cytologists who have studied most North and Central American maize and much of the maize of South America, as well as most of the races of teosinte, the closest relative of maize. Basically, maize and teosinte have the same chromosome number and the same genetic and cytological maps. Few chromosomal rearrangements occur, and those that do occur are usually rare. There is, however, considerable cytological polymorphism for chromosome knobs, distinctive heterochromatic regions that differ in size and chromosomal location. A specific knob size at a specific chromosomal location follows normal Mendelian segregation, and mutation-type events changing knob size and transposition-type events resulting in a new knob-forming position (or a loss thereof) are sufficiently rare that neither has been observed by several generations of maize cytologists. By careful cytological analyses, the authors have distinguished among small, medium, and large knobs (or no knob) at each possible knob-forming site on each chromosome at the pachytene stage of meiosis. By also studying the early diplotene stage of meiosis, they were able to determine the presence and size of each knob on each member of every pair of chromosomes. In addition, they have studied the presence both of B-type chromosomes and of abnormal chromosome 10, two additional cytological polymorphisms found in maize and teosinte.

The authors have convincingly demonstrated a number of associations (i) between specific chromosome knobs and specific routes of maize transfer; (ii) between specific maize knob configurations and specific geographic regions; and (iii) between maize knob configurations and knob configurations of the annual Mexican teosintes.

Of special interest to anthropologists and archeologists are (i) transfer of maize from southern to northern Mexico and the United States Southwest, along the Pacific coast; (ii) a second route for introduction of maize from Mexico into the United States Southwest that apparently ran from central Mexico northward to the Rio Grande; and (iii) two important intercontinental interchanges that are now well documented: Guatemalan highland and Andean South American maize and southern Mexican and northwestern Venezuelan maize. It is apparent that most of the indigenous maize of Andean South America shared a single knob complex, presumably from a single early introduction, descendants of which account for most of the older Andean landraces.

More than half of the book consists of tables and maps that present the voluminous data, collection by collection. With the exception of the northeastern United States, some of eastern Central America, major portions of northwestern South America, and southern Argentina, virtually all maize-growing regions of the New World were sampled. The English text contains very few misprints and is photographically reproduced from typescript on good-quality paper. The book reflects creditably not only upon the authors but also upon its publisher, the Colegio de Postgraduados, Chapingo.

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Cladistics in Action

Advances in Cladistics. Papers from a meeting, Oct. 1980. V. A. FUNK and D. R. BROOKS, Eds. New York Botanical Garden, Bronx, N.Y., 1981. xii, 250 pp., illus. Paper, $29.50.

Only the most ardent of noncomparative biologists can be unaware of the ferment that has made systematics one of the most vigorous and controversial of disciplines. I need not repeat the history here, but there has been widespread debate over three world views—one that emphasizes general similarity of organisms as a basis for grouping and classification (phenetics), one that emphasizes genealogy (cladistics, phylogenetics), and one that attempts to combine both of these aspects of diversity in a classification (evolutionary, or syncretistic, systematics). Two years ago, adherents of the cladistic school decided that there might be some profit in disengaging from the "paradigm wars" and having meetings at which cladists could talk among themselves to explore the consequences of their theories, without the disagreements over words, definitions, world views, and so on, that mark gatherings including members of different schools. This well-produced and attractive book is a document of the first annual meeting of the Willi Hennig Society, a group named after the German entomologist who was the formalizer of phylogenetic methodology. The papers are arranged in four groups: Cladistics and Molecular Biology, Theoretical Cladistics, Botanical Cladistics, and Biogeography and Cladistics.

A more or less sub-rosa antagonism has existed between cladists and many workers who use molecular data in systematics. The lead paper in the molecular biology section brings the debate into the open and clarifies why this antagonism exists. James S. Farris, for years a leading theoretician in numerical methods of phylogenetic analysis (and incidentally the founder of the Hennig Society) presents a fundamental challenge to the use of molecular distance data in phylogenetic analysis. Farris bases his argument on two theses: (i) that it is not clear what data such as immunological distances actually represent from a physical and biological viewpoint, and (ii) that available methods of analysis of molecular distances (for example, Nei's distance) result in phylogenies with nonsensical properties (like negative evolution). Since Farris himself devised one of the most used techniques for analyzing distance data, this paper should be carefully considered by the growing numbers of workers using those data and methods of analysis. Serious implications for molecular clock hypotheses (often supported by clustering methods that assume homogeneous evolutionary rates) are also discussed by Farris.

Following Farris's critique of molecular distance data is a paper by D. L. Swofford that compares several popular methods of analyzing such data, motivated by "the realization that biochemical systematists will undoubtedly continue to rely on distance measures." Perhaps the more idealistic among us would hope that scientists using molecular data will respond to any valid criticisms and search for scientifically defensible methods. Nevertheless, Swofford finds that, as judged by a variety of evaluation criteria, the most effective procedure is that developed by Farris (distance Wagner); Swofford includes an improvement in the algorithm. Another approach to the problem of how to manage biochemical data is taken by M. F. Mickevich and C. Mitter in their paper on methods of analysis for electrophoretic character data. The authors evaluate three methods, preferring Mickevich's transformation series analysis. This procedure has promise for general use with polymorphic characters, and it will be interesting to see how it is developed in the future.

