phy and notes. I find it amusing that the section (by far the largest) of the bibliography listing biographies includes full coverage of Norwegian Vilhelm Bjerknes, Hungarian George de Hevesy, and Austrian Lise Meitner, the last of whom, incidentally, receives the largest number of entries of all. Since all three of these figures spent parts of their working lives in Sweden, I take their inclusion to reflect an effort at completeness rather than an instance of Swedish cultural imperialism.

Although the individual essays for the most part are both illuminating and well written, as a presentation of history of Swedish physics in the 20th century the book is uneven and contains glaring omissions. It could, for instance, have drawn more effectively on the substantial scholarship in the history of the Nobel Prize institution, and the emphasis is on experimentalists at the expense of theorists. The coverage is further diluted by the stretching of the definition of physics. At the same time, the volume documents impressively the present vigor and potential of this field (not least given the overall youth of the Swedish contributors) and gives reason to hope that a more synthetic historical presentation of Swedish physics is within sight. This impression is strengthened by the fact that instead of presenting a framework for the specific contributions Lindqvist in his introductory essay sets an agenda for future scholarship in the history of Swedish physics. One can also hope that this spreading of the Swedish gospel—sponsored by the Swedish Council for Research in the Humanities and Social Sciences and by the Swedish Science Research Council—will serve to encourage agencies of other small countries to support similar enterprises, which, taken together, in turn may prepare for an improved national as well as international approach to the history of modern physics.

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Psychology via Physiology

The Neuroscience of Animal Intelligence. From the Seahare to the Seahorse. EUAN M. MACPHAIL. Columbia University Press, New York, 1993. xxviii, 506 pp., illus. $45 or £35. Animal Intelligence.

In 1904 the *Journal of Comparative Neurology* became the *Journal of Comparative Neurology and Psychology* and a psychologist, Robert M. Yerkes, joined the editorial board. "It is our aim," the new editor announced bravely in the first issue, "to bring together anatomical, physiological, and psychological facts in such a manner that their relations may appear. Thus, it is hoped, the specialists in structural works will be impressed by the importance of the functions of the organs which they study, while at the same time those whose chief concern is animal behavior will see more clearly that they cannot work to advantage until they know *what* is functioning." The collusion was short-lived. By 1911 the *Journal of Comparative Neurology* was itself again, and the *Journal of Animal Behavior* had been launched. The change was attributed to an increasing volume of behavioral research, but it was clear that separate paths were to be taken. The prevailing view among psychologists was that neurologists had much to learn from them but nothing to teach them. Psychological facts are no more accessible to physical and chemical analysis than to deep-sea soundings, one authority declared, and another said that as far as he was concerned the head could be filled with cotton wool.

Euan Macphail's contrary view is that the definition of cognitive functions is one of the main goals of behavioral neuroscience, which he thinks of as "doing psychology with the aid of physiological techniques" (p. 25). He is ever cognizant of that goal in this industrious review of a vast contemporary literature on sensitization, habituation, associative learning, and short-term memory in favorite vertebrate and invertebrate species, the contributions of which to psychological theory he is led, unfortunately, to overstate. It certainly is not to work on the hippocampus, for example, that we owe the distinction between place and response learning; nor to work on the cerebellum an appreciation of the limitations of the stimulus-substitution account of classical conditioning; nor to work with vertebrate spinal preparations the suspicion that classical and instrumental conditioning can be understood without reference to "high-level motivational and cognitive capacities" (p. 155).

