Lepidopteran Surprises

Molecular Model Systems in the Lepidoptera. MARIAN K. GOLDSMITH and ADAM S. WILKINS, Eds. Cambridge University Press, New York, 1995. xii, 542 pp., illus. $125 or £65.

The great strides now being made in the molecular biology of fruit flies have tended to eclipse the contributions that some of their four-winged relatives have made to our understanding of biological phenomena. This book succeeds extremely well in highlighting the research carried out with moths and butterflies and reminding the reader that these colorful creatures are really the unsung heroes of many contemporary lines of research.

Besides being intrigued by the striking wing patterns of the Lepidoptera, scientists have found other compelling reasons to study moths and butterflies. The large size of certain lepidopteran species has facilitated surgical and biochemical studies. The economic importance of other species has prompted investigations that have often led to findings of fundamental significance to biology as well as practical significance to humans. The contributors to this book have obviously fallen for these charms of the Lepidoptera. They convey their enthusiasm for these insects in discussing contributions of lepidopteran systems to the history of biology as well as the promise that these systems hold for the future of biology.

Although each chapter is self-contained, the authors have consciously attempted to mesh their chapters. Rather than presenting specialized research reports, each chapter provides a broad overview of an important area in lepidopteran research. The discussions also freely consider other insects as well as vertebrates. The authors have not been hesitant to emphasize the advantages of lepidopteran systems, but they are keenly aware of their present limitations. A common refrain throughout the book is the need for a germline transformation system. Recombinant baculoviruses discussed in the book's last chapter promise to meet this challenge. Reductionist approaches pervade each chapter, but a holistic view emerges from the book's organization. The introductory chapter and the epilogue contribute greatly to this unity.

Many branches of contemporary invertebrate as well as vertebrate research have their roots in lepidopteran studies that have been largely forgotten. The opening chapter resurrects this history and is rich in surprises. Few readers will be aware that the first reported studies of mutations in animals were based on work with silk moths or that the earliest studies of homeotic mutants were undertaken with silk moths years before E. B. Lewis began his thorough studies of the *Drosophila* bithorax complex. As another example of lepidopteran legacies, the authors mention that a moth hormone was first used to demonstrate that genes can be the primary target of hormone action. Our present knowledge of insect endocrinology, immunology, and olfaction has developed almost entirely from work with Lepidoptera. Acknowledging these and other little-known contributions of lepidopteran research to the development of many research fields is also to acknowledge the often tortuous and unpredictable course of discovery in science.

If the history of lepidopteran research is filled with surprises, contemporary research with Lepidoptera is also yielding some. Similarities often exist between genes of moths and flies, but differences between genes of these two groups seem to be equally numerous. The homeodomains of homeobox genes in fruit flies and moths are highly conserved, yet the phenotypes of their mutant genes can be strikingly different. Both the sequences of chorion (eggshell) proteins in flies and their organization are very different from those in moths. Nevertheless, promoters of moth chorion genes can still be properly regulated in transgenic flies. Clearly, there's more than one way to make an insect.

"Scanning electron micrograph of aeropyle crowns on the surface of the eggshell from *Antheraea polyphemus*. (Scale marker = 10 μm.)" [From Regier *et al.*'s paper in *Molecular Model Systems in the Lepidoptera*]

As the editors and the contributors have made abundantly clear, "an understanding of complex biological phenomena will occur only when diverse systems are studied." Throughout the book we can see how various research areas have benefited from the interplay of different systems. Not only have the Lepidoptera been instrumental in initiating many of these lines of research, they promise to maintain this tradition.

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A Cellular Structure

The Telomere. DAVID KIPLING. Oxford University Press, New York, 1995. x, 208 pp., illus. $69.95 or £145; paper, $31.50 or £22.50.

