interpretation of cognitive illusions. Although he struggles to see the past in its own terms, he cannot resist reproaching early opponents of Darwin and of Copernicus for their cognitively explicable but rationally indefensible failure to embrace the new theories—Lyell's resistance to natural selection is "cognitively not much different from (not much more logical than)" resistance to wearing hockey helmets (p. 192), just as subjects in psychological experiments are "stubborn" and "downright stupid" in not applying modus tollens or Bayes's theorem.

In both cognitive psychology and the history of science, this normative *idée fixe* prevents Margolis from posing more interesting descriptive questions about how we cope with ambiguity and how the standards for explanation, not just this or that explanation, change in science. Although an abiding concern with rationality motivated Margolis's study, there seems to be nothing in his *P*-cognition view *per se* that would commit him to such a narrow normative stance. Margolis believes his account will prove itself by its empirical applications in fields like cognitive psychology and history of science. We believe, on the contrary, that the results of these initial empirical applications are largely disappointing, but that the general Darwinian outlook of *P*-cognition so ably developed by Margolis will prove of enduring value.

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Microbial Ecology

Microbial Mats. Physiological Ecology of Benthic Microbial Communities. YEHUDA COHEN and EUGENE ROSENBERG, Eds. American Society for Microbiology, Washington, DC, 1989. xviii, 494 pp., illus. $79; to ASM members, $59. From a seminar, Eilat, Israel, Sept. 1987.

Layered microbial communities, and the complex and intense biogeochemical interactions that occur within them, constitute a type of community structure that is fast becoming an important paradigm for the understanding of microbial ecology. Such communities, within which are included microbial mats, often remain poorly appreciated or understood even by those in the field, however. For this reason alone, *Microbial Mats: Physiological Ecology of Benthic Microbial Communities* is highly recommended. This interesting and informative book presents the results of a 1987 symposium: its rather tardy publication is a pity, but much of the material contained in it is excellent and not at all outdated.

As expected, there is variation in style and quality among the papers, but the volume includes well-written contributions from many of the major laboratories involved in microbial mat research. In coverage it ranges from the basic physiology of mat organisms, to isotopic and molecular genetic methods for the study of mat populations, to chemical and paleomicrobiological methods of looking at present and past mat communities.

The book includes excellent descriptions of a variety of different mat environments (hot springs, hydrothermal vents, and hypersaline ponds and lakes). There are discussions of the structure, function, and chemistry of these environments, including redox chemistry, oxygen gradients, carbon cycling, and light penetration and quality, along with presentations of techniques used to study these features. These include discussions of microelectrodes and new chemical approaches and an intriguing chapter on the use of fiber optic light guides for the measurement of spectral quality in mat communities, by B. B. Jorgensen. There is an entire section devoted to the physiology and biochemistry of some of the major mat-building organisms and techniques used to study them and another to their evolution and phylogeny, including an informative discussion of methods of molecular phylogeny by Turner *et al.* The final section deals with chemical and paleobiological studies of modern and ancient mats, concluding with an excellent chapter by Andrew Knoll discussing the paleomicrobiology of ancient mat communities. Knoll's concluding statement, "Limits to the interpretation of Proterozoic sedimentary successions . . . will not be reached until we know more about the present," provides a strong rationale for the study of the modern mat communities discussed elsewhere in the book. In fact, reading this chapter first might well provide the reader with a valuable perspective for many of the other studies reported here.

In this regard the lack in the book of an overview of the subject is troublesome. Apart from a preface by Cohen little or no effort is made to introduce either non-experts or students, who might potentially use this book, to the broader picture of the types of mats, the factors that define them, variations found in extant mats, and the short-term and long-term significance of mat communities. For example, comparison of mat communities with other layered microbial communities, such as those found in fjords, marine and freshwater sediments, and stratified lakes would have been welcome. The book will, even so, be a valuable addition to the libraries of microbial ecologists and others interested in organismal interactions, the evolution of microbial communities, and biogeochemistry. It should be a valuable teaching aid at the graduate level and will provide thought-provoking and informative material for years to come.

