ence has been immune from his powerful influence. It is appropriate, therefore, that this volume should be dedicated to him.

The Nature of the Solid Earth is a collection of 23 papers presented at a symposium conceived to honor Birch. A secondary purpose of the symposium was to set forth the achievements of the United States program for the Upper Mantle Project. Of the 36 contributing authors, who probably include a majority of the most creative and productive earth scientists of the English-speaking world, about one-third are former students or associates of Birch. The volume itself is a documented record of Birch's influence on modern earth science.

The papers in *The Nature of the Solid Earth* present a sample of what we knew two years ago about chemical and physical models of the earth, plate tectonics, regional geophysics, and physical properties of rocks. Some of these papers merely present updated versions of previous work by the authors, but some are original contributions. All are worth reading.

In the lead paper, Sydney P. Clark, Jr., Karl K. Turekian, and Lawrence Grossman present a new model for the early history of the earth. They propose that most of the earth was formed rapidly, in no more than 10^5 years, after which followed a slower accretion of a veneer of more volatile material of up to 20 percent of the mass of the earth in an additional period of 10^5 to 10^7 years. Don L. Anderson, Charles Sammis, and Tom Jordan review evidence on the composition of the mantle and core and conclude that the properties of the upper mantle are consistent with those of pyrolite and that the lower mantle contains more FeO than the upper mantle. A discussion by A. E. Ringwood reveals that many of the phase transformations in the mantle proposed by Birch in 1952 have been verified by laboratory and recent seismological evidence. Frank Press infers from a family of models based on a Monte Carlo analysis of travel times, density, eigenperiods, and surface waves that the density of the lithosphere is near that of eclogite, but that the underlying asthenosphere is less dense. Discussions by Edward Bullard of geomagnetic dynamos, an analysis by Richard R. Doell and Allan Cox of the Pacific geomagnetic secular variation and lateral uniformity in the lower mantle, and other papers by Paul W. Gast, by Robert M. Garrels, Fred T. Mackenzie, and Raymond Sievers, by Freeman Gilbert, by Anton L. Hales, by Eugene Herrin, and by Louis B. Slichter round out the papers on earth models.

The five papers on the implications of plate tectonics by D. P. McKenzie, David T. Griggs, William M. Kaula, H. W. Menard, and James Gilluly are stimulating, especially the paper by Gilluly on tectonics involved in the evolution of mountain ranges. Gilluly accepts the basic concepts of plate tectonics but argues forcefully and successfully that the supposedly rigid plates of the earth's lithosphere have been subjected to rather intense internal deformation and that many mountain ranges are formed far from the sea and within plates rather than at plate boundaries. If this were not so, continental geology would be pretty dull and continental landscapes would be almost featureless.

A series of concluding papers on regional geophysics and physical properties includes a review by G. P. Woollard of regional variations in gravity, a discussion by Robert F. Roy, David D. Blackwell, and Edward R. Decker of continental heat flow, and an analysis by Orson L. Anderson of patterns in elastic constants of minerals. W. H. Diment, T. C. Urban, and F. A. Revetta, L. Knopoff and J. N. Shapiro, and Eugene C. Robertson also contributed papers to these sections.

Editor Robertson, associate editors James F. Hays and Leon Knopoff, and all 36 contributing authors have honored Birch with a splendid book.

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Fossil Amphibia

Tertiary Frogs from Central Europe. Z. V. ŠPINAR. Junk, The Hague, and Academia, Prague, 1972. 286 pp. + plates. $34.90.

Few frog families are well represented in the fossil record, and at least six of the known families are not represented at all. Existing fossils are usually isolated finds, and population samples are extremely rare. This monograph is therefore quite significant for herpetologists, paleontologists, and other biologists interested in frogs, for the major part of it is an exhaustive study of the only known extinct frog family, Palaeobatrachidae, from the Oligocene and Miocene of Czechoslovakia and other areas in central Europe. Excellent rare material of the Pelobatidae is also described, as are fragmentary remains of two other families, but it is the palaeobatrachids that are of greatest interest, because of their primitive structure and their relationship to the living family Pipidae.

This study has been in progress for 20 years, during much of which time Špinar worked with this difficult material without adequate equipment and comparative specimens and with only limited possibility of outside contacts. In spite of these difficulties he has produced an amazingly thorough and well-documented study of these unusual frogs, including aspects of their ontogeny, sexual dimorphism, and ecology, as well as morphology, systematics, and phylogeny. Particularly useful is the extensive documentation of individual variation; at least 1100 adult and 80 tadpole specimens are preserved. Nearly half the book is composed of photographs of the individual specimens, and 96 text figures are included as well. Much of the significant work on frog systematics has been in English (at least in recent years), and we may be grateful to Špinar for having this book make its initial appearance in translation. The translation has led to some obscurities, most of them not significant.

Known since 1858, palaeobatrachids were the subject of early studies that included unrelated forms; the resulting confusion has led to subsequent (and unfortunate) ignoring of this group in studies on frog systematics. Nearly 30 species have been described, which Špinar reduces to 6 (including 2 new ones), placed in one genus with three subgenera. Two of these species are well defined and based on many specimens; the others are relatively rare and are based on rather minor features.

Since tadpole evolution in frogs is essentially unknown owing to the absence of tadpoles in the fossil record, analysis of the palaeobatrachid tadpoles is one of the most interesting aspects of this monograph. Špinar has been able to interpret an ontogenetic series, showing the timing of bone ossification, the presence of five pairs of ribs, and the participation of at least six vertebrae in formation of the urostyle. The tadpoles are very similar to those of living pipids in general appearance as well as in structure of the mouth. Many soft structures not ordinarily preserved are found in the palaeobatrachid fossils, including nerves and sense cap-

sules, blood vessels, heart, liver, kidneys, gonads, myosepta, ova, epidermal glands, and pigments.