Since many of the papers in this book

address theoretical cladistics, it is a surprise that one paper alone is in a section on theory. D. R. Brooks evaluates classifications from an information-theoretical view. Whether one will agree with his conclusions may ultimately rest on agreement with his basic premise, that classifications are meant to convey specific information about characteristics of organisms.

The section on botanical cladistics is significant in the first place by its very presence in the volume. Cladistics has been almost entirely the domain of zoologists, and the increasing interest in it on the part of botanists has been beneficial to all concerned. These papers fall into two categories: how certain special concerns of botanists (for example, hybridization) may affect cladistic theory, and cladistic analyses of actual plant groups. V. Funk concentrates on hybridization, parallelism, and the general lack of even rudimentary phylogenies for use in character analysis. K. Bremer and H.-E. Wanntorp consider the implications of cladistic analysis on classification, from the "phylum" to the "subfamily" level. Not surprisingly, the implications are profound, since many higher plant taxa are not monophyletic groups. The contributions of Sanders (on mints), Bolick (on a genus of composite shrubs), and Churchill (on a family of mosses) all illustrate actual analyses. Although they occasionally exhibit some confusion regarding some cladistic principles, the authors clearly show that, indeed, plants are tractable to cladistic analysis.

One of the most intriguing aspects of cladistics to emerge in recent years is its impact on biogeography. Working on the assumption that much or most of the distributional history of organisms is intimately tied to the history of their environments, cladistic biogeographers look for congruent patterns of plant and animal distributions and attempt to find general environmental causes for these patterns. One finds some surprises in this section of the book. For example, one of the prime subjects for students of southern continental distribution patterns since the time of Joseph Hooker is *Nothofagus*, the southern beeches. Yet, using vicariance methodology, C. J. Humphries concludes that *Nothofagus* had already undergone most of its diversification before the Gondwanian breakup and is not informative about the relationships of the southern continents (his conclusions are partly dependent on an unfortunately meager character data base). Further, Humphries examines the history of how biogeographers, unhindered by precise hypotheses of relationships within the group, used *Nothofagus* to show that prevailing geological theories were correct.

D. R. Brooks, T. B. Thorson, and M. A. Mayes use biogeography to suggest hypotheses of coevolution between South American freshwater stingrays and their helminth parasites. From the testing of a series of precisely constructed hypotheses, the authors conclude that the stingrays and their parasites represent radiations of originally Pacific species that were trapped by the Andean orogeny. Further, on the basis of parasitological relationships, Brooks *et al.* propose a hypothesis of relationships of the rays themselves. Mickevich briefly outlines a method by which biogeographic hypotheses can be evaluated, given certain kinds of data, based on her transformation series analysis. I had some difficulties in following some of the arguments presented in this paper because of some typographical errors and figures that were not as useful as they could have been. N. Platnick discusses conditions in which widespread taxa can be of use in biogeographical studies.

Advances in Cladistics should have been more carefully edited. In many places one gets the impression that the illustrations are based on slides from oral presentations inadvertently left in the papers through subsequent revisions. Some figures make little or no contribution to the explications, and it is a pervasive weakness that captions are virtually uninformative. Some papers are marred by critical typographical errors that raise sometimes insurmountable barriers to the reader.

A noteworthy aspect of this book is the participation of so diverse a group of biologists. Specialists in groups as different as mints and helminths were attracted to an organizing principle that allows communication and critical appraisal of hypotheses in comparative biology. Phylogenetic analysis, the foundation of this principle, promises to bring new vitality to comparative and evolutionary biology in coming years. This is not a book for the novice—it is, after all, a symposium volume written by specialists for each other. Nevertheless, given even a passing knowledge of systematic theory, the persistent reader can benefit.

A volume of contributions from the second annual meeting of the Hennig Society is now in preparation. Many issues discussed in the first volume will be addressed in the second, and comparisons will show the progress in the field in the intervening year. The quality, scope, and imagination expressed in this series may be the barometer of how this vigorous and growing brand of comparative biology is faring.

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Adaptive Syndromes

The Mammalian Radiations. An Analysis of Trends in Evolution, Adaptation, and Behavior. JOHN F. EISENBERG. University of Chicago Press, Chicago, 1982. xx, 610 pp., illus. $45.

The main theme of this book is the several adaptive radiations that have occurred among mammals at various times and places on this planet. The theme is not a new one, and every elementary textbook of vertebrate biology or evolution has examples drawn from the evolutionary convergences demonstrated by the mammalian radiations. However, Eisenberg's contribution is noteworthy because he treats these radiations as natural experiments—tests of evolutionary hypotheses. That such a detailed comparative analysis is now possible is due to recent rapid advances in our understanding of the phylogenetic relationships of mammals. This in turn is due to modern techniques that utilize not only the classical functional-morphological comparisons but also biochemical, immunological, and chromosomal data to establish and test hypotheses of relationship. Moreover, these new data are capable of analysis within the new taxonomic paradigm afforded by cladistic analysis. Add to these developments a radically new understanding of the evolution of the earth's surface during the "Age of Mammals" and one has the necessary material for the sort of evolutionary, ecological, and behavioral synthesis that Eisenberg has attempted.

This volume, although formally divided into four parts, really contains three rather distinct books. The first of these is a history of the evolution of mammals,