Environmental change and trophic ecology explain different THg bioaccumulation in two subpopulations of the Arctic ringed seal *Pusa hispida*

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Mercury (Hg) is categorised as one of the top ten chemicals of human health concern by the World Health Organization; therefore, the “Minamata Convention” was ratified in 2017 to regulate Hg emission. Arctic predators such as marine mammals show a more than tenfold increase in Total Hg (THg) concentration over the past 150 years (Dietz, Outridge and Hobson, 2009). Indeed, the Arctic is considered a global sink for Hg and, moreover, the Arctic Hg concentration is rising due to global warming (AMAP, 2021). THg accumulation trends in Arctic predators are spatially and temporally variable due to a myriad of ecological and environmental factors. Identifying the role of these drivers is crucial to implement proper Hg management mitigation plans, especially in the Arctic receiving multiple pressures.

The objective of the present study was to assess the importance of certain climatic and ecological factors as drivers of spatiotemporal THg variability in an endemic Arctic marine mammal species: the ringed seal *Pusa hispida*. We measured THg levels in muscle of two subpopulations, in North-west (NWG) and East Greenland (EG), collected from the mid-1980s up to 2016. We investigated the potential influence of physical factors (i.e., sea ice extent, North Atlantic Oscillation, sampling year) and trophic ecological proxies (i.e., $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$) on muscle THg concentrations. We measured THg concentrations using Absorbance Spectrometry (DMA 80 Milestone) while $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$ values were obtained using isotope ration mass spectrometry (Isoprime). We used Multivariate Linear Mixed Models (MLMM) to correlate temporal THg trends with trophic and environmental factors. Hg levels of ringed seal muscle in both subpopulations did not show a significant linear temporal trend (linear regression, p in EG =0.14 and p in NWG=0.25). THg in EG ringed seal muscle were lowest in the mid-80s (994 ng g^{-1} dw) and increased until 2012 (1,185 ng g^{-1} dw), reaching a plateau thereafter. THg in NWG ringed seal muscle increased from the mid-1980s (709 ng g^{-1} dw) to 2006 (1,406 ng g^{-1} dw). For EG ringed seals the MLMMs indicated THg to increase with smaller sea ice extent and higher $\delta^{15}N$ and δ ^{13}C. For NWG ringed seals the MLMMs showed THg to increase with larger sea ice extent and higher $\delta^{15}N$.

Our results suggested an increase of EG ringed seals' THg bioaccumulation due to the influence of sea ice melting to release deposited Hg from the underlying sea ice layers, trophic level, and habitat shift from coastal to offshore waters. For NWG ringed seals, the MLMMs showed a rise of THg with more sea ice extent and $\delta^{15}N$. Variations of muscle THg in NWG ringed seals seemed to be related with sympagic associated food webs. The rate of climate change impacts on feeding ecology and exposure to Hg at the local scale differed between the EG and NWG ringed seals. Our findings align with the effect of spatio-temporal variations of species habitat use and trophic ecology on the Hg bioaccumulation in Arctic marine mammals (Riget *et al.*, 2012 and Dietz et al., 2021). This underlines the necessity of a local-scale and species-specific focus in future Hg management efforts.

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