are exposed to regular hunting seasons. Newton also provides optimistic evidence that certain raptor populations decimated by persistent chemical pollutants are recovering now that the use of these chemicals has been curtailed.

Captive breeding and reintroductions of endangered raptors, especially the peregrine falcon, have been much in the news lately. Newton points out that the techniques involved, though still largely unproven, offer perhaps the only hope for certain endangered species. Falconry, perhaps the oldest relationship humans have with raptors, is surprisingly not discussed directly. A scholarly discussion of the negligible impact that falconry has on raptor populations might have helped quell lingering opposition to the sport.

Raptors enjoy an impressive following these days. For example, the 1979 meeting of Raptor Research Foundation, an organization of raptor biologists, attracted more participants than the combined attendance at the meetings of the three major ornithological societies of North America. This book is obviously essential reading for all raptor biologists and avian population ecologists, but Newton's lucid style makes it of value also to the growing number of naturalists who enjoy these impressive birds and wish to learn more about them.

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Population Biology

Theory of Population Genetics and Evolutionary Ecology. An Introduction. JONATHAN ROUGHGARDEN. Macmillan, New York, and Collier Macmillan, London, 1979. xii, 634 pp., illus. $24.95.

Over the last ten years, there has been much discussion of the need to integrate population genetics and ecology into one field, population biology, but few attempts have been made to do this at the level of a full-length book. For this reason, Roughgarden's book, which provides a self-contained treatment of population genetics theory, theoretical ecology, and evolutionary ecology, should attract considerable attention. The author has made many significant contributions to the application of population genetics techniques to evolutionary ecology and is thus well qualified to carry out the task.

Chapters 1 through 6 are concerned with the elements of population genetics. The treatment is clearly designed for those not previously acquainted with the subject, and much of the classical algebra associated with the Hardy-Weinberg law, selection at a single locus with two alleles, and other such topics is worked out in detail. I find it surprising that genetic drift is treated by means of stochastic matrices and diffusion theory (chapter 5), with no mention of identity by descent and the inbreeding coefficient. (Identity by descent is not introduced until chapter 10.) This necessitates a rather dogmatic style, with bald statements of the mathematical results needed, rather than the fuller presentation that the inbreeding coefficient approach would permit. Similarly, neutral allele theory is treated (in chapter 6) in terms of Ewens's sampling theory, without any mention of the Kimura-Crow formula for equilibrium heterozygosity. There is no treatment of the probability of fixation of mutant genes and no discussion of molecular evolution. Frequency-dependent selection is scarcely mentioned. These omissions limit the utility of this part of the book for someone wishing to learn basic population genetics, although the topics covered are mostly lucidly presented.

Chapters 7 through 10 cover more advanced topics in population genetics, such as selection with multiple alleles, multiple loci, and quantitative inheritance. Here again there is plenty of useful material, although one might question the emphasis placed on certain aspects of the subject and the omission of others. For example, in chapter 8 the fine details of the two-locus model are presented in such profusion that the basic principles underlying the interaction of selection and linkage are obscured. The effects of selection on quantitative characters are treated by means of the "segregation variance" introduced by Bossert, and there is no mention of the work of Bulmer and Lande that renders that approach obsolete.

Chapters 11 through 14 cover some special topics in population genetics and evolutionary theory, notably the evolution of genetic systems, evolution in varying environments, and the evolution of altruism. The treatment of genetic systems in chapter 11 is rather disappointing, as the coverage is highly selective. For instance, the possible evolutionary advantages of sex and recombination are treated largely in terms of their consequences for population properties such as the rate of evolution, with little reference to selection at the level of changes in the frequency of genes affecting parameters like recombination rates. On p. 201, the problem of the evolution of gamete size dimorphism is mentioned without any reference to the theory of Parker, Baker, and Smith. Similarly, the theory of mutation rate optimization is discussed in group-selectionist terms, without reference to Leigh's work on selection on mutator genes. Selection on the selfing rate is discussed without mention of Fisher's discovery of the intrinsic selective advantage of a gene that increases the rate of selfing. Sex ratio theory is only perfunctorily mentioned.

