list of algae least affected by the detergent comprises 14 species. On the other hand, 23 species either had been killed or appeared very unhealthy. The green filamentous algae, *Enteromorpha* and *Cladophora*, were bleached more rapidly than the others.

Laboratory studies, limited to short-term bioassays, contributed relatively little to the toxicology of oil and detergents. Convincing evidence has been accumulated, however, to demonstrate the fallacy of using massive quantities of detergent to combat oil pollution. Their use only complicated the situation and increased toxicity. The authors state that the most ideal detergent cannot of itself destroy the oil. Its function is to scatter oil slicks into small particles and make them subject to attack by oil-degrading bacteria. In concentrations of 10 parts per million detergents are capable of killing most aerobic oil-degrading bacteria. These findings will greatly influence future development of practical measures of protecting marine life against the massive spillage of oil.

Excellent color photographs of oil slicks on the surface of the sea are invaluable as a means of identifying by color the untreated and treated patches of crude oil carried by tides. Extensive subject and author indexes add to the usefulness of this attractive publication.

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Theoretical Biologists at Work

Progress in Theoretical Biology. Vol. 1. FRED M. SNELL, Ed. Academic Press, New York, 1967. xvi + 228 pp., illus. $10.

On being presented with a book entitled *Progress in Theoretical Biology* the reader may experience a certain feeling of suspense, for he hardly knows what he will find inside. To the question What is theoretical biology? one could give the trivial answer, whatever is done by scientists who call themselves theoretical biologists. This viewpoint has been adopted, at least in part, by the editor. The longest and most ambitious paper in the volume deals with the polymerization of protein molecules (Oosawo and Higashi), and could have appeared in a number of different publications which carry the words "progress" or "advances" in their titles. A comparison of the other papers suggests that "theoretical" is to be understood in at least three senses. First, it may simply mean speculative. The paper by Calvin deals mainly with experimental studies on the search for "chemical fossils," and in particular with occurrence of hydrocarbons in Archeozoic rocks. Members of the isoprenoid series were detected in the oldest rocks investigated (Soudan shale, 2.7×10^9 years old). Since the isoprenes occur in complex biochemical pathways leading to steroids and the side chain of chlorophyll, Calvin is led to interesting speculation on the presence of biochemically advanced organisms during these and even earlier times.

Examples of a second kind of theoretical biology are provided by the papers of Bremermann ("Quantitative aspects of goal-seeking self-organizing systems") and Stahl ("The role of models in theoretical biology"). In these cases, "theoretical" refers to any kind of a model which can be used to represent a biological system. Bremermann asks the question What limitations are placed on the structure, behavior, and growth rate of organisms by the amount of information that can be stored in the genome and by the energy requirements for the processing of this information? The force of information-theory arguments is largely negative, in showing what cannot be done. Thus it is concluded that anatomical structures and the connections among neurons in the human brain cannot be completely specified by the genome. Also, the number of behavioral responses that are genetically determined must be rather small. Bremermann states that the number is generally less than 30 in the animals that have been studied, and that this figure probably uses up a moderate fraction of the genome.

Stahl's paper is a summary of the use of models in biological problems. Because this is such a broad topic, ranging from predicting where one should fish for albacore to algorithmic models of thought, only a very general discussion is presented. The importance of dimensional similarity is stressed. In familiar problems, such as hydrodynamic modeling, it is well known that the Reynolds number must be the same for the model and the prototype. Stahl states that up to 200 dimensionless numbers have been defined in model studies and emphasizes that the similarity requirement has too often been ignored. The paper contains 285 references and should be useful as an introduction to the literature in this subject.

A third kind of theoretical biology is alluded to in the paper by Morowitz ("Biological self-replicating systems"), in which he quotes Bernal: "undoubtedly there should be a real and general biology . . . , the study of the nature and activity of all organized objects wherever they are to be found, on this planet . . . in other solar systems, in other galaxies." Thus theoretical biology must attempt to elicit from the properties of terrestrial organisms the basic features of all possible living systems. Although this kind of activity might at first appear to be better suited to philosophers than to biologists, it has immediate practical importance. Namely, how do you design experiments that can recognize the presence of life on another planet? Morowitz's paper is a prolegomenon to this general problem. He points out that a very small number of chemical compounds are present in terrestrial organisms and considers the problem of what is the simplest free-living system within the context of this chemistry. On the basis of theoretical considerations, mainly related to random noise, and known molecular mechanisms he arrives at a diameter of about 0.1 micron and "molecular" weight of 2×10^8 daltons for the simplest organism. These figures are about 10 times smaller than the values for organisms so far identified (PPLO, *M. laidlawii*, H-39), but since Morowitz's assumptions correspond to a bare minimum in size, for which statistical fluctuations are important, it is not too surprising that real organisms are somewhat larger.

