Tanner Dean Scholars Summer 2014 Research Grant Proposal

Effects of perceived predation risk on lay-date advancement in response to spring temperature in a migratory songbird

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ABSTRACT

Many bird species have advanced their lay dates in response to warmer springs linked to changes in the phenology of their prey. However, few studies have also considered the influence of top-down selection pressure on lay date via changes in the spring emergence of hibernating predators or predator abundance. We previously showed that black-throated blue warblers (Setophaga caerulescens) breeding at the Hubbard Brook Experimental Forest, New Hampshire, laid their clutches earlier in warmer springs, which was associated with greater abundance of caterpillars at the time of egg-laying. In a pilot study in 2013, we manipulated perceived predation risk by diurnally active predators by broadcasting Eastern chipmunk (Tamias striatus) and red squirrel (Tamiasciurus hudsonicus) calls throughout territory establishment until females completed their first clutch. We found no significant difference in first lay dates between experimental and control pairs. However, the year of our pilot study was cold and wet, and these conditions are not associated with earlier lay dates. We also conducted a correlational analysis using long-term data (1995-2010) and found that predator density had a strong influence on first lay date depending on climate: birds initiated breeding later in warmer springs with high local predator density. This finding suggests that predators might directly affect the ability of birds to adjust their lay dates in synchrony with increasing spring temperatures. We propose to continue to explore the mechanisms underlying the climate-dependent effects of predators on first lay dates using our experimental approach in the 2014 breeding season.

BIOGRAPHICAL SKETCH

One memory in particular stands out from my high school experience. I’m walking down a cobbled path, a small plastic back crinkling in my hand. Every few steps or so, I pause and toss a grape behind me on the path. Each time a smooth white bill darts out and snatches up the proffered fruit before it rolls away. I’m walking through the rainforest exhibit at Moody Gardens in Galveston, Texas, and I’m being followed by a piping guan.

The large turkey-like bird with a silky black coat and white crested head blinks one eye at me and bobs its long neck. I toss another grape and it snaps it up greedily. Looking down at this marvelous creature, straight from the rainforests of Trinidad, I can’t help but dream of one day visiting such a place, of exploring a vast wilderness filled with the most remarkable collection of feathered creatures. Volunteering for four years at the Moody Gardens rainforest became my initial outlet and survey into the world of organismal biology.

Through extensive training in animal husbandry I learned to appreciate the character and diversity of over 500 different species of fish, bird, mammal, reptile, and insect. From parrots to sea lions and everything in between; it was a paradise for a young animal lover being exposed to the biological sciences for the first time. I discovered an enthusiasm for my work that I had never cultivated for any of my academic courses before. I developed a strong work ethic and love of education through interactions with guests and fellow biologists. And though my work as an animal caretaker was mentally
and emotionally rewarding, I couldn’t help but continue to ask questions, often incessantly.

"Why does that fish swim that way?" or "Why does this bird call like this?" Questions about animal behavior left unanswered would simultaneously intrigue and frustrate me. It was not until I entered Cornell, and had the opportunity to interact with some of the most esteemed scientists in the field that I realized you could make a living studying animal behavior. I was immediately hooked. I realized my passion for organismal biology combined with a steady determination and a naturally inquisitive personality was well suited to work as a researcher. Finding my place in Mike Webster’s lab opened up a myriad of possibilities for the study of animal communication and behavior, and I found myself diving into a project with an unmatched eagerness from before.

