attempting something even more audacious, the reduction of all scientific disciplines to the principles of rhetoric.

In this schema, natural science holds the traditional epistemological status of social science; it is viewed as a construct of human subjectivity. Usually seen as the object of investigation (other than in Simon's sciences of the artificial, for example engineering or design), nature here appears only as part of the settlement of a controversy. In principle, that controversy could be reopened, once again removing nature from the scene. For Latour, all science is artificial in the sense that it is an object of investigation malleable within the bounds of its literature; it constitutes a universe of discourse, not a social institution mediating physical reality and biological processes. Social influences are viewed as irrelevant to understanding science since the settlement of scientific controversy affects society, not vice versa.

Latour's other major claim is that science and technology are much the same phenomenon. The argumentation for this claim is similar to that for science in the making. Convincing others to support a new technology is essential to establishing it as an accepted artifact. Moreover, Latour questions the linear model of technological development in which progress occurs in an orderly sequence of discrete phases, from research to development to innovation. He argues that since these activities often occur simultaneously, it is misleading to conceptualize them individually. A case study of the diesel engine's development shows both the tenuous linkage of final achievement to original concept and the contribution of numerous persons to the construction of a working device.

This is a social-movement model of science and technology in which recruitment of adherents is the key activity. Much as environmental groups or religious cults are dependent upon their supporters for survival and growth, so are scientists and technologists. Many might disagree with the weight Latour places on the nonrational justifications scientists offer for their work. It might well be asked whether pragmatic criteria are not more important in gaining support. Is not the question "does it work?" more important in the acquisition of support than the rhetorical system of authorial status and citation chains? Successful performance moves the black box toward closure; performance failure reopens it. Finally, do not the interests of powerful social groups (including scientists and engineers) play a part in opening, closing, and shaping the direction of research fields? Certainly there is a macropolitics to science and technology as well as the micropolitics that Latour delineates. Nevertheless, whether one accepts or rejects Latour's perspective, *Science in Action* is an important book in science and technology studies.

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Dialogue on the Ocean

A View of the Sea. A Discussion between a Chief Engineer and an Oceanographer about the Machinery of the Ocean Circulation. HENRY STOMMEL. Princeton University Press, Princeton, NJ, 1987. xiv, 165 pp., illus. $19.95.

The oceans circulate in a very complicated way in response to the action of two agencies: buoyancy forces, due to the action of gravity on density variations associated with variations in temperature and salinity, and wind stress. The circulation is influenced not only by the shapes of the bounding surfaces, including the topography of the ocean bottom, but also by gyroscopic effects (Coriolis forces) associated with the diurnal spin of the earth on its axis. Its study presents great practical and intellectual challenges to those engaged in this important area of geophysical fluid dynamics.

Henry Stommel has pioneered many advances in dynamical oceanography, starting in the late 1940s with his brilliant insight into the dynamical nature of the Gulf Stream and other rapid currents found at the western boundaries of oceans (for example, Kuroshio). His influence on the subject and that of his colleagues at the Woods Hole Oceanographic Institution, the Massachusetts Institute of Technology, and elsewhere would be hard to overestimate. In *A View of the Sea*, Stommel, with characteristic ingenuity, elucidates the intricacies of ocean circulation through an imaginary dialogue between the "mildly curious chief engineer of a research vessel—an intelligent and practical man who knows machinery and the sea—and an oceanographer on the same ship." The basic concepts of gravity, pressure, density, buoyancy force, centripetal acceleration, and centrifugal and Coriolis forces are introduced in the first three chapters, where it is shown that the fields of density and flow velocity in the oceans are intimately related. These relationships follow directly from the equations of hydrodynamics in the limit of the so-called "hydrostatic and geostrophic" approximations, but Stommel, eschewing the use of these equations, obtains the first results he needs by means of simple diagrams, argued over at some length by the engineer and the oceanographer. With a common language and working rapport thus established, the engineer and oceanographer get down to the strategy of the cruise in which they are engaged. This is the last of several cruises intended to establish as precisely as possible the distribution of density beneath the surface of a large triangular area of ocean south of the Azores; it is "part of a study meant to reveal an essential feature of the mid-ocean circulation: the beta-spiral." For convenience, the ocean is imagined as consisting of a moderate number of blocks of fluid of varying shapes and density. The blocks have to be manipulated and fitted together in a manner consistent with a number of rules and codicils dictated by dynamical considerations, an exercise discussed and debated at some length in the book.

For many problems in theoretical fluid dynamics it is convenient to take the Eulerian approach and express the governing equations in terms of quantities such as flow velocity, pressure, and density at fixed points in space. In others, the Lagrangian approach is adopted, which concentrates on the behavior of moving elements of fluid. The necessity of both types of consideration in dynamical oceanography is reflected in *A View of the Sea*, in whose final chapter the complicated three-dimensional trajectory of a typical individual fluid element is traced, starting in the upper layers of the Caribbean Sea and ending up in the lower reaches of the South Atlantic Ocean. The element first undergoes three anticyclonic twists, including short spells of northward movement in the Gulf Stream, then makes an excursion as far north as the Greenland Sea. There, at its coldest and densest, it reverses its general direction by joining a deep, rapid current near the coastline of North America, inshore of the oppositely directed, higher level Gulf Stream. This current carries it across the equator into the Southern Hemisphere.

In an appendix the author provides instructions for programming personal computers with color-graphics capability to carry out diagnostic constructions of "density blocks," which are tedious to perform by hand. "Why walk to San Francisco when you can fly, and get a good view of the scenery on the way as well?"

