Project description

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DNA double strand breaks in incubating female common eiders (*Somateria mollissima*) in Christiansø, Denmark.

Introduction

The Baltic Sea eider *Somateria Mollissima* population is decreasing, and this trend is also reflected in the large eider colony at Christiansø situated in the Baltic Sea (Laursen and Møller, 2014). This colony showed a 15-fold increase from 1925 until the mid-1990's, followed by a rapid decline in recent years. The decline during the last two decades was first reported from the wintering grounds and later from breeding areas (Desholm et al., 2002; Ekroos, 2012). The reasons for the decline are poorly understood and epidemic outbreaks, parasite infections, mass starvation, increased predation, and reduced survival of ducklings and adult females have been suggested to be partly responsible for the decline (Christensen, 1997; Camphuysen et al., 2002; Hario and Selin, 2002; Kilpi and Öst, 2002; Pedersen et al., 2003; Kats, 2007). However, no single study has so far shown that these factors account for the population decline, and a recent review (Ekroos et al., 2012) concluded that knowledge of the causes of declining survival of adult females is necessary for understanding the population decline.

The Christiansø colony has been monitored for 85 years and it is among the largest in the flyway breeding range counting up to 3000 nesting females (Laursen and Møller, 2014). The colony does not suffer from mammalian predations, and avian predation is limited due to proximity to people. Female survival in the colony has not been estimated directly, but the annual numbers of breeders is supposed to reflect survival, since site fidelity of adult females is known to be almost 100% (Franzmann, 1980).

The common eider is a long –lived sea duck that feeds benthically on mussels and other invertebrates (Waltho and Coulson, 2015). Only females take part in the incubation of the eggs. Consequently, the female common eider fasts for approximately 26 days, and might lose as much as 40% of its initial body mass during the incubation period (Korsschgen, 1977). Incubating common eiders are therefore exposed to a high degree of natural nutritional stress. At the end of incubation, they are assumedly in poor body condition (Hanssen et al., 2003; Hanssen et al., 2005; Kilpi et al., 2001). Blood levels of POPs increase during the incubation fast due to redistribution from fat stores (Bustnes et al., 2010). Thus, the natural stress combined with the exposure to increased levels of pollutants due to fasting raises concern that adverse effects from pollutants may occur even at relatively low exposure levels in common eiders.

Oxidative stress occurs when there is an imbalance between production of reactive oxygen species (ROS) and elimination of ROS by antioxidants and antioxidant enzymes (Finkel and Holbrook, 2000; Lushchak and Semchyshyn, 2012). Natural stress, such as breeding stress and energetic imbalance, may affect the oxidative balance of birds (Alonso-Alvarez et al., 2004). Furthermore, there is evidence that certain POPs may induce oxidative stress (Costantini et al., 2014; Fernie et al., 2005; Wayland et al., 2010), and it has been suggested that the toxic effects from both reduction-oxidation (redox)-active and redox-inactive elements are partially due to element-induced oxidative stress (Ercal et al., 2001; Hoffman, 2002; Koivula and Eeva, 2010). Since wildlife is exposed to complex mixtures of environmental chemicals, these mixtures have the potential for causing combined effects (interactions or additive oxidative effects when simultaneously exposed to metals and POPs) (Eaton and Gilbert, 2013; Oakley et al., 1996; Price et al., 2012).

Impaired antioxidant defence or increased production of ROS may cause oxidative stress (Finkel and Holbrook, 2000; Halliwell and Gutteridge, 2007; Lushchak and Semchyshyn, 2012), which causes injury to cells and tissues through oxidative damage to membranes or biomolecules, such as DNA, proteins and lipids (Finkel and Holbrook, 2000; Sohal et al., 2002). DNA double-strand breaks (DSBs) are among the most severe DNA lesions because they disrupt the continuity of the DNA template, which is essential for replication and transcription. Hydroxyl radicals can cause DNA single- and double-strand breaks by attacking the sugars of the DNA backbone (Friedberg et al., 2006b). Single-strand breaks (SSBs) or oxidative damage within 10 base pairs can create DSBs (Friedberg et al., 2006b; Pfeiffer et al., 2000). However, the most prevalent sources to DSBs occur during replication in dividing cells, when DNA replication forks encounter un-repaired DNA lesions, triggering fork collapse (Pfeiffer et al., 2000).

Un-repaired DNA DSBs may result in loss of chromosomes, cell death, mutations, chromosomal aberrations and carcinogenesis (Friedberg et al., 2006b; Kanaar et al., 1998; Pfeiffer, 1998; Pfeiffer et al., 2000). Thus, pollutant-induced DNA DSBs are important indications of severe genotoxic effects.

Krøkje´s group has in a previous study (Fenstad et al., 2014) shown that the frequency of DNA DSBs in blood of female common eiders, at Svalbard, increases during their fasting incubation period. Body mass decrease during incubation correlated with the percent increase in DNA DSBs frequencies, indicating that stress inflicted by fasting and body mass reduces DNA integrity in wild common eiders.

Prof Christian Sonne, Aarhus University and colleagues are performing a project on Common eiders at Christiansø, and they want to include a study on DNA-DSBs in the female incubating common eiders.