UNDERGROUND TALES

David W. Wolfe, in *Tales from the Underground:* A Natural History of Subterranean Life (221pp, Perseus Publishing, 2001) lets us know there's much more happening beneath our feet than we're aware of. With new scientific techniques, we can study environments deep down, and this study has revised our view of life's origins and functions as profoundly as did Copernicus' 16th century debunking of a human-centered universe.

And once again homo sapiens seems more fragile and less central than we had thought.

"The total biomass of the life beneath our feet is much more vast than all we observe above ground." And, as we'll see, we're totally dependent upon what goes on there.

Wolfe starts deep in the earth and in the past and works his way toward the surface and the present. We now know that bacteria ("extremophiles") live thousands of feet down, without oxygen or light, some in rock heated by radioactivity and magma, at temperatures above the boiling point of water.

And that's probably where life began, three and a half billion years ago. Because of constant meteor showers, earthquakes and floods, life could not have survived then in the warm shallow seas posited by Darwin. Instead it probably began in deep ocean sediments, or deep fissures in the earth.

On the new, many-branched tree of life, plants and animals occupy a couple of twigs on the top third. The other two thirds are occupied by strange sounding bacteria and their cousins the Archaea, creators of vast deposits of

methane. And instead of the progression from simple to complex we've cherished, all branches seem to have risen from a common primitive form.

As to the transition from non-organic to organic, Wolfe posits clay as one possibility, with its vast, electrostatically charged surface area, its ability to self-replicate and self-assemble. "Dust thou art, and to dust thou shalt return."

All cells need nitrogen, and seven tons of it, in its gaseous form, cover every square yard of earth's surface. Yet plants and animals cannot access it in this form: hence the need for nitrogen-fixation, comparable in importance to photosynthesis. Rhizobium bacteria learned to cooperate with plants' roots, changing gaseous nitrogen into a plant-usable form and receiving sugars in return. This allowed earth's carrying capacity to expand dramatically.

But in the early 20th century we learned to fix nitrogen chemically, and now supply more than nature does. The trouble is, plants take up only one third of this, and the rest is lost through run-off, creating huge "dead zones," like the one at the Mississippi's mouth, the size of New Jersey.

Almost all plant species' roots are joined by fungi that help (or enable) them to get nutrients. These "form the foundation of most terrestrial ecosystems" – orchards, savannas, tropical forests, deserts, etc. You begin to see what I mean by our dependence on the subterranean.

Soils can both kill and cure, containing tetanus and late potato blight (now "back with a vengeance") as well as antibiotics like streptomycin and penicillin.

No nation, Wolfe says, manages its topsoil sustainably: erosion outpaces soil formation by ten to one. The tropics today are like the 1930's Dust Bowl. Solutions: maintain

vegetative cover, plow sparingly and not on hillsides, establish windbreaks. Keep as much carbon-rich organic matter as possible slowly decomposing in the soil, and release as little carbon dioxide as possible to the atmosphere. Such practices might justify Wolfe's "conditional optimism."

"All of us are truly and literally a little bit of stardust" – because our bodies' and our earth's elements come ultimately from the Big Bang and subsequent burning stars. Thus are far and near, ancient and modern, joined in us.