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.

JOSEPH F. BUNNETT
Thimann Laboratories,
University of California,
Santa Cruz, CA 95064

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

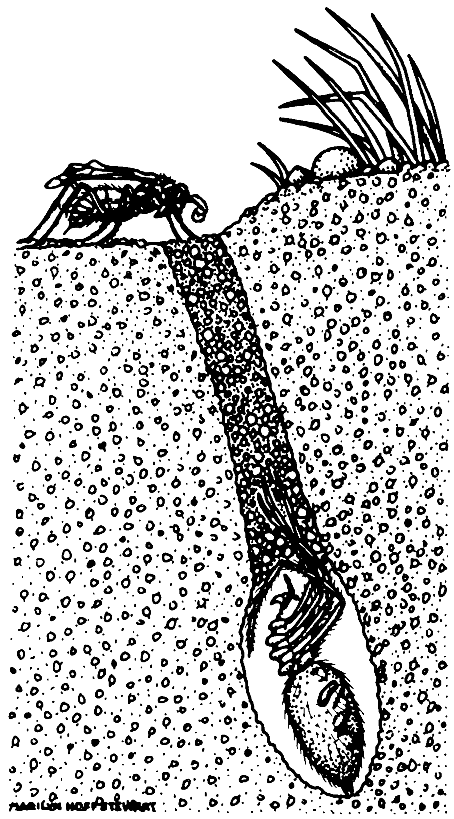
"Coal tit in typical storing posture at the end of a spruce twig, just before inserting a conifer seed (in bill) into a bud capsule." [From *Food Hoarding in Animals*; drawing by Marilyn Hoff Stewart, after S. Haftorn (1956)]

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.

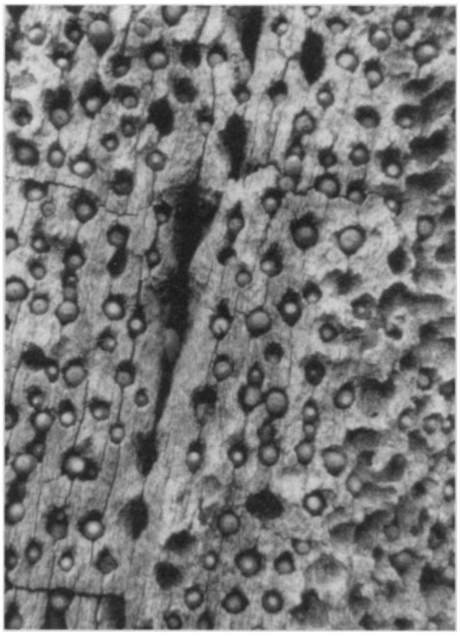
Mammals, birds, and arthropods that create dispersed caches remember quite precisely where they have placed them. For a bird like Clark's nutcracker this means remembering for several months thousands of locations scattered over many square miles. Other food-hoarding birds do the same, as do sciurid 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]



"Acorns stored in a dead tree by acorn woodpeckers in California." [From *Food Hoarding in Animals*; photograph courtesy Walter Koenig]

press; and McNamara *et al.*, *Behavioral Ecology* 1, 12–23 [1990]), and these should, at the very least, help organize future work on the function of food hoarding and the ecological pressures that have affected its evolution.

Vander Wall casts a wide net. Mass provisioning by insects (filling a burrow with prey on which eggs are laid) is regarded as an example of food hoarding, though my own feeling is that this creates too heterogeneous a category to hope for common causal or functional explanations of food hoarding. For anyone who disagrees, *Food Hoarding in Animals* contains a wealth of material on mass provisioning, ably presented. A further critical comment is that the discussion itself is sometimes uncritical, giving as thorough and balanced a coverage to ideas that are best discarded (for example, that food hoarding evolved from "food envy" in animals) as to ideas that make interesting testable predictions (for example, that hoarding occurs in animals that cannot economically defend a rich food source).

Behavioral ecologists concerned with food storing, foraging, and the coevolution of animals and plants will find *Food Hoarding in Animals* a valuable reference work. Anyone simply curious about the behavior of animals will find much in the book to enjoy.

DAVID F. SHERRY
Department of Psychology,
University of Western Ontario,
London, Ontario, N6A 5C2, Canada

Atoms and Laser Light

The Theory of Coherent Atomic Excitation. BRUCE W. SHORE. In two volumes. Vol. 1, Simple Atoms and Fields. Vol. 2, Multilevel Atoms and Incoherence. Wiley-Interscience, New York, 1990. xxxiv, 1735 pp., illus. $123.

The Theory of Coherent Atomic Excitation is a two-volume monograph that examines the resonant and near-resonant interaction of light with atoms. Studies of such interactions are often concerned primarily with the properties of the light and use the ideas of quantum or nonlinear optics. This book differs sharply from such treatments in that the emphasis is on the behavior of the atom.

