BOOKS *et al.*

HISTORY OF PHYSICS

Two Nobel Prizes and a Hole-in-One

Leon Cooper

"Natural ability or capacity" is the fourth of the *Oxford Universal Dictionary*'s definitions of genius. Preceding it we find (i) "a god or attendant spirit allotted to every person at his birth," (ii) "a demon or spirit," and (iii) "characteristic disposition...or turn of mind." In popular usage, we have "evil genius" and "starving genius," as well as "mad genius." The one I like best is offered by a performer in an early staging of *The Marriage of Figaro*, conducted by Mozart himself. Never, he said many years later, would he forget the experience of singing under the animated direction of the little genius in the podium.

John Bardeen, the "true genius" in this biography by historians of science Lillian Hoddeson and Vicki Daitch, poses a problem. A gifted physicist, Bardeen was a bit shy and not a very good communicator, not a publicity seeker, and not particularly eccentric. Possibly more damaging, he enjoyed family life, children, and picnics, and he loved to play golf. Thus, Bardeen has been of limited interest to a star-crazed public that expects instant cinema. But those who are curious about what happens in the real world of science will find Hoddeson and Daitch's carefully researched account of Bardeen's life and science of great interest.

The authors provide a detailed chronicle of Bardeen's family, background, and early career that evokes the spirit of the academic world before World War II as well as the physics communities during and after that conflict. Hoddeson and Daitch give us an insider's look at research in the once-fabled Bell Telephone Laboratories. Along with insights into comings and goings in the academic community, they convey some of the tensions that almost inevitably arise among very talented and individualistic scientists who are working together—or in competition—on important problems. And their account is enlivened by many anecdotes. We learn, for example, of the contrast between European and American reactions to Princeton of the early 1930s. Whereas Einstein and Wigner missed the European coffee houses, "Bardeen didn't care about coffee houses but he did care about games, such as bowling or bridge, which were readily available in Princeton."

True Genius
The Life and Science of John Bardeen
by Lillian Hoddeson and Vicki Daitch
Joseph Henry Press (National Academies Press), Washington, DC, 2002. 479 pp. $27.95, C$37.95. ISBN 0-309-08408-3.

The book also presents a reasonably detailed account of Bardeen's scientific interests, from some of his early work on electrons in solids to his late work on charge density waves. The latter research proved to be an anticlimactic chapter in Bardeen's scientific life; his faults magnified, his strengths diminished. Its story exposes the unpleasant underbelly of academic research—ambushes by reviewers of scientific articles and the sometimes savage attacks of younger scientists on their elders no longer at the peak of their powers.

Trying to repeat. Though an avid and good golfer, Bardeen admitted that his two Nobel prizes topped his one hole-in-one.

The book succeeds best in the authors' descriptions of the two great scientific achievements, each rewarded with a Nobel Prize in physics, in which Bardeen played major roles: the invention of the transistor (a technological accomplishment probably as important as the electric generator was for the 19th century) and the development of the theory of superconductivity (a remarkable solution to a 50-year-old mystery with extraordinary ramifications for the rest of physics). Although their account of the superconductivity research, in which I participated, does not always correspond to my own memory, the authors recreate the situation in such a lively manner that I found myself reliving the experience and being reminded of long-forgotten moments. The authors also discuss Bardeen's lifelong interest in developing technologies, as well as his involvement with various government groups and industries. They describe his marvelously timed interaction with the Haloid Company (later Xerox) and highlight his role in supporting fundamental research in an industrial setting.

In all, *True Genius* is a detailed and animated rendering of Bardeen's life and science. In some places the science has been oversimplified and some explanations are glossed over, but these are minor shortcomings given the book's overall excellence and its intended broad audience.

I was less happy with the book's epilogue "True Genius and How to Cultivate It." Although it may be personal prejudice, in my opinion the authors' exploration of the nature of genius leads to generalities that add little to their excellent account of the particularities of Bardeen's life and science. In the end, we are left with what we have already learned. Despite his important contributions to two of the greatest achievements of 20th century physics, John Bardeen led a more or less normal life and shared the tastes, virtues, and faults of many of his contemporaries. Should we be shocked (like Claude Raines in *Casablanca*) that his life does not easily lend itself to a Hollywood production? And was Bardeen a genius? Rather than wrestle with that second question, I would retire the word. My guess is John would do the same.

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INVERTEBRATE ZOOLOGY

Sorting Sponges

Joseph Pawlik

Consider the lowly sponge. Rapidly passed over in most undergraduate biology courses, the phylum Porifera is usually remembered only as the most primitive group of multicellular animals. The immobile bodies of sponges have no true tissues, and they are full of holes and channels used for filter-feeding. The uncomplicated nature of the sponge body plan leaves many with the impression that sponges are somehow less evolved, less diverse, and certainly less sophisticated than phyla higher on the tree of life. But this impression is very wrong.

In evolutionary terms, sponges were the first animals to figure out a best way to live, and they stuck to it. Their seemingly

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simple way of life appealed to taxa in other phyla as well, prominent among them some bivalve molluscs and the tunicates (sea squirts). Sponges diversified broadly and probably very early in the evolution of metazoa. Ranging in size from a few millimeters to several meters across, they appear in a surprising variety of shapes. Sponges are found in all aquatic habitats, and they are dominant members of the benthic community in locations as diverse as Antarctica's McMurdo Sound, Caribbean coral reefs, freshwater Lake Baikal, and the deep sea. Sponges form symbiotic relationships with various heterotrophic and autotrophic bacteria, protozoa, and macroalgae, and these interdependencies develop to the point that for some individuals more of the biomass is contributed by symbiont than by sponge. Excellent synthetic chemists, sponges have been the largest source of unusual secondary metabolites isolated from marine organisms. These compounds are presumed to serve diverse functions, including predator deterrence, antifouling, screening ultraviolet radiation, and maintaining symbiotic consortia. Among the phylum's surprising oddities are species that "walk" over substrata on long extensions (often leaving baby sponges in their wake) and carnivorous sponges that have lost the ability to filter-feed and instead engulf small prey that get caught on their Velcro-like surfaces.

