bilin or green" symbionts lead to cryptophytes, rhodophytes, euglenoids, chlorophytes, and higher plants, while also in this line are the higher animals, ascomycetes, and basidiomycetes. Provocative to the end, the authors suggest that these two lines constitute two kingdoms into which all eukaryotes could (should?) be classified.

Fascinating points occur throughout the book in relation to specific groups: 70 mutants of *Chlamydomonas* defective in wall synthesis, with most mutants differing from the wild type by a single gene and control of wall synthesis apparently extranuclear; production of scales of various types in Golgi systems and endoplasmic reticulum of prasinophytes, chrysophytes, and prymnesiophytes, providing keys to informational behavior of endomembranes and to cell wall origins; flagellar roots of bewildering complexity, all asymmetric and all of phylogenetic import, but all of unknown function in relation to locomotion or communication with organelles to which they attach (nuclei, chloroplasts, plasmalemma, eyespots); and so on. However, most of the authors consider their cytological, ultrastructural, and biochemical information phylogenetically, and their contributions lead naturally to the concluding chapter by Stewart and Mattox, where problems abound. What of the apparently genuine absence of flagella in red algae? What of suggestions that microtubules evolved first as cytoskeletal components of the eukaryotic cell and that 9 + 2 flagella are relatively recent? What is the functional difference between mitochondria with flat and tubular cristae that could determine which type of pigmented endosymbiont became incorporated into a cell as a chloroplast? (The authors do propose answers to these questions, for which see the book.)

No doubt the anti-endosymbiosis camp will be heard; no doubt others will revive ideas on origin of flagella from spindles rather than vice versa; no doubt further data will accumulate to support or modify the ideas presented here (one awaits detailed information on conservative proteins with impatience). In the meantime, this book contains much to educate and stimulate the phycologist, protozoologist, and general biologist who might not immediately think that the phytoflagellates are of much interest to him or her.

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Chaos and Strange Attractors

Nonlinear Dynamics. Papers from a conference, New York, Dec. 1979. ROBERT H. G. HELLEMAN, Ed. New York Academy of Sciences, New York, 1980. xii, 508 pp., illus. Cloth or paper, $98. Annals of the New York Academy of Sciences, vol. 357.

Nonlinear dynamics encompasses a wide variety of phenomena, from turbulence to interacting species and ecologies. In fact, any phenomenon whose evolution is governed by nonlinear rate equations could be given the nonlinear dynamics label.

From the older, more traditional problems such as turbulence, there have emerged new applications and some new and exciting ideas (with catchy names such as "chaotic flows" and "strange attractors") that have attracted many workers to the field.

The book edited by Helleman, containing 44 papers presented at a conference, attempts to summarize the state of numerous aspects of the subject as of late 1979, with chaotic behavior of nonlinear deterministic systems the underlying theme. The attempt succeeds admirably to say the least. The papers, almost without exception, are clear and readable even to the nonspecialist. They are mostly theoretical in nature, but there are a few interesting and delightful experimental papers on turbulence. There is even a list of introductory references for those who do not wish to plunge immediately into chaos.

The papers are ordered in the way they were presented at the conference and are grouped sensibly under the general headings of Turbulence, Ergodic and Integrable Behavior, (applications to) Physics and Chemistry, Chaotic Maps and Flows, Chemical and Fully Developed Turbulence, and Strange Attractors. The potential reader who has heard of and may wish to know more about chaos and strange attractors will find much of interest under these headings, including the exotic universal behavior of simple maps on an interval and its possible relevance to turbulence.

Within the aforementioned categories, the reader will find applications to ecology and epidemiology, astrophysics, statistical mechanics, plasmas, reaction-diffusion systems, turbulent convection and flows, and some other more specialized topics, as well as some papers on more mathematical aspects of the subject. In fact it is difficult to think of something nonlinear that is not at least touched upon in this book. Mathematical and physical practitioners will surely find something of interest in it and will be tempted to learn more, even if they are not nonlinear specialists.

The field is seeing renewed interest and contains exciting new ideas and some hints of major breakthroughs, and it is possible that much of the contents of this book will not stay current in the near future. It will, however, stand as a useful source of references to the state of the nonlinear dynamics art circa December 1979. It is to be hoped that the next conference proceedings on this subject will be as well organized and presented as its immediate predecessor.

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Denizens of the Amazon

The Fishes and the Forest. Explorations in Amazonian Natural History. MICHAEL GOULDING. University of California Press, Berkeley, 1981. xii, 280 pp., illus. $20.

Fish are a major food source in the Amazon Basin, and Goulding contends that many commercial species are almost as dependent on the Amazonian forest, and as vulnerable to deforestation, as the better publicized terrestrial fauna. The floodplains of most Amazonian lowland rivers are inundated annually, forming extensive varzea forests. In this popular account of his studies on the larger fishes of the Rio Machado and Rio Madeira in southwestern Brazil, Goulding argues that these forests are the ultimate base of the aquatic food chain.

Goulding convincingly shows that many common fishes move into inundated forests and eat large quantities of fruits and seeds, fattening up for the rest of the year. (Several of the larger characins break hard nuts with dentitions that seem nicely specialized for nut-cracking; some of the piranhas masticate seeds with dentitions that seem as fiercely specialized for flesh-eating.) During low water, the fish move into floodplain lakes or back into the main river and eat little. Throughout the year, insects, leaves, and detritus are also important varzea-derived food sources. Thus, the varzea is the direct food source for a number of commercial species and the indirect source for the numerous piscivorous fishes.

This is solid work, but Goulding concludes too much from it. He claims that