viously had the function of stratifying society and distributing the goods and wealth of that society."

There seems to have been a research shift (some would call it a sensible, perhaps temporary, retreat) in recent years. Few investigators are concentrating on the goal of predicting later functioning from infant test scores. Many are simply trying to describe and conceptualize infant functioning per se. The papers that illustrate this trend reveal the pervasive influence of Piaget, who labels infancy the period of "sensorimotor intelligence." Within this framework infancy is seen as a period when sensory, perceptual, and motor patterns (schemas) emerge, are practiced, and, ultimately, are coordinated with each other. The infant gradually constructs a world which includes notions of object permanence and simple spatial and causal relationships and the concept that available means can be mobilized in the service of more and more complex and remote goals.

Various papers discuss the components of Piagetian sensorimotor intelligence and describe the recently developed tests that purport to assess them. One paper describes a factor analysis of responses on the traditional Gesell scale which yields clusters consistent with Piagetian developmental hypotheses, and another describes a new four-level characterization of sensorimotor intelligence. It is hoped that this characterization will aid in the evaluation of various Piagetian tests and in the definition of component domains whose interrelations could then be explored. Still another paper elaborates the view that human sensorimotor intelligence, unlike the abstract, verbal cognitive activities of adulthood, is strikingly similar to that of other primates. It shares an evolutionary history and is similarly "canalized," that is, based on genetic predisposition. Environment is not unimportant in the emergence of sensorimotor intelligence, but, it is contended, almost all naturally occurring primate and human environments provide sufficient support and stimulation that there are relatively few individual differences in attaining criterion performance. This last assertion, however, requires far more empirical support than is yet available.

In general, the description of infancy in Piagetian terms is more conceptually satisfying than the traditional normative catalog of behaviors. Nevertheless, at this point in time, performance on available Piagetian instruments is no more consistent than performance on traditional tests. Moreover, although sensorimotor intelligence is conceived of as a sort of concrete model of later abstract reasoning, no one has yet demonstrated a predictive relationship between the two.

Individuals labeled "intelligent" in Western industrialized societies are often those with outstanding verbal skills. While infants, of course, are only in the beginning stages of language development, the sense of the potential importance of linguistic skills is reflected in this volume, where several papers suggest they are important precursors of later cognitive skills. It is reported, for instance, that, for girls, early vocalization substantially predicts adult cognitive functioning. Other authors contend that it is in the early precursors of language that we find the roots of socioeconomic class differences in intellectual functioning, and it is suggested that early intervention programs should be heavily aimed at language development. Finally, an entire paper is devoted to a detailed analysis of one infant's progression toward comprehension and production of the concept "why." This type of analysis is considered useful because "the linguistic mastery of terms that lack portrayable correlates ultimately gives the child access to types of information and information processing that is inaccessible through sensorimotor learning."

It has been traditional in American psychology to view cognitive and emotional development as separate. At several places in this book that distinction is questioned. One paper, for example, presents a convincing argument that affective responses, that is, "looking smart," "showing interest," actually figure importantly in the scoring of both traditional and Piagetian test items, although the affective component has not been explicitly acknowledged. Another paper reports that an analysis of the Bayley scales led to the identification of three clusters of items that "measured cognitive abilities but that had a strong underlying motivational component."

The general picture that emerges in this volume is of a vigorous but fragmented field of research. Infant behavior is seen as complex and interesting in its own right, but there is not yet general agreement about which are the most useful dimensions in which to conceptualize it. Also, as the title suggests, there is a tacit belief that the activities of infancy relate to adult cognitive functioning. However, the direct or circuitous routes by which an infant's search for a hidden object leads to an adult's solution of an abstract problem have certainly not yet even been sketched. This book will prove disappointing to a layman seeking answers. It should be of considerable interest to any social scientist interested in the process whereby alternative points of view and alternative research strategies focus in on a complex problem of human development.

WINIFRED SHEPARD
Department of Psychology,
State University College at Fredonia,
Fredonia, New York

Continuing in the MacArthur Tradition

Ecology and Evolution of Communities. Papers from a symposium, Princeton, N.J., Nov. 1973. MARTIN L. CODY and JARED M. DIAMOND, Eds. Belknap (Harvard University Press), Cambridge, Mass., 1975. xiv, 544 pp., illus. $29.50.