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Topics in Astrophysics

Astrophysics of Gaseous Nebulae and Active Galactic Nuclei. DONALD E. OSTERBROCK. University Science Books, Mill Valley, CA, 1988. xviii, 408 pp., illus. $36.

In 1864 William Huggins aimed his spectroscope at nebulae and discovered that some showed emission lines (hence "gaseous nebulae"), whereas others showed star-like spectra. In 1974, when appeared Osterbrock's now classic textbook on the optical spectroscopy of photoionized gas, *Astrophysics of Gaseous Nebulae,* its subject still dominated the fields implied by the title. Like many of my contemporaries, I learned the physics of photoionized gas from the 1974 book. My opinions on this revised version thus reflect gratitude to a reference tattered by a decade of use, compromised by an undergraduate's desire for revenge on an opaque textbook.

As an introduction to the physics of photoionization, line transfer, and optical diagnosis of diffuse atomic gas, it remains without peers. The first nine chapters are largely unchanged. The discussion of charge-exchange reactions has been updated, and it is now publicly confessed that HII regions may not be homogeneous, spherical, or similar to the sun in abundances of elements. References to the recent literature are given, and the tables incorporate modern data. An infuriating number of misprints infested the first edition; many but by no means all of these have been corrected. Three new chapters have been added. One describes the optical line emission from nova and supernova shells, and two briefly review diagnostics and classification of the emission-line regions of active galactic nuclei. The reader is introduced to Seyferts 1.8 and 1.9 but is spared further significant figures.

The subject matter is fundamental to all of astrophysics, and being without serious competition this book will appear on the desks of astronomers at all stages of their

education. As a textbook, however, it now leaves much to be desired. It presumes acquaintance with atomic spectroscopy at a level posessed by lamentably few new graduate students. The detailed tabulations are less useful than they once were, since photoionization codes with better atomic data are now widely diffused through the astronomical community (though knowledge of their limitations is unfortunately not so widespread). We can hope that the next edition will include a floppy disk with such a code and a discussion of numerical techniques and sources of data.

Most seriously, the new title is misleading in its generality. Astronomy has grown enormously in the two decades since the structure of the book was laid down. Optical spectroscopy is now only a small, though still important, branch of a much broader endeavor, with equal opportunities for employment at all wavelengths. The reader will find here no mention of x-ray spectroscopy, molecular gas, or even the infrared lines so important to the study of embedded HII regions and the center of our Galaxy. There is no discussion of cooling curves, radiative shocks, multiphase media, stability of photoionization equilibria, or any of the physics of active galactic nuclei other than the state of their peripheral emission line regions. A course on $(AGN)^2$ in which this was the only source used would be quite imbalanced. The field urgently needs a companion volume addressing the omitted topics. Students should still read Osterbrock's book; they will just have to read it faster than did their predecessors.

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Marsupials Right Side Up

Possums and Opossums. Studies in Evolution. MICHAEL ARCHER, Ed. Published in Association with the Royal Zoological Society of New South Wales by Surrey Beatty, Chipping Norton, NSW, 1987. In two volumes. lxxxiv, 788 pp., illus., + plates. $112.

Mammals are divided into about 30 orders, among which the marsupials are usually assigned only one. In our biased way we tend to think of marsupials as inferior pouched mimics of more familiar "placental" mammals; thus we refer to Tasmanian "wolves," "rat" kangaroos, koala "bears," and marsupial "cats" and "mice." Those of us who don't hang upside down from the bottom of the earth often downgrade living marsupials to the status of primitive "living fossils" from lost worlds. But now that era is ending.

Living marsupials are exclusively American and Australasian, but they were distributed widely in the past. Only the reinvading opossums represent them now in North America, but they were present here from well back in the Cretaceous until the Miocene, and again at the end of the Cenozoic. Marsupials have been in Australasia since the Miocene or earlier. They were in Antarctica in at least the Eocene, South America in the whole Cenozoic, Europe in the early and mid-Cenozoic, and westernmost Asia and northernmost Africa in the mid-Cenozoic. They are not known from the eastern Asian mainland, where their placental sister-group has long held sway.

