A Brain Structure

The Hippocampus. ROBERT L. ISAACSON and KARL H. PRIBRAM, Eds. Plenum, New York, 1986. Vol. 3, xviii, 438 pp., illus. $59.50. Vol. 4, xxiv, 374 pp., illus. $57.50.

These two new volumes of *The Hippocampus* treat discoveries that have occurred since 1975, when the first two volumes were published. As the editors point out, scientists study the hippocampus in part because it offers a useful model system in which to investigate certain fundamental neurobiological questions. Volume 3 contains chapters written largely from this perspective; though timely, informative, and well worth reading, they fail to explain the fascination that the hippocampal formation—the focus of more that 250 presentations at the 1986 Society for Neuroscience meetings—holds for neuroscientists. Volume 4 contains chapters that take a broader view of the hippocampal system and its role in overall brain function; these chapters must bear the burden of conveying the current excitement and sense of progress among hippocampus researchers.

Though individually interesting, the chapters of volume 4 collectively seem to confirm the impression of a graduate student quoted by Pribram that the hippocampus is "the black hole of neuroscience." This is unfortunate. Many would argue that we know more about the details of the hippocampal system (witness the chapters in volume 3) than any other brain system and that the involvement of the hippocampus in learning and memory makes it an ideal structure in which to study the biological bases of cognitive function. Though the exact nature of its role is not clear, most researchers agree in broad outline about what the hippocampus is doing, and even to some extent about how it is doing it. The reason this emerging consensus is not reflected in these volumes has to do with what has been omitted.

Several areas of research responsible for generating much of the excitement about the hippocampus are either underrepresented or not represented at all. First, there is at present intense interest in long-term potentiation (LTP) in the synapses of the hippocampus, both for what this phenomenon tells us about plasticity in mammalian brain circuitry and for what it suggests about the role of the hippocampal system in memory processes. The two chapters on LTP in volume 3 pay scant attention to functional issues. Nor is there any discussion in either of these volumes of how the structure of the hippocampus relates to its functions. Recent interest in parallel distributed processing (PDP) models in cognitive science has focused the attention of many investigators on the apparently distributed fashion in which the hippocampus operates. Structural simulations of this brain region are a goal of several investigators, and such models will surely tell us a great deal about how "matrix" memory could work in a biological system. In such connectionist models, memory is stored through changes in the connection weights between elements. The hippocampus is attracting attention not only because it is built like a matrix, but also because it has a prominent synaptic-weight change mechanism: LTP. This is heady stuff, but the interested reader will not find out about it in *The Hippocampus*.

Second, there is no discussion of hippocampal development in either of these volumes. Though a chapter in volume 2 of the series remains pertinent, much has happened in the past decade. The facts of hippocampal development are unusual, and they raise many exciting possibilities that are being actively explored. Put briefly, in most altricial species the hippocampus undergoes extensive postnatal maturation; therefore it is not operational early in life, and its development is open to considerable environmental influence. Given that the hippocampal system is implicated in memory for unique instances (discussed in volume 4 by Gerbrandt, Pico, and Ivy), its absence early in life is intriguing, to say the least. Several investigators, myself included, have speculated on the role this fact might play in infantile amnesia, a phenomenon first noted by Freud. This and other ramifications of the postnatal maturation pattern deserve more attention.

The chapter by Mahut and Moss in volume 4 does take up developmental issues, but it must serve double duty as the only discussion of the extensive work being done with primate models of hippocampal function. Such work is sharpening our notion of memory and increasing our understanding of the localization of particular functions to specific brain "modules." Though this chapter does its job well, I would have liked to see an entire chapter devoted to the issue of *which* specific memory functions the hippocampus is critical for. The results from the study of amnesic patients, widely reported even in the popular press, would be an obvious source.

