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MICROBES MESSING AROUND

Barbosa, Pedro, Vera A. Krischik, and Clive G. Jones (eds.). 1991. **Microbial mediation of plant-herbivore interactions.** John Wiley & Sons, Inc., New York. xiii + 530 p. $95.00, ISBN: 0-471-61324-X.

Exploring how one species can modify the relationship between two others has become something of a growth industry in ecology. What explains this fascination with multispecies interactions and indirect effects? Are the complex details of these relationships essential for understanding nature, or are they, more often than not, just amusing epiphenomena? Some insights about this problem can be found in *Microbial mediation of plant-herbivore interactions,* a 30-author volume that examines its subject from just about every conceivable angle.

According to the editors, "The chapters in this book demonstrate that microbial mediation of plant-herbivore interactions is indeed widespread and has diverse and significant impacts on plant-herbivore relationships" (p. 2). In my opinion, the book clearly succeeds in showing that microbial effects on plants or insect herbivores are widespread and diverse, but the question of a significant mediating impact is another matter. Most chapters demonstrate the potential for impact, often by using carefully contrived laboratory microcosms. Artificial diet experiments described by V. A. Krischik, for example, nicely show how plant allelochemicals and microbes potentially can interact to govern performance of insect herbivores living in a growth chamber. However, most of the contributions are more sketchy about evidence for the actual scope of microbial mediation in natural environments. One of the few chapters that squarely address the need to extend laboratory studies to field situations is by N. D. Johnson and B. L. Bentley on symbiotic nitrogen fixation and resistance to herbivory in legumes; even here, some key issues are examined with only correlative field studies, where herbivory is confounded with site effects. Granted, there are formidable technical problems in doing manipulative field experiments with most of these interactions. But many of the chapters in this volume are made unsatisfying by the fragmentary and conflicting nature of the studies being reviewed. For some topics, existing empirical work is so limited that the authors can provide little more than gratuitous speculation (e.g., C. G. Jones and F. T. Last's 33-page discourse on how ectomycorrhizae and environmental factors supposedly interact to influence resistance of trees to herbivory). Thus, in parts of this volume, the attempt to critically review these relationships seems premature, because relevant experiments simply haven't been done yet.

Furthermore, some authors use an unfortunate ploy to enliven their discussions: a questionable or controversial theory is imported from another context, without critical comment and without justifying its necessity for understanding the interactions being considered. Examples include E. R. Ingham and R. Molina's speculation that the grazing optimization model applies to protozoa feeding on mycorrhizal fungi, G. C. Carroll's notion that fungal endophytes induce "chemical mosaicism" in plants as a tactic to thwart herbivore damage, and A. H. Purcell and L. Nault's interest in whether coevolution in plant/pathogen/vector associations may provide anticompetitor benefits by protecting communities from invasion by exotic species.

A handful of chapters do contain nicely balanced treatments, combining interesting factual background, clean organization, and critical insights. I would single out the contribution by K. Clay on the anti-herbivore role of fungal endophytes in grasses, J. C. Schultz and S. T. Keating's account of how plant tannins can modify the pathogenicity of viruses to gypsy moths, and P. F. Dowd's discussion of symbiont-mediated detoxification of dietary toxins in insects. These reviews should be useful to a broad audience.

But overall, in what way is this volume likely to shape the attitudes of ecologists toward multispecies interactions? One of the main impressions left is that these relationships are pretty messy and idiosyncratic. This may encourage despair about whether coherent generalizations are possible. On the other hand, a second impression left by this book is that vast opportunities exist for rigorous research on these systems, because much of the work done to date is so primitive. This book thus lays the groundwork for future studies, by outlining the major types of three-way interactions among these groups of organisms. More generally, by stressing that all plants and insect herbivores must live in a broader community context that includes microbial mutualists and pathogens, the book may signal a noteworthy shift in research agenda for students of plant-herbivore interactions.

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THE BIOLOGY OF LIFE SPAN

Gavrilov, Leonid A., and Natalia S. Gavrilova (transl. by John Payne and Liliya Payne). 1991 (Russian edition 1986). **The biology of life span: a quantitative approach.** Harwood Academic Publishers, New York. vii + 385 p. $120.00 ($40.00, SAS members), ISBN: 3-7186-4983-7.

The study of life span is an inherently compelling discipline influencing many different fields of biology. Understanding the mechanisms which determine the life span of organisms is of interest to researchers in the fields of demography, gerontology, ecology, genetics, radiobiology, toxicology, epidemiology, and others. Unfortunately, despite this wide appli-

cation, there has been only isolated progress of this science because of limited communication within and between fields, a situation that is often aggravated by language barriers. The authors of *The biology of life span: a quantitative approach* point out that specialists studying lifespan do so in isolation, repeating the same mistakes, and reinventing previously established generalizations. In a backward sort of way, this disconnectedness among disciplines has led to an optimism for the future of this field of research, because patterns and concepts rediscovered independently several times are in all likelihood correct.

