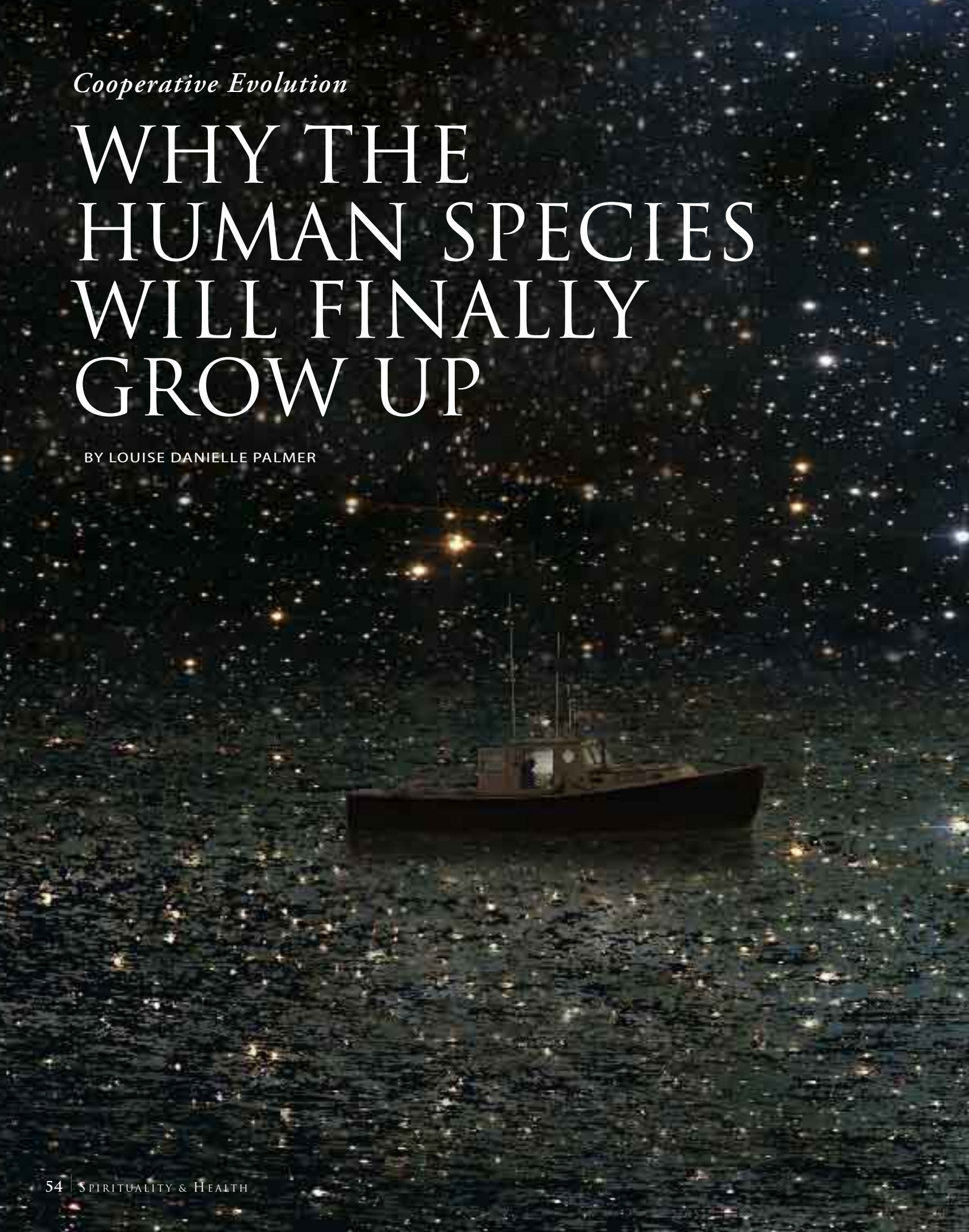
Cooperative Evolution

WHY THE HUMAN SPECIES WILL FINALLY GROW UP

BY LOUISE DANIELLE PALMER



From the rails of her Greek fishing boat, evolution biologist Elisabet Sahtouris realized that what was true under the microscope was also reflected in the cosmos: our planet is alive, self-organizing, endlessly abundant, and highly cooperative. Despite the ravages of environmental and human destruction, Sahtouris believes we can learn from the natural world that a shift from competition to cooperation is possible. It is part of our own maturation as a species. It is also key to our survival.

