Ethics and Science: Moral Consideration

In 1972 an essay titled "Should Trees Have Standing?—Towards Legal Rights for Natural Objects" triggered a fierce debate among lawyers and philosophers about ascribing moral consideration to nature.[1] It has long been accepted in ethics and law that standing[2] (and thus moral consideration) is given only to persons and their institutions.[3] In the reasoning of deontological ethics, humans have direct duties only to one another. From this perspective, a duty to care for a forest is really a duty to another person not to harm her property or a duty to all other citizens not to damage public land, including the trees on it. Similarly, the natural law tradition of teleological ethics limits our moral community to humans by reasoning that the natural world exists for the purpose of human happiness.[4]

The consequential approach to ethics known as utilitarianism allows an alternative view. In *Introduction to the Principles of Morals and Legislation* (1789), Jeremy Bentham defines happiness as pleasure (and the absence of pain) and argues that animal suffering should be considered in predicting what actions will yield the most pleasure.[5] A leading contemporary utilitarian, Peter Singer, also includes sentient animals in our moral community.

Chapter 1 argued that reasoning evolved from the social experience of primates, and in this chapter we learn that the self-organizing nature of organisms and ecosystems has parallels with human autonomy. As rationality and autonomy are grounds in traditional ethics for limiting moral consideration to humans, might these new scientific insights prompt us to revise our ethical presumptions and embrace duties directly to (or for) nonhuman animals and ecosystems? Might current science also support redefining the consequential standard of happiness, extending our moral community to include animals that suffer as well as the integrity of forests and other ecosystems?

To address these questions, we first assess how current science limits as well as expands our knowledge. Then we consider how our understanding of evolution and ecology is relevant for environmental ethics.

What We Know and Can't Know

"It is often claimed that science stands mute on questions of values: that science can help us to achieve what we value once our priorities are fixed, but can play no role in fixing these weightings. That claim is certainly incorrect. Science plays a key role in these matters. For what we value depends on what we believe, and what we believe is strongly influenced by science."[6]

What we believe about the world depends on what we know, and the most recent studies in science reveal the limits of our ability to perceive reality as it is.

Sense-Making

Biologists now verify that *our brains construct our perceptions.* Our neurological system does not simply record data. Perception is a process of active construction, not passive absorption.[7] The human brain has complex feedback systems that filter and interpret sensory experience, and these systems are affected by our experience. Our understanding of reality is constructed by our expectations and beliefs, based on all our past experiences, which are held in the cortex as predictive memory.[8]

These facts change our view of what we call knowledge in at least two ways. First, these internal structures select and value sensory input that is consistent with them, creating an exaggerated sense of agreement between the internal and external worlds. Second, this results in their limiting further changes in brain structure by environmental input.[9] Every observation involves some "initial predisposition to notice some things rather than others."[10] Our worldview is always *our* worldview.

Physicists now confirm that our perception is limited*.* The theory of quantum mechanics holds that we create what we experience by selecting from among the many possibilities that may be made actual. "The observer does not create what is not potentially there, but does participate in the extraction from the mass of existing potentialities individual items that have interest and meaning to the perceiving self."[11]

Furthermore, quantum mechanics has verified experimentally that we live in a *nonlocal universe.* We are unable to understand the total reality of a particular event, because the entire universe is entangled.[12] Whatever we know, we know only from within the entangled relationships that constitute our sense of reality. Yet these entangled relationships also transcend our "local" knowing.[13] Thus our observations cannot fully disclose reality, because perceiving one aspect of what is happening hides complementary aspects that we might otherwise see.[14]

In short, the division between mind and world, which defines classical physics and much of philosophy based on a Newtonian view of the world, is inconsistent with current science. "When nonlocality is factored into our understanding of the relationship between parts and wholes in physics and biology, then mind, or human consciousness, must be viewed as an emergent phenomenon in a seamlessly interconnected whole called the cosmos."[15]

This scientific view of the limitations of our understanding does not deny the existence of a real physical world, but rather rejects an objectivist conception of our relation to it. The world is not detachable from our conceptual frameworks. It appears in all the describable ways it does because of the structure of our subjectivity and our intentional activities.[16]

These scientific insights have three critical implications for ethics. First, we must take into account the effect of our consciousness on what we observe and describe.[17] The "transition from the 'possible' to the 'actual' takes place during the act of observation."[18] If we address environmental issues from within the environment, which is our habitat, we see that *we are the environmental crisis.*

Second, because we shape what we know, our responsibility in making ethical decisions is crucial. "Living is a process of sense-making, of bringing forth significance and value."[19] Our knowledge may be limited, but acting on our knowledge makes sense of both the world and our lives. Therefore, *we are the only solution to the environmental crisis.*

Third, the dichotomy in traditional ethics between humans (as rational and autonomous beings) and other living organisms must now be understood as a way of seeing the world, not simply as the way life is. Each ethical pattern of thought actualizes some of the potentialities of life, but obscures other possible ways of seeing the world.[20]

Science confirms that moral consideration is a human decision. Traditional ethics has limited the moral community to humans and their institutions. On the basis of current science, however, we may decide that it is rational to ascribe moral consideration to organisms, species, and ecosystems. *We are responsible for realizing the moral potentiality of nature.*

In the next section we see that these implications are supported by recent arguments modifying the theory of evolution and by research in ecology. Like every form of human knowledge, scientific reasoning is dynamic. We are responsible now for discerning how to apply recent scientific conclusions to our environmental crisis.[21]

An Evolving Theory of Evolution

When Charles Darwin described evolution as the result of "natural selection," he was drawing an analogy to the breeding of animals. It was well known that breeding stock with certain traits led to changes in a species. Darwin's hypothesis was that changes also occur spontaneously in nature, and that changes contributing to the survival of an organism in its environment are more likely passed on to the next generation.