The most prominent feature of laser light—its coherence—makes it necessary to replace Einstein's rate equations with the time-dependent Schrödinger equation in the description of atomic excitation by laser light. In this regime of coherent excitation, atomic dipole moments are important as well as the atomic populations of ground and excited states. Standard perturbation theory, which is at the heart of conventional atomic spectroscopic theory, is insufficient because laser light fields can be very strong. On the other hand, if the light is nearly resonant the description of the atom itself may be simplified; instead of giving a full description of the atom in configuration space, we may restrict our attention to the subset of relevant states involved in the interaction. The simplest model atom that serves this purpose is the celebrated two-level atom. The time-dependent equations solved in Shore's monograph are therefore written in the energy representation, where truncation of the atomic structure is most natural. The strong light fields may, for most applications, be described as classical external waves (although their description in terms of quantized photon states is also explained).

The two-level atom in a monochromatic field in the so-called rotating wave approximation lends itself to analytic solutions, and these are carefully explained by Shore. The equations for more complicated atoms must be solved numerically, however, and various numerical techniques and results are also described in detail. In addition, the interaction of atoms with partially coherent fields is treated, and various classical stochastic models of the noisy laser light are presented.

The book is very detailed and stresses completeness rather than overview and synthesis. Derivations are fully reported, making the arguments easy to follow. It will be very useful to those who work or are just beginning to work on resonant optical problems. The book contains a nearly complete set of references and will also serve as a compendium and guide to the growing literature on this subject.

Most textbooks on quantum mechanics pay so much attention to the study of stationary states that students could get the impression that classical mechanics is about time-dependent processes and quantum mechanics about eigenstates of the Hamiltonian. (Even scattering theory is usually treated in a stationary picture.) The subject of coherent atom excitation offers a wealth of quantum-mechanical, time-dependent phenomena and brings to life this often forgotten side of quantum mechanics. This book would be useful as a source of such examples or for reference in a graduate-level course.

KAZIMIERZ RZĄŻEWSKI
Institute for Theoretical Physics,
Polish Academy of Science,
P1-02668 Warsaw, Poland

Books Received

Acarine Biocontrol Agents. An Illustrated Key and Manual. Uri Gerson and Robert L. Smiley. Chapman and Hall, New York, 1990. x, 174 pp., illus. $89.50.

Acts of Meaning. Jerome Bruner. Harvard University Press, Cambridge, MA 1990. xx, 179 pp. $19.95. Jerusalem-Harvard Lectures.

Analytical Instrumentation Handbook. Galen Wood Ewing, Ed. Dekker, New York, 1990. xiv, 1071 pp., illus. $195.

Applications Development Using Case Tools. Kenmore S. Brathwaite. Academic Press, San Diego, CA, 1990. xxiv, 263 pp., illus. $49.95.

Applied Virology Research. Vol. 2, Virus Variability, Epidemiology, and Control. Edouard Kurstak *et al.*, Eds. Plenum, New York, 1990. xviii, 368 pp., illus. $75.

The Arctic Ocean Region. Arthur Grantz, L. Johnson, and J. F. Sweeney, Eds. Geological Society of America, Boulder, CO, 1990. x, 644 pp., illus., + plates + microfiche cards. $85. Geology of North America, vol. L.

Aspects of Seismic Reflection Data Processing. R. Marschall, Ed. Kluwer, Boston, 1990. x, 295 pp., illus. $115. Reprinted from *Surveys in Geophysics*, vol. 10, nos. 2–4 (1989).

Atom-Probe Field Ion Microscopy. Field Ion Emission, and Surfaces and Interfaces at Atomic Resolution. Tien T. Tsong. Cambridge University Press, New York, 1990. x, 387 pp., illus. $100.

The Beilstein Online Database. Implementation, Content, and Retrieval. Stephen R. Heller, Ed. American Chemical Society, Washington, DC, 1990. viii, 168 pp., illus. $34.95. ACS Symposium Series, 436. From a symposium, FL, Sept. 1989.

Biological Psychology. Eugene H. Galluscio. Macmillan, New York, 1990. xxvi, 708 pp., illus. $44.

Biotechnology of Fungi for Improving Plant Growth. J. M. Whipps and R. D. Lumsden, Eds. Cambridge University Press, New York, 1990. x, 303 pp., illus. $89.50. From a symposium, Sussex, U.K., Sept. 1988. Reprint, 1989 ed.

Biotechnology in Pulp and Paper Manufacture. Applications and Fundamental Investigations. T. Kent Kirk and Hou-Min Chang, Eds. Butterworth-Heinemann, Boston, 1990. xxviii, 666 pp., illus. $95. From a conference, Raleigh and Myrtle Beach, SC, May 1989.

Bubble Wake Dynamics in Liquids and Liquid-Solid Suspensions. Liang-Shih Fan and Katsumi Tsuchiya. Butterworth-Heinemann, Boston, 1990. xvi, 363 pp., illus. $95. Butterworth-Heinemann Series in Chemical Engineering.

Cell Lineages in Development. Frank A. Pepe *et al.*, Eds. New York Academy of Sciences, New York, 1990. xii, 171 pp., illus. Cloth or paper, $50. Annals of the New York Academy of Sciences, vol. 599. From a symposium.