overview of how the evidence from Chad contributes to our understanding of the Quaternary in tropical Africa. The freshness of Lake Chad's waters perplexed even the early European explorers because they expected and usually encountered saline waters in semi-arid closed basins. Carmouze provides a hydrologically and biogeochemically sound explanation for the low salinity of the main body of Lake Chad. The heart of the book is nine chapters that concern the biota and its responses to falling water levels. Six chapters are devoted to the distribution and abundance of the macrophytes, phytoplankton, zooplankton, zoobenthos, fish, and animals associated with macrophytes, and three concern the productivity of the phytoplankton, zooplankton, benthos, and fish. Conspicuous omissions are measurements of macrophyte productivity as well as information on bacterial activity or the periphyton. In fact, the bacteria and periphyton of tropical lakes remain the least studied components of these ecosystems. Three additional chapters attempt to describe the trophic linkages. Although rich in detail, these 12 chapters are shy of integration and synthesis; exceptions are Saint-Jean's treatment of zooplankton and Lemoalle's examination of phytoplankton production. Almost all the literature cited is specific to Lake Chad. The concluding chapter abstracts the book into a succinct summary and contrasts Lake Chad with Lake George (Uganda). However, the discussion is limited to biomass and production values and offers scant insight into ecosystem functions that would help extrapolate the wealth of information about Lake Chad to other wetlands in semi-arid regions.

To the extent that *Lakes of the Warm Belt* and *Lake Chad* are representative of limnological research on tropical lakes, several conclusions are apparent. Although the continuation of descriptive studies founded upon careful taxonomy and sampling is essential, experimental testing of well-formulated hypotheses is definitely required. Conspicuous gaps in information concern the role of bacterial activity in nutrient recycling, the influences of land use on nutrient supply, and, in turn, how nutrient and food web dynamics interact to effect water quality and harvestable resources. The intensifying exploitation of tropical inland waters makes the need for such research especially urgent.

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Creative Personages

Springs of Scientific Creativity. Essays on Founders of Modern Science. RUTHERFORD ARIS, H. TED DAVIS, and ROGER H. STUEWER, Eds. University of Minnesota Press, Minneapolis, 1983. x, 344 pp., illus. $32.50.

Springs of Scientific Creativity contains 12 papers on major figures in the growth of the exact sciences from the time of Galileo and Newton to that of Michael Polanyi and John von Neumann with emphasis on 19th- and early 20th-century figures. The papers are unified by their biographical focus and by an emphasis on scientific style. Only about half of them explicitly focus on the notion of creativity that gives the book its title. Another four make bows in that direction by appending concluding remarks on creativity to papers that are largely anecdotal accounts of the research programs of the traditional "founders" chosen for treatment.

Thomas Settle's little gem of a paper about experiments on falling bodies described by Galileo and his predecessors in 16th-century Italy makes not one direct reference to "creativity." But it deserves to be read by a wide audience of physicists, general science students, and historians and psychologists interested in science. (I wouldn't dream of disclosing his strategy and spoiling everyone else's pleasure.)

Most of the remaining papers are curiously old-fashioned in their approach. They are unabashedly hero-worshiping in tone; they freely attribute the old 19th-century romantic characteristic of unanalyzable "genius" to their subjects; and they seem to agree about little except that creativity is a characteristic of individuals and that, though it may be described in particular cases, it is something that cannot be bound by rules.

The authors seem to be aware of the recent psychological literature on scientific creativity. Stanley Goldberg, writing on Einstein, at least cites some of it before he asserts that "creative thinking has always been a mystery [and] it must remain so" (p. 233), and others refer to cognitive styles, tolerance for frustration, and the bringing together of divergent traditions in creative acts. But most are implicit advocates of Francis Galton's Victorian theory of hereditary genius. (C. W. F. Everitt goes back four generations in the Clerk and Maxwell clans.) Only Everitt attempts to bring psychoanalytic insight to bear on the issue of creativity, offering some fascinating but highly speculative comments on Maxwell's relationship to his parents, his masochistic streak, and his extraordinary tenacity in carrying out "painful" calculations.