Aplysia (the seahare of the subtitle) and *Hermissenda* (another gastropod mollusk) figure prominently in two chapters on associative learning in "simple systems." Because of its restricted sensory and motor properties, *Aplysia* is hardly an ideal subject for behavioral research on learning, and *Hermissenda* much less so. Macphail suggests that the behavioral changes induced in *Hermissenda* by pairings of light and rotation may not be typical of conditioning in gastropods or even in *Hermissenda* itself, and that Pavlovian experiments have not demonstrated anything more than "the facilitation of preexisting excitatory connections" in either animal (p. 113). A curious claim is that work on punishment shows *Aplysia* to be "capable of learning in tasks that may involve instrumental conditioning and that do not [merely] involve strengthening of a withdrawal response" (p. 129); although punishment is operationally instrumental, it can be understood in the same way as aversive classical conditioning. An equally curious claim is that contingency (as opposed to contiguity) is important for conditioning in *Aplysia*—that the animals "somehow assess the probability of a UCS [unconditioned stimulus] in the presence of the CS [conditioned stimulus] relative to its probability in the absence of the CS" (p. 132); only someone who still holds to the discredited contingency theory of vertebrate conditioning, unaware of the deficiencies of the experiments that gave

Vignettes: Discrimination

You probably think it's easy being a bioenergeticist, spending day after day interconverting kilocalories and kilojoules and trying to think about the reaction changes of entropy along metabolic pathways. Well, I don't want to complain, but those of us working in the thermodynamic foundations of biology don't get a lot of respect.

—*Harold J. Morowitz*, in *Entropy and the Magic Flute* (Oxford University Press)

Atoms are nice, atoms are fundamental, but they're not chemistry. Chemistry is about molecules, the fixed but transformable way in which atoms get together for a while.

—*Roald Hoffmann and Vivian Torrence*, in *Chemistry Imagined: Reflections on Science* (Smithsonian Institution Press)

rise to it, could be persuaded by what Macphail sees as "prima facie evidence" (p. 133). Experiments with other invertebrates offer Macphail some reason to hope that "*Aplysia* may indeed be capable of greater feats" of learning than have already been demonstrated (p. 139), but for now there is only his hope. As to whether the neural changes produced in *Aplysia* and *Hermissenda* by paired stimulation are pre- or postsynaptic, the results for the two animals are at odds, and it is difficult to disagree with Macphail's advice that we "approach work on mammals with an open mind on this issue" (p. 156).

The greater part of the book is devoted to the role of the hippocampus in learning, various theories of which are generously (sometimes ludicrously) given the benefit of every doubt. If recognition is the function of the hippocampus, why should hippocampal injury reduce the rat's initial wariness of novel tastes? The answer is that "all stimuli appear relatively novel, and genuinely novel stimuli may therefore not be effectively classified as novel" (p. 243). If the "place" cells of a rat register spatial location, why should they not fire when the rat is wrapped in a towel? Perhaps the cells become active only when the rat is "processing information concerned with anticipated movement from one place to another" (p. 267), which, wrapped in a towel, it would not be. If a lesion is assumed to disrupt "declarative" memory ("knowing that") as distinct from "procedural" memory ("knowing how"), why should the performance of monkeys in an easy (object) discrimination be impaired while their performance in a difficult (pattern) discrimination is not? The difficult discrimination must have an important procedural component, as must eyelid conditioning, which also is unimpaired.

In the end Macphail is bound to admit that none of the competing theories of hippocampal function comes off very well. The highly touted mapping theory is clouded by such facts as that there are many fewer "place" cells than originally imagined, that their fields are variable, and that hippocampal injury fails to impair performance in some spatial tasks while it does impair performance in some nonspatial tasks. The difficulty for the selective-attention theory, backed by the absence of latent inhibition in lesioned animals, is that they show overshadowing and blocking as well as impaired performance in some tasks that make no obvious demands on selective attention. The theory that the hippocampus is responsible for "working" or short-term memory, as distinct from "reference" or long-term memory, is faced with the same sort of difficulty; performance in some tasks that do not seem to require working memory is disrupted by hippocampal damage while performance in some tasks that do seem to require it is not. (None of the theories makes contact with an interesting body of data on reward-schedule effects that Macphail unaccountably ignores.) Macphail takes comfort in the reflection that, at the very least, "*all* the major theories of hippocampal function appeal to concepts . . . derived from cognitive psychology," while acknowledging that "it has proved difficult to specify exactly which learning tasks engage 'cognitive' processes" (pp. 335–36). The consensus may be no more, of course, than a product of common anthropomorphic predilections. Whether physiological or other techniques are employed, "doing psychology" fruitfully first of all requires a disciplined grasp of the subject that the investigators whose work on a diversity of neural tissues Macphail considers do not often seem to possess.