Darwin proposed that natural selection might account not only for changes within a species, but also for the evolution of diverse species. Thus, the word *selection* had a different meaning for Darwin than for animal breeders; they select animals for breeding with the purpose of improving a trait. Darwin conceived of natural selection as a *natural process* involving random changes that over time make species more fit to survive in their environment.

Fit for an Environment

Many organisms in an environment are predatory. Herbivores eat plants, and carnivores eat herbivores and smaller carnivores. This obvious fact and Darwin's theory about why the more fit survive in nature were used as evidence to support a political and economic theory known as Social Darwinism. The moral philosopher Herbert Spencer was the first to characterize natural selection as "the survival of the fittest."[22] The phrase was used to rationalize the success of the rich and the suffering of the poor, without challenging the economic and political injustice that at least partly explains this disparity.

Many scientists now reject the notion that evolution is all about combat and instead see predation as a process of *coevolution*. The predator and prey or parasite and host require coevolution in which both flourish, because the health of the predator or parasite depends on the continuing existence and welfare of the prey or host.[23]

For example, parasitic wasps lay their eggs in caterpillars, and after these eggs hatch in a caterpillar, the larvae feed on it. The wasps find the caterpillars by following the scent of a chemical, which is present in the caterpillar feces but is also secreted by the plant when caterpillars feed on it. Together, parasitic wasps and the plants that caterpillars feed on have evolved a relationship enabling all three species to survive.[24] Relationships such as these involve complex patterns of fitness for an environment.[25]

Social Darwinism nonetheless continues to cast a shadow over environmental ethics. We find this thinking, for example, in the "lifeboat ethics" that makes an ecological argument "against helping the poor."[26] Clearly there are dangers in drawing ethical inferences from scientific theories. We should keep this in mind as we consider how genetics has led to a revision of the Darwinian theory of evolution, known as the neo-Darwinian synthesis.

Genetic Environment

Darwin proposed the theory of natural selection before scientists were able to confirm the existence and role of genes. Now the scientific discipline of genetics explains how the traits of an organism are transmitted to subsequent generations and also how changes may occur among genes that will affect the traits of an organism. It is important, however, to emphasize that genes do not act on their own, but within the totality of the hereditary information of an organism (its genome).

"How, when and to what extent any gene is expressed—that is, how its sequence is translated into a functioning protein—depends on signals from the cell in which it is embedded. As this cell is itself at any one time in receipt of and responding to signals, not just from a single gene, but from many others which are simultaneously switched on or off, the expression of any single gene is influenced by what is happening in the whole of the rest of the genome."[27]

That is, a gene does not simply produce a trait. Genes are part of a process that constructs proteins, which depend not only on the amino-acid sequence dictated by a gene, but also on the environment; the presence of water, ions, and other small molecules; and acidity or alkalinity.[28] Genes contain information about development, but the expression of genetic information depends on the environment.

The environment for individual gene-sized sequences of DNA is made up of the rest of the genome and the cellular machinery in which it is embedded. The environment for the cell is the buffered milieu in which it floats. For the organism, the environment is the external physical, living, and social worlds. Thus the features of the external world that make up the environment differ from species to species; "every organism thus has an environment tailored to its needs."[29] Organisms affect both their environment and their genomes. More precisely, their activity affects the environment; therefore the environment that selects among phenotypes that will survive and reproduce is partly the result of those organisms' activity.[30]

The story of the Codlin moth provides an example of organisms altering their own evolution. This pest for apple growers, because it lays its eggs on apples, for some unknown reason began laying its eggs on walnuts. In less than a century, these moths genetically evolved into a distinct species. The genetic change did not cause a new behavior change, but rather was its result.[31]

The active *engagement of organisms and genes with their environments* makes a summary like "the survival of the fittest" too simple. Also, it is misleading to assert, as biologist Richard Dawkins does, that: "We [humans] are survival machines—robot vehicles blindly programmed to preserve the selfish molecules known as genes."[32] The word *selfish*, expressing an analogy to caring only about oneself, does not reflect the process by which genes are expressed through interactions in the environment of a cell, which occur within the environment of the organism as the organism interacts with it.

Biologist Steven Rose finds it unfortunate that economic and political influences, "which shape our metaphors, constrain our analogies and provide the foundations for our theories and hypothesis-making" support "biology's currently dominant reductionist mode of thinking."[33] Biologist Francisco J. Ayala is much less critical of reductionist thinking in biological research, but states emphatically: "Human beings are not gene machines."[34]

Learning

The claim that humans are "blindly programmed" is also overreaching, because there is ample evidence that all kinds of organisms, as well as humans, learn to change themselves and their environment. Animals learn because the same genes that respond to signals from within also respond to an organism's experience in the environment. Animals can learn because they can alter their nervous systems based on external experience. They can do that because *experience can modify the expression of genes.*[35]

Most animals not only are able to perceive and act, but can learn from their experience and change their behavior. For instance, bees are “prewired” to orient by the sun’s position on the horizon, but also learn the sun’s trajectory at ‘their specific latitude at a particular time of year.[36] Bees also communicate what they have learned. They “dance” in the hive to indicate to other bees where pollen is to be found and, after locating new sites suitable for nesting, refrain from communicating in the hive the direction of a new site until the bees “agree” which potential site is best.[37]

Among some chimpanzees, older chimps teach youngsters how to forage for food by using a stick to draw termites out of their nest. In other communities, adult chimps use stones to crack nuts while younger chimps watch. Because not all chimps do these things, we know that these traits are not caused by genes. Diverse *phenotypes* (chimps using sticks, chimps using stones, and chimps using neither) are expressed by one *genotype* (chimpanzee). These various behaviors are taught and learned, which is what we mean by *culture.*[38]

