*Work, Ladies Home Journal, Colliers*, and *McClures*, and especially Upton Sinclair's *The Jungle*, that was decisive in bringing about reform. The key individual in the pure food and drug story, however, was neither a journalist nor a politician but U.S. Department of Agriculture scientist Harvey Washington Wiley, who in 1890 began to mobilize the scientific and medical communities, consolidate business interests, and bring together reform-minded journalists and women into a tight coalition that actively campaigned for federal regulation. Motivated by both self-interest and redirected religious impulses, Wiley proved instrumental in persuading Congress to move forward and provided scientific expertise at several critical junctures.

Yet after Wiley and his allies achieved victory in 1906 the chief chemist was only partly satisified with the result of his efforts, stating that "The bill is not as good as we should like it, but it is a splendid foundation on which to erect a more perfect structure in the future" (p. 271). Indeed, present-day critics point to insufficient enforcement procedures, inadequate numbers of personnel, and outdated analytical methods as major shortcomings of food and drug inspection. This 20th-century story awaits to be told with the thoroughness and the critical eye with which Young treats its antecedents. With its richness of detail, array of historiographical material, and critical insights, *Pure Food* should serve as a model for such scholarship.

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# Considering the Ants

**The Ants**. BERT HÖLLDOBLER and EDWARD O. WILSON. Belknap (Harvard University Press), Cambridge, MA, 1990. xiv, 732 pp., illus., + plates. $65.

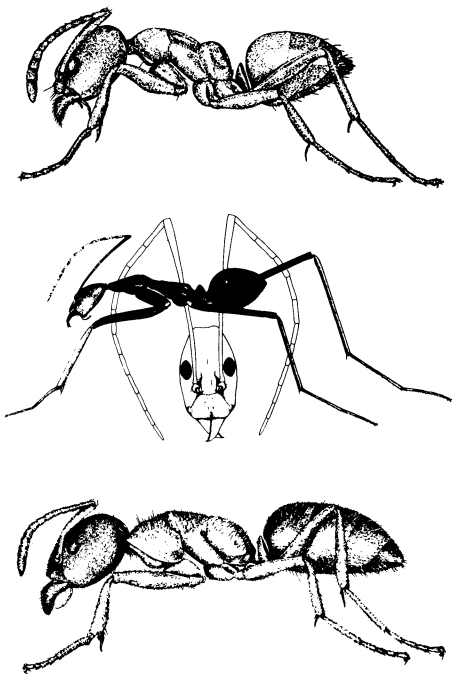
Exactly 80 years ago W. M. Wheeler published his classic book *Ants*, which has remained in print ever since, peerless and known as the ant bible. Now at last we have a new authorized version: *The Ants*. Coming after eight action-packed decades in which the study of ants has helped promote discovery in all aspects of organismic biology and their importance in almost all terrestrial ecosystems has been recognized, Hölldobler and Wilson's mighty tome will surely take its place among the greatest of all entomology books. The subject of the enterprise is a single family of insects. The result is a wonderful exploration of almost every ramification of evolutionary biology, from developmental biology to the structure of ecological communities. Hölldobler and Wilson remind us of August Krogh's famous maxim of biological research: for every problem there is an organism ideally suited to its solution. But actually the authors show that the more one knows about every aspect of the life of one's study organisms the better the biology. Their book is a testament to Darwin's insight that to really understand evolution we must dwell, at least in part, among the finest of fine details.

*The Ants*, like every great book and every ant colony, is much more than the sum of its parts. In writing the book Hölldobler and Wilson have remembered many simple lessons they probably learned in their childhoods. First, entomologists are entomologists because they like looking at insects (the illustrations—which include 24 color plates—in this book are lavish and detailed in the extreme). Second, entomologists remain entomologists because of the extraordinary diversity of their study animals (there may be 20,000 ant species on this planet). Third, many biologists never become entomologists because it can be hard to identify insects and the technical terms can be terminal.

