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Mercury in Hair of Muskox on the Seward Peninsula

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Abstract: Problem statement: Muskoxen (*Ovibus moschatus*) are distant relatives of sheep (Caprinae) and have roamed the Arctic for a million years, with populations reaching North America between 150,000 and 250,000 years ago. Muskox populations could be negatively influenced by climate change and increased exposure to contaminants. Since the snow depth is a critical factor in their ecology, effects could occur throughout their distribution. Muskox typically feed on plants on hilltops and upper slopes where shrubs are increasing at the expense of graminoid and lichen species. Besides changes in plant species composition, wildfires and flooding, as well as renewed mining developments, can lead to an increased incidence of total Hg (THg) bioavailability. **Approach:** In this survey THg concentrations were measured in the hair of muskox at several sites on Seward Peninsula of Alaska, USA. **Results:** Muskox exhibited mean THg levels in the hair of 29.3 ng g^{-1} for the west base of Mineral Mountain, 28.6 ng g^{-1} for Nature Hill and 23.0 ng g^{-1} for the camp at Deering. Means for THg levels at Anvil were 35.2 ng g^{-1} at the top, 31.8 ng g^{-1} on the southwest slope and 29.9 ng g^{-1} at the base. Qiviut from two muskox at Anvil and Mineral Mountain possessed lower THg values than when compared to their guard hair (32.9 and 44.8 ng g^{-1}, respectively). **Conclusion:** These current THg levels are relatively low and helping establish a baseline for Hg exposure in muskoxen.

Key words: Muskoxen, mercury, climate change baseline

INTRODUCTION

Global climate change is expected to have substantial impacts on plant communities and the herbivores that graze on them (Harte and Shaw, 1995; Harte *et al*., 2006). Arctic herbivores, such as Muskoxen (*Ovibos moschatus*), are vulnerable to landscape disturbance caused by climate change or increased mineral developments (Alessa *et al*., 2008). Mercury (Hg) levels have increased in the far north as a result of industrial activity across the globe. Hg occurs naturally in the environment, but the atmospheric pool has grown because of increased use of coal as an energy source in Asia (Lokken *et al*., 2009; Wong *et al*., 2006). Hg and MeHg assimilation by plant foliage may increase as transport from Asia to Western Alaska increases. In the Arctic, the spring thaw can release Hg that has accumulated in snow pack, increasing the Hg bioavailable for magnification up the food chain (Kirk *et al*., 2006). High concentrations of Hg and MeHg can also be problematic for arctic residents, who commonly harvest subsistence species as their major food source (Loring *et al*., 2010).

In western Alaska on the Seward Peninsula, Hg exposure has not been extensively characterized, but can exist sporadically in association with past gold-mining activities. Here, we monitored several areas on the Seward Peninsula to begin to establish a baseline for the accumulation of Hg in muskox across the region. In this first survey, our goals were (1) to compare Hg concentrations in the hair muskox to observe variations between years and (2) to determine the relationship between Hg in muskox and the mining history of their ranges.

MATERIALS AND METHODS

In northwestern Alaska, muskox typically feed on hilltops and upper slopes. We collected qiviut and guard hair opportunistically from free roaming muskox

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on the Seward Peninsula. The samples were collected during the summers of 2008 and 2009. The Anvil, Mineral Mountain and Nature Hill are close to Nome (64.5°N, 165°W) on the southern coast of the peninsula, whereas Deering (66°N 163°W) is to the north. Hair samples were placed in a plastic bag and transported by air to Frontier Geosciences (Seattle, WA).

Hair samples were washed in dilute detergent and dried before analysis. The samples were digested whole without subsampling. Total mercury (THg) analysis was conducted with a standard curve, spanning the entire range of interest and corrected for blanks. For each analytical set (15-20 samples), one matrix duplicate, two matrix spikes and several matrix blanks were co-processed. The means for blank THg ranged from 0.03-0.21 ng g^{-1}. From a DOLT-3 standard, the spike recovery averaged within 6% of the expected value. The relative percent difference between duplicates was within 7%. THg concentrations were measured with Cold-Vapor Atomic Fluorescence Spectrometry (CVAFS) method, after nitric and sulfuric acid digestion. The hair sample was digested with hot refluxing 70% HNO_3 : 30% H_2SO_4 for 2 h, then diluted 4 fold with a solution of 10% (v/v) 0.2NBrCl. Aliquots of each digest were purged with Argon onto gold traps as a concentration step and then thermally disrupted into the detector.