Chapters 15 through 20 treat the ecology and evolution of single-species systems. The basic concepts of density-dependent population growth and models of selection with density dependence are presented clearly and straightforwardly in chapters 16 and 17. Chapter 18 deals with the dynamics of age-structured populations, mostly by means of continuous-time models. Indeed, on p. 328 the Leslie matrix approach is (inaccurately) described as not allowing an easy calculation of population growth and age distribution. Chapter 19 includes a treatment of selection in age-structured populations, using the Von Foerster differential equation approach to modeling continuous-time populations. This seems an unnecessarily complex method of attack. There is also a useful account of life-history evolution, although the attempt on pp. 369–370 to explain the inverse relation between reproductive value and mortality rates in children, in terms of a trade-off between reproduction and survival, overlooks the fact that human infants do not reproduce.

Chapters 21 through 24 are concerned with multispecies systems, both from the point of view of pure theoretical ecology and from the evolutionary viewpoint. Chapter 23 in particular contains an elaborate discussion of the consequences of selection for interactions between species, based largely on Roughgarden's own work. The book ends with appendixes on elementary statistics, computer programming, and stability theory. The last should be especially valuable to biology students interested in theoretical problems.

As the author states in the preface, the book contains material for two very different audiences: beginning students of the subject and advanced students and professionals. I suspect that it would have been wiser to separate this material. Both audiences will find themselves being forced to pay for material they cannot use, and the style of the book suffers

from an appearance of uncertainty as to the level at which it is aimed. Even the elementary chapters tend to end with citations of recent papers (often unrepresentative of the field as a whole). There is little attempt to convey a sense of the history of the subject; for example, Fisher, Haldane, and Wright are given their major citations as 1958, 1966, and 1969 respectively. There is also a somewhat annoying level of misprints and minor factual errors (the picture of a *Primula* on p. 171 and on the cover seems to represent a species hitherto unknown to science, and I doubt whether Timoféef-Ressovsky will be flattered by being consistently referred to as Timoféef-Rossovsky). All this will be confusing to a beginner. The strength of the book lies in its detailed treatment of certain theoretical topics not available in book form elsewhere. This is particularly true of the last two chapters, which deal with topics close to the author's heart, and which professionals and advanced students will certainly wish to consult.

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Volcanoes

Volcanology. HOWEL WILLIAMS and ALEXANDER R. MCBIRNEY. Illustrated by Christine McBirney. Freeman, Cooper, San Francisco, 1979. 398 pp. $33.50.

