Reproduction at high latitudes: Environmental regulation of the neuroendocrine system in wild, free-living song birds

For most bird species reproduction is seasonal and breeding is regulated by environmental cues including photoperiod, food availability, temperature, and social interactions. My research interests lie in understanding how these environmental factors coordinate both the timing and the progression of reproduction and associated behaviour. Understanding how organisms respond to environmental perturbations is essential for coping with environmental challenges, especially when extreme global weather events are becoming more frequent due to climate change. I will give an overview of recent research giving examples from wild free-living passerines. There is evidence that neuroendocrine adaptations underlie the unique behaviour required to maximize survival and reproductive success in capricious environments. These species such as the white-crowned sparrow (Zonotrichia leucophrys) and Lapland longspur (Calcarius lapponicus) rapidly modulate their stress response and adapt their behaviour to optimise reproductive success in a very short breeding season which is often fraught with inclement weather events.

METHODS

We performed field work, hormonal analysis and RNA sequencing on samples from wild, free-living Lapland longspurs and white crowned sparrows during their arrival on the breeding grounds and during incubation on the Arctic tundra of Alaska, USA. Samples were collected over multiple years across the breeding season and during an extremely cold arrival period and incubation during an extreme weather event.

RESULTS & DISCUSSION

We describe changes in corticosterone stress responses and identified differentially expressed genes associated with inclement weather events. One gene FKBP5, was significantly up-regulated in the hypothalamus during a snowstorm, suggesting that FKBP5 is functionally important for the during an environmental stress response. FKBP5 is reported to be a regulator of the Hypothalamic-Pituitary-Adrenal (HPA) axis during the stress-response, and acts to modulate glucocorticoid receptor sensitivity. FKBP5 acts as a co-chaperone, negatively regulating the glucocorticoid signalling pathway and provides a mechanism by which an individual can rapidly and accordingly adjust its HPA axis function in response to unpredictable environmental perturbations. Such findings will contribute to the understanding of gene expression changes in multiple physiological systems to mediate stress in wild free-living birds. With such wonderful examples of environmental adaptations and regulation, avian behavioural neuroendocrinologists are entering an exciting period. Using the annotation of many more avian species' genomes to devise comparative genomic approaches and species-specific genetic tools, the identification of the genes responsible for integrating environmental information, neuroendocrine signals and reproductive behaviour is within our reach.

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