Looking back I realize how much this job has changed my life, by teaching me new skills, allowing me to work in habitats and with organisms that I only ever dreamed of, and giving me the opportunity to interact with a dizzying array of fascinating people. With my project this summer I look forward to exciting new discovery and the hopes that the results we obtain help add to the ever expanding body of scientific knowledge.
STATEMENT OF PURPOSE

Introduction

Higher average spring temperatures over the last three decades, a consequence of climate change, have led to forward shifts in the reproductive phenology of many organisms\(^1,2,3\). Some species are able to alter their reproductive phenology to best match this trend and subsequent advances in resource availability\(^4\). Birds in particular have shown close associations between earlier peaks in food abundance that result from advanced tree phenology and adjustments in their timing of laying\(^5\). In some cases though, a migratory species may encounter an ecological “mismatch” if constraints in the timing of migration result in a peak of food abundance at the breeding grounds that does not coincide with the care of its nestlings\(^6,7\). In other cases, a species, like the black-throated blue warbler, may be able to alter its breeding phenology accordingly and take advantage of the early emergence of prey\(^8\). However, the mechanism underlying these shifts is unclear. Shifts in the phenology of food abundance, a bottom-up effect, can influence the optimal timing of egg laying. But if warm spring temperatures also allow mammalian predators to emerge from hibernation earlier, their presence may influence the timing of nest building and nest placement in females who benefit by waiting for full vegetative leaf-out in order to maximize concealment of their nests. Thus, higher natural predator densities early in a season have the potential to constrain an adaptive advancement in lay-date brought about by increased food abundance.

Not only can changes in the phenology of predators potentially alter the timing of predation events, but growing evidence suggests that there are also indirect behavioral consequences to the perceived presence of predators, outside of any lethal effects\(^9\). This “ecology of fear” hypothesis proposes that the effects of predators on prey numbers may be much greater than those attributed by direct killings alone, and that certain anti-predator behaviors may lead to decreased reproduction or death from other causes\(^9,10\). Anti-predator responses may include changes in habitat use, increased vigilance, and adjustments to foraging behavior. One study found that the perception of predation risk alone was sufficient to reduce total reproductive output of a resident population of song sparrows by forty percent\(^11\). The focus of this study was on the effects of perceived predation on parental investment in the incubation and nestling stages. To follow up on this work, I am interested in determining whether perceived predation risk plays a role in the reproductive phenology of migratory birds, or if another mechanism resulting from climate change is responsible for any phenological shifts described. Finally, I am also interested in any modification of parental investment that might be caused by the adoption of certain anti-predator responses.

Objectives

I hypothesize that early season perceived predation risk will influence nest placement and also constrain an advancement in lay-date in black-throated blue warblers. I predict that females in territories with experimentally elevated perceived predation risk will build their nests later, choose more concealed nest sites, and lay their eggs later than females in the control territories. I also predict that females nesting in territories with
high natural predator densities will show similar responses to females nesting in experimental territories. My second objective is to investigate the effects of perceived predator risk on parental investment. I hypothesize that increased perceived predation risk will cause female warblers to adopt anti-predator behaviors that influence their level of investment in their eggs and young. I predict that females nesting in experimental territories will have shorter incubation bouts than those in control territories and will show increased vigilance and a greater tendency to flush from the nest when exposed to directed playbacks during the nestling stage.

Methods (study species, general field methods/experimental design)

The Black-throated blue warbler (*Seiophaga caerulescens*; hereafter BTBW) is a Neotropical migratory songbird that breeds in the northern hardwood forests of eastern North America. At our site at the Hubbard Brook Experimental Forest in New Hampshire, females construct open-cup nests approximately one meter above the ground, primarily in hobblebush (*Viburnum lantanoides*), which makes the nests relatively accessible and easy to find. Females typically lay 3-5 eggs, incubate for eleven days, and feed their young in the nest for nine days before they fledge. BTBWs are not limited by a single peak in food abundance, but still show advancements in lay-date in response to warmer spring temperatures that facilitate a longer breeding season. Earlier breeding, which leads to higher annual fecundity for pairs that can attempt a second brood, is thus under strong selection pressure.

To test my first hypothesis—that early season perceived predation risk will affect nest placement and constrain lay-date—I will continue an experiment using predator playback at the Hubbard Brook Experimental Forest in Woodstock, New Hampshire. The year of the pilot study (2013) was cold and wet, and we suspect that no significant difference in lay-date between experimental and control territories was observed because these conditions were not conducive to advancements in lay-date or because of a limited power to detect an effect. This season we will repeat the experiment to increase our sample sizes and, by consequence, our power.