This book, originally published in Russian, summarizes and refers to many valuable, but previously inaccessible, studies. Nearly one out of every five references in the text is in Russian. The summaries, figures, and analyses of these works, particularly the authors' own papers, are the most valuable aspects of this text, and should contribute toward a major step forward in the development of this field.

The text begins with a general and historical discussion of the biology of life span, followed by a chapter on data analysis and interpretation, focusing particularly the authors' interests in describing the statistical distribution of life spans. Succeeding chapters discuss human mortality patterns (and consider the prospects for extending human life), evaluate the concept of species specific life span, and discuss various biological models describing mechanisms which determine life span. The final chapter is devoted to a historical analysis of mathematical models to describe life span patterns. The authors believe that models based on reliability theory show the most promise for describing these patterns.

The historical roots of life span studies are not in gerontology, but rather in demography and population biology. The authors view the biology of lifespan as a broad field which investigates the mechanisms of death at all stages of the life cycle, often before signs of aging appear. They consider explaining individual differences in these patterns as the key issue in the biology of life span, and that these are best presented in detailed life tables. They emphasize that data such as mean life span can be very misleading and useless for comparative studies. For example, the mean life span of Swedish men is 72.2 years, yet the mean probability of dying between ages 71–73 is less than six percent. Life table construction is reviewed, and one of the most useful aspects of the text is a list, in the appendix, of previously published life tables for animals, and the conditions under which they were obtained. The authors urge that future publications in this area, researchers include fully expanded life tables. Life tables are cumbersome, but reporting only the mean, median, and maximum life spans, even with survivorship curves, does not allow investigation of the statistical distribution of life spans. The authors believe that discovery of the "law" of life span distributions is one of the major unsolved problems yet to be investigated in this field. It does not seem realistic, however, to assume that there will be one "law" explaining the wide diversity of life span patterns existing in nature.

The authors make no secret about their interest in a grand research project in the USSR to develop new approaches to life extension, and to test the ones which are possible on human beings. They state: "The practical interest of these investigations is to open up the possibility of predicting and controlling the lifetimes of organisms, and most importantly, to discover ways of extending the lives of human beings." Following a discussion of "current" life tables for humans it is noted that human age-dependent mortality has remained historically constant, despite changes in social conditions. They repeatedly return to the processes of "wear and tear" which are observed in inanimate machines as the best model to describe the processes which limit life span. First, there is a "working in period," during which time new machines show a high initial failure rate, but this failure rate decreases with time. This period is equivalent to the period of high infant mortality in humans. Next there is a "normal working period," during which time there is a constant, but low, rate of failure. Finally there is an "aging period," during which time there is a rise in the rate of failure with increasing age. The future prospects and methods for extending human life depend on explaining this final failure of the organism late in life. Instead of solving specific diseases, they believe that efforts should be directed towards understanding this period of "limited reliability," during which time an organism passes into a state of non-specific vulnerability which results in simultaneous susceptibility to a wide variety of diseases.

One of the limitations of the book is that except for humans, *Drosophila* is the only organism considered in detail. Other organisms are only mentioned in appendices: a list of published animal life tables and a list of traits which show a positive, negative, or zero correlation with life span. The patterns of life span for organisms which have exceptional longevities and lack age related increases in mortality (e.g., bivalve mollusks, some species of barnacles, crustaceans such as lobsters, long-lived perennial trees) are not evaluated despite the fact that these species could form the basis for a thorough comparative analysis. The field of demographic analysis of life span is broader than humans, and it is unfortunate that the text falls very short on comparative analysis.

The other disappointing aspect of the text is its negative tone. The authors are very critical of some previous mathematical models, and even state that "leading journals are not a reliable screen against models with blatant errors." Clearly, there have been previous mistakes in the literature, some of which have been perpetuated through mutual citation (the normal life span distribution law, the notion of an absolute limit to species longevity, and the limited cell division hypothesis, to mention but a few examples). Even though it is important to correct previous misconceptions, it is unfortunate that these criticisms become the central focus of the text. In places, their criticism is deflated by the nature of the "reliable" sources that are the target of their criticism. The Bible is referred to twice within one table, alongside journals such as *Evolution,* as an authority on maximum human life span, and the new *Encyclopedia Britannica* (1989) is referred to at least six times as a "solid publication." This leads to the authors belaboring ideas that are well known to be antiquated, and which are given very short shrift in other recent texts (Finch, C. E. 1990. *Longevity, senescence, and the genome.* University of Chicago Press, Chicago, and Rose, M. R. 1991. *Evolutionary biology of aging.* Oxford University Press, New York). Rose's book reviews the theoretical basis of our understanding of aging and lifespan from an evolutionary perspective. Finch's book is a very comprehensive review of patterns of survivorship and senescence across all phyla. It reviews these patterns using evolutionary, molecular, cell, and physiological approaches.

