Book Reviews

Signals and Receivers

Insect Communication. TREVOR LEWIS, Ed. Academic Press, Orlando, Fla., 1984. xviii, 414 pp., illus. $55. From a symposium, London, Sept. 1983.

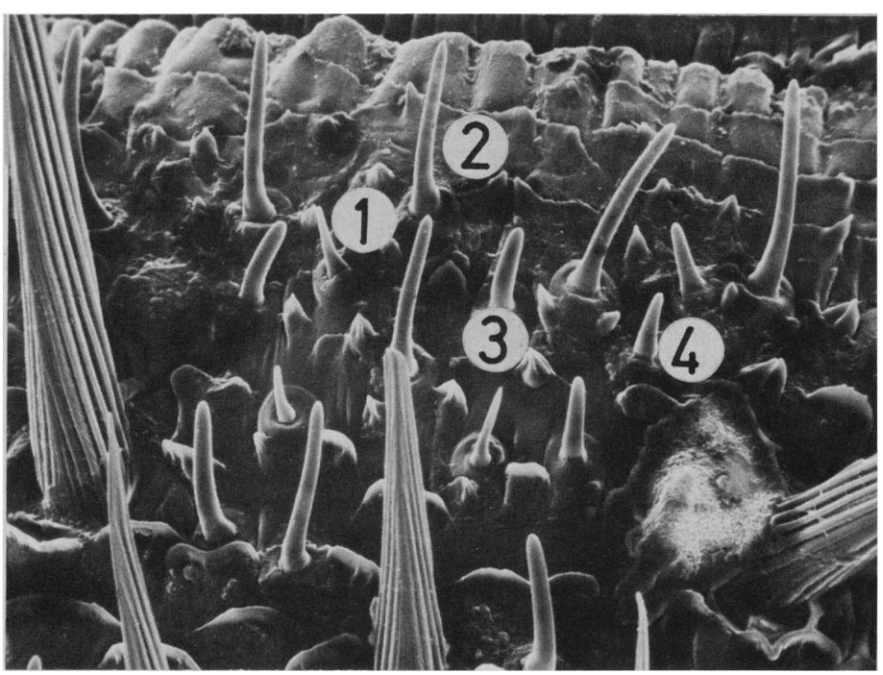
The diversity of communication systems in the million or so species of insects is staggering, and their simpler nervous systems make feasible a neuroethological understanding of the entire process of reception, integration, command, and response. In the past 30 years, advances in engineering and chemical analysis have enabled us to learn more about the signals of insects than we had in the previous 300 years. Insect communication is far more complex and exciting than we used to believe.

To celebrate the 150th year of the Royal Entomological Society, 19 researchers from six countries presented 16 papers in a symposium on important recent developments in the study of insect communication. This volume is the result of that symposium. Entomologists and vertebrate behaviorists whose knowledge of insect communication is limited to textbook accounts will profit from these well-written chapters.

Wehner and Srinivasan lucidly contrast the compound eyes of insects with the single-lens eyes of jumping spiders and humans. Compound eyes provide large fields of view—often the entire surrounding world—at the expense of visual acuity, which however can be enhanced in special "foveal" regions. For detailed visual analysis, insects must get quite close to objects, which may be why insect visual communication is usually restricted to short ranges. Visual communication is important in fireflies, and Case presents a good functional account of recent studies of the subject, with special emphasis on the mechanisms, origin, and evolutionary significance of synchronous flashing. Such flashing is spectacularly demonstrated by the three species of *Pteroptyx* in southeast Asia, whose males congregate in mangrove trees by the thousands and synchronize flashes so closely that follow-the-leader control is impossible.

Acoustic communication, the modality to which we humans are most attuned, is conspicuously used by a few insects like cicadas and katydids and inconspicuously used over short distances by others, like stoneflies. Bennet-Clark reviews recent research on sound transduction and the structure and function of receptors, and Ewing briefly reviews the mechanisms of sound production and how "songs" are used in sexual communication.

