

Nature's Chemicals: The Natural Products that Shaped Our World

Author: Balick, Michael J.

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The Extraordinary Diversity of Nature's Chemicals

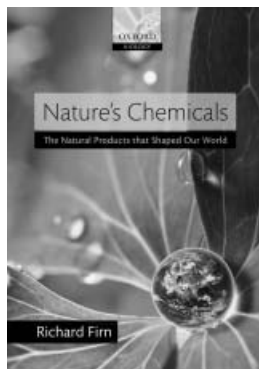
Nature's Chemicals: The Natural Products That Shaped Our World.

Richard Firn. Oxford University Press, 2011. 264 pp., illus. \$44.95 (ISBN 9780199603022 paper).

As author Richard Firn reminds us in the first chapter of *Nature's Chemicals: The Natural Products That Shaped Our World*, "all organisms are made up of chemicals." This is the starting point of a fascinating book about natural products (referred to as NPs) and how they have evolved and shaped the trajectory of civilization. Hundreds of thousands of individual chemical compounds are produced by plants and microbes; their variety within a single species accounts for the difference in taste between a pear and an apple, for example. The majority of NPs have their origin in three categories of chemicals: isoprenoids or terpenoids; polyphenols, phenylpropanoids, or polyketides; and alkaloids. These groups form the base of the metabolic pathways that produce the immense chemical diversity found today in living things.

Firn engages the reader by posing questions that we have all wondered about and then addresses them using examples that touch our daily lives. For example, he reflects on the eighteenth-century idea that naturally occurring chemicals are different from those made synthetically, and therefore, the former are to be favored: Mother Nature is, after all, the chief chemist. Individual molecules—synthetic or derived from natural sources—can have the same structure and properties, but when constructed into chemicals, they may not. Vanillin can be synthesized, but natural vanilla extract differs chemically (and monetarily) from synthetic vanilla flavoring. Natural vanilla extract contains compounds other than vanillin, and many consumers prefer the flavor and texture

produced by the pod of the vanilla orchid. Some of these consumers have a desire to support developing-country farmers—even though the price of synthetic vanilla extract, made from an industrial fermentation process that converts ferulic acid into vanillin, might be much lower.



Controlling the supply of certain NPs—those that are in limited supply or restricted geographically in their production—can provide money and thus power to those who manage the resource. Human obsession for plants that produce coffee, tea, spices, morphine, cocaine, and quinine has influenced world history, and when these NPs are controlled by a monopoly, the geopolitical landscape of the world is altered. One example is cocoa, which contains theobromine—a stimulant similar to caffeine—as its key NP. With its early origins in Central America, the bean reached Europe in the late 1500s. Bolstered by its reputation as an aphrodisiac, chocolate became popular and spread throughout other parts of the world, where it was appreciated as a healthful drink. Chocolate merchants became wealthy as a result of their trade in this bean, which could only be grown in the tropics. The story of the coca bush—the source of cocaine—is much darker. Traditionally used by indigenous populations, the plant is now the raw material for the multibillion-dollar cocaine trade. Coca is also one of the important ingredients in some

soft drinks, considered by Firn to be "a very profitable way of selling water by adding a few cheap NPs."

Nature's Chemicals summarizes the history of scientific thought addressing another question: Why are NPs produced by plants in such a variety of structures? An early belief was that plants and their compounds were created with the purpose of benefiting humans. Another belief was modeled on observations of animal physiology combined with the notion that plants must also eliminate waste. Without livers or kidneys, plants were thought to excrete their waste as "weird chemicals." Another theory suggested that NPs were a sort of test chemical needed to generate variation in species, maximizing the number of differences in the population of a plant so that natural selection could identify the fittest individuals. Other theories are discussed, including the widely held chemical convolution model, whereby plants use NPs as a way of fending off predators, which at the same time are developing defense mechanisms to overcome these chemical protections. Firn points out weaknesses in this model and discusses a newer model to explain the extraordinary diversity of NPs.

Dubbed the "screening hypothesis" and proposed by Clive G. Jones and Firn in 1991, the new model seeks to explain NP diversity through the evolution of specific metabolic traits in plants: "There could be ways that organisms could maximize the production of chemical diversity and increase the chances of retaining even some "redundant" NPs. The retention of some "redundant" chemical diversity is necessary in order to seed the generation of new chemical diversity." A section of a chapter in *Nature's Chemicals* is devoted to a complex and compelling explanation of this theory. As a student of ethnomedicine, I found this book to be fascinating and rich in information helpful for understanding the diversity of plant chemistry,

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its historic and contemporary importance to human society, and how and why plant organisms will continue to evolve novel compounds in a process that is both dynamic and ongoing.