Bearing such considerations in mind, Hölldobler and Wilson begin with not just keys to, but illustrations of, all the 297 known living genera of ants. This is a mammoth undertaking that required the authors to recruit the help of Barry Bolton of the British Museum (Natural History) and Robert Taylor of the Commonwealth Scientific and Industrial Research Organisation in Australia. In a book that does not contain a dull sentence even these keys are readily readable. Furthermore, in an age in which the earth's biodiversity is so vulnerable and uncharted it is an important statement, in itself, to begin with such a wholehearted testimonial to the fundamental importance of systematics.

The importance of myrmecology in biology throughout this century is seen in such diverse concerns as allometry in morphogenesis, the role of kin selection and communication in social behavior and evolution, and the importance of competition as a force that structures ecological communities (as exemplified by territoriality and character displacement). At least one chapter of this huge book is dedicated to each of these topics. The chapter on communication, in particular, shows how far evolutionary biology has progressed in the last few years. Previous reviews of communication in ants have been largely based on a catalogue of chemicals found in the pheromone signals ants send one another. Now Hölldobler and Wilson combine their talents to consider the ethology and evolutionary biology of communication in a quantitative, theoretical framework. As a result we are on the verge of a theory of the syntax of ant communication. Each chapter provides a thorough and largely up-to-date literature review spiced with wit and wisdom. A favorite example of a humorous calculation that provides serious insight is that one milligram of the trail substance of the leafcutting ant, *Atta texana*, if laid out with maximum efficiency, would be enough to lead a colony three times around the world.

Hölldobler and Wilson are advocates of what they call a bottom-up approach. They are not just referring to the natural posture of the ant collector but to the need to observe and understand how ants are behaving, organizing their lives, and making a living before attempting to generalize about, for example, competition and community structure. This ongoing need for careful observations in the field coupled with experimentation in field and laboratory is surely of paramount importance. Only after such studies should one venture an interpretation of adaptations within the context of constraints imposed by the animals' phylogenetic history.



Three genera of the subfamily Dolichoderinae as represented in *The Ants*. Top to bottom, *Iridiomyrmex*, *Leptomyrmex*, *Lometopum*.

In the light of these tremendous standards, Hölldobler and Wilson sometimes put perhaps too much emphasis on worker ants' being like preprogrammed machine parts designed by colony-level selection to serve their colony in its role as a superorganism. Though it is timely to revive Wheeler's superorganism model of the ant colony, because in many cases adaptations that promote gene replication and survival exist only at the colony level, generalization can be misleading. Much very recent work is also beginning to show that in many ant species workers are themselves reproductive and that workers, sometimes in a continuous conflict with the queen, may largely determine their society's life history and sex allocation. At this stage we simply do not know how subtle is the decision-making of individual workers, particularly reproductive ones in small societies, yet Hölldobler and Wilson repeatedly comment that ants have small brains. This emphasis on the simplicity of individuals hardly seems parsimonious, as elsewhere, for example, Hölldobler and Wilson document the wonderful navigation skills of foragers of the desert ant *Cataglyphis* (which can learn and form cognitive maps) as shown by the pioneering work of Rüdiger Wehner and his colleagues. If individual foragers can have such processing power, it is surely not a good working assumption to suppose that all ants are stereotyped simpletons in other roles. Such issues as the intelligence of the individual colony member or the collective intelligence of the colony may be the stuff of future revolutions in the study of social insects.

"A solitary forager of the desert ant *Cataglyphis bicolor*." The genus *Cataglyphis* "represents the extreme [foraging strategy] of solitary hunting combined with solitary retrieval." Workers of *C. bicolor* "make about 5 to 10 forays each day. . . . The foragers "tend to persist in only one or a very few directions for their lifetime, if for no other reason than that travel outside the nest is very dangerous and life is short. Most of the workers are soon picked off by spiders and robber flies, in spite of their ability to run . . . up to a meter per second. . . . Yet the system is so efficient that the average forager retrieves a food weight during her lifetime 15 to 20 times greater than her own body weight." [From *the Ants*; photograph by R. Wehner]

