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Indicators of body condition, energy demand and breeding success in the Ruddy Turnstone Arenaria interpres, a species of concern

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Although the Ruddy Turnstone Arenaria interpres is a species of high concern in Canada (Donaldson et al. 2000) and the United States (Brown et al. 2001), its breeding ecology is poorly understood (Nettleship 2000). Reproductive physiological and energetics studies are critical to understanding how environmental conditions affect breeding success and population viability. The breeding ecology and behavioral endocrinology of Ruddy Turnstones were studied at East Bay, Southampton Island, Nunavut, Canada in 2003. Hormonal patterns associated with energy regulation and sex-specific parental efforts were investigated to understand better how high latitude breeders meet energy demands. Normally, plasma corticosterone (CORT; the major energy-regulating hormone) is low, but can rise rapidly to help an individual through periods of potential stress (the adrenocortical response; Wingfield 1994, Harvey et al. 1984). While acute high CORT levels redirect behavior to life saving activities, chronic levels can compromise reproduction (Wingfield 1994). Previous studies have shown some Arctic-breeding birds reduce this response during critical breeding stages (Wilson & Holberton 2004, Reneerkens et al. 2002, Holberton & Wingfield 2003, O’Reilly & Wingfield 2001), possibly increasing the threshold for life-saving responses that may otherwise compromise breeding success, e.g. desertion.

The study used the Mayfield method to estimate nest success (Bart & Robson 1982). Incubation period was assumed to be 23 days (Nettleship 2000). Body condition was assessed by size-corrected body mass, with the body mass divided by the flattened wing length cubed (Winker et al. 1992, Summers 1988, Davidson 1983). Relative incubation effort was assessed during twelve 24-hour behavioural watches: six at mid-incubation (eight to fifteen days after onset of incubation) and six at late incubation (sixteen to twenty-three days after onset of incubation). To measure the adrenocortical response at different parental stages, blood samples for CORT were taken within four minutes (baseline) and at 10 and 30 minutes after capture during mid-incubation and early brooding, which includes the stage from when the first chick is hatched to when all chicks were hatched and found in the brooding, which includes the stage from when the first chick is hatched to when all chicks were hatched and found in the immediate vicinity of the nest. A direct radioimmunoassay procedure was used to determine CORT concentrations (Wingfield et al. 1992).

Nest success was 0.33 (95% CI 0.19-0.55; 321 exposure days); 42% of nests were lost to predators.

Overall, incubating females were significantly leaner than incubating males (stages pooled; t = 2.254, P = 0.032). There was some indication that body condition varied by stage, and this difference approached significance (main effect of stage: \( F_{1,24} = 3.067, P = 0.055 \)). However, there were no differences in body condition between the sexes within each stage (stage * sex interaction: \( F_{2,51} = 0.070, P = 0.932 \)). Females were somewhat leaner than males within the mid-incubation stage, and this difference approached significance (t = 2.01, P = 0.059).

Regarding parental effort and CORT secretion, breeding pairs shared incubation duties equally (total contribution by either sex did not differ significantly from 50% at either mid- or late-incubation; t = 1.1, P = 0.321, t = 0.79, P = 0.467, respectively), and this was reflected in their similar patterns of CORT secretion. Specifically, males and females showed extremely similar adrenocortical responses during mid-incubation (main effect of sex: \( F_{1,18} = 0.344, P = 0.565 \); sex * time interaction: \( F_{2,36} = 0.797, P = 0.458 \), two factor repeated-measures ANOVA, \( P > 0.05 \) for all Tukey post hoc comparisons of each sampling interval). As during the mid-incubation stage, males and females showed extremely similar CORT profiles during the early brooding stage (main effect of sex: \( F_{1,11} = 0.478, P = 0.501 \); sex * time interaction: \( F_{2,26} = 0.530, P = 0.595 \), two factor repeated-measures ANOVA, \( P > 0.05 \) for all Tukey post hoc comparisons of each sampling interval).

In contrast to the mid-incubation period, brooding birds did not express an adrenocortical response: CORT concentrations did not increase significantly in response to capture and handling during early brooding (repeated measures ANOVA, within subjects: \( F_{2,26} = 1.326, P = 0.283 \)). CORT concentrations were not significantly different between the sexes at any time during sampling (post hoc for repeated measures time 0, P = 1.00; time...
10, \( P = 0.725 \); time 30, \( P = 0.447 \).

However, both males and females (sexes pooled) showed dramatic changes in adrenocortical secretion patterns between mid-incubation and brooding (main effect of stage: \( F_{1,13} = 0.116, P = 0.736 \); stage * time interaction: \( F_{2,56} = 29.18, P < 0.001 \). two factor repeated-measures ANOVA; Fig. 1). Baseline CORT was significantly higher during the brooding stage (Tukey, \( P < 0.001 \); Fig. 1). While ten minute values did not differ, CORT concentrations at the 30 minute sampling period were significantly lower during the brooding stage as compared to the mid-incubation stage (Tukey: \( P = 0.015 \); Fig. 1).

Next success of Ruddy Turnstones at East Bay was relatively low in 2003 compared to other years (1.00 in 2000, 0.83 in 2001; P. Smith, pers. comm.), and the predation rate (42%) was higher than estimates from other areas within their North American breeding range (18-27%; Nettleship 1967, Parmelee & MacDonald 1960).

In this study, incubating females were significantly leaner than incubating males, possibly owing to their greater initial reproductive investment via egg production. Due to the severe environment in which they breed, females breeding at high latitudes may not be able to regain energy reserves until brood desertion is a viable option for them during the early to mid-fledging period. Poor condition upon arrival may subsequently affect parental effort and breeding success in both sexes, as effects may be cumulative throughout the breeding season. If a female begins the season in poor condition, a male’s ability to compensate for her early desertion would depend on his own energy reserves. Further research is needed during spring migration and throughout the annual cycle to identify factors limiting arrival condition, and, thus, breeding success of both sexes in high latitude breeders.

Previous studies of Arctic-breeding shorebirds have not compared parental effort, as reflected by the adrenocortical response, during the brood care and incubation phases. Caring for precocial young can be demanding (Hegyi & Sasvari 1998), especially for high latitude breeders facing time and energy constraints (Ashkenazie & Safriel 1979, Byrkjedal 1989). An increase in baseline CORT during brooding may be the proximate mechanism that helps parents meet the demands of parental care at high latitudes by facilitating the additional foraging and feeding required to meet their own energy needs while caring for offspring. The reduced expression of the adrenocortical response during brooding may be a mechanism to increase the threshold for abandonment during this period of greater parental effort, especially when faced with few or no re-nesting opportunities.

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REFERENCES