

BOOK REVIEWS

**Avian Growth and Development: Evolution with-
in the Altricial-Precocial Spectrum.**—Edited by J.
Mattias Starck and Robert E. Ricklefs. 1998. Oxford
University Press, New York. xi + 441 pp., 166 illus-
trations. ISBN 0-19-510608-3. \$70 (cloth).

The study of avian development has been peculiarly subject-oriented, with individual researchers largely focused on particular aspects of the topic. Throughout the 1940s and 1950s the field was dominated by the morphological and physiological research of Adolph Portmann, research which extended across many wild species but which was also to a great extent mirrored in corresponding work on poultry. The first real synthesis of the field within a natural history context—Margaret Morse Nice's 1962 classic *Development of Behavior in Precocial Birds*—was focused on ontogeny in precocial birds, and my own *The Growth and Development of Birds* in 1984 was heavily ecological in cast, only rather succinctly synthesizing basic morphological and physiological patterns. The present multi-author volume, on the other hand, is immediately noteworthy for its in-depth review across the entire spectrum of avian development, extending from cellular through evolutionary processes to modeling of growth patterns.

The book consists of 17 chapters from 20 contributors, with a brief Preface and systematic and subject indices. The Preface explains how the multiple authorship was coordinated among contributors in a series of three symposia and workshops, a process that has minimized, though not entirely eliminated, the individualistic quirks, omissions, and repetitions that typically characterize multi-author work. The individual chapters range in size from 15 to 40 pages (not counting the final Appendix-like Chapter 17 tabulating growth parameters). Chapter 1 by Starck and Ricklefs is titled *Patterns of development: the altricial-precocial spectrum* and describes and justifies a new index of functional maturity, used within many of the later chapters to sequence ontogenetic events and degree. That index is calculated as the residual for each species from the allometric regression of the lean dry fraction of the neonate on neonatal mass. What is especially useful about the new index is that it clarifies relations between the awkward altricial/semi-altricial/semi-precocial/precocial classes of earlier classifications of modes of growth, classes whose defining attributes were often inconsistent within a species. The new index shows that altricial species have low values (immature tissues) relative to all other species (including semi-altricials); within the latter, the index is quite variable and the species are positioned along a true continuum, with the clear implication that evolutionary diversification of ontogenies has been gradual rather than categorical. The strong evidence adduced for organization along a single dimension and documented across dozens of species supports my own earlier argument that development was constrained at whole organism rather than at tissue level, even though indi-

vidual tissues commence functioning on their own individual schedules.

In Chapter 2, Ricklefs and Starck use data on body masses, egg masses, and incubation period of some 799 species (an astonishingly large compilation, though it must have been infuriating not to make the 800!) to ask whether embryonic growth was correlated with position on the altricial-precocial spectrum. The most important findings were the absence of such correlation, great conservatism in embryo transition through the 42 morphological stages of Hamburger and Hamilton, and the differentiation of altricial and precocial condition only shortly before hatching. These findings unequivocally contradict Portmann's long-unchallenged hypothesis that altricial birds simply hatch at an earlier stage in ontogeny. As Ricklefs and Starck write (p. 41), "It is astonishing that avian embryonic development in a range of species from penguins to songbirds can be described by these same 42 normal stages, independent of the mode of development . . . the succession of embryonic stages seems to be almost invariant among birds, . . ." Whether this invariant growth rate is due to an individually limiting tissue (for which the brain and nervous system—disproportionately large during embryonic development—would be a prime candidate) or to the need to maintain some particular quality of tissue growth even at the cost of slow overall growth remains for future research.

Subsequent chapters similarly focus on individual themes or tissues. Starck further refines the organismal growth constraint idea to show how having different trajectories for tissue differentiation and for organ growth permits mosaic patterns among organ systems, with accompanying trade-offs between growth rate and functional maturity. Carol Vleck and Theresa Bucher bring a fresh look to the physiology of the hatching process, long ignored as merely the end of embryonic growth or the start of nestling or chick growth! A competent synthesis by G. Henk Visser covers the development of temperature regulation. Although this includes good coverage of biophysical issues and of such emergent concepts as peak metabolic rate and its allometry, I was somewhat disappointed with it. First, Visser persists in the use of Nice's classification of development modes, despite the findings of Chapter 1. Second, in discussing how some birds can withstand low body temperatures, he details only studies of petrel chicks, with passing reference to other species, and totally ignores the seminal work of David Lack on the adaptive significance of torpor in the European Swift *Apus apus*. In addition, consideration of the energy costs to the parents of warming a torpid chick back to normal temperatures would have been appropriate here. The following chapter by Høhtola and Visser on the development of locomotion and endothermy is notable for its emphasis on the developmental biochemistry and electrophysiology of muscles. It is clear that the advent of new techniques has opened up lines of research that were previously extraordinarily difficult to pursue, and that the new thinking in this chapter is

