Alfred Chandler in the concern with how markets affect economic and technological development. On the basis of research conducted during a year spent at the University of Tokyo, Fransman provides descriptions of major Japanese cooperative projects in the areas of computing, related electronic devices, and optoelectronics, as well as conceptual discussions of technical change, economic development, and what he calls the "Japanese technology-creating system."

There is one overview chapter on the development of Japanese computer and device technology between 1948 and 1979, and then the organization of particular projects is examined in a series of case studies: the VLSI (very-large-scale integrated circuits) Project, 1976–1980; the Optical Measurement and Control System Project, 1979–1985; the Japanese Supercomputer Project, 1981–1989; the Future Electronic Devices Project, 1981–1990; and the Fifth Generation Computer Project, 1982–1991. Some of the case studies contain details that are not easily accessible in English, notably those on the Supercomputer Project, which promoted research on high-speed gallium arsenide and Josephson junction devices, and the Optical Measurement Project, concerned with optoelectronic integrated circuits. The case studies are followed by an analysis of the history and current status of cooperation and competition in these sectors of Japanese industry.

Fransman's main point is by no means original, but it is correct and perhaps not universally accepted by economists: that one must look beyond market forces to understand all the factors that influence the process and institutions of technical change. In particular, he argues that "for-profit" companies, even in Japan, do not have sufficient incentives to conduct basic research. A related notion is that of "bounded vision," that is, that organizations' views of what is important are constrained by their existing activities, profit motives, and other forms of self-interest. This, too, is hardly a new idea for readers familiar with organizations and administrative theory, particularly Herbert Simon's idea of "bounded rationality."

According to Fransman, bureaucrats from the Ministry of International Trade and Industry (MITI) during the 1950s, '60s, and '70s acted on the belief that cooperative research would help Japan catch up with the West, especially with IBM in computers. Since market forces did not spontaneously encourage firms to cooperate, the Japanese developed national research programs, focusing initially on catching up with the West and then on creating new technology. Even within Japanese national programs, however, Fransman concedes that Japanese firms have still been too competitive with each other to cooperate very extensively, and he cites the scarcity of joint patents.

He does argue that the Japanese have conducted some cooperative R&D successfully because of how they have organized it. First, they have pursued two kinds of cooperation: coordinated in-house research, where companies work individually but with some external coordination; and joint research, where companies send personnel to joint facilities. The former has been the dominant form of cooperative research in Japan because of the competitive nature of Japanese firms, although Fransman believes that the joint form leads to more true creation and sharing of knowledge. Second, the Japanese have allowed some firms to dominate projects by sending more researchers, thus recognizing the value of "tacit knowledge": know-how that can be obtained only by direct participation in a research group. It follows that a firm that sends more researchers to a project than other participants can learn more and thus has incentives to cooperate; secondary participants can also learn under this arrangement. In addition, Fransman argues that, rather than "pre-competitive research" (which he sees as a "contradiction in terms" because all knowledge eventually affects competition), the Japanese do "oriented basic research"—basic research that is guided by specific, detailed goals and that might be called long-term applied research. As a result, projects usually achieve something.

While these are interesting and important ideas and the book should interest academics, managers, and policy-makers concerned with cooperative R&D in Japan or in general, there is not much in it that will be new to observers of Japan who are familiar even just with English-language sources. The underlying arguments can be found in works of Chalmers Johnson, Marie Anchodoguy, Kenneth Flamm, and Ronald Dore, among others; better English sources exist on specific projects, such as the VLSI and Fifth Generation Computer efforts; and there also exists a large collection of studies, both theoretical and empirical, of the management of technological innovation in R&D labs, transfer of technology among and within firms, and information sharing. None of this, nor the large economics literature on cooperative research among rivals, is cited. Nor is Fransman's key conclusion new, though it is correct: that Japanese government subsidies provided more money for research than would have been available otherwise, albeit without promoting much knowledge sharing across firms, and that these funds and even limited knowledge diffusion probably pushed Japanese industry forward faster than it would otherwise have moved, although firms were clearly going in the same directions anyway.

