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Implications of mercury and lead concentrations on breeding physiology and phenology in an Arctic bird[☆]

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ABSTRACT

Although physiological traits and phenology are thought to be evolved traits, they often show marked variation within populations, which may be related to extrinsic factors. For example, trace elements such as mercury (Hg) and lead (Pb) alter biochemical processes within wildlife that may affect migration and breeding. While there is a growing understanding of how contaminants may influence wildlife physiology, studies addressing these interactions in free-living species are still limited. We examined how four non-essential trace elements (cadmium, Hg, Pb and selenium) interacted with physiological and breeding measures known to influence breeding in a free-living population of common eider ducks (*Somateria mollissima*). We collected blood from female eiders as they arrived at a breeding colony in northern Canada. Blood was subsequently assessed for baseline corticosterone (CORT), immunoglobulin Y (IgY), and the four trace elements. We used model selection to identify which elements varied most with CORT, IgY, arrival condition, and arrival timing. We then used path analysis to assess how the top two elements from the model selection process (Hg and Pb) varied with metrics known to influence reproduction. We found that arrival date, blood Hg, CORT, and IgY showed significant inter-annual variation. While blood Pb concentrations were low, blood Pb levels significantly increased with later arrival date of the birds, and varied negatively with eider body condition, suggesting that even at low blood concentrations, Pb may be related to lower investment in reproduction in eiders. In contrast, blood Hg concentrations were positively correlated with eider body condition, indicating that fatter birds also had higher Hg burdens. Overall, our results suggest that although blood Hg and Pb concentrations were below no-effect levels, these low level concentrations of known toxic metals show significant relationships with breeding onset and condition in female eider ducks, factors that could influence reproductive success in this species.

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1. Introduction

There is increasing interest in determining how measures of immunity and stress relate to survival and reproduction (Hennin et al., 2012; Humborstad et al., 2016; Madeira et al., 2016). Since there is an expectation that environmental contaminants may influence the condition and reproductive success of an individual directly or indirectly by altering physiological traits (Blévin et al.,

2014; Tartu et al., 2015), there is a need for integration of toxicology into this expanding field. Mercury (Hg) is of particular concern for marine birds in the Arctic, due to high levels of this trace element in the environment (Provencher et al., 2014b; Riget et al., 2011). Importantly, Hg has been shown to be an endocrine disruptor in both captive (Jayasena et al., 2011) and wild birds (Tartu et al., 2016a, 2013), even when exposure is low but chronic. In addition to Hg, marine birds are also exposed to other trace elements that are known to be toxic. For example, marine birds are exposed to lead (Pb) through shot from hunting activities, which can also have negative impacts (Merkel et al., 2006; Scheuhammer, 2009). Thus, it is important to consider trace metals in relation to

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