Book Reviews

The Solid Earth

The Earth. Its Origin, Structure and Evolution. M. W. MCELHINNY, Ed. Academic Press, New York, 1979. xvi, 598 pp., illus. $74.50.

Undoubtedly one of the half-dozen leading centers for research in the earth sciences is the Australian National University at Canberra. Its leadership has evolved since 1952, first under the guidance of John C. Jaeger and then from 1972 to 1978 under Anton Hales. This book is dedicated to Jaeger and Hales and is entirely written by present and former faculty and associates of the Research School of Earth Sciences in Canberra.

Despite the limitation of authorship to Canberra, the book constitutes the best single-volume review of research in the physics and chemistry of the solid earth in at least seven years. Hence for the nonspecialist it is a convenient guide to current understanding of most aspects of the solid earth and to the leading questions on the subject.

A book about current research in an active field cannot, of course, avoid biases if it is to address the speculative edge. Such tendencies toward bias are particularly apparent in the opening chapter, on the composition and origin of the earth, which is fittingly by A. E. Ringwood, who has done the most to bring renown to Canberra. Ringwood strives to reconcile data with two modeling ideals—a uniform composition for the mantle and a bulk composition that differs from carbonaceous chondrites only in the loss of relatively volatile elements. His petrological and geochemical arguments are persuasive but tend to be one-sided: he does not take into account some recent data, such as isotopic indications of enduring inhomogeneities in the mantle, and does not sufficiently emphasize the speculativeness of some extrapolations, such as those concerning the miscibility of iron and iron oxide in the core.

The remaining 16 chapters are roughly one-third geochemical and two-thirds geophysical. Of the geochemical, one by Liu, who reviews high-pressure phase equilibria experiments, is complementary to Ringwood's. Liu concludes that the most plausible solution is a 3-percent increase in iron relative to magnesium in the lower mantle; however, the uncertainty of this solution is greater than its difference from the homogeneous composition postulated by Ringwood. Four papers are on aspects of crustal evolution, ranging from a discussion of porphyry copper deposits to estimates of continental crust composition from rare earth elements. An impressive conclusion of the paper on rare earth elements, by Taylor, is that even the oldest differentiations in the Archean were andesitic (like island arcs), rather than anorthositic (like the moon), in character. Another important discrimination is made in a paper on mid-ocean ridge basalts by Green, Hibberson, and Jaques, who conclude that there cannot be a direct genetic relationship between the parent magma of these basalts and the more mafic rocks found in the ophiolite complexes commonly thought to be relics of ocean ridge associations.

Among the geophysical papers, geomagnetism is most strongly represented, with four chapters. Most novel to this reviewer were the inferences from statistical analyses of temporal variations by McElhinny, who suggests that the variations are caused by changes in boundary conditions arising from mantle convection. Perhaps sounder is a summary of continental drift for the last 350 million years by Irving, who pioneered this application of paleomagnetism before it acquired respectability. Other sound and up-to-date geophysical reviews are on the rotation of the earth, seismology and the internal structure of the earth, mantle convection, the thermal regime in Australia, and earthquakes and plate tectonics. Also pertinent to the problem of lower mantle composition is a discussion of seismic velocity-density systematics by Liebermann.

Although the chapters are mostly reviewish in nature, some, such as that by Green and collaborators, present new data, and in nearly all cases the authors have made important original contributions to the work discussed. All in all, the book is a pleasing reminder of the rapid progress in the earth sciences in recent decades, not only in plate tectonics but also in subjects, such as paleomagnetism and high-pressure petrology, in which Canberra has been a leader.

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A Population of Mammals

The George Reserve Deer Herd. Population Ecology of a K-Selected Species. DALE R. MCCULLOUGH. University of Michigan Press, Ann Arbor, 1979. xiv, 272 pp., illus. $16.

Six white-tailed deer released on a fenced 5-square-kilometer reserve in 1928 erupted to a peak of around 220 animals in the mid-'30's. They were subsequently held by hunting at levels between 70 and 160. By chance the reserve is owned by the University of Michigan, and the result of that happy coincidence is the best ecological study ever undertaken on a population of large mammals. Not that the competition is particularly fierce: Sinclair's work on the African buffalo runs it close, and the Isle Royale study on moose and wolves is another contender, as is the study of Laws and his associates on elephants in East Africa, but most of the other studies that have been done coalesce into an amorphous mass of nothing much.

McCullough's book can be divided into four sections. The first few chapters give his data—essentially the result of 19 years of bookkeeping. Mortality, reproduction, population size, and sex ratio are tracked with high fidelity. Having shown what the population did he shows in the next section how and why, by integrating these data within an empirically derived stock-recruitment model. Estimation of the yield curve and carrying capacity follows naturally. The third section discusses the bearing of the study on the broader issues of population regulation and natural selection, and the book ends with a couple of chapters on its implications for wildlife management.

The book is difficult to find fault with. As I read it my standards kept inching upward, and at that level of heightened sensitivity. I will mention one aspect of the study that disappointed me. McCullough makes it plain that he views a pop-

ulation of herbivores as part of a larger interacting system comprising the plants that the animals eat and shelter under, the animals themselves, and the predators that prey upon them or shoot them. Yet there is no information given on the levels of food available to the deer, their food intake being indexed instead by animal density. If food is so important why was it not measured? and why does the "ecosystem hypothesis" of chapter 1 contract to a single-species model by chapter 6?

