Thoughts on Living Systems

Towards a Theoretical Biology. 1, Prolegomena. Proceedings of an International Union of Biological Sciences symposium, Bellagio, Italy, Aug.–Sept. 1966. C. H. WADDINGTON, Ed. Aldine, Chicago, 1968. viii + 234 pp., illus. $8.95.

It would be easy to condemn this book out of hand. Even as "prolegomena" it seems, at first glance, to be a pretentious hodgepodge of original notes, essays, correspondence, and reprints of uneven merit and level of difficulty. Biologists will find many of the papers extremely heavy going—such as that by Paul Lieber on "Constants of nature"—and other papers quite trivial—such as Waddington's "Does evolution depend on random search?," which is a competent attempt at elementary education of the Neo-du-Noüyian school of mathematicians but not a contribution to theoretical biology. For two reasons, however, I'm not going to condemn the book. First, attempts at making theoretical progress in biology are all too often impeded because of a widespread distaste for theory among biologists ("Don't bother me with theory, I've got ten students chained to my lab bench digging out *the facts*"). In my view virtually any progress toward a theoretical biology, no matter how halting, is to be encouraged. The second reason for not condemning the book is more important—it contains some very interesting papers.

Biologists will find Ernst Mayr's article "Cause and effect in biology" and Waddington's comments on it (both reprinted from *Science*) straightforward, clearly written, and interesting. Similarly, Waddington's introductory article, "The basic ideas of biology," also contains considerable meat, including an interesting discussion of the limited applicability of information theory in biology. I am surprised, however, that he seems to feel (p. 8) that the only information which a developing organism gets from its environment comes in the form of food molecules. Waddington must also be in contact with a rather strange orthodoxy in modern Neo-Darwinianism when he states that it "usually tacitly assumes that randomness of genetic mutation implies randomness of phenotypic variation . . ." (p. 18). His own work, as well as that of Rendel and many others (to say nothing of dominance and epistasis), is well known to evolutionists, and they could hardly function if they made this "tacit assumption." In spite of these and other quibbles I finished reading Waddington's paper with my usual admiration for him, and a slight feeling of disappointment that other biologists often do not seem very interested in his ideas.

Howard Pattee's article on the physical basis of coding will be of interest to most biologists, as it deals with the reducing of current molecular "explanations" of life to physical terms, and with related problems of the origin of life. It seems characteristic of natural sciences that quite consistent explanations may be achieved at various levels of reduction, but some molecular biologists have gotten into the habit of claiming that biological phenomena cannot really be understood until they are understood at the molecular level. It gives a population biologist a certain perverse pleasure to see Pattee claim, in essence, that molecular biology must be reduced to quantum mechanics before life will be understood.

After wading through some of the more mind-bending contributions, the reader can always relax with Michie and Longuet-Higgins' "A party game model of biological replication" (reprinted from *Nature*)—a diversion which makes a good point about the evolutionary value of genome-phenome separation. Another short, interesting paper is that of Maynard Smith on "The counting problem." He asks, for instance, how a developmental system, when stimulated, manages to do something N times, such as produce a given series of vertebrae. Even shorter is Waddington and Lewontin's "Note on evolution and changes in the quantity of genetic information," which is of such interest that it should be reprinted in a journal such as *Evolution*.

Towards a Theoretical Biology is clearly a volume which should be examined before purchase. Its contents are too diverse for a general recommendation to biologists. Perhaps its greatest drawback is the lack of really general discussion of whether or not a "theoretical biology" analogous to theoretical physics *should* exist. That it should—a view which I share intuitively, but would like to see justified—has been taken for granted by the participants. Above all, this volume makes it clear that if a theoretical biology can be achieved, the moment of creation lies well in the future.

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Superconductors: Possibilities and Actualities

Superconductivity in Science and Technology. Proceedings of a conference, Chicago, May 1966. MORREL H. COHEN, Ed. University of Chicago Press, Chicago, 1968. viii + 164 pp., illus. $5.95.

This is a fascinating book because it gives a very good description of the state of work on superconductivity in 1966. Its contributions range from the best in the field to the mediocre. Some review the past, and others occasionally give an exciting look into the future. It ends with a very intriguing article, by Schmitt and Morrison, on the economic aspects of superconductivity, research and, more important, applications. This concluding article poses the question, Where has all the money gone—the several hundred million dollars spent—and how worthwhile has the expenditure really been?

One soon realizes that the answers have already been given in the preceding pages of the book. Bardeen reviews certain aspects of the BCS theory, the theory most widely accepted today. Josephson describes the Josephson effect predicted by him almost six years ago. Also, his article is, from an esthetic point of view, one of the highlights in this collection.

The applications, such as superconducting magnets and engineering uses of quantum effects, are reported by Hulm and Mercereau. These authors give a good picture of the state of technology in 1966. By contrast, in their article Garwin and Matisoo deal with one of the most exciting projects of the future, transmission of electric power through superconducting cables. In an exceptionally well-thought-out and excellently documented study, they consider everything from Maxwell's stresses to shipping coal on barges. They come to the conclusion that for the transmission of high power over long distances, the superconducting cable is technically feasible and economically competitive.

Thus one comes back to the question of whether all the work on superconductivity and superconductors has been

and will be worthwhile, scientifically as well as technically.

