

story of Western science in the Pacific should be melded with that of Western science in Asia. The Pacific is a meeting ground for East and West in a larger sense, as the editors acknowledge. The scientific history of the Pacific now opens onto an even wider stage with an enlarged cast of players.

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## Social Insects

**Interindividual Behavioral Variability in Social Insects.** ROBERT L. JEANNE, Ed. Westview, Boulder, CO, 1988. x, 456 pp., illus. Paper, \$39.85. Westview Studies in Insect Biology. Based on a symposium, Hollywood, FL, 1985.

There has been a quiet but significant renaissance occurring in studies of social insects, in which the role of individuals in the structure and function of insect societies has been receiving increasing attention. It has long been apparent that colonies function as highly coordinated units to perform a wide variety of tasks, but the extreme variability characteristic of individual worker behaviors at any given time has been a significant barrier to the development of a comprehensive theory concerning the control of colony-level activities. The concept that colonies operate as "superorganisms" that are more than the sum of their individual workers was articulated by Wheeler and others during the first half of this century, but has languished in recent years owing to the lack of mechanistic explanations of how colonies could control individual worker activities. The empirical studies collected in this volume represent significant progress in understanding this question.

Almost all of the 14 papers were initially presented at a joint symposium of the Entomological Society of America and the North American Section of the International Union for the Study of Social Insects. The contributions are remarkable in their consistently high quality as well as in their uniformity of approach. The latter reflects not only an exceptionally good editorial job by Jeanne but also the sophisticated level of analysis that is being applied to social insect colonies.

Recent studies of social organization have benefited greatly from the techniques and concepts provided by the developing field of behavioral ecology. In this work, the tools of the trade include detailed recording of ethograms, measurement of colony growth and development, analysis of between-task

transitions, and some "old-fashioned" natural history. These techniques, when applied in the theoretical contexts of caste polyethism and kin selection theory, have provided some major advances in understanding how social insect colonies function. For example, it is now clear that the extensive variation in what workers do at any age or time has real importance for colony survival, by providing the flexibility to respond to rapidly changing environmental conditions as well as foraging opportunities. Also, there appears to be genetic structure to this variation, so that individuals within the nest have different capacities to perform functions and to develop into reproductives. Finally, specialization by workers to perform particular tasks may be more significant than previously thought. Though few workers are lifetime specialists, those that do specialize for extended periods may provide unique contributions to colony economy, such as the undertaker honey bees, which remove corpses from colonies.

The major criticism I have of this collection has to do with the quality of the book's production. Westview Press has filled an important niche in academic publishing through their series *Studies in Insect Biology*. Unfortunately, the quality of the content of the books has not been matched in the production; the typeface, paper quality, and printing of this one are so poor as to make reading it a real chore. Also, more rapid publication would have been desirable, as this field is moving so rapidly that some of the contributions in this volume have already been eclipsed by more recent work.

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## Atmospheric Chemistry

**Chemistry of the Natural Atmosphere.** PETER WARNECK. Academic Press, San Diego, CA, 1988. xiv, 757 pp., illus. \$85. International Geophysics Series, vol. 41.

In 1963, Christian Junge's classic textbook *Air Chemistry and Radioactivity* defined the emerging field of atmospheric chemistry. For years there has been a need for a revised version. Other fine books have been published in recent years, especially those by Seinfeld and by Finlayson-Pitts and Pitts, but none has replaced Junge's text. Warneck set out to produce such an update and has succeeded admirably. Reflecting the enormous growth of the field since 1963, Warneck's book is twice the length of Junge's,

but Warneck maintains Junge's devotion to general principles that are applicable both to natural and anthropogenic phenomena and to local and global problems. In contrast, the other texts noted above have greater focus on local air pollution problems.

The "radioactivity" in Junge's title refers to his inclusion of information about transport and deposition that was gained from the huge "tracer experiments" provided by atmospheric testing of nuclear weapons in the 1950s and early '60s. Warneck covers the use of radium daughters to determine aerosol residence times and occasionally includes results from fallout of fission products or ratios of carbon-14 to total carbon, but radioactivity is a minor feature of his book. The major addition since 1963 is the explosive growth of knowledge of rates of gas-phase reactions resulting from extensive studies of photochemical smog and of the formation and destruction of stratospheric ozone. Although Warneck's coverage of gas-phase reactions is not as detailed as those of the air pollution books, it is quite good, especially as applied to the natural atmosphere. Not only does he treat kinetics in a conventional way, but he demonstrates the use of tropospheric and hemispheric box models to estimate concentrations of radicals that have so far defied direct measurement. Warneck discusses important reaction pathways in groups of about five elementary reactions, frequently bringing these groups together in diagrams that summarize the big picture. Unfortunately for students, he does not do this in all cases. It would have been helpful if he had assigned a number to each elementary reaction and used it throughout. Also, he could have explained more of the tricks, many involving the steady-state approximation, that kineticists and modelers use to simplify the treatment of complex sets of reactions.

Changes in the treatment of aerosols, which Junge covered in depth, are not as extensive. Today better devices are used more routinely for collection of size-segregated particles, and more detailed chemical analyses are now possible with use of x-ray fluorescence, neutron activation analysis, ion chromatography for inorganic species, and techniques such as gas and liquid chromatography and mass spectrometry for organic species. Warneck explains the use of enrichment factors in relation to the crustal abundance pattern; they have been helpful in identifying sources of airborne particles. The aerosol chapter is followed by one that covers the thermodynamics of uptake of water by particles and the subsequent growth of droplets in fogs and clouds, and goes on to treat scavenging and the composition of rain. As is typical of his approach,