Chapter 16. Interconnectedness—The Third Biggest Idea Ever

Calling her Gaia is a bit fanciful, I admit. That is, thinking of Earth as a goddess. And scientists do not, in fact, think of the Earth as a goddess. Not even the grandfather of the Gaia Hypothesis, James Lovelock, or the late Lynn Margulis, who gave the hypothesis its biological underpinnings. (Yes, I asked her.) But you can think of Earth as an organism. Not all of the components of an organism are, themselves, alive; a snail's shell, and your fingernails, are not alive. The cells that make shells and fingernails are alive, but those components themselves are not. Similarly, the air is not alive, nor is the water, nor are the rocks, but they are all part of a living system.

The question, however, goes beyond whether the parts interact. Any time you get entities together, they will interact. As explained in an earlier chapter, if you get two molecules next to each other, the electrons of one will repel the electrons of the other, changing both. The question is whether the interactions work together to produce a holistic function.

And the systems of the Earth seem to do just this. The Earth, as a whole, is governed by what we call *negative feedback processes.* A good everyday example of negative feedback is a thermostat. In the winter, when your house gets too cold, the thermostat turns on the heater; once the heater warms the house up, the thermostat turns the heater off. A similar process occurs with the air conditioning in the summer. Your body does this too. If your body gets too hot, the little arteries in your skin dilate and allow more blood to enter, causing your hot blood to flush the skin and dissipate some of its heat. If your body gets too cold, the little arteries constrict and keep the heat down in the core of the body. And the Earth does this too. If the atmosphere gets too much carbon dioxide, causing a greenhouse effect, plants will grow more, removing some of the carbon dioxide and causing the Earth to cool. The only problem is that this process takes a long time, and is not happening rapidly enough to prevent the Earth from experiencing global warming that, while not dangerous to the survival of the Earth, will prove astonishingly disruptive to human civilization. In the short run, *positive feedback processes* may predominate. As the ice caps melt, the oceans absorb more heat, causing the Earth to warm up and causing more ice caps to melt which causes the oceans to absorb more heat…and so on. Over the long term (but not soon enough to save human society) the negative feedback processes predominate.

The land surface is not a stage upon which the biological drama plays out. Plants need soil, but soil needs plants. Good soil is fluffy and dark because of the partially decomposed plant material in it, and earthworms burrows contribute to the soil's porosity. And then, over time, biological processes affect the very process of rock formation. Not all rocks, of course; volcanic rocks owe little to biology. But sedimentary rocks consist not just of mineral sediments but of biological material, sometimes (in the case of coal and oil and even some kinds of limestone) vast amounts of it. The diatomaceous earth deposits north of Santa Barbara consist of billions of shells of microscopic diatoms:

[photos]

The chalk deposits of Dover, in England, also consist of billions of shells of dead microbes, in this case coccoliths. And perhaps the best example of all is that all of the oxygen in the air came from photosynthesis of plants.

Some of the interactions of organisms are easy to see. It is easy to see predators eating prey and the prey eating plants. But it took scientific research to reveal to us that what the

predators do affects the plants. If predators become scarce, the populations of prey explode, and they start eating the plants. A green plant cover might depend, in large measure, on a healthy population of predators, even though the plants and the predators do not directly interact.

Most of these interconnections are invisible and were, before scientists studied them, unknown. Trees and humans directly interact with one another; for example, trees produce oxygen that humans breathe. But oxygen is invisible. There was a time, not far into the past, when nobody understood this direct and vital connection between humans and trees. Certainly no religious leader or philosopher figured it out based on their studies.

The vast interconnectedness of the world is a concept that science has made possible. When I walk in the great outdoors, I feel at home not just because all organisms are my distant cousins but because all of the things I do and all of the things they do are ecologically interconnected. This is one of the biggest of the Big Ideas.