Tropical Horticulture

Many books on tropical horticulture have been written by authors of little experience who repeat errors already in the literature. Arthur Thomas, the author of **Gardening in Hot Countries** (Faber and Faber, London, 1965. 207 pp., 30s.), avoids these pitfalls by discussing plants and methods that he has used and found successful.

Thomas received his early horticultural training in Britain and then went to tropical Africa where he made his career in tropical horticulture. For many years he was in charge of the Botanic Garden at Entebbe, Uganda. His book is thus slanted toward African conditions and plant materials. However, owing to the great uniformity in the plant materials used for landscaping purposes all over the tropics, any gardener in the tropics will find that most of the plants mentioned in the book are grown in his own area.

Throughout the book Thomas recommends following local methods and using local plant material as much as possible. He wisely advises the gardener not to attempt to make a temperate climate garden in the tropics. In hot climates, orchids are much easier to grow and will give the gardener more satisfaction than roses. Where the climate is warm and sunny a northern type of floral display is not needed in the garden, and lush green foliage and shade trees will be more satisfying in the long run.

The book covers the whole range of activities from preparing soils, plant propagation, the control of insects and pests, to selecting the right plant for a certain spot in the garden. Many species of plants are briefly described. The wealth of plant materials in the tropics is so great that a good sized encyclopedia would be required to give much detail about the plants found even in one locality!

Some of the taxonomy in the book is outdated, but this will not disturb gardeners. More disturbing is the omission of a description of the side-veneer graft in the chapter on propagation. This method is now the most common one used in many tropical countries.

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An Explanation of Life Based on the Laws of Physics

In this concise, lucid treatise, **The Machinery of Life** (McGraw-Hill, New York, 1966. 222 pp., $7.95), Dean Wooldridge has set out to prove that everything about life, from its chemical beginnings to consciousness in man, is explainable through the laws of physics. Where a physical explanation is not possible this is due to ignorance, remediable in time, he maintains, and not to supernatural involvement. One could not agree more with this view.

In a remarkably short space Wooldridge traces the abiogenic transition of simple inorganic substances through the formation of simple and complex organic compounds, precellular structures (coacervates), and cells to higher forms, in a logical and narrative style. The clarity achieved is all the more remarkable in view of the paucity of illustrations (only six original drawings in the nucleic acid chapters). This brevity and clarity were made possible, in part, by avoiding the controversies that today characterize this subject. The physical explanations of the stages through the formation of simple coacervates, where experimental documentation abounds, are compelling. Each successive level of organization of matter is easily seen to be the almost inexorable outcome of the conditions of the preceding level. As his narrative unfolds, Wooldridge calls attention, at every turn, to the fact that no supernatural forces had to be invoked.

A wide gap exists between coacervates and the most primitive "living" thing toward which Wooldridge is driving. This is a critical part of the story. Much rests on a convincing explanation of the transition based on physical laws. Experimental evidence is lacking here and henceforth the explanations are based on premise built on premise, all mechanistically sound to be sure, but the inexorability of the argument is gone. One can make other premises based on other models, and this is one point at which the Vitalist can take his departure and press his own case. This departure could have been delayed, I believe, had Wooldridge chosen Fox's proteinoid microspheres for his precellular models, in view of the recent advances reported in the construction, properties, and maintenance of microspheres.

Wooldridge next sets out to derive functional nucleic acids from first principles, but it is clear that he has taken his cues from our present knowledge of the physics, chemistry, and hereditary role of modern nucleic acids, and has woven a story ad hoc. The five chapters on nucleic acid are based on too many unrelated, purely chance events leading to an advanced mechanism for polymer synthesis which only by chance finds usefulness in some fortunate coacervate. This strains credulity. The chemistry of the coacervates, on the other hand, remains nebulous, and one has the picture of a rather precise mechanism operating almost *in vacuo*. This is a natural outcome of the present-day excessive preoccupation with the concept that DNA is the secret of life. As Commoner has argued in several perceptive articles, the reverse may be the case: Life is the secret of DNA. It is more likely that nucleotides, singly and as polymers of various lengths, played an early part in precells and developed in complexity with the developing complexity of the rest of the chemistry and that they were at all times an integral part of that chemistry.

Another point at which the Vitalist can take his leave from the Mechanist's explanations is at the level of the "mind." At this level the arguments of each at the present time must rest on the faith each has in his own view.

I should imagine that most scientists have outgrown the vitalism-mechanism controversy. However, the layman and the student should find this book a very stimulating and fascinating exercise.

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Astronomy for the Layman

The earth has not always been here. When and how did it come into existence? The solar system *is* a system, not a random collection of objects. When and how was it born? These are heady questions, inviting both the wildest speculations and the most serious scientific investigations. Very substantial progress has been made during the last 35 years, and new evidence in this intriguing and continuing mystery story —and new questions—have come from such diverse sources as nuclear reactions in the sun and stars, the chemistry of meteorites, Martian craters, red shifts in distant galaxies, earthquakes, astrometric binaries, the eccentricities

of comet orbits, asteroid rotations, collapsing galaxies, and craterlets on the moon.