Finally, there is no presentation of the spatial story. The notion that the hippocampus has a special role in creating internal spatial representations, or mental maps, continues to stimulate research. The carefully analyzed properties of single "place" neurons in the hippocampus of the freely moving animal may constitute the best data we have concerning the neural correlates of a complex cognitive function. Virtually everyone working on the hippocampus in the rat uses spatial behavior as the diagnostic tool to assess its functional status. A collection of papers on the hippocampus without a single chapter on the spatial hypothesis cannot be considered complete.

Let me close on a more positive note. These volumes contain a lot of good, hard work. I have already mentioned a few of my favorite papers. The chapter in volume 4 by Gabriel and his co-workers provides a thoughtful analysis of the kinds of things the hippocampus must be doing, at both the neural and conceptual level. Another chapter in volume 4, by Gray and Rawlins, attempts to bring together two important, but quite different, perspectives on hippocampus. The editors of *The Hippocampus* have shown us most of the major traditional vistas in hippocampal research. It will fall to others to show why the aisles full of hippocampus posters at scientific meetings are abuzz and why many physicists interested in studying the brain in the language of statistical thermodynamics are coming around asking questions about "place" cells, LTP, and the microstructure of the dentate gyrus.

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Troublesome Insects

Fire Ants and Leaf-Cutting Ants. Biology and Management. CLIFFORD S. LOFGREN and ROBERT K. VANDER MEER, Eds. Westview, Boulder, CO, 1986. xvi, 435 pp., illus. Paper, $45. Westview Studies in Insect Biology. From a conference, Gainesville, FL, March 1985.

Ants, wrote the Reverend William Gould in 1747, must be the work of "an ingenious Artificer," as they are so evidently intended for the moral instruction of mankind and the sustenance of game birds. On considering the fire and leaf-cutting ants, however, it is difficult to discern a providential design. The often devastating depredations of these insects have inspired a great deal of basic and applied research, to which this invaluable volume provides an excellent introduction. Some familiarity with ant biology is assumed. However, a wide range of readers will be interested in the thorough cataloguing of economic impact, the search for innovative management techniques, and the fundamental sociobiological studies for which these ants serve as models.

The fire ants *Solenopsis invicta* and *S. richteri* are opportunistic "weed" species. Intro-

duced into the United States about 1920, they spread rapidly, damaging certain crops and stinging painfully. Leaf-cutting ants (*Acromyrmex* and *Atta* spp.), by contrast, are the predominant herbivores of the New World tropics. They energetically harvest fresh vegetation on which to cultivate fungi as food for their larvae, providing intense competition for agriculture. Five sections of the book cover economics, biology and ecology, behavior and semiochemicals, physiology and biochemistry, and control strategies. The international group of contributors (15 of the 34 papers have at least one foreign author, and much of the work on leaf-cutters appears in English for the first time) make accessible an extensive literature and summarize their recent findings.

Three especially noteworthy reviews present the intricacies of chemical communication in these species (Fletcher on *Solenopsis* queen pheromones, Howse on leaf-cutter trail following, and Vander Meer on *Solenopsis* trail following). Such investigations are only beginning to elucidate the impressive sophistication of social insect semiochemicals, with multiple active constituents contributing different components of complex behavioral responses. Also exciting is the neurobiological study of *Acromyrmex* by Delabie *et al.* suggesting that maturation of the olfactory system enables ants to learn certain chemical cues in an imprinting-like manner. Despite intensive research, large gaps remain in our understanding; topics for future work on *Solenopsis* ecology and physiology are surveyed by Tschinkel and Vinson, respectively. The recent appearance of a polygynous form of *S. invicta* in the United States has particularly significant biological and control implications.

Insufficient distinction is made between the appropriate goals for control of fire and leaf-cutting ants. We would be well rid of our imported fire ants, despite their potential control of other insect pests; however, this is not so easily accomplished. Indiscriminate use of toxic baits may even aid *S. invicta's* advance, as this species quickly invades new habitat from which we have obligingly eradicated the competitive native species. Leaf-cutting ants, on the other hand, are a spectacular component of the indigenous Neotropical fauna. Reading, for example, Vilela's worry about reinfestation from poorly controlled populations, I found myself hoping that "permanent reservoirs" of leaf-cutters would remain untouched. It is disturbing to learn that such toxicants as mirex (dodecachlor), heptachlor, and aldrin, no longer permitted in the United States, are recommended for use in Brazil. Alternative management methods, addressed in several papers, are urgently needed.

