



Mercury distribution in the skin of beluga (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) from the Canadian Arctic and mercury burdens and excretion by moulting

R. Wagemann^{a,*}, H. Kozłowska^b

^aDepartment of Fisheries and Oceans, Central and Arctic Region, Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, Canada R3T 2N6

^bUnit 1-1290, Amazon Drive, Port Coquitlam, B.C. Canada V3B 7Z8

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Abstract

Beluga and narwhal skin as a whole (in Inuktitut known as “muktuk”) is considered to be a delicacy by native Canadian and Greenland people. Individual strata of the skin, and muscle from 27 beluga from the western, and 20 narwhal from the eastern Canadian Arctic, were analyzed for mercury and the thickness and density of each skin layer was measured. Mercury was not uniformly distributed in the skin, but increased outwardly with each layer. The concentration was only 0.29 and 0.16 $\mu\text{g/g}$ (wet wt) in the innermost layer (dermis) of belugas and narwhal respectively, and 1.5 and 1.4 $\mu\text{g/g}$ (wet wt) in the outermost layer (degenerative epidermis) of beluga and narwhal, respectively. There was a significant ($\alpha=0.05$) association between age and mercury concentration in each skin layer, the regression coefficients progressively increasing from the inner layer (dermis) to the outer layer: 0.011–0.063 $\mu\text{g/g year}^{-1}$; 0.034 $\mu\text{g/g year}^{-1}$ for skin as a whole; 0.054 $\mu\text{g/g year}^{-1}$ for muscle. The concentration of total mercury was 0.84 and 0.59 $\mu\text{g/g}$ (wet wt) in skin as a whole (muktuk) of beluga and narwhal respectively, and 0.12 and 0.03 $\mu\text{g/g}$ in blubber, respectively. The average, total mercury concentration in muscle tissue was 1.4 and 0.81 $\mu\text{g/g}$ wet wt, in beluga and narwhal respectively, exceeding (except for blubber) the Canadian Government’s Guideline (0.5 $\mu\text{g/g}$ wet wt) for fish export and consumption. The skin surface area of an average-size beluga and narwhal was estimated (6.10 and 6.50 m^2 , respectively), as were excretions of mercury through moulting (13,861 and 6721 $\mu\text{g year}^{-1}$; 14 and 7 mg year^{-1}) for belugas and narwhal, respectively. The whole-body mercury burden (699,300 μg ; 700 mg) for a 1000 kg beluga and its various tissues were estimated, as was the fraction of mercury excreted by moulting (2–0.42% of the whole-body burden). Annual mercury burden increments in beluga skin, muscle and the whole body were estimated (2750; 17,280; 40,00 $\mu\text{g year}^{-1}$, respectively), using regression coefficients of age on mercury concentration. The annual gross mercury intake via food was estimated (131,400 μg), of which 70% was excreted.

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* Corresponding author. 100 Nicollet Avenue Winnipeg, Manitoba, Canada R3T 2N6.

1. Introduction

A number of investigators, most recently, Jones and Pfeiffer (1994) and St. Aubin et al. (1990), have described the structure of the skin of some cetaceans. The skin consists basically of four layers, the outermost layer (degenerative epidermis), underlain by the stratum externum, which in turn is underlain by the stratum intermedium and finally the innermost layer, the dermis, which is underlain by blubber.

The seasonal epidermal moulting of beluga has been described by Smith et al. (1992), and St. Aubin et al. (1990). Beluga molt in the summer in near-shore shallow water and estuaries by rubbing their bodies against bottom sediments, sandbars, pebbles and stones in estuaries, Smith et al. (1992). During moulting the degenerative epidermis and stratum externum are shed, and parts of the next, thicker, layer, the stratum intermedium are sometimes also lost (Smith et al., 1992). Moulting of narwhal is less well documented, but native hunters have observed it (personal communication).

The Inuit in the coastal communities of the Canadian Arctic and Greenland continue to hunt beluga and narwhal for food. The meat and skin (called “muktuk”) are eaten raw or cooked and the skin is sometimes also eaten after ageing (fermenting). Muktuk remains to this day one of the sought-after foods in the Arctic and is considered to be a delicacy by the Inuit. Of prime concern to these consumers are the levels of contaminants in the tissues.

Although mercury concentrations in tissues, other than the skin, of Arctic, cetaceans have been well documented, Hansen et al. (1990), Wagemann et al. (1983, 1990), Dietz et al. (1996), information on mercury in the skin has been lacking. The primary purposes of this investigation were to measure the mercury concentration in the skin (muktuk) as a

whole and in muscle tissue, and its distribution in the skin of belugas and narwhal. Individual layers (strata) of the skin were separated and the mercury concentration was measured in each layer, which allowed estimating the annual loss through moulting; additionally, whole-body and tissue mercury burdens and annual mercury burden increases as well as mercury intake via food were estimated.

2. Materials and methods

2.1. Sampling

Belugas were sampled (27 animals), during native hunts, at different locations in the western, Canadian Arctic in the Beaufort Sea, in July, 1993 (Table 1). Narwhal were sampled (20 animals), in October, 1993, in the eastern, Canadian Arctic at Repulse Bay on the Melville Peninsula, and at Iqaluit in Frobisher Bay at the southern end of Baffin Island (Table 1). The sampling protocol has been described previously (Wagemann et al., 1990, 1983). Muktuk samples were taken laterally on the axillary girth, and flesh (muscle) samples were taken from the *longissimus dorsi* muscle. The tissue samples were stored in a freezer (−40 °C), and prior to analysis were thawed just sufficiently to be cut.

2.2. Handling of the skin

A detailed morphological description of the skin was available for beluga (St. Aubin et al., 1990) but not for narwhal. The different layers of the skin were visually identified for both species. The layers were carefully dissected, and the concentration of mercury, the thickness, weight, unit area, and the density of each layer were measured. The degenerative epider-

Table 1
Beluga sampling locations in the western and narwhal in the eastern Canadian Arctic

Beluga (western Arctic)		Narwhal (eastern Arctic)	
Location	Lat./long.	Location	Lat./long.
Shingle Point	69°00' N 137°27' W	Repulse Bay	66°20' N 86°20' W
Paulatuk	69°23' N 124°00' W	Iqaluit	63°44' N 66°3' W
Hendrickson Isl	69°30' N 133°35' W	–	–
East Whitefish	69°38' N 133°52' W	–	–

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