genotypes. The gene-culture link is completed by assuming that the fertility rates are modified by genotype-dependent social behavior. Accordingly, if use of a culturgen is defined as a phenotype, the Lumsden-Wilson model is equivalent to a single-locus model with incomplete penetrance. In order to apply the model to real data the validity of the single-locus model has to be established for individual behavioral traits. Furthermore, the magnitude of the fertility differences associated with different social behaviors must be precisely estimated because the relative differences in reproductive fitness may be only a few percent of the population average. Unfortunately, much practical experience in population genetics shows that such efforts will be extremely difficult, especially for such behavioral traits as aversion to strangers and skirt length in women, notwithstanding the allure of the quest.

The authors note the analogy between gene-culture coevolution and island biogeography in chapter 7. This extension is a natural one because the innovation of culturgens and their persistence in a population is analogous to the introduction of a new species and its survival. The final chapter summarizes and discusses future directions for human sociobiology.

Lumsden and Wilson have succeeded in demonstrating the theoretical possibility that genetic bias in cognitive and behavioral development can simulate pure cultural transmission. They have synthesized an abundance of fascinating interdisciplinary data into a dynamic model that emphasizes underlying mechanism. The Lumsden-Wilson theory of gene-culture coevolution will reward all who carefully study it because the authors have given us an explicit blueprint of the machinery linking genes and social learning as well as reviewed relevant operating characteristics of cognitive development.

Sadly, their sophistic presentation seems to be motivated by unjustified hereditarian advocacy. This is surely counterproductive to their goal of uniting the social and biological sciences. Their main conclusions depend on arbitrary assumptions and mathematical analyses that are ambiguous. The validity and generality of their assumptions about the inheritance of social behavior must be tested empirically. They lack perspective on the practical limitations of both genetic epidemiology and evolutionary genetics and pay inadequate attention to existing theories of frequency-dependent selection. Most critically, their theory can have little heuristic value because it is open to only weak tests at best. It will primarily serve to widen the schism between social and biological sciences because of its provocative overstated rhetoric.

The book is not suitable for a general audience. It requires some knowledge of stochastic processes, especially theories of Markov processes. The relationship, or lack of it, between the theoretical interpretations and the mathematical results must be cautiously weighed. The serious flaws in this theory can be remedied only by greater emphasis on the design of empirical tests and collection of extensive human data. Until that is done, the Lumsden-Wilson theory, like the psychodynamic theories of Freud and his faithful disciples, will enjoy wide retrospective explanatory power but can make only limited testable predictions.

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Phytoplankton Dynamics

The Physiological Ecology of Phytoplankton. I. Morris, Ed. University of California Press, Berkeley, 1980. x, 626 pp., illus. $74.50. Studies in Ecology, vol. 7.

Our attempts to understand the behavior of phytoplankton have been stymied to a large degree by our inability to bridge the gaps in spatial and temporal scale between the real world of microbes and the simulated world we are forced to deal with. This inability is related far more to our limited analytical and experimental capabilities than it is to any lack of creative hypotheses about how small organisms cope with their environment. Morris, in his preface to this important book on phytoplankton ecology, forewarns us of this problem by stating that "understanding the interactions between natural populations of organisms and their environment is not easy." The 15 chapters that follow, written by an articulate and most competent group of phytoplankton ecologists and edited in an exemplary fashion by Morris, are, on the one hand, reassuring in clearly demonstrating the great progress we have made in the past decade in dealing conceptually with the relations between physical processes in the aquatic environment and the physiological and biochemical machinery of the phytoplankton. On the other hand, the book reveals many of the inadequacies in our bag of experimental tricks that, unless remedied, will keep us in the dark for a long time to come.

The book is divided into four sections: Algae and Methodology, Light, Carbon and Photosynthesis, Nutrient Dynamics, and Population Dynamics. The chapters are uniformly well written and documented, and there is good continuity between sections. The opening chapter by Taylor is a synoptic review of the basic biology of phytoplankton, reflecting the author's many years of painstaking observations on the taxonomic and physiological characteristics of the phytoplankton groups. His view that in placing major emphasis on rate processes we are in danger of ignoring systematics serves as a somewhat sober reminder that the tedious and unrewarding jobs of counting and enumerating species are, and always will be, integral components of ecological analysis regardless of how sophisticated the science becomes.

Phytoplankton rate processes are, however, a major integrating theme of the book, and the emphasis primarily is on the physiological response to environmental perturbations. The chapters by Harris on photosynthesis and light, McCarthy on nitrogen dynamics, Walsby and Reynolds on sinking and floating, Platt and Denhan on patchiness, and Malone on algal size point out the gross disparities between the actual temporal responses of phytoplankton in a highly dynamic and changing environment, controlled for the most part by mixing and turbulence, and the measurement of these responses on captured samples contained in small bottles.

Similarly, Huntsman and Sunda elucidate the tremendous difficulties facing the physiologist in trying to understand the role of trace metals in phytoplankton ecology, primarily because of analytical limitations in determining the ambient concentrations, degree of complexation, and chemical kinetics of these sparingly soluble constituents. The importance of organism–trace-metal interactions becomes increasingly clear, however, as analytical techniques continue to improve. As Sakshaug and McCarthy point out, limitations in both quantitative low-level analysis of ambient nutrients and determination of the chemical composition and total biomass of phytoplankton in the presence of other organic materials place severe restrictions on our ability to test many of the current hypotheses on the physiological response of phytoplankton to nutrient availability. In this regard Smayda painstakingly outlines what we know about phytoplankton species succession and suggests that what is observed is the net result of small-scale perturbations in time and space superimposed on large-scale changes. From my viewpoint as a physiologist who normally deals with one perturbation at a time, the complex world of phytoplankton portrayed by Smayda will never be understood until we can make accurate measurements of each of the parts.