At the age of 43, Elisabet Sahtouris, an evolution biologist with a doctorate in brain science, quit her job at PBS, sold her car, house, and stuff, and moved to a tiny island in the middle of the Mediterranean. It wasn't the first time she had walked away from an illustrious post to satisfy her curiosity. Sahtouris had already left academia, including teaching at MIT, for good. "There was a party line about the science

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Scientists tell us the story of where we came from and what life is about. The key is to update this creation story, because it shapes both our beliefs and our reality.

you could teach and believe in, and the suit was just too tight for me. Science couldn't answer my big questions — who are we, why are we here, and where are we headed?" So Sahtouris went to find the answers for herself in the world of nature, becoming something of a Greek philosopher along the way. But first she went fishing.

Sahtouris bought a *kaiki* (a classic seagoing vessel), and settled on Agistri, a Greek island that was once a leper colony, the perfect place to disappear. One day, while wandering through Agistri's forests, a tiny walking stick insect fell onto her sleeve, changing her mind about her life's work.

"I hadn't seen one since I was a little kid growing up in the Catskills," she remembers. "Back then, I lived in a seamless world where things hadn't been taken apart yet and put into little boxes. It was a deep grounding that told me that science and spirituality had been artificially separated. Somehow, in that moment, I realized then that I still needed to write the scientific story of the living Earth."

And so she did. Fifteen years, three novels, one children's book, thousands of hours of reflection, and dozens of research conferences later, Sahtouris finally wrote her magnum opus, *EarthDance*, evolution biology's version of the grand theory of everything. Or, put simply, her theory of how things work. Embedded in this theory is a radical call to change that Sahtouris is bringing to corporations, academia, and political institutions all over the world, from the United Nations and the World Bank to the EPA and the Australian government.

"Scientists tell us the story of where we came from and what life is about," she says. "The key is to update this creation story, because it shapes both our beliefs and our reality."

Descartes convinced us that nature is machinery that we can take apart and master, she points out. Darwin taught us that the natural world evolved by trial and error, that resources are scarce, and that every individual and every species is in fierce competition. We live in a dog-eat-dog world, we say, as we justify our actions and their result: radical climate change, biological and nuclear warfare, rampant habitat destruction, water shortages, and extremes in global wealth and poverty.

Sahtouris, however, insists that there is hope for us as a species by showing us that this story isn't entirely accurate. Looking through her lens, we see that the planet and its life forms are both competitive and cooperative. We see that every living being is part of some larger being and negotiates its self-interest in order to sustain the larger being to which it belongs, a principle at work everywhere in nature — except in the current human realm. We haven't figured this part out — yet. But despite the ravages of environmenal and human destruction, Sahtouris believes we can change our modus operandi if only we can develop a different vision of life on Earth. Such a shift, she says, could be part of our destiny, our maturation and evolution as a species. It certainly is key to our survival.

Our New Story Begins

Once upon a time, a goddess whirled out of the primeval darkness, wrapped in flowing white veils, creating Earth from her body. So begins the Greek myth of Gaian creation, one that finds its echo in modern astronomy. We now know that the earliest swirling white forms were born of a huge explosion of energy we call the Big Bang. Out of this energy, heavy and light particles formed, creating currents of motion and great gas clouds that pushed and pulled these particles about. From this star dust, more swirls were formed, the thickest of them creating proto-galaxies sparkling with light. Proto-galaxies evolved into galaxies, exploding and pulsing into richer patterns and parts, eventually forming planets including the Earth. Although this is a radical simplification of a highly complex process Sahtouris describes, what is important is her hypothesis that an intelligent patterning began to unfold as soon as the universe whirled itself into being.

