certain after the discovery of further evidence.

The first and last chapters of the book present Robinson's views on the broad picture of hominid evolution and should be read by all students of the subject. His ideas are often at variance with what is usually taught. For example, he believes that *Ramapithecus* was a pongid, *Gigantopithecus* was a hominid and a possible ancestor to us all, *Paranthropus* was a descendant of *Gigantopithecus* and an ancestor to *Homo*, there were two genera of early hominids in the early Pleistocene with very different adaptations, and *Homo africanus* was an efficient biped. These controversial views will be debated for years to come.

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Parasites

The Biology of Trematodes. DAVID A. ERASMUS. Crane, Russak, New York, 1973. vii, 312 pp. + plates. $24.75.

The trematodes, or flukes, are parasites of incalculable importance in medicine and agriculture. The schistosome eggs found in mummies of ancient Egypt seem to mock the progress of medicine, for this tiny worm remains a scourge of that land today. According to Hulse it was *Schistosoma* as much as Joshua that "fit the battle of Jericho"; it plagued Napoleon's troops in Egypt and MacArthur's troops in the Philippines; and only a couple of decades ago it was held responsible for decimating an army in southern China. No less destructive when out of uniform, *Schistosoma* has blocked the construction of a vast modern dam. It is not, however, the spectacular episodes that count most. The disease is an insidious one. Even mild attacks can lead to lifelong debility, and millions of people are affected. In domestic animals the common liver fluke, *Fasciola hepatica,* has from medieval time been known to cause devastating losses in sheep, and though massive outbreaks of fatal disease have become increasingly rare as a result of modern chemotherapy, it still causes a major economic loss by reducing productivity of sheep and cattle. Many fluke species appear to do little harm to their hosts under natural conditions. Others have bizarre effects of little everyday concern; the English pearls that Julius Caesar dedicated to Venus were probably induced by trematode larvae in mussels; larval flukes frequently cause blindness in fish; and there is some evidence that the suicidal running aground of whales is due to flukes in the brain.

The schistosome and the liver fluke are only two of the many flukes that do threaten, in the most overt way, the welfare of man and his animals. Thus a book on the biology of trematodes is of importance to people in many disciplines. Erasmus has pitched *The Biology of Trematodes* toward those "already familiar with the basic characteristics of the group." No genus or species is described in full; information on a member of the group can often be excavated in great quantity, by means of the index—but you must first know your fluke.

Erasmus devotes major chapters to each of the basic larval stages of the trematode, with additional chapters on general features or biological processes. Information on, say, the cercaria is then to be found in six different chapters. Repetition is unavoidable; and some pieces of information, even when given only once, are to be found under surprising headings. Erasmus does try to wring some generalizations from batches of related findings, but has not attempted the degree of distillation and integration achieved by J. D. Smyth in *The Physiology of Trematodes.* Erasmus's book must rather be judged as a source of fairly detailed information and as a guide to the literature. Questions of balance, accuracy, and comprehensiveness then become of the greatest importance.

The medical and veterinary aspects of trematodes have been so thoroughly described that Erasmus wisely limits his treatment to a few brief summaries. The single paragraph on the pathogenesis of schistosomiasis creates an unfortunate impression of little experimental accomplishment—an impression apparently arising from an exaggerated view of the place of serum analysis in experimental pathology. The author goes on to warn that in helminthoses "the exact role of the helminth in producing disease can be determined only on gnotobiotic hosts." One wonders here if Erasmus appreciates the limitations of pathological studies in gnotobiotic hosts and if he knows of a single case in which such studies have revealed the exact role of a helminth in pathogenesis. In another section of the same chapter Erasmus offers three paragraphs on the immunology of schistosomiasis—all dealing with Smithers and Terry's renowned work, with no mention of other studies, such as those of Warren, that open up entirely different approaches. Morbid matters are almost incidental to *The Biology of Trematodes*, however, and in the rest of the book, Erasmus achieves a clear, though qualified, success.

The ultrastructure of trematodes is given special prominence, as is justified by the author's intent to present "some of the more recent discoveries and ideas developed through the use of modern techniques." Electron microscopy has in fact revolutionized our concept of the trematode tegument in the last decade. The recognition of the fluke (and tapeworm) tegument as a metabolically active body covering is having a profound effect on our understanding of nutrition, immunology, and what Erasmus calls the "host-parasite interface." Because of the absence of a mouth or gut, attention was long focused on the body wall as an absorptive surface in the tapeworms; but in the flukes, where these structures are present, oral absorption was regarded as more important. It is now clear that in their feeding, as in their sex life, flukes demand the best of both worlds, and Erasmus discusses the important role played by both the mouth and the tegument in the intake of nutrients. Similarly, the absence of an anus in flukes previously led to the assumption that the only means of expelling the by-products of digestion was by vomiting and perhaps, for soluble wastes, through the mysterious "flame cell" system; but now the tegument, too, should probably be accorded an excretory function.

In his treatment of the common liver fluke, *Fasciola hepatica*, Erasmus gives no hint of the controversy that has surrounded the very basic issue of whether the fluke is a blood feeder. Discussion of the topic is hidden under "pathology and host response" and not easy to track down even with the use of the index. Moreover, the matter is dismissed with the comment that some workers have suggested that the adult is a blood feeder and some have described the ingestion of blood. A few references are given but there is no mention of the arsenal of sophisticated technology that was brought to bear on the subject and that led nearly all workers (with the notable exception of Dawes) to the conclusion that the adult fluke is a very avid blood feeder.