Špinar has clearly demonstrated that palaeobatrachids are related to pipids. Such derived character states as flooring of the Eustachian tube by the pterygoid, structure of the middle ear, tadpole, and elongated metapodials confirm this, and there are many suggestions of relationship to *Xenopus*, most primitive of living pipids. That palaeobatrachids form a distinct family is indicated by possession of uniformly procoelous vertebrae and a unique synsacrum incorporating at least three vertebrae.

In the area of higher classification Spinar's views are likely to differ from those held by some workers on anuran systematics (although it must be said that this is not an area in which agreement is common). While agreeing that pipids and palaeobatrachids are closely related, he believes that the latter are also related to the ancestry of "higher" (nonascaphoid) frogs. The character states indicating this are listed on his page 33; most of these are primitive, some overlap with pipids, and the functional significance of others is not well established. Špinar regards the presence of procoelous vertebrae in palaeobatrachids as particularly significant. In light of the developmental origin of procoelous and opisthocoelous vertebrae, many workers will not find this particular argument persuasive, nor will all be able to accept isolation of paleobatrachids in their own suborder in light of their close resemblance to pipids.

Špinar has attempted to substantiate his systematic views with a detailed analysis that deserves careful scrutiny. He has clearly perceived the pipid relationships of palaeobatrachids; that his ultimate phylogeny has (in my view) been overly influenced by particular character states does not detract from the superlative value of his monograph. In spite of the widespread interest in frog systematics, there are few living frog families that have been monographed with the care and detail offered in this case. This book is not to be viewed entirely as a specialized monograph; any vertebrate biologist concerned with amphibians will need it and it is a necessary resource for institutional collections.

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Russian Neuroscience

Vertebrate Memory. Characteristics and Origin. I. S. BERITASHVILI. Translated from the Russian edition (Tbilisi, 1968) by John S. Barlow. Plenum Press, New York, 1971. xiv, 144 pp., illus. $12.50.

This stimulating monograph by Beritashvili (Beritoff) offers certain unique approaches to the study of the brain mechanisms of memory that Western researchers might well find of considerable value. It is an interdisciplinary account, as Beritoff emphasizes the behavioral and anatomical basis of memory and also touches on its physiology and chemistry.

Beritoff distinguishes three forms of memory: image memory, emotional memory, and conditioned-reflex memory. These are reasonable conceptual distinctions which can be operationally defined by the different training situations in which each memory form is demonstrated. There is a tendency, particularly in recent work on the substrate of memory, to use the conditioned-reflex form of training but not to consider the possible contributions of emotional and image memory. The former, indeed, is usually viewed as a confounding variable. In such experiments, the so-called stress control subject is probably an animal that has been trained predominantly to have an emotional memory. The concept of image memory, it should be noted, is rarely used in the interpretation of experiments dealing with the neural substrates of memory.

Whether or not one agrees with this analysis, Beritoff's conceptual framework provides the reader with a perspective on problems related to the analysis of memory. It should be noted also that such conceptual skeletons in our own closet as "images" and "emotion" have been in recent years the subject of study by experimental psychologists in this country. Perhaps Beritoff's "subjective" terminology, then, will not even grate on the psyche of the modern behaviorist.

The monograph provides another new perspective which I found particularly interesting, all the more so perhaps because it arises from such a traditional approach. I refer to the section on the phylogeny of memory, in which Beritoff describes the degree to which each form of memory is present in the vertebrate series. This research suggests some fruitful naturalistic approaches to memory. For example, Beritoff notes that, in what in this country is called a one-trial passive avoidance task, fish cannot remember an aversive shock for more than 10 to 12 seconds. Might it be possible to construct a phylogenetic, or at least comparative consolidation, time dependency? What would be the neural substrates of these behavioral facts? Beritoff also provides a discussion of the ontogenetic and clinical approaches to the study of memory.

The reader will see no hard data, to which many of us are accustomed. Behavioral results are described qualitatively and no graphs or statistics are presented. This may leave certain scientists wary, but I think their inclusion would have changed the character of this book, detracting from the essential conceptual points.

We may be grateful to the translator, John Barlow, for a superb text, readable, clear, and concise. The book represents a distillation of Beritoff's 50 years of research at Tbilisi University. We are indeed fortunate to have this essential monograph now readily available, perhaps to relieve, in some measure, our provincial and sometimes narrow outlook on the study of memory.

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Books Received

Advances in Organic Chemistry. Methods and Results. Vol. 8. Edward C. Taylor, Ed. Wiley-Interscience, New York, 1972. x, 460 pp., illus. $18.50.

Africa. A Study in Tropical Development. L. Dudley Stamp and W. T. W. Morgan. Wiley, New York, ed. 3, 1972. xiv, 520 pp., illus. $14.95.

Aide-Mémoire de Détermination Bactérienne. R. G. Capet. Vigot, Paris, 1970. 136 pp. Paper, 38 F.

Analytical Methods for Pesticides and Plant Growth Regulators. Vol. 6, Gas Chromatographic Analysis. Gunter Zweig and Joseph Sherma. Academic Press, New York, 1972. xxviii, 766 pp., illus. $35.

The Anesthesiologist and the Surgeon. Partners in the Operating Room. John P. Bunker. Little Brown, Boston, 1972. xxii, 158 pp. $8.95.

ANOVA 45. A Flexible Computer Program for the Analysis of Variance. Instructions for Use. Roger J. Weldon and Alan B. Humphrey. University of Arizona Press, Tucson, 1972. x, 70 pp., illus. Spiral bound, $6.95.