OUR SPLENDID KIN

More species of beetle inhabit Earth than any other kind of life, but bacteria are by far the most numerous organisms on Earth. Taken together, bacteria are also the most diverse. They are the oldest, having had the most time to evolve to take full advantage of Earth's varied habitats, including the living environments of their fellow beings.

By trading genes and acquiring new heritable traits, bacteria expand their genetic capacities—in minutes, or at most hours. A huge planetary gene pool gives rise to temporarily classifiable bacterial "types" or "strains," which radically and quickly change, keeping up with environmental conditions. Bacteria in the water, soil, and air are like the cells of a growing global being. Whereas your genes are inside a body with a discrete life span, a bacterium takes and gives out its body's genes in and from the surroundings. Although, of course, like all life, bacteria can be killed by starvation, heat, salt, and desiccation, these microbes do not normally die. As long as the ambience permits, bacteria grow and divide, free of aging. Unlike the mammalian body which matures and dies, a bacterial body has no limits. A disequilibrium structure thrown up by an evolving universe, it is, in principle, immortal. Sequestering order in a disordering universe, the silent bacterial biosphere preceded all plants, animals, fungi, and even the protoctist progenitors of all these forms of larger life. Without the bacterial biosphere no other life would ever have evolved, nor would it live today.

Bacteria are the most tenacious beings known. Some survive extreme environments in the dry Sinai Desert, others in the salts of the Red Sea. Some inhabit Antarctic rocks; others thrive in the Siberian tundra. More bacteria inhabit your mouth right now, even if you've just brushed your teeth, than there are people in New York City.

Bacterial tenacity should not be underestimated. This entire planet is bacterial. Human technologies and philosophies are permutations of the bacteria. Eating, infecting, and irreversibly merging with one another, bacteria spun off powerful new prodigies: the protoctists, fungi, plants, and animals—all of which keep alive the metabolism and movement of the bacteria from which they derived.

Scientists were originally surprised when they detected hemoglobin, the red protein pigment in human blood, in legume roots of pea, bean, and alfalfa plants. Had vegetables somehow appropriated this red, oxygen-carrying iron molecule from the animals which feed on them? Possibly. But hemoglobin now has been discovered in the filamentous, sulfur-oxidizing bacterium *Vitreoscilla*. More likely, therefore, hemoglobin evolved in the bacterial ancestors of both plants and animals. Hemoglobin is chemical evidence of a "blood tie" to early life—a blood tie that evolved long before blood. Molecules like green chlorophyll and red hemoglobin that evolved in colorful and wily bacteria suggest the extent to which they are our kin.

FROM PLENTY TO CRISIS

Threatened by the indifference of the matter from which it evolved, life was enveloped in a world of dangers. At each point in its evolution, life has raised the stakes of existence. Overcoming itself, expanding its sensitivities and capacities, life has plunged into new realms and new risks—but also new opportunities.

Consider: life produced startling new forms during the time it was exclusively bacterial. Only recently has science revealed the dazzling events that occurred early on in life's evolution. To be recognized and understood by organic beings in the Cenozoic, these most ancient wonders of natural history had to await micro-, molecular, and paleobiology. Subvisible metabolic changes and the power of our planet to process its soil and atmospheric gases can be inferred today from an arcane fossil record of microbes. And vestiges of the past are revealed by teasing through molecules and molecular processes that characterize the biosphere today. Moreover, devel-