BOOK REVIEW

P. W. Colgan (Ed.), *Quantitative Ethology*, Wiley, New York, 1977, 363 pp., index; $25.00

Quantitative Ethology describes various data analytic techniques, most of them multivariate, which are generally well known by data analysts in the social and natural sciences. The presentation is divided into eleven chapters, most with distinct authors, so that the advantage of exposition by specialists can be weighed against the inevitable variability in style and expositional quality that results from this practice. Although most of the book is given to explaining data analytic techniques per se, the motivation and examples are drawn from studies of animal behavior. In this way, a more familiar and less stark context is provided in which the student of animal behavior can approach the subject.

Although the level of presentation differs somewhat from one chapter to the next, a reader would benefit greatly if fortified with some quantitative or statistical training in his background. The first chapter, on data collection, is presented in a clear, straightforward style that will speak effectively to many readers. The second chapter, on repertoire analysis, should probably be skipped by all but the most wary readers, as it deals with a conceptually difficult topic and its author seems not to be aware of the recent statistical literature on the subject.

The third chapter, on information theory, gives a good explanation of the basic ideas, and then goes on to give a realistic discussion of many of the problems that this type of analysis can raise. As the chapter points out, information theory analyses are often useful and quite general, but lack robustness and thereby tempt workers to reach tenuous conclusions.

The fourth chapter, on temporal patterns, provides a good description of what the data analytic needs are in this area. The analytic techniques discussed are not very deep, and the tendency to generalize about behavioral data, as if they were of a type that admits generalizations, together with references to non-operational concepts, such as "sum of absolute fitness values," as if they could be implicated as measured values in an analysis of data, undermine the effectiveness of this chapter somewhat.

The chapter on hierarchical cluster analysis gives a good basic definition of the techniques from a computational point of view. The chapter is rich in examples and will no doubt serve to give the reader an introduction to these ideas. It seems to lack some of the modern theory that integrates techniques in unified concepts, and much of the work testing ideas of nonspecificity, congruence, and statistical significance goes unmentioned.

Contingency tables can provide a very basic tool for the analysis of quantitative data in ethology because behavior patterns are often best recorded as nominal data. The sixth chapter gives sound, classical statistical approaches to the analysis of data of this kind. These should be among the basic tools of all experimental ethologists.

Multidimensional scaling has enjoyed considerable popularity among quantitative psychologists in the recent past. It is applicable to a wide variety of situations, including many that may be encountered in ethology. The technique provides a means of arranging in space (usually of two dimension for easy viewing) entities that have each been measured for many variables. Such spatial ordinations can often reveal patterns of overall similarity and difference that may be suggestive of theory, which can then be tested by more direct means. The exposition is sound, though quite technical. Several examples help make the ideas more comprehensible to persons with weaker statistical backgrounds. The next chapter, on principal components analysis, presents a technique that serves the same purpose as multidimensional scaling but is based on more stringent assumptions, and thus admits more efficient computation and stronger statistical statements. It too is presented fairly rigorously but is rich in examples.

Multivariate analysis of variance provides a tool to test the credibility of specific hypotheses of animal behavior. Chapter 9 provides an explanation of this tool, and gives examples of how it can be used to strengthen the arguments for and against hypotheses to explain behavior. The field of ethology badly needs strength in this area.

Systems analysis has recently enjoyed some popularity in ecology, where recently many workers have begun to appreciate more fully its shortcomings. There is little reason to believe that, at present, systems analysis will be useful in the analysis of ethological data. Nonetheless, Chapter 10 presents an effective introduction to some of the basic ideas in systems analysis. As the author suggests, perhaps the most valuable use of systems analysis lies in the diagrams that can be used to visualize relations among behavioral components.

The short chapter on modeling concerns the use of systems of simultaneous differential equations in studies of ethology. This approach is closely related to systems analysis in that the same kind of equations can be generated by each. It suffers from the same shortcomings, namely, what does it mean in ethological terms that data can be closely simulated by systems of differential equations?

It is clear to all that ethology as a science can only be enriched and strengthened by the use of rational, objective, quantitative methods. *Quantitative Ethology* makes a solid contribution to this enrichment. Serious students of ethology can expect to benefit greatly from it, especially Chapters 1, 6, and 9.

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