Brain Plasticity

In humans and other mammals, changes in the brain take place as an organism responds to changing environments. This making, pruning, and rewiring of neural circuits is called *neuroplasticity.* “[F]rom the earliest stages of development, laying down brain circuits is an active rather than a passive process, directed by the interaction between experience and the environment.”[39] The development process in the young organism does not assign every synapse to a task that is fixed, but leaves open the possibility of ongoing adjustments in the adult.[40] *Our experience changes our brains.*

Until recently scientists thought that aging brought an end to neuroplasticity, but research has verified that the brain is always adapting. This is necessarily so, because of the size of the genetic code. “The human brain is estimated to contain about 10^{12} neurons and roughly 10^{15} synapses, but human chromosomes contain about 10^{5} genes. Even if these estimates are off by one or two orders of magnitude, one can see that the instructions for wiring together the brain must be quite general in character. There is simply not enough information in the genetic code to specify in advance every synaptic connection, let alone the finer details of neuron geometry.”[41]

As a biological process, neuroplasticity is constrained by an organism’s genetic expression and natural development, but humans have an extraordinary capacity to recover from brain injury. The adult brain can grow new neurons and repair damaged regions, as well as reprogram areas of the brain for new tasks that enable us to remember, think, and dream.[42]

Changes in our brains are largely the result of what we do and experience in the outside world. The structure of our brain—the size of different regions, the strength of connections between areas—reflects the lives we have led.[43] Simply exercising enhances brain function by stimulating neural connections. In addition, exercise increases levels of serotonin, norepinephrine, and dopamine, which are important neurotransmitters in thoughts and emotions.[44] *Doing changes our thinking.*

We can also change our brains in significant ways by *focusing our attention* on the changes we want to make. “Paying attention matters. It matters not only for the size of the brain's representation of this or that part of the body's surface, of this or that muscle. It matters for the dynamic structure of the very circuits of the brain and for the brain's ability to remake itself."[45]

For a pianist, just thinking about playing the piano results in a measurable, physical change in the brain's motor cortex. Patients with depression have, by "thinking differently about the thoughts that threaten to send them back into the abyss of despair . . . dialed up activity in one region of the brain and quieted it in another, reducing their risk of relapse."[46]

Our minds can change our brains! This fact is crucial for doing ethics.

How we understand evolution affects our thinking about ethics, so we need to be clear about what we know from recent science:

- Organisms evolve and change the environment that "selects" them.
- Organisms coevolve as well as eat one another and compete for survival.
- Humans (and many other organisms) learn, communicate, and choose.
- Some animals change their brains by changing their minds.

In natural selection, cooperation and competition are complementary. This is especially clear in predator-prey relationships, because predators have evolved to favor different prey and hunting strategies in specific ecological niches.[47]

Ecosystems and Emergent Properties

Understanding evolution now involves *ecology,* the study of the relationships between and among organisms and their environment, including both nonliving factors and other organisms.[48] Like every scientific discipline, ecology includes diverse explanations. Throughout the twentieth century ecologists debated whether the environment is best represented by organic models that emphasize a dynamic community or by economic models that analyze the whole in terms of its parts.[49]

Recent research has shifted the focus to ecosystems. Analyzing the environment as a living system involves assessing the relationships within the system as well as its emergent properties, which are not reducible to the functions of the parts of an ecosystem. Ecology now concerns the *integrity* of an ecosystem.[50]

Relationships

Many relationships within the environment are mutually beneficial, or *symbiotic*. Fungi in the soil attach to the roots of trees to form structures called mycorrhizae, a relationship that benefits both the trees and the fungi. The trees supply carbohydrates to the fungi, and the fungi increase the ability of the root system to absorb water and minerals. It is estimated that 95 percent of all plants on earth participate in this symbiotic relationship, and some species of trees would not survive without the assistance of fungi.[51]

We find in the environment of cells another important example of symbiosis, which is the result of *coevolution*. The scientific consensus now is that mitochondria—specialized structures that convert carbohydrates, fats, and proteins into a usable form of energy—evolved from bacteria that were incorporated into the cells of organisms early in the evolution of life. The fact that a typical cell in every animal, plant, or fungus has about two thousand mitochondria "powering" it suggests that this evolved symbiotic relationship is important for being fit to survive.[52]

The ecological relationships of tree roots and fungi, and also mitochondria within every plant, fungi, and animal cell, illustrate mutually beneficial coevolution that is not accurately characterized using notions such as the "survival of the fittest" or "selfish genes." So we should not be surprised that one definition of an *ecosystem* is "an ecological community together with its environment, functioning as a unit."[53]

Ecosystems

Within an ecosystem, "[e]very species is bound to its community in the unique manner by which it variously consumes, is consumed, competes, and cooperates with other species. It also indirectly affects the community in the way it alters the soil, water, and air."[54]

An ecosystem, however, may also be defined as the living and nonliving components and processes that comprise and regulate the behavior of a subset of the biosphere, where the biosphere is understood as a global ecosystem composed of living organisms and nonliving materials that provide the nutrients for life.[55] This description emphasizes the contribution of the parts to the whole.

Bacteria, the most abundant form of life on earth, play a crucial role in the complex processes of ecosystems. Without bacteria, we would not have nitrogen in our soil, and the ground would be unable to sustain the trees that produce much of the oxygen we need to breathe and the crops we grow for food. Hundreds of millions of bacteria live in our intestines, stomach, and mouth and assist with our digestion.[56] In fact, the majority of the cells in your body are bacteria and other microorganisms.[57] Every person is a community of life.[58]

"[O]f all the organisms on Earth today, only prokaryotes (bacteria) are individuals. All other live beings ('organisms'—such as animals, plants, and fungi) are metabolically complex communities of a multitude of tightly organized beings. That is, what we generally accept as an individual animal, such as a cow, is recognizable as a collection of various numbers and kinds of autopoietic [self-organizing] entities that, functioning together, form an emergent entity—the cow."[59]

If all organisms larger than bacteria are intrinsically communities, then we need to *understand evolution more ecologically.*[60] In every multicellular organism, bacteria are participating in the life of the organism rather than "competing" with it for survival. Thus, evolution is more accurately described as a process of natural selection in which communities that are fit for changing environments are more likely to survive.