Sky and Telescope, a journal with high standards of editorial competence and a wide coverage of astronomy, is attractive to laymen and amateur and professional astronomers alike. Papers from 13,000 pages of it and its predecessors (dating from 1931) were expertly selected by Thornton Page and Lou Williams Page, the editors of **The Origin of the Solar System: Genesis of the Sun and Planets, and Life on Other Worlds** (Macmillan, New York, 1966. 350 pp., $7.95), in order to present this account, which is necessarily speculative at times, of our increasing understanding of the origins of the earth and the solar system. The Pages have provided continuity by inserting numerous appropriate commentaries, especially necessary in a book of this type and on this subject, where many of the contributions are "dated" and need to be put into proper perspective. The book will be enjoyed by all those who enjoy reading *Sky and Telescope*.

Selections of special interest are "How did it all begin," by Henry Norris Russell; "The solar energy spectrum" by Harriet Malitson; "Finding the age of the earth," by Otto Struve; "Barnard's star as an astrometric binary," by Peter van de Kamp; "The origin of comets," by Otto Struve; "Some astronomical aspects of life in the universe," by Su-Shu Huang; and "How can we detect radio transmissions from distant planets?", by Frank Drake.

This last contribution concerns Project Ozma, the controversial observational program of listening for radio signals from possible intelligent life outside the solar system. It seems to me that this program may well have been based on a fundamental misconception. *If* there is such life "nearby" (and one should remember here that only one possible planet has been tentatively located outside of the solar system), it would be almost completely improbable that its level of technology would be within 50 years of ours; it may be at a pre-Stone Age level, or it may be highly developed beyond our wildest imaginings. If the latter, such intelligence would have radio reception and transmission facilities not just billions of times more powerful than ours, but something really "out of this world." Some of our own transmissions, made during the past half century, are spreading out through space and should eventually reach such life—if it is there—and be readily detected and interpreted—there. An answering transmission would be so powerful that it would be readily received without special preparations, and so intelligently put together that its source would be obvious. Perhaps we should just sit down and wait. And perhaps we shouldn't answer!

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Biochemical Engineering

Suichi Aiba (Institute of Applied Microbiology, University of Tokyo) was joined by A. E. Humphrey, a visiting American engineer, and Nancy F. Millis, a visiting Australian microbiologist, in writing **Biochemical Engineering** (University of Tokyo Press, Tokyo; Academic Press, New York, 1965. 339 pp., $15). That the authorship should span three continents is appropriate because the subject draws on the separate disciplines of biology, chemistry, and physics which, like the world, are being drawn closer together. Books like this one can help knit the sciences through practical engineering problems.

The authors properly define biochemical engineering as "concerned with economic processing of materials of biological character or origin to serve useful purposes." Then they promptly narrow the scope of the book to fermentation engineering—that is, the application of chemical engineering to the industrial use of microorganisms. It is the only thorough book on the subject now available, and I believe it will be widely used as a reference source and text book.

In the first chapters, which describe microorganisms and their fermentation pathways, particular attention is given to practical application. These chapters are so valuable that one wishes Miss Millis had participated in the writing of the rest of the book, which suffers from disregard of the underlying biology or biochemistry. On the whole, the subjects treated are the right ones: kinetic patterns of growth and product formation, aeration and agitation, sterilization, special equipment, and control devices. The approach is also correct in that it provides an analytical rather than a descriptive account of the fermentation process. Frequent references to data in the current literature and the citing of worked-out numerical examples aid the reader. A logical innovation is the early discussion of continuous fermentation, even though the technique is not used much in industry.

It is stated in the preface that no mathematical understanding beyond calculus is required, but microbiologists will be confused by engineering quantities (eddy diffusivity, for example) that are not adequately explained in physical terms. Although it is stated that modern theories of mass transfer, which are briefly described, are useful for solving aeration problems, the authors do not provide additional discussion. Even engineers will feel that the mathematical manipulations are often cumbersome. For example, a rather involved discussion of the cumulative age of cells in continuous culture leaves the reader unsure about whether they are older or younger than indicated by their mean retention time in the fermentor. The treatment of batch sterilization of media is unnecessarily elaborate. A practising engineer would either make a linear approximation to the proposed exponential and hyperbolic heating curves, or he would realize that his knowledge of heat transfer coefficients was inadequate and do a graphical integration of measured heating and cooling curves. Neither approach is mathematically very elegant.

The strong point of the book, then, is that it provides a starting point, not that it is a complete designer's manual or student's text. Many new ideas are presented and there are some data from the Japanese literature about which we in the West are too often ignorant. Thus, in many ways it is a pioneering effort.

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"Tree Grasses"

This handsome volume, **The Bamboos: A Fresh Perspective** (Harvard University Press, Cambridge, Mass., 1966. 362 pp., $10) by F. A. McClure, contains a wealth of information, much of it new, that has been distilled from a lifetime of experience in the study of bamboos. Probably no botanist, past or present, has had so intimate an acquaintance with these "tree grasses," in all parts of the world in which they grow, as the author of