The most disappointing chapter is the most ambitious sounding: "Cooperation and competition in the Japanese computing and electronic devices industry: a quantitative analysis." Rather than an economic analysis of industry concentration and levels of competition or of cooperative research, the "quantitative" in this heading refers to numerical answers to a short questionnaire concerning four cooperative projects filled out by senior managers from four Japanese companies. The questions dealt with the managers' perceptions of the intensity of competition and their assessments of the benefits of the cooperative projects. The proper way of doing such an analysis is to sample a much larger number of managers and perhaps researchers and subject the responses to some sort of statistical analysis that would tell us something about their reliability or consistency. The idea of a questionnaire such as this is a good one, but in its present form the quantitative analysis does no more than assign numbers to subjective impressions of a few managers.

Finally, the author has squeezed into the book various things he learned or found interesting while in Japan, regardless of whether they fit with his story about cooperative R&D. There are hasty references to Japanese "just-in-time" (JIT) inventory control practices, total quality control (including an appendix that maps out NEC's TQC system with no discussion), and other Japanese modes of operation or organization that seem to encourage information flows suitable for stimulating incremental innovations. Elaborating on these observations and relating them to the other material in the book would have made a unique contribution.

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Interpreting Fossils

Owls, Caves and Fossils. Predation, Preservation, and Accumulation of Small Mammal Bones in Caves, with an Analysis of the Pleistocene Cave Faunas from Westbury-sub-Mendip, Somerset, U.K. PETER ANDREWS. University of Chicago Press, Chicago, IL, 1991. viii, 231 pp., illus. $39.95.

The fossil record is not an unbiased snapshot of the past. To interpret it properly, paleontologists must understand the various processes that have affected fossil assemblag-

es from the time of death until the time they are unearthed, collected, and studied. Most taphonomic studies of mammalian fossil assemblages have focused on bones of large ungulates. *Owls, Caves and Fossils* offers a new and comprehensive perspective on accumulations of bones of small mammals, especially those found in caves. The taphonomy of these deposits is critical to paleoecology because small mammals are one of the best proxies for paleoenvironmental reconstruction of terrestrial ecosystems.

In the first two chapters of the book Andrews provides a general overview of the taphonomic pathways for small mammal accumulations. He compares and contrasts these pathways with those documented for bone accumulations of larger mammals. There are some interesting similarities in, for example, bone weathering stages, the correspondence between gnawing by carnivorous mammals of various sizes, and the trampling of bones by larger animals. There are also some interesting differences, which generally relate to the biology of the small mammals and their predators, primarily raptors.

Owls, as indicated in the title, are one of the most important agents of accumulation for small-mammal bones, although extensive discussions of other raptors and small carnivorous mammals are also provided. In fact, the real strength of the book is in the detailed comparisons of these agents of accumulation and the documentation of bone modification patterns by which they can be recognized. It may not always be possible to isolate a specific agent, but Andrews defines five categories that are generally easy to recognize and are useful in making taphonomic interpretations.

