

BOOK REVIEWS

Biotic Reshufflings

The Paleobiogeography of China. YIN HONGFU, Ed. Oxford University Press, New York, 1994. xiv, 370 pp., illus. \$120 or £80. Oxford Biogeography Series, 8. Translated from the Chinese edition (1988).

Grappling with the tectonic history of California seemed a formidable task during my graduate school years, given its mélange of suspect terranes and abrupt transitions between geologic units. The incorporation of fossils to reconstruct paleobiogeographic history added several levels of complexity, for not only were plants and animals shuffled around by the shifting tectonic bits and pieces that now make up California, they also respond to differing climatic, environmental, and ecological requirements on a single tectonic plate, producing often intricate distributional patterns. Although California has a level of tectonic and biogeographic complexity similar to that of China, it has but 4 percent of the area. Imagine, then, the difficulties facing Yin Hongfu and his colleagues at the China University of Geosciences in Wuhan and Beijing as they undertook the first synthesis of Chinese paleobiogeography in a tectonic framework. Paleobiogeographic treatments are also prone to conflicting goals, whatever the complexity of the region studied. Is their purpose to reconstruct plate history? to aid in reconstructing paleoenvironments, paleoclimate, and geologic history? Or is the evolutionary history of lineages or communities of primary interest? and if the latter, is biotic dispersal or physical disruption of the region (that is, vicariance) of greater importance?

China comprises at least four major tectonic units, each of which includes a host of smaller tectonic units. Buried in this complicated package is the history of the ancient seaway of Tethys, which lay between the supercontinents of Gondwana and Laurasia during the late Paleozoic and Mesozoic, the earlier history of the Paleozoic continents, and the later formation of Asia. This volume, through a system-by-system description of the major biogeographic realms, regions, and provinces in China, provides a concise documentation of the changing patterns of floral and faunal distributions and their paleoenvironmental implications. Discussion of the tectonic processes that underlie the patterns and of

their paleoclimatic implications is largely limited to the final two chapters, and evolutionary considerations are of minor importance in the work. Proper documentation of distributional patterns is the foundation for other studies, however, and 12 of the 15 chapters are primarily concerned with characterizing biogeographic units through cluster analyses of a database of some 217,000 records on the distribution of 12,468 Phanerozoic fossil species. (Some systems are far better characterized than others, with the Cambrian, Carboniferous, Triassic, and Tertiary data sets far larger than those for other systems.) That results of the cluster analyses are occasionally at odds with the recognized designation of provinces, discrepancies that are not always explained, and that there are relatively few attempts to use the paleontologic data to challenge previous plate reconstructions simply illustrate the amount of work that remains to be done on the biotic history of this pivotal region.

In their chapter on the Permian, Xu Guirong and Yang Weiping provide some perspective on the complexity that emerges from the analyses. Globally, the Permian is divided into three biogeographic realms, the Boreal realm of Siberia, Mongolia, Kazakhstan, northern Europe, and North America, the Paleo-Tethyan realm along the equator, and the Gondwanan realm encompassing much of modern South America, Africa, India, Australia, Antarctica, and a few bits of Asia. Elements of each of these realms are present in China, and the realms are divided into seven distinct biotic provinces, probably about one-third of the global total. Within a single biotic province, distinct faunas (or floras, not to be too zoocentric) occupy different sedimentary environments and can usually be identified as discrete biomes. Xu and Yang recognize a total of 16 such biomes within the seven Permian provinces. This careful attention to distinguishing geographically based provinces from environmentally based biomes is an important feature of good paleobiogeographic studies and a hallmark of this pioneering synthesis of 600 million years of biotic history in China.

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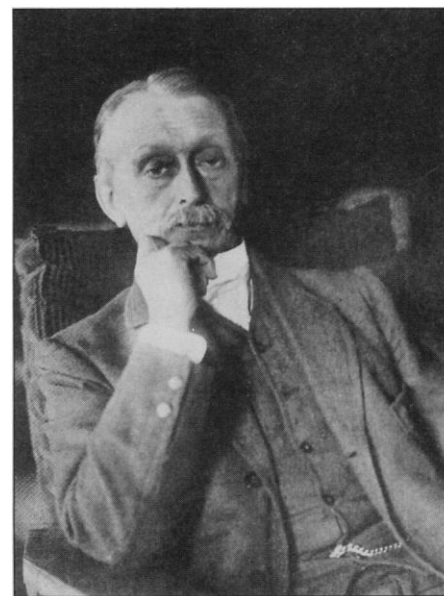
A Displaced Cosmology

The Milky Way Galaxy and Statistical Cosmology, 1890–1924. ERICH ROBERT PAUL. Cambridge University Press, New York, 1993. xiv, 262 pp., illus. \$44.95 or £30.

What today is called by some galactic astronomy, or the study of the structure of our galaxy, has had a history, Robert Paul persuasively argues in this book, that was both revolutionary and continuously in flux. The period he has chosen to study was, conceptually and methodologically, dominated by a revolution.

At the turn of the century and for almost two decades thereafter, the visible universe was most frequently described as a static Sun-centered ellipsoidal system of stars some 10,000 to 18,000 parsecs in diameter and from 1800 to 2400 parsecs in thickness. By 1922, virtually through the efforts of one man, working with the largest telescopes in the world and with techniques far removed from those of his forebears, the stellar universe had become a very different place, some 90,000 parsecs in diameter, with the Sun displaced well toward the periphery.

