that root researchers in their fields by conveying the intellectual and technical milestones of the field and attributing credit to its pioneers. For many historians, such stories have the quality of myth. Holmes shows that these stories can be largely true and thus provides a valuable case study for racier scholars. *Meselson, Stahl, and the Replication of DNA* should be rated G, recommended for general scientific audiences.

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BOOKS: ECOLOGY

Splendor of Humble Symbionts

Paula T. DePriest

Lichens are classic symbioses in the sense of Heinrich Anton de Bary's 1879 "*zusammenleben ungleichnamiger Organismen*." In fact, the term symbiosis had been coined two years earlier by the German lichenologist Albert Bernhard Frank. Lichen-forming fungi, some 14,000 species from a wide variety of groups, live in intimate contact with one or more small photosynthetic partners that are either green algae or blue-green cyanobacteria. Through this symbiosis, the modest filamentous and unicellular partners burst into intricate forms (fruticose beards and treelets, foliose leaves and disks, crustose warts and blankets) and bright colors (chartreuse, orange, red, green). Together, fungus and photosynthesizer form a physiological unit that is amazingly tolerant of even extreme environments, but usually equally intolerant of pollution. If not for their diminutive statue (most are less than a few centimeters tall), lichens might be the orchids of the fungal world. But they are often overlooked and seldom granted such acclaim. Perhaps worse, novices who squint at lichens often mistake them for mosses.

Now lichenology has a photo-illustrated guide that should not be overlooked—the long-awaited *Lichens of North America*. This lavish volume, published in collaboration with the Canadian Museum of Nature, is more than could have been expected: larger, with its 800-plus pages weighing nearly eight pounds; more beautiful, with 939 high-quality color photographs; more complete, with 1500 species covered in detail or mentioned; and more useful, with a 27-page identification key to genera and major groups and separate keys to 1050 species within their respective genera.

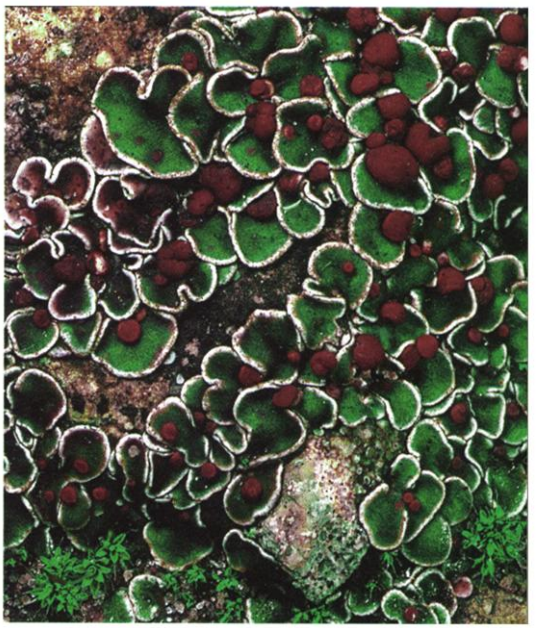
Lichens of North America
by Irwin M. Brodo, Sylvia Duran Sharnoff, and Stephen Sharnoff
Yale University Press, New Haven, CT, 2001. 819 pp. $69.95, £50. ISBN 0-300-08249-5.

The book begins with an overview of lichens, their biology, and their significance. These 113 pages cover topics ranging from "What Lichen Are" to "Collecting and Studying Lichens." Irwin Brodo, an emeritus research scientist at the Canadian Museum of Nature, has produced an accessible and authoritative text appropriate for advanced high school and college biology students as well as professional biologists. Chapters on the impact of lichens, "Lichens and Ecosystems" and "Lichens and People," reflect the special interest of Stephen and Sylvia Sharnoff. To produce an appropriately timeless volume, the discussions of active research areas and internal disputes in lichenology have been simplified and stripped of bibliographic citations. Nonetheless, Brodo is especially adept at shaping the ongoing debates. For example, his brief consideration of the far-from-simple nature of the lichen symbiosis highlights the difficulties in determining whether the partners are "harmonious and mutually beneficial" or the fungi are parasites "exploiting their algal or cyanobacterial hosts."

