Pathfinding in Ecology

Perspectives in Ecological Theory. RAMÓN MARGALEF. University of Chicago Press, Chicago, 1968. viii + 112 pp., illus. $4.50. Chicago Series in Biology.

For the past 15 years Margalef has been concerned with proposing and exploring possible new ecological paths. His approach is frankly speculative and analogical. To some extent mathematical theories are invoked rather than analyzed. Cybernetics, systems theory, and information theory are picked up and tossed about and occasionally are made very useful—as for example, in his information-theory analysis of the spatial distribution of phytoplankton.

To a very large extent Margalef has worked and thought alone and developed his ideas without the abrasive intellectual contacts that we take for granted in America. This produces freshness and conviction but also leaves me with a feeling that sometimes the introspective conviction becomes more poetic than scientific. For example, Margalef is convinced that biological communities age or mature in a way more or less analagous to the maturing of an individual. He has set up certain criteria by which he distinguishes between mature and immature communities. These criteria are partially empirical—so that older individuals and more crowded populations are considered to characterize mature rather than immature ecosystems—but some of them are nonempirical and without any obvious derivation. The biomass preserved per unit energy flow is one such criterion, and this is speculatively extended to the idea that mature systems produce less entropy than immature systems in exchanging a fixed amount of energy. The usefulness of such speculation is not immediately apparent, particularly since precise measurement of entropy in any ecological context is yet to be made. Margalef also states with respect to maturity that "the structures that endure through time are those most able to influence the future with the least expense of energy," which sounds fascinating although I'm not clear exactly what it implies.

In short, there is a kaleidoscopic juxtaposition of specific theories, loose speculation, and fresh, insightful statements. I suggest that this book by all means be read by ecologists, but with an attitude of caution. The reader is in fact required to do the job the editors should have done. In his foreword Margalef indicates that the English was considerably improved by the "editors and colleagues." In fact, the English is fine. I wish that, in addition, Margalef had been required to argue his ideas against rather stiff opposition before the book went to press. This is the first volume in a prospective series with a distinguished collection of editors. I have the impression, which may be false, that these editors have considered their role as honorary with regard to this volume.

Ecology is in an overstrained and embarrassing position. After years of neglect and underfinancing, during which courses in ecology consisted largely of misidentifying local beetles and research in ecology consisted of amassing mason jars full of mixed offal and detritus to be somehow "quantified" later, ecology has recently become fashionable, and the publication of this book is related to this new fashion. For the past five years or so government agencies have become increasingly concerned with problems of the environment or at least concerned with looking concerned. (Environmental research is an ideal thing for vice presidents to worry about, thereby solving at least one problem.) Ecology, after years of feeling itself rather homely, is being treated as a newly discovered beauty—and responding in the flustered and sometimes foolish way that one would expect of an adolescent beauty newly emerged from the cygnet stage.

This gives rise to foolish expectations on all sides. Ecology is not merely a "viewpoint" or an "attitude." If it were, then we might expect the answers to real questions to come from the attitude or viewpoint of its practitioners, in the same way that religious sages can on occasion produce answers when called on. But just as authentic religious leaders indicate the beginning of a path to answers and expect their disciples to walk with their own feet, only the charlatans offering instant salvation, so the authentic leaders of ecology are almost desperately looking for paths rather than proclaiming answers.

Despite the objections I have to certain aspects of the book it is clear that Margalef is a serious intellectual leader in ecology and that he has indicated at least the beginnings of several new and potentially exciting paths. That none of these paths is followed very far may be a virtue related to Margalef's insight and honesty.

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Phycology

Algae, Man, and the Environment. Proceedings of an international symposium, Syracuse, N.Y., 1967. DANIEL F. JACKSON, Ed. Syracuse University Press, Syracuse, 1968. x + 554 pp., illus. $18.

This volume is not unlike other symposium volumes in its strengths and weaknesses. The title is ambitious and its broad coverage reflects the heterogeneity of the content. At best the book presents a sampling of some kinds of research dealing with algae, from the applied to the strictly basic. It will serve to bring to the attention of the reader the concern of individuals and governments in an increasingly studied group of microorganisms. However, it is very much a potpourri, the contents ranging from reviews of the recent literature in Russia and New York state to an exposure of taxonomic philosophy and to studies dealing with the engineering of sewage treatment in which the algae are scarcely mentioned at all. Most specialists would severely criticize the lack of cohesiveness in the selection of topics and an attempt to organize a symposium which focused so little on any segment of the subject. However, in this very fault the book provides the general reader with a selection of intriguing, and in some cases beautiful, papers dealing with certain aspects of phycology.

The book is entertaining. The reminiscences of Harold Bold, who provides an overview of both research and researchers, will undoubtedly stimulate phycologists to look with more perspective at their discipline, as it will acquaint the casual reader with the trends in research. Norma Lang has assembled a striking collection of electron photomicrographs which exquisitely dissect the ultrastructure of the blue-green algae. Especially suggestive to readers concerned with the mechanisms of suspension of algae in natural waters are the figures showing numerous static gas vacuoles in *Nostoc*. The Schwimmer brothers have summarized a fair portion of the literature on the medical problems associated with algae. Careful examination of this literature will undoubtedly make many readers wonder what has happened to Koch's postulates for establishing the causality of a microorganism in disease.