Surprisingly, most of these workers have evaded the question of how the adult fluke actually procures host blood when surrounded by grossly thickened bile-duct walls.

One of the most astonishing of all trematode life cycles is that of the lancet fluke (*Dicrocoelium dendriticum*), a trematode of importance in sheep and cattle. The story of how the larva in the ant host produces a kind of "lockjaw" that anchors the ant to a plant, thereby making it vulnerable to ingestion by a browsing sheep, so taxes my credulity that I wanted to know what Erasmus makes of it. I looked in vain, for Erasmus considers the life cycle "well-known." So, although much attention is given to the migration of larval trematodes, the antics of this strange and important larva are not mentioned—and Hohorst and Lammler, who described them, are not to be found in the author index. Indeed, Erasmus seems rather capricious in his choice of references. Considering the multitude of references that had to be omitted, one wonders about the need for references in support of the conclusion that we do not yet understand the final step in the localization of *Fasciola* in bile ducts.

For the experienced researcher or teacher, the book's unorthodox selectivity is likely to be one of its great strengths; for the advanced student the emphasis on modern developments will be a similar strong point. Despite some discrepancies between text and indices and some inconsistencies in terminology the book is an accurate compilation of reported observations. It is comprehensive within its chosen limits and makes readily available a vast amount of information on this very important group of parasitic worms.

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Semantic Memory Models

Organization of Memory. A conference, Pittsburgh, 1971. ENDEL TULVING and WAYNE DONALDSON, Eds. Academic Press, New York, 1972. xiv, 424 pp., illus. $17.50.

This volume serves the valuable function of documenting the recent emergence of semantic memory as a central concept in psychological thought about language and memory. "Semantic memory," as the editors state in the preface, "is concerned with storage and utilization of knowledge about meaning of words, concepts, relations among them, and rules for the use of such knowledge." Semantic memory is by no means the only topic covered in this symposium, four of the papers being very competent reviews of memory organization written with emphasis on various current problems including organization in free recall, measurement of organization, and organization and recognition memory. A fifth article, by Greeno, about an imaginative sequence of studies on the learning of mathematical formulas, is rather misplaced in this volume. In this review, I will confine my attention to the remaining five papers, all of which are concerned with semantic memory.

A major purpose of Bower's contribution is an attempt to answer the question "How far can you get without a semantic memory?" He describes FRAN—a program written by John Anderson which uses a simple association network to simulate human behavior in free recall tasks. A free recall task is one in which the subjects learn lists of words and are free to recall them in any order they choose. Like all the memory models to be discussed below, FRAN consists of a data base representing information in long-term storage and a processor that operates on that data base. Its data base, the association network mentioned above, consists of 262 words—all nouns—each of which is linked to some of the others by simple associative bonds. Two words are linked if either appears in the dictionary definition of the other. All the bonds are of the same kind. The task is to learn a list of, say, 24 words from the data base and later to recall them in any order. To perform this task, FRAN makes use of a probabilistic learning process which tags these items in the data base and finds and marks associative pathways in the data base between tagged items. In recalling the list, FRAN, starting from a small set of remembered items, searches along marked pathways to find other list items.

This relatively simple scheme performs remarkably well in simulating free recall in humans. Its learning is influenced in just the same way as is human learning by the amount of time spent studying the list, the length of the list, the position of the to-be-remembered word in the list, and a surprising number of other such variables. In a very few cases, FRAN has clearly failed to simulate human behavior in standard free recall situations. Despite an occasional failure, however, Bower has ample reason to claim that "FRAN is the most powerful explicit model of free recall now available." Only when we go beyond the usual limits of the free recall experiment does FRAN begin to fail seriously. For example, if the list of words to be learned is structured as a sentence, people learn it much more rapidly than they do a list of the same words in scrambled order. For FRAN, however, all word orders are about equally memorable, since none is intelligible to it.

What can we conclude from FRAN's successes and failures? First, we can agree with Bower that, if one stays within the confines of the usual free recall experiment, there is very little reason to prefer a semantic memory to FRAN's simple associative network. This fact, we should note, may be taken either as an indication of the failure of the more complex models or as an indication that the standard free recall experiment fails to reveal some of the interesting processes of human memory.

The failure of FRAN to understand language was, of course, expected. If the semantic memory models are to be judged an improvement over FRAN and other simple associative models, they must successfully simulate a human behavior which depends on language comprehension. Winograd's [*Cognitive Psychol.* **3**, 1–189 (1972)] success in designing a program that understands natural language in a highly restricted environment is a sign that successful simulation of human comprehension may not be far off.

Three of the papers in this volume —by Rumelhart, Lindsay, and Norman; Kintsch; and Collins and Quillian —are directly concerned with the design of semantic memory systems. The three approaches have much in common. They all include a semantically structured data base, that is, one in which the concepts are linked by many types of relations (rather than just by associations) in ways that facilitate the representation of the meaning of sentences. In the Rumelhart, Lindsay, and Norman model, for example, the data base employs the relations subset of, property of, location of, actor, instrument, and at least a dozen more. The memory representation of the sentence "The rock rolled down the mountain"