Comparative tables of the number of species of plants, insects, and birds of different regions were compiled by Alfred Russel Wallace in his last book, *The World of Life*. He wrote, "This distribution constitutes the primary and fundamental fact in the relation of species to the whole environment—it is, in fact, the broadest and most simple expression of that relation." Over the next half century little progress was made in the expression and interpretation of this relationship, although Charles Elton and G. Evelyn Hutchinson's development of the niche concept and C. B. Williams's and F. W. Preston's studies on diversity provided useful tools. It was for the late Robert MacArthur in a brilliant, but tragically short, working life to lay open the whole subject of the structure and evolution of natural communities, viewed as evolving assemblages of species. The insights he brought from the combination of his real knowledge of birds with his mathematical skills spawned a whole new area of ecology to take its place beside studies of the dynamics of populations and of the trophic structure of communities expressed in terms of the circulation of energy or chemical components. At last the relationship between

species, in the plural, and their environment, to which Wallace had drawn attention, was being elucidated.

In the present volume MacArthur's teacher, collaborators, relatives, and pupils have come together to pay tribute to his genius. Fittingly they have not looked back but forward. Each of the 18 chapters represents largely new work, and the volume as a whole provides an authoritative account of the current state of knowledge and indications of future directions in this branch of ecology. One of the most important indicators is provided by Richard Levins, who in the first chapter applies loop analysis to the long-standing problem of diversity and stability in communities, a topic also discussed by Egbert G. Leigh, Jr., in chapter 2. To use this powerful method it is necessary to know the nature of the effects of one species on another and to be able to recognize self-regulation; but the much more difficult task of determining the magnitudes of the effects need not be attempted. Levins shows that the addition of a further species to a community may be either stabilizing or destabilizing, depending on the matrix of the interactions and their signs, and shows how this method may be used to enhance our understanding of evolutionary pressures and outcomes.

In the shortest chapter (seven pages) in the volume, Robert MacArthur's brother, John W. MacArthur, shows how the total number of species found in an area may be related to a measure of environmental variation or climatic "noise." The fit of his empirical formula, which has only two parameters, to many different sets of data is remarkably good. He points out that the measure of noise is related to whatever it is in an environment that opposes the establishment of new species. The pursuit of this lead will surely prove profitable; one may be sure that it would have excited Wallace.

A wide variety of measures have been proposed for the expression of the relationship between the number of individuals and the number of species in a community, its diversity. In a mere 25 pages (plus mathematical appendices), Robert M. May brilliantly relates these many and, to the nonmathematician, diverse approaches. His account should remove the bit of mystique this subject has had and staunch the flow of papers on "improved" indices of diversity or equitability. He shows that for large assemblages of species a log-normal pattern of relative abundance may be expected; with smaller assemblages where "niche preemption" is likely the log series, a less even distribution than the log-normal, may be found to apply. In smaller assemblages where the same resource is limiting for a number of species and the allocation to each is random, the "broken-stick" model will apply. May cautions against single-parameter characterization of diversity and suggests that, if a single parameter must be used, the simple dominance measure (d = the number of individuals in most abundant species divided by total number of individuals) is probably best.

Students of natural communities soon realize that, to use Alex Watt's terms, along with pattern there is process. Communities change, usually in a particular sequence, termed succession. In chapter 9 Henry S. Horn analyzes forest succession in Markovian terms. He shows how field observations on the distribution of seedlings in relation to mature trees may be used to build up a transition matrix that will predict the composition in x theoretical generations. Apart from its theoretical importance, and one looks forward to its application to a tropical rain forest, this paper will surely become the basis of field exercises for students.

One of the landmarks of MacArthur's work was his simple exposition of the idea that the combination of extinction rates and speciation rates should lead to species diversity in a large area approaching a steady state. With Edward O. Wilson he illuminated our understanding of island biogeography by his consideration of these processes: speciation being enhanced by immigration. In chapter 5, Michael L. Rosenzweig explores this concept further, particularly for continental floras and faunas. In the final chapter the same ideas are applied by Wilson and Edwin O. Willis to the practical problems of wildlife conservation, the size and shape of reserves, the creation of new habitats, and the manipulation of ecosystems.

In many of the chapters aspects of species abundance or community structure are investigated in relation to findings from particular groups of organisms: Arthur M. Shapiro with butterflies, William M. Schaffer and Madhav D. Gadgil with plants, Henry A. Hespenheide, James R. Karr and Frances C. James, Martin L. Cody, and Jared M. Diamond with birds, James H. Brown with rodents, Leigh with large mammals, Eric R. Pianka with lizards, and Ruth Patrick on stream communities. Not surprisingly the conclusions of these authors do not always agree, and this adds to the stimulation afforded by the book as a whole.

