

picture of Carnot, an engineer deeply involved in the political events of his time, who nevertheless retained a constant and productive interest in mechanics and mathematics. The book is handsomely printed, and Gillispie closes it with a very useful bibliographical essay.

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## Harvey as Inductivist

**William Harvey and the Circulation of the Blood.** GWENETH WHITTERIDGE. Macdonald, London, and Elsevier, New York, 1971. xvi, 270 pp. + plates. \$12.75.

Historians of modern science have offered few instances of radically conflicting interpretation firmly based on sound research and developed through cogent argument. The case of Harvey now becomes a notable exception. In question is Harvey the discoverer and at issue, to state it bluntly, are facts versus ideas. Gweneth Whitteridge favors facts and discounts ideas. Her study presents a forceful, ample, and often persuasive portrayal of the English physiologist as a "rational, unemotional" Aristotelian and the quintessential empiricist. By means of meticulous exposition and occasional general discussion, she seeks principally to create a chronology of Harvey's physiological studies. Her purpose and achievement are, however, anything but a mere precise dating of research and discovery. She stalks bigger game, and thus nicely transforms an extremely valuable assessment of Harvey's debt to his predecessors (notably Realdus Columbus) and a record of his own masterly anatomical investigations into a stern but fascinating polemic against the philosophical school of Harvey interpretation.

Whitteridge denies the famous doctrine of circles or its advocates any innovative influence on Harvey's consideration of the circulation of the blood. That discovery in her account is rendered the product of indefatigable and imaginative observation and experiment. Harvey loses all semblance of speculative philosopher and, above all, Neoplatonic metaphysician and becomes physiology's preeminent inductivist, moving from more or less randomly accumulated evidence and preliminary hypothesis to later testing and confirmation, or rejection, of that hypoth-

esis. Unfortunately, this hackneyed methodological sequence is of uncertain validity. It is also of dubious value in interpreting Harvey and raises some question, because of unsure terminology, regarding the true objective of Whitteridge's analysis.

The reader of *William Harvey and the Circulation of the Blood* will be uncertain whether its author really intends to relate the "history of a discovery" or whether she hopes, following Harvey's own words, "to confirm it by sense and experience" (p. xi). At issue is the ambiguous delimitation of "discovery" and "confirmation," the treasured innovation being, of course, Harvey's total view of the motion of the heart and circulation of the blood. Whitteridge's great knowledge of the available evidence lends credence to her claim that, for the present, the precise date of Harvey's discovery is unattainable. She also asserts (p. 111) that Harvey's vigorous collection of data by means of comparative anatomy, vivisection, and astute observation indeed bore fruit: "At some stage these observations ceased to be random." Yet this is not to resolve but to restate crucial questions. Why did his observations cease to be random? Had Harvey found his hypothesis? How had he done so? Or, as is not unlikely, had his investigations never really been "random"? Had he, even before his Lumleian lectures of 1616, a hypothesis by which to work? In either case, what are the terms of the hypothesis or hypotheses which entered Harvey's mind?

It is at this point that the philosophical and certainly more audacious interpreters of Harvey, preeminent among them being Walter Pagel (*William Harvey's Biological Ideas*, 1967), make their contribution. Acknowledging the paramount role of vivisection and comparison in the confirmation of Harvey's discovery, they focus on the act of discovery or, at the very least, the conceptual preoccupations informing it. Here are emphasized Harvey's various allusions to heart and hearth, solar influences and meteorological cycles, allusions which Whitteridge is willing to dismiss as after-the-fact appeals to authority. (In this alone, she believes, Harvey acted as a traditionalist.) Whitteridge implicitly accepts Harvey's presentation throughout *De motu cordis* as not only the obvious logical exposition of a new doctrine but a virtual record of a great discovery. This is a perilous assumption and one which

probably necessitates an inductivist interpretation of Harvey's achievement.

Elsewhere Whitteridge offers an uncommonly useful chapter on Harvey's views on the physiological primacy of heart or blood (the former holding sway over the mature body but the latter, because of its qualities and action in embryological development, being the truest basis of life in general). In appendix 1 appears, for the first time since the 17th century and in both Latin and in English translation, the most complete extant version of Caspar Hofmann's letter to Harvey of 19 May 1636 setting forth a Galenist's objections to the new doctrine of the circulation of the blood.

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## Boron Compounds

**Carboranes.** RUSSELL N. GRIMES. Academic Press, New York, 1970. xiv, 272 pp., illus. \$14. Organometallic Chemistry series.

The term "carborane" refers to a relatively new family of organoboron compounds which may be thought of as boron hydrides or polyhedral borane anions in which one or more boron atoms have been replaced by carbon atoms. We therefore find very stable carboranes which have closed polyhedral structures and some degree of electron-delocalization stabilization and relatively reactive open-framework carboranes containing more hydrogen atoms than carbon and boron atoms. Those of the former series (termed *closo*) are amenable to electrophilic substitution reactions and derivative formation with a vast variety of organic functional groups. Those of the latter, generally more unstable, series (termed *nido*) are less amenable to derivative formation and sometimes serve as precursors to *closo*-carboranes. Finally, recent work has provided a third general class of carboranes in which the basic framework structure contains atoms other than carbon and boron. Examples of this type of structural modification are known in which elements of groups II, III, IV, V and the transition metals are incorporated as framework members. Thus, the car-

borane family, taken as a whole, constitutes new materials for investigation and eventual incorporation into useful products such as thermally stable polymers, pharmaceuticals, and electronic components.

