# Biology as Power

**Controlling Life**. Jacques Loeb and the Engineering Ideal in Biology. PHILIP J. PAULY. Oxford University Press, New York, 1987. iv, 252 pp. + plates. $24.95. Monographs on the History and Philosophy of Biology.

Few scientists of the past century have excited more passion and popular interest than Jacques Loeb. His experiments on artificial parthenogenesis commanded worldwide publicity and even inspired talk of a scientific basis of the doctrine of immaculate conception. His personality and values were the model for one of the most forceful, if simplistic, images of the scientist in popular literature: Max Gottlieb in Sinclair Lewis's *Arrowsmith*. He has entered mythology as a symbol both of ruthless reductionism and of German science transplanted to America. It is remarkable that Loeb has received little attention from biographers; it is more remarkable that this, the first book-length biography of Loeb, succeeds so richly in capturing not only the details of his life but also the meaning and implications of his work.

Pauly's theme is simple but powerful: Loeb stands at the fountainhead of a new tradition in the biological sciences—a tradition that places more emphasis upon the control of organisms than on a formal or complete understanding of their nature. Whereas his contemporaries, like Francis Bacon before them, believed that power and knowledge were inextricably linked, Loeb thought it possible to manipulate life without understanding it, to treat the organism as a black box from which all manner of behaviors could be coaxed by environmental cues. He was, Pauly suggests, an engineer in biologist's clothing.

Loeb's concern with control, Pauly proposes, evolved slowly during the course of his extended education in the 1880s and early 1890s. From his teacher of physiology at Strassburg, Friedrich Goltz, Loeb acquired the conviction that organisms were far more complex than mechanists suspected. From an associate at the University of Würzburg, the botanist Julius Sachs, he derived an interest in the tropisms of lower organisms. From visits to the Naples Zoological Station he obtained a familiarity with the techniques of marine biology. Most important, in the writings of the physicist and philosopher of science Ernst Mach and the Austrian engineer Josef Popper-Lynkeus Loeb discovered reasoned arguments for his own half-formed and inarticulate opinions. In particular, he found strong support for the notion that scientists, rather than searching vainly for true causes, should really be concerned with producing effects. By 1891, Loeb had come to see himself as an engineer of living substance.

Loeb's consuming interest in molding life found full expression in the work he did on embryology and development after moving to America in 1891. Following a brief interlude at Bryn Mawr, Loeb pressed ahead with experiments first at Chicago and then at Berkeley. The most famous of these, of course, was his production of fatherless sea urchins, but there were also experiments on artificial parthenogenesis in other organisms, on the production of mutations, and on the extension of life. These experiments, Pauly persuasively argues, were not efforts to reduce biology to physicochemical laws, although they have often been understood as such; rather they were attempts to manipulate life processes in the absence of an understanding of mechanisms. Loeb did not know exactly why changes in osmotic pressure triggered the development of sea urchin eggs and was not especially interested in finding out: that the cells could be made to divide was sufficient.

One might suppose, as Loeb initially did, that America, home of the supposedly practical, inventive, and impatient Yankee, would be a congenial place for a biological engineer. But, as Pauly reveals, Loeb discovered in the United States a belief in progressive evolution even more offensive than the mechanistic reductionism of his former colleagues in Germany. Isolated intellectually, repeatedly challenged to provide material explanations for the phenomena he studied, and frightened by the racist and militarist purposes to which evolutionism was being put, Loeb eventually stumbled into the camp of the mechanists. He ended his career at the Rockefeller Institute, where he became the symbol of a reductionism hardly distinguishable from that which he had once opposed.