There are striking differences in the diversities of the lizard faunas of North American, African, and Australian deserts, and Pianka concludes that these are mainly related to the differences in the diversity of resources exploited by the lizards in each desert or to the size of the lizard niche space. He found the third potential explanation, increase in niche overlap with increased diversity, untenable and demonstrated a negative correlation between the two. Conversely, in the next chapter Brown considers that with desert rodents there is a positive correlation between the overlap in resource utilization and species diversity. Both may be correct; the mechanisms for "species packing" may differ from taxon to taxon or, as Pianka points out, it may be an artifact due to the increased number of closely related species in the more diverse faunas.

Diamond's chapter, "Assembly of species communities," which is in fact a study of the avian faunas of the islands around New Guinea, occupies almost one-fifth of the volume (editor's prerogative?). It is a monograph in its own right and will undoubtedly be of wide and lasting interest to ecologists and evolutionary biologists. Not all Diamond's arguments convince, and in places they seem inconsistent. His estimates of field populations suggest that higher avian densities occur on islands largely occupied by r-selected "supertramps" than on islands inhabited by K-selected "high-S specialists." He claims that this is due to the "overexploitation" of resources by the K-selected species and not to the action of predators, a view based on the diversity of predators on islands dominated by supertramps. Yet from his argument on overexploitation he concludes that "predators in high-S communities have a major impact on the densities of their prey" (p. 385). In this context he is clearly considering birds as predators and not as prey. I am more persuaded by the arguments of Joseph H. Connell, who in chapter 16 lucidly analyzes the structure of natural communities. He utilizes a wide range of evidence from plants and animals and from terrestrial and marine environments and concludes that predation is more intense in more benign physical conditions.

Hutchinson contributes the penultimate chapter, and reading this and Connell's that precedes it, I became aware of a change in approach. Was it just that the reference citations had suddenly widened again to include ecological work of other "schools," indeed of other countries? Was it that calling on a much wider range of organisms and data Hutchinson's and Connell's conclusions seem firmer and free from the type of false

comparisons that I feel spoil, for example, some of Leigh's arguments? Restricting his data to large mammals, seven examples, Leigh shows that the amplitudes of population fluctuations in tropical situations are not less than those in temperate species. However, as J. W. MacArthur points out in this volume, environments are best considered in relation to the extent of the variation in their environmental conditions. The semiarid tropical areas, from which Leigh's two wild, tropical examples are drawn, should not simply be grouped with tropical rain forest in a contrast with temperate regions.

The last section of Hutchinson's chapter, entitled "coda," resolved my uncertainty. In a lucid and powerful argument Hutchinson warns of the danger of excessive generalization and points out the need for "a wide and quite deep understanding of organisms, past and present." He reminds his fellow ecologists of Robert MacArthur's own strictures against an obsession with an intellectual approach to ecology. Yes, this was the difference. Here and there in some of the earlier chapters with their apparently limited knowledge of the literature, as evidenced by the restricted list of references, and their arguments based on a single restricted taxon of animals, I felt a vague unease. There are very real difficulties in quantifying bionomic observations (on habitats, feeding habits, and other such parameters); the more the investigator knows of the biology of the organisms in the trophic levels above and below, the sounder will be his judgment in this process. Studies of predators' fluctuations may be misleading without a knowledge of the fluctuations of their prey, whether these be plants or other animals. But how many students of bird ecology measure changes in available prey or game biologists available forage? Certainly some, but are they becoming proportionally rarer or more abundant?

This handsomely produced volume is an outstanding collection of papers on the species composition of communities by the "MacArthur school." So long as the warning of the Hutchinson coda is obeyed we may expect continued and substantial progress to arise from the approach of this school, so that we may better understand our environment and, as Wilson and Willis prophesy in the final words of the volume, engage in "creative work that is orders of magnitude even more extensive."

