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Common Eider (*Somateria mollissima*) body condition and parasitic load during a mortality event in the Baltic Proper

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ABSTRACT

During late spring of 2007 and 2015, we observed unusually high mortality of Common Eiders (*Somateria mollissima*) on Christiansø in the Baltic Proper. The number of dead birds (2007: 125; 2015: 110) composed 5–10% of the total colony. In 2015, we collected 15 (12 adult females, three subadult males) of the 110 recently deceased Common Eiders for detailed autopsy. The average body mass of the females was 1,040 g (920–1,160 g) which is *ca* 60% lower than what can be expected of healthy females during wintertime. Similarly, for the subadult males the average body mass of 1,203 g (1,070–1,300 g) comprised only 45% of what can be expected for healthy subadult males during winter. All 15 birds were thus severely emaciated and cachexic with general atrophy of muscles and internal organs. Hunger oedema, distended gall bladder, empty stomach, empty and dilated intestines and dilated cardiomyopathy were observed as well. In addition, all 15 Common Eiders were infected with high loads of the acanthocephalan parasite *Polymorphus minutus*. No gross morphological changes suggested toxicological, bacteriological or viral causes to the mortality. Taken together, our autopsy suggested starvation leading to secondary metabolic catabolism and eventually congestive heart failure. Five birds that were examined in 2007 showed the same symptoms. We suspect that the introduction of suboptimal feeding conditions in combination with a high parasite load over the last decade synergistically caused high physiological stress leading to population level effects manifested as high mortality.

Keywords: avian, emaciation, food depletion, parasite infection, starvation, waterfowl

1. INTRODUCTION

Unusually high mortality of Common Eiders (*Somateria mollissima*) (heareafter eider) has been reported for five different incidents in North America (Madin, 2009) and one in the Dutch Wadden Sea (Camphuysen *et al.*, 2002). While starvation has been suggested to be one cause it could not explain all occurrences as some years had dying birds in good body condition (Madin, 2009). More local causes may be energetic constraints, or exposure to contaminants and diseases. Energy constraints are often related to the nutritional quality of Blue Mussels (*Mytilus edulis*) that constitute the primary food source (Cramp and Simmons, 1977). In fact, a decline in the use and contamination with farmers' fertilisers have been proposed as a potential main cause for the decline in the Baltic Sea eider duck population over the last decades due to fewer and slower growing Blue Mussels (Laursen and Møller, 2014). Blooms of the algae *Prymnesium polylepis* have been suggested as well to lower eider duck body condition and may be even responsible for increasing numbers of non-breeding eiders (Larsson *et al.*, 2014). Finally, high prevalence of acanthocephalan parasites has earlier been associated as well with mortality in eiders (Camphuysen *et al.*, 2002)000 common eiders died. Dissected birds were severely emaciated and 94% were infected with the acanthocephalan parasite Profilicollis botulus. Green shore crabs (Carcinus maenas.

The colony of eider ducks located in the southern part of the Baltic Proper at the island Christiansø is the second largest in Denmark (Christensen and Bregnballe, 2011). The local breeding population numbered 1,445 and 1,750 nesting females in 2007 and 2015, respectively. The eiders at Christiansø are migrating between wintering

grounds at the western part of the Baltic Sea south to the Dutch part of the Wadden Sea. They return to the summer breeding grounds from late February to early April (Lyngs, 1992). While it is not unusual to find some 5–15 eiders dead during the breeding season (unpublished data author query: please include names of people from whom the unpublished data came) during 2007 and 2015, the colony at Christiansø experienced a unusually high mortality as 125 and 110 birds were found dead during May and June, respectively, composing 5–10% of the total colony. Here we report the results from a subsample of these birds that were subjected to a standard veterinary autopsy protocol in order to uncover the underlying potential cause of death.

