Agents Matter and Matter Agents: Interpretation and Value from Cells to Gaia

PHILIP CLAYTON AND ELIZABETH SINGLETON

There is not so much Life as talk of Life, as a general thing. Had we the first intimation of the Definition of Life, the calmest of us would be Lunatics!
—EMILY DICKINSON TO ELIZABETH HOLLAND, 1877, Letter 492

For centuries, treating simple organisms as agents was viewed as sheer human projection. After all, Descartes assured us, animals are mere machines. In these pages we wish to defend the opposite affirmation: *Every participant in the dynamics of Darwinian evolution is an agent with "interests," acting with and through its environment*. That means literally every participant, from the simplest cell to Gaia, the earth's ecosystem as a whole.

What is changed when we consider every living being—from unicellular organisms to humans, and beyond—as perceiving, experiencing, valuing, and valuable agents? We suggest that the argument works best when one develops it simultaneously from both ends of the spectrum. What results is a sort of symmetry, like the famous Whiteheadian symmetries, but in this case a symmetry of part and the whole, of the very small and the very large. Symmetries invite a double movement. One follows them downward or inward, tracing agency all the way back through evolution to the smallest units on which natural selection operates; and one follows them upward or outward, all the way to the biosphere as a whole.

This pervasively agential approach to biology—running from the smallest, simplest unicellular organism to Gaia as a whole, and simultaneously in the other direction as well—spawns a compelling ethic of embodied responsibility. We hope also to show that it transforms standard views of mattering and minding and, as a result, challenges long-held assumptions about science, theology, and their (co-)evolving intertwinings.

AGENCY

Immanuel Kant's commitment to Newtonian principles and to a mechanistic universe ran deep. Thus it is doubly a reflection of his genius that he intuited an agent-based framework for comprehending the nature of life. As Kant wrote in the *Critique of Judgment*,

> An organized being is then not a mere machine, for that has merely moving power, but it possesses in itself formative power of a self-propagating kind which it communicates to its materials though they have it not of themselves; it organizes them, in fact, and this cannot be explained by the mere mechanical faculty of motion.[1]

Consider the humble eukaryotic cell.[2] Cells do self-propagating work. Work, in the most basic sense, means constraining and employing energy for a purpose. A cell captures energy inside its cell wall and employs that energy to carry out processes that sustain the structure and the functioning of the cell—processes, in short, that keep it alive. As cells carry out this complex web of work, constraining and employing energy and doing things with it (such as DNA replication and enzyme synthesis), the astonishing fact is that they attain a kind of closure: Each successful cell eventually builds a viable replica of itself.

Formally speaking, this process of self-closure corresponds closely to the self-propagating organization that Kant identified. Note that the self-propagating organization one finds in cells does not involve matter alone, energy alone, information alone, or entropy alone. It is a process that involves all these factors—and something more, as well. It appears that this self-propagating organization, "communicate[d] to its materials though they have it not of themselves," is a new form of energy-matter organization in the world; it is *living matter*, ontologically emergent. The structural and functional features of the eukaryotic cell meet Kant's requirement for ontological emergence: The whole has causal powers not possessed by the parts. Because the "whole" of the cell is capable of building copies of itself, it is capable of evolution by natural selection. All that's necessary is that mutant variants of the minimal autonomous agent, or real cells such as bacteria, can themselves have heritable variants that are selected for or against in their particular environment.

Volumes have been written on human agency. The majority of the theological tradition shares a crucial assumption in common with the humanist tradition, which it spawned: the assumption that humans stand at the pinnacle of creation. The agency-centered ontology that we offer here turns that assumption on its head. No more can we use human traits as the standard for

moral consideration, measuring the value of all bodies based on their likeness to human bodies or selves. We may well *start* with our own embodied existence; Donna Haraway's recognition that all knowledge is "situated knowledge" leaves us no alternative.[3] All who reflect have a mother language, a first experience of embodied thought. But finding analogous agencies both as we move downward to smaller parts and as we move outward to broader systems quickly decenters our starting point, and thus ourselves. We are, it turns out, neither center nor pinnacle. Would that we could find "new theologians," like Nietzsche's "new philosophers" in *Beyond Good and Evil*,[4] who could think with us part and whole, pan-sacred and pan-profane, in a pan-agential world.

What happens, then, when we begin to understand agency at the ends of the biological spectrum? Ascriptions of agency and purpose represent a standard form of explanation in accounts of human behavior. In this chapter we use those well-established results as a touchstone—and, in part, as a point of contrast—for developing a theory of biological agency. After all, humans regularly offer teleological or "means-ends" explanations in which reasons appear as causes of behavior: She proclaimed the defendant innocent because she was not convinced by the prosecutor's arguments; he repeated his point because did not believe they heard him the first time.[5] If human action, reasons, motives, intents, and purposes do not offer an adequate vocabulary and framework for the attribution of teleological explanations, nothing does. Whatever theoretical stance one takes regarding full-blown human action, it is a stunning fact that the universe has given rise to entities that do, daily, modify the universe to their own ends. Philosophers call this capacity *agency*.

