geologic lore. Adjust one's expectations and one will find the volume to be an important and valuable reference. Some of the chapters certainly will become required reading for all students of the earth sciences.

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Plant Population Biology

Genetic Differentiation and Dispersal in Plants. P. JACQUARD, G. HEIM, and J. ANTONOVICS, Eds. Springer-Verlag, New York, 1985. xviii, 452 pp., illus. $65. NATO Advanced Science Institutes Series G, no. 5. From a workshop, Montpellier, France, May 1984.

The title of this work is somewhat misleading since it implies a specific focus on dispersal and its genetic consequences. Instead the volume represents a sample of current research in plant population biology; some papers examine genetic differentiation and others examine various dispersal phenomena, but these topics are often incidental to their main themes. The main merit of the volume for a North American audience is its strong European, and particularly French, flavor. Fifteen of the 28 contributions are from France, with four each from the Netherlands and the United States and the remainder from Belgium, Germany, Japan, and the United Kingdom. Since all papers are in English, the work serves to introduce the North American reader to current research projects being undertaken in some of the major European laboratories.

The work is organized into four sections, commencing with genetic differentiation, first at the level of molecular variation and single gene polymorphisms and second at the phenotypic level. This is followed by treatments of dispersal, first involving gene flow and second by what is termed phenotype dispersal. The editors have not provided any significant introductory material, conceptual or otherwise. This lack, the scant subject index, and the large number of typographical and translation errors combine to give the impression of a hastily assembled volume.

Over a third of the contributions present electrophoretic data on enzyme polymorphisms both at a local scale and from regional surveys. The technique provides a rich source of markers for studies of mating systems and gene flow, but attempts to characterize the genetic variation and heterozygosity of populations on the basis of a few loci are of doubtful value and undermine the biological significance of a number of contributions. In their examination of the scale of population substructure in the clonal plant *Trifolium repens* Gliddon and Saleem demonstrate how electrophoretic techniques can be most profitably used by population biologists. A novel aspect of their contribution concerns the recognition that in clonal plants the vegetative "dispersal" of inflorescences as plants grow laterally can have an important influence on neighborhood size. Plants of different sizes will tend to disperse their genes by varying amounts. This contribution and a model by Van Dijk on neighborhood sizes in plantains highlight some of the difficulties in the application of Sewall Wright's nieghborhood models to plant populations.

Despite a strong surge of interest in the quantitative genetics of plant populations in North America, relatively few contributions in this volume examine the genetic basis and heritability of life history traits. An exception is Roach's study of phenotypic and genetic correlations between juvenile and adult characters in *Geranium*. Although population ecologists have long been aware that the magnitude of juvenile mortality has important consequences for the evolution of life history patterns, there has been little work on the nature of genetic variation during the prereproductive phase of the life cycle. Roach concludes that despite the presence of considerable genetic variation for fitness during this period in natural populations, response to selection of juvenile traits may be constrained because of maternal effects, negative genetic correlations with adult fitness components, and the enormous microsite heterogeneity of most plant habitats. A short review of interactions between environment and genotype by Kelley, including the "rediscovery" of Finlay and Wilkinson's regression methods for analyzing the performance of genotypes over a range of environments, may presage the emergence of a major field of inquiry in experimental quantitative genetics. It is surprising that despite the long tradition in plant biology of using clonal transplants for examining ecotypical differentiation, population biologists have been slow to take advantage of the clonal nature of many plants to examine how the fitness of genotypes can vary from place to place within patchy environments.

