

Land and Sea Records

The Past Three Million Years. Evolution of Climatic Variability in the North Atlantic Region. N. J. SHACKLETON, R. G. WEST, and D. Q. BOWEN, Eds. The Royal Society, London, 1988. viii, 278 pp., illus. £53. First published as *Philosophical Transactions of the Royal Society*, vol. 318 (1988). From a meeting, London, Feb. 1987.

An understanding of the changing nature of climate variability through time is fundamental to determining linkages between various parts of the earth's global climate system. In this book, which contains 14 papers from a Royal Society "discussion meeting," the target is nothing less than the cause of the ice ages. The evolution of climatic sensitivity over the last three million years has been widely ignored until recently. As Shackleton states in the preface, "There has been a tendency for Quaternary specialists to distance themselves from phenomena that have characteristic times longer than a few tens of thousands of years, just as the rest of the geological community regard anybody investigating phenomena with characteristic times of less than a million years as a dangerous catastrophist. At this meeting we were forced to bridge that gap."

The bridge is being built by marine geologists, who in recent years have obtained continuous, high-resolution sedimentary sections from ocean drilling. With these detailed marine records, they have set the goals toward which terrestrial workers will strive. For example, in the lead paper in the volume Ruddiman and Raymo document the intensification of North Atlantic climate variability over the last three million years at a degree of resolution that would have been inconceivable a decade ago and then put forward an important hypothesis on the role of recent tectonism in modifying global climatic patterns. Sarnthein and Fenner focus on the role of oceanic productivity in controlling atmospheric carbon dioxide content and on potential climatic feedbacks.

In contrast, from my perspective as a marine geologist the land-based studies seem to bog down in questions of reliability of signal interpretation, correlation, and chronology of their fragmented records. For example, Catt reviews difficulties of interpreting climate change from soils, due to the complex interactions of local climate, exposure time, parent material, and postburial modification. The greatest potential appears to lie in loessial soils. Judging from a recently published study of Chinese loess deposits (Kukla *et al.*, *Geology* 16, 811 [1988]), Catt's statement is already proving true. The climates within cold stages are addressed by

West, who notes that evidence for past temperatures is reasonably good but reconstructions of precipitation and snowfall are more problematical. He emphasizes that our tendency to classify episodes as "glacial" or "interglacial" masks huge complexities within each regime, which are critical to interpreting mechanisms of change.

De Jong documents more than two million years of climate change in northwest Europe, using data assembled from pollen analyses of many sites, but notes that precise correlation to the deep-sea record is not yet possible. Cronin infers a 100,000-year climate cycle in his record of fossil ostracods from the eastern United States but emphasizes that the record is too fragmented and dating too uncertain to resolve shorter-period fluctuations in detail. In an account that is controversial when it conflicts with traditional stratigraphic interpretations, Bowen and Sykes review European land-sea correlations using amino acid stratigraphy. They assert that "traditional classifications of the continental Quaternary are inadequate and mostly oversimplified." In his study of the Canadian Arctic, Andrews states that "although it is tempting to correlate amino zones with the marine isotope record . . . [this] is only a hypothesis that requires rigorous testing." It is useful to have these complexities of interpretation, correlation, and chronology debated as they are here. A wide range of paleoclimatologists will become more aware of both the strengths and the limitations of data sets outside their expertise.

Noting the difficulties inherent in the land record, Shackleton, Imbrie, and Pisias ask boldly, "In areas where the prospect of reconstructing long records that are suitable for comparison with the deep-sea records is remote, is there any palaeoclimatic justification for continued Quaternary research?" Their answer, of course, is yes. The land-based record offers spatial detail and sensitivity that the deep-sea record will never achieve. Both areas give important, if distinctly different, information. Together they give insight that each alone would not provide.

In this combined land-sea approach lies the greatest strength of the book. This is a truly interdisciplinary offering, including micropaleontology, geochemistry, paleobotany, seismic profiling, and soil science as well as traditional Quaternary geology. Given the individual quirks of each field, the papers must emphasize a variety of spatial and temporal scales, and there is a vast range of specialized jargon represented, which may mean slow reading for the uninitiated. But fighting through the jargon is worth it. The book neatly summarizes the current

state of the art in the study of climate variability over the designated time frame.

