their supporters). Knowledge without power generates irony, which has been an important mode of discourse among sociologists. It is relatively rare in the discourse of the powerful and in scientific journals. So that even if the ASA had opted to drive its social reformers and other committed visionaries out of the discipline and even if every sociology student were well-trained in mathematics, in formal hypothetical thinking, and in the design of controlled experiments, sociology might still be an improbable, if not an impossible, science. *The Impossible Science* is well worth the attention of readers of this journal.

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Inflating Universes

Particle Physics and Inflationary Cosmology. ANDREI LINDE. Harwood, New York, 1990. xviii, 362 pp., illus. $60; paper, $29. Contemporary Concepts in Physics, vol. 5. Translated from the Russian by Marc Damashek.

The intellectual merger of particle physics and cosmology has been one of the scientific triumphs of the past decade. The seeds for this merger were planted back in the '70s with the establishment of the big bang model and with the realization that the early universe was sufficiently hot and dense that the physics governing it was dominated by nuclear and elementary particle effects. The recent confirmation of predictions from cosmology about the number of fundamental particles by experimental results from the Large Electron Positron and Stanford Linear Colliders (LEP and SLC) has completed the merger. Intellectually, however, it was probably the idea of inflation that most attracted particle theorists to cosmology. Although others such as Gliner, Kazansas, Sato, and Starobinsky also played with some of the ideas involved, inflationary cosmology really took off in 1980 when Alan Guth showed that the type of fields predicted in grand unified theories could drive a rapid expansion of the early universe. This solved a number of the longstanding initial-condition problems of the standard big bang model and stimulated a real revolution in cosmology. It was immediately recognized that the cosmological initial conditions could be a natural consequence of the unification of the forces, and that one might even use the cosmological consequences of a unified theory to ascertain its validity. However, one important hurdle existed in Guth's original formulation—though he could get the rapid expansion to occur, Guth was not able to get from that phase back into the more slowly expanding universe in which we find ourselves now.

This problem was resolved by Andrei Linde working in Moscow (and independently by Paul Steinhardt and Andreas Albrecht working in the United States). Linde's solution became known as "new inflation," and he went on to show that other formulations of inflation might also work. In fact, he showed that essentially any scalar field existing at early times in the universe could cause inflation, and since all unification models seem to have some sort of scalar field, they all lead naturally to some sort of inflating phase. Linde dubbed the idea that any simple scalar field could cause inflation "chaotic inflation," and the production of multiple inflating epochs by multiple scalar fields has come to be known as "stochastic inflation." When coupled with ideas about quantum gravity, stochastic inflation leads to multiple inflating, causally disconnected universes. Linde's work, along with his dynamic personality, wry sense of humor, and prodigious publication rate, has made him one of the world's leading cosmologists. There is little doubt that Linde, although young, is assuming the mantle of the late Yakov Zel'dovich as the Soviet Union's leading cosmologist, and now that he has accepted a position at Stanford University he is also becoming one of America's leading cosmologists.

Linde's book *Particle Physics and Inflationary Cosmology* clearly and succinctly presents the development of inflationary cosmology in the language of modern quantum theory. (Also recently published, by Academic Press, is a collection of Linde's original papers entitled *Inflation and Quantum Cosmology*). The monograph is written primarily for those approaching the subject from the particle physics rather than the astrophysics side of cosmology and is at a level appropriate for the advanced graduate student. The book has fewer typographic errors and linguistic awkwardnesses than are typical for monographs translated from the Russian, but more than are usually encountered in other works in theoretical physics. The Russian references are particularly complete, which is a boon to those of us less familiar with that literature. This is, however, at the cost of being somewhat less complete with regard to the Western references.

The book focuses on the connection between particle physics and inflation, and the reader will not find other aspects of the particle-cosmology connection, such as dark matter, nucleosynthesis, baryosynthesis, and other more phenomenologically oriented subjects, discussed in any significant way. However, the discussion of inflationary cosmology is extraordinarily thorough. Various potentials and their effects on inflation are treated in great detail. The physics of phase transitions in a hot universe is well described. The derivation of scale-free fluctuation spectra at the end of inflation is made clear. The discussions of both the new and the chaotic inflationary scenarios emerge as natural consequences of the framework developed earlier in the book.