Paradoxically, it is Thomas Hughes, the author who most self-consciously draws from romantic literary analyses, who offers the most interesting analytic suggestions regarding creativity. He develops an imaginative comparison of the creativity of Elmer Sperry with that of Thomas Mann's fictional composer, Adrian Leverkühn. Like his colleagues in this volume, Hughes denies that we can find a "method of creativity" or that creativity can be "managed" in any traditional sense. But instead of dropping the issue there, he draws suggestions from Sperry and Mann that invite us to view creativity as a form of social deviance and that therefore locate some necessary but not sufficient conditions for creativity in the domain of *social* psychology.

In spite of the fact that the book won't offer many new insights for the professional psychologist who works on scientific creativity or for the professional historian of modern physics, it offers a very nice introduction to the current biographical tradition in the history of science; so I would have no hesitation about handing it over to a bright and curious student of physics who wants to learn about the mythic figures of that discipline. All of the papers are gracefully written, and all can be read by a general scientifically literate audience.

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Environmental Errors

The Deer Wars. The Story of Deer in New Zealand. GRAEME CAUGHLEY. Heinemann, Auckland, New Zealand, 1983 (U.S. distributor, ISBS, Beaverton, Ore.). viii, 187 pp. + plates. $17.95.

We are all aware that heavy browsing by herbivores leads to soil erosion. Right? Not necessarily, says Graeme Caughley. He recounts what happened when deer were released in the 19th century in New Zealand and spread through the mountain forests.

From the beginning of the present century it was accepted that New Zealand forests had evolved in isolation, protected from serious herbivore damage. Naturally, deer were viewed as wholly destructive—at best they prevented regeneration of forest, at worst they were the

cause of the heavy silting of rivers, especially those that flowed across the Canterbury plain in South Island. This silting, if not stopped soon, threatened to wash Christchurch into the sea.

Initially deer were released by "acclimatization societies," whose aim was to turn New Zealand into a replica of England, with deer for the landed gentry to hunt. But deer became too successful, and by 1930 they were recognized as pests. The government then set about eradicating them. Government shooters were employed to wipe out deer in a well-planned—or so they thought—attack. The initial optimism regarding what was to be a short campaign was not seriously disturbed when it took a little longer. Twenty-five years later (1955), with no visible reduction in deer numbers on the important watersheds, the Forest Service took over responsibility. *They* knew about forests, and *they* would sort out the mess. Twenty-five years later deer were still present in large numbers.

Meanwhile, starting in the 1960's, two other processes began. First, scientific projects investigated plant communities, geology, and erosion rates in the mountains, with startling and uncomfortable results. Moas, large ostrich-like, flightless birds, lived in the forest until their extinction a few centuries ago. They fed on forest vegetation: for a long period of New Zealand history forests and herbivores coexisted. Geologists found that the Southern Alps are being uplifted at a rate of 50 centimeters a century. More important, they are being eroded 40 centimeters a century, and the greatest erosion rates are found where plant cover is greatest. The main erosion agent is simply rainfall. In 1977, a dry year, some rain gauges recorded 8.9 meters (350 inches) in the Southern Alps. But rainfall is much higher on the wooded western slopes of the range. Indeed, it is so high that no amount of vegetation would hold the rock and soil under this deluge. Erosion rates here were ten times higher than the world average for mountain country. Under these conditions, plant cover types and the presence of deer have effects so slight as to be virtually unmeasurable. Whatever the fate of Christchurch, it will not be determined by deer.

Second, deer became a commercial commodity. Initially private shooters had earned small sums by selling meat or skins, but in the late 1960's meat and antler velvet prices soared and larger commerical enterprises took off. These culminated in the use of efficient helicopter gunships that eventually cleared large areas of high country. Then, in the 1970's, farmers developed domestic deer herds, and deer became more valuable alive than dead. The public image of deer, it seems, had accomplished an unexpected aboutface.

Caughley writes with penetrating insight and dry wit. Partly autobiographical, this is not so much a narrative as a personal commentary on events. Caughley's exasperation over stupid mistakes is reflected in the later chapters on politics and the law; these become rather embroiled in legal semantics. Overall this is an unusual, interesting, and amusing account, well written. There is also a more serious message; the story is a classic example of how people can be blinded by preconceptions. To quote Caughley: "The justification of deer control operations from 1933 to present was . . . based on an unfortunate fallacy, but the real damage was caused by that error evolving into a treasured axiom rather than into a testable hypothesis. Axioms die hard."

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