win's scientific work is less comprehensive than Ghiselin's but also less dogmatic and humorless. For Ghiselin, Darwin was a thinking machine grinding out scientific generalizations by a foolproof method. In Ruse's view, Darwin was a human being influenced by philosophical ideas, religious beliefs, and social attitudes as well as by scientific evidence, and a member of an interacting scientific community. Unlike Ghiselin, Ruse recognizes that Darwin was an evolutionary deist when he wrote the *Origin of Species*, but Ruse underestimates the influence of Darwin's deism on his scientific thinking. He also undervalues the importance of Darwin's belief in the long-run progressive tendency of natural selection for his speculations concerning the causes of progress and retrogression in human society, as set forth in *The Descent of Man*. Darwin did not originate "social Darwinism," but he shared its tenets to a marked degree and thereby added to its influence.

Perhaps because of his desire to get on with the main argument of his book, Ruse's introductory chapter gives a rather truncated view of the prehistory of evolutionism in natural history. One misses some reference to Buffon, the most "Darwinian" of all Darwin's forerunners. Buffon attacked the species problem with many of the same tools—studies of geographic distribution, experiments on hybridization, investigation of variation under domestication, and construction of a theory of pangenesis—that Darwin used. One is also surprised to see Lamarck described as "not greatly innovative" and as having never conceived organic evolution as branching. Strange to say, Ruse reproduces the branching diagram of animal evolution from Lamarck's *Philosophie Zoologique* and then warns the reader "not to confuse Lamarck's diagram with Darwin's superficially similar diagram" (p. 9)! It is true that Lamarck began by trying to arrange animals in a "unique and general series" rising steadily toward more and more complex forms. But he was too good a naturalist to fudge the facts, and he eventually conceded that "this simple series is really not entirely conformed to the order in which nature has produced the different animals; for that order is far from being simple; it is branching [*rameux*] and appears even to be composed of several distinct series." The diagram of Lamarck's evolutionary system given on p. 10 is Ruse's, not Lamarck's. Like Darwin himself, Ruse underestimates Darwin's debt to the pioneers who first broke with the static view of nature and natural history.

But it will not do to end this review on a negative note. True to his purpose, Ruse has produced a useful and highly readable synthesis of the literature bearing on the conversion of the British scientific community to belief in organic evolution in the years 1830 to 1875 and on Darwin's role in that process of conversion. The book is skillfully organized and written with verve, imagination, and welcome touches of humor. The illustrations are well chosen and instructive, and there is a good bibliography at the end of the book. A philosopher of science has proved himself a good historian.

JOHN C. GREENE
Department of History, University of Connecticut, Storrs 06268

Hunter-Gatherer Demography

Demography of the Dobe !Kung. NANCY HOWELL. Academic Press, New York, 1979. xxii, 390 pp., illus. $24.50.

Hunter-gatherers who number only 455 and who do not reckon age would seem to defy demographic analysis. But in this book Howell orchestrates longitudinal censusing, stable population modeling, and simulation to overcome these hurdles in a generally convincing study of these noted Kalahari desert dwellers. The undertaking will interest anthropologists, demographers, and human biologists because of its methods, its uncovering of one of the lowest known levels of natural fertility without contraception, and its implications for hunter-gatherer existence, once prevalent but rapidly disappearing in the late 20th century.

Equilibrium assumptions and stable population methods underlie Howell's quest to exemplify a hunter-gatherer adaptation with !Kung materials. The data in hand, a population registry of Dobe-area camps periodically updated from 1963 to 1973 and fertility histories of 62 postmenopausal women, do not extend through time or in numbers enough to permit our inferring basic demographic parameters except through stable population analysis. But these techniques presume unchanging age patterns of mortality and rates of fertility. Fortunately, the !Kung long have dwelled in isolation substantial enough to rule out the major changes in mortality and fertility that recent centuries' altered diet, public health, and lifeways have brought the rest of the world. Thus the techniques make sense here more than for many groups of similar size that ethnographers might study elsewhere in the world. Howell uses population features observed in the best of the field data to select the level-5 model of mortality from the Coale and Demeny "West" family of stable models. This becomes the basis for her inferring such features of the !Kung population as age-specific mortality and absolute ages of individuals who can otherwise only be ranked younger or older than one another. Independently derived fertility parameters complete the stable model.