THE FIRST AGENTS

With this touchstone in place, we turn to a new question: What is the minimal natural system to which one might attribute teleological or purposive explanations?

The first systems to which one can meaningfully attribute agency and (some measure of) autonomy are, we suggest, the simplest biochemical molecular systems on which natural selection can operate. Such systems must be able to reproduce themselves. In standard works on the origin of life, this entails (among other things) having a particular kind of membrane that separates "inner" and "outer." The "inner" includes information that codes for building a successor organism. There must also be some perception of the environment, presumably via osmosis through the membrane, so that the organism "knows" when the surrounding chemical solution contains a sufficient quantity of the building blocks needed for its reproduction. When the organism's receptors signal the appropriate conditions, its membrane needs to open or dissolve, so that chemicals can bond with receptor sites (proto-RNA) that were

formerly inside its membrane, in order to make a duplicate of the original informational system. New membranes must then grow around both the original and the copy, so that the original organism now exists as two.[6] (The full story is far more complex and far more fascinating than any brief summary can capture. In particular, there are multiple interesting proposals concerning how a system can evolve these reproductive capacities before it is able actually to reproduce.)

Darwinian natural selection can operate on this simple biochemical system, this proto-organism, only if two conditions are met. First, the copying process can't be perfect;[7] some variance needs to enter into the process of reproduction. Second, the environment needs to select for some copies and against others. The natural result of differential selection is that some variants will increasingly come to dominate a particular environmental niche, whereas others will go extinct. Once this Darwinian process begins, the rest is history—or so biologists believe. The patterns and outcomes of emergent complexity, once launched in unicellular organisms, continue to do their work across the eons of evolution. One need not believe that the process is necessary or pre-designed in order to wonder at the profusion of agents, adaptations, and functions: intercellular communication, organ systems, symbiosis across species, social learning, mental representations—all linked within a single global system, Gaia.[8]

What plausible conjectures can we make about biological agents across evolution? Can we say that they are, in some sense, "agents like us" without an illicit projection of distinctively human attributes onto them?

As noted, even simple agents have an "inner" and an "outer" world. It follows that they are connected to an environment in a way that no mere biochemical solution is. (We return to the implications of this amazing emergent phenomenon in the next section.)

The dynamic within which biological agents exist cannot be explained in purely chemical terms. As living organisms, they exist within webs of competition and cooperation. Only the tools and concepts of biology suffice to account for what it is for them to exist. Pre-biological theories cannot fully explain the natural dynamic that defines the unique type of entities that organisms are.

Put differently, that organisms exist within an all-consuming Darwinian dynamic means that they have interests as no mere chemical compound does. If their membrane opens in an environment containing toxins, the individual dies. Dying is not one of the thousand natural shocks that chemicals are heir to; it's not a property that one can ascribe to any chemical compound as such. By contrast, if one species

releases large amounts of toxins into its environment (or changes the global climate, as one species has now managed to do), the entire system of related organisms can become extinct.

Having interests means that, for organisms, not every outcome is equal. Being bathed in nutrients is good, and being bathed in toxins is bad. Of course, the simpler agents lack the kind of internal feedback system (nerve cells, central nervous system) that would be necessary for them to become consciously aware of, or to consciously feel anything about, these results. "Good" and "bad" are products of the task bequeathed to them by that Darwinian dynamic that defines their existence: to survive and reproduce.

We thus need to use some values language to define their existence. Of course, since simple organisms could not use this language themselves, speaking in this way is in some sense a projection: We are doing the valuing here. But in another sense it's not pure projection. Uranium-238 radiates alpha-particles and decays into uranium-234. This may be good or bad for us, but it doesn't matter to the uranium. By contrast, obtaining food sources and reproducing are part of succeeding for an organism. They matter to it, even when it has no thoughts or feelings about the matter.

Indeed, a second dimension of value emerges with organisms. As complexity increases over evolutionary time, it becomes less and less likely that starting the process over again would yield exactly the same organism. Greater organismic complexity, and increasing dependence on particular ecosystems, produces an ever-greater probability that a second history of random variation and selective retention would not produce the same species over again. The extinction of a species is (with a high level of probability) the definitive end of that particular lineage and its members. Whatever structures, functions, and experience may have characterized these organisms will be permanently lost. They are, in this precise evolutionary sense, unique. Over time, then, the biosphere begins to include a new form of contingency—an emergent form of "possibly not being."

Biodiversity is an instrumental good for humans, since it increases our own odds of survival. But arguably it is also an intrinsic good that the world would contain a rich range of types of beings and experience—at least theologians have traditionally argued in this way. If so, then the permanent loss of unique life-forms and their experience brings with it a loss of value.

