that the very best cows produce about five times as much as the national average (25,000 as compared to 5500 kilograms per lactation).

Nevertheless, although the improvement is striking, it is only about half as rapid as would be expected if the most efficient selection had been practiced. And in much of the Third World there has been very little genetic improvement of native strains.

For decades breeders have tried, with almost no success, to identify individual genes that affect production traits. Molecular markers will surely advance this hunting expedition. This book includes one outstanding example of a monogenic trait of great economic importance, the multiple-birth gene, *F*, in Booroola Merino sheep. The effect on litter size is roughly additive (+/+, 1.5; *F*/+, 2.2; *F*/*F*, 2.7). During each generation of selection for increased litter size, females of the selected Booroola strain were mated to introduced males from another strain. If the trait were polygenic, such selection would not succeed, because of the 50 percent dilution with each generation of outcrossing. Selection during backcrossing was long ago suggested by Sewall Wright as a way of finding and isolating a major gene; the Australian sheep breeders were unwittingly doing just this.

The current volume is substantially improved over its predecessor in several small but important ways. The printing and page format are better, there is an index, and the references for all the papers are pooled into a single list. Understanding some of the papers requires familiarity with statistics and matrix manipulations, but the majority are accessible to general geneticists. Here is a way to find out what is happening in the far from quiescent field of quantitative genetics.

The book is appropriately dedicated to Clark Cockerham, a student of Lush's and a leading statistical geneticist.

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Directions for Limnology

Complex Interactions in Lake Communities. STEPHEN R. CARPENTER, Ed. Springer-Verlag, New York, 1988. xviii, 283 pp., illus. $64. From a workshop, Notre Dame, IN, March 1987.

This book results from a workshop initiated by the National Science Foundation Ecology Program "to rethink research on community ecology of lakes" and "to set the tone of community level research in lakes for the next 5 to 10 years." It is clear this document is designed to support the establishment of a research center. The result is a view of community ecology that showcases the idea that organisms at the "top" of the food web are largely responsible for the observed species distributions at lower levels. Such a simplistic view is difficult to support given the available data, however, and the term "complex interactions" is proposed as a unifying theme. The idea is that recognition of the complexity should lead to greater care in experimental design and interpretation of results. Of course, it also leads to the conclusion that one investigator cannot hope to cover all the bases, hence the necessity for research centers (four are actually suggested).

The first half of the book is devoted to a set of eight plenary papers that present a series of examples of complex interactions. Three papers deal with pelagic food webs. Mills and Forney conclude that consumer forces control biological structure and producer forces regulate production at each trophic level (the latter is clearly unavoidable, given the direction of energy flow). One repeated theme is the idea of "bottlenecks" in food webs. In eutrophic Oneida Lake the bottleneck results from the inability of zooplankton to exploit large phytoplankton species in late summer, and in oligotrophic Gwendolyn Lake it results from the recruitment of juvenile midge larvae. Neill makes the excellent point that graded perturbations, rather than all-or-none, are most useful for understanding the limits of various interactions. Persson *et al.* decry the traditional schism between aquatic ecologists and fisheries biologists and also call into question the regression approach to understanding food webs. They offer an alternative approach that relies on determining the number of trophic levels along a productivity gradient. The lack of consideration of microbial interactions or trophic shifts by many species illustrates just how simplistic the model is.

Two contributions deal with the potential importance of microbial processes in food webs. The energetics question of how much of the carbon fixed by algae is burned up by the respiration of microbes and how much is transferred to higher trophic levels is raised. The role of *Daphnia* as a keystone species in this transfer process is championed in both papers. Some new and innovative techniques for measuring interactions among these small organisms are obviously required.

Two additional papers, based on models, deal with effects of time scale on food web processes. The model of Bartell *et al.* is particularly irritating in its unrealistic assumptions and parameters and reliance on dichotomies. The authors' explicit goal was to identify "particular circumstances where competition or predation dominate control" of community structure. I cannot perceive how such a result would be useful in a system of complex interactions. Concepts such as "control" and "direction" should be replaced with that of relative turnover rates. Carpenter emphasizes the importance of processes acting on the time scale of the lifespan of the dominant predator. Curiously, humans as the dominant predators in many aquatic systems are not considered.

I found the five group discussion chapters to be the most interesting part of the book, probably because they are more reasonable in tone than some of the plenary papers. The goal was to identify recent advances, current problems, and research needs with respect to food web interactions, size-structured interactions, habitat interactions, microbial interactions, and scale in design and interpretation of community structure. It is obvious that lakes are an ideal place to investigate many of the basic issues in community ecology. The food web group emphasizes the usefulness of gradient experiments and cautions against extreme manipulations that "may achieve statistically significant results of little ecological significance." Size structure is broadly useful as a scaling factor, and it is suggested that size-structured bottlenecks deserve study and that the physiological and reproductive potential of dominant species must be well known. Lakes are complex, heterogeneous spaces, so habitat interactions usually cannot be neglected. This group considers biogeochemical interactions to be important and actually mentions parasitism. Refreshingly, differential effects along gradients are a major theme. The microbial interaction group sees an undeveloped opportunity to take advantage of the fast time scales of microbial communities to examine many general theories in ecology. The group dealing with problems of scale is concerned mainly with experimental design from test tubes to comparisons across lakes. Many useful warnings are included.

Unfortunately, the theme of "top down" vs. "bottom up" control of community structure pervades these discussions. I have never seen the usefulness of an either-or conceptualization for processes that operate along a set of continuums governed by relative rate processes. The fact is that both growth and loss rates are involved in determining the abundances of species. In my opinion, it is counterproductive to ask which is "more important" for any particular species or trophic level. It would be better to try to develop ways to determine some of these rate processes more accurately and to include turnover rates in food web models.

