argument and serious constraints on its usefulness.

The book discusses amazing examples in the literature of plastic and adaptive phenotypes, including the famous defensive morphologies of *Daphnia* induced by the presence of predators; the winged and wingless morphs of bean beetles induced by resource depletion; and the quorum-sensing genes of bacteria, which control suites of genes, induced by high density. The latter are particularly important to human health because of their role in virulence and the formation of biofilms.

In contrast, when a gene is expressed only in response to a specific environmental stressor, spatially or temporally restricted in its extent—such as extreme temperatures, density, or disease—that gene does not experience very strong natural selection. Copies of the gene are not expressed in those individuals who do not encounter the environment. As a result, these genes are not screened by natural selection but rather become targets for mutation. Total selection on the genes underlying the capacity for plastic phenotypic responses is the average of the selection experienced by the proportion of copies expressed and the proportion not expressed. Total selection is weakened because of this averaging, and the mutational load of these genes is increased in proportion to the rarity of the environment. Indeed, adaptation to very rare environments is hardly possible: If not expressed frequently enough, mutation, accumulation, and mutational meltdown eliminate the genetic basis for the capacity for such flexibility. If all is not lost, then the expected level of polymorphism for persisting genes will be higher, as will the divergence of these genes among closely related taxa. Although evolutionary biologists prefer to interpret genetic differences among taxa as being the result of strong positive natural selection, these "plasticity genes" diversify among taxa for the opposite reason—a relaxation of selection. The pattern across taxa is the same—immense diversification—but the explanations are polar opposites: strong diversifying selection versus relaxed constraint. This type of alternative explanation, founded in classical theory, is not often discussed and is overlooked in the enthusiasm to embrace newer, but untested, concepts.

One field likely to be enhanced by this volume is evolutionary developmental (evo-devo) biology. Anticipation of the merging of these two disciplines has been ongoing for 100 years; in fact, Wright, who joined the faculty of the University of Chicago in 1925, was hired by the great embryologist and then chair of the Department of Zoology Frank R. Lillie, with the expectation that Wright's research would help integrate the fields of evolution and development. Almost every chapter in this work is relevant to evo-devo students. Although some current topics also construed as extensions of the modern evolutionary synthesis (e.g., new discoveries in human evolution, biochemical taphonomy, geoimaging technologies) do not appear in this book, I strongly recommend the reading and critical discussion of *Evolution—the Extended Synthesis* to all.

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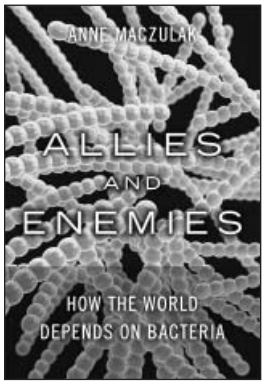
WHERE IS THE BEAUTY AND EXCITEMENT OF THE BACTERIAL WORLD?

Allies and Enemies: How the World Depends on Bacteria. Anne Maczulak. FT Press, 2010. 224 pp., illus. $24.99 (ISBN 9780137015467 cloth).

As the primary title of Anne Maczulak's book promises, most of the content of *Allies and Enemies: How the World Depends on Bacteria* concerns the dichotomy of bacterial pathogens versus bacteria as useful facilitators of various industries and technologies. The book's subtitle, however, may require more of a departure from a human-centered point of view. Although Maczulak hints at it throughout, I don't think she quite captures with examples the overwhelming and pervasive existence of microbes that is completely separate from (and oblivious to) the narrow interests of humans. Maczulak may interpret the "world" to mean the human world, but the fact is that we humans dwell *within* a bacterial world, which Maczulak fails to firmly establish.



It is a challenge with any popular book on bacteria to know the background and expectations of its target audience. Maczulak attempts to include general information on cells throughout the book, but with a volume of just 170 pages, it may have been more efficient to start with basic microbiology, make several main points understood in the first chapter, and then move on to the illustrative examples. Instead, her efforts at introduction were confusing. For example, archaea are briefly introduced as being synonymous with extremophiles, which they are not; there may be many more mesophilic archaea. Meanwhile, Maczulak confounds her assertion by introducing various interesting extremophiles, among them both bacteria and archaea, but she fails to distinguish between the two. Ten pages later comes the canonical Woesian family tree that typically introduces archaea.

