

Book Review

Tales From The Underground. A Natural History of Subterranean Life, David W. Wolfe (Perseus Publishing, 2001) 221 pp, ISBN 0-7382-0128-6; \$26.00 (hardcover)

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Every year, in the first class of my General Chemistry course, I tell my students about the Roman god Janus, the double-faced god who stands guard at the doorway of homes, one face looking outward, and the other inward. I point out to them that like Janus, chemists live astride the interface of two worlds: the visible macroscopic world of chemicals, bulk properties and observable changes, and the unseen one of atoms, molecules and quanta, and that our job is to shuttle back and forth between the two, interpreting the phenomena in the seen world in terms of the properties of the unseen one.

Perhaps this is one reason why I was intrigued by *Tales From The Underground*, with its title reminiscent of Dostoyevsky's *Notes From The Underground*. The main reason, though, was that, like most people, I live my life on the surface of the earth, not giving much thought to what goes on beneath my feet, except when something like the Big Dig inconveniences me, or exposes something fascinating or horrifying, or when I am battling subterranean critters determined to destroy roots in my lawn and garden. I thought it might be worthwhile for me to move beyond this adversarial relationship to something more positive and informed.

Wolfe, an Associate Professor of Plant Ecology at Cornell, sets out to introduce the general reader to the underground world, to its enormity, to how little of it is actually known and understood, to the profound effect it has on the aboveground world of which we are most aware, of its tremendous promise and the surprises it can hold for us, and of the tenuousness of its existence in the face of stresses imposed by human activity. With his clear and enjoyable prose style, he has largely succeeded in crafting an enjoyable introduction to a world of which most of us probably know relatively little.

The book is divided into three parts. The first, "Ancient Life", addresses the question of the origin of life on earth and examines the recently-emerging hypothesis that it began, not in the seas or pools, but in subterranean environments, perhaps with the surfaces of clays functioning as primitive "enzymes", providing catalytic sites, or even, with their aperiodic crystalline structures, sites for biomolecular assembly, rather like protogenes.

Wolfe next turns to the remarkable variety of extremophiles, microbes that thrive in environments of extreme high temperature and pressure, and the surprising chemistry that they manifest, which has greatly expanded our ideas of biochemical reactions:

“Many of these microbes have unusual metabolisms. For example, some of them ‘breathed in’ iron oxide (rust) as a substitute for oxygen in their respiration process. Others exhaled methane gas ... as a waste by-product, which was subsequently utilized as an energy source by another important group of microbes sharing the same habitat. A particularly important discovery was that some of these creatures were able to utilize metals other than iron, such as cobalt or uranium in their biological processes.”

Perhaps the most intriguing section deals with the relatively recent discovery of the archaebacteria, and the subsequent realization that they are both far more widespread than initially realized, and no mere curiosity or evolutionary sidetrack, but a third branch (the *archaea*) of the tree of life (along with the *bacteria* and the *eukarya*). It is remarkable that something this fundamental should have gone undetected for so long, and a sobering reminder of how much remains undiscovered under our very feet (both figuratively and literally).

Part II (“Life Support For Planet Earth”) focuses on the essential role played by microorganisms in creating and sustaining the ecosystem of earth, beginning with the nitrogen-fixing bacteria and ending with a discussion of microbes and the chemical weapons they produce to ensure their survival. Wolfe provides a brief overview of the discovery of antibiotics and their role in transforming the quality of human life in the twentieth century, but his presentation makes it clear that, from the perspective of the microbe, all their chemical products are beneficial, their classification as toxins or antibiotics being meaningful solely from a human perspective.

Wolfe also includes a historical sketch of Charles Darwin’s studies of the role of worms in creating and maintaining soil, providing a vivid reminder to those of us who are gardeners that healthy worms in a freshly turned spade of soil are not merely a symptom of good soil, but one of the causes.

Perhaps the most interesting section, though, dealt with mycorrhizal fungi which grow on the root hairs of trees, facilitating the uptake of nutrients and the root systems of neighboring trees, functioning as a “connecting tissue” in forests, in effect creating a subterranean ecosystem. Without them, even single trees would have a hard time existing, because their roots would be incapable of taking up sufficient nutrients.

In the final section of *Tales From The Underground*, Wolfe turns to the influence of human activity on soil and its inhabitants, exploring the ways in which farming, development, and the addition of chemicals directly to soil (whether for beneficial

purposes, or as waste products), or indirectly, through water or air pollution, are placing stresses on the creatures of the underground, affecting their prospects for survival. Whether mammals (the prairie dog, the black-footed ferret and the burrowing owl), worms and insects, or bacteria and fungi, Wolfe makes a strong case that they should not be looked at simply as individual cases, but as members of a complex, highly-linked ecosystem, of which humans are one part, and that our survival is inextricably bound up with theirs.

At the risk of sounding a quasi-religious note, I cannot help recalling how apt the biblical assertion that “Inasmuch as you did this for the least of these, my [kindred] you did it to me” seems in this context.

Wolfe’s book, though brief, concludes with a generous section of notes and references, pointing the way for future exploration on any of the topics he has covered, and it makes for enjoyable and informative reading. It will give you a new appreciation for the ground beneath your feet.