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BOOK REVIEW

DENLINGER D.L., GIEBULTOWICZ J.M., SAUNDERS D.S. (eds) INSECT TIMING: CIRCADIAN RHYTHMICITY TO SEASONALITY. Elsevier, Amsterdam, 2001, 234 pp., hard cover, ISBN: 0-444-50608-X. Price USD 118.

Insects, like other organisms are subject to daily cycles of light and dark and to seasonal cycles of climatic change. The analysis of insect timing presented in this book is based on three interrelated symposia hosted at the XXI International Congress of Entomology held at Iguassu Falls, Brazil, August 2000: "Circadian Clocks in Insects: Molecular and Cellular Perspectives" organized by J.M. Giebultowicz and M.D. Marques, "Photoperiodic Induction of Diapause and Seasonal Morphs" organized by D.S. Saunders and H. Numata, and "New Complexities in the Regulation of Insect Diapause and Cold Hardiness" organized by D.L. Denlinger and O. Yamashita. There are chapters in this book on the molecular mechanisms of circadian rhythms, the anatomical and functional organization of the multi-oscillatory system, physiological and molecular analyses of seasonal regulation of development, and physiological events associated with overwintering strategies.

Molecular mechanisms of circadian rhythms are best understood in *Drosophila melanogaster*. In the chapter "Molecular control of *Drosophila* circadian rhythms" by P. Schotland and A. Seghal, seven genes (*period*, *timeless*, *dClock*, *cycle*, *doubletime*, *cryptochrome*, *vrille*) are described and shown to participate in transcription-translation feedback loops involved in circadian clock controlling overt circadian behaviours. Recent progress in understanding the effects of light and temperature on the clock and output mechanisms at the molecular level is discussed. The chapter "Organization of the insect circadian system: spatial and developmental expression of clock genes in peripheral tissues of *Drosophila melanogaster*" by J.M. Giebultowicz, M. Ivanchenko and T. Vollintine demonstrate that the expression of clock genes is not limited to the CNS. Rhythmic co-expression of PERIOD and TIMELESS proteins occurs in several internal organs (oesophagus, proventriculus, hindgut, Malpighian tubules, fat body, rectum, spermatheca). Several lines of evidence discussed in this chapter suggest that peripheral oscillators are photoreceptive and independent of the central oscillator in the CNS. Circadian rhythms in the structure and subcellular organization of neurons of the first optic neuropile, the lamina, in three species of flies, *Musca domestica*, *D. melanogaster* and *Calliphora vicina*, are described in the chapter "Cellular circadian rhythms in the fly's visual system" by E. Pyza. The lamina's rhythm, an output of the circadian clock, can be studied at the neuronal level. The chapter "The circadian clock system of hemimetabolous insects" by K. Tomioka, A.S.M. Saifullah and M. Koga" mainly describes the anatomical dissection of neural pathways through which overt circadian rhythms in crickets and cockroaches are regulated. Roles of serotonin and pigment dispersing hormone in coupling the two bilaterally redundant clocks in the optic lobes are discussed.

Ten chapters are devoted to seasonal regulation of development. While there is evidence that the photoperiodic measurement of time is a function of an insect's circadian system, the molecular mechanisms are largely unknown. The uncertainty of the exact nature of the photoperiodic timing mechanism has given rise to a number of formal models. The blow fly, *C. vicina* is used to illustrate that behavioural rhythmicity and oscillations underlying photoperiodic time measurement are probably regulated by separate circadian clocks ("The blow fly *Calliphora vicina*: a "clock-work" insect by D.S. Saunders). A two-oscillator model for long- and short-night measurement/accumulation is proposed for two aphid species, the vetch aphid, *Megoura viciae*, and the pea aphid, *Acyrthosiphon pisum*. Input via an opsin-based photoreceptor and the possible role of melatonin in the clock output are discussed ("Photoperiodism and seasonality in aphids" by J. Hardie). In the noctuid moth, *Mamestra brassicae*, the night-length measurement shows either an hourglass or a circadian-oscillator feature depending on experimental conditions ("Photoperiodic time measurement and shift of the critical photoperiod for diapause induction in a moth" by S. Masaki and Y. Kimura). Two chapters discuss photoperiodism in two dipteran models, *C. vicina* and *Drosophila* species. In the chapter "Geographical strains and selection for the diapause trait in *Calliphora vicina*", D.S. Saunders discusses the differences between latitudinal strains and reviews the principal recent views on photoperiodic time measurement. The paper by M.T. Kimura ("Evolutionary aspects of photoperiodism in *Drosophila*") analyses the still rather enigmatic problem of the origin and evolution of photoperiodism in subtropical and warm-temperate species.

Photoperiodic signals are converted into a hormonal message. Hormonal regulation of diapause is discussed both at the physiological level ("Anatomy and functions of the brain neurosecretory neurons with regard to reproductive diapause in the blow fly *Protophormia terraenovae*" by S. Shiga and H. Numata) and hormone gene level ("Insights for future studies on embryonic diapause promoted by molecular analyses of diapause hormone and its action in *Bombyx mori*" by O. Yamashita et al.). Four chapters focus on the analysis of diapause related mRNAs, proteins and other molecules, like sugars and polyols ("Molecular analysis of overwintering diapause" by S.R. Pali et al., "Stress proteins: a role in insect diapause?" by D.L. Denlinger, J.P. Rinehart and G.D. Yocum, "Regulation of the cell cycle during diapause" by S.P. Tammariello, and "Significance of specific factors produced throughout diapause in pharate first instar larvae and adults" by K. Suzuki, H. Tanaka and Y. An).

The last two chapters deal with insect cold-hardiness. The first of them ("Surviving winter with antifreeze proteins: studies on budworms and beetles" by ten researchers from the Queen's University, Kingston, Canada) focuses on antifreeze (= thermal hysteresis) proteins of two freeze-susceptible insects, spruce budworm (*Choristoneura fumiferana*) and mealworm beetle (*Tenebrio molitor*), and particularly on the genes that encode them. The last chapter ("Using ice-nucleating bacteria to reduce winter survival of Colorado potato beetles: development of novel strategy for biological control" by R.E. Lee, Jr. et al.) describes the findings on the function of ice-nucleating bacteria in reducing cold-hardiness. The studies were performed on the Colorado potato beetle (*Leptinotarsa decemlineata*) and *Pseudomonas* sp. bacteria. It is suggested that such reduction of cold-hardiness could be used to control the abundance of freeze-intolerant insects.

Overall, by bringing together several interrelated biological clock topics, the book "provides a good platform for the movement of the field into the new century" as is stressed by James W. Truman in the foreword.

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