Research Note

Brood patch temperature during provocation of incubating common eiders in Ny-Ålesund, Svalbard

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In this short note we describe the behaviour and body temperature changes of three incubating female common eiders (*Somateria mollissima*) during provocation made by humans approaching the nest. The study site was near the settlement of Ny-Ålesund, Svalbard. Temperature transmitters were implanted subcutaneously at the brood patch and data recorded using a VHF receiver. We found that the female eiders in the experiment exhibited a passive defence response ("freezing"), accompanied by a significant drop in brood patch temperature (0.6 °C) during provocation; this temperature drop lasted for 5 minutes. These results accord with other studies of the physiological changes which accompany the passive defence response in birds and other animals.

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Environmental stressors, such as approaching predators, induce physiological changes in birds, mammals and other animals. Autonomic responses must enhance the physiological and behavioural ability of the animal to cope with these events (Harvey et al. 1984). In wild birds, two types of behavioural responses have been described: the active and the passive defence responses. The former involves the activation of the sympathetic nervous system, which induces the "fight-or-flight" response. The animal reacts actively against the stressor, preparing itself either to confront the threat or to escape (Gabrielsen & Smith 1995). The physiological changes which accompany the active defence response include increased heart rate and respiration, redistribution of the blood flow to the skeletal muscles, enhanced glycemia and higher body temperature (Siegel 1980; Culik et al. 1990; Gabrielsen & Smith 1995). In contrast, other birds show a passive defence response in which the animal crouches or freezes (Gabrielsen, Blix et al. 1985). This behaviour is particularly suited to incubating birds, which, by remaining motionless on the nest, enhance their chances of being undetected by predators (Gabrielsen 1984; Steen et al. 1988). The physiological aspects of the passive defence response include reduced skeletal blood flow and lowered heart rate and respiration (which lessens the body odour emitted, hindering detection by a predator) (Gabrielsen & Smith 1995).

In a previous study of incubating female common eiders (*Somateria mollissima*) in Svalbard, Gabrielsen (1984) found that both females nesting close to the settlement of Ny-Ålesund and those nesting in dense colonies on small islands in the area showed the passive ("freezing") defence response. However, the physiological changes accompanying this behavioural response showed some interesting differences between the birds nesting in the settlement vs. the island colonies (see discussion in Gabrielsen 1984).

Although respiration and heart rate data have been recorded during provocation of incubating common eiders in Svalbard, less is known about the effect on body temperature of incubating eiders. In this paper we describe the changes in body temperature, measured at the brood patch, during human provocation of incubating female eiders breeding in Svalbard. In this species, maintaining a constant nest temperature is of especially important because the high Arctic is a harsh environment in which eggs can cool rapidly, and frequent reheating of eggs is energetically demanding for a bird fasting during the 24 - 26 day incubation (Korschgen 1977; Gabrielsen, Mehlum et al. 1991). After arriving at the Svalbard breeding site in mid-April, the female lays a clutch of 4 - 6 eggs, which it then incubates alone. During this period, the female relies entirely on its body reserves for its energy needs, losing 30 - 40 % of its initial body mass (Korschgen 1977; Parker & Holm 1990; Gabrielsen, Mehlum et al. 1991; Criscuolo et al. unpubl. data). This fasting strategy enables the female eider to maintain a high level of nest attendance (Melhum 1991; Criscuolo et al. unpubl. data), which reduces egg predation—mainly from gulls (*Larus hyperboreus*).

Materials and methods

The fieldwork was carried out in Ny-Ålesund (78°55 N), on the western coast of Spitsbergen. In June 1999, three female eiders nesting close to the settlement were caught on the nest and transported to the Norwegian Polar Institute laboratory (less than 150 m away). During the females' absence from the nest, the eggs were covered with down and grass to avoid nest predation and egg cooling (egg temperatures were not measured during the study). The eiders were anaesthetized with isofluorane-enriched O_2. Temperature transmitters (TXH 2 radio tag 148 MHz, Televilt International) were implanted subcutaneously in the brood patch, the defeathered abdominal area which functions to warm eggs. The birds were transported back to the nest, still under anaesthesia, 100 - 120 min after being captured. The birds were placed on the nest and awoke from the anaesthesia while sitting on the eggs.

