1950's the second period began under the leadership of von Frisch's student Martin Lindauer and a few others. Close attention was paid for the first time to the other species of *Apis*, which occur in southern Asia, and the independently evolved stingless bees of the Old and New World tropics. A more evolutionary interpretation was attempted of the adaptive functions of the distinctive traits of *Apis mellifera*, now viewed as but one species whose history had been played out under environmental circumstances peculiar to the Old World tropics and warm temperate zones.

The latter approach, which augmented but in no way supplanted the older mode of research, gained new impetus during the 1970's when field and experimental research came under the influence of the relatively new disciplines of behavioral ecology and sociobiology. Among the leaders of this latest advance has been Thomas D. Seeley of Yale University (perhaps best known to the non-entomological public as the developer with Matthew S. Meselson of the bee-feces hypothesis of yellow rain). Seeley's research has been notable in combining experimental designs marked by flair and originality reminiscent of the von Frisch school with theoretical questions based on a sophisticated reading of natural selection theory. *Honeybee Ecology* is a terse and well-written book that summarizes his own and related research. It is a worthy successor to Lindauer's *Communication among Social Bees* (1961) and C. D. Michener's treatment of *Apis* in *The Social Behavior of the Bees: A Comparative Study* (1974), a masterly statement of what we know about honeybee behavior and, equally important, of why honeybees behave in such and such a way and not another.

A couple of examples from Seeley's research will convey the overall flavor of current research on honeybees, as well as the study of social insects more generally. The first is from the domain of behavioral ecology. P. K. Visscher and Seeley monitored the foraging activity of a colony by translating the workers' own waggle dance, which gives information on the direction and distance of the flower beds being visited. The method was augmented by recording the different species of pollen brought in by the bees. The data were plotted onto circular maps with the hive in the center, so that the destinations of the foragers could be followed as though they were moving objects on a radar screen. The results included some surprises, including the fact that a single colony patrols an area of over 100 square kilometers and brings in food from an average distance of 2000 meters. Workers occasionally work over 6 kilometers away, although the most common patch distance was 600 to 800 meters. If we translate this into human terms, the activity is the equivalent of a tribe of 30,000 or so people hunting for food in a circular area with a radius of about 800 kilometers—say the whole state of Texas out of Abilene. The bees' exquisite communication system allows them to shift the focus of their activity on a day-to-day basis across the immense terrain, a pattern that Seeley calls the "information-center strategy" of foraging.

The second example is from the related field of sociobiology. A fruitful debate among students of social insects has been whether the insect colony is a concoction of the queen who forces her offspring into raising their brothers and sisters instead of their own offspring or whether it arose because the workers find it more profitable to rear siblings in a social setting than offspring in solitude. Seeley shows that honeybee workers do not start laying eggs on their own until both the queen and the brood are absent. In other words, only when the workers have lost all chance of rearing a substitute queen do they resort to direct reproduction of their own. Furthermore, workers are inhibited from rearing new queens by a special "queen substance," 9-ketodecenoic acid, which the old queen manufactures in her oversized mandibular glands. But the inhibitory material is not forced on the workers by their mother. Quite the opposite: workers visit the queen to collect the substance, then travel through the hive to share it with their nestmates. The whole procedure appears to be a method of monitoring the presence or absence of the queen on a day-to-day basis. Seeley concludes that "the present-day social system of honeybee colonies is evidently not one of a despotic queen ceaselessly dominating the reproduction of thousands of worker-daughters, but rather one of workers themselves benefiting by providing for the well-being of their queen, the individual whose reproduction provides their best avenue for propagating their genes."

Because nervous systems are evolutionary products subject as much to the idiosyncrasies of long-term history as to principles of molecular genetics, behavioral biology must progress in good part by the comparison of carefully chosen paradigm species. Seeley's book takes its place among such recent works as Daniel E. Koshland's *Bacterial Chemotaxis as a Model Behavioral System* and Eric R. Kandel's *Cellular Basis of Behavior* (featuring the marine snail *Aplysia*) as a fine exemplar of this approach.

