eminent scientists were university-educated, and nearly half held university positions.

Seventeenth-century natural philosophers devoted much of their energy (and rhetoric) to developing new scientific methodologies to replace the Aristotelian. Ernan McMullin approaches this development by examining the conception of knowledge that the participants in the revolution thought they were providing and how it changed through the course of the 17th century. He shows how the usual neat, modern categories of induction, deduction, and hypothetico-deduction break down when applied to such thinkers as Bacon and Descartes. Most of his long paper is devoted to the first half of the century. It would have been still more valuable had he presented a fuller account of the methods that emerged from the practice of the working scientists of the second half of the century, the Hookes, Boyles, Huygenses, and Mariottes.

The science of the Scientific Revolution, and especially the canonical core of astronomy, mechanics, and the mathematical sciences, gets shunted to the side in *Reappraisals*. Presumably the editors judged this aspect of the history to need only minimal reappraisal. Westman contributes a paper in which he endeavors to place the preface to Copernicus's *De revolutionibus* in the context of humanist rhetoric and patronage. In the last two papers, Michael Mahoney presents an interesting analysis of the changing criterion of intelligibility in 17th-century mathematics and Alan Gabbey argues convincingly that Newton's achievement in celestial mechanics has defined our conception of mechanics and blinded us to other contemporary revolutions in mechanics. Gabbey illustrates this with the rigid-body problem of determining the center of percussion, which was solved before Newton's *Principia* appeared and left untouched by him.

*Reappraisals* certainly rises above most collections of papers by diverse authors. My only disappointment comes from measuring it against the editors' original goal of providing a new synthesis for the Scientific Revolution. Finally, it should be noted that the volume contains nothing from the increasingly popular perspective of the social constructivists, the school that holds that science is socially constructed like any other body of knowledge and holds no privileged status. Such an approach demands a far more radical reappraisal than that contemplated here.

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## Lives of Chemists

**From Cologne to Chapel Hill**. ERNEST L. ELIEL. American Chemical Society, Washington, DC, 1990. xxii, 138 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

**The Right Place at the Right Time**. JOHN D. ROBERTS. American Chemical Society, Washington, DC, 1990. xx, 299 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

**From Design to Discovery**. DONALD J. CRAM. American Chemical Society, Washington, DC, 1990. xxii, 146 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

These books are the first in a new series that is to comprise autobiographies of 22 prominent organic and other chemists. The series is edited by Jeffrey I. Seeman, who selected the contributors on the basis of "seminal contributions over a multi-decade career," with the overall intention of delineating the scientific development of organic chemistry during the past 30 to 40 years and of documenting the "hows and whys." The authors of these first three books include one Nobel Prize winner (Cram) and two who must be strong candidates for future Nobel Prizes.

All three books are valuable in two ways: they give condensed but integrated accounts of their authors' scientific contributions, and they tell something of the personal circumstances and attitudes that contributed to the authors' success. Their treatments of their scientific work will be useful not only to historians of chemistry but also to students wishing to learn the chemistry discussed.

The books nevertheless differ in character. Eliel was born in Germany, and his book includes his story of escape from Hitler's clutches. He mentions that his Ph.D. adviser, Harold Snyder of the University of Illinois, taught him the importance of clear and organized writing. Even though English is his adopted language, Eliel's book shows that this lesson was taken effectively to heart. Eliel's career has involved a larger component of public service, especially to the American Chemical Society, than those of the other two authors. I wish he had said more about that service; as it stands, his book concerns mainly his research in stereochemistry and authorship of an important book in that field.