If the introductory chapters are primarily written for newcomers, amateur and professional lichenologists alike are fully rewarded in the "Guide to the Lichens," which occupies the bulk of the volume. From the estimated 3600 species of lichens in North America, the authors present individual entries for 804 of the most common, conspicuous, or ecologically significant. The attention paid to crustose lichens is a great advance beyond the coverage in previous popular guidebooks. The species accounts include descriptions, photographs, and distribution maps along with brief comments on habitat, variation, and ecological importance. The keys and descriptions are convenient and practical, and the photographs show the species to their best advantage under natural conditions. Most lichens lack "common" names, so the authors present newly coined vernacular names for most of the macrolichens and most genera of crustose lichen. But I am not convinced that such nicknames will make remembering species any easier.

After presenting the species accounts, the authors provide a classification scheme, a glossary, a bibliography, and a taxonomic index. The classification is a necessary but disappointing compromise between developing research and previous systems. In it, and throughout the text, species names are presented without their nomenclatural authorities. Although this information is available through links from a Web site created by the Sharnoffs (www.lichen.com), its inclusion would have provided a stand-alone resource for professionals.

Besides providing such extensive coverage of its subject, *Lichens of North America* is a masterpiece of photographic illustration. The page design and layout add to the volume's beauty. Photographs appear to float within the generous margins. The colors are subtle and completely natural. Whether illustrating orange and yellow lichens draping over rocks, gray lichens veiling a serene gravestone angel, or yellow-green grandfather's beard festooning trees in a Cascades forest, the images are technically superb and printed with excellent resolution, sometimes at nearly five times life-size. They present what previously could only be seen through a hand lenses. But more important, they show lichens—even the hard-to-portray greenish-black *Collema* and *Leptogium*—in perfect field conditions. Readers interested in learning how these images were captured will enjoy the introductory section "Photographing Lichens: Techniques and Advice."



A colorful scale. *Psora pseudorussellii* is found on limestone exposures from southern New England across the Midwest to Texas.

CREDIT: SYLVIA AND STEPHEN SHARNOFF/FROM *LICHENS OF NORTH AMERICA*

The book is the result of a symbiosis among the authors themselves. Irwin Brodo produced excellent text that is factual and interesting. Sylvia and Stephen Sharnoff took the high-quality photographs over more than a decade of relentless travel throughout North America. Unfortunately, Sylvia Sharnoff,

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who had the original inspiration for the project, did not live to see its completion. This is a shame because the finished book is so much more than the sum of the parts that she knew. The photographs, introduction, keys, and descriptions are combined in such an appealing way that the volume makes lichens almost better than they could possibly be.

Even if such a carefully produced masterpiece cost a small fortune, I would recommend it for every serious professional and amateur lichenologist and for every public and university library. But with its reasonable list price every person interested in natural history should have a copy. I only hope that the publisher decides to reprint the keys separately, so I can take them into the field and preserve the book for my coffee table. Enjoyment of North American lichens has long been restricted to professionals and the most determined amateurs. This superior guidebook will make them accessible to all.

BOOKS: OPTICS AND ART

Framing the Evidence

Patricia Fara

Like searching for the holy grail, retrieving lost secrets from the past has always been a tantalizing, alluring quest. Isaac Newton immersed himself in arcane alchemical lore as he obsessively pursued the uncorrupted knowledge of the ancient Greeks, and Immanuel Velikovsky shot to infamy by rewriting science to explain biblical miracles and Egyptian mysteries. Now David Hockney, a prominent British artist who lives in California, claims to have discovered why pictures became far more realistic in the 15th century. In Hockney's version of the history of Renaissance art, neither divine inspiration nor the skill of genius caused this dramatic shift. Instead, lenses and mirrors provide the hidden explanation of how Caravaggio, Holbein, Raphael, Giorgione, and van Dyck were able to produce paintings that are as deceptively natural as photographs.