Henry Stommel has interesting and often original views about life in general and science in particular, some of which shine through in the anecdotes and "one-liners" that enliven every chapter of what will doubtless and deservedly prove to be a

highly successful attempt to explain important aspects of the ocean circulation to a wide audience.

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Psychology and Neurobiology

Memory and Brain. LARRY R. SQUIRE. Oxford University Press, New York, 1987. xiv, 315 pp., illus. $24.95; paper, $14.95.

In the preface to *Memory and Brain*, Larry Squire cites the remarkable activities of the late 19th century, when Hermann Ebbinghaus, William James, Theodule Ribot, and Sergei Korsakoff provided a pioneering agenda for the study of memory in normal and brain-damaged humans. The modern era, in which the biological basis of memory is studied in laboratory animals as well as in humans, was heralded by the work of Karl Lashley and Donald Hebb in the first half of this century. Squire's book provides a contemporary view of the brain systems used for memory, with emphasis on the primate brain. Neurobiological and psychological findings are discussed in relation to the central problem of understanding memory in humans.

At the heart of this book is the theme that many fundamental questions about memory can be addressed by examining its biological organization. The scope of this endeavor is outlined in the opening chapter. An account of the organization of memory in the brain must treat the molecular events that control changes in synaptic function, the neural systems where such changes occur, and the emergence of behavioral memory from networks characterized by synaptic plasticity. Accordingly, the discussion ranges from descriptions of synaptic change, the modulation of memory by neurotransmitters and hormones, and the search for engrams to consideration of the relation of neural systems to specific features of behavioral memory. Despite its grounding in biology, the treatment is not reductionistic. Squire maintains a dialogue between the psychological and neurobiological levels of inquiry.

A fundamental question for both psychologists and neurobiologists is whether memory is a unitary entity that can be explained by a single set of general principles. The study of memory and the brain increasingly produces data that argue against this perspective. It is well known that damage in diencephalic and temporal lobe structures in humans is associated with an amnesic syndrome. Perhaps the most striking realization of the past decade or so is that these amnesic patients possess some relatively intact memory and learning capacities: when the appropriate assessment procedures are used, they can perform as well as normal subjects. Such data are obtained on tasks that require the mastery of certain motor, perceptual, or cognitive skills or that show the residual effects of exposure to items such as individual words, a phenomenon known as the repetition priming effect. Squire uses these data to emphasize the opportunity that study of the brain holds for understanding psychological processes. A naturalistic nomenclature may emerge that is based on the types of memory that can be associated with particular brain systems and thereby dissociated from one another. An important adjunct to this endeavor is the recent recognition that considerable continuity is preserved among primates in the brain systems used for memory. Nonhuman primates have been used to model the brain damage most often associated with amnesia in humans. Like amnesic patients, these animals have a profound anterograde amnesia on some tasks, along with certain preserved learning and memory capacities that, to some extent, map onto those described in humans.

The taxonomy of memory is not clearly established. It is likely that certain distinctions formulated through psychological study (for example, episodic and semantic, working and reference memory) are indeed embedded in the organization of brain systems. The properties exhibited by particular forms of memory, such as accessibility to conscious recollection, may be linked to the unique organizational and functional properties of distributed, specialized brain systems. This general theme permeates the latter half of the book.

Another quite different example of the interface between the concerns of psychology and of neurobiology is provided by the study of the nature of forgetting: the fundamental question here is whether, once established, a memory is truly susceptible to decay or simply becomes inaccessible despite its continuing representation. In a chapter entitled "Memory and the developing nervous system," Squire discusses neurobiological studies that indicate a continuous sculpting of the nervous system by the information it processes. He suggests that the issue of forgetting will be resolved ultimately by such studies of the nervous system, in which it may be determined whether synaptic changes that represent information survive or, alternatively, disappear with time or the storage of additional information.

For the younger student of memory, the book provides not only an up-to-date account of the subject but also some edifying discussions of earlier research. The evolution and demise of the concept of molecular coded information as a mechanism for memory are traced in a discussion of memory transfer experiments. A useful chapter is dedicated to a review of Wilder Penfield's work on memory localization, studied by brain stimulation during the course of neurosurgery: more recent studies that suggest a reinterpretation of these data are also discussed.

In reviewing the progress of research on memory, Squire points to an increasing interaction between psychology and neurobiology, to the mutual benefit of these disciplines. His book is clearly designed to be accessible to all parties interested in this exchange.

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Breeding Systems

Helping and Communal Breeding in Birds. Ecology and Evolution. JERRAM L. BROWN. Princeton University Press, Princeton, NJ, 1987. xviii, 354 pp., illus. $45; paper, $16.50. Monographs in Behavior and Ecology.

The evolution of communal breeding, defined in this book as breeding "characterized by the normal presence of helpers at some or all nests," is one of the most interesting and complex problems tackled by behavioral ecologists. It is interesting because helping seems to be altruistic and altruism seems contrary to the selfishness that one might expect in an evolutionary process driven by differential survival and reproduction. It is complex because hypothesized costs and benefits of helping involve virtually all the other topics in behavioral ecology (among them agonistic behavior, foraging, reproductive behavior, and cooperation), each of which involves major uncertainties. It is therefore not surprising that communal breeding has been the focus of heated debates, with researchers disagreeing over which of the potential costs and benefits drive its evolution.

In this book Brown presents a unified theoretical framework composed of the feasible alternative hypotheses about communal breeding. From this framework he identifies two major reasons for past controversies. One is failure to consider as alternative options all combinations of three key variables: dispersal, delayed breeding, and help-