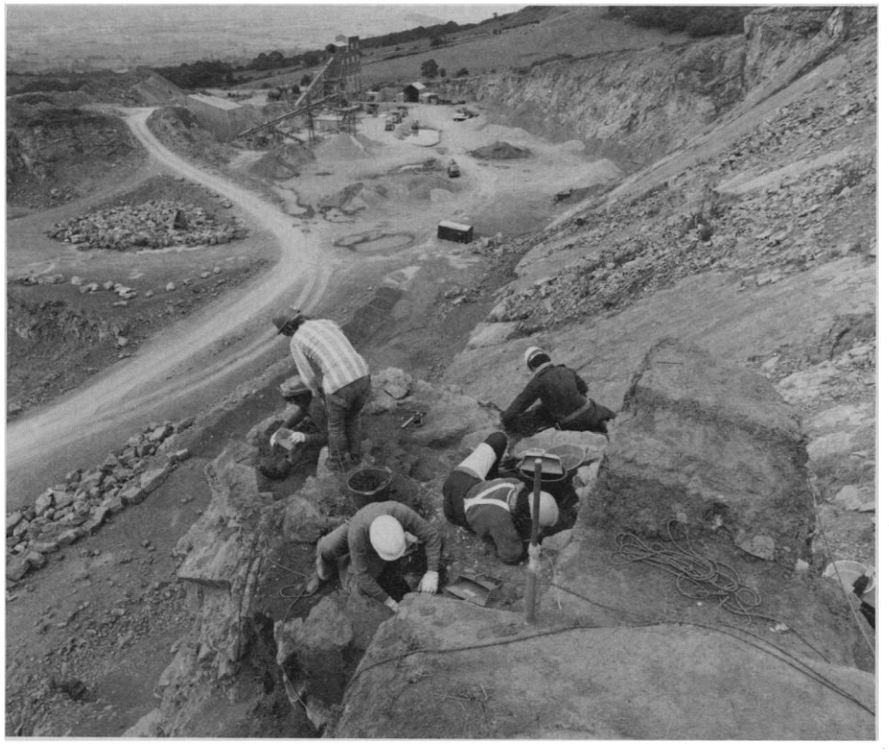
Three basic bone modification patterns (skeletal element proportions, bone breakage, and effects of digestion) are considered by Andrews. Effects of digestion provide the most indicative signature because, unlike skeletal element proportions and bone breakage patterns, they are not duplicated by depositional and post-depositional processes. Also, in direct contrast to other published accounts, Andrews demonstrates the preferential digestion and loss of some skeletal elements by barn owls. The book is profusely illustrated with scanning electron microphotographs, which, because of their clarity and abundance, can easily serve as a synoptic collection for paleoecologists wishing to identify specific agents.

Although the book focuses on cave systems, the taphonomic principles are applicable to other depositional systems. Andrews draws examples from his experiences in Great Britain, Europe, and Africa, but many of the results can be utilized in other areas. There are a few cases where examples from other areas might have been relevant. For instance, whereas Andrews believes that humans were not an important agent in the accumulation of small mammal remains in caves, human coprolites from several cave sites in the United States suggest that small mammals may have been an integral part of the diet for specific groups at certain times. A discussion of potential problems with bones from packrat (*Neotoma* spp.) middens would also have been of interest, since these are important in North American caves. For example, in the mountainous terrains of the western United States, it is not uncommon for owls to forage at one elevation and deposit their pellets near a cave inhabited by packrats at another elevation. The packrats then include these bones in their middens with locally collected vegetational material, leading to an incongruous paleoenvironmental reconstruction.

In the second part of the book, Andrews applies the taphonomic principles outlined previously to a complex sequence of bone accumulations in a middle Pleistocene cave site, Westbury-sub-Mendip (WSM). Chapters 4 and 5 provide background information on the cave and its stratigraphy. In short, the site is not an open cave today but a series of cave fills exposed by limestone quarrying. There are at least 10 different collecting localities and 20 stratigraphic units with multiple microstratigraphic subdivisions. Many separate faunules of different ages and taphonomic histories have been recognized.

Chapter 6 provides an analysis of the taphonomic pathways for each sublocality and microstratigraphic unit within the cave. The systematic approach and depth of analysis in this chapter set a standard for future studies in the taphonomy and paleoecology of micromammal accumulations. Andrews does not, however, provide any discussion of sampling techniques, and it is hard to envision undertaking this type of detailed analysis on every element from a diverse and abundant collection of remains. The last chapter focuses on the paleoecology of the different faunules at WSM. Andrews correlates the WSM fauna with the last part of the Cromerian interglacial. However, he notes that the environmental fluctuations reflected in the mammalian faunules are not consistent with palynological reconstructions for this interglacial and concludes that "these events (as represented by the different faunules) could form part of a separate interglacial complex."