The Past Three Million Years focuses on the North Atlantic region, for it is only here that sufficient work has been done to attempt a broad summary. Studies of long-term climate variability will continue as more samples become available from the Ocean Drilling Project and other global studies, and this collection serves as a grand statement of strategy for such work. The volume is nicely edited and printed, and the Royal Society's practice of including the discussions that followed papers at the meeting is helpful, as it flags hidden assumptions and controversy that might otherwise be missed.

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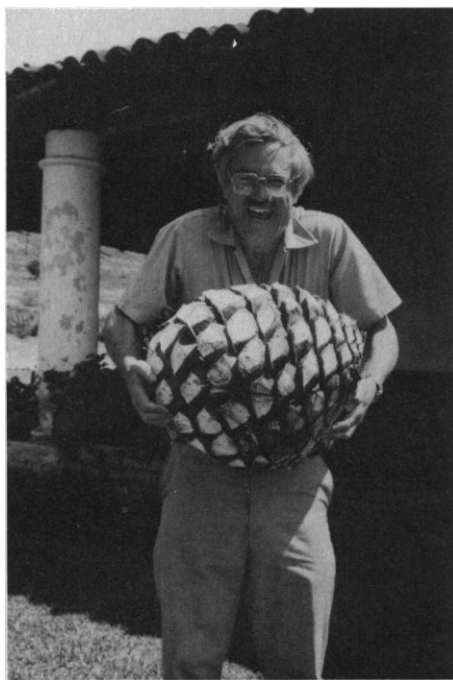
Succulents and Their Ways

Environmental Biology of Agaves and Cacti.

PARK S. NOBEL. Cambridge University Press, New York, 1988. x, 270 pp., illus. \$59.50.

Agaves and cacti belong to unrelated plant families, yet they share ecological, physiological, and anatomical features. Both are succulent, although the agaves are leaf succulents whereas the cacti for the most part are stem succulents. Both are largely natives of the New World, occurring in arid, semiarid, and semitropical habitats, but they are cultivated throughout the world for food, fiber, and other uses. Importantly, both have the photosynthetic mechanism crassulacean acid metabolism (CAM), which imparts great resistance to drought. Nobel has developed from a biophysical point of view a comprehensive and excellent treatment of these two interesting groups of plants.

After an outline of the economic uses of the plants, the history of research on them, and their taxonomy and anatomy, there is a detailed development of the principles of plant gas exchange that provide a basis for understanding how these plants react to their environment. Subsequently, Nobel develops in biophysical terms concepts of water relations, temperature, photosynthetically active radiation (PAR), and soil nutrients as they relate to the ecophysiology of agaves and cacti. The final chapter brings the entire work together using an index referred to as EPI, the environmental productivity index. This index relates the actual CO₂ uptake over a 24-hour period to the maximal CO₂ uptake possible as affected by water, temperature, and PAR. Validation of the EPI



The author of *Environmental Biology of Agaves and Cacti* holding the stem and attached leaf bases of a plant of *Agave tequilana*. This part of the plant "is called a piña because it resembles a pineapple (or a 'cabeza,' meaning head). This piña was harvested from an eight-year-old plant and will be taken to a local factory for roasting 24–36 h followed by shredding and then fermenting of the mash for 36–48 h as a prelude to distillation to obtain tequila." [From *Environmental Biology of Agaves and Cacti*]

model by correlation with actual growth of agaves and cacti was possible.

The book is unique in that it is not only a thoroughly documented study of the environmental biology of the plants it deals with but an exceptionally clear account of the physical aspects of plant ecophysiology. It is an outstanding biophysical ecology text because it clearly integrates the principles it develops with the functioning of plants in their natural environment. In addition, it is a nice review of CAM giving support to the notion that it is a metabolic sequence resulting in adaptation to drought.