Welcome in Roberts's book are the thumbnail sketches he gives of his coworkers, telling something about their personal characteristics and their subsequent careers. His book's title, *The Right Place at the Right Time*, is too modest, for there were other scientists in the same or similar places and times whose careers did not blossom as Roberts's did. His scientific presentations are not recommended for bedtime reading, simply because understanding the topics dealt with requires careful, rigorous thought. Roberts probed very deeply into the intricacies of nature. An interesting feature of the book is the considerable space Roberts devotes to his objections to Herbert C. Brown's position concerning solvolysis mechanisms and the participation of nonclassical carbocations as intermediates. Without reviving an old battle, let me observe that Roberts would not have given Brown so much attention had he not considered Brown's role in those debates to be significant.

Cram's book is remarkably short given his many important contributions. As the series editor remarks in a note at the beginning, the part of the book that deals with Cram's research in host-guest chemistry, which started in 1970 and was the basis of his Nobel award, is a "very serious description," whereas the account of all that went before is more anecdotal and detached. Cram's treatment of his host-guest research is a beautiful presentation of the ideas and the experiments involved, and is recommended to those who wish to learn about the concepts of host-guest chemistry. The early part of the book is terse but lucid, reading something like an integrated, illuminated (with structural formulas) abstract of the research performed. Actually, it is better than Cram's journal paper abstracts, which tend to bury the reader in detail. An attractive feature of the book is that Cram cites work by others that extended or corrected conclusions he had reached.

Surely these three mature, productive scientists have come to appreciate certain principles that pertain to the profitable conduct of research and to successful interaction with coworkers. But they don't overtly express much of that wisdom. To be sure, bits of it pop out as asides here and there. I think chapters concerned expressly with such matters would be desirable for the series.

During my years as editor of *Accounts of Chemical Research*, it was occasionally suggested at meetings of the editorial advisory board that *Accounts* should publish articles in which a famous scientist would recount the story of a major discovery, telling something of the thoughts and behavior of the people involved as well as the scientific tale. The suggestion, however, always met some resistance. Human memory of events long ago often requires mental reconstruction, and the plausible reconstructed story may subconsciously favor the rememberer. Some

advocated that, as a counterweight, a person who worked in the same or nearby research area at about the same time be invited to comment in an addendum. As it turned out, we never sought such articles.

One might suggest that books in the present series should carry such addenda. In the early 1950s, I was interested in the problems solved by Roberts' benzyne mechanism, and I would have been a reasonable candidate to contribute an addendum concerning that phase of his work. Had I been invited to do so, I would have told that as of 1952 I had been very favorably impressed by Roberts, who appeared to me to be a rising star, but when a friend at Berkeley told me of a seminar talk in which Roberts suggested an intermediate with a triple bond in a benzene ring, I was saddened to see an otherwise promising man propose such a ridiculous mechanism. As it happened, in 1953 I was asked to referee the communication to the *Journal of the American Chemical Society* in which Roberts proposed the benzyne mechanism; when I saw the evidence, I was immediately convinced and recommended the manuscript for publication with only minor revision. That experience taught me that one should never reject a mechanism just because it is ridiculous; only experimental evidence or unchallengeable theory is a proper basis for rejection.

I look forward to seeing other books in this series.

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## Storage Ecology

**Food Hoarding in Animals.** STEPHEN B. VANDER WALL. University of Chicago Press, Chicago, 1990. xii, 445 pp., illus. $76; paper, $29.95.