Emergent Properties

Ecologists also verify that ecosystems have emergent properties, including energy transfer, nutrient cycling, gas regulation, climate regulation, and the water cycle. Ecosystem functions cannot be easily explained by even the most extensive knowledge of the ecosystem's components.[61] Because emergent processes are not adequately understood, the consequences of damaging an ecosystem are unpredictable.[62]

Therefore, the emergent processes of ecosystems are irreplaceable. "There are no plausible technological substitutes for soil fertility, clean fresh water, unspoiled landscapes, climatic stability, biological diversity, biological nutrient recycling, and environmental waste assimilative capacity. The irreversible loss of species and ecosystems, and the buildup of greenhouse gases in the atmosphere, and of toxic metals and chemicals in the topsoil, ground water and in the silt of lake-bottoms and estuaries, are not reversible by any plausible technology that could appear in the next few decades."[63]

These emergent processes, however, have resiliency.[64] The many relationships of an ecosystem are maintained through *self-organizing processes,* rather than top-down control. Each individual in a species acts independently, yet its activity is complementary with the other species. Cooperation and competition are entangled and balanced.[65] Also, *diversity* matters. The more species living in an ecosystem, such as a forest or lake, the more productive and stable the ecosystem is.[66]

Therefore, understanding ecosystems is important for environmental ethics, because:

- Ecosystems sustain symbiotic and predatory relationships among organisms.
- Ecosystem processes are complex, self-organizing, diverse, and resilient.
- The emergent properties of an ecosystem are irreplaceable.
- The consequences of damaging ecosystems are unpredictable.

These lessons do not determine our ethical choices, but are the "environment" in which our choices will be "fit" or not. Adopting this worldview means considering possibilities or probabilities, rather than simply describing facts, because every environment is always changing due to its dynamic nature and our impact on it. In the words of philosopher of science Karl Popper, "The future is open."[67]

Ascribing Value to Nature

Science cannot verify that nature has a purpose, nor can scientific reasoning prove or disprove that the natural world has intrinsic worth. Yet scientific knowledge is relevant for addressing these questions. The next three subsections consider the ethical implications of the scientific conclusions that nature generates diversity, evolution is an emergent process of life, and ecosystems (as well as organisms) are self-organizing.

Nature Generates Diversity

The "biosphere is profoundly generative—somehow fundamentally always creative."[68] Life fills every niche of nature, and as the environment changes, the dynamic process of evolution enables some species to adapt. Random genetic changes and competition play a crucial role, but organisms (including human beings) also coevolve.[69]

"When two species are ecologically intimate, closely influencing each other's lives as do predators and prey or hosts and parasites, each normally becomes a major source of selection operating on the other; in such situations, coevolution occurs. As a species, human beings are ecologically intimate with lots of organisms, from cows and crop pests to mackerel and malarial mosquitoes, and coevolution affects us in many ways."[70] If human life has value, it seems reasonable to ascribe value to the natural process that has enabled human life to evolve.

Some who argue against attributing value to evolution assert that value requires purpose, which is missing in a theory that attributes the survival of random changes to their fitness in an environment. Yet the lack of objective evidence for a purpose in nature does not prove that nature is only random or without value (or even without purpose).

"It is certainly true that there is randomness in evolutionary nature, but it is not random that there is diversity. Four billion species do not appear by accident. Rather, *randomness is a diversity generator*, mixed as it is with principles of the spontaneous generation of order . . . *randomness is an advancement generator*, supported, as advancement comes to be, by the trophic pyramid in which lower ways of life are also conserved."[71]

Ayala describes natural selection as a process "that is not random, but, rather is oriented and able to generate order or 'create.' The traits that organisms acquire in their evolutionary histories are not fortuitous but determined by their functional utility to the organisms, 'designed' as it were to serve their life needs." To be sure, Ayala notes, random changes are an integral part of the evolutionary process. Yet he affirms that natural selection is creative, although not conscious.[72]

When we are unable to solve a problem, we sometimes try whatever we can think of, and this may lead us to a solution. Our own experience, therefore, confirms that making *random changes need not be without value.* Similarly, in evolution random changes explore the potentialities of an ecosystem, sifting through options for diversity and advancement. A creative process that produces value might be characterized as purposeful, if by that we mean having "an overall aim toward the actualizing of value."[73]

In addition to random changes, however, it seems that evolution is driven by two other phenomena. First, there is "symbiogenesis"—the appearance of new behaviors, new metabolism, new tissues, new organs or organelles, and new gene products, in symbiotic partners. Biologist Lynn Margulis suggests that this process of coevolution is the main source of inherited variation in the evolution of the first nucleated cells and their descendants.[74]

Second, the "choices" made by organisms play a crucial role in natural selection. "Darwin spoke of sexual selection, but culinary or gustatory selection must also operate in organisms that choose one part of their largely edible environment over another. With whom we decide to associate in eating and living seems crucial, and likely influences subsequent evolution—perhaps even, through amplification, events millions of years in the future."[75]

Evolution is not simply a mix of random events and necessity, though both are significant. "The direction of organisms in their growth, evolution, and conscious, purposeful behavior cannot be denied."[76]

Evolution Is an Emergent Process

Seeing evolution as "a linear progression from lower atomized organisms to more complex atomized organisms no longer seems appropriate. The more appropriate view could be that all organisms (parts) are emergent aspects of the self-organizing process of life (whole), and that the proper way to understand the parts is to examine their embedded relations to the whole."[77]

That is, evolution generates not only organisms but diverse and complex ecosystems. According to moral philosopher Holmes Rolston III: "Ecosystems are in some respects more to be admired than any of their component organisms because they are generated, continue to support, and integrate tens of thousands of member organisms. The ecosystem is as wonderful as anything it contains. In nature there may sometimes be clumsy, makeshift solutions. Still, everything is tested for adaptive fitness."[78]

Some argue that ascribing inherent worth to ecosystems will necessarily mean valuing human culture less, because humans pose the greatest threat to ecosystems.[79] Yet contrasting the value of human culture and ecosystems ignores the scientific facts that humans can only survive in ecosystems and are themselves ecosystems. Therefore, it makes sense to value these natural facts as well as "our own" purposes.

