problems to which the reader is accustomed in his own field of specialization. We also encounter some other perennial views defended with vigor and enthusiasm, such as the embryonic versus the primitive nature of cartilage and the fresh-water origin of vertebrates. But no inordinate amount of space is devoted to these old favorites, and controversies of broader scope, possibly more subject to ultimate resolution, such as those that concern the evolution of Lower Paleozoic vertebrates, the origin and nature of vertebrate classes, and the origin and taxonomy of mammalian orders, make up the bulk of the book. Whether he agrees with them or not, Romer's treatment of all opinions that he considers significant is fair, temperate, and knowledgeable.

It should be noted that the period covered by *Notes and Comments* has been marked by a great deal of activity in vertebrate paleontology, with respect to both new discoveries and development of theory. Romer has contributed heavily to this progress and continues active in the field, and his commentary, coming just at this time, is valuable not only as a review of the state of the art but also as a signpost for the future.

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Plant Form

Growth and Organization in Plants. Structure, Development, Metabolism, Physiology. F. C. STEWARD. Addison-Wesley, Reading, Mass., 1968. xii + 564 pp., illus. $15. Addison-Wesley Series in Life Sciences.

This is an unusual book by an unusual man. While it could not possibly be recommended for use as a textbook, or even as a reference source for a balanced review of the entire area of plant growth and development, it should be consulted by all advanced workers in the field as a provocative synthesis of the ideas of one of our most versatile and literate plant physiologists. For those who have never heard Steward lecture on "Carrots and Coconuts" (can there be anyone, anywhere, who has not experienced these tours de force, punctuated by toy-pistol clicks to signal slide changes?), this monograph will communicate some of the color, dash, and style of his memorable oratory, and also of his often controversial concepts of plant function.

The book was first organized as a series of lectures given to college teachers of biology. Steward has obviously chosen to expound at greatest length on topics closest to his own researches; thus of the slightly more than 500 references in the bibliography, 87 bear his name as an author, and another 10 refer to work done by his students or colleagues. The result is a skewness in content and in the analysis of subjects to which Steward has contributed. For example, one certainly gets the impression (pp. 141–42) that Steward and Caplin, not van Overbeek, Conklin, and Blakeslee, first introduced coconut milk into plant tissue culture media. Nowhere is it mentioned that Letham has isolated zeatin riboside, a cytokinin, from coconut milk and that its presence probably accounts for some of the properties of coconut milk; rather, the impression is left that the unique growth promotion elicited by coconut milk is due entirely to amino acids, auxins, inositol, and other components isolated in Steward's laboratory. In all the discussion of cellular totipotency in tissue culture there is no mention of the classic paper of Muir, Hildebrandt, and Riker, who probably first showed unambiguously that single isolated plant cells can grow to tissue masses from which formed plant organs can later be made to differentiate. The natural occurrence of 1,3-diphenylurea in coconut milk is stated as a fact, though doubts as to this have been publicly expressed, there being a possibility that the substance was accidentally introduced into the batch being industrially concentrated. All this takes many pages, while topics like tropisms, endogenous rhythms, abscisic acid, ethylene, and phytochrome are barely mentioned, despite their much greater importance.

On the other side of the coin, Steward is at his best when discussing broad questions of organization and form. It is here that his encyclopedic grasp of growth and differentiation brings him to clear and exciting expositions, punctuated by frequent references to insufficiently quoted older literature. His distrust of the practice of applying to higher plants facile explanations based on simplistic views of genetic regulation in procaryotes leads him to rely on more complex mechanisms. This may be good medicine for students who were raised in an age characterized by relatively uncritical acceptance for all organisms of events so far found to occur only in *Escherichia coli* and its relatives.

Both because of its insights and its controversial views of many subjects, this mind-stretching book deserves to be read carefully and appreciatively by a large audience.

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Turbulent Flow

Physics of Negative Viscosity Phenomena. VICTOR P. STARR. McGraw-Hill, New York, 1968. xvi + 256 pp., illus. $9.95. Earth and Planetary Science Series.

The most controversial thing about this book is its title. The motion of the ocean and atmosphere is almost invariably turbulent, the structure of the flow being governed by the balance among the energy inputs, the effects of rotation and stratification, and the interactions between the eddies of the turbulence and the mean flow. It is an old idea to seek an analogy between the random eddying motions in the turbulence and the random motion of the molecules of a gas; the latter gives rise to molecular viscosity acting on a macroscopic motion, the former being conceived to produce an "eddy viscosity" that acts on mean, larger-scale flow. The work of Taylor, Townsend, Corrsin, and others showed 20 years ago that the analogy is in principle erroneous; the "eddy viscosity" is not in general a local parameter but, because of large-scale exchange processes, one that depends upon the whole field of flow and its time history. Despite this, the idea is often a useful one in calculating the properties of simple turbulent flows, and its use in dynamical meteorology and oceanography is widespread.

Molecular viscosity is, for thermodynamic reasons, essentially positive; it represents a diffusive process. In turbulence, on the other hand, particularly in stratified and rotating fluids such as the atmosphere and ocean, inertial effects can lead to concentrations of momentum such as exist in the Gulf Stream and the atmospheric jet stream. If wave motions are involved, momentum can be extracted from the mean flow at one point and released elsewhere, the transfer being essentially radiative. If we insist on making param-

eters of all these interactions between mean and fluctuating motions by means of an eddy viscosity relating local "eddy" stress to local rate of strain, the coefficient may well be negative; it may be meaningless.