but the herald of what is to come. F. M. Anne McNabb, Colin G. Scanes, and Michal Zeman discuss the endocrine control of development, with results from this new field offering some clear insights but only a limited body of data from which to draw inferences. Thyroid function in precocial chicks develops during embryony, being critical for the accelerated homeothermy of the neonate, but starts only well into the nestling period among altricial species. On the other hand, plasma growth hormones follow a common accrual path in the two groups. For most hormones, however, information is available only for precocial species, precluding comparison across developmental classes. Chapter 8 on the ontogeny of immune function (Victor Apanius) reflects a field that is at an even more primitive stage, showing suggestive patterns that yet lack solid foundations for their interpretation and comparative analysis. Perhaps because of this, Apanius' chapter lacks the "Conclusions" section present in most other chapters. Chapter 9 (Heinz Düttmann, Hans-Heiner Bergmann, and Wiltraud Engländer) contains attractive illustrations of particular behaviors and their components, and provides a comprehensive sweep across the full range of neonatal behaviors. Interestingly, while only some behavior patterns appear in near-final form early in development, those emerging only gradually are not necessarily limited by incomplete maturation: injection with testosterone may result in the complete behavior being abruptly manifest!

Analysis of the phylogenetic constraints on variation in growth (Chapter 10, Starck and Ricklefs) suggests that selection for body mass appeared early in evolution, followed thereafter by variation in growth rate dominated by that selection, with a few scattered anomalies. Chapter 11 (Ricklefs, Starck, and Marek Konarzewski) analyzes internal constraints on growth rate. Although several lines of evidence indicate that organs involved in assimilation and distribution of food and oxygen or in removal of waste products may limit growth, the authors dismiss that explanation in favor of a fundamental antagonism between growth and function of tissues. Their rejection is based on the gut being sensitive to changes in food supply, on growth rate being insensitive to mortality during development (they argue that if supply organs were flexible, growth should be adjusted to mitigate mortality), and on overall growth rate being sensitive to modes of development primarily dependent on the demand tissues (muscle, skeleton, integument, etc.). However, as they themselves recognize, costs of increase in the gut (etc.) are unknown, even though it can occur; cost of the flexibility in growth rate is therefore also unknown; and if the demand muscles are limited ultimately by supply organs, it is irrelevant that overall growth is limited by demand muscles. Hence, I depart from the authors in thinking that their evidence for rejection of supply-side limits in the organism is "compelling," but at the same time I concur with their conclusion that resolving the relative role of intertwined constraints is incredibly difficult. On this point their synthesis of the material, and the carefully thought-through research agenda they offer, are the strengths of this chapter.

Chapter 12 (William Schew and Ricklefs) reviews

developmental plasticity and emphasizes the value of food restriction experiments in understanding evolutionary variation in growth rates. The role of genetic factors in shaping growth rates is examined by Arie van Noordwijk and Henry Marks, who conclude that asymptotic size has ample genetic variation, allowing rapid environmental selection for change in body size. Interaction of genotype with environmental factors also emerges here as an expanding research topic. In Chapter 14, the causes of growth variation and its implications for fitness are reviewed by Sabine Gebhardt-Henrich and Heinz Richner. I found this the most disappointing chapter in the book, it being a largely discursive catalog of possibilities that lacked the decisiveness of the other chapters. Even their "Unresolved Questions" failed to inspire me to want to study the issues raised, and, tellingly, their chapter lacked a "Conclusions" section.

The remaining substantive chapters are synthesis ones. Konarzewski returns to join Sebastiaan Kooijman and Ricklefs in Chapter 15 on models for avian growth and development. These models are far from the simple graphical models traditionally found in growth studies, instead turning to the use of dynamic programming to handle the complexity of state variables involved. However, the authors' deployment of these models met with mixed success, correctly predicting growth rates in small and in univoltine species but failing with other species. Even so, the chapter provides a glimpse of the state-of-the-art in growth modeling, making it clear that it is only a matter of time and further effort before these approaches yield a rich pay-off. Chapter 16 by Ricklefs and Starck is again a sweeping synthesis, this time as to the evolution of the developmental mode in birds. It is best described as a rich treasure house for graduate students entering the field and in need of ideas deserving research attention.