LIFE AS SEMIOTIC AGENCY

Biosemiotics offers one of the most powerful tools in theoretical biology for conceiving the meaning of the emergence of life. Jesper Hoffmeyer from the University of Copenhagen provides a cogent presentation of the biosemiotic standpoint:

> Some billions of years ago it happened that a number of daughter cells from a single monocellular organism developed a series of symbiotic relationships with one another and, in time, even entered into a process of shared ontogenetic differentiation—so that there emerged a small multicellular organism, consisting of cells with connected life histories but with differentiated roles in their newly collaborative mode of being. These cells having reached this state, it would no longer be sufficient for us as scientists to describe the activity of each single constituent cell in isolation. Rather, one would hereafter have to consider the presence of a new holistically autonomous actor, an interpreter—or a system of interpretants as Stanley Salthe (1993) has formulated it—that is able to organize the semiotic life processes of negotiating an external environment for the benefit of the collective, and at the expense of the interests of single cells. Thus, in a certain sense, the appearance of a multicellular organism might be seen as the appearance of a new kind of causality in the natural world, i.e., a formal causality, as suggested in the Aristotelian scheme.[9]

We might want to quibble that what Hoffmeyer describes is not only formal but also final causality in Aristotle's sense. Still, the concept of biosemiotics is compelling, and the rapid growth of this field has in our view been fruitful for biology. For biosemioticians, an organism is an entity with interests, a "holistically autonomous actor." It interprets its environment in light of those interests, and as it does so events in its environment become signs for it. The classic features of semiotics emerge: signs, interpreters, interpretations, and interpreted phenomena. Indeed, if one accepts that semiotic relations are the basis of knowledge, it follows that all organisms know (in some extended sense of "know").

What is powerful about the biosemiotic approach is that it introduces a robust notion of (teleological) agency *without needing to appeal to an anti-naturalistic or dualistic metaphysics*. A new dynamic is manifest in the natural world, one that evidences final causation. By contrast, it's not clear that introducing mental substances—a move completely anathema to modern science—is philosophically sufficient to explain the qualities of agency.

For the biosemiotic thinkers, a unicellular organism is already a unit of meaning, interpretation, and purpose.[10] In Darwinian terms, its purpose is to survive and reproduce, and actions that help bring about this purpose can be called purposive actions. This starting point, biosemioticians argue, is sufficient to provide all living organisms with a "for-the-sake-of" structure. Stuart Kauffman describes organisms' interests in humorous terms: Every organism is "out to make a living" in its world.[11] With interests and goals come values for the organism itself, long before the emergence of consciousness.

When a single-celled organism spins its flagellum in order to move up a glucose gradient and obtain more nourishment, it interprets the higher glucose concentration as a good and acts in order to ingest more of it. Of course, the interpreting here proceeds solely at the chemical level, through osmosis and chemical bonding to the external cell membrane; we have no evidence of thoughts, mental attitudes, feelings, or other subjective experience. Still, the three basic elements of interpretation ("semiosis") are already present: There is an interpreter; there is a state of affairs being interpreted as a sign; and there is an interpretation (in this case, the movement of the organism toward nourishment). If semiosis is knowledge, then there is knowledge. And there are also consequences: If the organism misinterprets a toxin as nourishment and moves toward it, it will die.

In a sense, it doesn't really matter whether one calls these actions "real interpretations" or merely "proto-interpretations"; the broader point still remains. A continuum, a similarity-in-difference, runs from the simple interpretations that unicellular organisms make when they respond to their environment, all the way through to the multidimensional interpretations that primates and other complex animals form as they creatively vary their behavior in response to new stimuli. Step by step, the interpretations become more complex, more multifaceted, and more comprehensive as they respond to, and thereby help create, ever-more-complex eco-contexts for action.

According to the emerging systems perspective that we defend, the program of biology is to reconstruct the ever-growing complexity of organisms, structures, and behaviors as one moves along the continuum of complexity from the simplest organisms to the most complex ones. One will expect to find analogs to many human functions in more simple organisms. Simple organisms perceive their environment, though without eyes; they know or are aware of features of their surroundings, though without conscious awareness. They act to fulfill goals, though without forming conscious intentions. In short, they are interpretive agents, agents of interpretation—which makes life a sort of hermeneutical agency. In some contexts biologists emphasize the continuities across multiple regions of the spectrum of complexity, and at other times they emphasize the discontinuities.

INDIVIDUAL AND COMMUNITY, PART AND WHOLE

The biosphere was packed with living, interpreting systems well before human beings came onto the stage. These agents possess many of the properties that one sees manifested today in "higher" organisms, albeit in less developed forms.