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Since Maczulak's focus throughout the book is the detailed recounting of the history of microbiology, I wish she had also tackled the history of Carl Woese's reinvention of the field. This approach might have introduced and showcased archaea more effectively.

In other places, while trying to provide some basic biological information, Maczulak makes generalizations that are too casual, as when she declares that bacteria are less bound by the sort of spatial constraints that limit protozoa to aquatic places and fungi to soil. In a book this succinct, the background material must be chosen carefully and used with more precision. All bacteria and archaea are aquatic in that their reproduction and metabolisms require water in the environment, even if only a thin film around a particle. Maczulak also declares that the overwhelming majority of bacteria live in soil. If she is including all sediments in oceans and other bodies of water as "soil," as well as all of the tropical substrates that are not quite soil, then this statement might be true, but it is too loose a comment to be stated on its own as fact.

The history of microbiology can be presented as inspiring reading—Paul de Kruif being the leader of that genre. The strengths of *Allies and Enemies* all lie in the sections in which Maczulak delves into detail about the personalities and lives of her protagonists: The events in Koch's and Hesse's lab are nicely depicted, the interactions of Pasteur and Winogradsky are well developed, and the history of *Escherichia coli* is thoroughly researched and interestingly written. Maczulak's ability to tell a good story is highlighted again in her descriptions of the myriad bacteria in and on the human body. As an aside, I disagree with Maczulak that Hooke is a forgotten hero of bacteriology; he merits numerous pages from historians and philosophers of science for his many accomplishments. Hooke's particular microscope design, however, was never as effective as van Leeuwenhoek's. Hooke's subjects were much larger objects, such as fleas and fly eyes, and never cells of bacterial size.

The tone of the book changes when Maczulak tries to clarify what we know and do not know about the origins of antibiotic-resistant bacteria. Although the origins of some antibiotic-resistant bacteria can be isolated to stockyard animals dosed with prophylactic antibiotics, she claims that "it can be difficult to prove" any real connection. I was at first puzzled by the prevarications in this section and then wondered whether Maczulak was speaking from some firsthand experience with the beef industry. (She has a consulting firm that deals with compliance audits for industries concerning microbes.) If so, I wish that she had told the story more directly in the book instead of presenting it as an intractable problem. A similar equivocal tone appears in the section on genetically modified food, another topic that might have benefited from a more forthright approach that included the author's experiences with such industries.

Segments of the book that are not about pathogens tend to be about bacteria as essential providers for specialized activities in industry and technology. This dichotomy of bacteria acting as either pathogens or industrial aids is already pervasive in the popular press and does not need such reinforcement. Another disconcerting theme I found in *Allies and Enemies* is the idea of "our" world being primarily inhabited by bacteria. Put more accurately, it is their world that we inhabit. Bacteria simply dominate the ecosystems; have been and continue to be intrinsically influential in our evolutionary history; and, quite simply, make nutrient cycles of life possible.

The final chapter concludes that bacteria are our best friends and that we should stop worrying about germs. Yet more than half of the book is focused on the pathogenicities of bacteria and their relentless resistance to the best antibiotics. The chapter "Bacteria in Popular Culture" emphasizes depictions of plague and tuberculosis in art and literature and then segues into a discussion of bacteria as destroyers of the artwork itself. Alas, I had been hoping that Maczulak would review the growing body of art that celebrates bacterial ubiquity and diversity. Often, such art is colorful and transient, involving flows of living bacteria interacting on a substrate.

A surprising epilogue appears at the end of the book, containing information typically found in introductions to microbiology lab manuals. Maczulak includes instruction on how to do serial dilutions, how to count colonies, and even how to use logarithms to calculate large numbers. As one who has written a book on bacteria, I know it is a challenge to frame the audience. I think both Maczulak and I would like to envision our readers as so enthusiastic about microbes that dabbling in the laboratory would be their next irresistible step. But in the case of *Allies and Enemies,* those extra pages of instruction may have been better used to reinforce the grand scale of everything bacterial.

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SERIOUS EVOLUTIONARY GENETICS

Elements of Evolutionary Genetics. Brian Charlesworth and Deborah Charlesworth. Roberts and Company, 2010. 768 pp., illus. $68.00 (ISBN 9780981519425 cloth).

Wherever the study of evolution intersects with the study of inheritance we have evolutionary genetics. Evolutionary genetics thus covers a huge chunk of evolutionary biology, as without inheritance there can be no cumulative change. The

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