Of the four portions of the book, the first, giving the data and intial analyses, is superb. The second, which integrates those data, is excellent within the restraints imposed by the single-species framework. The third, on selection and regulation, is weak only according to the high standards set by the rest. McCullough employs his data to dispose of the more bizarre Wynne-Edwardian predictions on group selection, concluding thereby that group selection is unimportant. But because he has no data on the dynamics of the plants he is unable to test the more likely group-selection mechanisms, driven by interaction between tropic levels, that are proposed by Gilpin and others.

The last portion, aimed at wildlife management, will come as a revelation to many in that field. In two incisive chapters McCullough dispenses with much of the conventional wisdom of that discipline. He shows that life tables are seldom useful for shaping management options, not because of any defect inherent in the methodology but because age-specific mortality can seldom be estimated accurately enough. Here is the voice of the practitioner rather than that of the theoretician. Among other things McCullough puts sustained-yield harvesting of large mammals onto a scientific footing with the help of his empirical relationship between stock size and recruitment.

The book should have an immense impact on wildlife management, but will it? The amalgam of codified "principles" offered by most universities as training in wildlife management will not equip many to cope with this book. I suspect that the study will be more influential in population ecology than in wildlife management. It presents a detailed case history, replete with multitudinous data that will entertain modelers for a decade. I doubt, however, that they will extract much more from them than has the author.

Before this book appeared one could claim confidently, and with little exaggeration, that white-tailed deer and *Drosophila* were the most studied and least understood of animals. It was a useful line for belligerent biologists at sherry parties. McCullough's book will act as an unfortunate brake upon the free flow of convivial repartee in the small hours before the next conference paper.

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Units of Natural Selection

The Natural Selection of Populations and Communities. DAVID SLOAN WILSON. Benjamin/Cummings, Menlo Park, Calif., 1980. xviii, 186 pp., illus. $12.95. Series in Evolutionary Biology.

For years, biologists have interpreted various traits and adaptations as being of advantage to an entire population or even a species. For example, consider the assertion that "mockingbirds lay fewer eggs during a drought because competition for restricted food supplies would be detrimental to the species." Such group selectionist statements have a fatal flaw: "cheaters" that laid as many eggs as possible would reap a higher reproductive success than individuals that voluntarily decreased their clutch size for the benefit of the species. The same phenomenon can be interpreted more plausibly in terms of classical Darwinian selection at the level of the individual: during droughts, parental birds cannot bring as many insects to their nest and therefore cannot feed and fledge as many chicks as they can when food supplies are more ample. Birds can actually leave *more* surviving offspring to breed in the next generation by laying fewer eggs. Most modern evolutionary biologists have dismissed the sort of "naïve" group selection described above as untenable.

But now the pendulum has swung, and thinking about group selection has achieved greater sophistication. Sewall Wright anticipated the new mathematical arguments nearly half a century ago, envisioning two distinct types of selection at the level of groups. For "extinction" group selection to oppose individual selection, isolated selfish groups must go extinct faster than selfishness arises within altruistic subgroups and the majority of newly founded isolates must be altruistic. "Graded" group selection requires that distinct subpopulations contribute differentially to reproduction in a bigger population at large. In essence, entire groups must possess differential rates of survivorship, or reproduction, or both. Wright was careful to note that the course of selection within groups cannot be altered by selection acting between groups, and he stressed that group selection requires very restricted conditions.

Among the new generation of proponents of such mathematical theories of group selection is David Sloan Wilson, who in this little monograph challenges "traditional evolutionary biologists" to reconsider the group selection controversy in terms of what he calls "structured deme theory." His argument centers around "trait groups," which are simply homogeneous subsets of a population that vary in their ability to pass on their genes. (The similarity to Wright's model is evident.) With other theoreticians, Wilson sees a continuum between individual selection and group selection, depending on the degree to which a population is broken up into subpopulations. He asserts that the altruism-selfishness controversy is peripheral to the question of group selection. Much of the book's content has already been published in population biology journals. Wilson writes with urgency, as if he is leading a revolution in evolutionary thought, but whether this really offers a new paradigm or is merely a premature publication of an enthusiast remains to be seen. I found Wilson's thinking somewhat involuted, his writing style idiosyncratic in places, and his speculation concerning community-level selection unconvincing. He develops a theory of trait groups and structured demes, but his attempt to find empirical support for his models largely fails. Even his single "probable example" of trait group variation (pitcher-plant mosquitos) merely shows spatial genetic variability (hardly a surprise to any biologist); despite a concerted search, evidence for group selection in nature eludes Wilson entirely. He is well aware of the difficulty of testing the theory presented and tries to offer some suggestions. Few falsifiable hypotheses are offered, however, and the empirical sections of the book are largely adornments to the theoretical parts, without any real interplay between observation and theory.

Of course, the utility of a model can be assessed only by confrontation with data from the real world. This feedback procedure is often neglected in population biology today, where models are built on top of models or on flimsy data and theory is frequently seen as an end in