Neurochemical changes associated with mercury exposure in polar bears (Ursus maritimus) - Mercury levels in brain tissue

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INTRODUCTION

- Several contaminants in the environment are toxic to the central nervous system of mammals. In the Arctic ecosystem, mercury (Hg) is especially important because its levels have been rising and its derivate, methylmercury (MeHg), easily bioaccumulates in the food web (de Wit et al. 2004).
- Polar bears (Ursus maritimus) feed on the top of the food chain and bioaccumulate neurotoxins from their environment such as Hg and organohalogens (de Wit et al. 2004).
- The concentration of total Hg in polar bear liver (N=24) sampled between 1995 and 1997 in Alaska was 14.2±/¬ 12.9 µg g⁻¹ wet weight (ww) whereas the level in muscle (N=23) was 0.09±/¬ 0.07 µg g⁻¹ ww (Woshner et al. 2001). Total Hg levels in liver and muscle tissue from polar bears sampled in Greenland between 1980 and 2000 were similar; the concentration of total Hg in kidney (N=95) was 12.7 µg g⁻¹ ww (SE2:50) (Dietz et al. 2000).
- This study investigates the concentration of Hg in the cerebral cortex of wild-ranging polar bears.

METHODOLOGY

Sampling

- 26 polar bear skulls were provided by the Ministère des Ressources Naturelles et de la Faune (MRNF) of Quebec and were distributed by the Nunavik Research Center in Kuujjuaq, QC. These skulls were collected for a harvest management and population study in the eastern Canadian Arctic.

Brain dissection and brain region isolation

- The frozen polar bear skulls were sectioned anatomically with a band saw. The two brain hemispheres were removed carefully and stored at -80°C.
- The left polar bear brain hemispheres have been sliced in order to identify the brain regions.

Hg determination

- Levels of Hg in the frontal and occipital cortex of 4 animals were determined using heat-vaporization mercury measurement equipment.
- The tissues were freeze-dried to minimize the potential effects of varying moisture content resulting from storage.

Quality control

- A standard curve was produced using commercial HgCl₂ standards before each run.
- Certified standard reference materials (DORM-2, dogfish muscle, Analytical Chemistry Unit, National Research Council, Ottawa, Canada) and method blanks were included for quality control purposes.

RESULTS

Table 1: Total Hg (thg) in polar bear (N=4) cerebral cortex.

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<tr>
<th>thg [µg g⁻¹ dry weight]</th>
<th>0.351±/¬ 0.09</th>
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<tbody>
<tr>
<td>freeze-dried to wet weight ratio</td>
<td>0.225±/¬ 0.03</td>
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<tr>
<td>thg [µg g⁻¹ wet weight]</td>
<td>0.351±/¬ 0.09</td>
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- The concentration of total Hg in the cerebral cortex of polar bears ranged from 0.22 to 0.48 µg g⁻¹ dry weight (dw) (N=4).

DISCUSSION

- The detected levels of Hg in polar bear cerebrum are lower compared to those measured in various seal species.
- Levels of Hg have been measured in grey seal brain sampled in Nova Scotia in 1972 (Freeman and Horne 1973) and total Hg ranged from 0.19-0.45 µg g⁻¹ ww (N=6). Skaare et al. (1984) reported Hg levels ranging from 0.01 µg g⁻¹ ww (detection limit) to about 0.1 µg g⁻¹ ww in ringed seals and harp seal brains (N=31) from the Norwegian coast in 1989/1990.
- However, intro-species as well as temporal and spatial comparison of pollutant levels should be considered with caution.

FUTURE WORK

- Several neurotransmitter systems have been found to be sensitive to Hg and MeHg exposure. Neurotransmitter systems are involved in learning and memory processes and disruption of brain neurochemistry can negatively affect behavior (Shill 2004, Wess 2004).
- It has been shown that higher Hg and MeHg levels significantly correlated with the disruption of neurotransmitter systems in wild mink (Mustela vison) and river otters (Lontra canadensis) (Basu et al. 2005a, Basu et al. 2005b).
- Alterations in brain chemistry can be used as indicators of adverse neurological effects and should be considered as warning of possible ecophysiologial consequences of contaminant exposure.

- This project will expand these findings to examine neurotoxic effects associated with mercury exposure in polar bears. Activities of enzymes and transmitter receptors in the central nervous system and blood cells and their associations with the Hg and MeHg burden will be studied.
- This study will improve our understanding of the effects of environmental toxicants on the flagship species in the Arctic.

CONCLUSION

- The concentration of total Hg in polar bear brain was low compared to the levels in liver and kidney in other studies.
- The kinetics and distribution of Hg and MeHg in polar bear require further investigation.
- Neurochemical changes associated with Hg exposure will be addressed in future studies.

FINANCING

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REFERENCES