At all events, even those who may be critical of some passages in *The Ants* will nevertheless find insight and inspiration in this beautifully written book. Like Wheeler's epic, it will inspire many new generations of students with its blend of scholarship, enthusiasm, and unabashed delight. This book will convert many a young biologist, or even chemist, physicist, and mathematician, into a myrmecophile—that is (to quote from the book's extensive and invaluable glossary), into an organism that spends at least part of its life cycle with ant colonies. Given that there may be 20,000 species of ants on this planet and that of the 8800 species so far described only a tiny fraction have been studied in any detail, Hölldobler and Wilson's elegant invitation to "Go to the ant— . . . consider her ways and be wise" (Proverbs, chapter 6) should not be resisted.

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## Cephalopodologie

**Traité de Zoologie**. Anatomie, Systématique, Biologie. PIERRE P. GRASSE, Ed. Tome 5, fascicule 4, Cephalopodes. KATHARINA MANGOLD, Ed. Masson, Paris, 1989. 804 pp. F1100.

Comprehensive reference works frequently require a number of years to compile, are eagerly awaited by specialists, and once published gradually come into general use by researchers, educators, and students. The volumes of *The Invertebrates* inaugurated by Libbie Hyman in 1940 provide an excellent example of such a history, as does the classic *Traité de Zoologie* directed by Pierre P. Grassé.

Among works of such lengthy gestation the present installment of the *Traité* surely holds the world record. In the 1930s the eminent Swiss zoologist Adolf Naef was selected to write the volume on the Cephalopoda, on the strength of his classic monographs on the phylogeny, evolution, morphology, and embryology of these advanced invertebrates published in the preceding decade. Naef began the project in 1939, but the events of history, teaching and family responsibilities, and ill health conspired to limit the results to an accumulation of notes, which he submitted before his death in 1949 to Grassé. Grassé asked Adolf Portmann of the Institute of Zoology in Basel, who was not a cephalopod specialist, to complete the work using Naef's notes. Believing Naef's work to be outdated, Portmann abandoned the notes and wrote a 200-page manuscript, which he submitted in 1954. Because the recently submitted gastropod and bivalve manuscripts ran to 4600 pages, Grassé required that the cephalopod section be increased to 400, a task the displeased Portmann was unwilling to undertake until the early 1960s. The resurgence of research on cephalopods then prompted Portmann to enlist Katharina Mangold, a former student and established cephalopod specialist at Laboratoire Arago, Banyuls-sur-Mer, France, to incorporate the new literature into the manuscript. By the time one section was updated, preceding ones had become obsolete, and, as the objective of the *Traité* was to be "comprehensive," the project became locked in a cycle of updates. Around 1970 Portmann asked Mangold to be a full coauthor, and in 1974 when Portmann became ill Anna Bidder from Cambridge agreed to join the effort. During the next few years the aid of other specialists was engaged. Finally, the now huge manuscript was submitted in February 1981, nearly an order of magnitude larger than was demanded by Grassé 27 years earlier. Additional material was added in proof in 1985, and the latest literature was added in 1987. The long gestation terminated successfully in late 1989.

One can justifiably ask if a work 50 years in the making can be worth the wait. In the case of *Cephalopodes* the response is a resounding "Oui!" Nothing comparable to it exists in the cephalopod literature. The cephalopod volume scheduled for *The Invertebrates* has not been completed and perhaps never will be published, and the quantity and diversity of knowledge being accumulated on cephalopods make it unlikely that such a detailed and comprehensive one-volume work can ever again be assembled. The long developmental period moreover enabled the book to evolve, in keeping with the evolution of the field, from concentration on systematics and morphology to include material on biology and behavior, and the expansion of authorship enhances and enriches the results.

The French is straightforward, easily understood; sentences are not convoluted, and much of the terminology will be familiar to those acquainted with the literature in English. Somewhat disconcerting to the first-time user of the volume will be the location of the table of contents in the French manner on the very last pages of the book and the inclusion of page numbers there only in parentheses in the listings of the subsections of the chapters.

A short introductory chapter by Mangold, Bidder, and Portmann is followed by a detailed, well-illustrated chapter on the gen-