



## **Integration of Ecology and Endocrinology in Avian Reproduction: A New Synthesis**

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**Integration of Ecology and Endocrinology in Avian Reproduction: A New Synthesis.**—John Wingfield, Marcel E. Vissor, and Tony D. Williams, Eds. *Philosophical Transactions of the Royal Society of London, Series B* 363:1579–1723.— This issue comprises 11 reviews based on papers presented at workshops supported by the E-BIRD network. The E-BIRD network was sponsored by the European Science Foundation, the National Science Foundation (USA), and the Natural Sciences and Engineering Research Council (Canada) to encourage collaboration between avian evolutionary ecologists and endocrinologists interested in avian reproductive biology.

The motivation for the E-BIRD network was to contribute to the science needed to predict changes in ecosystems that are likely to be caused by climate change and human exploitation of natural resources. This requires better integration of many research disciplines applied to the study of ecosystems that are accessible to quantitative observation and experimental manipulation. A good example is provided by the reproductive ecology of birds, because they are easy to observe in a wide variety of natural habitats, and predictions made from field observations can often be tested experimentally both in the field and in the laboratory. Avian evolutionary biologists generally seek to understand how reproductive traits are changed by natural or sexual selection at the population level, without considering the underlying genes and physiological control mechanisms. The challenge of identifying genes that control natural changes in reproductive traits has yet to be met by advances in genetics and functional genomics, but hormones and their receptors are a key link in the chain between gene and reproductive trait. Avian reproductive endocrinology is a mature discipline, but the influence of related research in humans and domestic animals has not encouraged consideration of how natural selection may act on reproductive traits through hormonal mechanisms at different life-history or developmental stages to tailor population fitness to changing habitats.

These reviews consider this issue and are written by leading experts in avian ecology or reproductive endocrinology. Each

review provides a succinct introduction and then focuses on state-of-the-art science. Most pose challenging research questions, particularly to endocrinologists who are not generally used to thinking in terms of life-history stages, reaction norms, and phenotypic plasticity. Three themes are considered, based on presentations given at the three workshops supported by the E-BIRD initiative. The first theme (tradeoffs and constraints) addresses the question of how hormonal control mechanisms affect selection for life-history traits; the second theme (maternal effects) considers the mechanisms through which the physiological condition of parents influences the phenotype or genotype of their offspring; and the third theme (individual variation) explores the possibility that a better understanding of causes of individual variation may be important in understanding how hormonal control mechanisms are involved in selection for life-history traits.

The reviews on tradeoffs and constraints discuss the extent to which phenotypic plasticity is both determined and constrained by the underlying neuroendocrine control mechanisms. It is emphasized that different mechanisms underlying phenotypic plasticity are selected under different environmental conditions. The importance of correlated traits mediated by hormones is highlighted in the context of a quantitative genetic framework.

Reviews on maternal effects discuss what information is still needed to understand how the adult environment influences the development and phenotype of offspring. A potential route through which environmental conditions acting on the female affect the development and phenotype of offspring is the types and concentrations of hormones in yolk. This topic is discussed in relation to the expanding range of hormones discovered to be present in yolk, to interspecies differences in correlations between yolk hormones and phenotypes, and to the role of metabolizing enzymes and hormone receptors. Observations on large data sets from tropical and temperate species illustrate how differences in androgen deposition in yolk may explain adaptation to different strategies in maternal attentiveness. A fascinating maternal effect in some species is to change primary sex ratios in response to changing environmental conditions. The ecological importance of this is discussed, with a particularly insightful analysis of the possible mechanisms involved.

The third set of reviews, on individual variation, argues the case for a quantitative analysis of interindividual variation of endocrine systems in relation to life histories and evolutionary responses to environmental change. An in-depth review of endocrine regulation of individual behaviors highlights the importance of understanding the complexities of endocrine signaling pathways that control behaviors. The contribution of intrinsic (genetic or maternal effects) or extrinsic (environmental) factors to interindividual variation in circulating concentrations of hormones is discussed in relation to plasma testosterone levels in free-living Blue Tits (*Cyanistes caeruleus*), making the point that the role of extrinsic factors is overemphasized.

The high quality of these reviews is a testament to the success of the E-BIRD initiative in encouraging avian evolutionary ecologists and endocrinologists to broaden their conceptual approaches to understanding the evolution and regulation of avian reproductive strategies. The dialogue between avian

evolutionary ecologists and endocrinologists encouraged by E-BIRD workshops and these reviews will encourage new, and better-planned and integrated, collaborations. They highlight the opportunities for collaborations among evolutionary ecologists, developmental biologists, physiologists, and geneticists in the search for better predictive models of the impact of climate and habitat change on ecosystems. All those working in these disciplines will find these reviews stimulating and rewarding.—PETER J. SHARP, *The Roslin Institute, University of Edinburgh, Roslin, Midlothian EH25 9PS, Scotland, United Kingdom. E-mail: [peter.sharp@roslin.ed.ac.uk](mailto:peter.sharp@roslin.ed.ac.uk)*