Research in carborane chemistry has proceeded at a rapid rate, principally in the United States and the U.S.S.R. Consequently, an obvious need has arisen for a comprehensive review of the total literature. This task has now been completed with accuracy and thoroughness by Grimes, and for the first time a novice in the field has available a book that fully describes all aspects of carborane chemistry. Since carborane chemistry shares some aspects of organic chemistry, chemists of that persuasion may find this book valuable to their research interests. By the same token, chemists concerned with chemical bonding and unusual chemical properties will also profit by reading this book, since carborane chemistry is rich in novel problems related to structure and dynamics.

The book is well organized and contains nearly 500 references, numerous illustrations, and several tables describing the physical properties of many carborane derivatives. To some readers the only shortcoming of the book may be the reticence of the author to interpret the information he has compiled. This style is not unattractive in a book designed as an information bank, and this book fulfills that function admirably.

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## Some Eutherian Mammals

**Primate Behavior.** Developments in Field and Laboratory Research. Vol. 1. LEONARD A. ROSENBLUM, Ed. Academic Press, New York, 1970. xiv, 400 pp., illus. \$17.50.

Leonard Rosenblum is to be commended for his courage in undertaking to edit a hard-cover serial publication devoted to long articles on the behavior of primates, with contributions from a variety of disciplines. This series is now added to the two professional journals, two monograph series, and two informal newsletters also devoted solely to articles on this one of the 16 or so orders of extant eutherian mammals. The editor claims (p. xi) that in spite of the appearance of other books

and monographs there is a "need [for a] continuing arena of discourse" for scientists concerned with primate behavior. It is not clear to the reviewer that the order Primates is a sufficient universe of discourse for the exploration of any behavioral principle. It has yet to be demonstrated that the order exhibits so many unique features of behavior and social organization over such a wide range that general principles can be discovered from studies of members of this order alone. On the contrary, most of the concepts used by primate behaviorists were first developed in studies on species of other orders and of other classes of vertebrates. Nevertheless investigators from a variety of formerly well-defended academic territories, each with its traditional interests, techniques, and philosophical prejudices, have found a common interest in studies of primates. Publications such as the current volume provide at the least some mutual exposure across academic boundaries. Some evidence of cross-fertilization can be detected, especially in the comparative studies undertaken by experimental psychologists on species-specific learning abilities and in the interest zoologically trained investigators show in non-genetically transmitted patterns of behavior, or social traditions, as factors in the ecological adaptation of local populations. However, on these topics there is a wealth of information available from studies of animals in other taxonomic groups, and it is to be hoped that students of primates will not lose interest at the boundaries of the order.

Fortunately in this regard, the boundaries are ill defined, as is shown by the excellent review by Sorenson, in the current volume, of the taxonomic relations of the tree shrews. Certainly, as Sorenson points out, whether or not tree shrews are classified within the order, they will remain of interest to primatologists, and they offer a vantage point from which one may easily trespass into the opportunities for research offered by the other mammalian orders.

Gene Sackett reviews his ingenious experiments on the preference which rhesus monkeys reared under different conditions show for various stimulus animals, including conspecific and allospecific individuals. He concludes that underlying the observed preferences for conspecific animals are perceptual mechanisms which mature independent of learning opportunities, but that the early experience of the infant will also

affect its preferences in later life. In another chapter, Mitchell reviews a large number of studies of the effects of caging and captivity, and especially of social deprivation on the development of "abnormal" behavior in primates. The chapters by Sackett and by Mitchell, taken together, provide an excellent summary of one type of research into the development of social behavior of at least the rhesus monkey. But one is reminded of the six blind men who each described an elephant after touching but one part. The reviews suffer from lacking any overview of the life cycle of the species, or of the general pattern of maturation which has been described for many mammals.

Bernstein reviews the concept of "status" as used by students of primate social behavior, particularly in reference to agonistic behavior and social dominance, and their interrelations with other aspects of social organization. The review is admirably detailed and objective, but no other chapter in the volume could have profited more by an extensive review of the comparable literature on other taxonomic groups, if only to provide a set of generalizations to be tested against the literature on primates. The major reviews on dominance among vertebrates by Collias and by Allee are not even mentioned.

Rumbaugh reviews research on the learning skills of anthropoids, and includes a useful outline of the history of his subject. Of particular interest is the discussion of his own attempts to develop a test of learning ability that will produce truly comparable results when applied to different taxa. It should be pointed out, however, that this is not an attempt to discover the special learning talents that have evolved in each species as part of its unique organization, and therefore the research is not as close to comparative biology as the author implies in his introductory remarks.

Poirier's report on his field study of the Nilgiri langur in India, though a fascinating survey of the ecology and social organization of the species, seems out of place in this volume. Although the longest chapter, it is too short to include adequate documentation of many of his conclusions. A longer monograph under separate cover would have been preferable.

I expect that the volume as a whole, and perhaps the series, will prove use-