Actually, aggregating species according to trophic level doesn't seem like such a useful concept after reading this book.

The final chapter presents arguments for the research centers and makes a plea for collaboration. One has to ask if lumping the diversity of species interactions (trophic dynamics, size efficiency hypothesis, keystone predator concept, optimal foraging theory, and so on) under the single rubric "complex interactions" has produced a useful conceptual framework for funding future research. There is at least a danger of rejection of research ideas because they cannot cover the range of time and space scales necessary to understand the full range of interactions. The goal of achieving the mechanistic understanding required for adequate prediction is admirable, as is the suggestion that we need to have four sets of research lakes (comparable to oceanographic vessels!) to cover the range of gradients. But we must be aware of the possibility that only one research site will be supported. Given that more restricted situation, certain paradigms could be emphasized at the expense of originality. The artificial and counterproductive concept of top-down vs. bottom-up is but one example.

The workshop was designed to set a future research agenda for aquatic ecology. Therefore I feel driven to comment on the fact that only one woman was included among the 40 invited participants. We should consider the full range of diversity not only in our research but in our colleagues as well.

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Monitoring Brightness

High Speed Astronomical Photometry. BRIAN WARNER. Cambridge University Press, New York, 1988. xii, 291 pp., illus. $59.50. Cambridge Astrophysics Series.

With the advent of large telescopes and the accompanying sophisticated instrumentation for optical spectroscopic work and infrared technology, the concept of photometry is too often currently labeled as "old-fashioned" or "not important." There are a few private institutions and individuals who have persevered in this field, developing and using instrumentation specifically designed to provide the best measurements of the brightness of rapidly varying sources and accomplishing important scientific results with this technique. Brian Warner is one such individual. Being fortunate to have access to large amounts of time on small and medium-sized telescopes, he (with his students) has provided the astronomical literature with a wealth of photometric data and interpretation of them. His book is a testimonial to the power and value of high-speed photometry and its wide-ranging applications in astronomy. Throughout, the emphasis is on the astrophysics that has emerged from the data that have been acquired. Warner clearly states the value and uses of the data and comments when they have not been used to full potential (as in the high–time-resolution studies on flare stars and the interpretation of the flickering and quasi-periodic oscillations in cataclysmic variables).

The discussion ranges from good coverage of planetary science (occultations) to a very small section on extragalactic astronomy, with the major emphasis on stars (flare stars, cataclysmic variables, pulsars, and pulsating white dwarfs and non-degenerates). The order is based on the chronology of discoveries, which leads to an easy transition to the direct results following from technical developments. It also results in interesting reading including or excluding the astrophysics involved. For example, the path leading from naked-eye measurements of lunar occultations during the time of Copernicus to the determination of the diameter of Alpha Leo from a 1980 trace obtained with the Kitt Peak 4-meter telescope gives a very clear picture of how far we have come in technique and knowledge. Embedded in this description is a good discussion of the physics behind the fringe patterns and their interpretation.

This same concise but in-depth coverage of the physics involved permeates all the discussion of the interpretation of light variability, starting with effects from the atmosphere (scintillation) and telescope (drive errors) through the determination of the correct periodicities in a data string, including effects of possible biases from the sampling frequency and of beat periods and Doppler shift complications in work on binary stars. The inclusion of the equations based on first principles and the numerous well-done plots of light curves, power spectra, and diagrams will make this book very useful for graduate students or astronomers from other disciplines who want to learn about the techniques, problems, and applications of high-speed photometry. The book will also be a good handbook for established photometrists—I found it useful to be able to compare the flickering in cataclysmic variables with that in x-ray binaries and extragalactic objects with the aid of the detailed light curves given for each system.

The references and discussion are somewhat biased toward work accomplished at the University of Texas, but this can be attributed to the large contributions of astronomers there to the study of occultations and of variable stars following their development of innovative photoelectric systems in the late '60s. The references as a whole provide a good overview of the important work being accomplished in each field.

The dearth of results from two-dimensional detectors is ascribed by Warner to the newness of the technique. I expect that the charged-coupled device detectors will affect photometry in the '90s as photoelectric photometers changed the field in the '70s. This will be especially true for small telescopes (CCD photometry of 20th-magnitude stars can now be accomplished on 36-inch telescopes) and for extragalactic sources. Knowledge of photometric variations at timescales of less than seconds will probably change more slowly pending further improvements. I am confident that Warner's celebration of high-speed photometry will continue into the future. Readers of his book will be motivated to join in the fun of making observations of rapidly varying sources.

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Earth Science and History

The Behavior of the Earth. Continental and Seafloor Mobility. CLAUDE ALLÈGRE. Harvard University Press, Cambridge, MA, 1988. xiv, 272 pp., illus. $35. Translated from the French by Deborah Kurmes van Dam.

"Scientific theories are like talented artists: once recognized their merits seem so obvious that their success is assumed to be due only to their excellence." So Claude Allègre begins his breezy account of mobility theory and its transformation of the geological sciences. He goes on to note that his "attempt to trace in an uncomplicated manner the evolution of the ideas connected with continental mobility . . . is combined inextricably with the goal of explaining mobilist geology and its essential concepts" and that he has "purposely simplified the work to give it a manageable size, make it accessible to the general reader, and place it in its proper sociological context."

Like most books recounting the history of plate tectonics, this one spans the years from Wegener's original proposal of 1911 through the early 1970s, by which time it was obvious to most that a revolution had occurred. In addition to following the well-