Multicellular organisms are communities *cum* individuals—a community that has become an agent, a center and locus of action. Biosemioticians believe (rightly, in our view) that explaining the dynamics of individual organisms requires a threefold framework of sign, interpreter ("interpretant"), and interpretation. This framework, which semiotics draws from Charles Sanders Peirce, introduces the concepts of meaning and reference, and by implication value, all the way across the biosphere. Without these three concepts, we have argued, one cannot understand the evolution of life.

Note that the semiotic framework comes in more and less constricting forms. A deflationary approach, for example, is taken by Terrence Deacon in *Incomplete Nature*. Here semiotics functions to *limit* the kind of ontologies that may be introduced. Deacon insists that there are only three qualitatively distinct kinds of dynamics in the natural world: homeodynamics, morphodynamics, and teleodynamics.[12] Once goal-directed dynamics arise (which for Deacon occurs even before the first self-reproducing cell), all further developments of agents are only variations on this one theme. By contrast, we see no reason to exclude further qualitative developments. Social learning, animal cultures, mental representations, consciousness—all of these denote new emergent patterns, new forms of agency. Although we are pleased that Deacon has found a home in Buddhist metaphysics, we fear it may also prejudice his theory of agency. Where we perceive an agent-centered ontology—an ever-growing profusion of agencies throughout the biosphere—Deacon sees goal-directed patterns but the absence of agents as such.

Biosemiotic approaches do however share a more integrated understanding of the relationship between parts and wholes. Jesper Hoffmeyer formulates it as well as any other author:

> In most biological models, as well as in everyday folk psychology, the prototype *organism* remains essentially a vertebrate, like ourselves. Vertebrates are always well-integrated, coherent organisms with well-defined forms. They consist of genetically uniform cells and have well-defined life cycles, starting with a single cell and ending in reproduction via the transmission of germ cells. However, by far most organisms of this world are *not* vertebrates—and most of them do not obey the aforementioned criteria very well.[13]

For most life on this planet, the relationship between an organism, other members of its species, and its ecosystem are far more fluid than is the case for vertebrates with their more bony stabilities. As Elisabet Sahtouris writes, "No being in nature, outside our own species, is ever confronted with" the choice between individual and whole. She adds, "If we consult nature, the reason is obvious. The choice makes no sense, for neither alternative can work. No being in nature can ever be completely independent, although independence calls to every living being, whether it is a cell, a creature, a society, a species, or a whole ecosystem."[14]

In short, an adequate biology views living things as systems, as interconnected processes. This viewpoint clashes deeply with the anthropocentric, and clearly androcentric, view that to be an individual is to be separate from others. It's time to leave that myth behind. New resonances arise; one begins to think instead of Donna Haraway's companion species, Lynn Margulis's host of biotic others, Jane Bennett's animal-vegetable-mineral sonority complex, Karen Barad's agential realism, and other allies.[15] As soon as one begins to hear these harmonies, and the overtones that they produce, the symmetry between the very small and the very large comes into full view, bringing with it some rather revolutionary implications.

GAIA: THE BIOSPHERE-AS-A-WHOLE AS AGENT

As the biosemioticians courageously (and justifiably) extend semiotic agency and interpretation even to the simplest organisms, some theorists are (with equal courage) extending agency all the way outward to the Earth's biosphere as a whole. The "Gaia hypothesis," proposed by James Lovelock and further developed by Lynn Margulis, has exactly this function. On the Lovelock/Margulis hypothesis, the biosphere as a whole is a living entity that regulates itself in specific ways in order to support the continuation of life. If there are regulatory patterns that occur only at the level of the biosphere as a whole and not merely as an aggregate of its parts, as appears to be the case, then Gaia also has features of agency. Analogous to the simple microorganisms that make up most ecosystems, it (she?) too is a whole that is greater than the sum of its parts. Also like other organisms, it makes adjustments and adaptations so that the living parts of which it consists can continue to emerge and flourish.

It is difficult to convey how controversial this suggestion has been. Bruno Latour, for example, describes the responses of friends and colleagues as he was preparing his Gifford Lectures on the Gaia theory.[16] No real biology could make such anthropocentric, eccentric claims, he was told, and no scientist in his or her right mind would be associated with such views. Lynn Margulis, who wrote extensively on the Gaia hypothesis and who was the keynote

speaker at the fourth international conference on Gaia theory in 2006, came under equally sharp attack for her advocacy.