At the outset, David Kipling assigns his subject a rather slippery definition: "a telomere is whatever biological structure makes the end of a natural chromosome behave differently from a double-stranded break." This definition launches an encompassing description of a fascinating field. It demands the juxtaposition of a host of poorly understood biological observations about telomeres and the current rapidly expanding molecular view. And the definition is historically precise: after all, telomeres were first defined as cytologically identifiable structures that prevented natural chromosomal termini from undergoing the breakage–fusion–bridge cycles exhibited by newly produced DNA breaks. From this perspective, questions flow freely from the body of existing data. Which of the known molecular properties of telomeres is most important for this defining behavior? For all the excitement over the discovery of terminal DNA sequence properties in many organisms and associated proteins in a few, this central question awaits a response.

The book, like the structure, incorporates biochemical, genetic, cell biological, organismal, and evolutionary aspects. In organization the treatment flows roughly along the lines of structural description, followed by a shift in emphasis toward functional observations and, once the stage is set, discussions of a provocative miscellany of topics. Alongside the description of tandem repeat sequences found at chromosomal termini in a large number of organisms is consideration of the evidence that these repeats are the necessary and sufficient DNA elements required for telomere function. For example, newly formed chromosomal breaks that behave like telomeres are found to have acquired telomeric tandem repeat DNA sequences at the new termini. Yet it is not clear what molecular features of chromosomal ends provide the defining telomeric behavior. The guanine-rich strands of repeat sequences from many organisms can associate to form guanine tetrad structures in vitro, which in the-

ory might constitute the telomeric end-protection mechanism. Several of the repeat sequences have been demonstrated to form specific protein-DNA complexes in vitro and in vivo, which also in theory might perform the functions required uniquely for telomere behavior. In addition to protecting chromosomal ends from initiating deleterious recombination events, telomeres must also overcome the "end replication problem" inherent in the observation that all known DNA replication enzymes require a primer. Thus, the argument goes, in each generation some number of nucleotides will be lost from the 5′ end of the lagging strand at each chromosomal end. The discovery of telomerase activity (carried out by a ribonucleoprotein complex that adds additional repeat sequences to the guanine-rich strand of termini) conserved in such widely divergent organisms as ciliates, mammals, and now (since the publication of the book) fungi has provided a satisfying prospective resolution. However, there is intriguing experimental evidence that one or more recombinational mechanisms may also play a significant role in maintaining telomere length. Although it is clear that characteristic telomeric repeat lengths are observed in different species (or even tissues for mammals), the mechanism for maintenance of a characteristic average length is not yet apparent. Later chapters in the book provide in-depth discussion of a variety of topics including new telomere formation in genome rearrangements, the relationship of human telomere loss to carcinogenesis and aging, variegating position effects on transcriptional activity near telomeres, and natural (evolutionary) alterations in primate chromosome architecture. *Drosophila* telomeres, which lack terminal tandem repeats, are given consideration in an independent chapter that evaluates the current best hypotheses put forward for telomere function in this organism.

Despite the breadth of information included (papers cited range from 1885 to 1994) many recent important experimental advances are not covered in the book; all presumably were published after it went to press. Clearly, the study of telomeres and their biology is a rapidly moving, robust field of research. Thus, with no fault implied, the book will not substitute for a good literature search for relevant papers from 1994 and beyond.

In *The Telomere* Kipling has certainly met, and possibly exceeded, his modest goal of compiling "an accessible introduction to a field full of fascinating and unique phenomena"; he has produced an incisive and captivating account with material of interest to a broad spectrum of telophiles, from spectators to central players in research. Each chapter includes a copious, well-organized reference list with full titles, and reviews are listed separately from the longer list of primary papers. At the end of the book, a helpful index facilitates the revisiting of favorite data bits or ideas. There are very few figures, but each is well chosen to enhance the text. In fact, the dearth of figures may simply represent the degree to which current knowledge is insufficient for accurate depiction of the spatial arrangement of objects, and additional drawings would have only provided distraction.

The Telomere is rigorous in summary, bold in speculation, and near comprehensive in scope. Contained concisely within 208 pages, the rapid succession of facts and ideas is adequate to satisfy even the immediate-gratification habit of TV generations. For a work of nonfiction, I found *The Telomere* to be a gripping read.

