

Ketterson / Nolan Research Group Collection

This document is part of a collection that serves two purposes. First it is a public archive for data and documents resulting from evolutionary, ecological, and behavioral research conducted by the Ketterson-Nolan research group. The focus of the research is an abundant North American songbird, the dark-eyed junco, *Junco hyemalis*, and the primary sources of support have been the National Science Foundation and Indiana University. The research was conducted in collaboration with numerous colleagues and students, and the objective of this site is to preserve not only the published products of the research, but also to document the organization and people that led to the published findings. Second it is a repository for the works of Val Nolan Jr., who studied songbirds in addition to the junco: in particular the prairie warbler, *Dendroica discolor*. This site was originally compiled and organized by Eric Snajdr, Nicole Gerlach, and Ellen Ketterson.

Context Statement

This document was generated as part of a long-term biological research project on a songbird, the dark-eyed junco, conducted by the Ketterson/Nolan research group at Indiana University. For more information, please see IUScholarWorks (<https://scholarworks.iu.edu/dspace/handle/2022/7911>).

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MLBS Goals.2009
6/6/2009

Objectives

Hormones play important roles in reproduction, influencing many attributes of vertebrate animals, and making them especially interesting compounds. The primary goal of our research is to explore the role of testosterone in the expression and evolution of complex behavior and physiology in a songbird the dark-eyed junco. We employ a mix of experimental and correlational approaches. For many years we focused only on males, but we now study both males and females, with greater emphasis on females. We seek to understand the mechanisms underlying sexual dimorphism and co-variation among phenotypic characters. We are also quite interested in the indirect effects that the hormonal state of parents can have on the phenotypic development of their offspring.

In addition we are interested in the junco for its own sake, it's ecology, evolution, vocal behavior, and life history. This has led us into studies of geographic variation, branching out to other populations and environmental conditions.

Much of the research conducted at MLBS in 2009 will address the relationships between behavior, and fitness, with an emphasis on female defense behavior, male vocal behavior, and the potential for chemical communication among juncos and between juncos and nest predators.

Background history

In the past (1987-2000), we saturated the study area with male treated subcutaneously with implants of testosterone or empty implants as controls (T- and C-males). We observed behavior and physiology, and measured relative reproductive success and survival of males of both types. The task required that we census twice a year, map territories, find nests, bleed/band/weigh nestlings, and then remove implants at the end of summer and mark the years' new juveniles. Numerous sub-projects allowed us to measure the effects of the implants on behavior and physiology. These findings are summarized in Ketterson and Nolan 1992, 1999, Ketterson et al. 2001, Reed et al. 2006.

Beginning in 2001 and continuing in 2002, we turned to implanting females and measuring the effect of T on them. We conducted studies like this in 2005 and 2006 as well. The rationale was to determine the extent to which males and females resemble one another in how they are affected by T. We argued that traits that are unaffected by T in females are insensitive, allowing selection to proceed on these traits in males without accompanying correlated phenotypic responses in females. For traits in which females are sensitive to T, then to the extent that the sexes are genetically correlated, a phenotypic response in females would be expected. The evolutionary implications would depend upon whether the responses were beneficial or detrimental. These ideas and findings to date are presented in Clotfelter et al. 2004, Ketterson et al. 2005, Zysling et al. et al. 2006, O'Neal et al. 2008, Ketterson et al. 2009. Some of the findings include that T-females were more likely to dominate in resident-intruder trials, were less responsive to simulated predation events, elevated corticosterone more in response to handling stress. T had no detectable effect on incubation or nestling provisioning. Rate of nest predation was greater in T- than C-females.

In 2003-2004, we took a break from implanting and focused on natural variation in T and co-variation between T and phenotypic characters including plumage coloration, body size, parental behavior, and immunoglobulins. When the female implant studies were fully completed in 2006, we again focused on natural variation (2007-present). Our measures were baseline T and T in response to a GnRH challenge, which results in an increase in T (GnRH → LH → T) and varies from individual to individual. We found sex and seasonal differences in response to GnRH (Jawor et al. 2006). In males we found co-variation between response to GnRH and response to an STI, and plumage (McGlothlin et al. 2008), as well as co-variation between baseline T, body size, and a measure of innate immune function (IgG, Greives et al. 2006). We also found co-variation between T in response to GnRH and parental behavior (McGlothlin et al. 2007). The big implication here is that because all these traits are interconnected, then if selection favors one trait, more than one may be respond to selection, and we are curious about how these complexities influence whether selection results in optimal or sub-optimal phenotypes. This brings us almost to the present.

2009

We are still working on the relationship between response to GnRH and fitness, with this the final year on that except to note returns next year. We are also very interested in variation among females in the degree to which they express male-like traits and whether there is a role for testosterone in androgyny. Males vary in their attractiveness to females and male juncos have very elaborate vocal behavior. We do not know whether that is related to testosterone, e.g. do stronger responders to GnRH have more elaborate songs, but more importantly we are interested in junco song for its own sake because it is quite out of the ordinary. We are also interested in chemical communication in juncos, something that likely has a connection to hormones but is again quite interesting in its own right. And finally, we are making the leap to studying the brain to see how individuals vary in their sensitivity to testosterone. This is an exciting time to be joining the project.

