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BOOK REVIEW

Goldsmith M.R. & Wilkins A.S.: MOLECULAR MODEL SYSTEMS IN THE LEPIDOPTERA. Cambridge University Press, New York, 1995, 542 pp. ISBN 0-521-40249-2 (hardback). Price GBP 65.00.

Twenty-six renowned scientists prepared 16 chapters reviewing the most exciting areas of molecular biology research in Lepidoptera. The first chapter describes the histories of insect endocrinology, physiology, biochemistry, genetics, and molecular biology, with an emphasis on the discoveries made on lepidopteran species. The last chapter accentuates three motivations for selecting Lepidoptera as research subjects: their uniqueness in certain features, their suitability for investigations of general insect phenomena, and their use as convenient models or "outgroups" for the phylogenic and general biology studies. It should be added that the book documents also a fourth reason for the studies on Lepidoptera: the perspective of developing novel methods for the pest control.

Fourteen chapters of the book are devoted to specific subject areas. Genetics is represented by a chapter on *Bombyx mori*, whose genetics is the best known of all Lepidoptera and offers interesting comparisons with the information on *Drosophila*. The chapter describes specific lepidopteran features such as sex determination mechanisms and diffuse kinetochores, presents a *Bombyx* chromosome map of about 200 genes specified by the phenotypes, and assesses progress in the construction of a molecular linkage map.

Lepidopteran genome characteristics are dealt with in two contributions, both providing a good general background. In the chapter on mobile elements, the reader finds definitions of satellite DNA (cca 200 nucleotides present in hundreds to millions of copies arranged in tandem clusters), short interspersed nuclear elements or retroposons (70–300 bp, contain internal RNA polymerase III promotor and a 3' poly(A) tail), and long interspersed nuclear or retrotransposable elements (6–7 kb, features shared with retroviruses). Lepidopteran *Bm1* and *Bm2* retroposons are described in detail and their origin from a tRNA is documented. The known retrotransposable elements of Lepidoptera are reviewed, with an emphasis on *R1Bm* and *R2Bm*, and are structurally correlated with those of other organisms and with retroviruses. The chapter on the use of genome analysis in phylogenetic studies offers a theoretical background, comparison with morphological methods, and a critical evaluation of several molecular approaches.

A review on the embryology of Lepidoptera attempts to integrate, not very successfully, the old descriptive work with the data obtained by experimental approaches in *Drosophila*. Various types of insect embryogenesis (from short to long germ anlage) are surveyed to accentuate the diversity found within Lepidoptera. Information on the establishment of embryonic axes and segmentation in *Drosophila* is described in the context of the lepidopteran embryogenesis. The role of homeotic genes in *Bombyx* is treated in a separate chapter. It has been known since 1941 that body segments in *Bombyx* are specified by genes clustered in the so-called E complex, in which recent molecular analyses disclosed *Drosophila* homologs *Ubx*, *Abd-A*, *Abd-B*, and *Antp*. There is increasing evidence that the homology concerns the gene sequence, mutual arrangement of the genes, and the function of the gene products.

The chorion of lepidopteran eggs has been chosen as a model system for molecular studies because it consists of large amounts of proteins produced by follicular cells according to a spatially and temporally precise pattern. Available information is reviewed in two chapters and referred to in several others. While *Drosophila*, with a simple egg shell, contains about 20 chorion genes, the silkmoths use ten times as many. In *Bombyx*, virtually all chorion genes occur in a 500 kb stretch of chromosomal DNA. Except for two, all silkmoth chorion genes belong to the α or β branches of a gene superfamily. Chorion genes are arranged in pairs, each consisting of an α-type and a β-type gene that are read in opposite directions and are driven by a single bidirectional promoter. The coding sequences of *Drosophila* and silkmoth chorion genes are unrelated, but in both species the genes contain similar *cis* regulatory elements and respond to similar *trans* regulators. The process of gene conversion underlies the concerted evolution of the lepidopteran chorion genes. Presented analyses of the gene conversion events in different chorion gene families reveals the significance of the recombination hotspots versus DNA deletions and insertions, and provides a background for our understanding of egg shell changes in lepidopteran phylogeny.