Occasional typographic errors are scattered across the book, though rarely with more than one on a page, e.g., p. 85. On p. 170 "economical" is mis-used for "economic." Surprisingly for some one who uses language with exactitude, Ricklefs slips in using "siblicide" where "fratricide" is intended ("fratricide" is the murder of a sibling and not, as often incorrectly assumed, only the murder of a brother, while "siblicide" violates the rules of etymology by joining word stems from two different languages). Figure 1.5 uses three different symbols (for the different developmental modes represented, I infer from Figure 1.4) but offers neither explanation nor cross-reference. Similarly, Figure 3.3 and 3.17 each use letters to reference particular features in the illustration but without explanation in their respective legends. Additionally, each chapter contains its own bibliography but there is none for the two citations in the Preface. I suspect also that many readers will be irritated by not being able to consult a unified bibliography at the end, a significant omission in a work that must surely become the standard reference in the field.

This book belongs in all college and university libraries and in reference libraries, and will unquestionably prove of value to most ornithologists, although it is probably too technical to be of interest to a general

audience. The book will be much cited!—RAYMOND J. O'CONNOR, Department of Wildlife Ecology, 240 Nutting Hall, University of Maine, Orono, ME 04469-5755, e-mail: oconnor@umenfa.maine.edu

The Bird Collectors.—Barbara and Richard Mearns. 1998. Academic Press, San Diego, CA. xvi + 472 pp., 190 black-and-white photos, 3 tables, 4 maps. ISBN 0-12-487440-1. \$49.50 (cloth).

This book is a history of people who built the great museum collections of birds around the world. The killing of birds for scientific purposes has become a contentious issue today, a subject which tends to polarize opinion and produce heated controversy. The authors, mindful of the controversy, and expressing ambivalence themselves (they have never killed a bird), manage to present an even-handed historical report on bird collecting and bird collectors. They say in the Preface, "... if you turn pale at the mere thought of killing birds or are shocked that collecting still continues, then we suggest that you take the time to consider the extent to which you, personally, are causing the deaths of wild birds." They then run through the list of automobile kills, cat owners, petro-chemical users, houses with windows, etc. On the other hand they deplore "indiscriminate collecting, illegal shooting for taxidermy, illegal egg collecting, the excessive mortality of birds caught for the pet trade." They have chosen to concentrate on collecting which is a "serious, necessary, and ongoing part of ornithology." They mention that bird collecting was most widely practiced from the middle of the 18th to the middle of the 20th centuries, and make an appeal to judge bird collectors within the context of their times and cultures. They have managed to produce a fascinating history that is largely non-condemnatory.

The book is divided into 17 chapters which consider different aspects of collecting or different sub-sets of bird collectors. The first chapter describes hunting and harvesting birds for food, sport, as vermin (e.g., bounties paid on 223,487 eagles in Norway from 1846–1900), decoration (e.g., millinery trade), and for collections. They assess the world's current museum collections at probably less than 10 million, and rightfully suggest that even large numbers like this pale to insignificance when compared to current destruction of birds by cats, cars, collisions with structures, pesticides, and habitat destruction. Chapter 2 makes the case that bird collections were essential for the development of ornithology, and that the bulk of 18th and 19th century books and journals relied on collections and collectors. The chapter concludes with some examples of hazards collectors sometimes encountered, often with lethal results. Chapter 3 deals with the practicalities of bird collecting—shooting, skinning, preparing, and labeling specimens, getting specimens shipped home—and ends with a section on museum disasters. Chapters 4–16 present general commentary and biographical sketches of collectors organized around themes or professions. Chapter 4 deals with the early museum makers from 1600–1820, and then follow chapters on early scientific voyages, trade and commerce, bird artists, government-sponsored collecting, army officers, medical doctors, the clergy, and far-

flung expeditions to Mongolia, Tibet, and China. Chapter 13, "The Great Accumulators," highlights the likes of Lord Rothschild and Richard Meinertzhagen. Chapters 14 and 15 focus on professional collectors and women collectors. The last two chapters concern important protectionists and conservationists who were also bird collectors (e.g., William Henry Hudson, Theodore Roosevelt, T. Gilbert Pearson), and the importance of old and new bird collections. This latter chapter presents sections on the need for continued collecting, and on objections to continued collecting, including a sub-section on the morality of killing birds. An appendix presents a list of holdings of 69 museums with 20,000 or more study skins, and, where appropriate, the number of mounted birds, type specimens, skeletons, specimens in spirits, nests, eggs, and whether current acquisitions are by passive (salvage) or active (killing) methods (or both).