Part of the money has gone into theoretical studies, and theories have made substantial progress during the last ten years. Part of it has gone into the development of superconductors for application and technology. The progress has been remarkable but, as Schmitt and Morrison point out, this development in no way approaches that of the transistor. One therefore asks, why not? Once again, the answer can be found with closer reading—this time in Berlincourt's contribution on superconducting materials. This article is the lengthiest and also the least satisfactory of the whole book. It starts with a rather sketchy review of the theories of Ginzburg and Landau and of Abrikosov and Gor'kov, a review which in no way equals the originals. The actual account of materials is again a review—a rather superficial and somewhat facetious condensation of Ben Roberts' excellent compilation for superconducting materials. This chapter evidences no coherence. Not once in this article on materials is a crystal structure mentioned. This kind of haphazard approach is symptomatic of what afflicts most efforts in the materials field and gives a clue to why the higher transition temperatures necessary for large-scale applications of superconductivity have not been reached. This, of course, is also the answer to why the economic development of superconductivity has not equaled that of the transistor. In contrast to the work that led to the transistor, research on the materials aspect of superconductivity has been mismanaged for a rather long time and the money, by and large, has not been spent wisely. Only a small and ever decreasing percentage of all this support has gone toward the discovery and development of those superconducting materials which dominate present-day technological use of superconductivity. A profound reassessment of the support in the materials field is necessary in order to achieve the higher transition temperatures which are undoubtedly possible. Only then will the intriguing technological developments envisaged in parts of this book, and by Garwin and Matisoo in particular, become realities.

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View from the Pier

Natural History of Marine Animals. G. E. MACGINITIE and NETTIE MACGINITIE. Second edition. McGraw-Hill, New York, 1968. xiv + 523 pp., illus. $10.75.

For those lacking a formal introduction to the seashore and the animals that inhabit it, this book could be a useful companion on the next jaunt to the coast, preferably the west coast of North America, whence most of the sketches were derived. Freed from the strictures of integrating form, function, and phylogeny, the authors supply glimpses of the lives and habits of animals living between the tides. The book is for the amateur enthusiast, although anyone interested in animal behavior and natural history will find a wealth of anecdotes for the next beach gathering.

Each phylum of animals is glimpsed through its more abundant or unusual species. Structural peculiarities serve as a focal point around which is woven an account of foods and food acquisition, reproductive behavior, and symbiotic and predatory relationships with other animals. Respiration, locomotion, molting, and regeneration of lost parts are treated either systematically or as otherwise appropriate. A final chapter treats the vertebrates which the land-bound enthusiast is likely to encounter, and these range from the small fishes living in tide pools, or commensally in the burrows of invertebrates, to the big mammals seen in the distance or along some remote rockbound coast.

An introductory section of 12 chapters sets the stage for the accounts of species. The interactions of marine invertebrates with their environment are only touched upon, but an attempt is made to sketch the diversity of environments, both physical and biological. Adaptations to the environment, including the acuity of sensory perception, are treated briefly.

The book, an apparent outgrowth of lectures delivered at the shore or beside an aquarium, loses some of its excitement away from its natural setting. There are moments, however, when a vivid sketch of behavioral patterns portrays the enthusiasm and patience of the authors. The tolerance of the innkeeper (*Urechis*) for its commensals and the homing instincts of the seaweed limpet are so deftly described that the reader becomes engrossed with the lives of these little creatures by the sea. He is assured of the individuality of the subjects at the climax of the story which describes the strong maternal possessiveness of the octopus toward its yet unhatched offspring. It is these little sketches that commit the uncommitted and save the book from the usual aridity of natural history aimed, all too often in this instance, at dispelling once popular myths.

The second edition includes 40 pages of additional descriptions which have all been tucked into the back of the book. Except for the addenda, little has been changed since the book's first appearance nearly 20 years ago.

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On the Honeybee

Traité de Biologie de l'Abeille. RÉMY CHAUVIN, Ed. Vol. 1, Biologie et Physiologie Générales, xvi + 548 pp., illus., 150 F.; vol. 2, Système Nerveux, Comportement et Régulations Sociales, viii + 566 pp., illus., 150 F.; vol. 3, Les Produits de la Ruche, viii + 400 pp., illus., 116 F.; vol. 4, Biologie Appliquée, viii + 434 pp., illus., 116 F.; vol. 5, Histoire, Ethnographie et Folklore, viii + 152 pp., illus., 46 F. The set, 578 F. Masson, Paris, 1968.

The honeybee has always seemed the special benefactor of man, an insect "of mysterious origin," as William Morton Wheeler once put it, "a divine being, a prime favorite of the gods, that somehow survived the golden age or had voluntarily escaped from the garden of Eden with poor fallen man for the purpose of sweetening his bitter lot." Whole libraries have been devoted to bees and beekeeping since antiquity. Aristotle is credited with the discovery of the principle that individual worker bees stick to one kind of flower in their foraging trips and of the fact that they communicate (by means unknown) the location of food discoveries. Pliny invented an observation nest with windows of transparent horn to watch the emergence of bees from brood cells. In the past hundred years tens of thousands of technical articles have been written on the honeybee, most of them on applied aspects, and no fewer than 20 periodicals, and scores of books, have been devoted exclusively to the subject. The information is generally very scattered and poorly organized.

An encyclopedia of the honeybee of the kind prepared under the direction of Rémy Chauvin is therefore very