Behavioural observations of the incubating eiders were done from behind a hide, ca. 50 m away from the nest. Body temperature was recorded (± 0.1 °C) every 5 - 10 sec by a VHF receiver placed 100 m away from the nest site. After implantation we did not observe nest desertion. However, one female eider lost her eggs two days after implantation. The two other females incubated until hatching. Only one female was recaptured at the end of the experiment and its thermistor retrieved under anesthesia.

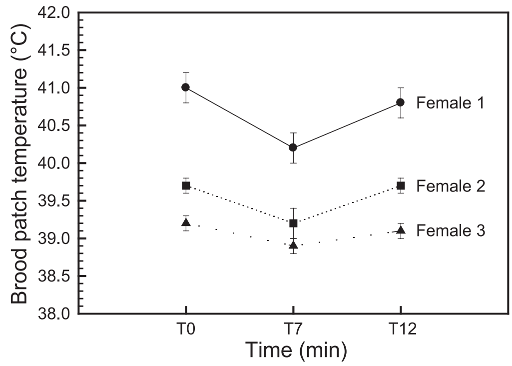

Fig. 1. Effect of the approach of a human towards the nest on body temperature of incubating female eiders. After 7 min of provocation the stress experiment stopped (T7) and the temperature of the bird was recorded for an additional 5 min (T7 to T12). This experiment was repeated 7 times on three female eiders. Body temperature at T7 was significatively different from the initial and final body temperatures.

The defence response was provoked by the approach of a human, walking slowly toward the female on the nest. The person stayed two m away from the bird for 7 min (including the approach period) and then left the area. The birds were never flushed from their nests. The provocation experiment was carried out twice a day—morning and evening. Each bird was provoked by humans seven times (n = 7).

Brood patch temperature was measured: 1) before the experiment, as the mean brood patch temperature during the two minutes before human provocation; 2) during provocation, as the mean brood patch temperature during the 7 min of human presence; and 3) after the provocation, as the mean brood patch temperature recorded for an additional 5 min following the researcher's withdrawal from the breeding area. This study was approved by the Norwegian Animal Research Authority, the ethical committee of the Institut Français pour la Recherche et la Technologie Polaires, the Norwegian Polar Institute and the Governor of Svalbard.

Statistical analysis was carried using an ANOVA for repeated measurements, followed by post-ANOVA Tukey tests. Values are means ± s.e.

Results

Upon provocation there was an immediate cessation of all outwardly discernible body movement. In a characteristic freezing posture, the head was held against the body and eyes were open. The birds remained motionless on the nest during the entire 7 min provocation.

The mean brood patch temperature during normal (undisturbed) incubation for the three birds was 39.7 ± 0.1 °C (n = 7), 41.0 ± 0.2 °C (n = 7) and 39.2 ± 0.1 °C (n = 7). Average values for all three birds before the experiment was 40.0 ± 0.2 °C (range 39.2 - 42.0 °C, n = 21). During the provocation experiment, the brood patch temperature of each incubating female changed significantly (ANOVA, F = 13.87, $p < 0.0001$; Fig. 1). After 7 min of human provocation, the brood patch temperature decreased to 39.4 ± 0.2 °C (range 38.5 - 41.4 °C, Tukey test, n = 21, T = -4.99, $p < 0.0001$). Five min after the end of the stress experiment, the birds recovered a brood patch temperature of 39.9 ± 0.2 °C, comparable to the initial value (range 39.1 - 41.7 °C, Tukey test, n = 21, T = -1.038, p = 0.55). An example of the temperature changes is illustrated in Fig. 2.