The silk glands, in which the expression of a few genes fluctuates from zero to extreme high rates within a few days, are also an excellent model for gene regulation studies. The capacity to express silk genes is acquired by the silk gland cells in response to transcription factors that specify the cell fate during embryonic development, while realization of this capacity is controlled by transcription factors acting during the larval stage. One chapter of the book reviews the current knowledge of these regulations in *Bombyx* and shows that homeogenes active in embryogenesis are expressed again in the functional silk glands. Another chapter analyzes regulation of polymerase III activity in the silk glands, which are characterized by a profound adjustment of the tRNA population to the use of amino acids in silk synthesis. It has been shown that the tRNA genes differ in the transcription rates (some are expressed exclusively in the silk glands), that are regulated at the level of class III promoters. The promoters proved much more complex than indicated by previous studies on *Xenopus* and some other systems. The work on *Bombyx* silk glands further divulged that the interaction of polymerase III with multiple transcription factors (one of them is an RNA!) controls the rate of transcription and thereby the compositions of the tRNA pool.

Intercellular signaling is accomplished by hormones whose effects on gene expression are being examined in several lepidopteran systems. A chapter on the hormonal control of gene expression in the epidermis and the fat body emphasizes the significance of the ecdysone receptor isoforms and the inexplicability of the juvenile hormone action. Another chapter deals with hormone action on the nervous system. The organizational effects are exemplified by hormonal control of neuronal remodelling during metamorphosis, when changes in the pattern of neuronal connectivity afford structural framework for the behavioral changes. The induction of ecdysial behavior in molting insects is presented as an activational hormone effect when ecdysteroids and the eclosion hormone elicit coordinated charching of specific motor neurons. The next chapter examines the development and function of the olfactory system. Odor molecules penetrate through cuticular pores into the fluid inside the sensory antennal hairs and, in a complex with odor binding proteins, are delivered to specific receptors in the membrane of the first order sensory neurons. The binding is transduced into an electrical signal to activate second order neurons in the deutocerebral olfactory glomeruli. Studies on moths greatly contributed to the current understanding of the developmental relationships between the primary and secondary olfactory neurons, the nature of odor binding proteins and odor membrane receptors, as well as to the mechanism by which ligand binding generates the electrical signal.

Current knowledge on insect defense against pathogens was largely obtained in studies on Lepidoptera and may be summarized as follows. An injury associated with sepsis activates hemocytes that trigger a conversion of soluble hemofibrin into a fillamentous mesh. Hemocytes trapped in the mesh close the wound by forming a rapidly melanizing plug, while the free hemocytes sequester and kill bacteria that penetrated into the hemocoel. Hemolymph lysozyme hydrolyzes the peptidoglycan of bacterial cell walls into soluble fragments that elicit the production of several immunodefense proteins by the fat body. The types, structures, and processing of these proteins are briefly described.

The molecular biology of Lepidoptera is associated with the research on baculoviruses or, more precisely, nuclear polyhedrosis viruses (NPV). The circular double-stranded NPV genome is enclosed in a nucleocapsid, and a large number of nucleocapsids is embedded in copious amounts of protein polyhedrin. The coding sequence of polyhedrin in the NPV genome may be replaced with a foreign gene: such recombinant viruses are either used to produce rare and expensive proteins that are harvested under in vitro conditions, or as biological control agents that kill a target pest more efficiently than a wild baculovirus. Transduced baculoviruses have also been produced; the introduced gene contains an insect promoter and its expression is therefore controlled by transcription factors specific for the infected insect cell.

The book as a whole is a much-needed survey of what is known about the molecular biology of Lepidoptera. The list of references is impressive and in most subject areas seems to include all crucial citations. Some of the described systems have been reviewed elsewhere, but such reviews often escape attention of those working on other lepidopteran systems. The book, which is a counterpart to the overwhelming information on the molecular biology of *Drosophila*, can highly be recommended to molecular biologists using insect models in basic research or developing transgenic organisms for the use in insect pest control. A general entomologist may find the reading difficult, but an easy introduction into the realm of insect molecular biology is hardly possible.

F. Sehnal