The biology of life span: a quantitative approach does not offer as broad a perspective as the title implies. This book is directed toward researchers interested in statistical patterns

and mathematical models of human life span. For students within this defined area of research, this text offers a good historical perspective, insight into the Russian literature, and insight into the quantitative analysis of life span. Ecologists will be better served by Finch and Rose.

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DEALING WITH STRESS

Hoffmann, Ary A., and Peter A. Parsons. 1991. **Evolutionary genetics and environmental stress.** Oxford University Press, New York. ix + 284 p. $75.00, ISBN: 0-19-857732-X.

In one of those simple-minded dichotomies, one could say there are two types of ecologists: Type I—those who revel in the diversity of adaptations and life histories, whose research aim is to add to the examples of the astonishing variety among living things, and who prefer exceptions which disprove the rule, and Type II—those who would attempt to bring order out of the chaos of variety, who seek rules among the myriad life histories and adaptations, and who try to fit the apparent exceptions to the rule into a larger scheme that makes sense. In amassing evidence for new paradigms that will withstand the test of time, Type II scientists must master a voluminous literature, and present both contradicting and supporting evidence. They take a far greater risk of being proven wrong, but the payoff can be great. The best Type II ecologist in history proposed a new paradigm for evolution, and brought about a radical shift in the way people view the world and themselves; he now resides in Westminster Abbey with others of similar stature.

Many, if not most, of us fit the Type I mold most of the time. With this book, Hoffman and Parsons reveal themselves to be Type II scientists. The authors not only examine evidence from a far-reaching review of the literature (668 citations), but propose general principles of stress response, identify needed research to test these ideas, and suggest methodology to carry out this research. They begin the book with a definition of stress, a term that routinely, and perhaps rightly, provokes groans because of its slippery definitions. They employ a broad definition which is unlikely to satisfy the groaners—a stress is "an environmental factor causing a change in a biological system which is potentially injurious." Thus, in the remainder of the book they consider stresses as diverse as high temperature, anoxia, high salt concentrations, low nutrients, flooding, low food supply, and exposure to toxins. Despite their own history of *Drosophila* research, Hoffman and Parsons treat the topic of stress in organisms as diverse as *E. coli,* nematodes, green algae, fungi, tussock grass, butterflies, killifish, deer mice, chukars, and iguanas. The diversity of stresses and organisms considered bolsters their conclusions about the nature of general principles of stress response.

The heart of the book is two chapters on genetic variation and stress. In Chapter 4, the authors show that the best way to understand the significance of stress resistance and stress evasion traits (the two broad classes of stress response) is to use existing intraspecific variation in combination with carefully designed experiments. By examining variation in stress response against a common genetic background, it is easier to infer the significance of particular traits (*vis-a-vis* comparisons among species, where the numerous trait differences may or may not be related to differences in response to stress). This more rigorous experimental approach to studying adaptation to stress is laudable, and bound to gain in popularity because ecologists have become increasingly dissatisfied with adaptive storytelling. Chapter 5 illustrates that stress may directly or indirectly influence the expression of genetic variability in populations, so that the evolutionary consequences of exposure to stress are often not readily predictable.

The organization of topics among and within chapters is occasionally difficult to follow. For example the chapter on general stress resistance (Chapter 6) is presented late in the book, and it is not clear why a separate chapter was organized around protein variation and stress (Chapter 2). In general, however, the authors write clearly, first introducing topics and then reiterating main points in summaries at the ends of the chapters. In between, and most valuable, are presentations of numerous examples of studies of stress responses.

The authors do not eschew the terminology of genetics (e.g., antagonistic pleiotropy, additive genetic variance, fluctuating asymmetry); these concepts, however, are defined clearly for the reader. Nor do they gloss over the complexity of genetic relationships among traits. For example, Chapter 7 provides a thought-provoking analysis of the costs of stress response traits and the consequent genetic tradeoffs, which may vary in a predictable way depending on the environment.

If you are involved in research on stress responses of organisms, this book is essential reading, no matter what your opinion of the term "stress." Ecologists particularly will benefit from understanding, and perhaps adopting, the genetic approach to studying adaptations to stress. Chapter 8 clearly shows how such studies are aimed at the crux of timely ecological issues such as distributional limits, global climate change, and conservation of biodiversity. The book would probably not fit into the organizational scheme of most courses as a text, but it could easily be the focus of a graduate seminar course, supplemented by readings from the original literature. Hoffman and Parsons have made a major contribution to the field with this Type II book. I predict that exciting Type I and Type II research will be stimulated as a result.

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