

# Economics As a Life Science

**You Can't Eat GNP: Economics As If Ecology Mattered.** Eric A. Davidson. Perseus Publishing, Cambridge (MA), 2000. 247 pp. \$23 (ISBN 0-7382-0276-2 cloth).

**The Nature of Economies.** Jane Jacobs. Modern Library, New York, 2000. 190 pp. \$21.95 (ISBN 0-679-60340-9 cloth).

**B**oth ecology and economics share the same Greek root, *oikos*, meaning "house." Linked with *nomics*, it means "management of the house." Linked with *logy*, it means "study or knowledge of the house." Obviously, study and knowledge should go hand in hand with management, and good ecology should be a basic ingredient in good economics. Unfortunately, in the recent past ideas about management of our world as encoded in conventional economic theory, in biologist E. O. Wilson's words, "can be summarized in two labels: Newtonian and hermetic. Newtonian, because economic theorists aspire to find simple, general laws that cover all possible economic arrangements...hermetic—that is, sealed off from the complexities of human behavior and the constraints imposed by the environment" (Wilson 1998, p. 197).

Two recent books are notable in the growing body of work that attempts to break the hermetic seal and reconnect economics with the real world. They are notable not so much for the novelty of the basic ideas they espouse—ideas that have been percolating in academic circles for at least several decades (Boulding 1966, Daly 1968, Costanza 1991, Costanza et al. 1997a, 1997b)—but rather for the eloquence and style with which they put the ideas across. Both books are eminently accessible and a joy to read, and therefore hold the prospect of reaching a much broader audience, both inside academia

and out. Reaching this broader audience is essential in order to break the hermetic seal, because it is going to take a lot of pressure from the outside to get the lid to start turning—there is very little pressure from the inside for change.

Eric Davidson's book is a readable summary of many of the main ideas of ecological economics. He begins by describing three basic fallacies of the mainstream economic model. The first he calls the "Marie Antoinette" fallacy.

The mainstream model assumes near-perfect substitutability between land (natural resources), labor, and capital. If we deplete all our natural resources, the mainstream model says that we can simply substitute more labor or capital—or,

as Marie Antoinette reportedly said when the French peasants were complaining about not having any bread, "Well, let them eat cake!" The truth is that manufactured capital, human capital, social capital, and natural capital function more like complements than substitutes (Costanza and Daly 1992), and a sustainable economic system requires a safe minimum of each of these four types of capital.

The second fallacy Davidson calls "Custer's folly"—the assumption that the technological cavalry will come over the hill to save us from ecological disaster just in time. The problem is that while technology might come up with solutions, it is foolhardy to assume that it

will, especially when the stakes are so high. It is much more rational to assume that technology will *not* come to the rescue at the last minute and to take a more precautionary approach that assures our sustainability regardless of technological developments (Costanza et al. 2000).

The third fallacy is "false complacency from partial success": If we can solve some environmental problems, we can, by extension, solve all environmental problems. Davidson likens this line of argument to a claim by a spouse abuser that he is a good person because he no longer beats his spouse as much as he used to. The truth is that many environmental problems that have appeared to be solved have actually just been moved to other regions or countries or social groups, often as a consequence of more open trade (Arrow et al. 1995). Also, in the crowded world in which we live, many new technologies have unintended consequences that may completely undermine and outweigh their initial, positive effects (e.g., DDT, chlorofluorocarbons).

Jane Jacobs' book is very different in style and deals with more fundamental issues concerning how economies work. It is written as a Socratic dialogue among a group of friends. This format allows for a very engaging and insightful treatment of some fairly complex topics, but at the same time it makes it difficult to place the dialogue in the rich academic literature on these topics. Jacobs focuses her effort in this dialogue on the basic functioning of economic systems, and the fundamental observation that they must obey the same laws of physics, chemistry, and evolutionary biology as any other complex adaptive system.

Jacobs is most famous for her work demolishing the doctrinaire views of city planners and forcing them to look at the way real cities really work (Jacobs 1961). In this book she does the same thing to economists, forcing the confrontation of unquestioned theory with reality. She also emphasizes some important philosophical positions that distinguish conventional from a more "ecological" economics.

The most basic of these positions is the idea that humans and their artifacts are just as much a part of nature as any other

organism. The Cartesian dualism that underlies conventional economics (and much of conventional science) assumes that humans are somehow fundamentally different from the rest of nature. This sets up a basic (and false) environment vs. economy dichotomy and leads to a host of other conceptual difficulties. The truth is that humans and their artifacts behave much like all other complex adaptive systems. The book is a treatise on how complex adaptive economic systems (especially urban systems) work and the kind of science and policy that flow from this understanding.

Both of these books are must-reads for anyone concerned with how economies really function. They are also excellent starter volumes for those just getting interested in this subject. It is to be hoped that this latter category of readers will be large and will help to break the hermetic seal isolating economics from the real world and force it to become the life science it desperately needs to be.

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## FUNCTIONAL AND EVOLUTIONARY BIOLOGY OF INSECT FLIGHT

**The Biomechanics of Insect Flight: Form, Function, Evolution.** Robert Dudley. Princeton University Press, Princeton (NJ), 2000. 476 pp. \$49.50 (ISBN 0-691-04430-9 cloth).