Although the book is based primarily on the work of Nobel and his associates, it is prepared in a scholarly manner, drawing on the published literature. It is a pity that so many of the excellent photographs are reproduced poorly, even to the extent that rulers and rattlesnakes referred to in captions are not visible. Throughout, the subject is presented with little teleology except in the chapter treating PAR and the orientation of cactus cladodes. Here the thesis is developed that orientation with respect to radiation is advantageous for maximizing CO₂ uptake. No doubt this is true, but one wonders about the cause-and-effect relationship. In any case, the orientation studies are

fully documented and contribute to our understanding of PAR interception in relation to subsequent growth and development.

I highly recommend this book to students and researchers alike who have interest in biophysical ecology, arid regions, and succulent plants in general.

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Some Other Books of Interest

Milestones In Immunology. A Historical Exploration. DEBRA JAN BIBEL. Science Tech, Madison, WI, 1988. xx, 330 pp., illus. \$35.

"Modern immunology," writes Debra Jan Bibbel, "taps our deepest concerns, addressing the question of individuality" and offering immunologists the opportunity to join other scientists in "probing directly the epistemological questions of existence." Seeing history both as offering "one of the proven paths to such philosophical pondering and transcendence" and as having practical uses, she has prepared this "guided historical exploration of immunology that focuses on the classic contributions." In it are printed abridgements of 73 such contributions, from Jenner's "Inquiry into the cause and effects of the variolae vaccine" (1798) to Kiessling *et al.*'s "Natural killer cells in the mouse, II," and Köhler and Milstein's "Continuous cultures of fused cells secreting antibody of predefined specificity" (1975). The papers are grouped according to theme: immunotherapy; allergy, hypersensitivity and immunopathology; immunochemistry; cells and interactions; theories; agents and adjuncts; immunogenetics; technology; and systems. For each group and for each individual paper there is an introduction in which Bibbel discusses in a nontechnical style the scientific issues involved and gives some biographical information about the author or authors, along with an occasional anecdote. Suggestions for further reading are included at appropriate intervals. In an epilogue that further develops the theme stated in her preface, Bibbel poses some zen koans and scientific enigmas and provides a philosophical view of immunology based on the view that "as in the web of Indra's jeweled beads, each facet of existence is reflected by all others." In conclusion she expresses the hope that "by . . . increasingly higher spiral orbits—undergoing cycles of reductive and holistic frameworks—science [will] not only

tolerate, but actually incorporate the formless, wordless reality that is beyond its manipulative grasp," a development she believes will entail an increasing role for psychobiology and psychophysics.—K.L.

Drugs, Athletes, and Physical Performance. JOHN A. THOMAS, Ed. Plenum Medical, New York, 1988. xvi, 237 pp., illus. \$39.50.

Not an examination of actual practices in the sports world, this book is, rather, a summary of biomedical information regarding various endogenous and exogenous substances that have been associated with athletics. Written at a level suitable for students or for a lay audience but citing primary research literature, the volume includes chapters on vitamins, anabolic and androgenic steroids, analgesics, calcium, muscle relaxants, anti-inflammatory agents, human growth hormone, and central nervous system stimulants. In addition there are chapters on nutrition and fluid balance, fuel utilization and insulin requirements, immunity, and female reproduction as related to exercise and physical performance. A chapter on drug abuse, which includes a table listing 82 drugs banned by the National College Athletic Association, categorizes such drugs as ergogenic, restorative, and recreational, reviews some of their therapeutic and deleterious effects, and predicts for the first category that "it will be increasingly difficult to separate therapeutic use and abuse." In all, 20 authors, most of them affiliated with medical schools, have contributed to the work.—K.L.

Domestication of Plants in the Old World. The Origin and Spread of Cultivated Plants in West Asia, Europe, and the Nile Valley. DANIEL ZOHARY and MARIA HOPF. Clarendon (Oxford University Press), New York, 1988. x, 249 pp., illus. \$75.

This volume is an attempt to provide "a review of the origin and the spread of cultivated plants in southwest Asia, Europe, and Africa north of the Sahara . . . up to classical times." After a brief introduction discussing the nature of the available evidence, information about genetics, wild ancestry, and history of domestication is presented crop by crop, with chapters devoted to cereals, pulses, oil and fiber crops, fruit trees and nuts, vegetables and tubers, condiments and dyes, and fruit collected from the wild—some 70 species or other categories in all. A further chapter lists plant remains