For, in the frame of Elsasser's analysis, vitalism could be worthy of consideration only if there were some likelihood that biological systems were not subject to the restrictions imposed by basic physical principles, and experiment has rendered this likelihood very small. The real question is not whether biological systems are material systems—they are—but whether they are *mechanisms*. He departs immediately from the seldom-criticized alternatives of vitalism and mechanism.

In fact, the question whether living organisms are mechanisms depends first on the construction of a rigorous and relevant definition of a mechanism; and it is perhaps the relevance, the rarest commodity in discourse about biology, that impresses a biologist most strongly about Elsasser's enterprise. The aspect of mechanisms chosen as most relevant is their performance as converters of information, and his approach is through Information Theory and related areas of physical science. Over a hundred pages devoted to a treatment of problems of feedback and control, information, and storage and memory make rich reading for the biologist, taxing him without bankrupting him. The gist of the argument is that the theory and practice of automata does in fact provide criteria of physical mechanisms in the light of present-day physics, against which biological systems can be tested. If this is not the case, Elsasser's approach loses much of its force. On this point, other readers who are unfamiliar with the field may be troubled by the impression that, while the major part of the argument is abstract and logical, another part seems to hinge on the natural history of electronic systems now in use. One wonders how sure the author can be that the boundaries of physical mechanisms are essentially fixed.

If we know what to expect of a mechanism, we have tests to apply to the various attributes of living organisms. It is clear that biological systems include a great many mechanisms. But the significant test in the author's opinion is given by those expressions of the biological world which may be formulated in terms of the acquisition, storage, and conversion of information. The simplest and most universal of these is the genetic system embodied in the chromosomes. The one that is superficially most similar in operation to the devices familiar to the physicist is the central nervous function of animals. The third—and here Elsasser touches on the sorest spot in mechanistic biology—is development and morphogenesis in those aspects classically covered by the term "epigenesis."

The outcome of his analysis is that living organisms, in these expressions, are not mechanisms as physics can define mechanisms. We need not consider the reasons why he arrives at this conclusion; it is not the function of a book review to give the plot away. But the trouble is not merely the usual "we can't explain this biological phenomenon physically because we don't know enough about it." We seem to know more than enough about the biological systems to prove that they do not conform, and the mechanistic unification can be saved only by discovering something about physical mechanisms that would remove some of their limitations. It is not that the physicist cannot design machines to perform functions analogous to those of organisms, but that the designs are so fundamentally different from those provided by organic evolution.

If we take the position that biological systems are a part of the physical world whose operations, in some very important respects, are not encompassed by the physicists' image of that world, the next step is clear: that image has to be broadened and the direction in which it should be broadened may be indicated by the problems of biology. In Elsasser's view, biology calls for extensions of physics, beyond quantum mechanics, in the same sense that the knowledge of subatomic phenomena called for advances beyond classical physics, without at all affecting the usefulness of the older science in a large domain for which it was designed in the first place. As to the direction in which the advance is likely to take place, his prediction sounds positively musical to a biologist's ear. He stresses the likelihood that the new physics, in one way or another, will be the physics of systems with complex structure. It takes no persuasion to convince a biologist that this indeed is the realm in which the answers to many of his problems lie; such a view has been forced upon him by experience. And if the realm needs to be defined otherwise than by its complexity, we may hazard that it is a domain of objects that are huge by the physicist's standards, with macromolecules at the lower limit. The fact that associations of large molecules are found in nature only to the extent that they are made by living organisms is probably not trivial.

Some of the theoretical implications of structural complexity are dealt with in a chapter on structure and variation. The final chapter deals with the theory of measurement.

If Elsasser is correct, the physical foundations of biology have yet to be established. Insofar as this book is a call to action, much of the action must take place in physics. The author is too modest about his acquaintance with the subject matter of biology to suggest how his ideas might influence the actual course of biological research. The earlier impact of physics upon biology has been fully assimilated. We need no longer be convinced of the merits of quantitation, the consolations of numbers, or the puissance of instrumentation. If the jinni does not appear when the biophysicist rubs his magic lamp, we are generally willing to buy him a bigger lamp. In any case, philosophy does not change the ways of scientists by direct precept, but only by influencing their thoughts about what they are doing. In this case we are assured of the validity of our mechanistic approach to parts of the biological whole. If physics does not sustain us in studies of the whole, we can still resort to the pure art of biological research, which consists of forcing organisms to tell us in their own terms the rules by which they operate.

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Progress in Psittacosis Research and Control. F. R. Beaudette, Ed. Rutgers University Press, New Brunswick, N.J., 1958. xii + 271 pp.

This book is the record of the proceedings of the second symposium on psittacosis, held in New York City in February 1956. Both symposia (the first one was held in 1953) were carried out under the auspices of the New Jersey Agricultural Experiment Station, Rutgers University, and with the financial support of the Hartz Mountain Products Company of New York. The late F. R. Beaudette arranged both symposia. M. Pollard completed the editing of the proceedings of the second symposium.

Psittacosis is a public health and industrial problem which cannot be treated lightly, but which, at the same time, does not deserve the attention accorded a major problem. The purpose of this gathering was to provide suitable recommendations for its control. The symposium ended with the confident conclusion that psittacosis in parakeets and turkeys can now be controlled by adequate chemotherapy and isolation.

Although practical aspects are emphasized, the first three chapters—by Dubos, Huebner, and Shope, respectively—are stimulating lectures on general problems of host-parasite relationship. The most noteworthy contributions are those of K. F. Meyer and his associates on the ecology of avian psittacosis and on the chemotherapeutic control of psittacosis in parakeets. These chapters represent a wealth of experimental work exceedingly well planned and analyzed. Valuable information can be found in many of the other chapters. Steele and Scruggs describe recent epidemics, and Andrews discusses federal developments in psittacosis

control. The disease and its chemotherapy in turkeys are discussed by Davies and Delaplane, and chemotherapy in the parakeet is discussed by Bussell and Pollard. Psittacosis-like agents in mammals are described by Baker; various aspects of diagnosis, by Fagan, Volkert, Christiansen, Benedict, and Gordon. The book also contains the informal discussions which took place at the meeting and a chapter on current trends written by Pollard after the meeting.

The reader versed in the field of psittacosis will find a fair amount of repetition of material already available in other publications and some important omissions in the discussions, but he will find reading this book quite profitable. Although the scope of the book is rather limited, several chapters will enlist the interest of the student of the broad aspects of host-parasite relationship.

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(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

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