The author seeks to interpret many fascinating examples of flow in the earth's atmosphere, the solar atmosphere, ocean circulation, and laboratory experiments in terms of an eddy viscosity. The viscosity is, of course, found to be negative whenever concentrations of flow exist or whenever energy is transferred from smaller to larger scales. For one who understands some fluid dynamics a description of these effects in terms of a negative viscosity is entertaining to read; for others it will surely make them even more mysterious than they are.

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A Method for Dating

Thermoluminescence of Geological Materials. Proceedings of a NATO Advanced Research Institute, Spoleto, Italy, 1966. D. J. MCDOUGALL, Ed. Academic Press, New York, 1968. xvi + 680 pp., illus. $25.

The papers in this volume stem from a 10-day conference at which 62 papers by 72 authors were presented. As is the case with many symposium volumes, the contributions range from trivial to important, and fully half of the papers could have been omitted with no loss to total information content of the volume. The papers can be grouped under the general headings of theory, instrumentation, and applications.

Unfortunately, thermoluminescence theory is today at best a palimpsest, thinly embracing a relatively rich phenomenology and supplying little guide to the successful application of thermoluminescence to geological and archeological problems. Theory seems to provide little explanation for such phenomena as the initially rapid change with time in the rate of depopulation of high-temperature traps, the effectiveness of radiation at high energy levels in the creation of new traps, the relationship between triboluminescence and thermoluminescence, or grinding glow, nor does theory predict that thermoluminescent glow curves should only be measured in an oxygen-free environment. A measure of the lack of theoretical guidance is that many of the authors of the book dismiss portions of signals that are not understood as "spurious."

Unfortunately, the chapters on design and instrumentation are particularly unenlightening. One is cautioned to have an instrument "able to record with high fidelity," that design of the apparatus should be "considered in its broadest overall aspects," and that "properly designed equpiment will provide operational convenience"; one is warned to "avoid the expense of overdesigned functional sections and inadequacies of underdesigned functional sections." In this section one is also informed that "manual control is a method of operation in which the rate is controlled by the operator." We are also told that "a detector is a device which responds to the phenomena being investigated," we are instructed to select a "suitable device," and finally we are told that "the design should accurately tailor the equipment to the measurement needs in every respect."

A substantial number of papers appear under the general heading Applications of Thermoluminescence. A series of papers on geological age determination could be summarized by the single sentence, It can't be done. Thermoluminescence of a mineral is determined not only by its total radiation dose but by saturation of traps, production of new traps with time as a result of radiation damage, drainage of traps, which is a function of thermal history, and the creation and drainage of traps as a function of stress history. It is clear that because of the uncertain history of the average mineral in a geological environment thermoluminescence can give relatively little age information. Even in ideal situations where the thermal history of material is known and most of the variables that can affect thermoluminescence are not operative, such as in recent lava flows, age dating results are not very encouraging. Aitken *et al.* show that the feldspars of the Mount Etna lavas range in thermoluminescence from 0.1 to 90 times the expected glow. Therefore this reviewer cannot agree with the enthusiastic remark of one contributor to this volume that "thermoluminescence can furnish much valuable information about the age of igneous intrusions, faults and metamorphic events."

Dating of archeological artifacts by thermoluminescence seems to be far more promising and on far better ground. Papers by Ralph *et al.* and Aitken *et al.* describe the techniques of archeological age measurements on pottery sherds. In both precision and accuracy, their results do not compare unfavorably with carbon-14 results. It seems likely that in the not too distant future thermoluminescence may become a routine archeological tool.

Unfortunately, it seems likely that many of the other attempted applications of thermoluminescence, such as the determination of paleotemperatures and the determination of geological temperatures, will fail, for the thermoluminescence clock or dosimeter is not sharply set by the event in question, as is the case with the firing of a ceramic pot.

In particular, in this volume the contributions from Oxford by Aitken and his co-workers stand out as of exceptional quality, and they should particularly be read by anyone interested in the application of thermoluminescence to archeological or geological problems.

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Nucleases and Substrates

Enzymes in Nucleic Acid Research. MICHEL PRIVAT DE GARILHE. Hermann, Paris; Holden-Day, San Francisco, 1968. xiv + 393 pp., illus. $16.25. Chemistry of Natural Products.

This volume naturally falls into two separate parts. The first half serves as an introduction to the structure and origin of nucleic acids and analytical methods for studying them, whereas the second half is apparently a revision of the author's earlier book, *Les Nucléases.*

The first part, evidently written so as to make the book conform to the natural products theme of the series, discusses the nomenclature, basic concepts, synthesis, and isolation of nucleic acids. These chapters tend to be written in a confusing style, which often leads to self-contradictory statements and half-truths. To cite only a few examples, on page 29 we are told that there exist three classes of RNA and on page 37 that there are four, and on page 38 a fifth type is discussed. On page 30 we are told that the messenger RNA's are "unstable, since as soon as they have delivered their message, they should