Elisabet Sahtouris

AUTOPOIESIS

This single-cell diatom, which passes on half of its shell when it reproduces, illustrates the process of autopoiesis. We know something is alive if it is autopoietic, continually recreating itself and its parts, while organizing itself in relationship to its surroundings.

"Our universe, or cosmos, has always been a dance of interactions among the large and small moving patterns, contributing to each other's formation," she writes in *EarthDance*. Although these patterns aren't yet understood, it is becoming obvious that they form a "cosmic unity of process… rather than a chaotic spray of unrelated parts."

A close look at evolution reveals a spiraling pattern that repeats itself, an endless movement of wholes dividing themselves into smaller, more complex parts which join other parts to become larger wholes. This process is the foundation of Sahtouris's theory of evolution, one pattern in which is holarchy.

Holarchy is a term originally coined by the philosopher and scientist Arthur Koestler to represent a whole made of its own parts that is also part of a larger whole. We live in a universe of holons within holarchies, where everything is connected and embedded in everything else. Our solar system is a holon within a galaxy within innumerable galaxies, just as our cells are holons within the organ within the body, which is a holon within the larger ecosystem, and within the holon of the Earth itself.

Life Is Rock Rearranging Itself

"I have a real thing for ammonites," Sahtouris tells me. We are sitting in her Santa Barbara apartment, looking at a chunk of rock in which is embedded an ancient, ossified, spiraling shell-like creature. How, I ask her, did that creature get there? How did life begin? Some think life was planted on Earth from elsewhere. Others believe that the first bacteria were the product of the life-giving source, a "cosmic consciousness" that directs and underlies all of creation. Mainstream science tells us that life is an accident of organic chemistry. This is what Sahtouris tells me: life is a process, rather than inanimate matter that suddenly, somehow comes alive.

"I love the idea that life is rock rearranging itself, that creatures came from the Earth's crust and return to the Earth's crust," she says, holding up the fossil. So what constitutes life? Chilean biologists Humberto Varela and Francisco Maturana define it using the term autopoiesis, Greek for self-creation or self-production. "A living entity is one that continually creates itself, and self-organizes in relationship to other entities," Sahtouris

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explains. The Earth itself fits this definition, just as the body does. Even galaxies behave in a way we can recognize as living by this definition: they keep their form while constantly creating and replacing their parts, growing as well as dividing to form offspring galaxies.

"Does it make sense that life comes from non-life, as most scientists have it, or that consciousness arises from non-consciousness?" Sahtouris asks. "If the universe is in the business of self-creating living systems, science would no longer have to find the origins of life. It would be built into the whole shebang. Or maybe it's she-bang." She laughs at the pun.

The Surprise of Competition

The story of how bacteria developed reveals a fascinating and instructive turn in the evolutionary wheel of life. It also illustrates the second organizing principle in Sahtouris's vision of evolution, the maturation cycle. The cycle begins with unity and moves to individuation, which creates tension and conflicts, which are resolved through intelligent innovation and cooperation, creating another level of unity until individuation begins again.

This cycle repeats itself infinitely at all levels of creation, Sahtouris shows, beginning with the first 2 billion years of Earth's life, when bacteria ruled the world. The first bacteria, or microbes, got their energy by breaking up supply molecules using fermentation. Sahtouris calls them bubblers. They multiplied like crazy, colonizing the planet. Eventually, the bubblers gobbled up all free food molecules and began to die off. In crisis, however, they made some key innovations. Bubblers discovered a way to trap sunlight and produce energy, food, and DNA by rebuilding molecules using certain light-sensitive chemicals. This process is called photosynthesis, and it gave rise to the second type of bacteria, blue-greens.

The universe is a self-creating living system. "Does it make sense that life comes from non-life, or that consciousness arises from non-consciousness?" Sahtouris asks.

Blue-greens repeated the pattern, creating enormous colonies that turned into muddy masses that turned to rock and eventually extended into continental shelves. But there was a problem: the waste gas the blue-greens excreted — pure oxygen — was poisonous and it was piling up fast. Once again, in the midst of crisis, bacteria discovered a way to recycle this waste: some developed enzymes that made the oxygen harmless to themselves while others discovered a way to burn, or make food from, oxygen. Sahtouris calls them breathers. Of course, respiration, like fermentation and photosynthesis, produces waste. But this time, the waste was carbon dioxide — the very gas needed for photosynthesis, helping not only the blue-greens survive, but the bubblers and breathers as well.

