NEW TITLES

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A Pandora's Box for Longevity

Longevity: The Biology and Demography of Life Span. James R. Carey. Princeton University Press, Princeton, NJ. 2003. 278 pp., illus. $75.00 (ISBN 0691088489 cloth).

This book definitively announces a scientific revolution in our understanding of life history, aging, demography, and kindred subjects. Though the trail of papers by James Carey and his colleagues dates back to 1992, this is the first thorough presentation of an empirical fact of great scientific and practical importance: At late ages, the aging process eventually stops. Although mortality rates increase exponentially through most of adulthood in almost all plants and animals, late in adult life, mortality rates plateau and sometimes even fall.

Carey is an entomologist at the University of California–Davis, but his research interests over the last 15 years have taken him far beyond the confines of entomology. His expertise covers a considerable spectrum of biology, from demography to evolutionary ecology to gerontology. The medfly, *Ceratitis capitata* (or the Mediterranean fruit fly), has been his primary focus since the late 1980s. Working with colleagues in Mexico, Carey has pulled together experiments in which tens of thousands to more than a million flies were used to estimate death rates at each adult age. It was the sheer scale of this work that revealed the anomalous cessation of increases in mortality rates late in life. Indeed, throughout *Longevity,* Carey insists on the importance of large numbers of organisms in experiments on demography, aging, and related topics. This is somewhat analogous to the value of high-energy particle colliders for physics. Only the big machines can show us something really new. Similarly, Carey argues, large-scale experiments are required to show us the truth about longevity, especially mortality at late ages.

Clear intimations of the finding that aging stops can be found as far back as 1939, but the work of James Carey, together with his colleagues, was the first to bring it to the general attention of scientists. At first, scientists—myself included—challenged their results. Frank disbelief was a common reaction. The rebuttals from Carey and his colleagues were extensive and, ultimately, for me, convincing. Carey presents both the initial results and their defense in detail in this volume, a body of work that has convinced all specialists who have read the research. Finally, other scientists have confirmed Carey's findings with other organisms, from nematodes to humans.

In the course of defending their original finding, Carey and his colleagues uncovered a wealth of demographic information connecting the cessation of aging and sundry biological variables in medflies: population density, sex ratio, nutrition, and reproduction. This work, summarized in Carey's book, is of substantial value, although it is not as revolutionary as the finding that aging ceases. Other scientists have obtained comparable results, and Carey sketchily reviews their work, too.

The style of the book is not racy or absorbing. Carey is more concerned with letting the massiveness of his data speak for itself. Indeed, the book is almost better read by looking at the figures rather than wading through the words. The key points are made best by the patterns in the data.

This volume is an essential addition to the libraries of researchers in a wide range

of biological fields, but it does have its shortcomings. The most important one is that Carey's attempts to explain the cessation of aging late in life fail to be compelling, even though it was his groundbreaking work that established that finding. He does discuss demographic theories that try to explain the phenomenon, but he pays scant attention to the alternative evolutionary theories of late life. He does not even cite the relevant references in the evolutionary field. Instead, he speculates about the evolution of aging and late life, emphasizing kin selection and direct selection for life span. Many of his ideas are very interesting, but they are not developed formally. Nor are they always connected to critical experiments that have already been published or that could be proposed. This is a striking anomaly, coming as it does from an author who repeatedly belittles or ignores the experiments of others on the grounds that they are too small or too poorly designed to be useful. Carey is quite right in his criticisms and in the high standards that he has set for experimental design across several fields. He might, however, have adhered to the same standards in evaluating his own conjectures.

Regardless of this blemish, *Longevity* is one of those rare scientific books that has something both important and new to say. Carey opens up a Pandora's box of strange and galvanic results, results that have already shaken the foundations of several fields. Both demographers and evolutionary biologists are recasting biological theory in terms of these results, though their efforts are in striking contrast to each other as to substance. That is, there are strong disagreements between the sides. Evolutionary biologists have even published experimental tests of their theories that purport to explain the cessation of aging, though one would not learn this from Carey's book. These are heady days for demography, ecology, evolutionary biology, and gerontology, thanks in large part to Carey.

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UNITING DEVELOPMENT, PLASTICITY, AND EVOLUTION

Developmental Plasticity and Evolution. Mary Jane West-Eberhard. Oxford University Press, New York, 2003. 794 pp., illus. $100.00 (ISBN 0195122348 cloth).