This conclusion and the paleoenvironmental interpretations are based upon an analysis of the Taxonomic Habitat Index (THI) for each of the separate faunules. The THI as defined by Andrews (p. 167) is "a



"Site W2/9 at the top of the side chamber deposits of Westbury Cave. This shows the start of the second years excavation of the Western Bluff, with the solution deposits extending from the foreground to the top of the reference section on the right." [From *Owls, Caves and Fossils*]

cumulative index obtained by combining the habitat indications of all of the species in a fauna" and it is determined for extant species "by scoring them for the range of habitats from which they have been recorded." This approach is an intriguing way to quantify the habitat variability for individual species, but it assumes modern analogs for past ecosystems, although Andrews recognizes that past habitat preferences may not have been the same. A potential problem is that many owl species, as Andrews notes, may not be opportunistic feeders and their diets may represent the past environment selectively. It would have been interesting to apply the THI analysis to modern owl pellet accumulations to assess its ability to reflect modern environments.

There is an extensive appendix providing summaries of the general biology of different species of raptors and mammalian carnivores, with important references. These data form the foundation for many of Andrews's taphonomic principles, but the appendix is also a valuable resource for anyone interested in raptors and small carnivores. Information on how these species sample their environments is especially interesting.

Owls, Caves and Fossils will be a keystone in the paleoecological interpretation of small mammal accumulations. Like any good piece of research, it raises many new questions and avenues to pursue. The field of microtaphonomy will surely mushroom as a result of its publication.

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Nitrogen-Fixing Systems

The Biology of *Frankia* and Actinorhizal Plants. CHRISTA R. SCHWINTZER and JOHN D. TJEPKEMA, Eds. Academic Press, San Diego, CA, 1990. xviii, 408 pp., illus., $95.

This well-designed book presents a review of most of the papers that have been published up to 1990 on the biology of actinorhizal plants and their nitrogen-fixing nodule symbionts. It contains 14 readable chapters on various topics in the biology of these plants and 4 chapters that focus on the current and potential uses and management of actinorhizal plants in forestry.

In a historical overview by A. Quispel a clear description is given of the discoveries made before 1950 and in the "modern period" from 1950 to 1978. This period was characterized by the work of G. Bond, to whom the book is dedicated, on root-nodule physiology and by the discovery of new actinorhizal plants. The "new age," from 1978 to 1990, started with the first isolations of the nodule symbiont, *Frankia*. A significant part of the book deals with progress in the physiology and biochemistry of these newly isolated actinomycete strains and with the environmental factors affecting nitrogen fixation in actinorhizal nodules. W. B. Silvester, S. L. Harris, and J. D. Tjepkema in their excellent review describe the regulatory effects of oxygen in nitrogen fixation and show the unique position of *Frankia* within nitrogen-fixing organisms.

Treatment of the ecology of *Frankia* is restricted to one chapter on the occurrence and distribution of "spore positive" and "spore negative" nodules, which represent different groups of *Frankia* strains. This chapter clearly demonstrates the limits of conventional methods in microbial ecology and the need for molecular techniques in this area.

The chapter by A. Séguin and M. Lalonde on micropropagation and genetic transformation of actinorhizal plants and *Betula* illustrates the progress that has been made in the genetic improvement of actinorhizal species. This chapter and a chapter by J. Bousquet and Lalonde on the genetics of actinorhizal Betulaceae demonstrate the potential of *Betula* as an experimental recipient for host genes or host-gene modifiers involved in the association with *Frankia*, especially in view of the gene delivery systems already available in the Betulaceae.

The book demonstrates the significant progress that has been made in actinorhizal research, though it is still behind that made in research on legumes. The review by B. Mullin and C. S. An of the rapidly developing application of molecular genetics shows that this topic has been left almost completely to the students of the '90s. It is likely that most of the problems related to working with recalcitrant, slow-growing actinomycetes and woody plants can be overcome in the near future by using new molecular techniques.

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