Loeb's career touches upon such familiar issues in the history of science as the development of experimental biology, the conflict between mechanism and vitalism, and the rise of American universities as centers of research. Pauly handles these with a deftness and good judgment that inspire admiration. Even had his book ended with Loeb's death in 1924, it would have been a valuable addition to scholarship. But in a final chapter Pauly reaches beyond the limits of Loeb's life to address the larger question of Loeb's influence on the biological sciences, and in so doing makes a strikingly original and important contribution to the history of modern thought. Loeb's ideal of a technology of life influenced a younger generation of scientists, a remarkably influential group that includes the behavioral psychologists John B. Watson and B. F. Skinner, the geneticist Hermann J. Muller, and the inventor of the birth control pill, Gregory Pincus. Loeb's engineering ideal, Pauly suggests, survived him and, for better or worse, forms the background to the biotechnology of today. Readers may wonder about other sources of the engineering motif in modern biology; a biography is not the best vehicle with which to trace the elaboration of such a broad tradition of thought. Nevertheless, Pauly's ambitious and rewarding effort to understand the origins of biotechnology deserves applause and a wide readership.

JOHN W. SERVOS
*Department of History, Amherst College, Amherst, MA 01002*

## Small-Mammal Studies

**The Ecology of Woodland Rodents**. Bank Voles and Wood Mice. J. R. FLOWERDEW, J. GURNELL, and J. H. W. GIPPS, Eds. Clarendon (Oxford University Press), New York, 1985. xx, 418 pp., illus. $79. Symposia of the Zoological Society of London, no. 55 (London, Nov. 1984).

Considering the pervasive impact of small-mammal biology on a diversity of biological disciplines, from ecology, evolution, and behavior to physiology and genetics, a compendium of what we know about Europe's three most widespread woodland rodents should command our attention. The present volume contains 14 contributions from 16 invited participants, including four from outside the United Kingdom (one each from Poland, Sweden, Norway, and New Zealand).

The three principal subjects of this effort are the bank vole (*Clethrionomys glareolus*), the wood mouse (*Apodemus sylvaticus*), and the yellow-necked mouse (*A. flavicollis*), the last of which inhabits mature deciduous forests and is relatively poorly known. The geographic emphasis is on Great Britain, but the literature review and the integration of information with data on other relevant species, especially North American analogs, are extensive. In view of the widespread (Eurasian) distribution of these species, I sampled 435 literature citations and found that only 5 percent had non-English titles. I therefore suspect that considerable primary literature has been overlooked.

The chapters cover genetics, reproduction, behavior, olfactory and acoustic senses, food, energetics, parasites and diseases, predation, movements, population dynamics, and woodland small mammal communities as a whole. Those interested in any of these aspects of mammalian biology would profit from reading the relevant chapters. In addition, connoisseurs of the intricacies of population dynamics will find the three chapters on this subject an excellent overview of the field as seen by small-mammal ecologists. None of these chapters concludes that population regulation is simple in these species. All invoke multiple interacting parameters but avoid proffering an explicit multifactorial explanation. True to tradition, they call instead for further research. Both the bank vole and the wood mouse have the potential for contributing greatly to the theory of population regulation. In the case of the bank vole, considerable geographic variation occurs in the demographic patterns exhibited (annual cycles, non-cycles, and multiannual cycles), and the wood mouse, which is found in a variety of habitats, offers an opportunity to test hypotheses relating to habitat-induced variations in ecology and behavior.

Especially welcome is the chapter on parasites and diseases (Healing and Nowell), as this is a badly neglected topic in small-mammal biology and one destined for major expansion. The authors stress how the host-parasite system is influenced by various host properties (sex, age, nutritional state, behavior, immunological status) and by parasite variables, particularly host specificity and parasite species interactions. Some additional features of interest are: (i) Stenseth offers an excellent discussion of the advantages and disadvantages of mathematical modeling in ecology. (ii) Wolton and Flowerdew provide rare data on the critically important subject of frequency and distances of excursions out of home ranges. (iii) King concludes her survey of predation by claiming that the supply of alternative prey and habitat heterogeneity are critical variables in determining the influence of predators on prey populations. (iv) Stoddart and Sales give us a data-rich review of two little-studied sensory modalities (olfaction and hearing) in small mammals and urge studies focused on the interactions of these senses.

Given that the chapters in the volume overlap broadly, a good index would have been especially helpful for locating specific information, but the one index provided proves to be grossly inadequate. The volume remains an important contribution, however, not only as a compendium of what we know about several species of common rodents but as a statement of how small-mammal biology integrates into the larger arena of ecology, behavior, physiology, and evolution.