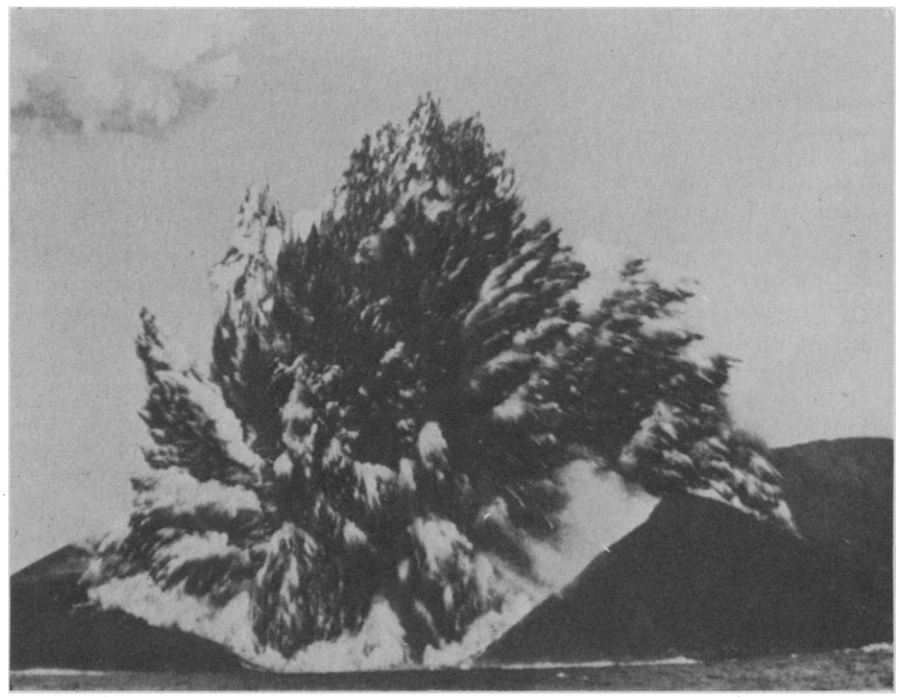
Over the past half-dozen years interest in volcanology has been greatly stimulated by studies of volcanic processes on the sea floor and by the recognition of volcanic activity as a major process on several extraterrestrial planetary bodies. As a discipline, volcanology embraces the study of the mechanics of volcanic eruptions, the physical properties of magma, the nature of volcanic gases, the morphology of landforms, and the distribution of volcanic activity in relation to various geologic settings. The important practical concerns of volcanology include the prediction of volcanic hazards, the restoration and reclamation of areas devastated by eruptions, and the utilization of geothermal energy. Earth scientists wishing for a review of these topics or for a textbook on which to base a course in volcanology will welcome the appearance of this book.

Readers for whom the book serves as an introduction to volcanology will find much of value in each of the 15 chapters, although the level of treatment and the timeliness of the material are somewhat uneven. For the more advanced student or researcher, chapters 2 through 7 will probably be the most useful because of their extensive treatment of the physical properties of magmas and the generally good mixture of theoretical, experimental, and observational data. In contrast, chapters 8 through 11 cover a lot of familiar ground, with examples of major volcanic landforms and eruptions drawn from the same "classic" localities described in many other geologic books. This section could have been improved with more examples from the authors' own observations in the Galápagos and Central America, or from the recent extensive activity in and near Kilauea on Hawaii, such as the growth of Mauna Ulu. Chapter 12, on oceanic volcanism, suffers from the same deficiency in that there are only brief allusions to the latest observations by photography and from submersibles along the Mid-Atlantic Ridge and Galápagos spreading centers.

Chapter 13, "Volcanism and orogeny," attempts to relate volcanic activity to geologic setting. Much of the chapter deals with island arc volcanoes and their relation to marginal seas and to their oceanic or continental crustal setting. This is a readable and comprehensive summary in which the authors avoid uncritical acceptance of many of the attractive but simplistic ideas that have been proposed in the recent literature. The authors' discussions of relations such as the migration of volcanic centers relative to plate motions or the correlation between the composition and the tectonic setting of magma end with caveats that point to the need for more definitive research.

For those desiring to do further reading on specific topics, the level of documentation and the arrangement of the references are less than ideal. It would have been more convenient if references had been grouped at the end of the chapters instead of in a single bibliography at the end of the book. Some of the most interesting and provocative statements in the book are not referenced and with the present arrangement there is little chance of tracing such statements to their source. Also, the value of some of the figures is compromised by a lack of information on sources or by an inadequate explanation of the criteria used to compile the information in the figures. For example, the map of "active volcanoes of the world" inside the front and back covers will surprise many readers with its inclusion of several active centers in the western North Atlantic Ocean and the apparent omission of Tristan da Cunha in the South Atlantic.

On balance, this is an attractive and readable book. It is logically organized and free of obvious typographical errors. The many excellent pen drawings by Christine McBirney are a positive feature. The book is a good source of material on those aspects of volcanology that



"A phreatomagmatic explosion caused by eruption of basaltic magma into shallow seawater during the early phases of formation of the island of Surtsey off the southern coast of Iceland in 1964." [Photo by S. Einarsson; reproduced in *Volcanology*]