ecological and have no counterpart in other sampling contexts; and because Seber himself has made notable contributions to them. They are not, however, suitable for very small and fragile animals such as plankton, soil organisms, and soft-bodied insects, and the book rather neglects animals of these kinds: only 15 of 66 examples deal with invertebrates, and these are durable species (such as snails, beetles, lobsters, and crabs). Quadrat-type sampling (more generally, the counting of individuals in a sample of "sample units") is dealt with only briefly, and I was sorry to find no mention of two-phase (or multi-phase) sampling, otherwise double sampling. This is the appropriate method when the animals of interest occupy a living space the quantity of which must itself be estimated, for example, microcrustaceans in marine algae or ectoparasites on rodents. Ecologists often need to use double sampling, and accounts of the procedure are hard to find.

Seber's book will be useful to a wide spectrum of ecologists, from academic theoreticians at one extreme to project-oriented workers (game managers, fisheries biologists, economic entomologists, and the like) at the other. Its usefulness to the latter group is obvious. Theoreticians, on the other hand, because they are concerned with the general rather than the particular, are apt to be impatient with the minutiae of data gathering and handling. But no theory deserves to survive (or even to be advanced) that cannot be supported by empirical evidence, and the book will provide theoreticians with a much-needed guide to the marshaling and rigorous interpretation of actual field observations.

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Plant Ecology: Gradients and Discontinuities

Handbook of Vegetation Science. Part 5, Ordination and Classification of Communities. ROBERT H. WHITTAKER, Ed. Junk, The Hague, 1973. x, 738 pp., illus. + tables. Dfl. 160.

With but few exceptions pre-1950 plant ecology was dominated by a philosophy according to which communities are made up of groups of species with similar distributions that are clearly separate from other such groups. In the last 25 years this view has changed, in large part because ecologists began sampling and analyzing vegetation using techniques that made no a priori assumptions about community discontinuity. This book describes and evaluates these techniques and relates their use to community classification.

This volume, part 5 of a new series, Handbook of Vegetation Science, is the first of the series to be published. Others will follow as they are ready. Aside from the introduction, ten of the book's chapters are concerned with ordination and nine with classification. Each of the two groups of chapters is introduced by the editor, Robert H. Whittaker, who summarizes the background of and the major ideas in the chapters that follow.

Ordination is a process by which communities or samples of communities are arranged in order (ordinated) along gradients of environmental change, or, alternatively, the samples are ordinated along compositional gradients, with those communities most similiar to each other being placed adjacently on a scale describing the range of similarity values among all such samples. This approach to community studies grew largely out of dissatisfaction with rigid views on the discontinuity of communities and from increasingly better information on the nature of species.

The idea of ordination is not new. Sobolev and Utekhin, two Russian contributors to the book, claim priority in ordination studies for their countryman L. G. Ramensky, who pioneered in this field 60 years ago and whose work they translate and synthesize here. In the United States H. A. Gleason had a similar, though less formally developed, point of view. Modern studies of ordination and gradient analysis did not get under way, however, until the early 1950's when Whittaker, working independently, and a group of ecologists at the University of Wisconsin led by the late J. T. Curtis developed convincing evidence that vegetation is continuously variable. The major contribution of the Wisconsin group has been the design and improvement of techniques used to sample and analyze vegetation.

Whereas in classification the emphasis is on combining samples that are similar to each other, in ordination one capitalizes on the differences among them with the purpose of arranging the samples in a linear or multidimensional framework that will reveal something of the relationships between the samples and their environments. In the last ten years or so a great deal of the work in ordination has been directed toward designing better methods of arranging and summarizing sample data so that they will lead to more easily recognizable community relationships while preserving some similitude to nature.

Several chapters describe the most important of these techniques, of which many have been borrowed from other fields. Apart from the mathematical sophistication required for their understanding, the problem some ecologists have with these methods is that there has been little evaluation of how and when specific techniques are useful or of the problems that may be associated with them. Fortunately, David Goodall does precisely this for methods having to do with species correlation and sample similarity, and Whittaker and Gauch evaluate a variety of ordination methods. The latter reach the conclusion that "there is often inverse relationship between mathematical complexity or elegance, and research effectiveness, of ordination procedures," and they conclude that somewhat simpler techniques combined with ecological understanding may yield the best results.

This conclusion will be greeted with some enthusiasm by those ecologists who tend to be suspicious that the kind of analysis that is most gratifying to the mathematician may be irrelevant or misleading to the ecologist. Both Goodall and Whittaker and Gauch offer advice on which techniques may be the most useful in different circumstances.

