Hamiltonian aspect of the lattice devised by Kogut and Susskind within the framework proposed by Wilson. For much of the discussion the gauge group is discrete and the relation between phase transitions and confinement of static quarks is viewed in terms of Wilson-type area laws. The Coulomb gas representation also appears, but no mention is made of the rigorous results on Debye screening obtained by Brydges. In all, these three papers give a good overview of the lattice approach in the study of gauge theories.

At the other end of the scale, the relation of gauge theories to particle physics, there are seven papers in which quantum chromodynamics is the central topic. J. S. Ball deals with infrared problems related to the definition of an effective coupling constant in perturbation theory, and H. Leutwyler presents some interesting ideas on quark-bound states related to a nonvanishing expectation value for gluon contributions to products of quark currents. G. Kramer discusses the experimental picture, particularly perturbation theory calculations on jet formulation in electron-positron annihilation. For a mathematical physicist there is the welcome news that the data on jets are consistent with a quark-gluon view of hadron physics. As one of their main features non-Abelian quantum gauge fields should exhibit asymptotic freedom—the effective interaction strength between quarks and gluons should be energy dependent and become weaker at higher energies, at least if the gauge symmetry is not spontaneously broken. Asymptotic freedom makes gauge theories particularly attractive in that it may allow a more successful approach to the renormalization of the theories. This, of course, remains to be seen. Nevertheless asymptotic freedom is key to the incorporation of the parton model in quantum chromodynamics, wherein the quark and gluon constituents of hadrons appear to behave independently at high enough energy. A paper by B. Humpert and W. L. van Neerven discusses the dependence of parton cross sections upon the renormalization scheme chosen. It is clear that this aspect of quantum chromodynamics lacks the precision that perturbation theory has in quantum electrodynamics.

Other papers deal with instantons and the problem of quark confinement in gauge theories as well as the Ising model treated as a lattice gauge theory. These topics are well discussed here, as they have been elsewhere. A final paper I should like to mention is by K. D. Rothe and B. Schroer on the definition of various infinite determinants that arise in the mathematical analysis of gauge theories. The authors discuss the zeta function definition and its relation to two-dimensional models, which is probably different from the renormalized determinant that is studied in the constructive approach. E. Seiler has written on this difference very recently. In summary, the book gives a balanced overview of the main subjects of study at present in gauge theories and will be a useful reference, though with the pace at which developments take place it is hard to predict in which direction the field will turn in the next five years.

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Plant Reproduction

Reproduction in Flowering Plants. Papers from a symposium, Christchurch, New Zealand, Feb. 1979. Science Information Division, Department of Scientific and Industrial Research, Wellington, New Zealand, 1979. ii, 262 pp., illus. Paper, NZ$7.50. *New Zealand Journal of Botany*, vol. 17, No. 4 (pp. 425–686).

The biology of plant reproduction is one of the focal points of research in plant evolution and ecology. Matters of prime concern include plant-pollinator interactions in single- and multispecies arrays, the phenology of flowers and inflorescences and of populations, the characteristics and efficiency of pollen dispersal, breeding systems, gametophyte competition and selection, seed dispersal and dormancy, and the characteristics of seed pools. These issues are being addressed through observation and to lesser extents through experimentation and theory. There has been no attempt at a broad synthesis of plant reproductive biology, perhaps as a result of the degree of specialization of researchers in the field and the paucity of communication across disciplines.

The 15 papers collected in *Reproduction in Flowering Plants* are reviews of several aspects of plant reproduction, all but one involving the prezygotic phase. The treatment is weighted heavily in favor of pollination ecology and breeding systems; Australian and New Zealand plants are highlighted. In the main, the papers are comprehensive and of high quality and have something new and interesting to say. They speak to the vitality of the area. We see a shift in emphasis from almost pure natural history toward experimentation in several papers. Questions of "what" are being augmented by questions of "why." On the negative side, the reader is infrequently challenged by novel concepts or approaches. Moreover, there are no attempts to link traditional areas of study or to focus on common problems or issues. We are left with a group of related papers each going its own way. Nevertheless, the proximity of so many good papers is a stimulus for creative thinking.

The relationships of flowers and their vertebrate pollinators is one of the emerging concerns of pollination biology. Papers by Armstrong and by Ford, Paton, and Forde treat the subject in fascinating detail. Armstrong describes the pollination biology of flowers pollinated by marsupial and placental mammals, especially rodents, and suggests that such flowers are derived from bird-pollinated flowers. Functional aspects of breeding systems are reviewed from several vantage points by Bawa, Connor, Ganders, and Godley. Why do so many species have specialized outbreeding mechanisms? Godley argues that the relatively high proportion of dioecious species in New Zealand (which has often been interpreted in terms of immediate, special adaptation) is a function of the taxonomic affinities of the immigrants to New Zealand. Dioecy also is relatively common among the trees of some tropical communities. Bawa observes that dioecy is related to animal pollination, but why animal pollination would favor or be associated with dioecy remains to be determined. In his review of heterostyly, Ganders proposes that floral dimorphy increases effective pollination and seed-set over the levels occurring in comparable homomorphic systems. He suggests that the ancestors of heterostylous plants were self-compatible and when selected for incompatibility may not have had a choice between diallelic heteromorphic and multiallelic homomorphic incompatibility. Perhaps dioecy also evolved from self-compatible ancestors as a path of least resistance to outcrossing. Whatever the advantages (or are they consequences?) of different outcrossing mechanisms, it is becoming apparent that the payoff is now. In a thoughtful commentary on reproductive strategies, Lloyd contends that the "evolution of self- and cross-fertilization, sexual and asexual reproduction . . . must be sought in selective forces affecting individuals in each generation." He advocates the interpretation of reproductive systems in terms of the success of plants as seed and pollen parents.