WILLIAM Z. LIDICKER, JR.
*Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720*

## Ciliates

**The Molecular Biology of Ciliated Protozoa.** JOSEPH G. GALL, Ed. Academic Press, Orlando, FL, 1986. x, 352 pp., illus. $49.50.

Like many other scientists, I was first introduced to biology by peering at *Paramecium* through a school microscope. The ciliates as a group of organisms have also provided an impressive number of experimental firsts. In the field of molecular biology, these include the first descriptions of self-splicing RNAs, the sequence and structure of telomeres, telomere-specific proteins, and extensive genome reorganization. Certain aspects of ciliate biology offer unique advantages to the molecular biologist. Perhaps the most dramatic is the presence of dimorphic nuclei. The micronucleus, which provides genetic continuity, is organized into conventional chromosomes but is transcriptionally inert. The highly polyploid and transcriptionally active macronucleus consists of subchromosomal DNA molecules whose segregation is amitotic in nature. This nuclear dualism makes ciliates natural model systems for a number of basic biological questions, such as genetic differences between somatic and germline nuclei or the chromatin structure of active versus inactive genes. Likewise, the generation of the macronucleus from the micronucleus provides an opportunity to determine in synchronized populations the mechanisms by which specific chromosomal rearrangements occur, including sequence elimination, DNA splicing, and generation of new telomeres.

The purpose of *The Molecular Biology of Ciliated Protozoa* is both to provide a general introduction to ciliate biology and genetics and to highlight those areas of research in which molecular progress has been most marked, with a special focus on areas unique to ciliates. The book certainly achieves these goals and, in so doing, fills a hole in the scientific literature. Each of the 11 chapters is a contribution from a recognized expert. Individual chapters are well written and readable, for the most part focusing on broad issues rather than experimental minutiae. Although each chapter can stand alone, they are well integrated with an admirable degree of cross-referencing and a minimum of repetition that reflect skilled and attentive editing. Where subjects are treated more than once, as in the case of the genomic rearrangements that accompany macronuclear development (discussed in detail in four chapters), the treatments take different perspectives.

Although the quality of the individual chapters is uniformly high, I especially enjoyed David Nanney's introduction, which provided fascinating insights into the history of ciliate studies. Nanney details the reasons for *Paramecium*'s early popularity as an experimental system (its large size facilitated visualization with the microscopes of the 1880s), as well as possible reasons for its fall from favor (being an organism in which extrachromosomal inheritance had been well documented, it became associated with anti-Mendelian, pro-Lamarckian factions). Eduardo Orias's chapter on conjugation presents a thoughtful discussion of the factors governing alternative pathways for the differentiation of genetically identical nuclei. Meng-Chao Yao describes the life history of *Tetrahymena* ribosomal DNA in impressive molecular detail: the multiple, palindromic, extrachromosomal copies in the macronucleus are derived from a single "half-palindromic" integrated copy in the micronucleus (thereby making *Tetrahymena* the only eukaryote in which it is possible to conduct genetic studies on the genes encoding ribosomal RNAs).

My only complaint with this book is to wish it were longer. It would have been especially useful to include more chapters on *Paramecium*, for example on its use as a system for neurobiologic and behavorial studies, and a description of the bacterial endosymbionts that confer the killer trait. I also would have liked to see even more photographs of the visually appealing ciliated protozoa, including pictures of replication bands, crescent nuclei, and preconjugative cilia loss. Like all books, this volume suffers from the fact that science moves faster than publishing. Thus, although some chapters list 1986 references, the book does not include discussion of the most recent advances, such as the transformation of both *Tetrahymena* and *Paramecium* or the non-templated replication of telomeres. However, the fact that much has happened in the past year is a tribute to the vitality of ciliate research. In any case, these reservations are minor. *The Molecular Biology of Ciliated Protozoa* is a welcome addition to the scientific literature and one that is likely to attract new converts to these fascinating and tractable creatures.

VIRGINIA A. ZAKIAN
*Basic Sciences Division, Hutchinson Cancer Research Center, Seattle, WA 98104*