the "hypocritical" gap between ideal and behavior.

This argument suggests that the post-modern youth may not be confronted with a gap between parental preaching and practice that is "objectively" any greater than that facing most generations. But they do confront an unusual internal ambivalence within the parental generation over the very values that parents successfully inculcated in their children, and they are "deprived" of a system of social interpretation that rationalizes the discrepancy between creed and deed. It seems likely, then, that today's youth may simply be able to percieve the universal gulf between principle and practice more clearly than previous generations have done.

Although this explanation is one to be considered, it seems to me that the most likely reason why the children are able to perceive the discrepancies is that they have been brought up in such a way that they have the courage and strength to perceive them. But whatever the reason, the perception is there and, Keniston believes, contributes to their political outlook:

This points to one of the central characteristics of today's youth in general and young radicals in particular: they insist on taking seriously a great variety of political, personal, and social principles that "no one in his right mind" ever before thought of attempting to extend to such situations as dealings with strangers, relations between the races, or international politics.

Although Keniston writes as a psychologist and for the most part confines himself to his own chosen field of study, he is clearly impressed and moved by the political approach of the young radicals:

The new radicals are at least confronting the central issues of our time, and confronting them more directly than most of us can afford to. They are asking the basic questions, making the mistakes, and perhaps moving toward some of the answers we all desperately need.

To my mind, one of the most significant features of their approach is the lack of idealization of leaders and leadership; and this is a natural outcome of their upbringing, an aspect of their basic attitude to life. Society has always idealized leadership, usually at terrible cost; and the hierarchical structure of our society is based on this idealization. It is so universal, so intrinsic to our thinking, that we take it for granted and fail to note the evil consequences. Is it possible that a new generation is growing up whose criticisms of society are more personally authentic, who have become accustomed to rely on their own immediate perceptions rather than on ideologies, and who do not need to idealize their leaders? Or is this group merely a bunch of raw youths who will learn better as they grow older? Are they just naive? If they are, then so is Keniston. And so am I. But I hope not.

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Ecological Disaster

"Torrey Canyon" Pollution and Marine Life. A Report by the Plymouth Laboratory of the Marine Biological Association of the United Kingdom. J. E. SMITH, Ed. Published for the Association by Cambridge University Press, New York, 1968. xiv + 196 pp., illus. $9.50.

The date of 18 March 1967 will be remembered by all concerned with oil pollution of high seas as a day of tragic accident, when a 970-foot tanker, carrying about 117,000 tons of heavy Kuwait crude oil from the Persian Gulf and traveling at about 17 knots, ran aground 15 miles off the west coast of Cornwall, England. An unprecedented spillage of oil continued to the end of April, when the tanker was bombed and set afire and disappeared from view, at that time probably empty.

Several naval and civilian organizations, including the Plymouth Laboratory, were mobilized to survey the situation, to record the damage to beaches, shores, and marine life, and to design measures to control the spread of contamination. At the same time attempts were made by various government and private organizations concerned with navigation to combat oil pollution by treating the heavy slicks with detergents. At least 12 different detergents were used in very large quantities. For instance, on the Cornish beaches alone, 10,000 tons of detergent fluids were used to treat about 14,000 tons of crude oil. Probably detergents were employed in similar ratios to oil in other areas. Thus from the very beginning the marine scientists engaged in the study faced two distinct problems—pollution by crude oil and contamination caused by massive use of detergents. Scientific studies were carried out simultaneously by 46 members of the Plymouth Laboratory staff and by a number of specialists from collaborating organizations of Great Britain and several European countries. The results of these studies are reported in the ten chapters of the present book; they deal with the sea surveys; zoo- and phytoplankton; surveys of shores, sublittoral zones, salt marshes, and sand beaches; toxicity tests of detergents and oil; and oil movements at sea. The individual chapters are the reports of the various investigators arranged in the order in which they were completed. Under this condition a certain degree of repetitiveness is unavoidable and the book as a whole lacks unity. The organization of the material seems to suit the nature of the study, however, and reflects the emergency condition under which the laboratory and field investigations were carried out.

The data accumulated by biologists, who were thoroughly familiar with local fauna and flora, are indispensable for further studies of pollution problems. One major inference, fully substantiated by field and laboratory studies, is that contamination by detergents was more dangerous that the toxicity of oil. The major compound used to deal with *Torrey Canyon* oil is identified as nonionic BP 1002 detergent, which does not dissociate in solution to any significant degree. Of the three components of BP 1002, the surfactant, the stabilizer, and the organic solvent, it was the solvent that was mainly responsible for the high toxicity. These findings are in contrast to what had previously been found in fresh water. Many species of zooplankton (*Calanus, Elminius,* larvae of *Sabellaria,* and edible oyster) were killed in relatively low concentrations within 24 hours. Likewise, detergents were fatal to many phytoplankton species (*Phaeocystis, Coccolithus, Halosphaera, Gymnodinium,* and others).

Many intertidal animals (actinias, annelids, shrimps, prawns, and limpets) were destroyed by various concentrations of detergent and oil mixtures within 24 hours. The bioassays were of short duration, and the authors wisely warn of the possible deleterious effects of long-continued exposures to very low concentrations of pollutant. Another interesting observation is that many species survived without apparent ill effects. Mussels were found to be quite resistant to oil alone and to moderate doses of detergent, though not to repeated intense treatments.

The damage sustained by the algae was extensive, being most severe at the higher level of the shore, where the toxic concentration was greatest. Not all the species are equally sensitive. The 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 valu-