What does it mean to attribute agency to the biosphere as a whole? The Gaia hypothesis leads one to look for features in the biosphere that are analogous to the qualities of other organisms. Each organism is a system of living systems; so too is the biosphere itself. One thus finds emergent properties in the web of life that are beyond human control, just as one finds value in this self-regulating living system of living systems that is not merely derived from its parts. Lovelock explains Gaia with scientifically infused wonderment:

> The entire range of living matter on Earth, from whales to viruses, and from oaks to algae, could be regarded as constituting a single living entity, capable of manipulating the Earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts.[17]

Of the various features of Gaia theory that have caused Lovelock and Margulis to be shunned by much of the scientific community, none has been more derided than the teleological suggestions implicit in the theory. Affirming that the earth-system has agency requires a broader definition of agency than most scientists have so far accepted, one that includes responsiveness of a system to changes within itself and its environment. On this definition, a living organism is a system of systems that function together, creating a new emergent system that manifests agency. Emergent agents are engaged with, even parts of, other systems. But their causal role in such interactions is as more than an aggregate of their parts or subsystems; they become actors in their own right.

Gaia theories range from cautious to bold. The most cautious introduce Gaia as pure metaphor; they speak of the biosphere *as if* it were the anthropomorphic Greek goddess in order to encourage more responsible environmental policies and lifestyles. Lovelock did affirm that homeostasis occurs at the level of the biosphere as a whole (the *biota*). On our view, this criterion is enough to constitute Gaia as agent and (if all agents are inherently valuable) as a locus of intrinsic value.

Lovelock became (regressively) less bold over time, however. In the end, he pulled back from his early claim that Gaia acts intentionally or with purpose, denying for example that "planetary self-regulation is purposeful, or involves foresight or planning by the biota."[18] Lovelock's retreat was not necessary, however. Homeostasis is goal-directed, whether or not it is consciously planned and maintained. As we have maximized value by extending it to the smallest biological agents, value should be maximized as one moves outward

to the largest system that manifests agential action. Gaia's homeostasis plays a crucial role in maintaining an earth environment that is favorable for life.

If agency does indeed extend outward to the biosphere as a whole, then we are also responsible to the embodied whole of life. To allow this responsibility to resonate more fully with human intuitions about moral obligation, we prefer to speak of the earth's biosphere as a whole not as "it" but as "she": Gaia.[19] We are interlocked and interdependent within her single web of life. Although we have the ability to do unspeakable harm to the systems of which she is composed, we are also able to contribute in more positive ways, helping the systems function smoothly and organically.

To consider the biosphere as an interpreting agent is to view ourselves and all other living agents within the biosphere as, together, parts of a larger living entity. As we know, human agents have the ability to cause malfunctions within this system. In their much-cited 1982 paper in *Science*, Jack Sepkoski and David Raup identified five mass extinctions,[20] and scientists are increasingly concluding that we are now in the midst of the sixth extinction, this one however, unlike the previous ones, caused by human activities.[21]

The most obvious implications of the Gaia hypothesis are that we are not responsible only to isolated individuals (or to those species we find either useful or cute), but also to that communion of bodies that together make up the system of all living things, and that we must find a way to live among and within this living system of life. Elisabet Sahtouris, in her book *EarthDance: Living Systems in Evolution*, writes that "it is one thing to be careful with our environment so it will last and remain benign; it is quite another to know deeply that our environment, like ourselves, is part of a living planet."[22] If the earth's biosphere itself is a living system with agency, our moral responsibility is not to the earth as lifeless manner, but to Gaia herself and to all the specific living systems and environments that constitute and sustain her.

On the one hand, agency that extends to living systems as a whole means that we should be fearful because we cannot control or predict Gaia's response to the mess we have made.[23] The earth possesses emergent properties that are unpredictable. On the other hand, it also means that we should be hopeful *because* we cannot control or predict the response of the earth to the mess we have made. There is hope beyond human hands and possibilities beyond human imagination as Gaia interprets and responds to the changes inside of her. After every disaster life has flourished in a new way, growing differently and more complex—creating systems within systems that have agency and express a will to life by responding to their contexts in ways that express the creativity of living agents.

When combined with the affirmation of the agency of all living things, this approach means that agents are not valued only in and of themselves.

Agents are also valued as participants in the entire system of life, which is held together by networks of bodies and objects. As Sahtouris writes, "No being in nature can ever be completely independent, although independence calls to every living being, whether it is a cell, a creature, a society, a species, or a whole ecosystem."[24] Gaia thrives when conscious, powerful agents like us limit our consumption for the sake of the whole (kenosis) and when we foster the unique contributions of those agents whose existence is more precarious than our own.

To recognize that Gaia exercises her own agency requires a balance between valuing individuals and valuing collectives. All of us living things depend on this balance; every organism depends on its ecosystem, and every ecosystem on its organisms. Also, every organism is itself a network, dependent on the proper functioning of its parts (as cancer so painfully reminds us). This interdependence is even more dramatically true of Gaia. Drought in Africa is not drought for Asian farmers, and the cancer in your friend's body is not cancer in yours. But all droughts and all cancers are internal to Gaia. Her network encompasses them all; her body includes them all; her fate hangs in the balance in each case. Once we begin ascribing agency to networks, we recognize the drastic implications that follow for the way we conceive of morality and relationships, as well as for the way we understand the living agents among whom we live.

