the authors suggest that significant constraints may be imposed by pedogenesis—and though they acknowledge the hypothesis has little or no supporting evidence and is not currently testable they suggest (p. 84) that it may have heuristic value in interpreting life histories in an evolutionary context. Arguments of this form signal critics of the evolutionary approach that the time is ripe to attack. In other cases, the theory is presented in such a way that only those already versed in it have a hope of following the argument. The authors present interesting and important data on sex ratio and sex-specific dispersal patterns in *Antechinus*, but the review of sex allocation theory that was meant to set the stage for those data is less than clear and omits some major references.

Evolutionary Ecology of Marsupials is the most current review of marsupial ecology, bringing together both well- and little-known work, presenting detailed data with broad vision. Even if it fails occasionally to complete arguments deeply or convincingly, no other volume does so much. Both professionals and graduate students will find it a fascinating, welcome addition to the literature.

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Host-Parasite Coevolution

Ecology and Genetics of Host-Parasite Interactions. D. ROLLINSON and R. M. ANDERSON, Eds. Academic Press, Orlando, FL, 1985. xii, 266 pp., illus. $45. Linnean Society Symposium Series, no. 11. From a symposium, Keele, U.K., July 1984.

The coevolution of parasites and their hosts is sometimes viewed as a gene-for-gene arms race that matches increases in virulence by the parasite against increases in resistance by the host. However, a commensal relationship may evolve if selection favors parasites with reduced virulence and hosts with increased tolerance. The 14 papers in this symposium volume are concerned with various aspects of host-parasite associations, focusing on genetic and ecological factors that may affect coevolutionary patterns. Reviews cover diverse research programs encompassing experimental epidemiology, natural history, immunology, genetics, and theoretical ecology. Recent advances in the theoretical ecology of host-parasite associations are reviewed by May. Mathematical models developed in collaboration with Anderson reveal a variety of conditions under which a parasite may regulate the abundance of its host in steady state, in cyclic oscillations, or in chaotic fluctuations. May also combines population dynamics with population genetic models by involving both frequency-dependent and density-dependent effects. Anderson and Crombie have examined age-related changes in schistosome infections of snails and mice. Their study represents a powerful blend of experimentation and mathematical modeling.

The volume contains several field studies that attempt to address various aspects of coevolutionary models. Kennedy questions the existence of equilibrium population dynamics on the basis of his studies of helminth parasites of fish in a large lake. He claims that the parasites do not affect the abundance of their fish hosts, but he apparently equates such regulation with a steady-state equilibrium, one of several coevolutionary outcomes discussed by May. Hudson, Dobson, and Newborn find that theoretical models based on parasite prevalence are capable of predicting stable versus fluctuating populations of red grouse. Unfortunately, this and other field studies are limited in the temporal and spatial scales they sample, and thus their interpretation regarding coevolutionary models is unclear.

Experimental epidemiology of hosts and parasites provides a more tractable approach for testing coevolutionary models. Levin and Lenski review the benefits of bacteria and phage systems for modeling host-parasite associations. The existence of lytic and lysogenic phages permits the modeling of both mutualistic and antagonistic associations. I found this paper one of the most stimulating and informative contributions in the book. Scott reviews her well-conceived experimental studies of a monogenean trematode and its guppy host. Continuous immigration of uninfected fish is necessary to sustain the parasite population.

Also notable are several papers that focus on genetic variability of parasites and their hosts. Barrett questions the existence of gene-for-gene coevolution in nature, claiming that evidence for this phenomenon derives from agricultural systems that favor simple qualitative genetic responses by parasites to resistant varieties. Two papers review population genetic studies of parasites or parasite vectors. Although considerable genetic polymorphism has been demonstrated in several vector species, comparable studies of the parasites are limited by the difficulties in sampling and culture. Genetic analyses of the mammalian immune response to parasitic infection are the subject of three papers. Blackwell provides an excellent review of her genetic dissection of the mouse immune response to leishmaniasis. This detailed work reveals a complex developmental process controlling a multilocus immune response. It should be apparent that to assess the validity of gene-for-gene versus quantitative genetic models for host-parasite coevolution more work of this quality needs to be done with other microparasitic and macroparasitic diseases of plants and animals.