Another poorly understood topic in plant population biology is covered by Hayward in his review of the genetic organization of quantitative traits in rye grass populations. Long-term studies at the Welsh Plant Breeding Station have demonstrated both nuclear and extranuclear control of genetic variation. The latter involves somatic variation, which in rye grass is selectable at the vegetative level. Selection experiments for rate of tiller production within clones indicate that responses are both age- and genotype-specific. Whether somatic selection is an important evolutionary phenomenon in natural populations of clonal plants is not known, but the problem certainly deserves more attention than it has been given. Cytoplasmic variation is also examined in Van Damme and Graveland's study of gynodioecism in *Plantago* in relation to ecological differentiation. The remaining three contributions from the Netherlands also involve studies of plantains, which seem to have become the experimental organism of choice in that country. Similarly, the long-standing interest in *Thymus vulgaris* (thyme) by French workers at Montpellier is reflected by two contributions on the species. Dommee and Jacquard examine the influence of environmental disturbance on female frequency, and Mazzoni and Gouyon describe horizontal structure and covariation of terpene polymorphisms with the floristic composition of vegetation. Both papers emphasize the difficulty of providing conclusive evidence about the nature of selection on plant traits in long-lived perennial plants without the use of experimental transplants and demographic techniques.

In a short but thought-provoking general commentary, Antonovics suggests that the use of summary population statistics has obscured the complexity and internal dynamics of plant populations. The contributions in this volume emphasize this point and indicate how the contrasting spatial and temporal scales involved in population studies can make integration of ecological, genetic, and physiological approaches to the study of populations a difficult but challenging problem.

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Paleoclimatology

Late Cainozoic Paleoclimates of the Southern Hemisphere. J. C. VOGEL, Ed. Balkema, Rotterdam, 1984 (U.S. distributor, International Publishers Service, Accord, MA). xii, 520 pp., illus. $40. From a symposium, Swaziland, Aug. 1983.

The symposium of which this book is the proceedings was motivated partly by marine evidence of a phase shift in climatic change of the two hemispheres, with the southern leading by 3000 years. Australian and New Zealand Quaternists had previously found little evidence for such a phase shift, and there is not much in this book. Most authors

do not explicitly address the question, but little in the timing of the climatic changes they describe seems out of phase with equatorial or Northern Hemisphere events. There are a few suggestions of an early Holocene thermal maximum, but early postglacial warming is known in climatically similar parts of the Northern Hemisphere such as Alaska.

A major exception is a paper on paleoclimatology by Harrison *et al.* that incorporates a substantial lag in its model of the last glacial-interglacial transition. Data to support the model are partly marine and are not presented in sufficient detail to permit comparison with the evidence of the many other authors who imply interhemispheric simultaneity. Evidence of simultaneous change comes from the land, not the ocean, so the issue cannot be regarded as settled. Most current theorists of climatic change believe that astronomical irregularities in the terrestrial distribution of solar energy produce climatic oscillations by changing the size of Northern Hemisphere ice sheets. It is not inconceivable that the marine temperature effects of waning northern glacier ice might first become apparent in the southern ocean, but it is difficult to imagine how that would happen without simultaneously affecting the climate of the southern lands. Some of the apparent field facts or their theoretical interpretation must be faulty.

The book provides enlightenment and provocation on scales from that of a time series model embracing the entire climatic history of the earth to scanning electron microscopy of a minute charcoal fragment. The Taung site has been dated: it is apparently less, perhaps much less, than a million years old. Great progress is reported in the study of arid landforms, especially dunes. Those of Australia are much better dated by radiocarbon than those of Africa, but nowhere have the new radiometric methods more suitable for wind-blown silts and sands been widely employed. Africanists will enjoy Cooke's lucid history of horses, elephants, and pigs, Butzer's well-balanced multidisciplinary assessment of the late Quaternary, and the new paleoclimatic evidence from caves. Equally valuable are Bowler and Wasson's sweeping review of ice-age environments in inland Australia, Mildenhall and Pocknall's account of the Miocene and Pliocene paleobotany of New Zealand, and Mercer's summary of South American glacial geology. Mercer soberly reminds us of field evidence that is not consistent with current ideas about climatic change.

The last chapter of the book is a synopsis of a workshop on climate change and mammalian evolution that followed the symposium. The workshop concluded that two episodes of biological change, one around the end of the Miocene at 7 to 5 million years ago and one in the late Pliocene at 2.5 to 2 million years ago, seem especially suitable for study concerning possible climatic effects. A plausible case can be made for these as times of rapid global climatic change.