To consider the network of life as a whole as perceiving, aware, valuing, and valuable suggests that there is a larger teleology for life that extends beyond, but may be inclusive of, human flourishing. As Lynn Margulis and Dorian Sagan write, "A biological system acting cybernetically gives the impression of teleology. If only the results and not the feedback process were stated, it would look as if the organisms had conspired to ensure their own survival."[25] We argue that they not only give "the impression of" teleology; they *really are* teleological. Each of us is an agent among agents, in interfolding networks that join together and manifest Gaia, the largest living agent, in whom we live and move and have our being.

To endorse the Gaia hypothesis is to step clearly beyond inherited notions of agency. Elisabet Sahtouris formulates these implications most clearly:

> For now what matters is to understand this new way of seeing that all evolution—of the great cosmos and of our own planet within it—is an endless dance of wholes that separate themselves into parts and parts that join into mutually consistent new wholes. We can see it as a repeating, sequentially spiraling pattern: unity → individuation → tension/conflict → negotiation → resolution → cooperation → new levels of unity, and so on.[26]

Sahtouris argues that we continue to miss the clues about the nature of biological organisms because "we have not understood ourselves as living beings within a larger being, in the same sense that our cells are part of each of us."[27] The Cartesian myth, beholden to its strict Cartesian coordinates and to the Western legacy of dualism, has no place for the universal arising of all things from each other (*Pratītya-samutpāda*) of Buddhist thought, no place for the interdependent existence of part and whole, certainly no place for the embedded/embodied spiritualities of indigenous traditions. Only when one abandons the idea of unique soul-substances, each a "thinking thing" (*res cogitans*) with "his" own independent identity—as well as the God created in "his" image—can one begin to take on board the lessons that contemporary biology is teaching.

IMPLICATIONS OF THE PAN-AGENCY VIEW

This chapter plays but a small role in a larger (eco-)collection. The volume of which it is a part, taken as a whole, offers multiple ways of conceiving the natural world beyond the dualisms of matter versus mind, value-laden versus value-free, independent part versus all-encompassing whole. One can only hope that each succeeding generation will find these ideas easier to grasp, more congenial—more, well, natural.

Because what must occur is nothing less than a shift of worldview, and because science will need to play a major role in bringing about this shift, we have considered the entire spectrum of life from the very small to the very large. In a more lengthy presentation, one could explore specific features of interpreting, valuing agency at more of these individual levels—from the earliest unicellular organisms, the first participants in the Darwinian dynamics of natural selection, to microbiomes, to broad ecosystems, and finally to the entire system of life as we know it, the Earth's biosphere.

We have paid special attention to the origins of life in this chapter because the realm of the very small has so often been used as the reason for reducing life to nonlife. Atoms, molecules, the equations of biochemistry, genetics, proteomics—these building blocks are often presented as the antithesis to organisms, agents, and a life-centered perspective. We have suggested that the opposite conclusion follows. As Stephan Harding writes,

> Thus the great archetypes of Gaia and *anima mundi* that figure so importantly in the human soul could well be prefigured in some mysterious way not in some abstract realm far from this world, but in the very molecules and atoms that constitute our palpable, sensing bodies.[28]

In this age of systems biology and ecosystems theory, microbiology need no longer stand in opposition to Gaia. Biologists are only beginning to formu-

late the common principles that hold for all living, interdependent systems. We believe that the data and the experiments will eventually settle the matter on the side of agents. Or, to use the verbal form, what biology teaches us is that matter "agents." Conversely, since agents respond in material ways, we can again use the verbal construction: Agents "matter." In the spirit of that core principle of constructive science-religion dialogue, "creative mutual interaction," these two short phrases together offer a sketch of what we believe will eventually be the complete picture of the Earth's biosphere and the organisms that dwell therein.

Nor is this a matter of abstract academic dialogue and specialized disputation. This biology-inspired worldview supports an ecological way of being in the world. In *The Universe Story*, Brian Swimme and Thomas Berry make it the rallying cry of what they call the emerging Ecozoic Age.[29] Should humanity fail to live its way into an organic worldview, it is in our view unlikely that humans will find sufficient motivation to limit their consumption and change their lifestyles (and political systems) soon enough, and extensively enough, to avoid catastrophic environmental—and thus also social and economic—consequences. In the end, Gaia really does have the last word.

Western thinkers are only in the early stages of learning to think in the context of pervasive interdwelling systems, processes, and values. Non-Western cultures are millennia ahead of us in this regard: indigenous cultures and lifeways, India's *advaita Vedanta*, the Jain call to do no harm (*ahimsa*) to any living being, and the wealth of cultures nourished on the Buddhist teachings of Dependent Arising and interbeing. Indeed, the whole dispute between Gaia's advocates and their opponents could be reread as a battle between the worldview or "metaphysic" of interbeing and that of independent or substantial being.