The seasoned reader of astronomical history might well remark, "I've heard all this before." And indeed the historical reconnaissance of what has been dubbed (not by Paul) "the Galactocentric Revolution" has been both extensive and thorough. What Paul has done is turn the tables to look primarily at what was displaced. In doing so, he has both filled a major gap in the liter-



Jacobus Cornelius Kapteyn, around 1914. [Yerkes Observatory]



Astronomers at Mount Wilson Observatory, 1910. Facing left, J. C. Kapteyn; in light suit, Karl Schwarzschild; at extreme right, V. M. Slipher. [Yerkes Observatory]

ature and has opened up a new pathway to understanding how science changes.

Paul carefully defines "statistical cosmology" to describe the activities of those who constructed either empirical or mathematical models of the structure, form, and content of the visible stellar system. Both types of modeling efforts were based on statistical studies of the observed spatial and luminosity distributions of the stars. The empirical school, led by Jacobus Kapteyn, relied on numerical techniques to determine the number density of stars in space and how they distributed themselves in luminosity, whereas the mathematical school, led by Hugo von Seeliger, built theoretical models using the frequency distribution laws of Maxwell and Boltzmann and tested them against the observations.

Paul distinguishes statistical cosmologists from those who merely catalogued data about the stars and focuses primarily on the Dutchman Kapteyn and how his numerical techniques, especially his method of determining the mean parallaxes of groups of stars, led to his discovery of star streaming at the turn of the century and how he eventually developed the idea of a finite Sun-centered system that has been called the "Kapteyn Universe." Paul contrasts Kapteyn's empirical style with that of the Munich mathematical theorist Seeliger, who during the same period developed elaborate models of the stellar universe based upon complex luminosity and density functions, but who found a universe similar to the Kapteyn Universe. Paul then identifies how these two lines of inquiry were elaborated but ultimately failed to account for various observed dynamical features of the visible stellar universe. Finally, Paul recounts how the young Mount Wilson astronomer Harlow Shapley,

cast in an entirely different mold from Kapteyn or Seeliger, showed that their concept of the stellar universe had to be profoundly modified, and in so doing helped to usher in the decline of statistical cosmology.

Along the way, Paul demonstrates in helpful detail how Kapteyn marshaled a large fraction of the world's observatories to engage in a coordinated "plan of selected areas" to gather the data necessary for building and then distinguishing among possible statistical models of the stellar universe. His discussion here will be highly valuable to those

who wish to comprehend the ultimate complexion of astronomy in 20th-century America and how it differed from, yet depended upon, astronomy on the Continent.

Although Paul attempts to explore the degree to which statistical techniques were accepted by astronomers generally as the path to cosmological modeling, he succeeds in showing only how the modelers themselves regarded statistical methods, since he confines his attention to those people who were engaged in constructing the models and explicitly neglects others, primarily in the United States, who limited themselves to collecting and cataloguing the masses of data that were required. By inference and by omission he demonstrates indeed that Americans were not prominent in statistical astronomy. This is an important point and should be developed. Consideration of how Americans reacted to the use of statistical techniques during this period would help us appreciate why some of them sought out alternative methodologies.

In general, however, Paul succeeds admirably in his basic goal of showing how this episode changed the practice of much of stellar astronomy, as well as the concept of the size and extent of our galaxy. The book contains a few unfortunate blunders (though none undermine its main arguments), and the writing is at times turgid and redundant. But the book was written more for the specialist historian and journeyman astronomer than for the casual reader. It is a very welcome contribution to the literature made all the more poignant since Paul, a valued colleague in the historical profession, died soon after its publication.

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Oil Damage

Marine Mammals and the Exxon Valdez. THOMAS R. LOUGHLIN, Ed. Academic Press, San Diego, CA, 1994. xx, 395 pp., illus. \$49.95 or £38.

Probably the single most publicized human-caused environmental disaster in United States history is the March 1989 Exxon Valdez oil spill. Both the efforts to clean up the spill and the efforts to assess its impact were unprecedented, and the final cost to the Exxon Corporation will exceed \$10 billion.

Beginning within days after the spill and continuing through 1993, a series of studies were designed and executed to determine the extent and magnitude of the effects of the spill on marine mammals, particularly sea otters. Many of these studies have been compiled into the present 21-chapter, semi-technical book. Much of the information discussed in the book has been presented elsewhere, but the book is a convenient



"A formerly oiled harbor seal pup being fed at a rehabilitation center in Homer, Alaska, May 1989." [From S. T. Zimmerman *et al.*'s chapter in *Marine Mammals and the Exxon Valdez*]

compendium with excellent overviews and summary conclusions.

About a third of the book is devoted to studies that quantify population-level impacts, with much of the remainder focusing on behavioral, pathologic, or toxicologic studies designed to understand how petroleum hydrocarbons negatively affect free-ranging marine mammals. In an overview, Ballachey *et al.* note that the "studies [were] driven largely by impending litigation against the Exxon corporation"; thus the researchers concentrated "on estimating acute mortality and documenting continuing damages." Overall, as is pointed out in the final chapter, "The reader . . . will sense the frustration of researchers attempting to sat-