EDWARD O. WILSON
Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138

Plant History

Geological Factors and the Evolution of Plants. BRUCE H. TIFFNEY, Ed. Yale University Press, New Haven, CT, 1985. viii, 294 pp., illus. $25. From a symposium, Montreal, 1982.

This book contains a collection of papers presented at the Third North American Paleontological Convention. In the words of the editor, the intention was to discuss "the synergistic interaction of organisms and environment as viewed on the paleontological time scale." Such an all-embracing assignment is bound to be inadequately carried out in a volume of just under 300 pages. Nevertheless this is, on the whole, a readable, informative, and stimulating book.

An introductory chapter by Tiffney puts the papers in an evolutionary context and raises a series of fundamental questions regarding synergistic interactions of the past. Unfortunately, some of his questions (for example those relating to the Mesozoic) are left unaddressed because the papers that follow are strongly biased toward the Paleozoic.

Following examinations of the origin of autotrophic eukaryotes (by Awramik and Valentine) and biochemical aspects of the origin of land plants (Chapman) Beerbower paints a vivid picture of the harsh terrestrial environment prior to and during the invasion by plants.

Three papers deal with the reconstruction of global paleogeography, paleoclimate, and phytogeography. Barrett's paper outlining early Devonian paleogeography and climate appears to have been a casualty of the three years "in press." His techniques are similar to those published previously by Parrish, and many of the points he raises are reiterated in this volume by Raymond, Parker, and Barrett ("Early Devonian phytogeography") and Raymond, Parker, and Parrish ("Phytogeography and paleoclimate of the early Carboniferous"). In fact the repetition, though it allows the papers to stand alone, is tedious for anyone reading the volume as a whole, but the authors of both phytogeographic papers are to be commended for stating clearly the criteria for data inclusion and for taking into account possible sources of bias such as taxonomic and depositional sorting factors. It is to be hoped that these papers will set a standard for subsequent work of this type. However, the paper on Devonian phytogeography is not without flaws. Early Devonian land plants characteristically had simple yet rapidly evolving morphologies and were capable (through homospory) of long-distance dispersal. Under these circumstances only the narrowest of time slices are likely to yield meaningful phytogeographic patterns. The time slices used by Raymond, Parker, and Barrett are somewhat broad in this context. Additionally, early Devonian plant data are sparse, with the result that large geographic areas (for example the "west coast of Laurussia") are characterized by single assemblages of only two genera. A more graphic illustration of the power of the techniques is presented in the paper by Raymond, Parker, and Parrish, but the volume as a whole could have benefited from a Mesozoic example with a larger data set, more reliably known paleogeography, and a more diverse flora.

The paper by DiMichele, Phillips, and Peppers discussing the influence of climate and depositional environments on Pennsylvanian coal-swamp plants presents an informative overview of coal-swamp plant biology. I am not sure that I agree entirely with the argument that because coal swamps represent edaphic islands they are *excellent* indicators of general climate trends. After all, their existence is dependent to a large extent upon topography and local geology, and they must have created their own microclimates.

The final paper by Cope and Chaloner discusses the occurrence of wildfire in a biological and geological context.

I would have liked to see a more balanced, less "inbred," volume. Nevertheless this is an exciting collection of papers that ought to be read widely and encourage further interdisciplinary research.

ROBERT A. SPICER
*Life Sciences Department,
Goldsmiths' College,
London SE8 3BU, England*

Poliovirus

The Molecular Biology of Poliovirus. FRIEDRICH KOCH AND GEBHARD KOCH. Springer-Verlag, New York, 1985. xvi, 591 pp., illus. $74.

The tiny virus that causes poliomyelitis has been intensively studied in the laboratory for 30 years. Today, the fundamental principles concerning the structure and replication of poliovirus are well understood, and the next decade or two can be expected to yield answers to the remaining questions.