Chemicals are the premier communication modality in insects and are the topic of the majority of chapters in this volume. Boeckh nicely summarizes our current understanding of the physiology of odor reception. The old concept of a single-compound pheromone triggering an all-or-none reaction in a single receptor type has been superseded by a picture involving chemical mixtures and graded responses. Food receptors exhibit broad odor spectra, and the coding that distinguishes complex food odors may involve different levels of excitation of the same receptors. Silverstein lucidly describes how chemical structure affects the discrimination of similar pheromones. He emphasizes the pitfalls of analyzing gland contents rather than the emitted pheromones, the risks of altering chemical structure during identification, and the compromises behaviorists must make in laboratory bioassays. Cardé and Charlton scrutinize communication by sex pheromones in the Oriental fruit moth and the gypsy moth. Even in these well-studied species, it remains uncertain how the different components of the pheromone blends act at long distances and how the insects are able to orient to pheromone sources under natural conditions. From an agricultural viewpoint, Wall evaluates the potential uses of pheromones in control of insect pests. Detecting the first appearance of a pest is feasible for 187 species, although procedures for monitoring established populations in order to time pesticide applications have been developed for few of these. The use of pheromones to suppress pest populations through mass trapping or disruption of communication has met with very limited success and shows little promise. Vinson summarizes



"Investigation of structure and function of olfactory sense organs in the American cockroach proceeds as follows. After recording from certain sensilla under microscopical control, a sketch is drawn of their relative positions. A cut in the cuticle, a cactus spine or a prominent hair can serve to identify a particular area of cuticle. Then the sensilla are examined and classified according to morphological criteria . . . and according to wall structures and innervation. . . . 1. Two-celled single-walled (sw) type A sensillum with wall pores; one cell responded to fruit odours (apple, banana), alcohols and some esters. 2. Four-celled single-walled (sw) type B sensillum with wall pores; two cells responded to different female pheromone components. . . . 3. Two-celled double-walled (dw) type A1 sensillum with spoke channels; one cell responded to fatty acids and amines. 4. Three-celled double-walled (dw) A1 sensillum; one cell responded to cooling, another to meat odour." [From J. Boeckh's chapter in *Insect Communication*]

how parasitoid wasps commit "chemical espionage" by tapping the chemicals released by their host insects (and by their hosts' plant hosts) in order to locate their prey.

Integration of activities within the remarkable colonies of social insects depends on chemical communication. Even in the honey bee, the best-studied insect, we still have much to learn about the chemistry and functions of the pheromones produced by its many exocrine glands. Bark beetles use aggregation and dispersal pheromones in their mass attacks on trees, and a quite sophisticated understanding of their chemistry and ecological function is apparent in the account by Borden. Howse nicely compares the use of pheromones for alarm and defense across the social bees and wasps, ants, and termites. In general social insects either have large colonies with strong nests that they defend vigorously or have smaller colonies and weaker nests from which they readily abscond when faced with attack. A more chemical approach is taken by Morgan in his review of recruitment pheromones of social Hymenoptera. Koeniger describes how honey bees and hornets are able to recognize pupae in order to incubate them. Hölldobler reviews recent studies of individual and dominance recognition in social Hymenoptera. He speculates that primitively social insects (like sweat bees) learn the individual, genetically determined odors of each nestmate, whereas workers of advanced social insects learn colony odors that originate with the queen. Communication among workers that results in division of labor may involve ritualization of signals originally used for other purposes and "modulatory communication" that modifies the probability of reactions to diverse stimuli rather than releasing specific behavior patterns. Hölldobler also suggests that the evolution of insect sexual communication may predominantly involve mate assessment and choice, a topic pursued in considerable depth by West-Eberhard. West-Eberhard provocatively argues that there is little evidence that species-specific sexual communication evolved to prevent interspecific mating. Rather, such signals evolved through intraspecific competition among males for mates.