During the past several decades, the study of insect flight and other topics in invertebrate locomotion has been dominated by detailed mechanical analyses in a few model systems. This engineering focus has led to major advances in our understanding of the aerodynamic mechanisms and power requirements for flight; it has also largely ignored the astonishing diversity of insect flight and the evolutionary processes that generated it. This is in curious contrast to the many studies of vertebrate form and function in which mechanical and evolutionary perspectives have been usefully integrated. In his important new book, *The Biomechanics of Insect Flight*, Robert Dudley, et al. goes beyond the standard engineering perspective to explore the diversity and biology of insect flight from morphological, functional, and evolutionary perspectives.

The opening chapter, "Flight and the Pterygote Insecta," focuses on flight and insect diversity, and makes clear that the book is not simply about biomechanics in its narrow sense, as the analysis of organisms as mechanical devices. Dudley is largely successful in providing a thorough, almost encyclopedic, overview of the functional biology of flight in all its manifestations: functional anatomy, kinematics and aerodynamics, physiology and energetics, sensory biology, and ecological and evolutionary contexts. There is an excellent balance and consistency in how these diverse topics are reviewed,

and Dudley's mastery of the relevant literatures is impressive—there are 102 pages of references, which make up more than 20 percent of the entire book. Instead of focusing on a few model systems, the book emphasizes patterns of variation in flight characteristics among taxa. Along the way, Dudley provides thoughtful and balanced, yet critical, discussions of some complex issues, including the morphological origins of wings and of flight, the determinants of mechanical power output, and aerodynamic scaling. His descriptions of unsteady–steady aerodynamic mechanisms are the clearest that I have read and will be very helpful for newcomers to the field.

One of the great strengths of the book is its focus on evolutionary and phylogenetic aspects of flight diversity. At key points Dudley maps morphological or physiological flight characteristics onto currently available phylogenetic trees of winged insects as a means of focusing discussions about important evolutionary transitions in flight. There are also comparative analyses of hypotheses about evolution of insect diversity, body size, and flightlessness, which explicitly account for phylogenetic effects. These are now standard approaches in evolutionary biology, but are largely unused in the worlds of insect flight and invertebrate biomechanics. As a result, the book is a wonderful source of interesting evolutionary hypotheses that invite further study on topics ranging from the aerodynamic roles of fore and hind wings and flight muscle characteristics to miniaturization and hovering flight.

Dudley's encyclopedic approach does have its drawbacks. Complex sentence structure and a rigorously formal tone are the norm: I can't say I actively enjoyed reading all of the book. The extensive descriptions of variation and diversity in anatomy, wing kinematics, and other issues are sometimes tedious, and in places it is hard to follow the essential points. The entire book contains only 20 figures and tables that provide quantita-

tive data, a surprising paucity given the quantitative nature of the field. The most important limitation, however, is the lack of mathematical treatment of aerodynamics and fluid mechanics. For example, although simple algebraic expressions for steady-state forces and components of power are provided, there is no formal definition of circulation or vorticity, no analysis of the development of circulation during unsteady motion, and no presentation of the Navier-Stokes equations for fluid motion. Omitting the math undoubtedly makes the book accessible to a wider audience, but the book does not provide the background needed to understand the recent research and literature on mechanics of insect flight; interested researchers and students will need to go elsewhere for this information.

Despite these limitations, *The Biomechanics of Insect Flight* is a masterful survey and synthesis of our current understanding of the functional and evolutionary biology of insect flight. It provides an excellent resource and reference for researchers interested in flight. More generally, it is a rich source of interesting ideas and testable hypotheses about evolution of functional diversity in the most species-rich taxon on earth, and it should appeal strongly to students in search of research questions and study systems in which to explore the evolution of form and function.

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## A COMPLETE INSECT REFERENCE

**American Insects: A Handbook of the Insects North of Mexico.** Ross H. Arnett, Jr. CRC Press, Boca Raton (FL), 2000. 1003 pp., illus. \$89.95 (ISBN 0-8493-0212-9 paper).

This second edition is massive, consisting of more than 1000 pages, all tabulatory. It offers several profound improvements over the initial issue, primarily in its copious, helpful illustrations compiled by coleopterist Arnett, who died last year at 80. Not a vade mecum, this book is meant to be left in the laboratory, available for decades of referrals. Its 57-page index facilitates easy reference by using headings down to species, plus common names, metamorphic features, reproductive behaviors, migration, light production, aberrations, and "uniquenesses."

In brief, the book contains descriptions of each known order of insects, extant or extinct, and each family of insects known to occur in North America; taxonomic sequential lists of each described genus of insect known to occur in North America and tables of described species in each of those genera; accounts of over 17,000 species of North American insects, including many descriptions and many illustrations of species that are known to be pests in North America.

In all 12,357 genera and 87,107 species of North American insects are described, with literature references to all of these genera and species. After hints concerning insect collecting, biogeography, and ecology, the bulk of this book is divided by orders.

With shipping added to the cost of the book, all this itemized information comes to \$102.38, approximately a dime a page.

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