The book can be read with pleasure and profit by anyone interested in climatic change, in evolution, or in the general geology of late Cainozoic time. It will compensate them, as it did me, for missing an excellent meeting.

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The Austronesian Expansion

Prehistory of the Indo-Malaysian Archipelago. PETER BELLWOOD. Academic Press, Orlando, FL, 1986. xii, 370 pp., illus. $58; paper, $34.50.

Bellwood's *Prehistory of the Indo-Malaysian Archipelago* concentrates on Indonesia and Malaysia because of their central position in the spread of early Austronesian language and culture. He relates evidence from biological anthropology, archeology, linguistics, and ethnology in reviewing the peopling of this area. The survey, from the first prehistoric human occupation to the historically documented civilizations, offers a long-term cultural development perspective essential for understanding modern ethnolinguistic diversity.

A detailed discussion of Pleistocene geology and environment emphasizes the impact of changing sea levels on land migration routes into the main island groups. The earliest peoples in Asia are seen as belonging to *Homo erectus*; these small scattered populations came as migrants originally out of Africa and were in Java more than 1,000,000 years ago. Still problematic for the archeologist is that evidence of culture, even in the form of stone tools, has not been found in direct association with the early fossils. The Hoabinhian, perhaps the earliest widely accepted stone tool complex in Southeast Asia, dates to the terminal Pleistocene and early Holocene; Bellwood accepts the Sonviian tools from northern Vietnam, at around 23,000 B.C., as the oldest known. Ax-like stone tools with cutting edges finished by grinding occur unexpectedly early throughout East Asia and Australia: in Japan (30,000 years ago), Australia (20,000 years ago), and Indo-Malaysia (more than 10,000 years ago?). Bellwood holds out the possibility of as yet unclarified relationships between early Japanese tools and those found in Southeast Asia.

Bellwood sees "the main Austronesian expansion between 3000 and 1000 B.C. as the foundation for major biological, linguistic, and cultural changes in the prehistory of the archipelago" (p. 320). The early view that waves of migrants inundated Southeast Asia from the north and introduced new technology and languages is shown here to be inconsistent with much available evidence; however, the Austronesians are still seen as derived from the north, specifically South China, via Taiwan. Bellwood ties the Austronesian expansion to agriculture and challenges two widely held ideas about early food production in the tropics: that cultivation of vegetative planting species preceded that of the cereals, and that agriculture began in an "affluent foragers" condition of leisure and plenty. Agricultural origins in Southeast Asia are reinterpreted in terms of shifting emphases, with dominance of cereals prior to 4500 B.C., then an increase in the importance of tubers, spread of tuber and fruit cultivation into new areas, and complicated developments involving wet rice and animal husbandry in Indo-Malaysia.

The pre-Austronesian occupants of Indo-Malaysia—except in the Malay Peninsula—were not practicing food production in the sense of purposeful cultivation of plants, according to Bellwood. Root crop cultivation was being developed early in the New Guinea highlands, however, and a case could be made that a similar process of increasing control over food resources was under way in Indo-Malaysia prior to Austronesian expansion.

Bellwood finds the earliest center for annual rice cultivation at about 5000 B.C. in China's Lower Yangtze drainage, and this center is independent from others in India and possibly Thailand. Rice was introduced into Taiwan, the homeland Bellwood posits for the Initial Austronesian language group, before migrants moved from there on to the Philippines. The earliest dates for rice in Taiwan become critical in this interpretation, then. The lack of evidence from Indonesia makes an assessment of early Austronesian food production difficult; Bellwood offers a credible hypothesis.

The working hypothesis that "the Austronesian languages of Sumatra, Malaya, and Vietnam (and possibly Java?) were not established prior to about 1000 B.C. or later in some areas" (p. 123) is generally acceptable. At about that time Indo-Malaysia was rapidly brought into the Neolithic world. That this was without population replacement (p. 168) brings into question the mechanisms of such a major shift in language, culture, and thus, potentially, in