Howell makes innovative use of microsimulation to evaluate her stable population analysis. Monte Carlo methods allow her to observe what happens to !Kung-sized populations of individuals who reproduce and die according to the vital rates of the model. In effect she takes the stable model as a null hypothesis and generates the sampling distributions of various population parameters resulting from stochastic variation within it. As a result, she can estimate the probable error in having used stable models to estimate individual !Kung ages. She discovers that the stable population model is consistent with various empirically observed features of the !Kung. She demonstrates, as is required if the !Kung are to stand as exemplifying a long-term Kalahari desert adaptation, that such populations do not tend to extinguish because of stochastic variations in size. Finally, she paves the way for more refined microsimulation of !Kung kinship networks and domestic composition later in the analysis. The approach is innovative in that demographers, who rarely study such small populations, concern themselves little with stochastic variability. Further, this taking of Coale and Demeny stable models as null hypotheses not to be rejected for hunter-gatherers unless observations about them fall outside ranges of variability expectable under them is an important alternative to the building of completely new stable population models that some students of hunter-gatherer populations have espoused.

Howell's substantive findings about !Kung fertility are more interesting than those concerning mortality because they are more difficult to explain. The moderately high mortality suggested for the !Kung prior to their recent contact with outsiders, largely attributable to infection and parasitic disease, is not uncommon among human groups, and the only features notable about death among the !Kung are that malnutrition does not play a major role as cause and that violence does, the latter finding belying the !Kung reputation as "harmless people."

By contrast, !Kung low fertility poses an enigma. The !Kung have the same age-specific *pattern* of marital fertility as other populations lacking the use of contraception but much lower *levels*. In terms of Coale's "Hutterite" indices, their 0.40 index of marital fertility is very low indeed. Howell implicates the mean age at menarche (the !Kung have the latest observed in human populations) and long intervals between births in this low fertility. Sterility from venereal disease, which some cohorts contracted from outsiders, also plays a part. To explain these patterns, Howell turns her attention to the controversial Frisch critical-fatness model, which postulates that women mature reproductively when they accumulate body fat to levels critical for menarche and then for stable reproductive ability. Although the !Kung eat balanced nutrients, they consume relatively few calories. They are remarkably lean. When Howell converts stature measures to estimates of individual women's levels of body fat, the results suggest that the Frisch model, if valid, could be implicated in !Kung low fertility. Not only would maturing !Kung women approach menarche and stable reproductive ability late because of low deposition of body fat, their body fat would drop below critical levels for stable reproductive ability while they lactate, thus extending birth intervals. Moreover, critical fat levels thus could serve to regulate this hunter-gatherer population homeostatically should it outstrip the Kalahari desert's capacity for feeding it. The hypothesis is too intriguing for Howell to set it aside easily. On the other hand, the data in this section of the book will not convince Frisch's critics, and Howell is careful not to embrace the explanation. In the final analysis she leaves !Kung low fertility explored but unexplained.

Howell's forthright exposition adds to the credibility of the study. She confronts fairly the difficulties and probable pitfalls of analytically bounding groups such as the Dobe, many of whom have joined other !Kung settlements or have taken up livelihoods at new Bantu cattle-posts. After exploring the genetic implications of !Kung demography, she is willing to acknowledge that the results are inconclusive.

If the study falls short anywhere, it is in its lack of comparative ethnographic perspective rather than in its demography. Howell eschews comparing !Kung with other hunter-gatherers, for whom demographic data are largely unreliable. But had she done so she would have recognized how prevalent among them are women's enjoyment of sexual liaisons and women's reluctance to bear and raise children who will tie them down. Correspondingly she might have focused more attention than she does on !Kung infanticide and on cultural explanations of why !Kung fertility is so low.