The breathers were the last in the main group of Earth's bacteria, which still populate every inch of our planet. Today, chloroplasts in plants are descendents of blue-greens, while the bacterial descendents of their ancient relatives, the breathers, evolved into mitochondria that are found in the cells of almost everything from fungi and plants to animals and humans.

From Competition to Cooperation

For 2 billion years, bacteria had the world to themselves, Sahtouris explains, citing the work of her mentor, Lynn Margulis. They developed different lifestyles, competed with each other, and provoked worldwide crises such as global hunger and pollution, dramatically changing the Earth. At each stage of their evolution, they made innovations and eventually evolved from an exploitative, selfish existence to a harmonious, cooperative one. From these collaborations they eventually created a large, collective nucleated cell from which all other life evolved. It was the biggest step — or leap — in evolution, occurring about halfway through Earth's life.

This is how it happened: bacteria engaged in an ever more complex "DNA information trade," or what Sahtouris calls the first World Wide Web. Opening their cellular walls, slipping DNA back and forth across their boundaries (original sex), they streamlined operations and assigned themselves jobs in a division of labor. They tried on different shapes and sizes, becoming more varied and more interdependent, assuring both their autonomy and their holonomy on Earth.

Their success, however, challenged them again with overpopulation and food shortages. Breathers

HOLARCHY

A holon is something that is whole in itself, such as a cell, but is embedded within another holon, or a larger whole, such as an organ. Each holon has its own self-interest, but also works within the self-interest of the larger holon which contains it, forming a holarchy.

began invading bubblers and eating their insides while multiplying inside their walls. Eventually, they evolved cooperative schemes, sharing survival strategies and creating a new life form that was thousands of times bigger than any one bacterium. From this "multi-creatured cell," with mitochondria as energy generators and a nucleus containing a vast library of information, a common DNA gene pool was born. We ourselves are related to this cell, as our bodies are made of them. In fact, every plant, animal, and human on the planet evolved as colonies of these nucleated cells.

The enormous diversity of the DNA library in each nucleus, and the complexity of cellular function itself, still perplexes geneticists today. We are made of up to 100 trillion cells, each one a holon within a massive holarchy. In a holarchy, no level is more important than the next, and each level must negotiate its interests with those of other levels within the whole.

"Self-interest at every level of holarchy leads to negotiated compromise and dynamic harmony in the end," Sahtouris explains. "This goes on in our bodies every second. Every cell and every organ has self-interest. A cell can't live without its host organ, any more than the organ can live without its cells. Just like bacteria, they must negotiate those differences toward harmony."

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It was the ancient Greeks who understood that whatever humans did affected all beings and all levels of the cosmos, and that everything reflected everything else.

Modern cellular biology tells us that DNA rearranges itself in response to challenges within and beyond the cell, or even the entire body. Geneticists have discovered, for example, that the genome cuts out DNA sequences and reshuffles them when necessary. This allows evolution to proceed rapidly, and, as Sahtouris points out, intelligently.

"If there is an occasional fortuitous mutation," she says, "it takes an intelligent genome to recognize and incorporate it, rather than repairing it as is usual with any genetic mutation. Fifty years of scientific evidence has shown us that evolution happens when DNA intelligently reorganizes itself in response to some kind of stress. Genomes repair mutations when they detect them; in bacteria, they create whole new metabolic cycles bringing new genes into play as needed."

Cliffs Notes on Creation

There are three concepts necessary to understanding Sahtouris's evolution theory — autopoiesis, holarchy, and the maturation cycle. They operate simultaneously in an alive, intelligent, self-directed planet, and we can see them in every aspect of creation.