As Gaia brings discomfort to a traditional model of biology, she brings equal discomfort to traditional theologies. Gaia's lifeworld entails a thought-world long forgotten, even repressed, in the intellectual categories that dominated paradigmatic Western philosophy and theology. Dead matter, isolated atoms, freestanding substances, and controlling empires offer little help in comprehending the interdependent world of Gaia and her indwelling systems. Any theology that would render support and nurture to a Gaian world must learn to cultivate concepts such as participation, immanence, panentheism, reciprocity, and mutual indwelling. As the distance between sacred naturalism and fully immanent theism grows smaller, the old dichotomies disappear.

An agent-centered biology invites theologians into an ancient-future space of reflection. There is no reason why God, having shed "his" imperialistic trappings, cannot be invited back into this space of agential-life-lived-together—the space of *conviviality*, as other authors in this collection have named it.

Clearly, the Whitehead-inspired process theologies belong in this space, since they affirm a noncoercive divine lure that is equally operative on every agent, whatever his or her level of complexity. Process theologians have generally not included Gaia among the "actual occasions" worthy of lure; we hope we have helped to rectify that wrong.

More generally, this chapter invites a teeming profusion of green theologies, corresponding to the manifold ways that the immanent Divine may be conceived as luring, tugging, and binding the whole range of interlocking biological agents. Theologians are only beginning to set aside the anthropocentrism of the Hebrew and Greek cultures and describe an entire biosphere awash in divine presence at every level. If the co-participation of divine and finite agency is possible at the human level,[30] imagine the profusion of interagency when participation is extended across the entire spectrum, from cells to Gaia! Here, truly, is *perichoresis* (mutual indwelling), now extended beyond the intradivine persons to the interdivine entangling of divine and finite agencies.

At the very end of *On the Origin of Species* Darwin asks us "to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth." We have yet to see a generation of theologians courageous enough to imagine God as truly filling and being at home in this entangled space, so that the interests of the myriad entangled agents are truly present within the divine—a theology of Supreme Entanglement. But we are drawing closer.

It is fitting that we should conclude with the words of Lynn Margulis. Her work and life symbolized the push beyond acceptable boundaries: Well-funded for her work on symbiosis, she was later blacklisted in scientific circles for her advocacy of symbiogenesis and the Gaia hypothesis. In the midst of this shunning she called for biologists and others "really to listen to the rest of life," since "as just one melody in the living Opera we are repetitious and persistent."[31]

We predict that the empirical evidence will eventually catch up with her conception. In the meantime, we offer it as a vision of what we believe is the road that lies ahead:

> We may think ourselves creative and original but in those talents we are not alone. Admit it or not, we are only a single theme of the orchestrated life-form. With its glorious nonhuman past and its uncertain but provocative future, this life, our life, is embedded now, as it always has been, in the rest of Earth's sentient symphony. . . . Life is open to the universe and to itself.[32]

NOTES

Although the entire article counts as coauthored, Elizabeth Singleton receives primary authorial credit for the final two sections of the paper. Both authors thank Catherine Keller and Mary-Jane Rubenstein for their extensive comments and suggestions for improvement. We have treated their many interpolations with the seriousness they deserved, viz., by incorporating as many as we could into the published version of the chapter. (The chapter thus performs its thesis: Truly, no author is an island.)

1. Immanuel Kant, *Critique of Judgment* (1987), 221.
2. We draw here from Stuart Kauffman and Philip Clayton, "On Emergence, Agency, and Organization," *Philosophy and Biology* 21, no. 4 (2006): 501–21.
3. Donna Haraway, "Situated Knowledges: The Science Question in Feminism as a Site of Discourse on the Privilege of Partial Perspective," *Feminist Studies* 14, no. 3 (1988): 575–99.
4. Friedrich Wilhelm Nietzsche, *Beyond Good and Evil: Prelude to a Philosophy of the Future*, trans. and ed. Marion Faber (Oxford: Oxford University Press, 1998), paragraphs 42–44.
5. See Georg Henrik von Wright, *Explanation and Understanding* (Ithaca, N.Y.: Cornell University Press, 1971); Roderick M. Chisholm, *Person and Object: A Metaphysical Study* (London: G. Allen & Unwin, 1976); Timothy O'Connor, "Dualist and Agent-Causal Theories," in *Oxford Handbook on Free Will*, ed. Robert Kane (Oxford: Oxford University Press, 2001), 337–55.
6. David W. Deamer, *First Life: Discovering the Connections between Stars, Cells, and How Life Began* (Berkeley: University of California Press, 2011); Steen Rasmussen et al., eds., *Protocells: Bridging Nonliving and Living Matter* (Cambridge, Mass.: MIT Press, 2009).
7. The imperfection of all copies/repetitions is of course a major poststructuralist trope, perhaps most powerfully expressed in Derrida's "Différance" article, published in *Théorie d'ensemble* (Paris: Editions Seuil, 1968); see also Jacques Derrida, *Writing and Difference* (Chicago: University of Chicago Press, 1978). Note the resonance with Deleuze's concept of repetition as the habitation of difference in Gilles Deleuze, *Difference and Repetition*, trans. Paul Patton (New York: Columbia University Press, 1994).
8. Philip Clayton, *In Quest of Freedom: The Emergence of Spirit in the Natural World* (Göttingen: Vandenhoeck & Ruprecht, 2009), esp. chaps. 2–3.
9. Jesper Hoffmeyer, *The Semiotics of Nature: An Examination into the Signs of Life and the Life of Signs* (Scranton, Pa.: University of Scranton Press, 2008), 98. Mentioned in the quotation is Stanley N. Salthe, *Development and Evolution: Complexity and Change in Biology* (Cambridge, Mass.: MIT Press, 1993).
10. See Jesper Hoffmeyer, *Legacy for Living Systems* (New York: Springer, 2010).
11. Stuart Kauffman, *Investigations* (Oxford: Oxford University Press, 2000), and *At Home in the Universe* (New York: Oxford University Press, 1995).
12. Terrence W. Deacon, *Incomplete Nature: How Mind Emerged from Matter* (New York: W.W. Norton, 2012).