This reasoning also supports ascribing value to biodiversity and the survival of other species, as well as the habitats that sustain all life. "Moral consideration should first be directed toward the natural community or ecosystem as a whole, so that the overall good for the ecosystem is the primary goal of action. But this communal good should be supplemented by a consideration of natural individuals and species, so that in cases where ecosystemic well-being is not an issue, the protection of endangered species or natural individuals can be morally justified."[80] I suggest in chapter 4 that this is more reasonable than including in our moral community *only* certain individual nonhuman organisms.[81]

I agree with Mary Midgley that we may have duties to plants and trees, as well as animals and species, because as beings who form a small part of the earth's fauna, we exist in relation to that whole, and "its fate cannot be a matter of moral indifference to us."[82] I argue in chapter 7, however, that this need not mean ascribing rights to nonhuman individual animals. Expanding our moral community will likely increase our conflicts of duty. Yet conflicts are the stuff of ethics and law, so this is no reason to deny moral consideration to organisms and ecosystems. Moreover, the law has already extended our responsibility to include protecting endangered species and the integrity of ecosystems.

Organisms and Ecosystems Are Self-organizing

Life is self-organizing at all levels. "Far more complex than any computer or robot, the common bacterium perceives and swims toward its food."[83] In pursuit of their own survival, bacteria have made the earth's environment viable for us and other life by removing carbon dioxide from the atmosphere, producing oxygen, and "inventing every major kind of metabolic transformation on the planet."[84]

A bacterium constantly changes its material composition by metabolizing nutrients from the environment. This is true for all organisms, including human beings. "Every five days you get a new stomach lining. You get a new liver every two months. Your skin replaces itself every six weeks. Every year, ninety-eight percent of the atoms in your body are replaced. This nonstop chemical replacement, metabolism, is a sure sign of life."[85]

While metabolizing, however, a bacterium (like every organism) maintains its biological integrity by making sense of the world so it can remain viable.[86] Not even a bacterium is a survival machine. As an organism, it must change its matter to maintain itself and so must aim beyond its present moment.

Having such an *identity* is certainly not the same as having autonomy or rationality, which are the human attributes that philosophers have argued justify limiting moral consideration to persons. Yet an identity distinguishes organisms from nonliving natural resources and is the evolutionary root of autonomy and reason.[87] "Every organism has a *good-of-its-kind;* it defends its own kind [its own way of life] as a *good kind.*"[88]

"A plant, like any other organism, sentient or not, is a spontaneous, self-maintaining system, sustaining and reproducing itself, executing its program, making a way through the world, checking against performance by means of responsive capacities with which to measure success. Something more than physical causes, even when less than sentience, is operating; there is information superintending the causes; without it the organism would collapse into a sand heap. The information is used to preserve the plant identity."[89]

Every organism is oriented toward the future. “Thus life is facing forward as well as outward and extends ‘beyond’ its own immediacy in both directions at once.”[90] There are no conscious intentions in the actions of bacteria or most animals. Yet the emergent properties of self-organization and sense-making, and the forward trajectory of every organism in seeking its own good, are evidence that *all life has value for itself.*

This is true of plants as well as animals, because plants “sense all sorts of things about the plants around them and use that information to interact with them.”[91] For instance, if the plant known as the sea rocket detects unrelated plants growing nearby, it aggressively sprouts nutrient-grabbing roots. But if it detects related plants, it does not.[92]

Consider also the remarkable self-organization of slime mold, which normally exists as single cells that repel each other. When food is scarce, the cells aggregate and differentiate to form a creature that looks like a slug, except that it sprouts a stem that will release spores. In an adverse environment, the individual organisms collaborate and specialize for the purpose of surviving as a species, not merely as individual organisms.[93]

We therefore can distinguish two forms of intrinsic worth—the intrinsic value *for itself* that we find in all life, as well as the intrinsic value *in itself* that we ascribe to rationality and autonomy. Intrinsic value for itself arises with the nature of all organisms to maintain their functioning integrity. Intrinsic value in itself arises with consciousness, reason, and language.[94]

This distinction allows us to affirm both the good of nature and the good of human culture. We recognize that a self-organizing natural system has intrinsic worth (for itself), but we also acknowledge the intrinsic worth (in itself) of the science that identifies this natural fact and the ethics that ascribes value to it.

Rolston writes: “Ecology discovers simultaneously (1) what is taking place in ecosystems and (2) what biotic community means as an organizational mode enveloping organisms. Crossing over from science to ethics, we can discover (3) the values in such a community-system and (4) our duties toward it.”[95] Objective knowledge is not without intrinsic value, but requires subjects to measure and assess its intrinsic value—as well as any possible instrumental value. As moral subjects, we should be responsible for the values we find in nature.

