi and in the parenchyma. Around 50 of them were found also in each peribulla tympani space and a large number was present in the blowhole lumen but none were present in the nasal diverticula. They were identified as *Pharurus pallasii* (Van Beneden, 1870) Arnold and Gaskin, 1975 and representative specimens (Coll. No. NMC PC 1984-0556) were deposited at the National Museum of Natural Sciences of Canada, Invertebrate Zoology Division, Ottawa,

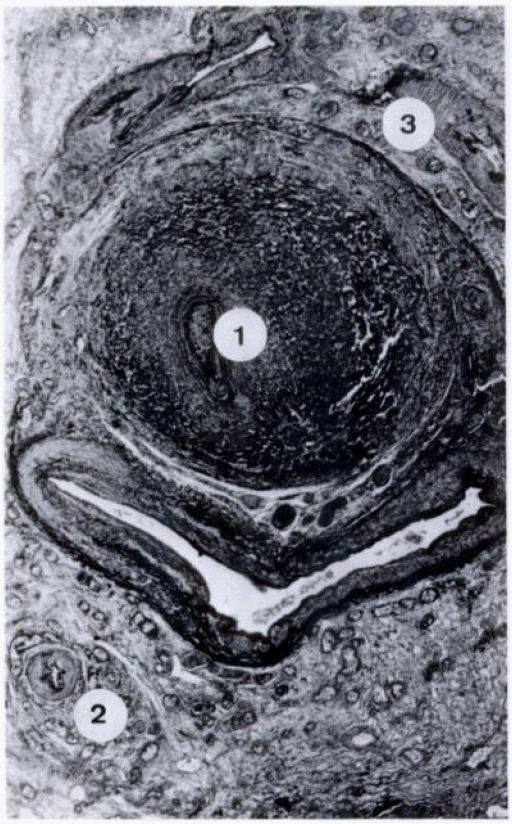

FIGURE 5. Well organized and recanalized thrombus in a pulmonary artery of a beluga whale from the St. Lawrence River. The new recanalizing vessels (1) have mural elastic fibers. Longitudinally oriented smooth muscle cells were also seen in the new vessels' "media." Small pulmonary artery with intimal fibrocellular proliferation and apparently hypertrophied media (2). Dilated and congested vasa vasorum are seen around the recanalized vessel (3). Verhoeff, ×8.7.

Ontario. Autolysis of the liver was extensive and all other organs were grossly normal.

Microscopically, the rupture site of the pulmonary trunk was very thin, had small fissures and a great amount of collagen between the fragmented and disorganized elastic lamellae. Arterial vasa vasorum had a thick media formed by disordered muscular fibers separated by variable amounts of collagen. Their lumen was almost occluded. The intima of the pulmonary trunk was raised by clumps of cells and

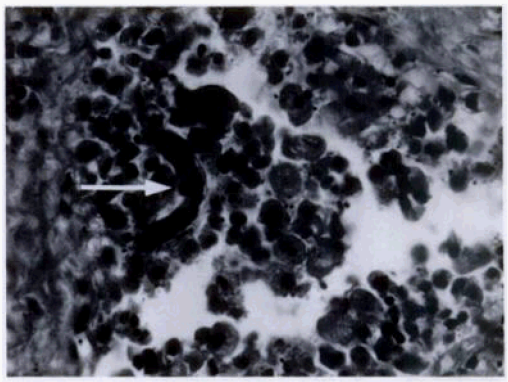

FIGURE 6. Lungs from a beluga whale from the St. Lawrence River. A larva (arrow), probably *Pharurus pallasii*, is found in an alveolar space filled with abundant exudation of inflammatory cells. HPS, ×400.

the adventitia was absent leaving the bare media lacerated by dense islands of red cells (Fig. 2). The intimal plaque of the pulmonary trunk consisted of a dense mature fibrous cap invading superficially the media. Some mononuclear cells with large and slightly basophilic nuclei were abundant in the deepest parts of the lesion. Their abundant cytoplasm contained fine to large oil red O-positive granules.