This volume suffers from some of the usual problems of symposia. The papers are not well integrated, and the introduction by the editor does not tie them together. Lewis does nicely identify four frontier areas in which advances can be expected in the near future (electromagnetic communication, pheromone blends, practical applications, and communication in little-studied orders of insects). In places details are presented that belong in technical journals, and at times an entomologist or a vertebrate ethologist can get lost in technical jargon. Recent findings regarding the fine structure, diversity, and function of sensilla are not well represented (except for auditory organs). Coverage is limited to intraspecific communication (except for Vinson's chapter on parasitoids), despite recent discoveries about interspecific communication, especially involving chemicals.

On the other hand, there is little duplication among chapters, and the authors are conscientious in stressing discoveries of the last ten years. A modern evolutionary perspective is maintained throughout; communication "for the good of the species" has finally been laid to rest, even in entomology. A specialist who keeps abreast of the immense, scattered primary literature will find few surprises in this volume. The rest of us should read it. No other recent book presents such a diversity of stimulating papers on insect communication.

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Mineralogy

Feldspars and Feldspathoids. Structures, Properties and Occurrences. WILLIAM L. BROWN, Ed. Reidel, Boston, 1984 (distributor, Kluwer, Hingham, Mass.). xviii, 541 pp., illus. $74. NATO ASI Series C, vol. 137. From an institute, Rennes, France, June 1983.

Feldspars are the most abundant substances in the crust of the earth and moon and are formed in environments ranging from the earth's sedimentary surface to the molten regions of the deeper crust, their principal home. Feldspar compositions form the basis for the classification of igneous rocks. Although rather simple chemically, they are wondrously diverse and complex structurally, and hidden within them are many of the clues to understanding the genesis of the continental crust. The interplay of crystallization temperature, cooling rate, presence or absence of volatiles, pressure, bulk composition, and late-stage hydrothermal modification, coupled with recalcitrant behavior as a result of large activation energies for aluminum-silicon diffusional interchange in the strongly bonded continuous silicon-aluminum-oxygen networks (containing the relatively mobile alkali and alkaline-earth atoms in the interstices), leads to a plethora of structural and textural variations. Structural state equilibrium in some feldspars is achieved with difficulty or not at all, and metastable stranded states abound in nature. Perhaps it is a pity that so much effort in solid state research goes into synthetic compounds when so much of nature's own is there to confound us.

This volume contains the invited review lectures given at a NATO institute. Two previous NATO institutes on the subject were held in Oslo in 1962 and Manchester in 1972, and the proceedings of three conferences clearly record the developments in the 20-year period. Since 1972, great advances have been made in automatic x-ray diffractometers, electron microscopes and microprobes, ion probes, and a variety of spectrographic methods. Detailed structural information is now rapidly available, and hitherto unknown microstructural and compositional details are revealed.

The current volume is more coherent than the earlier two. The 1962 volume contained 40 largely unrelated contributions that for the most part presented research results; the 1972 volume had 32 papers also for the most part of the type published in journals, including some of the early work that used transmission electron microscopy to study feldspars. The 14 review papers in the present volume, although not all-inclusive, do cover the field in a reasonably satisfactory way. The reports of research that were presented at the conference will be, or have been, published elsewhere. The first two chapters (on feldspar structures, by P. H. Ribbe, and phase relations of plagioclase feldspars, by J. V. Smith) are reworked and updated versions of papers by the same authors in *Feldspar Mineralogy*, volume 2 (1983; the second volume of the second edition of the series Reviews in Mineralogy), and in general the volume under review supplements and extends the valuable earlier volume. The chapters vary in style and coverage from those concerning the broad application of microtextural (transmission electron microscopic) analysis of alkali feldspars in interpreting the thermal history of rocks (I. Parsons and W. L. Brown) to those of interest to a limited audience concerned with the niceties of feldspar crystal chemistry and structure as revealed by thermal and mechanical behavior (thermal expansion of alkali feldspars, by H. Kroll, and mechanical properties of feldspars, by M. Gandais and C. Willaime). One of the