The Molecular Biology of Poliovirus is an attempt to provide a scholarly and complete description and analysis of research on all aspects of this virus. The book is far more than a textbook survey. Most of it is devoted to the more recent developments in the field, presented as logical extensions of previous work. The book includes thoughtful interpretations and speculations by the authors.

The book contains 11 chapters divided into two sections, the first of which deals with the virus particle and its RNA and protein components. Although the book was published before the complete atomic structure of the poliovirus particle was announced (in September 1985), it presents all of the basic principles and most of the final lessons, and it provides all of the background necessary to understand new publications. A chapter on the structure and function of the genome is especially well synthesized, with critical analyses of discrepancies and other inadequacies in the literature. Although a uniform nomenclature for all poliovirus proteins based on genome map coordinates was adopted at a meeting of the European picornavirus study group in 1983, the authors do not utilize it in most of the book. This is unfortunate, since subsequent usage of the new nomenclature has made the old difficult to follow, especially for younger workers.

The second section of the book deals with the steps in the replication of the virus. These include the early interactions of the virus with the host cell, the accompanying morphological alterations of the host cell, the translation of the viral genome, the replication of the viral RNA, assembly of the virion, and morphogenesis. Every effort appears to have been made to make each chapter a self-contained, high-quality, and up-to-date review. The section begins with an introductory chapter that contains a number of useful tables that list biochemical constituents and measurements of the Hela cell and essential background information that is hard to find in other sources. Similarly, the chapter on translation of viral proteins contains a concise but useful summary of initiation factors and of mechanisms for the synthesis of cellular proteins that serves as a basis for comparison and examination of systems for the control of viral translation. By ending with the authors' speculations on the functions of intracellular compartmentalization, the otherwise purely descriptive chapter on the morphological alterations of the host cell is made thought-provoking. Despite the book's appropriate concern with the host cell as an introduction to virus replication events, it does not deal with pathogenesis or virus-host interactions at the tissue (neurovirulence) or organism (immune response) levels.

Progress in this field has been extremely rapid in recent years. Considering that the authors' literature survey must have terminated some time in 1983, it is to their great credit that the book contains almost no wrong information. The coverage of a few subjects has been outdated by recent findings, but in most of these cases there are hints that allow the reader to predict the new results. It is a tribute to the scholarship of the authors that some of their prophecies have already been proved correct. For example, protein 2A had not been identified as a second viral protease at the time the book was written, but the authors predict the existence of a second protease, encoded somewhere on the viral genome. The final chapter, entitled "Conclusions," lists the still unanswered questions concerning poliovirus. One appendix contains a list of laboratories currently working in the field, and another includes directions for building poliovirus models out of paper or an apple. A 12-page appendix deals with the geometry of isometric particles, and the complete nucleotide and amino acid sequences of all three serotypes of poliovirus are tabulated in a final appendix. The reference list is extraordinarily complete. *The Molecular Biology of Poliovirus* is highly recommended for students of poliovirus and related viruses as well as for those already involved in the field.

ELLIE EHRENFELD
Departments of Biochemistry and
*Cellular, Viral and Molecular Biology,
University of Utah School of Medicine,
Salt Lake City 84132*

Weathering Processes

The Chemistry of Weathering. JAMES IRVING DREVER, Ed. Reidel, Dordrecht, 1985 (U.S. distributor, Kluwer, Hingham, MA). viii, 324 pp., illus. $44. NATO Advanced Science Institutes Series C, vol. 149. From a workshop, Rodez, France, July 1984.

This collection of 17 papers has the diversity and scope to make it a suitable introduction for the nonspecialist interested in an overview of current geochemical research on weathering. Indeed, its scope is such that the specialist will find topics and perspectives that he or she may not have encountered. The papers, in rough order of presentation, cover thermodynamic models, laboratory dissolution experiments, and field studies covering the scale from individual soil profiles to continental watersheds. Some of the contributions, although interesting case studies, are somewhat narrowly focused, and I will only discuss those that have wider application.

The opening papers, by Sposito and Fritz, address two problems that complicate the modeling of weathering processes. The first is that some secondary clays, such as kaolin-