In the lungs, multifocal fibrosis, sometimes obliterating the normal pulmonary architecture, was observed (Fig. 3) and there was dense and diffuse cellularity throughout the parenchyma due mainly to lymphocytes and macrophages and secondarily to eosinophils and plasmocytes. Proliferative intimal fibrosis was seen in the small muscular arteries and arterioles. The media of the smallest vessels was sometimes invaded by fibrous tissue and showed disorganization of the smooth muscle cells (Fig. 4). Some medium-sized pulmonary arteries were nearly occluded by well recanalized thrombi; recanalizing vessels often had new elastica and new media made of longitudinal smooth muscle cells (Fig. 5). Intact female adult *Pharurus pallasii* were found in the lumen of bronchioles and in cavities in the pulmonary parenchyma (Fig. 3). They elicited

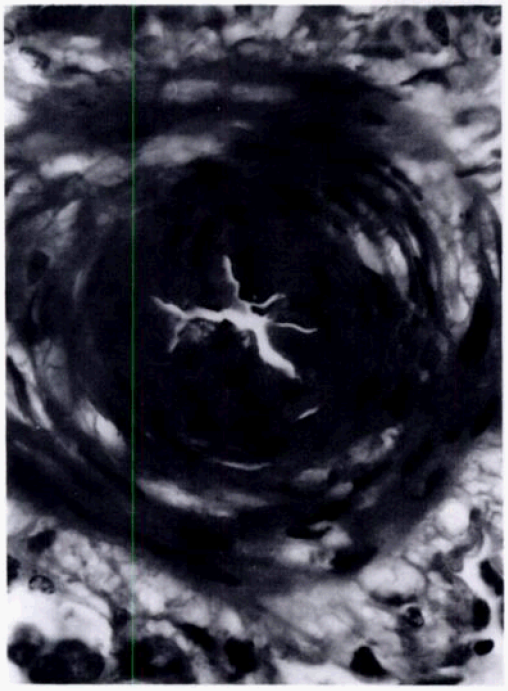

FIGURE 7. Pulmonary arteriole from a normal beluga whale killed in the Canadian Arctic. The lumen is almost occluded by a fibrocellular intimal proliferation. HPS, ×1,004.

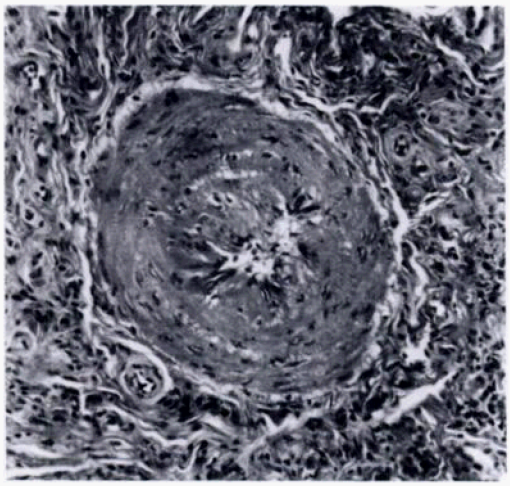

FIGURE 8. Small pulmonary artery from the same animal as Figure 7. The vessel shows papillary fibrocellular intimal proliferation. HPS, ×287.

slight peribronchiolar infiltration of eosinophils admixed with a few macrophages which sometimes contained brown pigments negative to a hemosiderin-specific stain (Prussian blue). The presence of adults in bronchioles was often associated with well organized peribronchiolar lymphoid aggregates. Presence of free larvae induced abundant exudation of a mixed population of inflammatory cells, mostly mononuclear, into the alveolar and bronchiolar lumina (Fig. 6). Some granulomatous lesions consisting of calcified debris surrounded by fibrous tissue infiltrated by mononuclear cells were occasionally present. In the control animals, the same vascular peculiarities with the exception

TABLE 1. Concentrations of polychlorinated biphenyls in different tissues of two beluga whales from the St. Lawrence River and the Baltic Sea and in pinnipeds from the St. Lawrence River (in ppm, on a wet weight basis).