GEORGE A. COLLIER
Department of Anthropology, Stanford University, Stanford, California 94305

An Updating in Petrology

The Evolution of the Igneous Rocks. Fiftieth Anniversary Perspectives. H. S. YODER, Jr., Ed. Princeton University Press, Princeton, N.J., 1979. xii, 588 pp., illus. Cloth, $35; paper, $15.

The science of igneous petrology is founded on astute observation of rocks, guided by the rigorous principles and data of physical chemistry. Almost all the latter have been developed since 1900, and the one man who stands out in their development is the late N. L. Bowen of the Carnegie Institution of Washington. His 1913 experimental phase equilibrium diagram of the plagioclase feldspars stands without major revision today, and his powerful theoretical analyses brought a good many matters to completion. His invited lectures at Princeton in 1927 formed the basis of an elegant treatise (1928) whose pointedly Darwinian "evolution" in the title reflected Bowen's lifelong emphasis on fractional crystallization as a clue to the diversity of igneous rocks. The book is still treasured for its masterly integration of experiment and observation, its exquisite prose, and its driving intensity. It is the work of a young scientist who was to see nearly three decades more of discovery, culminating in a spectacular resolution of the granite problem with O. F. Tuttle in which it was proved that granite magma could easily be produced by the partial melting of sedimentary rocks.

The present volume is a sort of Bowen Redux, written by 18 strong men, one to a chapter. The ground rules imposed by the editor required limitation to the broad subject matter of the original chapters, with only moderate allowance for verbal inflation despite the explosion of both field and experimental knowledge since 1928. The result has a unity of purpose imposed by Bowen and a unity of tone far above that of a typical festschrift.

There are many things in the book that Bowen would have liked, among them an extension of theory that enhances the quantitative application of phase equilibria to natural rocks and melts. Investigations at controlled oxygen fugacity have clarified the role of oxygen in magma evolution. Studies at high pressure with and without H_2O and CO_2 have illuminated the origins and source regions of magma and have provided the groundwork for understanding the degassing of the earth to form the atmosphere and hydrosphere. Kinetic studies of crystallization rates have permitted cooling histories to be calculated for terrestrial and lunar volcanic glasses. Detailed field evidence and new theory have clarified the process of crystal sorting as a mechanism of fractional crystallization. Isotope and trace element studies are being used effectively to detect contamination of magmas by crustal rocks or by other magmas. The studies that Tuttle and Bowen pioneered with granitic rocks have been extended to the economically interesting alkaline rocks. The feldspar-free lavas, given short shrift by Bowen, have been extensively explored in laboratory analog systems. Most striking, knowledge of the earth's interior and of plate tectonics has provided a global framework for the consideration of magmatic processes. Bowen's own able attempts to frame such a setting suggest that he would have greatly appreciated this revolution. The new chapters contain information and ideas not previously published in journals.

If such a book can have a conclusion, it is probably that Bowen's identification of fractional crystallization as a ruling process causing diversity in igneous rocks was correct but that the myriad processes between the generation of magma at depth and eventual crystallization of the *n*th batch of liquid make fractional crystallization alone too simplistic a model. Nevertheless, Bowen's insights are celebrated in every chapter. Even when wrong, he was edifying, and he was seldom wrong without good reason.

Bowen's book served for half a century as a blueprint for research, practically a super-proposal. Can its latter-day counterpart hope to serve such a function? Probably so. For example, silicate liquid immiscibility, discounted by Bowen, has now been convincingly demonstrated in lunar and terrestrial rocks and in the laboratory, and yet a strong case for its operation on a significant scale in nature is difficult to make. And perhaps the most challenging subject for new research will be the structure and thermodynamic mixing properties of silicate