2. MATERIAL AND METHODS

In 2007 and 2015, unusually high numbers of dead and dying Common Eiders were recorded at Christiansø (55°19′N 15°11′E; Figure 1) located northeast of Bornholm in the Baltic Proper. During 15 May–7 June 2007 and after the recording of pre-mortal fatigue and lethargy symptoms, 125 dead eiders were found of which 42 were weighted (22 adult females, four subadult females, eight adult males, eight subadult males). Five of these birds were sent for autopsy and post-mortem examination at the Danish Veterinary Institute. During 1–19 June 2015, another large number of 110 dead eiders were found dead and dying. Of these, 15 eiders (12 adult females, three subadult males) were collected, weighted and sent to the Department of Veterinary Disease Biology at the University of Copenhagen for post-mortem examination. All specimens were subjected to the same post-mortem inspection and autopsy at the two laboratories. Masses were recorded using a Pesola® spring balance (10 g accuracy) and the post-mortem procedure followed the one described by Alcorn (2008), including examination of respiratory, digestive, urogenital, cardiovascular, nervous, musculoskeletal and endocrine systems. In addition, the presence of intestinal acanthocephalan worms in the gastrointestinal tract were recorded.

3. RESULTS AND DISCUSSION

In 2007 and 2015, a mortality of 5–10% was found in Common Eiders. In both years, the dying eiders appeared emaciated and showed symptoms of fatigue and lethargy. The birds were unwilling to fly when disturbed and were eventually not able to stand, often lying apathetic on the ground until the time of death. Often birds were sitting motionless at the shore in sleeping positions, the head turned with the bill in the back feathers. No other bird species were found dead at Christiansø during these two years.

The average body mass for the dead adult females was 1,145 g in 2007 and 1,040 g in 2015, almost 60% lower than expected for adult females in good condition during winter (Table 1). For subadult males, the average body mass was 1,244 g in 2007 and 1,203 g in 2015, some 45% lower than expected for subadult males in good condition during winter (Table 1). Visual inspection showed intact bodies without traces of contamination (*e.g.* oil) or presence of visible ectoparasites. On visual

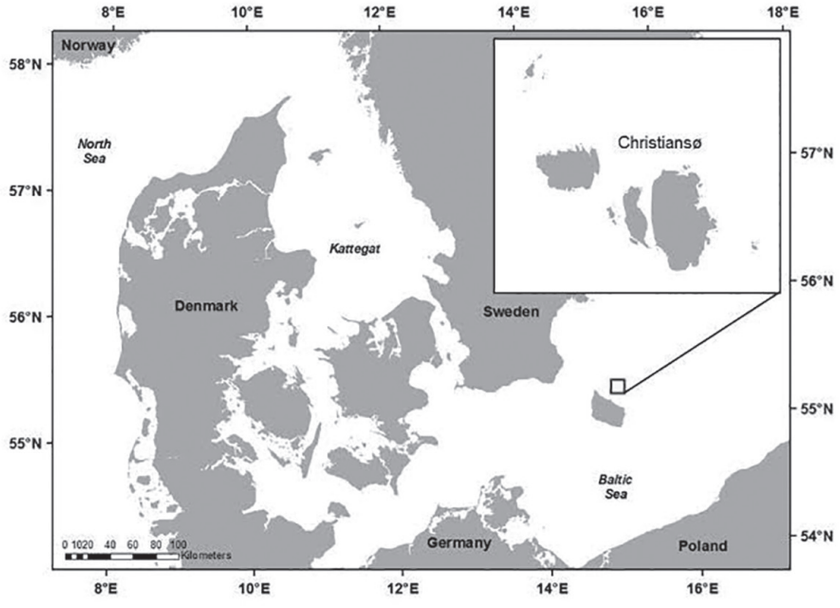

Figure 1 Map of the study area.