The paper of Oosawa and Higashi ("Statistical thermodynamics of polymerization and polymorphism of protein") is concerned with a very different kind of problem, but one which is central to our understanding of the structure and function of cells at the molecular level. The mechanism of assembly of proteins into filaments, tubules, membranes, or entire viruses is a subject of intense research activity, and this paper provides a general discussion of the initiation and control of polymerization which should be valuable at least as a starting point for treating such problems. The central thesis is that polymerization must proceed by nucleation and that specific small molecules may be important as modulators of polymerization and depolymerization. However, the theory presented is highly oversimplified and in some cases misleading. It is implied that there is a very sharp transition between monomers and helical polymers as the concentration of added monomers is increased above a critical value (fig. 3). However, the equations have a singularity at the critical concentration, and the mathematical problem is not treated explicitly. Furthermore, the authors assume that the free-energy change per bond is constant; consequently their equation 4*a* predicts that the number concentration of polymers with *i* residues decreases with increasing *i*. The interesting feature of biological systems is that long polymers are formed which often have a very narrow length distribution function. It was shown by Casper (1963) that a peak in the length distribution can arise if the free energy per bond decreases with polymer length. Although a simple theory is valuable in that it makes possible a general discussion, the more subtle aspects of the properties of biological polymers should not be overlooked.

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Stars and Plasmas

Plasma Astrophysics. Proceedings of the International School of Physics "Enrico Fermi," Course 39, Varenna, Italy, July 1966. P. A. STURROCK, Ed. Academic Press, New York, 1967. xviii + 364 pp., illus. $19.50.

P. A. Sturrock was the director of the course of which this book is the proceedings; the contributors, each of whom is distinguished in his field, were drawn from universities and institutes in the United States and Europe. The subjects of the lectures may be divided into three general categories: plasma physics, observational astrophysics, and the use of plasma-physical concepts in the interpretation of astrophysical phenomena. Plasma physics and astrophysics are, of course, relatively advanced disciplines, but the application of plasma physics to astrophysics is still at an early stage of development; therefore the appearance of a set of lectures oriented toward plasma astrophysics is welcome.

Several chapters of the book are concerned mainly with fundamental physical processes. The first chapter, an introduction to plasma physics by R. Lüst, is much like the article of the same title which Lüst contributed to course 24 of this series of proceedings; however, the material discussed is so fundamental that its inclusion in this volume is justified. Sturrock's chapter on the elementary theory of electromagnetic waves in plasma is clearly written, covers a wide range of topics, and would be suitable even for a reader not previously acquainted with the subject. Another exceptionally well-presented article is P. A. G. Scheuer's discussion of radiation mechanisms that may be important in astrophysical radio sources; Scheuer's use of simple but deep physical arguments avoids the very complicated mathematics that one often finds in discussions of this subject. Perhaps the most ambitious of the chapters on fundamental plasma physics is R. M. Kulsrud's review of a great variety of plasma instabilities. Kulsrud has succeeded in explaining most of these instabilities by fairly simple physical arguments; nevertheless, his treatment of this very complicated subject would be rather difficult reading for a novice, and would serve best as a review for readers who already have some background in the field of plasma instability.

Most of the lectures on observations and their interpretation treat one of two broad topics: stellar magnetic phenomena (mostly solar phenomena, including flares and radio bursts), and radio galaxies and quasars. H. Zirin's brief discussion of the solar atmosphere (especially the chromosphere) is clearly written, and might be rewarding reading for a beginner; in addition, there are detailed and well-referenced chapters on observations of solar magnetic fields and velocity fields and on the principal theories of stellar magnetism. There are detailed reviews of optical and radio observations of radio galaxies and quasars, and G. R. Burbidge presents a thorough, well-referenced summary of the various theories of quasars and radio galaxies that had been proposed by mid-1966.

A few of the lectures treat in detail specific applications of plasma physics to astrophysics. Sturrock discusses his closely related theories of two phenomena which have vastly different scales, solar flares and radio galaxies (and quasars). E. N. Parker describes his theoretical work on a number of astrophysical topics, including the solar wind, wave generation in the solar photosphere, and the role of the cosmic-ray gas and the galactic magnetic field in the dynamics of the galaxy.

As the editor explains in the introduction to the book, it was not possible to include in the course a set of lectures concerned with solar-terrestrial relations. This omission is unfortunate, for the application of plasma physics to "space science" will doubtless be one of the most fruitful areas of scientific investigation in the near future.

The character of the chapters varies with the authors. In some instances the printed presentation is polished; in others it is a rather telegraphic transcription of lecture notes. Some of the lectures are suitable for students not previously acquainted with the subjects; others are aimed at listeners or readers with a fairly extensive background in the field. In general, the quality of the printing is good, with occasional typographic errors. Anyone seriously interested in the application of plasma physics to the interpretation of astrophysical observations would do well to look through this collection of lectures.

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Sensory Receptor Systems

Lateral Line Detectors. Proceedings of a conference, New York, April 1966. PHYLLIS H. CAHN, Ed. Indiana University Press, Bloomington, 1967. xvi + 496 pp., illus. $18.50.

Among fish and among larval and aquatic amphibians, specialized sense organs are found on the body and head which are called lateral line organs because of their linear distribution on the sides of the animals. These organs are of two kinds: one type detects some function of water displacement at the surface of the body and the other—much rarer in its occurrence—is sensitive to electric field gradients. Historically these two distinct systems have been considered together.

This volume is based on a conference, held at Yeshiva University, which brought together many of the people