One can formalize evolution by natural selection using the equation $\Delta\bar{z} = sV_G / V_P$; that is, the change in mean phenotype of a trait across generations ($\Delta\bar{z}$) is a function of the covariance of the trait and fitness (force of selection, s), the amount of genetic variation of the trait (V_G), and the amount of phenotypic variation of the trait (V_P). Mary Jane West-Eberhard posits that the Darwinian modern synthesis has focused almost exclusively on the first two elements of that triumvirate and ignored the third. Her central thesis is that the primary driving engines of evolution are the appearance of new phenotypic variation by environmental change and the plastic capacity of genomes. To support this claim, she has undertaken a 10-year effort that marshals an immense array of facts and examples (637 pages of text and about 3000 references).

This book alternately stimulated me, frustrated me, and caused me to jot copious notes in response to West-Eberhard's ideas. Such varied reactions can be expected in response to a book of this scope, which provides one of the most comprehensive, current summaries of macroevolutionary facts while putting forward new and unique ideas. West-Eberhard cuts through the thicket of terminological clutter that evolutionary biology is prone to. She often begins a chapter by summarizing the key ideas and the many terms used to present those ideas; then she presents a slimmed-down set of key terms, clearly defined, that she will use. This book is a must-read for molecular biologists, molecular geneticists, and developmental biologists for the way it dispels typological thinking. For evolutionary geneticists, this book opens up the black box of development.

The heart of the book is West-Eberhard's contention that "environmental induction is probably more important than mutation for the origin of adaptive novelties" (p. 499). This contention provides an important explanation for a major hole in modern evolutionary theory, the origin of traits. West-Eberhard's theory is that traits derive from environmentally induced plastic variation. Such new phenotypic variation becomes available to selection because "environmental inducers...are inexorably present" (p. 504). She proceeds to push this idea in as many directions as possible, some more successful than others. For example, her developmental-plasticity hypothesis of speciation is a plausible addition to current theories. Problems arise, though, in her

push toward microevolution, which highlights the biggest shortcoming of this book, a failure to provide a formal version of its central thesis.

West-Eberhard opens her preface by stating that this is a book for those "interested in evolutionary theory." Given this statement, what appears odd is that the book contains not a single equation or simulation result. Other theories are mentioned, but no details are ever provided. It only slowly dawned on me that this lack is quite deliberate and follows from West-Eberhard's contention that a gene-focused evolutionary theory is misguided. Quantitative genetics is barely mentioned, with only three entries in the index.

While West-Eberhard makes numerous predictions about how her hypothesized mechanisms would operate, all are made in a broad, hand-waving fashion. Ignored are details such as the frequency of environments and their predictability, the spatial structure of populations, and migration rates. Some of her predictions are convincing, though I am very skeptical of others. The lack of a quantitative theory is a potentially serious problem. The history of evolutionary biology is littered with examples of intuition and verbal theory shown to be wrong. For example, evolution in spatially structured populations can be quite different from that in unstructured populations. Fine-scale adaptation requires that the environmental inducers also vary on a fine scale. If they do, they cannot be omnipresent, as required for the inducers to be responsible for the origin of novel traits. The development of a quantitative theory is a challenge left by this book.

West-Eberhard fails to acknowledge the successes that the modern synthesis has achieved over the past 70 years in explaining and predicting microevolutionary processes. In making a case against the importance of mutations of small effect in gradual evolution, for example, she ignores mutation accumulation experiments that clearly demonstrate that mutation alone can account for sufficient new variation. Experiments of long-term selection in a single environment have shown the efficacy of selection fed by mutational variation.

What are the relative roles of selection, mutation (in the broad sense), and developmental potential in setting the course of evolution? Although West-Eberhard demonstrates that developmental potential *can* be important, we still need to determine whether it *is.* Complaints about adaptationism come down to contention with the general belief that selection always optimizes a trait. Theory predicts optimization, but the reality recognized by most evolutionary biologists is that the environment often changes too quickly for optimization to occur. While "fish gotta swim and birds gotta fly" (penguins excepted), one can consider these as first-order adaptations. It is the second-order term—more fine-scale adaptations—that is under debate. West-Eberhard makes a convincing case that the importance of developmental processes has been misconstrued, yet in making that case she is often guilty of making the opposite error. Her text and argument are too complex for her to be accused of dogmatism, but she often seems to overstate her case. West-Eberhard's theory is very phenocentric. While rightly criticizing genocentric theory, she ignores the merits of that theory. A complete understanding requires both.