T. R. E. SOUTHWOOD

Imperial College Field Station, Silwood Park, Ascot, Berkshire, England

Fish in the Inland Tropics

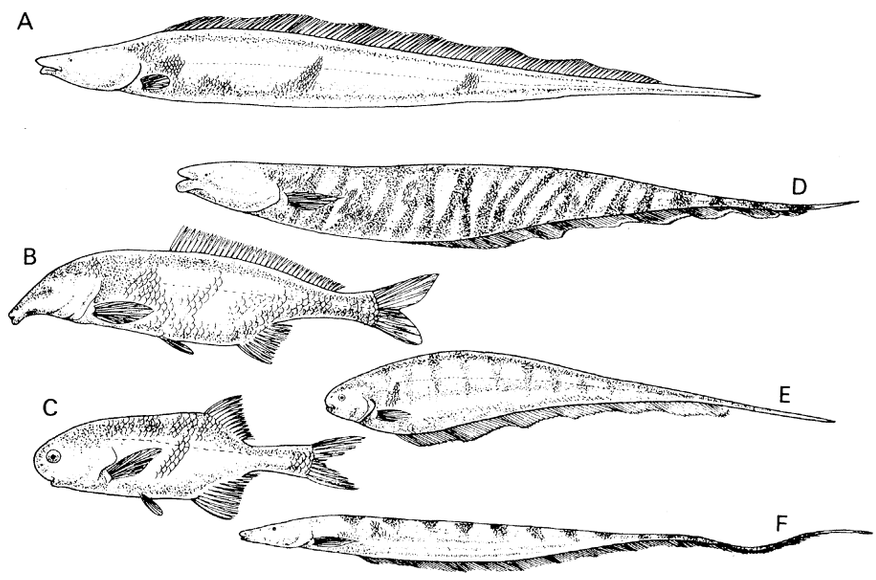
Fish Communities in Tropical Freshwaters. Their Distribution, Ecology and Evolution. R. H. LOWE-MCCONNELL. Longman, New York, 1975. xviii, 338 pp., illus. $26.50.

From the dead-leaf-mimicking South American anabantid *Monocirrhus*, which gently drifts down to the stream bottom to devour an unsuspecting fish, to the overwhelming variety of cichlid species of the Great Lakes of Africa, the diversity of tropical freshwater fishes provides an infinite number of stimulating biological questions. As scientific knowledge of these fishes has proliferated, major contributions have been (dare we say) spawned by four important Old World investigators. A monograph by P. H. Greenwood (*Bull. Br. Mus.* [*Nat. Hist.*] *Zool.* Suppl. 6 [1974]) examined in detail the cichlid species flock associated with Lake Victoria. G. Fryer and T. D. Iles's highly enjoyable book *The Cichlid Fishes of the Great Lakes of Africa* (Oliver and Boyd, 1972) focused on the over 500 cichlid species from the lakes of Africa and the great wealth of literature concerning them. Now R. H. Lowe-McConnell provides a broad review of tropical fishes from Africa, South America, and Asia.

The title may be misleading if one is expecting that all tropical areas will be covered equally. In fact, the book relies heavily on the African literature (about 65 percent), with some treatment of South America (27 percent) and little (less than 8 percent) on Asia. (Central America is entirely omitted for some reason.) This imbalance basically reflects the state of knowledge about these different faunas. The book provides a complete inventory of what is known about tropical fish populations from these regions.

Also included in the book are a bibliography of more than 500 listings and a useful index of fish names along with their synonyms. The latter is most helpful, since many fish species have had their names changed at an even faster rate (and perhaps with less justification) than that at which new African nations have been rechristening lakes and rivers named by their colonial predecessors.

One can appreciate the information available on tropical fishes by considering three types of questions that characterize, in a simple way, the development of biological knowledge: what? how? and why? In Africa, answers to most of the what questions are known from studies of fish taxonomy (what species are present) and zoogeography (what are their distributions). Many how questions have been answered, including ones concerning the behavior of many species (how fishes communicate and reproduce), trophic relationships (how fishes feed), and growth rates. The most basic questions, the ecological and evolutionary why's, have also been considered, including ones concerning competition and predation selective pressures, the food resource spectrum, community organization, the maintenance of



Convergent evolution in two unrelated groups of electric fishes: the mormyroids of Africa (A to C) and the gymnotoids of South America (D to F). "Convergence occurs in types of electric discharge, ecology and body form; propulsion is by undulations of a long unpaired fin in many cases." (A) *Gymnarchus niloticus* (100 cm); (B) *Mormyrus kannume* (60 cm); (C) *Petrocephalus catostoma* (9 cm); (D) *Gymnotus carapo* (30 cm); (E) *Eigenmannia virescens* (25 cm); (F) *Gymnorhamphichthys hypostomus* (15 cm). [From *Fish Communities in Tropical Freshwaters*]