From the first week in May through the second week in June, the timing of male BTBW arrival and territory settlement will be documented by surveying three long-term study plots located at high (700-850m) mid (450-650m) and low (250-400m) elevation every three days. Once males have settled at a site, territory boundaries will be mapped using locations of counter-singing and agonistic encounters with neighbors. All males will be caught and banded using conspecific playback, and females will be banded while incubating. On the mid-elevation plot, focal territories will be randomly assigned to control (n = 12) or predator playback treatments (n = 12). Two speakers spaced 20 m apart will be established in the centers of experimental territories and automated to playback predator vocalizations for 5-min periods at 10 min to 1 hour intervals from 0500 – 1900 from 5 – 30 May (core period of territory establishment). Playbacks will be alternated between speakers, and speakers will be rotated around each territory every four days, to reduce habituation and simulate predator movement. Natural nest predator density will be quantified for each focal territory by conducting four 5-min point counts of diurnally active predators (primarily eastern chipmunks *Tamias striatus* and red squirrels.
*Tamiasciurus hudsonicus* during each of six biweekly periods from early May through July (n = 24 censuses per focal territory over the season). Each nest will be located within focal territories to determine lay-dates for first nests. Timing of territory settlement and first lay-dates of control and experimental territories will be compared and the relationships among natural nest predator density, nest placement, timing of territory settlement, and first lay dates will be examined.

To test my second hypothesis—that perceived predation risk can influence parental investment—I will conduct targeted playbacks of either red squirrel calls or eastern chipmunk calls to females incubating or brooding. A female response score will be created beforehand so that the observer can quickly and objectively identify anti-predator behaviors including decreased incubation time, a greater tendency to flush from the nest, and increased vigilance indicated by vocalizations or posture. A female from each experimental and control territory will be observed for 20 min after the continuous playback period has ended, and the average behavioral score (from 0-5, with 0 being no reaction and 5 meaning the female flushed from the nest and vocalized) will be compared between the two groups.

My resources include 1) the field sites and facilities at the Hubbard Brook Experimental Forest. Housing maintained by the Hubbard Brook Research Foundation, is close to the study sites and provided for researchers and field technicians at a local rental rate. 2) Three institutions (Wellesley College, Dartmouth College, and Cornell University) contribute staff and students to the research effort and also organize the collective effort responsible for maintaining the long-term population dataset on BTBWs. 3) PIs Webster, Rodenhouse, Sillett, and Holmes act as mentors for undergraduate and graduate students, and provide resources including recordings and software from the Cornell Lab of Ornithology. 4) Funding from a National Science Foundation-Research in Undergraduate Institutions-Long Term Research in Environmental Biology (NSF-RUI-LTREB) award allows the BTBW crew to buy necessarily equipment like video cameras, speakers, binoculars, GPS units, etc.

**Significance of Research**

My project builds on previous work examining the effects of climate variability on reproductive success in black-throated blue warblers. One of the primary objectives of the study is to identify the mechanisms by which abiotic and biotic factors affect population demography and examine behavioral responses to environmental variability. Identifying these mechanisms can provide a greater understanding of how factors, such as climate change or land-use change, may potentially impact organisms in similar habitats. Finally, this research will contribute to the broader research effort being conducted at Hubbard Brook, leading to new questions and insights on a system that has been studied for more than 40 years.

**Personal Interest**

I am interested in this project because I wish to gain further experience designing experiments, collecting data in the field, analyzing data, and writing scientific papers for publication. The study of animal behavior has always interested me so I find the subject
of perceived predation exciting, as understanding its effects helps us build a more complete picture of how animals perceive and interact with their worlds. Lastly, Hubbard Brook provides a unique opportunity for collaboration with experienced researchers and access to data from a renowned long-term population study.

References