Table 1 Body mass (g) of dead Common Eiders collected during mortality incidents at Christiansø during 2007 and 2015. For comparison, reference values of healthy Common Eiders' body mass is included (Camphuysen *et al.*, 2002 and references therein). Blank cells: data not available

	Christiansø				Healthy Common Eiders			
	2007		2015		Denmark		Western Baltic	
	Adult females	Subadult males	Subadult females	Subadult males	Adult female	Subadult male	Adult female	Subadult male
	$n=23$	$n=8$	$n=12$	$n=3$	$n=7$	$n=61$	$n=7$	$n=61$
Mean	1,145	1,244	1,040	1,203	2,142	2,166	2,588	2,460
SD	144	89	83	119				
Range	925–1550	1110–1350	920–1160	1070–1300				

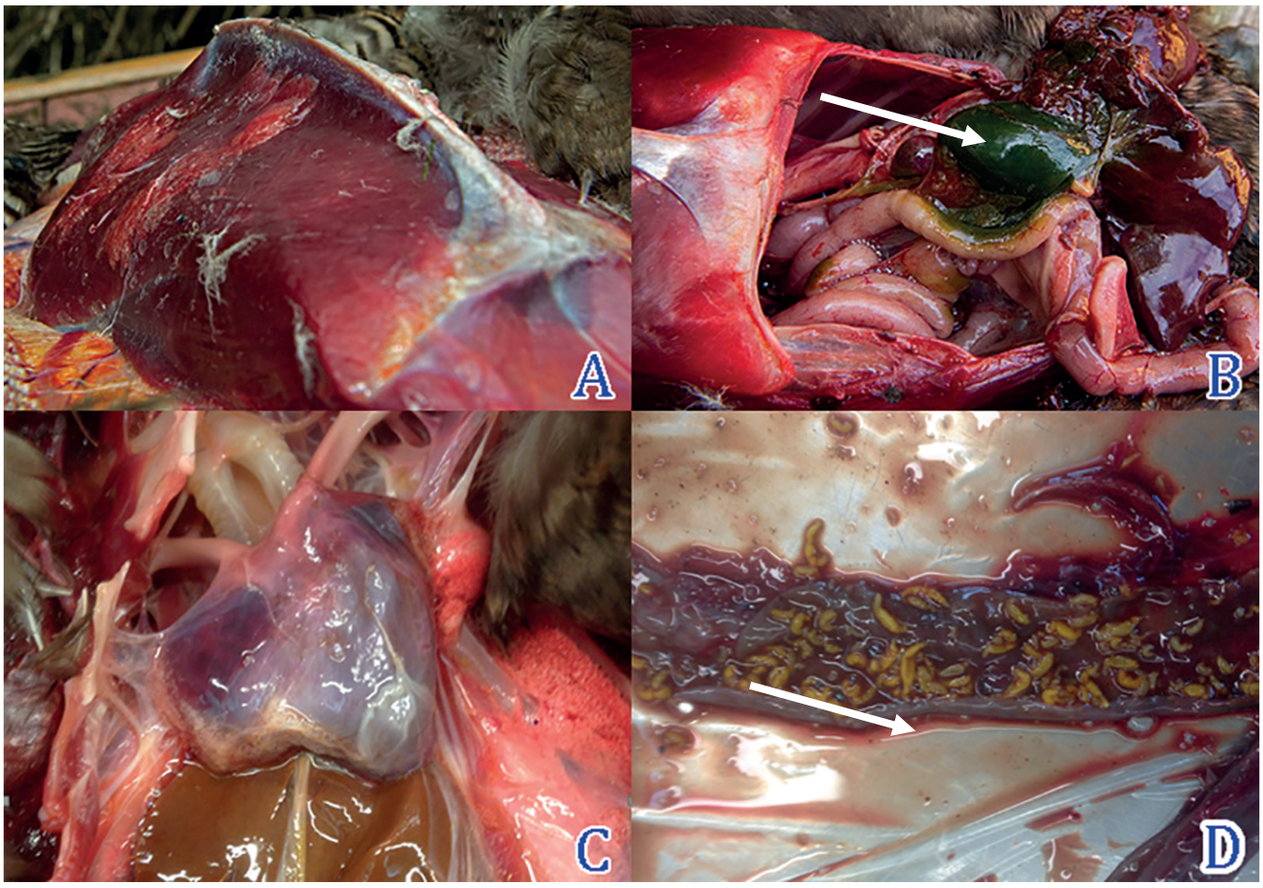

Figure 2 (A) An emaciated adult female Common Eider with prominent keel and greatly reduced pectoral muscles, Christiansø, 16 June 2015. Photo: P. Lyngs. (B) Gross morphology of the coelomic cavity of an adult female collected at Christiansø, 16 June 2015. Notice the enlarged gall bladder (arrow) and pale organs. Photo: P. Lyngs. (C) Gross morphology of the sternal region of an adult female Common Eider collected at Christiansø, 16 June 2015. Notice the enlarged heart (dilated cardiomyopathy; arrow). Photo: S.E. Garbus. (D) Section of intestines. All 15 investigated Common Eiders from the 2015 mortality incident were highly infected with the acanthocephalan parasite *Polymorphus minutus*. Photo: S.E. Garbus.

examination and palpation, the skin appeared pale but intact. The eiders were emaciated and had an empty crop, prominent keel and greatly reduced pectoral muscles (Figure 2a). No skeletal deformity or fractures were observed, and the bill appeared normal and the inside of the mouth and tongue were without any lesions. Body orifices and mucous membranes were in all cases pale without discharge, ulceration, plaques or foreign objects.

Dissection showed that subcutaneous and deposited fat resources were almost depleted. Severe atrophy of the breast muscle indicated that few of the dissected birds were capable of flying (Piersma, 1988; Gaunt *et al.*, 1990; Camphuysen *et al.*, 2002) or capable of wing propulsion during descent to the bottom for the action of foraging (Heath *et al.*, 2006)but speed also affects travel time to foraging patches and therefore time and energy budgets