Some researchers think of Australasia as the marsupial center of origin, probably because familiar koalas, kangaroos, and other living Australasian marsupials are viewed as odd products of long evolution on a moving continental fragment of ancient Gondwanaland. But South America, too, was long an isolated Gondwana fragment and the site of much extinct and some living but less familiar marsupial diversity. Some claim South America to be the original marsupial turf, but marsupials are absent from the Late Cretaceous Los Alamitos mammalian assemblage from Argentina. Negative evidence can be fickle, but on that basis I doubt if marsupials were cryptic South American residents in much if any of the Late Cretaceous. Arrival there in the earliest Paleocene from a source outside of South America makes more sense.

For *Possums and Opossums*, Michael Archer assembled a who's who of researchers to write two idea-filled volumes. The work is an intellectual feat that will convince anyone reading it that marsupials are amazingly diverse. It is a massive update of our knowledge of many groups of marsupials, not just possums (phalangeroids) and opossums (didelphids) as implied. The pace of reported discovery of extinct groups has accelerated greatly, sometimes in spectacular spurts as at the now famous Riversleigh Station sites in northwestern Queensland. Obviously, marsupials deserve to be assigned more than one mammalian order (eight are advocated in *Possums and Opossums*) and constitute fertile ground for new comparative analysis. Archer's volumes are a celebration of that. Their major thrust is toward unscrambling the phylogenetic history behind the diversity. Most of the authors have employed cladistic methods to hypothesize relationships, teasing apart raw similarity into what they take to be shared-primitive, shared-derived, and convergently similar characters.

Volume 1 deals with non-Australasian marsupials, begins coverage of Australasian ones, and contains several weighty but partially conflicting general reviews. The conflicts reveal much about how science works, warts and all. Three superb papers on sperm structure add to the fascination. Volume 2 is primarily a collection of descriptions of newfound Australasian diversity, primarily based on fossils. Seldom has so much genuinely new information appeared in a single work.

To express all this marsupial diversity in words, more than 50 new taxa and about 20 changes in rank are proposed. The proposals are of two main kinds: low-ranking taxa, up to family rank, based on new finds, and somewhat higher-ranking ones based on either cladistic or phenetic interpretation.

In a synthetic chapter, Aplin and Archer wrestle with the problem of how to express nested monophyletic levels without overburdening the Linnaean system with intermediate categories. Ironically, they themselves create two new ones. They adopt "sequencing" in about two-thirds of their classification. "Sequencing" in this context is an attempt to depict nested monophyly within a given taxon by the use of a list of subtaxa such that the first subtaxon is the sister of those listed below it, the second is the sister of those below, and so on to the end of the list. The system is equivalent to a pectinate cladogram showing the same information but can be compressed into less space and does not create a spate of new names or raise what are often single species to dizzyingly high ranks. However, it has the disadvantage that one must be able to see or remember the whole list in sequence in order to understand the hierarchical pattern. One cannot refer precisely to a particular monophyletic group without circumlocution. Aplin and Archer evidently couldn't stomach "sequencing" throughout their whole classification. Most of the other authors get along fine without needing to create new levels.

I kept track of the many introduced phylogenetic changes by constructing a cladogram, using such taxa as seemed required. I think the authors made a convincing (but not explicit) case for a primary bifurcation of marsupials into Szalay's Ameridelphia and Simpson's Eometatheria (Australasian marsupials). Ameridelphia is characterized by sperm pairing and Eometatheria by a reduction of lower incisor count (convergent with some ameridelphians). Other characters need to be supplied before these taxa (particularly Eometatheria) can be considered well supported. South American microbiotheres may or may not be the unique sister-group of the Australasian eometatheres; it remains to be shown that the eometatheres, micro-