Overall, this book is stimulating and informative. Most important, I learned how very much we do not understand about the genetics and ecology of host-parasite coevolution. Several papers concerning mathematical models and immunogenetics are not for the fainthearted, but parasitologists can gain considerable insight into these exciting research directions. The book does not offer many new insights for population geneticists or evolutionary ecologists, but it should serve its stated purpose if it encourages these scientists to adopt host-parasite systems in experimental studies. I was surprised that none of the authors addressed the potential contribution that quantitative-genetic and developmental-genetic methodologies could make in this area of research. The covariance structure and developmental constraints of key traits involved in host-parasite associations must be known if realistic coevolutionary models are to be developed. Are parasite virulence and transmissibility positively or negatively related? What are the costs of increased host resistance to other life history traits such as age-specific fecundity and survival? It is to be hoped that biometrical and developmental approaches will provide a better bridge between ecological and genetic information.

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Active Galactic Nuclei

Astrophysics of Active Galaxies and Quasi-Stellar Objects. JOSEPH S. MILLER, Ed. University Science Books, Mill Valley, CA, 1985. viii, 519 pp., illus. $30. From a workshop, Santa Cruz, CA, July 1984.

This important volume covers the output of the Seventh Santa Cruz Workshop on Astrophysics, which was held to honor Donald Osterbrock on his 60th birthday. It is an excellent collection of papers that will prove to be essential reading for all serious students of active galactic nuclei in the second half of the 1980's. In an introduction to infrared studies Rieke notes that, as was appropriate given the occasion and the location of the workshop, the optical region was the subject most discussed, with the result

that emphasis was on the ionized gas around active nuclei and the ultraviolet continuum that excites it. A balanced approach is essential in this field; as Weedman recognizes, in a chapter on the evolution of active galactic nuclei and quasars, there is "distressing proof to the observer of how our perception of quasar evolution depends on the tools of the beholder." As an example, more newly discovered Seyfert galaxies are likely to appear in the Infrared Astronomy Satellite catalog than in Markarian's optical catalogs because of the frequent association between active galactic nuclei and dusty star formation regions that can hide much of the optical emission.

The workshop went on for two weeks; there was thus time to discuss the subject in great detail—so much detail in fact that no one present at the proceedings seemed willing or able to provide the traditional conference summary. I think that Miller's decision to ask 21 of the participants to collect all the information into 14 chapters was a good one, considerably more useful than providing a copy of each of the individual presentations. The informal atmosphere of the meeting itself, free of the necessity to constrain presentations to what would definitely be converted to print, was conducive to the generation and exchange of ideas.

With but a few exceptions, the chapters that appear in the book are much better than the original presentations by the same authors at the workshop. The authors clearly learned a lot from each other and the participants and had time to think after everyone left Santa Cruz; as a result they have succeeded in passing on a very useful summary of the field.

At the workshop itself I most enjoyed a presentation by Elvis of the Einstein data on x-ray spectra; the quality of this presentation carries over into a chapter by Elvis and Lawrence. They highlight the striking uniformity of the hard x-ray spectra of objects discovered by x-ray techniques, the complete lack of such uniformity in the x-ray spectra of objects discovered at other wavelengths, and the diversity of soft x-ray spectra. X-ray astronomers, like radio astronomers a decade earlier, took a little time to realize that all quasars do not have canonical power-law spectra of slope $F_\nu \alpha \nu^{-0.7}$. The variety of slopes points to a possible variety of mechanisms for generating x-ray spectra. A masterly discussion of the iron spectrum by Netzer at the workshop is not included in the book. Very clear presentations by Malkan and Fillipenko at the workshop concerning the blue bump and the correlation of line width with ionization parameter are also not included. These two important contributions provided a great deal of insight into the likely structure close to the central engine and the immediately surrounding emission-line region.