Why do we have a duty to care for ecosystems? “The ecologist finds that ecosystems *objectively* are *satisfactory communities* in the sense that, though not all organismic needs are gratified, enough are for species long to survive, and the critical ethicist finds (in a *subjective* judgment matching the *objective* process) that such ecosystems are imposing and *satisfactory communities* to which to attach duty.”[96]

Moral philosopher Eugene Hargrove argues that such ecocentric arguments depreciate anthropocentric reasoning that ascribes value to nature for its beauty.[97] Stone disagrees: “A respect for nature may engender a preference for natural processes: for example, the natural flow of a river. Untouchedness strikes me . . . as a plausible good, and so does beauty.”[98]

Nature Has Objective Value

The step from ecology to ethics is inevitable, David Keller and Frank Golley argue, because as a species our actions impact the entire biosphere. “The old injunction against scientists uttering moral assertions, based on the notion that nature is devoid of intrinsic value or purpose, is misguided. Ecologists cannot, and ought not, refrain from making moral judgments."[99]

Is nature, however, without value until there are humans to value it? Not if we understand the act of ascribing value as recognizing value, rather than creating it. We attribute value to our lives because we reason that human life has worth. *Valuing is the subjective recognition of objective value.*[100] If our (subjective) valuing of nature is reasonable, then nature has (objective) value. Furthermore, the evolutionary and ecological processes that led to human life—and thus to consciousness, knowledge, and ethics—have objective value not only after humans exist, but in the millennia of natural history that generated a profusion of organisms and ecosystems.

We may draw two inferences for ethics from this conclusion. First, *we cannot limit our ethical reasoning to predicting likely consequences*. The consequentialist approach does not take into account the intrinsic worth of nature, but only values natural resources for their utility. Many moral philosophers assert that some form of consequential ethics is the best we can do. Nonetheless, if there are reasonable arguments for attributing intrinsic value to nature, then ethics requires considering what is best for the habitats we share with other species and not simply calculating what use of natural resources is best for human beings.

Second, ascribing intrinsic value to nature requires that we distinguish the world of human culture from the world of nature. In the *world of culture,* which is the traditional worldview of moral philosophy, we do not reason from what is to what ought to be. For example, murder in society *is* a fact, but no one suggests it *ought to be* morally acceptable. Deriving what "ought to be" from what "is" and reducing the question of values to that of facts is known in moral philosophy as "the naturalistic fallacy."[101]

Yet as we contemplate the world of nature and also ascribe intrinsic value to organisms and ecosystems, it is reasonable to infer that what is (in wild nature) is what ought to be. For example, predation in the natural world involves killing, which "ought to be" in the sense that we "ought to let it be," because this is how life in ecosystems has evolved and survives. Killing in nature is not the same as murder in society.

Rolston suggests: "What is ethically puzzling, and exciting in the marriage and mutual transformation of ecological description and evaluation is that here an *ought* is not so much *derived* from an *is* as discovered simultaneously with it. As we progress from description of fauna and flora . . . of stability and dynamism, and move on to intricacy . . . to unity and harmony with oppositions in counterpoint and synthesis, to organisms evolved within and satisfactorily fitting their communities, arriving at length at beauty and goodness, it is difficult to say where the natural facts leave off and where the natural values appear."[102]

The naturalistic fallacy is not the only mistake we might make. We commit the subjectivist fallacy if we claim all values lie in subjective experience, and the anthropocentrist fallacy if we think all values are nothing but human options and preferences.[103] Our subjective reasoning allows objective conclusions, and our anthropocentric values do not preclude ascribing value to the ecosystems that sustain life.

Our environmental crisis arises from a conflict between the world of human culture and the world of nature. Our way of life is the problem, and thus also our only solution. This crisis is due largely to our ethical failure, in the world of human culture, to grant moral consideration to the intrinsic worth of the world of nature.

How are we to resolve this problem? Rather than rejecting anthropocentric thinking for an ecocentric perspective, we should learn from both. An ecocentric perspective extends our moral community beyond ourselves to the world of nature, and anthropocentric reasoning defends the moral standards of social justice in the world of human culture.

NOTES

1. Christopher D. Stone, “Should Trees Have Standing?—Towards Legal Rights for Natural Objects,” *Southern California Law Review* 45 (1972): 450, reprinted in Christopher D. Stone, *Should Trees Have Standing?—Towards Legal Rights for Natural Objects*. This article was cited by Justice Douglas in his dissent in *Sierra Club v. Morton,* 405 U.S. 727 (1972), a decision by the Supreme Court upholding a lower court ruling that the Sierra Club did not have legal “standing” in its lawsuit to block a decision by the Forest Service that would allow development in the Mineral King Valley in the Sierra Nevada Mountains, because the Sierra Club itself could not show that it would be adversely affected. Stone proposed that the law should allow someone to represent the interests of trees in the valley, because the trees would be adversely affected by economic development.

2. “Standing is the ability of a party to bring a lawsuit in court based upon their stake in the outcome.” “Standing Law & Definition,” *USLegal,* http://definitions.uslegal.com/s/standing.

3. See Claire Andre and Manuel Velasquez, “Who Counts?” Markkula Center for Applied Ethics, Santa Clara University, http://www.scu.edu/ethics/publications/iie/v4n1/counts.html. Institutions are seen as representing the interests of persons.

4. Ibid. Aristotle wrote: “Plants exist for the sake of animals, and brute beasts for the sake of man.”

5. “Jeremy Bentham on the Suffering of Non-human Animals,” http://www .utilitarianism.com/jeremybentham.html.

6. Henry P. Stapp, *Mindful Universe: Quantum Mechanics and the Participating Observer,* 5, 117.

7. Sandra Blakeslee and Matthew Blakeslee, *The Body Has a Mind of Its Own,* 41.

8. Rita Carter, *Exploring Consciousness,* 128. “Anatomists have found that in most areas of the cortex, for every fiber carrying information up the hierarchy, there are as many as ten fibers carrying processed information back down the hierarchy.”

9. Bruce E. Wexler, *Brain and Culture: Neurobiology, Ideology, and Social Change,* 154–155.

10. Anthony O’Hear, *Introduction to the Philosophy of Science,* 24.

11. Stapp, *Mindful Universe,* 8. “Science is what we know, and what we know is only what our observations tell us. It is unscientific to ask what is ‘really’ out there, what lies behind the observations.” Jeffrey M. Schwartz, *The Mind and the Brain,* 273–274.