Major goals for 2009 (chronological order and primary grad student, post-doc, and REU responsibility)

1. Male and female response to GnRH in relation to phenotype and fitness (Amy, Kristal, Sarah, Team)
 - a. In the early season of 2009 and in the two preceding years we have measured T in response to GnRH of birds caught during April-May. A major goal described in the grant proposal that supports our work is to relate this hormonal variable to fitness – i.e., does the degree to which a bird produces T after being challenged with GnRH affect whether it settles on the study area, is mated or not, produces fledglings or not, returns in the following year, i.e. its reproductive success or survival?
 - b. Hence the presence/absence and reproductive success of EVERY BIRD on the study area is of interest to us. Where are their territories, do they have a mate all season, can we find their nests, etc. Every time you enter a piece of information

onto a nest log, a sighting sheet, a nestling weight sheet, the DNA list, or any banding sheet in excel, you are contributing to this goal.

- c. The early season team has collected the GnRH data; the current team will collect these fitness data, and Amy will coordinate these efforts with help from everyone.
2. Female behavior/ behavioral syndromes, i.e., does an individual's behavior in one context predict its behavior in another? (Kritsal, Miriam, Lauren)
 - a. Is a female's behavioral response toward a female nest intruder similar to that toward a male intruder, and are strong responders to one sex of intruder also strong responders to the other sex? Also does response vary with ecological factors, e.g. sex ratio? (simulated nest intrusions, SNIs) (Miriam)
 - b. How do individual females vary in flushing behavior and nest type? Does flushing behavior vary with stage of reproduction or nest type? Are females consistent in the type of nest they build? Does variation in flushing behavior relate to digit ratio (Lauren)
 - c. Does a female's response to a conspecific predict her flushing behavior or vice versa? We can ask this question by combining findings from Lauren and Miriam at the end of the season.
3. Female morphology/physiology/behavior (Kristal with help from team)
 - a. Does T in response to GnRH co-vary with digit ratio?
 - b. Do yolk steroids co-vary with digit ratio (Kristal)
 - c. Does female behavior co-vary with female yolk steroids, digit ratios, body size, or plumage?
 - d. Do the variables (a-c) predict frequency of EPFs, and other measures of fecundity or survival?
 - e. Do nestlings resemble their mothers in digit ratios?
4. Male vocal behavior within and across populations (Dustin, Becky)
 - a. Juncos are unusual in the complexity of the song they use in courtship and these low volume, complex vocalizations have received very little study in the past. Questions to be addressed this summer include the following.
 - b. Does male behavior vary in relation whether a simulated territorial intrusion (STI) consists of full volume long-range song (LRS), reduced volume long-range song, or short-range song (SRS)(courtship song)? (Becky)
 - c. Do males have individual repertoires of SRS as recorded on mini-microphones? (Dustin)
 - d. Does male vocal behavior vary depending on whether exposure to SRS is followed by exposure to a male lure as opposed to a female lure? (Becky)
 - e. How is male vocal behavior influenced by a simulated intrusion by a female producing trills (angry trills? fertile trills? Simulated sexy intrusions, SSIs)? (Dustin)
 - f. Do LRS and SRS produced in response to a female intruder vary by geographic location? (Dustin)
 - g. Do females respond more to SRS than LRS as measured by increase in LH after exposure to one song type, the other song type, or silence? (Dustin)

5. Preen gland secretions, individual variation and parental behavior (Amy)
 - a. Does incubation or nestling provisioning behavior vary in the presence/absence of similar/dissimilar preen oil applied to eggs or nestlings?
 - b. Do individuals vary in the composition of preen gland secretions by stage of reproduction?
 - c. Does variation in preen gland secretions relate to major histocompatibility complex (MHC)?
 - d. Do detailed observations of behavior at the nest on day 3 co-vary with other measures of individual behavior of individuals made by Kristal, Dustin or Team?

6. Is female aggression influenced by androgens? If yes, to what extent is variation among females in their aggressive behavior predicted by variation in hormone levels as opposed to neural response to hormones? (Kim).
 - a. Does variation among females in their aggressive response to a female intruder near the nest (SNI) predict neural sensitivity to androgens or other hormones known to be involved in male aggression.

7. Impact of experimentally elevated T on female fitness (team, clean up work)
 - a. Survival: conduct early spring and late season census to compare relative rate of return of T- and C-females implanted in earlier years (team). This applies only to the few birds surviving from when we last implanted females (2006).

Responsibility and credit

We have an MO that has been successful in the past and serves as a template. Each year the team as a whole collaborates to pursue our joint objectives. This year's projects, for example, build on the GnRH challenges from the early spring and will require that we all find and share nests. No nest, no study, so we all need to help find them; the same for recording and entering data. In addition, certain individuals have responsibility for particular goals, where responsibility consists of writing proposals and protocols and later analyzing data and writing the first draft of papers that result. This requires cooperation with other members of the team to be sure that studies don't interfere with one another.

Not every paper has every participant as an author, because some of the effort is seen as reciprocal. Typically graduate students and post-docs are first authors on papers that result from projects they conduct. Collaborating REU students are typically authors on those projects as well, with the necessary caveat, "if they turn out to be publishable." Sometimes they are, but sometimes they are not. Field assistants do not typically earn authorship in the first year at MLBS, but if they participate in multiple years they often do. Because some studies are conducted over multiple years, credit is sometimes shared with earlier participants.

Some papers are not associated with one individual or may summarize many studies, and frequently I am the first author on those. And certain individuals have 'special status' because they have invested so much effort in the demographic data that accumulate over time, e.g. Eric Snajdr and Nicki Gerlach.