Of the papers in the book, I enjoyed Weedman's "worked examples" of quasar evolution models—particularly his graphical presentation of the degree to which the shape of the expected redshift distribution is sensitive to limiting magnitude. I have suggested elsewhere that the drop in broadband magnitude across Lyα may scale roughly as $Z - 2$; that is, 0.5 mag at redshift $Z = 2.5$, 1.5 mag at $Z = 3.5$. When Weedman's graphs (or similar ones that Carswell and I published some years ago) and a simple plausible spectral effect like this are combined, the expected numbers of objects per field near $Z = 3.5$ can easily be less than at $Z = 2.0$ by a factor of 50 yet indicate no falling off the intrinsic luminosity or actual space density beyond $Z = 3.5$. Detailed arguments about redshift cutoffs in the optical range are extremely sensitive to the effects of selection. Hazard and Dunlop have suggested other evolutionary effects, including a tendency toward weaker emission lines and more nearly stellar color at very high redshifts. Weedman has correctly highlighted the study of the luminosity function at high redshifts as a fruitful subject for study during the next few years.

A paper by Begelman on accretion disks in active galactic nuclei is a particularly useful one for the observer, who is continually aware that he or she is merely chipping away from the outside, not very clear about what is happening in the middle, while the theorist is happily trying to find some direct relation between black holes and accretion flows and the fog of currently observable events around them being provided by the "DEO (Donald E. Osterbrock?) ex machina." Begelman clearly describes different modes of accretion with characteristic spectral properties and radiative efficiencies.

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Some Other Books of Interest

The Quaternary History of Ireland. KEVIN J. EDWARDS and WILLIAM P. WARREN, Eds. Academic Press, Orlando, FL, 1985. xxii, 382 pp., illus. $65.

Though the visible landscape of Ireland provides many tantalizing glimpses of its origins, say Edwards and Warren, "we remain largely ignorant of events for perhaps 90% of the Irish Quaternary sequence." This book begins with an account by Edwards and Warren of the history of Quaternary studies in Ireland, which date to Louis Agassiz's 1840 demonstration of evidence of glaciation. The account concludes with "a selected discussion of current views." A chapter by Mitchell on the preglacial landscape is followed by one by Warren in which he proposes a stratigraphic interpretation of the Quaternary sediments of Ireland. Other chapters cover glacial geomorphology, about which little is known (McCabe), periglacial features, which are widespread in Ireland (Lewis), the evolution of the coastline (Synge), the formation of soils (Culleton and Gardiner), vegetation cycles (Watts), vegetational evidence of anthropogenic activity (Edwards), Quaternary vertebrates (Stuart and van Wijngaarden-Bakker), prehistoric settlement (Woodman), the placing of Quaternary events in a chronology (Edwards *et al.*), and economic applications of Quaternary studies (Warren *et al.*). The chapters were refereed, but no attempt was made "to harmonize opinions," for the editors hoped that by including differences of opinion they would "stimulate further research aimed at resolving the many outstanding problems" in the field.—L.H.

Meteorites. Their Record of Early Solar-System History. JOHN T. WASSON. Freeman, New York, 1985. x, 267 pp., illus. $29.95.

Meteorites, Wasson notes, are our chief source of information about the earliest period of solar system history. He intends this book as a textbook for "a general course covering meteoritic evidence regarding the formation and early evolution of the solar system." The book begins with a discussion of the orbits of meteorites, phenomena associated with the fall of meteorites, craters created by the impact of meteorites, and the recovery of meteorites. A chapter on the classification of meteorites is followed by one on the age and isotopic composition of meteorites and isotopic anomalies in some meteorites that offer clues about the nature of presolar matter. Evidence for and against the hypothesis that iron meteorites are fragments of the cores of small planets is considered in the next chapter. The remaining chapters deal with the igneous formation of silicate-rich meteorites, models of solar system formation, evidence that chondritic meteorites formed in the solar nebula, nebula fractionation processes recorded in chondrites, and the relationship of meteorites to the planets, asteroids, and comets. Each chapter contains an annotated list of suggested readings. Nine appendixes cover such subjects as meteorite classification, units and constants, rudiments of celestial mechanics, and how to recognize meteorites.—L.H.