12. Robert Nadeau and Menas Kafatos, *The Non-Local Universe,* 5.

13. Ibid., 143. “And no scientific description of the physical substrate of a thought or feeling, no matter how complete, can account for the actual experience of a thought or feeling as an emergent aspect of global brain function.” Erwin Schrödinger explains: “Hence this life of yours which you are living is not merely a piece of the entire existence, but is, in a certain sense, the whole; only this whole is not so constituted that it can be surveyed in one single glance.” In Ken Wilber, ed., *Quantum Questions*, 97, in Nadeau and Kafatos, *Non-Local Universe*, 216.

14. This is known as the *principle of complementarity.*

15. Nadeau and Kafatos, *Non-Local Universe*, 5.

16. Evan Thompson, *Mind in Life,* 82, 164. “Objectivism takes things for granted, without asking how they are disclosable to human experience and knowledge, or how they come to be disclosed with the meaning of

significance they have. Objectivism in biology, for example, takes the organism for granted as a ready-made object out there in the world. No concern is shown for how the category ‘organism’ is constituted for us in scientific experience.”

17. This means that we should not seek “to disclose the real essence of phenomena, but only to track down as far as possible relations between the multifold aspects of our experience.” Niels Bohr, in Stapp, *Mindful Universe,* 86.

18. Werner Heisenberg, in Stapp, *Mindful Universe,* 95.

19. Thompson, *Mind in Life,* 158.

20. This is the philosophical implication of the scientific principle of complementarity.

21. Science is always an interpretation: “the fact that there is a strong international consensus among scientists that global warming is caused almost entirely by humans does not make it any less of an interpretation.” Ted Nordhaus and Michael Shellenberger, *Break Through,* 142.

22. Mary Midgley, *The Ethical Primate,* 6. The eugenics movement adopted this slogan. See “Modern History Sourcebook: Herbert Spencer: Social Darwinism, 1857,” http://www.fordham.edu/halsall/mod/spencer-darwin.html.

23. Steven Rose, *Lifelines: Biology Beyond Determinism,* 227. “It seems doubtful that ‘plant defenses’ are that and nothing more. Plants regulate but do not eliminate the insects and animals that have coevolved with them.”

24. Ibid.

25. Harold Morowitz argues that all evolution is coevolution. *The Emergence of Everything: How the World Became Complex,* 137.

26. Garrett Hardin, “Lifeboat Ethics: The Case against Helping the Poor,” *Psychology Today* (September 1974), http://www.garretthardinsociety.org/articles/art_lifeboat_ethics_case_against_helping_poor.html.

27. Rose, *Lifelines,* 131.

28. Ibid.

29. Ibid., 140. For a critique of Dawkin’s position, see “Genocentrism” in Thompson, *Mind in Life,* 173–194.

30. John B. Cobb, Jr., “Organisms as Agents in Evolution,” in John B. Cobb, Jr., ed., *Back to Darwin: A Richer Account of Evolution,* 221.

31. Ibid., 223.

32. Richard Dawkins, in Midgley, *Ethical Primate,* 5.

33. Steven Rose, *Lifelines,* 70.

34. Francisco J. Ayala, “From Paley to Darwin: Design to Natural Selection,” in Cobb, *Back to Darwin,* 96.

35. Gary Marcus, *The Birth of the Mind,* 98.

36. Ibid., 23.

37. The “language” of bees is transmitted genetically, but the dialects of some birdsongs are transmitted culturally. Timothy Goldsmith, *The Biological Roots of Human Nature,* 103–104.

38. Bijal Trivedi, “Chimps Shown Using Not Just a Tool but a ‘Tool Kit,’” *National Geographic News,* October 6, 2004, http://news.nationalgeographic.com/news/2004/10/1006_041006_chimps.html.

39. “The basic principle is this: genetic signals play a large role in the initial structuring of the brain. The ultimate shape of the brain, however, is the outcome of an ongoing active process that occurs where lived experience meets both the inner and the outer environment.” Schwartz, *Mind and the Brain,* 117.

40. Goldsmith, *Biological Roots of Human Nature,* 85, 74. However, “[C]ertain kinds of competence—perceptual, linguistic, social—do need to develop on schedule, or the deleterious consequences are reversed with difficulty, if at all. This is because the capacity for learning, like the development of body form,

is subject to some genetic constraints." See Gerald M. Edelman, *Second Nature: Brain Science and Human Knowledge,* 22.

41. Ibid.

42. Sharon Begley, *Train Your Mind, Change Your Brain,* 8.

43. Ibid., 8–9.

44. John J. Ratey, MD, with Eric Hagerman, *Spark: The Revolutionary New Science of Exercise and the Brain,* 5.

45. Schwartz, *Mind and the Brain,* 224

46. Begley, *Train Your Mind, Change Your Brain,* 9.

47. Nadeau and Kafatos, *Non-Local Universe,* 207.

48. Bill Freedman, *Environmental Ecology: The Ecological Effects of Pollution, Disturbance, and Other Stresses,* 550.

49. Writing in the last quarter of the twentieth century, Donald Worster argued that the split between an "organic, communal ideal and a more pragmatic utilitarianism remains in doubt." *Nature's Economy: The Roots of Ecology,* 257.

50. See Laura Westra, *An Environmental Proposal for Ethics: The Principle of Integrity.*

51. "Mycorrhiza," http://en.wikipedia.org/wiki/Mycorrhizae.

52. "Mitochondria," http://en.wikipedia.org/wiki/Mitochondria.

53. *Yahoo! Education,* http://education.yahoo.com/reference/dictionary/entry/ecosystem.

54. Edward O. Wilson, *The Future of Life*, 11.

55. Wikipedia, http://en.wikipedia.org/wiki/ecosystem.

56. Lynn Margulis, "Power to the Protoctists," in Lynn Margulis and Dorion Sagan, *Slanted Truths: Essays on Gaia, Symbiosis, and Evolution*, 79.