Discussion

As found in a previous study (Gabrielsen 1984), incubating female eiders nesting close to a human settlement show the passive defence response (freezing) when provoked by humans. The drop in eider brood patch temperature observed in this study is probably related to the activation of the parasympathetic nervous system and a reduction in blood flow to the skeletal muscles (Gabrielsen & Smith 1995). The passive behavioural response is also found in willow ptarmigan (*Lagopus lagopus*) in Norway (Steen et al. 1988) and in Svalbard ptarmigan (*Lagopus mutus hyperboreus*) (Gabrielsen, Blix et al. 1985). Ground-nesting birds typically crouch to the ground and freeze, relying on their cryptic colouration and reduced respiration to remain undetected. In opossum (*Didelphis marsupialis*) and deer mice (*Peromysus maniculatus*), the passive defense response is accompanied by a drop in body temperature: a 0.6 °C drop in body temperature among opossum (Gabrielsen & Smith 1985) and a several degree drop in deer mice (Rosenmann & Morrison 1974).

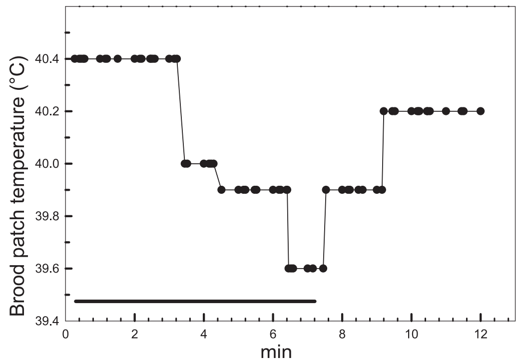

Fig.2. Typical profile of brood patch temperature in an incubating female eider during provocation. The duration of the presence of a human close to the nest is indicated by the black line.

Brood patch temperature measurements obtained in this study are well within the values obtained by Rahn et al. (1983) and Gabrielsen, Mehlum et al. (1991) from female eiders. Gabrielsen, Mehlum et al. measured a body temperature of 40.1 °C in non-incubating females. Rahn et al. measured the body temperature in the proventriculus part of the intestine after capture on the nest (39.1 ± 0.4 °C), as well as the external brood patch temperature with a thermistor implanted in an artificial egg (38.5 ± 0.6 °C).

It is interesting to compare the active defence response of penguins with the passive defence response of incubating eiders. When provoked, incubating Adélie (*Pygoscelis adeliae*) and gentoo penguins (*P. papua*) and moulting emperor penguins (*Aptenodytes forsteri*) show increased heart rate (Culik et al. 1990; Nimon, Schroter & Stonehouse 1995; Nimon, Schroter & Oxenham 1996) and a rise of 0.8 °C in stomach temperature (Regel & Pütz 1997). For these large, conspicuous birds, freezing is not an appropriate strategy against predators. In contrast, motionless, cryptically coloured eiders can be undectectable to predators, even from a few meters (pers. obs.). Moreover, penguins are better able to defend their nests against predators (Handrich, pers. comm.) than are female eiders, e.g. against Arctic fox (*Alopex lagopus*) (Ferens 1962): staying motionless is the more appropriate response for eiders.

Staying on the nest is also the most adaptive response in the context of the harsh environment of Svalbard. The ambient temperature in the study area during the incubation period (4 - 6 °C) is well below the optimal incubation temperature for the eggs (35 - 40 °C; Webb 1987); eggs cool markedly in the absence of an incubating parent. In greater snow geese (*Anser caerulescens atlantica*), birds nesting in the high Arctic and which only leave the nest for 25 min (2 - 8 recesses per day), the egg temperature decreased by 2.8 °C on average (Poussart et al. 2000). Similarly, a drop of 4.2 °C was recorded in spectacled eider (*Somateria fisheri*) for a recess duration of 37 min (Flint & Grand 1999). Incubating common eiders do not take recesses exceeding 10 - 15 min and always cover their eggs with down before leaving the nest, thus minimizing their cooling rate (Mehlum 1991; Criscuolo et al. unpubl. data).

With a mean value of 39.6 °C, common eiders show one of the highest brood patch temperatures of incubating birds (Drent 1975). The brood patch temperature drop which this study has shown to occur during provocation by a "predator" could have negative effects for eider eggs, but cooling is much more precipitous if the female actually leaves the nest, especially if it is unable to cover its eggs with down first. Moreover, reheating of the clutch after temporary nest desertion also has an energetic cost, even more deleterious for a bird which fasts for the duration of the incubation period.

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