

thors present their material in a manner understandable to the novice; in most cases jargon is minimized, and elementary and advanced references are provided. The book identifies several growth points in ethology and is written in a manner that allows and challenges workers in related disciplines to exchange ideas and approaches.

Dominance hierarchies have long interested students of behavior. The struggle for dominance has been explained easily on the grounds of individual selection. Recent workers, however, have documented complexities in the phenomenon—dominance may not correlate directly with aggressive level, dominant individuals may not achieve the most matings, and subordinate individuals may play a role in maintaining the dominance hierarchy. Mathematical techniques for quantifying the rigidity of dominance hierarchies were developed by Landau in the 1950's but only recently have emerged in the ethological literature. In this volume Bekoff discusses data that show that in five of ten groups of wolves hierarchies based on the behavior of subordinate individuals are stronger than those based on dominance behavior, and Aspey and Blankenship use factor analysis to demonstrate that subordination explains more of the variance in the behavior of spiders than does dominance. Game theory, which has proved fruitful in analyzing equilibrium points between aggressive and submissive behavior, is not addressed in the volume.

Temporal sequences of behavior have been difficult to analyze because of their complexity, frequent higher-order interaction with prior events, and dependence on context and motivation. Thus the probability that a given act will occur in a sequence may vary considerably from time to time, violating statistical assumptions of "stationarity" that are basic to Markovian sequence analysis. In their papers Oden, Steinberg, and Bekoff attempt to solve this problem by providing separate two-act contingency tables for initiators and responders and by partitioning data into steps of a sequence or into portions of the observation period or periods and analyzing the segments separately. Bekoff and Oden provide valuable new discussions of means of testing the variability and rigidity of behavioral sequences. Bekoff makes an eloquent plea for molding hypotheses and statistical tests to the biology of the animal rather than the reverse and for caution in interpretation. Steinberg presents a particularly clear account of the application of information theory to sequential vari-

ability and communication, including methods for testing statistical differences. The lack of exchange with ecology, where the use of information theory has a rich heritage, is surprising.

Aspey and Blankenship apply multivariate analysis to aggressive behavior of spiders and burrowing behavior of sea hares. Many readers will be skeptical of the procedure of measuring as many variables as possible, but the authors point out that this method identifies, with a minimum of human bias, groups of correlated data from populations of unknown heterogeneity. This is useful, since determining the degree of homogeneity in data sets is a major problem in the study of behavior, as was noted above with respect to sequence analysis, but the resulting composite factors must be carefully scrutinized for biological relevance and interpretation. One of the most valuable aspects of this paper is the authors' lucid comparison of several analytical treatments of the same data sets, identifying strengths and weaknesses of each technique.

Motivation, perhaps the greatest source of variation in behavioral data, remains one of the major unresolved phenomena in ethology. In a stimulating paper with connections to theoretical ecology and economics, Hazlett and Bach use stability analysis in a model of oscillating motivational states. They discuss how oscillations in motivational levels may result from interactions of different classes of behavior. Depending upon the structure of these behavioral interactions and external stimuli, behavior may shift to new stable points or oscillations or become unstable. It would be interesting to see if the ideas can be tested in real animals.

There is some overlap of topics among the papers in the volume, and several quantitative approaches in addition to game theory that have made contributions to ethology and evolutionary ecology recently are not included. My major criticism of the book is one that might be made of publications in a variety of fields. Why do not the assumptions of the quantitative methods used stand boldly with their critical demands in the opening paragraphs? No paper in this book lists and systematically discusses all the conditions that must be met for valid interpretation of the results. Such an approach is important for any study but is crucial in a volume that introduces a methodology.

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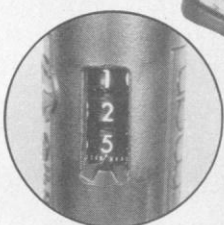
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