- In the bacterial world, microbes quickly rearrange their metabolism to allow them to digest whatever food is available. They are quick to change their genome, rather than wait around for mutations to adapt. In the plant and insect world, locusts generate cubic miles of animal matter in days, eating plants that have grown themselves out of the soil over a few weeks. When most of the plants are gone, the locusts begin to die off and are absorbed back into the soil as fertilizer. Mineral to plant to animal to mineral to plant and back again, over and over.
- In our bodies, cells operate by anabolism and catabolism, building up cellular material and breaking it down. Every one of our cells has 30,000 recycling centers in it to keep us healthy — 30,000 in one cell!
- Rainforests in the northern and southern hemispheres turn carbon dioxide into oxygen and act as pumps, driving moist ocean air high into the atmosphere and taking it to the poles as a critical part of the weather cycle.

"I Learned All of This Fishing"

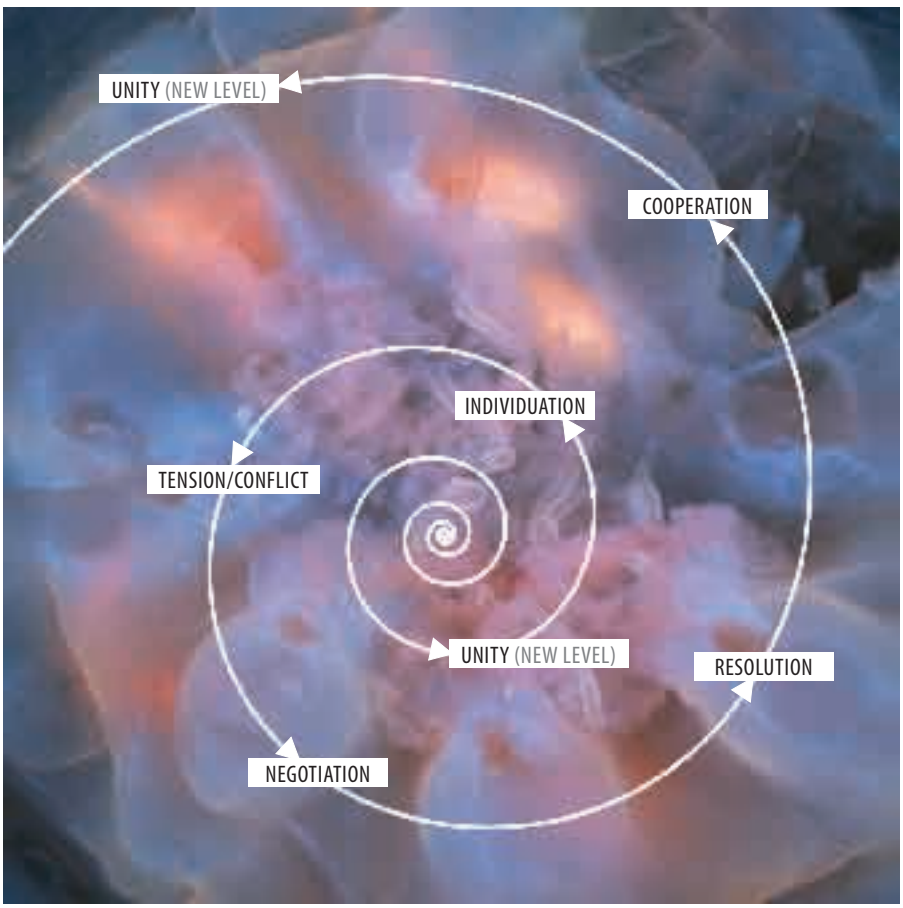
After a long day of interviewing, Sahtouris and I walked to a nearby beach (she hasn't owned a car in 20 years) and had a glass of wine together. That night, my head was exploding, moving from confusion to clarity and back again. Information overload. I wanted to know how she wove together the key concepts that drive her theory of evolution. The next morning, I asked her while she brewed us some Amazonian herbal tea.

"I was going out fishing for days at a time when I lived on Agistri," Sahtouris recalled. "The hardwood slats hurt my bones so I didn't sleep much. At night I would swirl the grappling hooks and nets in the water and see the bioluminescent plankton. Up above, the black sky was full of tiny stars just as the water seemed to be. There was no horizon, no division. As above, so below. I was halfway between macrocosm and microcosm. These images came to me while I was reading all kinds of philosophers and scientists, as well as Greek drama. It was the ancient Greeks who really understood that whatever humans did impacted all beings and all levels of the cosmos, that everything affected — and reflected — everything else. A lot came together that way. I meditated a lot, asking Nature whether what I was reading was true."

