the entire animal kingdom, beginning with Protozoa and invertebrates. The author shows that among these animals copulation and procreation are sometimes not mutually obligatory, that is, one can occur without the other. Even the presence of genitalia among organisms where copulation does occur does not mean that the sole function of the genitalia is copulation. The reviewer finds one example in particular very challenging to conventional evolutionary thought: Among flat bugs the genitalia, although retained, are not used for copulation or procreation at all. Rather, a method of extragenital mating has evolved whereby the male perforates the female's back and deposits the sperm into the wound, whereupon they enter the body cavity and eventually reach the ova. Among other organisms the genitalia, especially of the male, have taken on other functions in addition to copulation. Among mammals, including many primates, the genitalia are used for depositing scents which serve a variety of individual or social functions, such as indicating travel routes or marking territories. Among several Old World monkeys, where visual displays play an important role in social life, the genitalia have become brightly colored and may be conspicuously displayed, particularly in threat or in indicating group boundaries. Wickler draws upon the ethnological literature to argue that the widespread use of phallic designs and symbols among humans also serves the function of aggressive threat or territorial defense, often against anthropomorphic demons and spirits. Undoubtedly, experts on the various species or human groups may wish to debate the specific functions which Wickler imputes to these displays in his examples, yet his main conclusion seems secure, that the genitalia can serve functions in social life other than copulation. Since the genitalia have evolved modifications to serve their secondarily acquired functions for display Wickler can state another important principle: Changes in behavior can result in evolutionary changes in structure, and therefore norms for behavior patterns cannot be deduced from structure alone, particularly in regard to future behavior.

Many examples are given which show how behavior patterns derived from mating behavior come to be used to alleviate social stress, especially on the part of subordinate animals. These examples illustrate the principle of emancipation, which is shown to apply in animal groups as distantly related as primitive insects (termites) and higher primates (chimpanzees).

In the third part, pair-bonding in the context of reproduction is considered. Because the author is leading to a discussion of man, most of his examples now are derived from studies of vertebrates. He demonstrates that the behavior patterns used to maintain the bond within mated pairs of vertebrates often are derived from three sources: brood-tending behavior, redirected aggression, and mating behavior. Therefore, if we find an unstudied species of vertebrate, and we find that mated pairs occur within its social groupings, our working hypothesis will be that the behaviors which maintain these mated pairs will also be derived from those sources.

The fourth and final part of the book therefore is an examination of the nature of the pair bond among mated humans. Examples of mother-child behavior from the ethnological literature as well as commonly known examples from European peoples precede examples which show that many of the elements of behavior directed toward the human child also occur in emancipated form in the behavior between adult men and women. He finds that, as among the other higher primates, copulation itself has been emancipated from its procreative function and along with emancipated brood-tending behavior serves to maintain the bond within the mated pair. This, of course, is the climax of the book, and it contradicts the statements on the natural laws of procreation found in *Humanae vitae*. Wickler does not attempt to derive a moral code himself, but ends with restrained criticisms of theological assertions about natural laws which are contrary to the facts discovered by direct observation of nature.

Many of the conclusions and some of the facts in this book will be familiar to readers of popular ethology, but Wickler's work is far more restrained, far more ordered into a well-reasoned argument, and above all far better documented than any of the other books that have covered the same ground. Only the popular works of Konrad Lorenz are of comparable stature. It is likely, however, that Wickler's work will not become as widely popular as Lorenz's *On Aggression*, for instance, for Wickler is more difficult to read and each chapter requires careful study. Those who expect a flowing literary style and witty personal anecdotes will not find them. Yet some, like the reviewer, may prefer Wickler's craftsmanship that informs and fascinates with each sentence and paragraph and that, without polemic and with no attempt to titillate or even to amuse for amusement's sake, nevertheless charms the reader with each careful addition of detail to a work of high quality.

DONALD STONE SADE
Caribbean Primate Research Center, University of Puerto Rico, Punta Santiago, and *Department of Anthropology, Northwestern University, Evanston, Illinois*

Microevolution

Ecological Genetics and Evolution. Essays in Honour of E. B. Ford. ROBERT CREED, Ed. Blackwell, Oxford, and Appleton-Century-Crofts, New York, 1971. xxii, 392 pp. + plates. $24.50.

Edmund Brisco Ford is emeritus professor at the University of Oxford. These 19 essays have been dedicated to him by 24 of his friends and associates. Almost without exception, they reflect Ford's characteristic approach to biology, the integration of Darwinism and Mendelism at the intraspecific level. The topics dealt with are his favorites: polymorphism, mimicry, and melanism in natural populations of a variety of organisms, especially Lepidoptera. The editor has succeeded in the difficult task of producing a volume complementary to Ford's own *Ecological Genetics*, which has just appeared in its third edition (1971). There is little overlap between the books. Most of the contributors to the present volume have provided detailed expansions of topics briefly reviewed in the former. For example, B. Clarke and J. J. Murray have confined themselves to data on variation in one subspecies of the snail *Partula suturalis*. A. J. Cain, writing on the snail *Cepea*, explores in detail variation found in subfossil samples. Even papers on the Lepidoptera successfully avoid redundancy; it is pleasing, for example, to see two papers on the remarkable but little-studied mimicry in heliconid butterflies. J. R. G. Turner's paper is enhanced by a sumptuous colored figure, one of several in the book. Only one paper reports on data obtained by the currently fashionable electrophoretic techniques. The influence of Ford's ideas on human genetics and polymorphism is acknowledged through the presence of four

essays by members of the Nuffield Unit of Medical Genetics.