The book will be needed by phycologists because it provides an introduction to the literature of certain aspects of phycology not normally available

to the specialist. It places phycology on a global stage and may help the investigator to orient himself. The contributions are for the most part from the pens of distinguished authorities in the field. However, it will surely be confusing to the nonspecialist who expects to learn much about algae, man, or the environment.

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Advances in Algebra

The Great Art. Or the Rules of Algebra. GIROLAMO CARDANO. Translated from the Latin edition (Nuremberg, 1545) and edited by T. RICHARD WITMER. M.I.T. Press, Cambridge, Mass., 1968. xxvi + 270 pp., illus. $10.

In a sense Girolamo Cardano's *Ars magna* in 1545 was to mathematics what the *De revolutionibus* of Copernicus and the *De fabrica* of Vesalius had been two years earlier to astronomy and anatomy. Indeed, the *Ars magna* was perhaps the most revolutionary of the three. Copernicus had applied the mechanism of Ptolemy to the view of Aristarchus, and Vesalius had corrected details in Galen; but the work of Cardan disclosed the greatest step in the algebraic solution of equations since the days of Hammurabi. Quadratic equations had been solved by the pre-Hellenic Mesopotamians, but cubics had resisted the best efforts of ancient and medieval mathematicians. Today the solution is well known, yet the volume in which it was first made public has been as little read as it has been much praised. Even mathematicians who use the familiar "Cardan rule" frequently are unaware that in the *Ars magna* the author three times candidly wrote that he had obtained the key to the solution from Tartaglia and that the formula originally had been discovered in about 1515 by one Scipione del Ferro, professor of mathematics at Bologna. With an English translation available, perhaps it is not too much to hope that Cardan will be more widely read and that "his" rule will before long become known as "del Ferro's rule."

Past neglect of the *Ars magna* is easily understood. Quadratic equations today are represented by a universal notation, $ax^2 + bx + c = 0$, and solved by a single formula. From Babylonian days to the time of Cardan there were three distinct types of quadratic equation: square and thing equals number; square equals thing and number; and square and number equals thing. (A fourth type, square and thing and number equals zero, was excluded as having no solution.) For cubic equations there are 13 cases instead of three; and Cardan rhetorically and laboriously worked through each one, giving numerical illustrations and geometrically based demonstrations, all in the tradition of Mohammed ibn Musa al-Khowarizmi. In Witmer's translation the repetition of cases is unavoidable, but the tedium is mitigated through the liberal use of modern notations. A critic can argue that such modernization misrepresents the thought of the original, but such an indefatigable scholar can check the symbolic translation against the original rhetorical version in extant Latin editions. Less demanding English readers will welcome the fact that now they have a less challenging entree not only to Cardan's solution of the cubic but also to the surprisingly ample store of algebraic methods to be found in the *Ars magna.*

At one point in the book Cardan wrote that he would do little with equations beyond the cubic. "For as the first power refers to a line, the square to a surface, and the cube to a solid body, it would be very foolish for us to go beyond this point. Nature does not permit it." The author fortunately did indeed go beyond three dimensions, and in the next-to-last chapter he divulged a method, discovered by his amanuensis Ferrari, for solving equations of the fourth degree; and even quintic equations come in for some consideration. In one of the most rewarding portions of the volume, the chapter "On the transformation of equations," Cardan converts an equation of the form $x^5 + ax^3 = N$ to one of the form $x^5 = bx^2 + N$. He evidently was less timid about dimensionality than about imaginary numbers, which he stigmatized as "useless." At one point he framed and solved a problem leading to a quadratic equation with imaginary roots; but he missed the significant relation between imaginary numbers and cubic equations. It was later disclosed by Bombelli that when the three roots of a cubic are real, del Ferro's rule fails—that is, unless one follows a hazardous path through the realm of imaginaries. Following this discovery, one might well ask the very pertinent question, are "imaginary" numbers really imaginary?

There are algebraic novelties in the *Ars magna* which in part support Cardan's boast that the book is "so replete with new discoveries . . . that its forerunners are of little account." To the translator we owe a debt of gratitude for making so readily accessible this rich store of renaissance algebra, and it may be ungenerous to suggest that a more adequate index would have increased somewhat our debt. (Mention might incidentally be made of the confusion resulting when footnote indices are attached like exponents to numbers and unknowns: a casual glance on page 58, for example, might lead one to believe that a 16th-century mathematician was working with such things as x^{55} and 80^6.)

In addition to the text of the *Ars magna,* the reader will welcome the translator's preface in which attention is called to Cardan's numerous contributions to algebra. There is also a foreword, dated July 1968, in which, just a month before his untimely death, Oystein Ore left a perceptive evaluation of the place of the *Ars magna* in the history of mathematics and an account without rancor of the roles of Cardan and Tartaglia in their notorious feud. The *Ars magna* closes with the words, "Written in five years, may it last as many thousands." As Latin is becoming distressingly little read, it is only through translations such as this that Cardan's wish may come true.

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For Accelerator Users

Particle Acceleration. J. ROSENBLATT. Methuen, London, 1968 (U.S. distributor, Barnes and Noble, New York). viii + 183 pp., illus. $5.50. Methuen's Monographs on Physical Subjects.

In the preface to this volume the author states that it is intended primarily for those who are concerned with machines mainly as research instruments but must nevertheless learn the principles of their operation. The book deals with a wide variety of subjects, including cascade generators, insulating-core transformers, tandem Van de Graaff accelerators, and linear and circular accelerators of both low and high energy. It includes discussions of focusing, phase stability, beam extraction, and strong focusing as well as a very brief mention of "meson factories."