Despite West-Eberhard's attempt to make her theory universal, the book speaks mostly to the kingdom Animalia. Plants appear only as occasional examples, except for two notable, extended discussions of the evolution of maize and CAM (Crassulacean acid metabolism), a specialized form of photosynthesis. Little attempt is made to deal with the fundamental differences in the developmental mechanisms of plants and animals (e.g., plants do not have separate somatic and germ cell lineages), and there are some odd statements, for example, about metamorphosis in plants (something that does not exist). Fungi and single-celled organisms are almost entirely absent from the book.

West-Eberhard does an excellent job of discussing the early history of many of her ideas, often tracing them back to Darwin. Such attention to historical roots is frequently absent in biology. The downside, though, is the short shrift given to the literature of the past 15 years. The lengthy gestation of this book has led to some anachronisms. At times West-Eberhard seems to be arguing against ideas that were largely abandoned decades ago, at least by those in the forefront of research on these issues (although such ideas can have a surprising longevity, continuing to circulate in adjacent fields and lodging in textbooks). What is frustrating is her failure to acknowledge the evolution of these ideas in their core disciplines. For example, she seems to believe that plasticity as an important phenomenon is ignored by evolutionary biologists. This position is belied by the 10-fold increase between 1985 and 2000 in the number of published articles that deal with this topic.

West-Eberhard's complaints about the theory of the evolution of plasticity are based on her looking at quantitative genetic descriptions and models and failing to find mechanistic answers. Some of these limitations are due to confusions at the time the models were developed, and she fails to acknowledge advances in the years since. Overall, the book lacks references to the past 15 years of theory development. The few recent articles that West-Eberhard does cite are not those that have been central in the development of contemporary theory.

A good book should spark thought and controversy; and this book accomplishes that goal. I certainly do not agree with all of the ideas put forward here, but at its core, this book contains important new ideas about the evolutionary process. It behooves anyone interested in understanding the mechanisms behind large-scale patterns of evolution to grapple with this book.

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SIMPLE BY DESIGN

Experimental Design for the Life Sciences. Graeme D. Ruxton and Nick Colegrave. Oxford University Press, Oxford, United Kingdom, 2003. 136 pp., illus. $24.95 (ISBN 0199252327 paper).

Whenever the words "experimental" and "design" are placed together in a sentence, some biologists cringe and brace themselves for complex model statements and tough-to-understand equations. This is unfortunate, mostly because the line between the art of the design of experiments and statistical analysis has blurred. Granted, the two are inextricably linked, and complete understanding of experimental design means understanding the analytical costs or benefits resulting from the design utilized. However, to speak purely of the discipline of the design of experiments does not require complicated equations, and this book serves as proof.

If you are looking for a good textbook for a course in experimental designs, Ruxton and Colegrave's work could not solely serve for that purpose. There are no analyses of variance, no models, no equations, no homework problems. Does this sound strange for a book about statistics? What you must understand is the viewpoint of the authors. Ruxton and Colegrave, University of Glasgow Reader and University of Edinburgh Lecturer, respectively, claim that this is not a statistics book. They allude to statistical tests and their important role in experimentation. They also present an extensive bibliography of books that deal with analytical concepts. However, the authors believe that the subject at hand is not simply difficult equations and mathematics. As they state, experimental design is "about common sense, biological insight and careful planning." It's a mantra they chant throughout the text. Experimental design, they contend, is the basis for biology.

I think it is vital to understand the authors' goal in writing this book. I believe they have had innumerable conversations and consultations with biologists, and many of them have asked the same questions regarding the way experiments are laid out. Trust me, I know what that is like. It is likely that these conversations are so ingrained in their respective psyches that this book might have seemed to write itself. They approach each topic logically, and with excellent examples and case studies. The vibe that comes across from the book seems to favor the wildlife biologist, but it would be easy for any biologist, regardless of discipline, to extrapolate to his or her field and set of possible experiments. The authors also contrast biology nicely with the physical sciences. Though both of these broad disciplines require good fundamental experimental design, Ruxton and Colegrave argue convincingly that the presence of biological creatures induces a source of variation that requires more care in the design phase.

Who should consider reading this book? I know that there are many scientists out there who are uncomfortable with their knowledge of experimental design, stemming perhaps from a lack of formal training in the subject in graduate school. This book can serve as a primer for these individuals. An important aspect of this book is the inclusion of key definitions. These are always set apart from the rest of the text in boxes. If nothing else, the reader will be better equipped to discuss these issues with a statistician. For a good example, the authors present a nice discussion of sample size, and they define the related terms *power* and *error* and how they affect design issues. This is obviously an important step in any design. Keep in mind, however, that the reader will not be able to perform a power analysis based only on the contents of this book. They also stress in this context that a small amount of good data is much better than a whole bunch of bad data.