By and large, the articles are serious reviews, or specific treatments, of mature topics; thus the book emerges as a distillation or reinforcement of older ideas, not as a reaching for new ones. There is a distinct historical flavor; this is suitable in view of Ford's special position in the development of evolutionary biology. In the 1930's, Fisher, Haldane, and Wright laid the theoretical cornerstone of evolutionary thinking in this century. At about the same time, Ford commenced the construction of the edifice with data taken from nature. He had few peers in those days, perhaps only Dobzhansky, and I was delighted to find that the latter has contributed a characteristically lively essay on historical genetic changes in populations of *Drosophila pseudoobscura*.

The introduction to the bibliography refers to the "relentless excellence" of Ford's work. I used this list to locate his first paper, published 50 years ago, on variation in the butterfly *Heodes phlaeas*. Here is manifested the meticulous care and the sure style of the years to come. The young author adduces 50 pages of data and grapples with the prevailing ideas—particularly those of Weismann.

Three of the essays seem to me to be outstanding. One is on plant evolution in extreme environments by A. D. Bradshaw (whose name is missing from the "list of contributors"). After reading this beautifully wrought paper, I conclude that microevolutionary adaptation in plants deserves far more attention than it has had. The paper "Drug therapy as an aspect of ecological genetics" by D. A. P. Evans is full of new perspectives for those interested in the seemingly disparate subjects of pharmacology and population genetics. Finally, I was captivated by Miriam Rothschild's essay "Speculations about mimicry with Henry Ford." The pursuit of knowledge by generations of British naturalists (Gilbert White, Charles Darwin, William Henry Hudson) has been traditionally unfettered by the seductions of applied science. With charm and humor, Rothschild articulates the sheer delights of the intellectual adventure, the "Fragestellung," which is, indeed, characteristic of the Fordian approach to nature.

HAMPTON L. CARSON
Department of Genetics,
University of Hawaii, Honolulu

A Symbiosis

Gardening Ants, the Attines. NEAL A. WEBER. American Philosophical Society, Philadelphia, 1972. xx, 146 pp., illus. $8. Memoirs of the American Philosophical Society, vol. 92.

Long files of ants carrying fragments of leaves over their heads impress visitors to tropical and subtropical America. These "leaf-cutting ants" carry the fragments back to their subterranean nests to provide a substrate for a fungus which grows in large masses in nest chambers. The fungus in turn provides nourishment for the developing ant brood and adults of the colony. About 200 species of ants, constituting the tribe Attini, are known to culture fungi, mainly on insect excrement or dead plant materials. The common name "fungus-growing ants" has been universally applied to attines. Now, Neal Weber has rechristened them "gardening ants," a term fully as descriptive but hardly necessary.

In a personalized account Weber describes the results of a more-than-35-year romance with fungus-growing ants, a subject for which he clearly has preeminence. The nine chapters treat the main aspects of attine structure and biology including the life cycle, colony populations, nest structure, foraging behavior, and fungus gardens. An appendix provides a key to attine genera and records of the distribution of species occurring north of South America, mating flights, and guests, parasites, and predators.

Does each species of ant harbor a different species of fungus? Apparently not. Weber describes his pioneering efforts in developing culture methods to raise the fruiting bodies necessary for the identification of fungi. Only one fungus has so far been identified, but the magnitude of the task makes even that achievement significant. In contrast to the extensive description of studies of fungal culturing, Weber devotes less than half a page to the evolution of fungus-growing, a subject deserving more extensive explanation. Concerning the related question of the phylogenetic origin of Attini, Weber briefly mentions that they closely resemble the harvester ant genus *Pheidole*, a suggestion made nearly 80 years ago by von Ihering. No mention is made of von Ihering or of how attines resemble *Pheidole*.

The book is well illustrated; however, several figures are out of sequence and the captions of several others are misleading. Four tables lack titles. The list of species in the appendix would have been more valuable had it included those living in South America, where the majority of attines occur.

Weber has provided us with a comprehensive review of the literature and a wealth of heretofore unpublished observations. His book should become a primer for those intent on investigating the symbiotic association of ants with fungi.

PAUL B. KANNOWSKI
Department of Biology,
University of North Dakota,
Grand Forks

Anniversary Assessment

Insulin Action. Proceedings of a symposium, Toronto, Oct. 1971. IRVING B. FRITZ, Ed. Academic Press, New York, 1972. xx, 610 pp., illus. $17.50.

In commemoration of the discovery that the lives of depancreatized dogs and, indeed, the lives of patients with diabetes mellitus could be sustained by injections of pancreatic extracts, several international symposia were held during the 50th anniversary year. This book presents the proceedings of a symposium held in Toronto, scene of the historic discoveries of Banting and Best in 1921. As is implied by the title, the organizers of the symposium selected topics relating to the mechanism of action of the hormone and did not attempt to review all of the many scientific accomplishments that were sparked by the discovery of insulin. Thus the historic experiments that led to the elucidation of the primary structure of insulin, the equally historic achievement of the chemical synthesis of insulin, and current concepts of the use of insulin in the treatment of human disease are not considered. This is a commendable restriction in the scope of the symposium but limits the value of the book to medical historians and to the many researchers in the field of insulin action.

As with other symposium proceedings, many of the data have been published elsewhere in greater detail. Nevertheless, it is convenient to have them reviewed and summarized under a single cover. The initial chapters are concerned with the three-dimensional structure of the insulin crystal, and with the structure-activity relations of