MICHAEL J. BALICK

Michael J. Balick (mbalick@nybg.org) is vice president for botanical science, director, and philecology curator of the Institute of Economic Botany at The New York Botanical Garden, Bronx, New York.

TWO "DESTINED HUMAN DELIVERERS" OF ENVIRONMENTAL SCIENCE

Leopold's Shack and Ricketts's Lab: The Emergence of Environmentalism. Michael J. Lannoo. University of California Press, 2010. 216 pp., illus. \$24.95 (ISBN 9780520264786 cloth).

Aldo Leopold, forester and wildlife biologist, and Ed Ricketts, marine biologist, were two early twentieth-century naturalists whose works have reverberated across the decades and influenced a generation of environmental scientists and activists. Through intense observation and uncommonly clear writing, both men were able to develop and articulate an understanding of nature that linked the appetites of a rapidly industrializing nation to the vulnerability of its environment, long before the Earth Day awakening and the polarizing politics that consume current science and policy debates. If every discipline has its heroes, Leopold and Ricketts are two of the rock stars of environmental studies.

With *Leopold's Shack and Ricketts's Lab: The Emergence of Environmentalism*, Michael Lannoo has crafted a book designed to pull these two larger-than-life figures into focus, and he does so by linking their very different personalities to the places

most closely identified with their lives and insights: Leopold's shack in the Wisconsin Sandhills and Ricketts's waterfront lab on Monterey Bay. By weaving their stories together around these unassuming buildings, Lannoo manages to create a connection in the mind of the reader, a connection that did not exist between these men, who never met. By forging this link, the author integrates the terrestrial and the marine, the introversion of the researcher with the wanderlust of the naturalist, the discipline of science and the passion of activism. By tying these men to the modest structures where their most sweeping ideas came to life, Lannoo makes a connection that is both unexpected and insightful. And although their private lives could hardly have been more different, their impact on society is convergent and complementary. From the reader's perspective, the author's appreciation of both the men and their contributions is inspiring.

Ricketts and Leopold are a dynamic duo, yin-and-yang voices that together transformed natural history into environmental science and made the leap from insular and specialized disciplines to a new field with sweeping societal relevance.

Leopold's Shack and Ricketts's Lab is a short and entertaining read, a book that fans of both Leopold and Ricketts will appreciate. Each reader is likely to recognize one character and be introduced to the other. The reverence I hold for the shack and the ideas that flowed from it gave me entry to Ricketts's life, through his lab, and I expect the reverse will be true for other readers. Yet one cannot help but wonder

if the focus on the shack and the lab reveals true similarities, or if it is a device that pulls together the mythology surrounding each man, perhaps obscuring or ignoring the divergent lives they led. After all, Leopold's shack and Ricketts's lab were different in purpose, origin, and use. Whereas the lab served to process marine specimens for sale to students and researchers, the shack was a family retreat, where solitude and physical work restored the forests that had been lost to the saw and plow. Ricketts's lab was a gathering spot for authors and artists (frequent guests included John Steinbeck and Joseph Campbell), whereas Leopold's shack was a quiet refuge for family and, at times, a few close friends and students. And whereas the lab was a rented building squeezed between a sardine cannery and busy railroad tracks, the shack was in the boondocks, surrounded in Leopold's day by exhausted farmlands that were an unlikely destination for naturalists or tourists.

Similarly, the two men's personalities seem equally disparate: Ricketts, loud and boisterous, provided a meeting place for the unconventional intellectuals who sought freedom in the freewheeling California of the early twentieth century. If Ricketts provided refuge and inspiration for their great works, it was through the unvarnished life he shared with them, which included field excursions to Mexico and Alaska, as well as many days in California tide pools and festive evenings in the lab. Leopold, the quiet professor, spent most of his time at the shack with his children and students—planting trees, making detailed natural history observations, cleaning, fixing, and restoring, while cementing the personal bonds that come with hard work. Seen in this light, Ricketts and Leopold are a dynamic duo, yin-and-yang voices that together transformed natural history into environmental science and made the leap from insular and specialized disciplines to a new field with sweeping societal relevance.

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