Almost by accident, Sahtouris had returned to an ancient form of inquiry in the Western tradition. The ancient Greeks called science *philosophia*, or love of wisdom, looking to the natural world for guidance in human affairs. It was a perfect intellectual turn for Sahtouris: what most motivated her was uncovering the Earth science that would teach and inspire individuals, businesses, and governments to change the way they operate. Even some evangelical Christians critical of evolution theory are receptive to her message.

"To raise awareness and focus people's attention on sustainability and the role of cooperation in evolution is a big contribution," says Walter Eckhart, Ph.D., director of the Cancer Center at the Salk Institute in San Diego and professor of molecular biology and genetics. "People really respond to these ideas, even in places where they aren't necessarily welcome."

MATURATION



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The maturation cycle guides the evolutionary process, repeating itself infinitely at all levels of creation. The cycle begins with a state of unity or oneness; separation and division occur, giving rise to hostile competition and, sometimes, near extinction. In order to survive, negotiations follow and cooperation prevails, giving rise to a higher level of unity and organization . . . until the cycle begins again.

From Survival to Thrival

Darwin was right about species competing for resources, Sahtouris says, but he never saw beyond it as just one stage in the maturation cycle. Evolution proceeded when crises created by species forced them to go beyond "survival of the fittest" and find cooperative strategies for survival. For us in the West, this means it's time to grow up and move on to the next phase in our maturation cycle. It means recognizing that caring for each other and sharing resources works better than unrelenting competition, she says. It means it's time for us to see that our own survival requires us to abide by the basic principles that sustain life itself.

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Holarchy is one. It allows for everything to work both cooperatively and by self-interest. Self-interest is only a problem when it's not contained by that of the next level of holarchy. To create a dynamic, self-sustaining system, individual self-interest needs to be negotiated with the community's self-interest. If human beings understood this concept, Sahtouris suggests, perhaps business wouldn't be a race with winners and losers, driven by the tyranny of the bottom line. "No creature is a thing in itself," she says. "We study rabbits in habitats, but it's really all rabbitats!"

Humans are, as Dostoyevsky said, unfinished creatures. As one of the younger species on Earth, Sahtouris believes we are mid-stage in our evolution. Some are still trapped, like Darwin (or perhaps because of Darwin), in competition and

continued on page 75

Evolution

continued from page 61

survival mode, while others are moving toward collaboration and cooperation.

"We need a story that shows us nature as a whole Earth phenomenon, as an intelligent, learning organization with abundance and balance as its goal. It's thrival, not just survival. Nature is resourceful in crisis and that is perhaps the biggest lesson for us: we humans are in process, in this maturation cycle."

It's helpful to turn to one final example in nature to see where we are and where we could be. Ecologists divide the world into three kinds of ecosystems. In Type One, each species is hogging territory and resources, reproducing wildly and killing off others. Some California wild grasses behave this way. Grasses are the same age as humans, evolutionarily. Type Three ecosystems, on the other hand, are marked by "mutual consistency," where all species share food and habitats, getting for themselves while producing for others. From microbe to plant to animal, there is extraordinary symbiosis, communion, and complexity as both self-interest and the interest of the whole system are in dynamic balance. The rainforest, the prairie, and the coral reef are all Type Three.

Type Two ecosystems allow for species at different places in the maturation cycle: young species that are still wildly competitive and self-serving (most of us), as well as more mature species that have achieved high levels of cooperation (that would be the ants). The human realm is like a Type Two ecosystem, in transition, where Type Ones and Type Threes are tugging at the system, and where something larger and more complex — like a rainforest, or a true global village — might yet emerge. "Why do we think it's so hard to weave 6 billion people into one global family when a single human body is made up of more than 100 trillion cells?" she asks. ❖

Editors: where subheads now fall at the top of a column, we would like to leave them in that position if at all possible