For those of us who study sponge ecology or biochemistry, the lack of a consistent taxonomy has been a big problem. Until recently, sponge systematics had been balkanized by experts who focused on the few morphological characteristics that were deemed reliable indicators of sponge ancestry: skeletal elements, particularly inorganic spicules (silica or calcium carbonate) and organic fibers (collagen). Natural-products chemists had added the diversity of unusual secondary metabolites as a basis for chemotaxonomy, but questions concerning the provenance of these metabolites—sponge? symbiont? or both?—cast a pall over their general use. Specialists on sponges from different regions or time periods often failed to agree on systematic treatments, and as a result there have been frequent changes at all levels of taxonomy. The situation has been further complicated by the more recent application of molecular systematic approaches to sponge diversity.

In a model of international scientific cooperation, John Hooper (Queensland Museum, South Brisbane, Australia) and Rob Van Soest (Zoological Museum, University of Amsterdam, Netherlands) have brought together 45 far-flung experts in the taxonomy of extant and extinct sponges to forge a coherent compendium, *Systema Porifera*. In two volumes, developed over the course of six years and three international workshops, the contributors describe approximately 680 genera (from *Aaptos* to *Zyzzya*), 27 families, 25 orders, and 3 classes of living sponges as well as some 1000 genera, 245 families, 30 orders, and 6 nominative classes of fossil sponges. The more massive first volume is dedicated to the class Demospongiae, which contains some 95% of the living species including all of the approximately 150 species that inhabit fresh water. The second volume covers the extant classes Calcarea (calcareous sponges) and Hexactinellida (glass sponges) along with the polyphyletic and almost extinct "Sphinctozoa" and the Cambrian Archaeocyatha. The individual contributions are presented mostly at the family level. Each such chapter comprises a definition, diagnosis, scope, brief historical overview, and a dichotomous key to the genera. The keys are followed by comprehensive treatments of each genus, which include black-and-white distribution maps and illustrations of whole specimens and skeletal elements. Perhaps the most important components for most researchers are the extensive taxonomic histories detailed, with lists of synonyms for each genera. Each volume ends with a cumulative index to the genera and higher taxa.

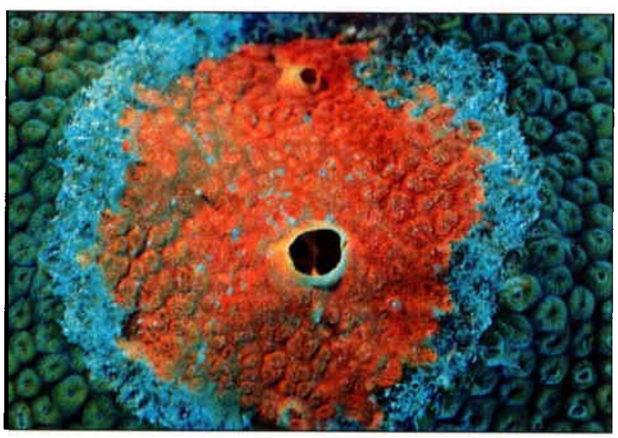
Systema Porifera
A Guide to the Classification of Sponges
John N. A. Hooper and Rob W. M. Van Soest, Eds.
Kluwer Academic/Plenum, New York, 2002. 2 vol., 1802 pp. $595, £398, €625. ISBN 0-306-47260-0.

For those seeking a taxonomic or identification guide to the sponge species of their favorite biogeographic region, *Systema Porifera* will not offer much help. But the two volumes will be an indispensable reference source for any taxonomist or ecologist who needs to put the extensive sponge literature of the past into modern context. More important, these volumes will form the basis (and provide important hypotheses) for future systematic studies, particularly those done using molecular data. As such, *Systema Porifera* is an essential addition to the reference collection of any university or research institution with zoological programs.

BROWSINGS

Structures of Nature. Photographs by Andreas Feininger. *N. Elizabeth Schlatter.* University of Richmond Museums, Richmond, VA (Distributed by University of Washington Press, Seattle), 2002. 72 pp. Paper, $24.95. ISBN 0-9713753-3-X.

The nature photographs of Andreas Feininger portray biological diversity at scales from minute structural elements to macroscopic views of organisms in their ecological niches. The photographer hoped that the fidelity of his black-and-white images—such as *Fluted Mollusk*, circa 1972 (left)—would show the beauty of organic functional form and document the interdependence and similarity of natural things (including humanity). Schlatter presents an introductory essay and selections from a current exhibition at the University of Richmond Museums, Virginia (the third installation of which continues through 18 May 2003).



A boring life. *Cliona delitrix* belongs to a family of sponges that both excavate and encrust their calcareous substrates. Clionid bioerosion can overwhelm reef corals (particularly when they are stressed by high water temperature) such as this *Montastraea annularis* on the Belize barrier reef.

CREDIT: (TOP) JOEL AND LILA HARNETT PRINT STUDY CENTER, UNIVERSITY OF RICHMOND MUSEUMS, VA; (BOTTOM) LAURIE M. PENLAND/COURTESY KLAUS RÜTZLER, CARIBBEAN CORAL REEF ECOSYSTEMS PROGRAM, SMITHSONIAN INSTITUTION