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Vignette: New Quarry

The hunting metaphor introduced by Paul de Kruif in his *Microbe Hunters* aptly describes the succession of movements in medical science in this century. Those hunters, who in the first two decades found the microbes responsible for many of the scourges of mankind, were replaced in the next two decades by the *vitamin hunters*, who discovered that deficiencies of vitamins could cause other epidemic diseases—pellagra, rickets, and scurvy. The vitamin hunters were superseded by the *enzyme hunters*, who showed how enzymes were assisted by vitamins in the metabolic operations responsible for cell growth and energy metabolism.

In recent decades the *gene hunters* have dominated. . . . A cadre of gene hunters is busy looking for the genes for human traits and the defects in these genes that cause inborn errors of metabolism. But the searches by these disease hunters are not basically different from those established for bacteria, fungi, plants, flies, and other animals. The greatest mystery now resides in brain processes—mood, memory, mental illness—which, when probed successfully with novel technologies, will turn the spotlight on a new breed of hunters (to whom we might refer as *head hunters*).

—*Arthur Kornberg*, in *The Golden Helix: Inside Biotech Ventures* (University Science Books)

Books Received

AIDS Clinical Trials. Dianne M. Finkelstein and David A. Schoenfeld, Eds. Wiley-Liss, New York, 1995. xiv, 458 pp., illus. $49.95.

Blastogenesis. Normal and Abnormal. John M. Opitz and Natalie W. Paul, Eds. Wiley-Liss, New York, 1994. xx, 403 pp., illus. $159. March of Dimes Birth Defects Foundation Birth Defects Original Article, vol. 29, no. 1 (1993). From a workshop, Big Sky, MT, Oct. 1991.

Changing Large Technical Systems. Jane Summerton, Ed. Westview, Boulder, CO, 1994. xii, 348 pp., illus. $49.85. From a conference, Vadstena, Sweden, Aug. 1992.

Diverse Topics in Theoretical and Mathematical Physics. Roman Jackiw. World Scientific, River Edge, NJ, 1995. viii, 514 pp., illus. $106; paper, $61.

Element of Risk. The Politics of Radon. Leonard A. Cole. Oxford University Press, New York, 1994. x, 246 pp., illus. Paper, $11.95. Reprint, 1993 ed.

The Fragile Contract. University Science and the Federal Government. David H. Guston and Kenneth Keniston, Eds. MIT Press, Cambridge, MA, 1994. xiv, 244 pp. $37.50; paper, $17.95.

Genetically Modified Organisms. A Guide to Biosafety. George T. Tzotzos, Ed. CAB International, Oxford, UK, 1995 (U.S. distributor, University of Arizona Press). x, 213 pp. $55.

How to Think about Weird Things. Critical Thinking for a New Age. Theodore Schick, Jr., and Lewis Vaughan. Mayfield, Mountain View, CA, 1994. xvi, 299 pp., illus. Paper, $18.95.

In Other Words. The Science and Psychology of Second-Language Acquisition. Ellen Bialystok and Kenji Hakuta. BasicBooks, New York, 1994. x, 246 pp. $27.

Mushrooms. Poisons and Panaceas. Denis R. Benjamin. Freeman, New York, 1995. xxvi, 422 pp., illus., + plates. $59.95; paper, $34.95.

Nanoscale Probes of the Solid/Liquid Interface. Andrew A. Gewirth and Hans Siegenthaler, Eds. Kluwer, Norwell, MA, 1995. xvi, 334 pp., illus. $177 or £112 or Dfl. 260. NATO ASI Series E, vol. 288. From an institute, Sophia Antipolis, France, July 1993.

Publishers' Addresses

Below is information about how to direct orders for books reviewed in this issue. A fuller list of addresses of publishers represented in *Science* appears in the issue of 26 May 1995, page 1220.

Cambridge University Press, 110 Midland Ave., Port Chester, NY 10573–4930. Phone: 800-872-7423; 914-937-9600. Fax: 914-937-4712.

Oxford University Press, Inc., Order Dept., 2001 Evans Rd., Cary, NC 27513. Phone: 800-451-7556; 919-677-0977. Fax: 919-677-1303.