over the entire dive cycle. However, diving behaviour has rarely been considered in relation to current velocity. Strong tidal currents around the Belcher Islands, Nunavut, Canada, produce polynyas, persistent areas of open water in the sea ice which are important habitats for wildlife wintering in Hudson Bay. Some populations of common eiders Somateria mollissima sedentaria remain in polynyas through the winter where they dive to forage on benthic invertebrates. Strong tidal currents keep polynyas from freezing, but current velocity can exceed 1.5 m s(-1. In general, the organs appeared pale and shrivelled without any lesions, haemorrhages or signs of bacterial or viral infection or state of toxicological poisoning (Figure 2b). Air sacs appeared transparent and glistening. The pericardial sac appeared thin, pale and transparent containing non-viscous serous fluid in excess. In general, a build-up of fluid (serous transudate) was observed in most of the birds in the thoracic and coelom cavity. The hearts were globose shaped with dilated ventricular and atrial heart chambers (Figure 2c). The livers appeared pale-yellow with enlarged gall bladders. The gizzards were empty and contained only small pieces of granite and marine litter (glass) for grinding up food. The gastrointestinal canals were completely empty except for parasites with some intestinal dilation.

Moderate to heavy presence of the clearly visible acanthocephalan parasite *Polymorphus minutus* were observed in all 2015 eiders (Table 2; Figure 2d). On average, the adult females contained 1,091 (80–5,200) worms and the subadult males contained on average 723 (330–1,240) *P. minutus* individuals. In the most heavily infected birds, the mucosa of the middle part of the intestine was completely covered. Presence of *Echinostoma* spp. (intestinal flukes), which can cause severe damage to the intestinal mucosa, were detected as well. Only one eider from the 2007 incident also had high loads of parasites in the intestines, among these thousands of *P. minutus* and *P. botulus*. Furthermore, protozoan parasites were found in both the liver and the brain. None of the birds were subjected to analyses for infectious diseases. The symptoms were non-specific and did not comply with botulism causing paralysis, duck plague causing characteristic lesions in oesophagus and cloaca, avian cholera causing quick death without mass loss, or high pathogenic avian influenza (Christensen and Bisgaard, 1997; Alexander, 2008; Christensen *et al*., 2008; Gough, 2008; Kaldhusdal and Jordan, 2008).