This important and useful collection maintains a salutary balance among pure and applied studies. Indeed, these approaches are often appropriately combined. Tschinkel's observation on *Solenopsis* applies to both groups: "Society's relatively high need for knowledge of this ant gives us the opportunity to carry out this research." Perhaps the ants provide moral instruction after all.

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Population Scenarios

Prehistory in the Pacific Islands. A Study of Variation in Language, Customs, and Human Biology. JOHN TERRELL. Cambridge University Press, New York, 1986. xvi, 299 pp., illus. $42.50.

This book is a must for every scholar of Pacific prehistory—not necessarily because they will agree with all its conclusions but because of its sweeping overview of different disciplines and the challenge it throws out to examine critically many well-established theories. The reader will find little in the book about the present state of archeological knowledge of the Pacific area, however, for, with the exception of details of the author's own excavations and related investigations on the island of Bougainville, the "cold" evidence is missing. By contrast, there is a great deal of theoretical speculation culminating with the view that if we keep three lessons in mind "there is hope that our present ignorance may give way to new understanding" (p. 270). These lessons are: that science is a two-step process requiring both imagination and evaluation; that there are many ways to learn about the past; and that we must draw our portraits of the past with people in them, giving proper weight to the human qualities that made successful colonization and integration possible.

There has been no shortage of theories about the peopling of the Pacific. Before the advent of modern archeological studies in the 1950s and '60s these theories were based on the apparent differences in physical types in various parts of the Pacific, on differences in language, and, largely, on conjecture. There emerged finally a view that has become accepted widely that there are two main elements making up the Pacific Island population—a dark-skinned group speaking non-Austronesian languages and a brown- or yellow-skinned group speaking Austronesian languages. Further, it is accepted generally that these groups moved out to colonize their Pacific homes at different times, the former migrating from Asia perhaps some 50,000 years or more ago, the latter perhaps only 7000 years ago.

Terrell argues cogently that the prehistorian not only must examine all the available evidence but must construct models of all possible alternatives. Ideally, tests must be made to determine which model best fits the evidence, and also to identify what further evidence is needed to validate the model that is favored.

One of the best examples of testing hypotheses for colonization of the Pacific Islands used by Terrell is provided by the computer simulations carried out by Levison, Ward, and Webb (*The Settlement of Polynesia*, Australian National University Press, 1973). Utilizing data about winds, currents, islands, and other variables, they conducted computer experiments showing the outcomes of hypothetical voyages. Their simulations showed the probability of successful colonization of particular islands from various points of origin. In the present book Terrell gives examples of many other models. For example, he lists alternative scenarios for the settlement of the Pacific Islands by members of two distinctive "races," or alternatively by two identical groups that then proceeded to differentiate from one another to give rise to the contrasts observable today. He examines models that could explain the extraordinary differentiation between languages in certain parts of the Pacific and great similarities in other parts. Other models examined refer to the effects of population size on the chance of survival or extinction on islands, the importance of communication networks and stepping-stone models in the transfer of goods and ideas, the likely effects of change and adaptation, and, finally, population growth and the implication of population size on the development of social strategies for living together.

There is a danger, of course, in demanding that models representing all possible alternatives be examined, since it allows the author to attempt to hide his own prejudices. In discussing the views of physical anthropologists that there are at least two different physical types derived from originally different stocks Terrell suggests that we might "think instead that Polynesians evolved their anatomical appearance just as they *evidently* evolved their language habits right there in the region formed by Fiji, Tonga and Samoa" (p. 150; emphasis mine), and he concludes, "Those who tell us that isolation alone could not have led to the evolution of differences among Fijians, Tongans and Samoans *are only guessing*" (p. 151; emphasis mine).