Linde's treatment of inflation in quantum cosmology provides a natural stepping-off point for his recent stochastic inflation. In his last chapter Linde lets his imagination run wild, and it's fun to see where it goes. He claims that the studies of the universe and of consciousness may be intertwined. He even speculates that consciousness, like space-time, may have its own intrinsic degrees of freedom. He draws some interesting parallels between the study of consciousness and the recent interest in the fundamental problems of the origin of space-time and such questions as why it is four-dimensional. He muses that an examination of consciousness, and other fundamental problems such as life and death, from a physics perspective rather than a philosophical or theological one, may be needed, and that perhaps apparently disparate sets of problems are not unrelated. Obviously such speculations as this, and his equating of vacuum energy with life, are not presented with the rigor of the rest of the book, but they do provide a way of ending what is basically a hard-core physics monograph with a truly vast cosmic perspective.

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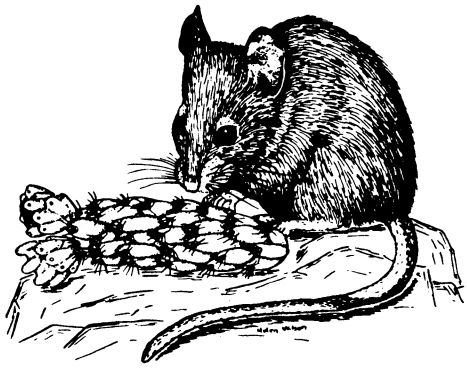
Paleoecological Troves

Packrat Middens. The Last 40,000 Years of Biotic Change. JULIO L. BETANCOURT, THOMAS R. VAN DEVENDER, and PAUL S. MARTIN, Eds. University of Arizona Press, Tucson, 1990. viii, 469 pp., illus. $55.

"In some circles," write Betancourt, Van Devender, and Martin, "the paleoecologist is considered an unfortunate ecologist, one who has the vantage of time but lacks too many pieces of the puzzle for a coherent view" (p. 435). In this volume, we are challenged to dispute this paradigm and juxtapose the clairvoyance offered by modern ecology against the less focused but broader vision of paleoecology. The result is a fascinating introduction to the world of packrat (*Neotoma* spp.) midden analysis in a series of well-written papers on the ecology of *Neotoma* and the paleoecology of the



White-throated packrat. This species "was responsible for building most of the fossil packrat middens in the Chihauhuan Desert. It apparently has lived in the Hueco mountains of Texas for the last 42 ka, adapting to *in situ* vegetation changes from Wisconsin woodlands to Chihuahuan desert-scrub." [From *Packrat Middens*; drawing by Helen A. Wilson]

American Southwest. The biotic history offered by these diversified data provides a unique perspective on semiarid ecosystems and their sensitivity to climatic change. For that reason, the volume will be of interest to ecologists, biogeographers, and Quaternarists alike.

The history of semiarid regions has long eluded the paleoecologist, who in temperate and boreal latitudes relies upon fossil pollen preserved in wetlands for a continuous record of vegetation and climatic change. Playa-lake sediments and spring deposits provided pollen records for some semiarid regions, but the paleozonation of vegetation remained unresolved. It was first reported in 1964 that packrat middens found in caves and rock ledges preserved a fossil record of wood, seeds, leaves, bones, and insects. Midden materials were identifiable to species (unlike most pollen grains) and had their provenance in the immediate area, enabling a detailed reconstruction of local vegetation. The organic remains were dated to as early as 50,000 years ago and thus could provide a record of biotic change from the present back through the last glaciation. In the last 26 years, the analysis of packrat middens from the American Southwest has proceeded at a rapid rate, thanks largely to Paul Martin and former students at the University of Arizona and to Philip Wells at the University of Kansas. Today the paleoecologic database assembled in this and other publications rivals that from any temperate region of the world.