Food shortage combined with high loads of parasites is likely to have caused catabolism of the body reserves of fat, muscle and vital plasma proteins which are converted by the liver into glucose as suggested by Hollmén *et al*. (2001). The catabolism of serum proteins, especially albumin, likely caused a decreased colloid oncotic pressure due to hyperproteinaemia/hypoalbuminemia (Thrall *et al*., 2006). When plasma proteins, especially albumin, no longer sustain sufficient colloid osmotic pressure to counterbalance hydrostatic pressure, oedema develops as was indeed observed. The low oncotic pressure leading to a hypotension and lower stroke volume (preload) caused hypoxemia. To compensate, the heart enlarges to achieve a higher stroke volume making the heart thin and flappy, *i.e*. dilated cardiomyopathy. This combined with other effects of malnutrition, *e.g*. general reduction of myocardial mass and content of myofibrils, will eventually lead to congestive heart failure (Pees *et al*., 2006). This, however, is secondary to the main causes of death being starvation and high parasitic load.

Pathological examination of the five dead eiders from the mortality incident in 2007 reported a similar cause of death, *i.e*. starvation with secondary severe infection from acanthocephalan parasites causing intestinal inflammation (Hammer, 2007). Flappy hearts were also observed and no bacterial, viral or toxicological causes were suspected. Compared to healthy eiders in Denmark (Enemark *et al*., 2012), the studied eiders had unusually high loads of *P. minutus*. Heavy presence of acanthocephalan parasites has previously been associated with poor body condition, emaciation and mortality in eiders (Grenquist, 1970; Borgsteede, 1997; Camphuysen *et al*., 2002; Thieltges *et al*., 2006; Hammer *et al*., 2007)000 common eiders died. Dissected birds were severely emaciated and 94% were infected with the acanthocephalan parasite Profilicollis botulus. Green shore crabs (Carcinus maenas. However, a Finnish review (Hario *et al*., 1995) found no evidence for direct acanthocephalan parasite induced mortality in eiders, but reported combined occurrence of a weakened physical condition and heavy parasite burdens of *P. minutus* and *P. botulus*. Moreover, another Finnish study (Hollmén *et al*., 1999) on eight eider ducklings experimentally infected with *P. minutus* found no

Table 2 Presence of the acanthocephalan parasite *Polymorphus minutus* in the intestines of Common Eiders ($n = 15$) found dead during the 2015 mortality incident at Christiansø (Baltic Proper), compared to reference values from healthy Common Eiders ($n = 53$) collected at Saltholm/Isefjorden (Denmark)

	Females			Males		
	Healthy Common Eiders		Present study	Healthy Common Eiders		Present study
	May 2010–2011	Nov 2010–2011	June 2015	May 2010–2011	Nov 2010–2011	June 2015
N	20	19	12	4	10	3
Mean	0.9	154	1,091	86	287	723
SD	0.30	41	1,510	77	142	467
Range	0–4	0–473	80–5,200	3–319	1–1,153	330–1,240

mortality but did observe slower mass gain. We therefore highly suspect that food shortage or poor food quality and high parasite loads synergistically stressed the studied eiders physiologically and resulted in population level effects manifested through the fatal starvation incidents. Interestingly, both in 2007 and in 2015 a number of eiders on Christiansø survived, showing no visible signs of emaciation. This may suggest that the eiders that did not die in the colony had sufficient energy reserves and lower burdens of parasites due to different wintering grounds or different foraging behaviour.

4. CONCLUSIONS

We conclude that starvation and a high load of gastrointestinal parasites caused the observed mortality incidents in 2007 and 2015 at Christiansø. The post-mortem examination of the eiders from 2015 showed that lack of food and a high presence of parasites had a dramatic effect on the body condition with secondary catabolic disease and congestive heart failure. These results indicate potential problems at the eider foraging grounds at Christiansø, and further research is needed to shed light on food web changes, parasite transfer dynamics and the impact on Baltic Sea eider populations.

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