Species	*n*	Origin	Blubber	Kidney	Liver
Delphinapterus leucas[a] (beluga whale)	1	St. Lawrence River	103.4	1.37	0.92
Delphinapterus leucas[b] (beluga whale)	1	Baltic Sea	6.2	—	0.34
Halichoerus grypus[c] (grey seal)	6	Sable Island, N.S.	7.1–24.6	—	—
Pagophilus groenlandicus[d] (harp seal)	18	St. Lawrence River	2–22	—	—

[a] This report.
[b] Harms et al., 1978; Meeresforschung 26: 153–161.
[c] Addison et al., 1977, J. Fish. Res. Board Can. 34: 937–941.
[d] Addison et al., 1973, J. Fish. Res. Board Can. 30: 595–600.

of thrombi were observed in the pulmonary tissue (Figs. 7, 8). Fibrosis was also observed, but to a much lesser extent. Adult nematodes, mostly degenerated, elicited dense lymphocytic reaction admixed with eosinophils. Chronic lesions developed into granulomas of the same nature as described above.

Interstitial fibrosis and fibrous thickening of the glomerular capsule, both moderate and multifocal, were found in the renal cortex. Adult helminths in the peribullar space elicited a moderate nonsuppurative chronic inflammation. A few larvae were lying free in the lumen. Large amounts of *Kingella kingae* were isolated from the spleen and the lungs and a smaller quantity was cultivated from the mediastinal lymph nodes. The concentrations of polychlorinated biphenyls (PCB's) found in this beluga whale are given (Table 1) and compared to concentrations found in the same species in the Baltic Sea and in pinnipeds killed in the Gulf of St. Lawrence.

Aneurysm of the pulmonary trunk is very uncommon in animals: bacterial endocarditis, medial necrosis or inflammation and atherosclerosis could not be demonstrated here. The vascular proliferative intimal fibrosis found in the lungs is a lesion observed in human pulmonary hypertension, but since it was observed also in control animals, it is not proof of this condition. Similarly, medial hypertrophy of pulmonary arterioles and arteries is normal in marine mammals (Butt and Howard, 1983, *In* Pathobiology of Marine Mammal Disease, Vol. I, CRC Press, Boca Raton, Florida, pp. 7–46). Right heart hypertrophy could not be demonstrated here because of the lack of standard measurements for this species and the normally thicker wall of the right ventricle when compared to terrestrial mammals (Green, 1972, *In* Mammals of the Sea, Ridgway (ed.), Thomas Pub., Springfield, Illinois, pp. 643–711). However, pulmonary hypertension remains a possible cause of this ruptured aneurysm since pulmonary thrombosis, fibrosis and pulmonary atherosclerosis were observed. Abnormalities of vasa vasorum have been associated with necrosis and rupture of the aorta and pulmonary trunk in horses (Van Der Linde-Sipman, 1985, Vet. Pathol. 22: 51–53). However, we could not compare the vasa vasorum of this animal to control animals and the significance of the observed alterations is unknown. Parasite migration causes aortic aneurysm in dogs (Bannor, 1976, Vet. Rec. 98: 302), but no parasite could be demonstrated in the present lesion. Trauma has been incriminated as a cause of aneurysm of the pulmonary artery in man (Spencer, 1977, op. cit.); the thorax of cetaceans is very flexible (Ridgway, 1969, Science 166: 1651–1654) and consequently, the pulmonary trunk might be less protected from potential injury. Therefore, trauma is also a possible cause for the vascular lesion observed here.

The concentrations of PCB found in this beluga whale are one order of magnitude higher than the concentrations found in the same species in the Baltic Sea and than in pinnipeds from eastern Canada. The significance of this finding is unknown.

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