tent to which they "wet" silica-rich materials, creeping up the walls of tubes and penetrating the very finest of cracks. I suggest that the introduction of molten sulfide can explain its presence in the chert at Jan and perhaps at Redstone as well.

In conclusion, this book offers careful documentation of a series of deposits most of which have never been documented properly before. It does not contain a wealth of geochemical data and, with certain significant exceptions, does not present new ideas on ore genesis. The editors and the initiator of the Robinson Symposium, Paul M. Kavanagh, have achieved the even more difficult task of persuading mining company geologists to take the time to describe their deposits, many of them classics, for posterity. Anyone who is interested in what these classic deposits look like cannot afford to be without the book.

A. J. NALDRETT

Department of Geology, University of Toronto, Toronto, Ontario M5S 1A1, Canada

Science 222 (4624): 610-611
Nov. 11, 1983

Lizards

Lizard Ecology. Studies of a Model Organism. RAYMOND B. HUEY, ERIC R. PIANKA, and THOMAS W. SCHOENER, Eds. Harvard University Press, Cambridge, Mass., 1983 x, 502 pp., illus. $35.

The approximately 3000 living species of lizards make up one of the most diverse elements of the world's terrestrial fauna. Because lizards, like birds, are predominantly diurnal and often conspicuous, they are well suited for the investigation of various types of ecological questions. The past decade has seen a large increase in the number of studies of lizards, and this symposium (which took place in 1980) undertook the challenging task of assessing the current state of the field.

The 16 chapters are divided into three sections, each with a brief introduction. Several shortcomings are evident in the format and preparation of the volume: I found the absence of chapter summaries a handicap, and the literature citations are grouped at the end of the book but divided by chapters, thereby combining the worst features of both arrangements. The index is inadequate: "behavior," "model," "mortality," "optimality," and "selection" are only a few of the important entries that do not appear.

The first section, Physiological Ecology, is the shortest and does not fully represent the scope of work in that area. Studies of the thermal relations of lizards have been in the forefront of environmental physiology, and work on water relations has been nearly as extensive, but neither topic is included. The chapters on activity metabolism by A. F. Bennett and on biophysical models by W. P. Porter and C. R. Tracy are, to a large extent, shorter versions of material presented by Bennett and Tracy in volumes 12 and 13 of the *Biology of the Reptilia* (edited by C. Gans and F. H. Pough, Academic Press, 1982). In contrast, K. A. Nagy's analysis of the annual energy budget of the small iguanid lizard *Uta stansburiana* is new and presents one of the most detailed applications to date of the doubly labeled water technique to field studies of animal energetics. The potential errors in estimation of energy flow with this method are numerous, but in the laboratory Nagy found only a 7 percent difference between estimates of energy flux obtained with doubly labeled water and estimates based on calorimetric measurements of food and feces. If similar accuracy can be obtained in field studies, calculations of energy flow at the level of populations are credible.

The second section, Behavioral Ecology, is dominated by a masterly review of sexual selection and territoriality by J. A. Stamps. Her analysis is limited to lizards, but the model she proposes is a general one. A process of formulation and testing of hypotheses leads to the conclusion that sexual dimorphism and territoriality in lizards are best explained by characteristics of their reproductive biology, not by trophic relationships. The power of this formal approach to behavioral ecology is illustrated by insights that unfold in a sequence that is aesthetically as well as intellectually satisfying.

Part 3, Population and Community Ecology, opens with a descriptive model of life-history variation by R. E. Ballinger that defines a component of genetic variance representing phylogenetic constraints such as body shape and reproductive mode. Like Stamps's model of sexual selection, Ballinger's life-history model integrates recent studies of the ecology of lizards to form a synthesis that promises new insights. Three different approaches to community ecology are represented by chapters on *Cnemidophorus* by T. J. Case and on *Anolis* by E. E. Williams and by J. Roughgarden and his associates. Case and Roughgarden *et al.* present mathematical models of interspecific interactions, whereas Williams extends the descriptive methods of his analysis of the *Anolis* fauna of Puerto Rico to other islands in the West Indies. The juxtaposition of these different approaches clearly illustrates the merits and problems of each. The mathematical models provide a sense of generality but depend upon anecdotal details to support conclusions of competitive exclusion. Williams's "close view" provides extensive information about the particular cases being considered, but the very quantity of specific, perhaps unique, detail makes generalization difficult.

The symposium reviewed here took place in the 15th anniversary year of a symposium of the same title that summarized the first burgeoning of work on lizards (*Lizard Ecology*, edited by W. W. Milstead, University of Missouri Press, 1967). The introduction to the new symposium presents graphs illustrating a rapid increase in the quantity of work on lizards in the past 15 years, the papers in the symposium allow one to assess the change in quality. That analysis leaves me with a sense of disappointment at the narrow perspective of many of the chapters.

The most conspicuous failure to integrate information from related approaches is the division between biophysical modelers and field ecologists. One receives the impression that proponents of biophysical models see the models as ends in themselves, not as steps to biological understanding, and that models are being extended beyond their ability to provide reliable information. Ecologists in turn appear to ignore the potential value of biophysical models to address specific, limited questions in field studies. For example, a biophysical model might transcend purely descriptive analysis of the structural habitat to identify important functional characteristics of the home ranges of lizards (see chapter 8 by Stanley F. Fox). Models can be used to test ecological hypotheses as well as to generate them: Do changes in the foraging behavior and in the use of microhabitats by sympatric lizards during dry periods reflect interspecific competition, as A. E. Dunham contends (chapter 12)? Or are they only a response by the lizards and their insect prey to changes in the physical environment?

An important, albeit discouraging, inference from the symposium is that the full integration of biophysical models and field studies may be more complicated than one would hope. Roughgarden's chapter summarizes the use of a "gray-body temperature index" (GBTI) to characterize the thermal niche of *Anolis*. The GBTI is defined as the equilibrium

temperature of an inanimate reference object the shape of a lizard and weighing 5 grams in the microclimate where a lizard perches. In practice, the GBTI is not measured directly but is predicted from measurements of solar radiation, air speed, and air temperature. The GBTI is useful in mathematical descriptions of the way some species of *Anolis* partition the habitat, but it does not predict the actual body temperatures of the lizards or their physiological responses to heat. In contrast, a large body of descriptive and experimental study has led physiological ecologists to generalizations about the ecological significance of exactly those features of the thermal biology of lizards. (For a review see R. B. Huey, in *Biology of the Reptilia*, vol. 12, pp. 25–91.) Consequently, the lack of correspondence between GBTI and conventional measurements of thermal ecology is disappointing. Is the concept of GBTI flawed, perhaps because of the two-steps-removed-from-reality method used to measure it? Or have the assumptions of environmental physiologists about the ecological relevance of the responses of organisms to temperature been too optimistic? Answering questions of this sort will clearly require the broadly integrative approach exemplified by the best papers in this symposium.

F. HARVEY POUGH
Section of Ecology and Systematics,
Cornell University,
Ithaca, New York 14853