The book is well-written and carefully-organized, a difficult job for a subject with a long and varied history and perspective. As the authors acknowledge, the coverage is Anglo-centric. It is rather spotty and uneven for the Western Hemisphere, e.g., Joseph Grinnell is barely mentioned, and professional collector H. Wedel is not mentioned at all. As might be expected in a book of this complexity, there is a sprinkling of minor errors in fact and spelling, but this should not detract substantially from the wealth of fascinating information presented. I found this book most interesting reading. Because of the nature of the subject matter and the balanced presentation, I suspect that parts of the book will irritate readers from the extreme fringe of the animal rights contingent, and a few people with a "if it flies it dies" mentality. Most people, however, should find this historical-biographical essay interesting and informative. I recommend it to any serious student of ornithology—WILLIAM E. DAVIS, JR., Division of Science and Mathematics, College of General Studies, Boston University, Boston, MA 02215, e-mail: wedavis@bu.edu

Habitats for Birds in Europe: A Conservation Strategy for the Wider Environment.—Compiled by Graham M. Tucker and Michael I. Evans. 1997. BirdLife International (BirdLife Conservation Series No. 6), Cambridge, U.K. 464 pp. ISBN 0-946888-32-9. \$45.00 (paperback).

As explained in this book, any continent-wide conservation strategy for birds must include guidelines for conservation of key species, list key areas, and also provide broad measures for the conservation of habitats and landscapes. For Europe those three components are treated in three separate books published by BirdLife International: *Birds in Europe: Their Conservation Status* (G. M. Tucker and M. F. Heath 1994), *Important Bird Areas in Europe* (R. F. A. Grimmett and T. A. Jones 1989), and the present book. To be useful, those three components must be fully integrated into land-use policies and regulations. It can be considered quite an achievement that those three books were published over a period of less than 10 years.

The present book was the result of a coordinated effort of close to 200 scientists and conservationists, who worked in eight habitat working groups. The re-

TABLE 1. Number of Priority bird species and % of these that have an Unfavorable Conservation Status in Europe by habitat.

Habitat	Number of Priority bird species	% with Unfavorable Conservation Status
Marine	62	45
Coastal	75	70
Inland wetlands	102	55
Tundra, mires and moorland	73	37
Lowland Atlantic heathland	16	100
Boreal and temperate forests	114	40
Mediterranean forest, shrubland and rocky	100	65
Agricultural and grassland	173	70

sulting eight "Habitat Conservation Strategies" form the bulk of the book, each habitat being covered in 30–35 pages. For each of the habitats (listed in Table 1), the book describes the habitat both geographically and ecologically, discusses political and socio-economic factors that affect the habitat, and then discusses the "priority bird species." That term is somewhat confusing as it combines both all species that regularly occur in the habitat and have an "Unfavorable Conservation Status" in Europe, as well as species that are highly dependent on the habitat at some point in their annual cycle irrespective of their conservation status. Then comes a discussion of the habitat needs of the priority birds and of threats to the habitat. In a final section, the conservation opportunities are listed followed by a numbered list of conservation recommendations.

The strategies used to collect and summarize this information are well presented in the Introduction and most data are well summarized in a large number of tables both in the text and in a series of appendices. The Introduction also outlines strategic principles used to produce the book and an exhaustive list of relevant international legislation. A final introductory chapter summarizes the main conclusions and recommendations.

One hundred ninety-five (38%) of the roughly 500 European bird species are listed as having an Unfavorable Conservation Status in Europe. To be listed as "secure" a species must have at least 10,000 breeding pairs and must not be declining. In Table 1 I have listed the number of priority species, and the % that have an Unfavorable Conservation Status in Europe by habitat (note that the total is larger, because some species are counted in more than one habitat). Table 1 shows that in all habitats a high percentage of the species have problems. In the semi-natural heathland habitat, all 16 species need special attention, because there is only about 5,000 km² of this habitat left in Europe. But even for the most common agricultural and grassland habitat, covering about 5 million km², or about half of the area discussed, 70% of the 173 species are of Unfavorable Conservation Status.