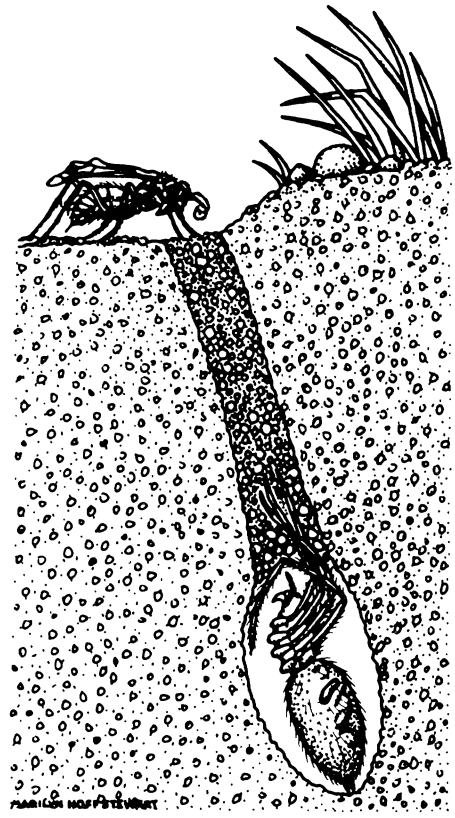
Food hoarding, defined by Vander Wall as "handling of food to conserve it for future use," has attracted the attention of behavioral ecologists because of the many questions it raises about the evolution of behavior. How do food-hoarding animals find the food they have cached? How are their preferred food plants affected by having seeds and nuts sequestered instead of dispersed? How, exactly, do animals benefit from storing food, and what ecological conditions favor its evolution? *Food Hoarding in Animals* provides, in the words of its publisher, "the first comprehensive survey of the literature on food hoarding in animals." And what a literature it is. Vander Wall has combed a wide variety of scattered sources for patterns in the occurrence of food hoarding and the selective pressures that have influenced its evolution. Birds do it, bees do it, even educated fleas would do it if their staple diet were not so perishable.

"Coal tit in typical storing posture at the end of a spruce twig, just before inserting a conifer seed (in bill) into a bud capsule." [From *Food Hoarding in Animals*; drawing by Marilyn Hoff Stewart, after S. Haftorn (1956)]

Mammals, birds, and arthropods that create dispersed caches remember quite precisely where they have placed them. For a bird like Clark's nutcracker this means remembering for several months thousands of locations scattered over many square miles. Other food-hoarding birds do the same, as do sciurid and heteromyid rodents. This facility with spatial problems has led to the use of these animals as a model for animal memory. The discovery that memory is the major means of cache retrieval merely opens the door to further questions, however. Is memory in these animals specialized for cache recovery, or is it instead a particularly conspicuous and easily observed use of capacities that are widespread in animals?

Coevolution between food hoarding animals and their preferred food plants has proceeded in two quite different directions, depending on the dispersal consequences for the plant of having its propagules cached. Red squirrels cache pine cones in middens in which germination is unlikely. Pines preferred by red squirrels have evolved small hard spiny cones with small winged seeds, all adaptations to reduce cone caching by squirrels. Nutcrackers and jays, in contrast, cache pine seeds in the ground in conditions favorable for germination. Pines preferred by these birds have evolved large, conspicuous thin-hulled seeds and cones that retain seeds until they are harvested by the birds. Nutcrackers are the major agent of dispersal for the stone pines (*Cembrae*) in Europe and Asia and probably brought the whitebark pine with them across the Bering land bridge to North America during the Pleistocene.

Despite the recent interest in food hoarding a central problem in this field remains unsolved, and that is, surprisingly, what the function of food hoarding is. It seems obvious that food should be stored in times of plenty for use in times when food is scarce, but many observations suggest that things are not always so simple. Some animals store food and then recover it later the same day. Others do more hoarding when food is scarce than when it is plentiful. Many ecological and physiological factors are important, including the predictability and abundance of food, the energy requirements of the animal, the capacity to store fat, the degree of competition for food, and the exposure to predation while foraging. Vander Wall thoroughly reviews the many functions that have been proposed for food hoarding and discusses the available evidence. What his review makes clear, however, is that quantitative models of the fitness consequences of food hoarding are badly needed. Since the publication of *Food Hoarding in Animals* two stochastic dynamic models of food hoarding have been produced (Lucas and Walter, *Animal Behavior*, in



"A paralyzed spider entombed in a small chamber by the spider wasp *Anoplius apiculatus*." Keeping prey alive serves to avoid spoilage. "Note the wasp egg on the spider's abdomen." [From *Food Hoarding in Animals*; drawing by Marilyn Hoff Stewart]