son why the former should not be incorporated systematically into the conceptual framework in the same way as the latter. A generally similar argument applies to the variable of stratification, in my opinion, although its analytic status, perhaps, is less clear. An advantage of this procedure is that variables which have the same logical status are not assigned different analytic weight; at the same time, the scheme requires the systematic examination of variables whose interaction with kinship may be of a high order of significance. Finally, it seems to me that cross-cultural comparisons which specify the character of the economic and stratification variables in addition to the politico-jural domain of Fortes would yield more precise statements of similarities and differences in kinship structure leading, in turn, to classificatory insights which could entail further refinement of the conceptual framework.

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On the Nature of Science

The Methodological Heritage of Newton. Based on a conference, London, Ontario, April 1967. ROBERT E. BUTTS and JOHN W. DAVIS, Eds. University of Toronto Press, Toronto, 1970. xii, 172 pp. $5.50.

Crossing the boundary of two related—but often compartmentalized—fields, this collection of essays on the methodological heritage of Newton has a message for both the historian and the philosopher of science. The message is twofold: (i) that the history and philosophy of science are in many ways concerned with the same question (fundamentally, "What is science?"); and (ii) that from their different standpoints practitioners of each field have a lot to tell those of the other.

Neither historians nor philosophers should be surprised to learn that Newton's influence extends far beyond the confines of science per se to the broader realms of methodology and philosophy. One of the major themes uniting this collection of essays is the documentation of that influence. The essays of F. E. L. Priestley, John W. Davis, Gerd Buchdahl, L. L. Laudan, and Robert E. Butts together argue the profound effect of Newton's ideas on discussions of scientific methodology and epistemology in the century following his death. The most striking impact, as one might expect, resulted from Newton's introduction of force into the conceptual framework of science, and from his concomitant disavowal of hypotheses. Buchdahl argues—and the theme is implicit in the other essays mentioned—that the introduction of force (in modern language, a theoretical term) ultimately resulted in a change in the metaphysical description of the physical world. Explanations were no longer restricted to the terms of the orthodox mechanical philosophy, matter and motion, but could also be couched in terms of various attractive and repulsive forces. Such a change of conceptual framework is bound to have had far-reaching significance. Eighteenth-century discussions of space, matter, method, knowledge, and God's role in the physical world all followed directly from Newton's introduction of forces.

As the essays of Hanson and Feyerabend reveal, Newton's influence in the philosophy of science extends beyond the 18th century up to present discussions of the structure of science. Contemporary discussions between the traditional positivistic philosophers of science (Hempel, Nagel, Reichenbach, *et al.*) and the new breed of philosophers (Hanson, Feyerabend, and Kuhn) can be viewed as yet further examination of Newtonian methodology. Does science proceed from neutral facts to general theories that represent continually closer approximations to the truth, as the "classical empiricists" (Feyerabend's phrase for the Newtonians) would have us believe? Or would the scientific endeavor be more appropriately described in other terms entirely? For example, Feyerabend argues that perhaps there do not exist any neutral (theory-free) facts to serve as a starting point. Perhaps some radically different description of science is needed.

Whatever the outcome of this debate—probably the most significant discussion taking place in the history and philosophy of science today—the debate raises the perennial question of the interrelation between the history and philosophy of science. The essays of Hanson and Feyerabend illustrate how deeply the historians and philosophers can affect each other, if they choose to take each other seriously. They have shown that if philosophy of science grows out of a close examination of the history of science, striking insights into the nature of science can be gleaned, insights which simply do not arise in more traditional philosophy of science which, at best, simply uses history as a convenient source of examples. The historians likewise stand to gain from this mutual relevance, a fact evident from the influence of the new philosophy of science on the thinking of historians of science. The whole issue of the role of conceptual frameworks (paradigms) in determining the characteristics of science in a given era—an issue clearly evident in the more purely historical essays in this volume—would not arise in the absence of serious philosophical thinking on the part of the historians.

In addition to the intrinsic value of the essays themselves in unraveling historical and philosophical questions regarding the methodology of science, this collection raises broader questions concerning the direction in which the field seems to be heading. From either point of view, it should be of interest to anyone seriously interested in the nature of science.

The utility of this interesting book is somewhat diminished by the absence of an index.

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Possible Biological Models

Fish in Research. A symposium, Vermillion, S.D., Nov. 1968. OTTO W. NEUHAUS and JOHN E. HALVER, Eds. Academic Press, New York, 1969. xii, 312 pp., illus. $8.50.

The participants in this symposium were asked to look at their areas of research and consider "what unique information of biochemical and physiological processes can be gained by using fish as experimental animals." As expressed in the welcoming address the challenge was "not so much to review what is known concerning fish, but to determine how studies on fish can yield unique insights into biochemical and physiological phenomena." The 16 contributions are grouped according to four major topics: cancer, metabolism, genetics, and nutrition.

