BOOK REVIEWS

Aging: Questions and Prospects

Why We Age. What Science Is Discovering About the Body's Journey Through Life. STEVEN N. AUSTAD. Wiley, New York, 1997. xii, 244 pp., illus. $24.95, C$34.95, or £19.99. ISBN 0-471-14803-2.

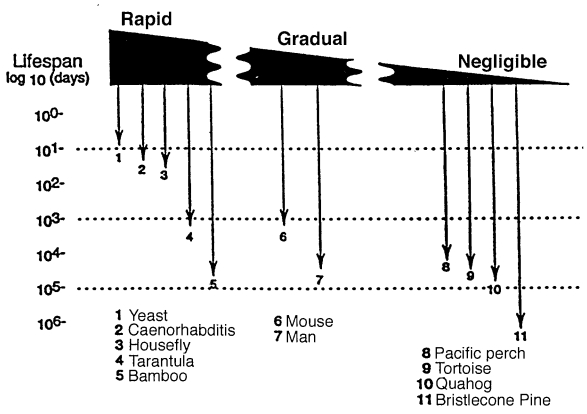
Between Zeus and the Salmon. The Biodemography of Longevity. KENNETH W. WACHTER and CALEB E. FINCH, Eds. National Academy Press, Washington, DC, 1997. viii, 312 pp., illus. $44 or £35.95. ISBN 0-309-05787-6. To be published 3 November.

The scientific study of aging has been an odd mixture of the accumulation of mountains of dismal evidence that shows that almost anything you can think of goes wrong with age and proposals of simplistic theories that try to explain aging in terms of single processes, ranging from defective testicles to shortened telomeres. The large potential payoff to the scientist who can promise a cure for the ills of old age has undoubtedly sharply reduced the level of rationality in this field.

For good reason, therefore, gerontology has been a Cinderella of biomedical science for much of this century. There is, however, widespread optimism that genuine progress is now being made in our understanding both of the basic cellular and organismal processes involved in causing senescent decline and of the evolutionary causes of aging. These two books, one, *Why We Age*, aimed at the general reader and the other (whose title contrasts an immortal being with one that undergoes particularly rapid senescence) at a professional audience, do excellent jobs of conveying the grounds for this optimism.

Steven Austad attempts to cover the whole of gerontology, ranging from the demography of mortality rates in primitive and contemporary societies, through the genetics and cell biology of aging, to the evolutionary biology of aging. His style is chatty but informative, and the book is spiced with descriptions of the personal characteristics of prominent biologists who have contributed to the study of aging. Austad's book can be read with pleasure and profit by any intelligent person with a smattering of biological knowledge. It is well informed, up-to-date, and sensible. In view of the problem of how to cope with an increasingly elderly population if our modern Western standard of living persists, it deserves to be widely read.

Austad begins with an account of the difficulty of establishing the authenticity of cases of extraordinary human longevity; the most extreme claims come from populations with the most unreliable records. It seems clear that the longest-lived person for whom an authentic record exists was Jeanne Calment, who recently died at the age of 122. Austad argues that, despite the vast reductions in mortality rates since most human populations abandoned the hunter-gatherer way of life, there is little evidence that there has been much change in the rate of aging, as measured by the rate constant of the exponential increase with age in the rate of mortality that characterizes most of adult life. Increases in life expectancy have been driven overwhelmingly by reductions in environmental causes of mortality that are extrinsic to the aging process.



Life-spans of sexually reproducing species and rates of senescence in the adults. [From C. Finch's chapter in *Between Zeus and the Salmon*]

But this does not mean that the rate of aging is a fixed characteristic of our own or any other species. Austad draws on evidence for genetic variability affecting aspects of senescence and on comparisons among species to emphasize the point that the rate of aging is ultimately determined by the main driving force of phenotypic evolution: natural selection. As he makes clear, the major success story to date in our understanding of aging is the realization that the ability of natural selection to improve survival or reproductive success declines with the ages at which genetic changes in mortality or fertility occur. The rate of this decline is greater the higher the level of mortality due to external causes, such as disease or predation. Given the existence of genetic variability with the appropriate age-specific effects on survival and reproduction, this principle can explain the near universality of a senescent increase in mortality rates and a decline in reproductive success with age, as well as the huge differences among species in the rate of aging. (Austad rightly gives credit to J. B. S. Haldane, Peter Medawar, and George Williams for developing the main ideas underlying the evolutionary theory of aging, but oddly does not mention that W. D. Hamilton first developed the correct quantitative formulation of how selection intensity depends on age of gene action.) Aging is not a biological mystery but a nearly inevitable product of natural selection, whose rate can be adjusted over evolutionary time in response to changes in environmental conditions.

Austad shows how these evolutionary ideas stimulated experiments using artificial selection to develop stocks of *Drosophila* that live as much as twice as long as normal, demonstrating that the prolongation of life-span by genetic means is not a biological fantasy. Of course, such a prolongation can also be achieved nongenetically, as witnessed by the effects of dietary restriction on longevity in laboratory rats and mice. Ironically, it is still unclear whether dietary restriction could work in our species.