Community classification as a formal enterprise originated with students of plant geography in the 19th century, at which time it was based primarily on the growth forms or physiognomy of plants. As knowledge of the structure and function of plants improved, the number of characteristics used in classification systems increased. Since community classification is not natural (in the sense in which a species is a

natural unit) it follows that no system has exclusive merit. Thus, various schools of classification have arisen which at times have engaged in bitter and polemic controversy over the relative merits of their systems. Although the controversy has largely faded, the traditions have not, and about half the book is given over to fairly detailed descriptions of the six or seven classification systems still used most widely. Some of the systems have rather wide use, while others have become entrenched among plant scientists in local areas. A few of these scientists, such as the European advocates of the Braun-Blanquet system, seek to promote wider use of their methods.

Without elaborating further on specific classification systems, it is apparent that the more information one has about nature the greater the degree to which it can be subdivided. Those classification systems that emphasize thorough familiarity with the flora, for example, categorize vegetation to an extent impossible for ecologists who have had a more cursory taxonomic background. Because ecology in the United States grew out of the dynamic community approach of F. E. Clements, the emphasis here has been placed on pattern and process and much less on species composition. It is unlikely that amalgamation of these very different approaches to classification will occur soon.

In his characteristically rational approach to such problems, David Goodall suggests that the use of numerical methods, such as those developed in modern taxonomy, would provide an objective and uniform method for classification. He may be correct in this view, but the adoption of such methods in community classification is probably even less likely than has been the abandonment of more traditional approaches to taxonomy.

If communities intergrade with each other, that is, if vegetation is continuous, why is classification necessary or desirable? The answer to this concern is, of course, that communities are continuous in an abstract but rarely in a concrete sense. Environment often changes along steep gradients, and disturbance frequently interrupts continuous vegetation patterns, both of which give the illusion of discontinuity. Furthermore, the interaction between two species sometimes results in sharp boundaries which may be accentuated if one species is conspicuous relative to the other. In a remarkable show of accommodation, most of the authors seem to agree that elements of both continuity and discontinuity are present in communities, that both species individuality and species groupings are realistic, and that both gradient analysis and classification are possible. Westhoff and Maarel conclude that "the difference between less extreme students of gradient analysis and that of the Braun-Blanquet approach [is] one of emphasis and perspective, not one of fact or understanding."

Not all ecologists will agree with the views presented in this book, and many will point out that ordination and classification are considerably behind the cutting edge of modern community studies. Nonetheless, this volume is valuable both as a historical summary of the development of two techniques used in the study of vegetation and, as was intended, as a handbook of the techniques themselves. In both respects, the book is successful.

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Geological Testing Ground

The Western Pacific. Island Arcs, Marginal Seas, Geochemistry. Proceedings of a congress, Canberra, Australia, Aug. 1971. PATRICK J. COLEMAN, Ed. Crane, Russak, New York, and University of Western Australia Press, Nedlands, 1973. xviii, 676 pp., illus. $44.

Upon his return from a lengthy geologic study of the western Pacific, an associate lamented to me that he had not learned much geology—he had, he explained, spent "too much time trying to learn the geography of this bloody region." Truly bewildering in complexity, the subaerial and submarine features of the western Pacific form a geomorphic maze that would snare Godzilla. This vast area of the globe is an extremely important one to most geologists, because it is here that the quasimythical geosyncline is thought to exist. Because geosynclinal rocks form a major part of the very stuff of the earth's crust, the western Pacific is a fundamental testing ground for geotectonic theory—if it fails here, the idea decays to rhetoric.

Realizing that the current pandemonium of plate, or, if you will, global tectonic thinking was revolutionizing the geotectonic roles that many geologists had assigned to island arcs and their companioning trenches and marginal seas, and that the western Pacific is constructed chiefly of these geomorphic elements, Coleman saw that a collection of modern papers on this area was needed. In part because the champions of geotectonic concepts are irrepressible, and in part because the western Pacific is a paradise of structural and magmatic complexities, it is not difficult to induce geologists to write about this area, whether they are burdened with new information to dispense or not.

In *The Western Pacific: Island Arcs, Marginal Seas, Geochemistry* Coleman has brought together a set of papers that originally, in one form or another, were presented at the 12th Pacific Science Congress in 1971. From Macquarie Island northward to Kamchatka, the contributors describe the structural, magmatic, and tectonic complexities of the western Pacific in varying detail, indulging themselves by either dabbling into or pontificating about underlying causes. A little more editorial screening would have been appreciated, but the book as a whole is a timely collage of the wide-flung geoscientific thinking that is being applied to the western Pacific.

The four dozen papers and abstracts in *The Western Pacific* are organized into four groups: Features of the Pacific Ocean Basin; Island Arcs and Related Structures of the Western Pacific Region; Marginal Areas of the Western Pacific; and Petrology and Geochemistry of Island Arcs in Relation to Tectonic Environment. The first group is a potpourri of papers and abstracts, some of them bearing only obliquely on the western Pacific, that deal with subjects as diverse as "meso-features" (whatever they are) of the Pacific sea floor and the effects on everything of an expanding earth. The 18 papers that are included in the second group make up the bulk (257 pages) of the