The reviews of breeding systems in the

Onagraceae by Raven and in the Gramineae by Connor speak not only of the diversity of these systems but of their lability in evolutionary and ecological time. Raven contends that in the Onagraceae self-pollination has evolved independently at least 150 times. Connor shows the great extent to which environmental variables may alter the balance between self- and cross-fertilization and sexual and asexual reproduction in grasses. Self-incompatibility not only is overcome naturally, it may also be circumvented by various laboratory procedures, the practice and application of which are discussed by Pandey and Cocking. The genetic and physiological bases of incompatibility are reviewed by Lewis and Heslop-Harrison respectively.

Scientists interested in reproduction within evolutionary or ecological frameworks will find the volume to be of great value.

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The Behavior of Fishes

Diversity and Adaptation in Fish Behaviour. MILES H. A. KEENLEYSIDE. Springer-Verlag, New York, 1979. xiv, 210 pp., illus. $37.80. Zoophysiology, vol. 11.

Students of ethology have long awaited a textbook on the behavior of fishes, not because the behavior of fishes is fundamentally different from that of other organisms but because their remarkable diversity makes them ideal for comparative testing of functional hypotheses. In many aspects of their biology the fishes are more variable than the notoriously diverse insects. Therefore it is not surprising that a book on the diversity of behavior in the fishes is more easily criticized for what it does not say than for what it does say, especially when the text occupies a mere 177 pages.

Keenleyside would seem to be an ideal author for a book on the subject. He has conducted laboratory and field research on many aspects of fish behavior including courtship, parental care, and schooling and has direct experience with freshwater and marine habitats in temperate and tropical climates. He wisely avoids simply recapitulating behavioral principles as they apply to the fishes, and instead emphasizes behavior as an adaptation to the diverse ecological situations faced by fishes. However, by his own admission the work is highly selective. There is a chapter on locomotion in fishes, but none on sensory mechanisms, and orientation is not discussed. Arthur Hasler's classic series of field studies of orientation in migrating salmon are not cited or listed in the bibliography. Nor is this the only gap in the book's coverage. Because of the prevalence of distinct and specialized larval forms, behavioral ontogeny is an important aspect of fish behavior, yet it is hardly mentioned here. The pivotal role of quantitative and experimental studies of fish behavior in generating many of ethology's fundamental principles is not even hinted at.

Roughly half (85 pages) of the text is devoted to reproductive behavior. This is a subject with which Keenleyside is very familiar, and we see glimpses of the book he might have written. However, this section has an organizational flaw in that the subject is divided among three chapters—on spawning site selection, breeding, and parental care—and the same examples are discussed in each. Keenleyside's use of references is singularly spotty. He cites his own contribution to a recent symposium volume, yet ignores relevant papers by several other contributors to the symposium. These chapters also suffer from unfortunate timing, for several important reviews and discussions of parental care in fishes appeared while the book was in press, too late to be taken into account (the most recent references cited are from 1978). The discussion of schooling in the final chapter is similarly compromised.

The book is not synthetic or comprehensive enough to be a reference monograph for professional fish behaviorists, and because it assumes a familiarity with the basic features of anatomy and functional morphology of fishes it cannot serve as an introduction to the fishes for other behaviorists. It is best suited to the student who is familiar with the basic biology of fishes and now wishes to know something of their behavior. Though not the definitive work we had hoped would appear, however, it is important as the first serious attempt by a senior researcher to produce an overview of the discipline. Previous works have all been symposium volumes or collections of papers haphazardly assembled, and Keenleyside has produced a volume that is of substantially greater value than these. In clearly perceiving that the unique and valuable features of fish behavior are its diversity of form and circumstance, he has charted a course that future authors would be wise to follow.

The book is well produced, well written, and easy to read. The illustrations are clear and straightforward, although there are occasional gaffes; a drawing of *Pantodon buchholzi* is so inaccurate in fin morphology that the species is scarcely recognizable.

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Books Received

Academic Turmoil. The Reality and Promise of Open Education. Theodore L. Gross. Anchor/Doubleday, Garden City, N.Y., 1980. x, 250 pp., $10.95.

Acoustical Imaging. Vol. 8, Ultrasonic Visualization and Characterization. Proceedings of a symposium, Key Biscayne, Fla., May 1978. A. F. Metherell, Ed. Plenum, New York, 1980. xii, 790 pp., illus. $59.50.

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British Coastal Shrimps and Prawns. Keys and Notes for the Identification of the Species. G. Smaldon. Published for the Linnean Society of London and the Estuarine and Brackish-Water Sciences Association by Academic Press, New York, 1979. vi, 126 pp., illus. Paper, $11.50. Synopses of the British Fauna, No. 15.

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