The evolutionary view of aging suggests that there is no single molecular or cellular cause of aging that accounts for the available evidence on what goes wrong with age, although processes such as oxidation of important molecules by free radicals released during respiration are clearly an important cause of cumulative damage to cellular constituents. Moreover, aging at the cellular level need not involve the same processes that cause deterioration of the whole organism. There is thus unlikely to be a single simple remedy for senescence. Austad concludes the book with a discussion of possible ways in which human aging could be slowed or prevented. He suggests that gerontologists interested in cellular mechanisms of aging might well profit from the study of creatures such as bats and birds

Vignettes: Behind the Imprimatur

I am a primarily legislative person who has held a highly judicial role: editor of a journal ....A journal editor's primary job is to evaluate the suitability of manuscripts for publication, a judicial job if ever there was one. But unlike many of my fellow editors, I feel uncomfortable evaluating manuscripts. So I tried to make a major part of my job one of innovation—redefining the priorities of the journal and dreaming up symposia that I thought would be exciting to readers.

—*Robert J. Sternberg*, in *Thinking Styles* (Cambridge University Press)

The term "reviewed publication" has an appealing ring for the naive rather than the realistic.... Let's face it: (1) in this day and age of specialization, you may not find competent reviewers for certain contributions; (2) older scientists may agree that over the past two decades, the relative decline in research funds has been accompanied by an increasing number of meaningless, often unfair reviews; (3) some people are so desperate to get published that they will comply with the demands of reviewers, no matter how asinine they are.

—*August Epple*, in *Organizing Scientific Meetings* (Cambridge University Press)

that have evolved unusually low rates of aging.

Concern for the future of modern society motivated the much more academic volume edited by Kenneth Wachter and Caleb Finch, which is based on a workshop held under the auspices of the Committee on Population of the National Research Council. The stated aim of the workshop was to bring together demographers and biologists and to stimulate an exchange of concepts and facts between workers in different fields of aging research. Too often, calls for such interdisciplinary exchanges lead to collections of papers that resemble Sam Weller's mythical encyclopedia article on Chinese metaphysics, but in the present case there is evidence of a substantial level of mutual appreciation, albeit with some inevitable fumblings and misunderstandings.

I was extremely impressed with the overall quality of the papers, which provide an excellent overview of current data and thinking on both human demography and the biology of aging. As the title and Wachter's introductory chapter suggest, the human life history can only be understood in terms of a general perspective on how the life history of a species evolves; we fall toward the upper range of animal (but not plant) species in terms of life-span, although birds far outdo us when their life-spans are adjusted for their much smaller body sizes. Useful reviews of the basic theory and data on this topic are provided in papers by Partridge, Rose, and Tuljapurkar. Unfortunately, our understanding of the evolution of the human life history is hampered by incomplete knowledge of the sources and intensity of mortality in the hunter-gatherer conditions that must have characterized human populations over most of their evolutionary history: there simply has not been enough time for significant genetic modification of patterns of age-specific reproduction and survival since the agricultural revolution, despite tremendous environmental changes that have had large direct effects on our life history traits. These questions are discussed in chapters by Austad, Carey and Gruenfelder, Kaplan, and Lee, with special reference to the problem of the prolonged post-reproductive survival of human females and the possible adaptive significance of the menopause. These phenomena at first sight seem to contradict the standard evolutionary models, since there is no direct pressure of selection to maintain survival after reproduction ceases. But (as was first pointed out by Williams), there may be a substantial indirect fitness benefit to post-reproductive survival, if it enables women to raise children or grandchildren more successfully. Though studies of contemporary hunter-gatherer societies seem to indicate that women have a good chance of surviving into their 60s, evidence from skeletal remains suggests the opposite, so it is currently unclear whether menopause and post-reproductive survival are adaptive or not.

A related question of considerable social importance is raised by the evidence that the rate of senescent increase in human mortality slows down in extreme old age. Contrary to Fries's biologically implausible proposal that there is a fixed upper limit to human life-span, the demographic data reviewed by Vaupel and by Wilmoth suggest that human mortality rates per year reach a high level late in life but tend to increase rather slowly or even plateau once people reach their centenary. Given the genetic and environmental heterogeneity of human populations, which lead to the surviving elderly being a highly selected subset of the population, it is difficult to be sure that this necessarily means that human senescence slows down in extreme old age. Such a slowdown is, however, suggested by data on model organisms such as *Drosophila* and medflies and raises some interesting questions for the evolutionists. An improved understanding of genetic factors affecting late-life human survival is of critical importance for resolving some of these questions; the methodology for obtaining this understanding is discussed in papers by Johnson and Shook and by Wallace. As discussed by Finch in the final chapter, the solid evidence that aging is susceptible to genetic and environmental modification opens up the distinct possibility that human aging could be significantly retarded by appropriate genetic and environmental interventions. Whether a substantial extension of life-span is socially desirable is another question, which is going to require careful consideration by the public. These two books together provide an important basis for such consideration.

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Browsings

And the Waters Turned to Blood. The Ultimate Biological Threat. Rodney Barker. Simon and Schuster, New York, 1997. 347 pp., illus. $24 or C$32. ISBN 0-684-83126-0.

A journalist's account of the work and struggles of JoAnn Burkholder and associates in identifying the dinoflagellate *Pfiesteria piscicida*, now afflicting fish of eastern U.S. coastal rivers, as an environmental and health hazard.

Feminist Sociology. Life Histories of a Movement. Barbara Laslett and Barrie Thorne, Eds. Rutgers University Press, New Brunswick, NJ, 1997. viii, 286 pp. $50, ISBN 0-8135-2428-8; paper, $19.95, ISBN 0-8135-2429-6.

Autobiographical essays by Joan Acker, Evelyn Nakano Glenn, Judith Stacey, R. W. Connell, Desley Deacon, Susan Krieger, Sarah Fenstermaker, Lynn Weber, Elizabeth Higginbotham, Bonnie Thornton Dill, Marjorie L. DeVault, and the two editors.