For all that, *The Neuroscience of Animal Intelligence* does put us much in Macphail's debt. The innumerable experiments cataloged so conveniently are on the whole worth knowing about, and the questions posed worth thinking about, despite the fact that the promised contributions to our psychological understanding have failed thus far to materialize.

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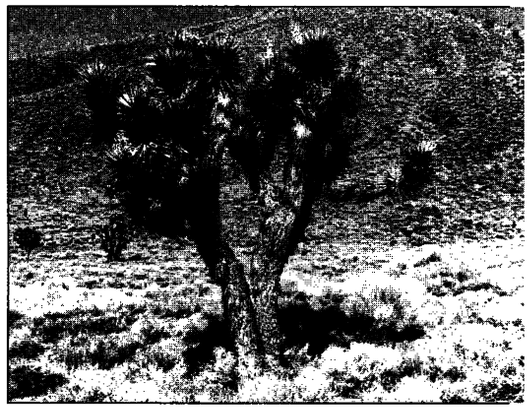
Living Landscapes

The Desert's Past. A Natural Prehistory of the Great Basin. DONALD K. GRAYSON. Smithsonian Institution Press, Washington, DC, 1993. xx, 356 pp., illus. $44.95 or £34.95.

The Great Basin, a region covering some 165,000 square miles in Nevada and California that has no river outlet to the ocean, has long fascinated explorers and scientists alike. It is a place where climate and climatic changes have directly and visibly affected the landscape and its inhabitants in many ways, in some cases quite brutally and in others rather subtly.

The past few decades have witnessed intensive exploration of the environmental history of the Great Basin, with new technologies and techniques being used to build upon earlier work. With this book Grayson has brought together the results of a wide variety of investigations in archeology, geology, paleohydrology, climatology, meteorology, biogeography, dendrochronology, and history (among other fields) to create an engrossing description of the region's changing environment during the past 25,000 years.



"Joshua trees in Joshua Flats, eastern Inyo Mountains, California; sagebrush and rabbitbrush dominate the understory." [From *The Desert's Past*]

Grayson begins by identifying several "Great Basins," viewed in terms of hydrography, physiography, flora, and ethnography, respectively. An introduction to the interactions of the Laurentide Ice Sheet and the Bering Land Bridge sets the stage for a discussion of Pleistocene mammals, extinctions, and early peoples, which is followed by chapters on the Late Pleistocene lakes, vegetation, and vertebrates of the Great Basin. The Holocene, or last 10,000 years, is described first climatically and then archeologically. An intriguing chapter is included on the demographics, social dynamics, and archeology of the ill-fated Donner Party of 1846–47.

The book provides a particularly useful overview of the insights gained through analysis of packrat middens and accelerator–mass-spectrometer radiocarbon dating over the past two decades. The remarkably late appearance of single-leaf piñon pine during the Holocene, for example, is now understood far better than it was only a few decades ago. The spotty nature of the packrat midden record has given rise to a number of conflicting interpretations, and Grayson has taken pains to present varying points of view. He does not, however, refer to Owen Davis's model of differential elevational changes in plant distributions as a result of orbitally induced insolation changes (*Science* **225**, 617 [1984]), which seems highly relevant to his analysis of Early Holocene biogeography.

The illustrations include many well-reproduced black-and-white photographs that enhance the text nicely. The maps, however, are another matter. Latitudes and longitudes are missing, as are some localities referred to in the text. Reading the maps often requires simultaneous use of a table. Some use of color, or a more effective use of