Although some of the authors are content to review their own recent research, several in each section take the opportunity to stress the unique findings arising from research on fish and the importance of fish as model systems for fundamental biological stud-

ies. This seems to be particularly true for the contributions in the section Topics in Cancer. Here it is stressed that several environmental factors have been implicated as important agents in carcinogenesis among vertebrates, including fish, where hepatomas, epithelial papillomas, and other neoplasms have now been studied. Fish offer several advantages for the experimental investigation of cancer: their total environment can be readily altered; they are poikilothermic and growth and metabolism often depend on temperature; growth is normally slow and often continues throughout life; large numbers of animals can be obtained from a single mating. Except for melanomas in killifish hybrids, epitheliomas in catfish, and hepatomas in trout, there is little detailed work on neoplasms in fish, and the comparative approach may prove to be very productive. Parallel comments can be made with respect to the other topics considered.

Even though some of the contributors did not deal with the specific question raised by the sponsors of the symposium, each of the authors is a leader in his field, and these reviews of recent findings should prove valuable to comparative biochemists, physiologists, and geneticists. This book is a useful addition to the fisheries literature. Moreover, it may direct the attention of some scientists working on the higher vertebrates to novel systems for comparative study; at the same time it provides worthwhile reviews of the literature in the areas considered.

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Proteins and Small Molecules

Multiple Equilibria in Proteins. JACINTO STEINHARDT and JACQUELINE A. REYNOLDS. Academic Press, New York, 1969. xii, 396 pp., illus. $15. Molecular Biology.

The understanding of the factors governing the interaction of proteins with small molecules is of central importance in enzymology, immunology, pharmacology, and diverse other areas of study. The appearance of a book that attempts a synthesis of the knowledge in this field is therefore of particular interest. This is a well-written compendium dealing with those compounds for which multiple binding sites on proteins have been observed. This category encompasses the interaction of proteins with hydrogen ions, detergents, urea, guanidine, organic solvents, hydrocarbons, dyes, and metal ions. The major strength of the book lies in the clear treatment of the thermodynamics of complex formation and in the exploration of the practical aspects and pitfalls of the various methods used for the determination of binding isotherms and hydrogen ion titration curves. The extensive reference lists should prove to be of considerable help to those who are interested in protein-small-molecule interactions.

The authors account with some success for the stabilizing and cooperative unfolding effects of certain ligands in terms of the interplay between the forces involved in complex formation and those responsible for maintaining the native protein structure. In this context, it is interesting to note that the more recent studies have forced little revision of the mechanisms of protein denaturation elegantly presented by Kauzmann in 1954 (in *The Mechanism of Enzyme Action*, W. D. McElroy and B. Glass, Eds., Johns Hopkins Press).

Not unexpectedly, considerations of binding phenomena involving bovine and human serum albumins dominate the discussion. However, despite an abundance of experimental data, few satisfying answers to the questions as to the nature of the binding sites and the apparent "configurational adaptability" of these proteins have been provided. The suggestion that "compared to other proteins, the surface of bovine serum albumin contains many hydrophobic patches or sites, and . . . fewer or smaller stabilizing clusters will be found in the interior of the molecule" has considerable appeal.

Specific complexes of antibodies with antigens, or of enzymes with cofactors, substrates, or inhibitors, are excluded from detailed consideration as not representative of multiple equilibria. One would be more readily reconciled to this arbitrary restriction if the authors adhered to it fully. Thus, specific complexes involving enzymes are examined, but in a purely descriptive and fragmentary manner, with little use of the results of recent x-ray crystallographic studies.

Aside from hydrogen ion equilibria, the attempt to interpret multiple equilibria in proteins is complicated by the lack of knowledge of the structure of the complex formed, the possible contribution of ligand-ligand interactions to the observed energy changes, and the changes in the distribution of conformational forms that the protein can assume at different ligand concentrations. Clearly, these factors will differ from one protein to another. Ultimately, the understanding of protein-small-molecule interactions, as well as the interpretation of the thermodynamics of complex formation, requires knowledge of the details of the interaction at the atomic level. Such information is available for a limited number of cases, principally those of enzyme-inhibitor complexes, or unproductive complexes of enzymes with substrates. Consideration of these complexes falls beyond the deliberately restricted scope of this book.

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Virology

The Chemistry and Biology of Viruses. HEINZ FRAENKEL-CONRAT. Academic Press, New York, 1969. x, 294 pp., illus. $9.

The author of this book has set himself the task of introducing students in biology, biochemistry, bacteriology, and the premedical sciences to the chemistry and biology of viruses. The book is also intended to help research workers in these fields broaden their specialization. As the author mentions in the preface, he has handled the material in a fairly elementary manner, avoiding especially higher mathematics and physics.

As tools of the molecular biologist, the geneticist, the biochemist, and more recently the immunologist, viruses have often been as well studied as the systems they are being used to explore. Assembling this information into a readable book is a worthwhile venture, and Fraenkel-Conrat has succeeded in nearly accomplishing the objective that he set for himself.

The book includes the methods used in isolation and purification of both viruses and subviral components and contains excellent chapters on the properties of viral proteins and nucleic acids, a subject on which the author is a recognized authority. A good background in biochemistry, however, is helpful in understanding these chapters. The relation of subviral structure to function is well described, as is the replication of plant and bacterial vi-