Overall, the book is an outstanding source of reference material for student and researcher alike. As a testament to the current renaissance in phytoplankton ecology, the book (which covers for the most part research through about 1977–1978, and in some chapters through 1979) already seems to be approaching obsolescence when compared with the recently published proceedings of the 1980 Brookhaven symposium, *Primary Productivity in the Sea* (P. G. Falkowski, Ed., Plenum, 1980; see review in *Science* **212**, 794 [1981]). The two volumes nonetheless, considered together, provide a comprehensive synthesis of the state of the art and define in explicit terms the scope and limits of our understanding of how very small organisms exist in the aquatic environment.

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Nuclear Shells

Theory of the Nuclear Shell Model. R. D. LAWSON. Clarendon (Oxford University Press), New York, 1980. xii, 534 pp., illus. $129. Oxford Studies in Nuclear Physics.

The goal of nuclear shell theory is to describe the energy levels of nuclei and transitions between these levels. Ideally the theory is based on known nuclear forces. In practice, however, a phenomenological description, in which the interactions between nucleons in various shells are parameterized, may be all that we can realistically hope for. The pioneering book on this subject is de Shalit and Talmi's *Nuclear Shell Theory*, published in 1963. Lawson continues their phenomenological approach in a more up-to-date treatment.

The technical apparatus of the subject has changed little since 1963, but more complete experimental data are now available. Lawson takes advantage of this to illustrate each idea with concrete examples from nature. Specific cases range from the lightest nucleus having more than one energy level, ^{4}He, to the heavy Pb nuclei. The experts in the field may know most of these examples, but few are found in previous textbooks on nuclear theory.

In principle, all nuclear states can be described by the shell model, but the number of configurations is generally too large to handle—even with the most powerful computers. Successful theory blends art and luck. The theorist must truncate the set of shell configurations that will be used in the calculation, and nature must provide him or her with nuclei that have limited numbers of active shells. Lawson progresses from the simpler "magic" nuclei to the more complex, mindful of the validity of the truncation approximations.

The calculational tools of nuclear shell theory are the angular momentum algebra and the fractional parentage expansion of wave functions. Lawson's step-by-step examples show how to use the angular momentum algebra. The most useful formulas needed for reference are compiled in appendixes. The fractional parentage expansion, which allows the theorist to isolate individual nucleons in a many-nucleon wave function, is thoroughly treated. The author is particularly careful in explaining sign conventions in the definition of wave functions. These conventions can be a stumbling block for those who want to apply the wave functions to experimental measurements.

The interaction between nucleons is best studied in nuclei with only two active particles. Lawson takes examples of these to deduce important characteristics of the interaction, such as pairing and the nearly perfect isospin symmetry. A major experimental tool for nuclear shell studies is the particle transfer reaction, because it is sensitive to the particular shell of the particle transferred. Taking examples of reactions on Ca isotopes, Lawson shows how to test the theoretical wave functions by calculating the reaction strengths, or spectroscopic factors.

Truncation of the shell configuration basis is not the only approximation technique at the theorist's disposal. Lawson discusses the weak coupling approximation, the seniority classification, pairing theory, and the projected Hartree-Fock approximation. Lawson demonstrates both the usefulness and the limitations of the approximations, with detailed examination of the wave functions and predictions for various nuclei.

Lawson's treatise does not cover vibrations or deformed nuclei, topics in which the shell structure is blurred. Most shell model calculations rely heavily on computers, and this numerical technology is not discussed or referenced. The useful techniques based on SU(3) and other higher symmetry groups are barely mentioned. Finally, Lawson's case method of approach can be disconcerting: the subject of beta decay is introduced during a discussion of the pairing approximation for In isotopes. These are minor shortcomings in view of what Lawson accomplishes in bringing together abstract theory and actual nuclei.

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Glaciers and Climate

The Last Great Ice Sheets. GEORGE H. DENTON and TERENCE J. HUGHES, Eds. Wiley-Interscience, New York, 1981. xviii, 484 pp., illus., + loose maps. In slipcase, $95.

Interest in the ice sheets of the world has rapidly increased during the last decade as the intimate relationship between glaciers and climate has become clear. For that reason the CLIMAP program of the National Science Foundation included a project to produce an analytical reconstruction of the late Pleistocene ice sheets. Even if it were viewed only as a report on that work *The Last Great Ice Sheets* would be extremely interesting and valuable; however, the book includes not only extensive and well-documented tabulations of data on the evidence relating to the areal distribution of the late Pleistocene ice sheets but speculations on glaciological theory as well.

It was not originally intended to publish all the papers contained in this volume together. As a result, the book is intermediate in nature between a collection of papers and a monograph. The closely related chapters (three on the areal distribution of ice during the last ice age, two on numerical methods of reconstructing glacier elevations, and three on ice sheet models) exhibit substantial redundancy (for example, entire maps are repeated with only the caption changed) and some inconsistencies in notation (for example, isostatically depressed levels are denoted by a prime in one chapter and an asterisk in another) and in spelling (Taimyr; Taymyr). Some of the figure legends are incomplete, and at least one map presents improper contouring. The absence of any list of figures and tables is a serious deficiency in a book having so many of them.

The authors' "most important conclusion is that the distribution of late Wisconsin-Weichselian ice sheets is not well