BOOK REVIEWS

Neural Integration

Dynamic Biological Networks. The Stomatogastric Nervous System. RONALD M. HARRIS-WARRICK, EVE MARDER, ALLEN I. SELVERSTON, and MAURICE MOULINS, Eds. MIT Press, Cambridge, MA, 1992. xx, 328 pp., illus. $65. Computational Neuroscience. A Bradford Book.

Donald Kennedy's 1967 *Scientific American* article "Small systems of nerve cells" enunciated a new view of the relationship between neural activity and behavior: that principles of neural integration underlying complete behavioral function can be traced in small systems of nerve cells characteristic of invertebrate nervous systems. This book presents another defining moment in this enterprise. *Dynamic Biological Networks* reports the fruition of years of painstaking study of central pattern generation in the crustacean stomatogastric nervous system. New and important principles of nervous integration have emerged. The once static view of neural circuit functioning has been replaced by a dynamic one in which neuromodulation plays a central role. These concepts are certain to be of ever greater significance as more complex systems and their behaviors are investigated. This book is essential reading for anyone interested in the dynamic operation of the nervous system.

The treatment begins with an overview of the anatomy and function of the four neural networks that make up the stomatogastric system (Johnson and Hooper). Thirty interconnected identified neurons form the pyloric, gastric-mill, cardiac-sac, and esophageal networks, which produce the rhythmic output necessary to mediate the feeding behaviors of Crustacea. The intrinsic electrophysiological properties of the component neurons, their synaptic connections, and the generation of rhythmic motor patterns are clearly presented. The analysis is then extended (Hartline and Graubard) to the nuts and bolts of the system with a consideration of the cellular properties of its individual neurons, including structure and function, voltage-gated currents, and several properties that play an important role in shaping the network output.

The pivotal role of neuromodulators in coaxing flexibility from this restricted system is reviewed by Harris-Warrick, Nagy, and Nusbaum. Modulation of firing properties and synaptic efficacy between neurons is emerging as an important theme in network function generally, and this chapter makes clear the significant contribution made by studies of the stomatogastric system to the development of this idea.

The magic of the system and the break with the older, "hard-wired" view is revealed in an account by Dickinson and Moulins of the ability of the system to use neuromodulation to produce a different functional output. Functional reconfiguration, in which a neuron's allegiance can switch from one circuit to another or in which circuits can merge or be disbanded and configured anew, underlies the dynamic behavioral output of this system.

The wealth of detailed cellular data already collected on this system begs for a theoretical modeling approach to tease apart the contributions of single neurons to the final output. Marder and Selverston summarize the daunting but very promising task at hand. Several different approaches to the modeling of the rhythmical neural networks of the stomatogastric nervous system are presented. The current work is summarized along with advantages and drawbacks of each approach.

Turrigiano and Heinzel close the circle with a chapter connecting behavior and neural activity. Exciting recent findings are beginning to bridge the gap between the cellular and network observations obtained with the isolated nervous system and the behavior observed in the more intact preparations.

A view of the stomatogastric system from a comparative and evolutionary perspective is presented by Katz and Tazaki. Though important details of decapod phylogeny are still uncertain, the evidence marshaled here supports a strong conservation of stomatogastric circuitry; the basic ensemble of neurons, their neurochemistry, and their principal connections are common to all decapods studied. The peripheral motor apparatus is more varied, serving the diverse gustatory life-styles of the decapods. An important insight emerging from this chapter is that neuromodulators may be a principal substrate for evolution, calling forth a repertoire of behaviors from a relatively fixed circuit.

Points of contact between central pattern generation and rhythmical motor output in other systems are considered by Pearson and Ramirez. Shared principles of operation among these systems are emerging, and the role of neuromodulation and network reconfiguration promises to be a unifying principle in motor systems, vertebrate and invertebrate alike.

Dynamic Biological Networks is a good read. The selection of topics and the pairing of authors from different professional lineages produce unbiased, thoughtful discussion of the topics at hand. The chapters can profitably be read individually, but the editors have exercised great care in integrating them, and the sum is much greater than the parts. Well-annotated, uncluttered illustrations and a discussion of how to use the book make it well suited for use in a graduate course.

The challenge now is to apply the approach represented by *Dynamic Biological Networks*, the analysis of circuits operating in their natural, modulatory environment, to other problems, including learning and development. The only downside is the nostalgia one feels for a simpler time of simpler systems.

Christine L. Sahley,
Department of Biological Sciences,
Purdue University,
West Lafayette, IN 47907

■

Land-Based Evolution

Terrestrial Ecosystems Through Time. Evolutionary Paleoecology of Terrestrial Plants and Animals. ANNA K. BEHRENSMEYER, JOHN D. DAMUTH, WILLIAM A. DiMICHELE, RICHARD POTTS, HANS-DIETER SUES, and SCOTT L. WING, Eds. University of Chicago Press, Chicago, 1992. xx, 568 pp., illus. $75; paper, $29.95. Based on a conference, Washington, DC, 1987.

Paleoecological and macroevolutionary patterns in the fossil record of the marine realm have received more attention in recent decades than have such patterns in the terrestrial realm. The marine record is significantly more complete and is richer in species and specimens through a longer time period than is the terrestrial record, permitting a head start in the evaluation of ecosystem evolution in marine communities, particularly of invertebrates. Although there have been some remarkable studies of terrestrial systems, the spottiness of their records has made the study of their trends through long reaches of time seem daunting. Now, it seems, that situation is about to change.

Terrestrial Ecosystems Through Time is an up-to-date treatment of the nonmarine fossil record; the subtitle, "Evolutionary Pa-