Bee Societies

The Social Behavior of the Bees. A Comparative Study. CHARLES D. MICHENER. Belknap Press of Harvard University Press, Cambridge, Mass., 1974. xii, 402 pp., illus. $25.

This book is, as the author writes, "concerned with the distinctively social attributes of the bees." It has three main parts. The first (Melittological Background, four chapters) presents some basic information and concepts and defines terms, aiming at giving the reader, lay or initiated, a common language. In this section one can see that the author has made some changes in his dendrogram (figure showing the phylogenetic relationships among tribes, subfamilies, and families of bees) since his 1944 paper; in this book the Apoidea are divided into nine families (the earlier dendrogram had seven) and 50 tribes and subfamilies (previously there were 48). The second part (16 chapters) is on comparative social behavior (caste determination, sex ratio, reproduction, communication) and its evolution. Chapter 5 presents the author's ideas on the evolution of social organization. Michener recognizes seven levels of socialization: solitary, subsocial, communal, quasisocial, semisocial, primitively social, highly social (the last two are also called eusocial). Part 3 (ten chapters) consists of an interpretative description of nests, life cycle, and many other aspects of behavior for five groups of social bees.

The evolutionary approach permeates the book, which presents many beautiful interpretations. An example is Michener's explanation for the parallel between the gradual diminution of caste intermediates and the gradual evolution of society in bees: "The more different the castes the less useful will a caste intermediate be—she is likely to be neither an effective forager and nurse bee (worker) nor an efficient egg layer (queen). Therefore switch mechanisms arise which assure that nearly every female develops either as a typical worker or as typical queen" (p. 107).

In the course of the book Michener, in addition to giving his own contributions and summarizing his ideas, reviews 700 papers, many times reinterpreting the data they contain. As in E. O. Wilson's *The Insect Societies,* the Brazilian school is well represented: 13 percent of Michener's references are to work done by this group, reflecting, in addition to the importance of the new school, the good command Michener has of the Portuguese language.

Michener's book and the other recent books on social insects by Wilson, von Frisch, and Lindauer apparently have a great region of overlap. However, new books in this field are not redundant, for the field is in a dynamic state, with new groups of researchers entering it, many changes taking place in the ideas of the old schools, and new discoveries being made. For 18 months ago, Michener's chapter on sex and caste determination was perfectly done. If he were writing it today he would have to cite 10 to 15 new papers that have advanced the subject considerably. The same is true of the account of swarming.

For every researcher, professor, or graduate student concerned with any species of social Apoidea this book is indispensable. I have been using it in my graduate course Genetics of Hymenoptera with excellent results, specially for giving to the students that kind of general knowledge, of common language, of intelligent look that every professor likes to find in his students.

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Motion at the Molecular Level

Internal Rotation in Molecules. W. J. ORVILLE-THOMAS, Ed. Wiley-Interscience, New York, 1974. xviii, 606 pp., illus. $39.95. Wiley Monographs in Chemical Physics.

Molecules are not internally at rest. With little expenditure of energy, rotation may occur about single bonds within a molecule. The result of this process is a reorientation between groups at either end of the bond. With additional energy (usually more than is thermally available at room temperature), rotation may occur about partial or even full double bonds. The amount of energy required to effect rotation depends on the identity and hybridization of the atoms that form the bond in question and on the substituents on these atoms. The field of conformational analysis has been concerned with studying the arrangements of atoms in space obtained by rotations about single bonds, the energetics of interconversion of these "conformations," and the influence of conformational interconversions on the reactivity of molecules in chemical processes. Conformational analysis has its experimental roots in the work of Pitzer and Hassel in the 1930's, although its theoretical foundations were laid much earlier. It became a major field as a result of the insight of Barton into the chemical consequences of conformations, and because of the development of instrumental methods for the characterization of conformations.

The title of this volume might suggest that the contents go beyond the field of conformational analysis to include data on rotational processes of partial and full double bonds. The scope of the book is in fact not so broad. The introductory chapter by the editor is concerned exclusively with the rotational properties of single bonds. Rotation about double bonds is referred to only in the chapter on theoretical methods, although studies of intermediate bonding situations (amides, α,β-unsaturated carbonyl compounds, and so forth) are treated quite fully in several chapters. This inconsistency in coverage may reflect the lack of general agreement among chemists about whether arrangements that result from rotation about partial double bonds should be called conformational or geometrical isomers. Conformational influences on chemical reactivity are not included within the scope of the book.

The approach of this book to conformational analysis is quite different from that taken in the older works on the subject by Eliel *et al.* and by Hanack. The present volume surveys experimental and theoretical methods rather than molecular systems. It is organized in a logical fashion, with each of the major methods covered by an expert in the field: chemical equilibration, dipole moments, vibrational spectra, nuclear magnetic resonance (NMR) and electron spin resonance, microwave spectroscopy, acoustic methods, electron diffraction, and ab initio calculations. In addition, there are two systems-oriented chapters, one on 1,3-dioxanes and cyclic sulfites, the other on medium effects. Both are excellent reviews of their subjects, but the subjects do not fit in with the organization of the remainder of the book.

Each chapter (or set of chapters) that deals with a particular experimental technique contains coverage of both the theory of the method and its applications. Each author considers a different mix of theory and application to be appropriate to his subject, and each reader will probably have yet a different opinion. To my own taste, the vibrational chapters are much too heavily weighted toward theory. The magnetic resonance chapter is essentially all theory. The microwave and electron diffraction presentations are reasonably well balanced. Because a number of different experimental techniques have been applied to the study of very simple molecular systems, there is considerable repetition of coverage. The energy diagrams for the interconversion of the conformational forms of ethane and of 1,2-disubstituted ethanes are illustrated in four different places. Such problems arise from the multiauthor approach. The ability to achieve a high level of expertise in each area, however, more than offsets the drawback of unnecessary repetition.

Because some of the experimental methods (microwave, electron diffraction, torsional vibrations) are applicable primarily to rather simple molecules, good coverage of these techniques is not difficult. The broader sweep of NMR, however, covers so much molecular territory that complete coverage would be an impossible task. Nonetheless, the most significant shortcoming of the book is its failure to provide even cursory coverage of many important areas studied by NMR. The addition of two chapters explicitly designed to survey NMR results, for example, one on acyclic systems and another on rings with other than six members, would have more realistically portrayed the volume of NMR studies. The chapter on 1,3-dioxanes might have been broadened to cover other six-membered systems. Another weak point of the book is the subject index. Five pages is insufficient for a volume of this size. A consistent set of energy units is not used throughout the book. Some chapters use kjoule/mole, whereas the majority use cal/mole or kcal/mole. One final regret is that one of the 20 contributors is unnecessarily singled out by title in the list of contributors, the table of contents, and the chapter by-line.

The book is relatively up to date in its coverage. Most of the chapters appear to have been written in 1972, with coverage complete through 1971. Several of the authors have written addenda to bring their material up to date through 1973. This book should assume its place as the standard reference work on internal rotation in small molecules, superseding the 1954 book by Mizushima. It will be of particular use to the person who wants an introduction to any of the several experimental techniques for measuring rotational barriers.

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