13. Hoffmeyer, *Semiotics of Nature*, 98.
14. Elisabet Sahtouris, *EarthDance: Living Systems in Evolution* (Lincoln, Neb.: iUniversity Press, 2000), 12.
15. Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm, 2003); Lynn Margulis, *Symbiotic Planet: A New Look at Evolution* (New York: Basic Books, 1998); Lynn Margulis, ed., *Symbiogenesis: A New Principle of Evolution* (Cambridge, Mass.: Harvard University Press, 2010); Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, N.C.: Duke University Press, 2010); Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, N.C.: Duke University Press, 2007).
16. Bruno Latour, *Facing Gaia: Six Lectures on the Political Theology of Nature*, Gifford Lectures 2012–13 (forthcoming). A draft version of the lectures was for a time available on the internet. A video of the lectures is still available at http://www.bruno-latour.fr/node/487, accessed February 15, 2015.
17. James Lovelock, *Gaia : A New Look at Life on Earth* (Oxford: Oxford University Press, 1987), 9.
18. J. E. Lovelock, "Hands Up for the Gaia Hypothesis," *Nature* 344, no. 6262 (1990): 100–102.
19. We regret that humans seem able to conceive the neutral gender only in mechanistic, nonagential ways, rather than organically. It is not in principle necessary to gender an entity in order to make it alive; asexual reproduction is widespread across the biosphere (e.g., bacteria).
20. D. Raup and J. Sepkoski Jr., "Mass Extinctions in the Marine Fossil Record," *Science* 215, no. 4539 (1982): 1501–3.
21. Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (New York: Henry Holt, 2014); see also "The Sixth Great Extinction: A Silent Extermination," *National Geographic*, March 28, 2012, online at http://voices.nationalgeographic.com/2012/03/28/the-sixth-great-extinction-a-silent-extermination/, accessed January 12, 2015.
22. Sahtouris, *EarthDance*, 4.
23. However, we can make predictions based on what we do know of Gaia. Those predictions, unfortunately, suggest a tumultuous future for life as we know it in Gaia.
24. Sahtouris, *EarthDance*, 12.
25. Lynn Margulis and Dorion Sagan, *Dazzle Gradually : Reflections on the Nature of Nature* (White River Junction, Vt.: Chelsea Green, 2007), 177.
26. Sahtouris, *EarthDance*, 24. Extensive empirical data could be cited in support of the Gaia model. For example, Jason Major writes that "researchers at the University of Maryland have discovered a way to identify and track sulfuric compounds in Earth's marine environment, opening a path to either refute or support a decades-old hypothesis that our planet can be compared to a singular, self-regulating, living organism—a.k.a. the Gaia theory." (See http://www.universetoday.com/95183/is-earth-alive-scientists-seek-sulfur-for-an-answer/#ixzz2w5ITpLVJ, accessed March 8, 2014.)
27. Sahtouris, *EarthDance*, 2.

28. Stephan Harding, *Animate Earth: Science, Intuition and Gaia* (White River Junction, Vt.: Chelsea Green, 2006), 88.
29. Brian Swimme and Thomas Berry, *The Universe Story* (San Francisco: Harper-SanFrancisco, 1992).
30. For a recent defense of this model, see Philip Clayton and Steven Knapp, *The Predicament of Belief: Science, Philosophy, Faith* (Oxford: Oxford University Press, 2009).
31. Lynn Margulis and Dorion Sagan, *What Is Life?* (Berkeley: University of California Press, 1995), 246.
32. Ibid.