Secret Knowledge Rediscovering the Lost Techniques of the Old Masters
by David Hockney

Thames and Hudson, London, 2001. 296 pp. £35, ISBN 0-500-23785-9. Viking Studio, New York. $60, C$87. ISBN 0-670-03026-0.

Does the use of optical devices mean that the great masters were cheating? Their desire to avoid detection might provide one reason for the lack of written historical evidence to support Hockney's argument. Disturbing though his conclusions are, they deserve to be taken seriously because he is himself an artist. By ferreting out forgotten tricks of the trade, Hockney seems to undermine his own status as a celebrity painter. His reliance on visual rather than textual evidence forces even his critics to reconsider how they view great masterpieces.

The extent to which artists used lenses and mirrors is an old debate. Some art historians have tried to reconstruct the optical techniques of Vermeer, who worked in Delft during the second half of the 17th century.

Tell-tale skull? Hockney suggests that the distorted skull in the foreground is just one of the clues in Hans Holbein's *The Ambassadors* (1533) that the artist used optical tools.

Hockney wants to take the story back to 1430 and into Italy as well as northern Europe. Initially prompted by his own attempts to draw like Ingres, Hockney scoured catalogs for hints that artists might have used optical aids. For scholarly support, he recruited two experts: Martin Kemp, an Oxford art historian who traced out the pre-photographic pedigree of cameras, and Charles Falco, an American scientist, whose explanation that a concave mirror can act like a lens helped Hockney overcome some technical stumbling blocks.

Hockney is a man of few words. In the book's lavish first half, he offers a collection of marvelous pictures as arguments in their own right. He devotes the plainer second half to textual evidence. This evidence includes an assortment of historical documents and an edited selection of correspondence with curators and his two academic guides that logs the progress of his investigations "over more than a year"—a surprisingly short period of time for formulating such a revolutionary thesis.

Hockney's major rhetorical technique is to juxtapose pictures depicting similar scenes and claim that the stylistic differences between them result from optical innovations: angels' wings start to gleam with near-photographic realism, suits of armor gain shiny reflections, rich fabrics acquire luster and volume. Another of his tactics is to argue that optical assistance would have made the painter's task much easier. The foreshortened chandeliers, lutes, and skulls that conventionally advertise artistic dexterity here imply that a lens has intervened. Unable to muster the logical, fact-based proofs that scientists are accustomed to evaluating, Hockney argues by persuasion. He starts with certainty, and then proceeds by supposition. Leonardo da Vinci knew about lenses, so it is not "too far-fetched to imagine" that he wanted to recreate the beauty of projected images. Mirrors alter the highlights on a basket of fruit, an effect "surely" known about by Caravaggio.

Hockney's unfamiliar modes of argument immediately sound all sorts of alarm signals. Unlike scientists who present only their final results, Hockney invites his readers to accompany him on a personal odyssey of discovery into the past. By guiding them along the route that he has taken, he skillfully sets out to convince them that no other route is possible. When facts don't fit his case, he devises convenient suppositions. Dürer, he suggests, chose to draw a perspective machine that was already out of date, although no reason is offered for this strange decision. For science's most famous picture, Joseph Wright's *An Experiment on a Bird in the Air Pump*, Hockney shifts ground, maintaining that although Wright might not have used a lens himself, optical technology was so widespread by the mid-18th century that people now demanded pictures of lens-like naturalism.

It is too easy to condemn Hockney for demoting the great masters to technicians who faked their skills by copying. Art museums are the secular temples of modern society, and it seems sacrilegious to challenge the genius of great artists. By rejecting this reverence, and restoring artists to their former status as master craftsmen (and women do only appear as subjects), Hockney allows interesting themes to be explored. During his own career, he has creatively incorporated photomechanical techniques, and he draws on this personal practical experience to propose convincing new solutions to long-standing problems of perspective. Exasperating though *Secret Knowledge* may seem, when it comes to pictures, we should look hard at an artist's visual arguments.

CREDIT: THE NATIONAL GALLERY, LONDON

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