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Source: BioScience, 63(5) : 407-408

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1525/bio.2013.63.5.17

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behavior, and many of his examples are, by necessity, only of those species with sufficient life-history traits and physiological data available for evaluation.

Williams does succeed at stimulating critical analysis and discussion of the field, in part by providing a list of future research questions at the end of each chapter. His text combines targeted, well-explained background information with a critical appraisal of current and past research and is illustrated with a range of black-and-white figures from the literature, most of which have been redrawn especially for the book. Thus, *Physiological Adaptations* is an excellent resource for seminar discussion and other question-led teaching at advanced undergraduate and graduate levels.

The most stimulating aspects of the book are the author's refreshingly direct opinions and approach to writing. He does not hide his frustrations concerning many aspects of the current state of avian reproduction research and is equally critical of the more traditional physiological and ecological approaches. Much of what is known about the mechanisms of yolk synthesis in birds, for example, has been derived from work on poultry in which estrogen-treated roosters were used, rather than hens. (The advantage for physiologists, of course, is that the male liver is highly responsive to estrogens and therefore provides a "cleaner" background for experiments, because endogenous estrogens are low in males.) However, studies of females are essential when there is a need to understand the physiological basis of variation in reproductive traits.

From the point of view of physiology, it is striking how mechanistic explanations that appear well established in poultry often begin to break down when they are tested in wild species. For instance, it has been predicted, on the basis of poultry studies, that the maternal hormone prolactin plays a key role in reducing clutch size and promoting incubation; however, this evidence has not been well supported in the limited number of nonpoultry studies that have been performed. Williams also expresses his exasperation about the persistence in the literature of certain widely held assumptions, despite little direct experimental evidence for those assumptions—for example, how egg production is demanding in terms of the energy and nutrients required. Although recent progress has been made with regard to integrating the physiological and ecological approaches to this research, the overall effort has not been well focused. Much work has been performed on variation in egg size and quality and on the possible underlying mechanisms, such as the deposition of yolk steroid hormones, but there has been little payoff in terms of evidence of long-term effects on offspring phenotype and fitness.

The effect of Williams's critical approach to writing *Physiological Adaptations* is an emphasis in the book on the lack of core knowledge in this research field, particularly in wild species, and especially in females. The central question that the author poses about the exent to which mechanistic variation can explain phenotypic variation in the life-history traits of avian reproduction remains largely unexplored, owing to the limitations of past research approaches. The book's value then lies in its emphasis on the need for the rigorous formulation and testing of research questions. However, for more rapid progress, better integration with emerging genetic and genomic approaches will also be required. As Williams points out, avian reproductive genomics is still in its infancy, but progress is beginning to be made with the availability of next-generation sequencing and the development of DNA chips for analyzing single-nucleotide polymorphisms in wild bird populations. The challenge will be in linking genotypic and phenotypic variation across very large data sets and ensuring that the information is applied effectively and critically to address the fundamental questions raised in Lack's book.

There is much to do before a book on genomic adaptations for breeding in birds can be published. In the meantime, Williams's book provides a rousing stimulus to the field and will provoke established and developing researchers to question what they really know about avian reproduction.

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doi:10.1525/bio.2013.63.5.17

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