The book is divided into four parts. In the first section, important questions are addressed concerning the behavior and ecology of modern *Neotoma* and the taphonomic limitations that might be imposed on the fossil record. Might dietary preferences bias a midden assemblage? (Depends on the species.) What is the collecting radius of a wood rat? (Usually less than 30 meters.) Do midden assemblages provide a good representation of local vegetation today? (They contain the dominant plants, but a complete picture of vegetation requires sampling several middens at one site.) For how long is a midden occupied? (Probably a few years.) Are fossil middens evenly distributed in time? (No, they cluster around 1000 years ago and 10,000 years ago, reflecting the research interests of the investigators.)

The second part of the book deals with the late Quaternary vegetation of different regions. In some respects the authors in this section are themselves like packrats. Each is territorial and pertinacious in how he chooses to quantify and interpret data and how he divides the geologic record. Areas of contention are clear. Van Devender infers a mild, wet glacial climate and fairly dry summers in the early Holocene in the Sonoran and Chihuahuan deserts. Spaulding suggests that the Mohave desert experienced cold, dry glacial conditions and wet summers in the early Holocene. Thompson draws upon an array of paleoenvironmental data to conclude that the Great Basin vegetation was impoverished during glacial times and that conditions were colder and slightly drier than today. In the Grand Canyon region, Cole believes that changes in vegetation at the end of the Pleistocene lagged well behind the triggering climatic warming, a conclusion that is disputed by Spaulding, Van Devender, and others. Betancourt's analysis of the Colorado Plateau focuses on the importance of local geology and physiography in creating associations of plants that today have no modern counterpart. To an outsider these disagreements sound somewhat fratricidal, and one wishes for more effort at conciliation. Indeed, on balance there is more agreement than dissension. All concur that desert communities in the Southwest do not have a long history. Some taxa clearly had their heyday in the glacial period (for example, bristlecone and limber pine in the Great Basin and Mohave region and pinyon pine in the southern desert lowlands) and today are relatively restricted. Other taxa, dominant at present like ponderosa pine, saguaro, and foothills paloverde, are rare in the fossil record, suggesting restricted glacial distributions. The midden record provides evidence of both long-distance dispersal and vicariance in the Holocene. Because the response of communities to past climatic changes is highly individualistic, modern communities appear as transitory associations in time.

The third section of the book presents some case studies in which packrat midden analysis has been used to address specific problems. Mehringer and Wigand examine in detail the late-Holocene spread of juniper in southeastern Oregon. Other components of middens, including grasses, mammals, and insects, are discussed in a series of papers, and in general they show less variability through time than the woody taxa. Likewise, Long and others produced a climate record based on stable isotope ratios in plant cellulose and found that it did not match that developed from the flora.

The last section reminds us that midden analysis is a tool that can extend beyond the range of North American *Neotoma*. Middens of Procaviidae and Petromuridae in the Middle East and Africa and *Leporillus* in Australia contain well-preserved biological remains, and the opportunities to develop a midden data base in other semiarid regions seem promising.

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Suborganismal Analysis

Molecular Systematics. DAVID M. HILLIS and CRAIG MORITZ, Eds. Sinauer, Sunderland, MA, 1990. xvi, 588 pp., illus. $65; paper, $37.95.

Molecular systematics began as an ambitious but relatively modest enterprise in 1904 with G. H. F. Nuttall's application of serology to the problem of relatedness among animal species. In the last decade it has grown to a veritable revolution as systematists have borrowed techniques from molecular genetics to study the distribution of genetic variation across the hierarchy of life. *Molecular Systematics* is a much-needed *how to* and *why* book on the application of molecular techniques in systematic biology. Hillis and Moritz have judiciously adopted a broad definition of systematics that includes comparative studies of biotic diversity at all levels; thus the book addresses intraspecific variation and microevolutionary process, traditionally the substance of population genetics, as well as the expected topics of phylogenetic inference and circumscription of species, the more traditional subject matter of systematic biology. Indeed, the application of molecular techniques to reveal the extent and organization of genetic variation not only between and within species but within the genome seems destined to form new syntheses between evolutionary biology, developmental biology, and genetics.

The book is organized into three sections that correspond to stages of a molecular