As another example, Ruxton and Colegrave give a splendid discussion of the importance of controls in experimentation. One of the great fallacies in experimental design is that every experiment must

have a control. The authors define explicitly what the difference is between positive and negative controls and state that controls are needed only if they are important in the comparisons with the treatments of interest. This, by the way, is an argument I've made on numerous occasions, an argument I have lost more often than won. The example Ruxton and Colegrave present is that of a new treatment being compared with an existing treatment (positive control), in which case the comparison of the new treatment with no treatment (negative control) is unnecessary.

The subject of actual experimental designs, such as the completely randomized design (or "randomised," as our friends from across the pond tend to spell it), isn't introduced until page 64. Since the book has only 114 pages, very little of the content is devoted to these issues. But the authors do include books in the bibliography that present these designs in greater detail. And the book does present a nice discussion of factorial arrangements. Main effects and interaction are defined. Strangely, the authors don't use the term *simple effect,* which usually serves as the antithesis of main effect. They do warn of the dangers of interpreting main effects in the presence of interaction, but not emphatically enough, in my opinion. I have seen many journal articles that present the *p*-values for the main effects of A and B and then proceed to discuss the significant interaction. This is a practice that should be nipped in the bud, and books like this one can help to nip it.

One item that I would have liked to have seen is the definition of an experimental unit. This would have fit well in the narrative of pseudoreplication, which was otherwise very nicely done. Another quibble I have is the characterization of crossover designs as repeated measures experiments. There are repeated measures studies that are not crossover experiments, and these play a prominent role in science. Readers would have benefited from a discussion of intrasubject correlation and how it is modeled. This subject could have been extended to spatial relationships as well.

When I started reading this book, I found myself questioning whether Ruxton and Colegrave could successfully omit equations from their book. They have managed to do just that. As a teacher of a course in the design of experiments, I have realized that all of the examples presented are worthy of the subject they represent. I enjoyed reading this book, appreciated the unique approach, and have recommended it to my students as supplementary reading. *Experimental Design for the Life Sciences* has found a permanent place in my library of experimental design material.

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A Bat Man in the Tropics: Chasing El Duende. Theodore H. Fleming. University of California Press, Berkeley, 2003. 311 pp., illus. $50.00 (ISBN 0520236068 cloth).

The Biology of Death: Origins of Mortality. André Klarsfeld and Frédéric Revah. Cornell University Press, Ithaca, NY, 2003. 211 pp. $29.95 (ISBN 0801441188 cloth).

The Environment, Our Natural Resources, and Modern Technology. Thomas R. DeGregori. Iowa State Press, Ames, 2003. 224 pp., illus. $19.99 (ISBN 0813809231 paper).

Florida's Snakes: A Guide to Their Identification and Habits. R. D. Bartlett and Patricia P. Bartlett. University Press of Florida, Gainesville, 2003. 256 pp., illus. $24.95 (ISBN 081302 6369 paper).

Microbial Diversity and Bioprospecting. Alan T. Bull, ed. American Society for Microbiology, Washington, DC, 2003. 524 pp., illus. $129.95 (ISBN 1555812678 cloth).

Primate Psychology. Dario Maestripieri, ed. Harvard University Press, Cambridge, MA, 2003. 619 pp., illus. $65.00 (ISBN 067401152X cloth).

Proceedings of the Third World Fisheries Congress: Feeding the World with Fish in the Next Millennium—the Balance between Production and Environment. Bruce Phillips, Bern Megrey, and Zhou Yingqi, eds. American Fisheries Society, Bethesda, MD, 2003. 766 pp., illus. $75.00 (ISBN 1888569557 paper).

What Genes Can't Do. Lenny Moss. MIT Press, Cambridge, MA, 2003. 228 pp., illus. $34.95 (ISBN 026213411X cloth).

Zoonoses: Infectious Diseases Transmissible from Animals to Humans. 3rd ed. Hartmut Krauss, Albert Weber, Max Appel, Burkhard Enders, Henry D. Isenberg, Hans Gerd Schiefer, Werner Slenczka, Alexander von Graevenitz, and Horst Zahner. ASM Press, Washington, DC, 2003. 474 pp., illus. $79.95 (ISBN 1555812368 paper).