We used one-way Analysis of Variance (ANOVA) with SAS statistical software to evaluate the effects of sampling location. Each sampling site was treated as independent. Significant differences in THg ($p \leq 0.05$) were tested with Tukey's Standardized Range Test. Since sample sizes were small and significance was not observed we report variation and confidence intervals.

RESULTS

THg in muskox hair collected on the Seward Peninsula ranged from 9.9-51.4 ng g^{-1} (Table 1). Means between the regional herds near Nome and Deering varied. Mean THg for Deering Camp during 2009 was lower than at Native Hill, Mineral Mountain and Anvil Mountain, in Nome (Table 1). Samples from Anival Mountain (SW Slope-CV = 16.0%; Base-CV = 20.1%) and Mineral Mountain (W Base-20.1%) exhibited the least variability, whereas those from Native Hill (CV = 46.5%) and Deering Camp (CV = 42.6%) were much more variable. The low numbers of individual muskox sampled make some comparisons difficult.

A comparison of qiviut and guard hair in two muskox showed a difference in THg levels, with the guard hair being higher than qiviut (32.9 ng g^{-1} versus 44.8 ng g^{-1}, respectively). A year effect may occur in means, as observed for Native Hill, where the range of THg and the mean varied between 2008 and 2009 (Table 1).

Table 1: Total mercury (ng/g) in muskox hair from the Seward Peninsula, Alaska, USA

Year	Location	Site	n	THg	Range	95% CI
2009	Anvil Mt.	SW Slope	9	31.8 ± 5.1	24.4 - 38.3	28.4 - 35.2
		Base	8	29.9 ± 5.9	18.9 - 37.4	25.7 - 34.1
		Top	2	35.2	34.5 - 35.8	
2009	Mineral Mt.	W. Base	11	29.3 ± 9.5	8.5 - 43.6	23.6 - 35.0
2009	Native Hill		8	28.6 ± 13.4	20.4 - 44.7	19.1 - 38.1
2008			2	36.5	30.5 - 42.5	
2009	Deering	Camp	7	23.0 ± 9.8	9.9 - 41.3	15.6 - 30.4
		Airport	1	41.3		
		Airport Flats	1	48.6		
2008		Ridge	1	12.1		
		Kugruk River	1	34.9		
2008	Triple Creek		2	45.4	39.3 - 51.4	
2008	Newton		1	21.7		
		Base	1	51.4		
		Newton Ridge	1	39.9		

In addition, Anvil Mountain had a lower mean at the base than at the top. Moreover, muskox grazing at the base of Mineral Mountain had a lower mean, similar to the pattern Anvil Mountain (Table 1). Anthropogenic effects can be seen in the Deering herd with higher levels of Hg around the airport.

DISCUSSION

Environmental monitoring and health-impact assessment of Hg exposure has increased in the North over the last 20 years (Loring *et al*., 2010; Cassady, 2010; Gamberg *et al*., 2005; Dehn *et al*., 2006; Horvat *et al*., 2000). Coastal communities in northwest Alaska are important for monitoring changes in mercury deposition and distribution because of both prevailing global wind and precipitation patterns as well as industrial development (Lokken *et al*., 2009; Loring and Gerlach, 2009; White *et al*., 2007; Dunlap *et al*., 2007). For THg monitoring on Seward Peninsula, muskox demonstrate the characteristics of a good indicator species: trans-Arctic distribution, accumulation of contaminants and accessibility for repeated sampling over time. The ability of biomonitoring to span across large temporal and geographic scales creates robustness of data that improves environmental assessment. Determining the baseline level for THg in plant and animal species is important for communities on the Seward Peninsula because this region is projected to become warmer over the next half century. Increased precipitation, water usage, sanitation and local mining development, including road building, will likely increase the Hg bioavailability and Hg transport up the food chain (White *et al*., 2007). Muskox monitoring using resampling techniques should be considered when designing impact assessment plans related to new mineral development involving gold, copper, zinc and rare earth elements.

CONCLUSION

Currently these total Hg levels in the hair of muskoxen are relatively low and begin to establish a baseline for change in mercury exposure, resulting from either development or climate change.

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