This book is an interesting attempt to bring together a large body of information that is highly relevant for

conservationists and policy makers. We can only hope that the latter will use this book to formulate conservation policies, because protecting habitats for birds will clearly also have a favorable impact on all plants and animals.—ANDRÉ A. DHONDT, Laboratory of Ornithology, Cornell University, Ithaca, NY 14850.

Missouri Breeding Bird Atlas 1986–1992.—Brad Jacobs and James D. Wilson. 1997. Natural History Series, No. 6, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO. xiii + 430 pp., 12 text figures. ISBN 1-887247-13-0. \$11.00 (paper).

Atlas of the Breeding Birds of Tennessee.—Charles P. Nicholson. 1998. University of Tennessee Press, Knoxville, TN. xiii + 426 pp., 8 text figures. ISBN 0-87049-987-4. \$45.00 (cloth).

An increasing number of states have completed their bird atlas projects and the final product, the atlas, has begun to appear; herein are two more such examples. These atlases serve a number of purposes, especially to the scientific and conservation communities [which are not necessarily exclusive of each other]. First and foremost, the atlas presents the latest knowledge on the distribution and often abundances of breeding birds in a particular political area. This should present a baseline that allows measurement of changes in distributions and abundances at some future time or even on a continuing basis where a species is of special concern. Knowledge of this nature also permits the assessment of avian biodiversity within this particular political unit and identification of areas that might need special protection.

For the scientific community, the data available in these volumes may prove useful in planning research projects. This might include selection of areas of high density for a species or examining areas of high diversity to determine what factors have affected or maintained the diversity.

Both of these volumes provide the basic data for any atlas, although in somewhat different formats. Both atlases show breeding distributions for the atlas period and briefly describe each species. The Missouri atlas includes a breeding phenology and figure of abundance in the six natural divisions for most species; why some species do not have these figures is not obvious to me. The evidence for cowbird nest parasitism is given where appropriate. Three appendices give data on block descriptions and summaries of species, number of hours and volunteers, the abundance data routes, and relative abundance of breeding birds by natural divisions. Appendix D lists 14 species reported in atlas blocks but neither confirmed nor expected to breed in Missouri. Appendix E lists Brown-headed Cowbird-parasitism rates for 46 species during the atlas work. Of the 167 species expected to breed in Missouri, atlas work confirmed 149 species, with 8 as probable and 7 as possible breeders. Only one species, the Black-necked Stilt (*Himantopus mexicanus*), was confirmed breeding for Missouri which had not previously been known to breed in the state. Three species of birds, Peregrine Falcon (*Falco peregrinus*), Gadwall (*Anas strepera*), and Northern Pintail (*Anas clypeata*), bred in Missouri during the atlas years, but not in an atlas block.

Although the Tennessee atlas presents much of the same information as the Missouri atlas, it delves more into the natural history and breeding biology of the individual species. Depending upon the species, the account for confirmed species (162 of 170) may also include a map of known breeding distribution by county prior to the atlas period (pre-1986). A large number of accounts include a map of abundance. The three appendices consist of a taxonomic list of birds, reptiles, insects, and plants mentioned in the text, a summary of the breeding chronology of the birds, and a list of Brown-headed Cowbird hosts (44 species) and type of evidence. Perhaps the major difference between the Tennessee and Missouri atlases comes in the section entitled "Landscape and Ornithology of Tennessee." This section reviews the history of ornithology in Tennessee and the environment of Tennessee—physiography, climate, vegetation, and the landscape,

including the prehistoric landscape and historic changes. The final chapter considers historic changes in the avifauna, both in distribution and abundance, and conservation efforts.

As with any book of this subject, it becomes out-of-date with publication. Nonetheless, such a volume remains important to anyone concerned with the avifauna of that particular political unit, including those in adjacent units. These volumes can also serve to a limited extent as a source book for natural history of the included avian species and, perhaps, as a guide to locate specific species. As such, these books will find a readership within the respective states, but those in adjacent states should also become familiar with these volumes.—KEITH A. ARNOLD, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843-2258, e-mail: kaarnold@tamu.edu