57. Edward O. Wilson, *The Future of Life,* 20.

58. Lynn Margulis, "Big Trouble in Biology: Physiological Autopoiesis versus Mechanistic neo-Darwinism," in Margulis and Sagan, *Slanted Truths,* 273.

59. Ibid.

60. Lynn Margulis and Dorian Sagan, *Microcosmos: Four Billion Years from Our Microbial Ancestors*, 16, in Nadeau and Kafatos, *Non-Local Universe,* 110.

61. Herman E. Daly and Joshua Farley, *Ecological Economics: Principles and Applications,* 431–432. "The concept of emergence essentially recognizes that an assemblage of parts in successive levels of organization in nature can result in wholes that display properties that cannot be explained in terms of the collection of parts." Nadeau and Kafatos, *Non-Local Universe,* 118.

62. Also, nonlinear systems are unpredictable. In nature the flow of streams and the weather are good examples. "A system like this, in which the outcome is exquisitely dependent on the details of the initial conditions, is said to be chaotic." James Trefil, *Human Nature: A Blueprint for Managing the Earth—by People, for People,* 180–181.

63. Robert Ayers, in Charles J. Kibert, Jan Sendzimir, and G. Bradley Guy, "Defining an Ecology of Construction," in Charles J. Kibert, Jan Sendzimir, and G. Bradley Guy, eds., *Construction Ecology: Nature as the Basis for Green Buildings*, 16.

64. Ecological theories now measure the *resiliency* of ecosystems rather than their *stability,* because disturbances are understood to be natural. Ned Hettinger and Bill Throop, "Refocusing Ecocentrism: De-emphasizing Stability and Defending Wildness," *Environmental Ethics* (Spring 1999), in Pojman and Pojman, *Environmental Ethics,* 187–188.

65. Ibid. Very similar organisms in the same habitat display adaptive behaviors that sustain the whole when food and other resources are scarce. One such behavior is the division of the habitat into ecological niches, wherein the presence of one species does not harm another, similar species. Nadeau and Kafatos, *Non-Local Universe,* 117.

66. "By 'productive,' scientists mean the amount of plant and animal tissue created each hour or year or any other given unit of time. By 'stability' they mean one or the other or both of two things: first, how narrowly the summed abundances of all species vary through time; and second, how quickly the ecosystem recovers from fire, drought, and other stresses that perturb it. Human beings understandably wish to live in the midst of diverse, productive, and stable eco-systems." Edward O. Wilson, *Future of Life,* 108.

67. Adam J. Chmielewski and Karl R. Popper, "The Future Is Open: A Conservation with Sir Karl Popper," in Ian Jarvie and Sandra Pralong, eds., *Popper's Open Society after Fifty Years: The Continuing Relevance of Karl Popper,* 32.

68. Stuart Kaufman, *Investigations,* 135. See Julie Steenhuysen, "Thousands of New Marine Microbes Discovered," *Reuters,* October 4, 2007, http://www.reuters.com/article/scienceNews/idUSN0441498020071004.

69. Paul R. Ehrlich, *Human Natures: Genes, Cultures, and the Human Prospect,* 61.

70. Ibid.

71. Andrew Light and Holmes Rolston III, eds., *Environmental Ethics,* 207. A trophic pyramid, or hierarchy, consists of the steps in a food chain within an ecosystem. "Trophic Level," http://en.wikipedia.org/wiki/Trophic_level.

72. Francisco J. Ayala, "From Paley to Darwin: Design to Natural Selection," in Cobb, *Back to Darwin*, 74–75.

73. John F. Haught, "Darwinism, Design, and Cosmic Purpose," in Cobb, *Back to Darwin*, 325.

74. Lynn Margulis and Dorion Sagan, "The Role of Symbiogenesis in Evolution," in Cobb, *Back to Darwin*, 178.

75. Ibid., 184.

76. Dorion Sagan, "Evolution, Complexity, and Energy Flow," in Cobb, *Back to Darwin*, 156.

77. Nadeau and Kafatos, *Non-Local Universe,* 109.

78. Light and Rolston, *Environmental Ethics*, 174–175. J. Baird Callicott affirms that "the good of the biotic community is the ultimate measure of the moral value, the rightness or wrongness of actions," and that "the effect upon ecological systems is the decisive factor in the determination of the ethical quality of actions." "Animal Liberation: A Triangular Affair," *Environmental Ethics* 2 (1980): 320, in Eric Katz, "Is There a Place for Animals in the Moral Consideration of Nature?" in Light and Rolston, *Environmental Ethics,* 86.

79. Attributing moral consideration to ecosystems is seen as undermining the value of human beings, who must be valued in terms of their contribution to the natural community "since the primary goal of moral action is the good of the natural community, and since human technology and population growth create many of the threats to environmental health, an [ecocentric or biocentric] environmental ethic may demand the elimination of much of the human race and human civilization." Katz, "Is There a Place for Animals in the Moral Consideration of Nature?" 87.

80. Ibid., 91.

81. Paul W. Taylor argues for the intrinsic worth of nature and that all organisms, including humans, have equal intrinsic worth. "The inherent worth of an entity does not depend on its merits. To consider something as possessing inherent worth . . . is to place intrinsic value on the realization of its good." "The Ethics of Respect for Nature," in David Schmidtz and Elizabeth Willott, eds., *Environmental Ethics,* 91. Because the good of humans includes caring for the earth in a unique way, I do not think it necessarily follows that the human "good" is the same in intrinsic worth as the "good" of every other organism. I do agree with Taylor, however, that extending moral consideration to animals does not necessarily mean granting them rights, because accepting duties to animals is another way of giving them moral and legal consideration.

82. Midgley, *Animals and Why They Matter,* 91.

83. Lynn Margulis and Dorion Sagan, *What Is Life?* 92.

84. Ibid., 90–92.

85. Ibid., 17.

86. Thompson, *Mind in Life,* 146–147.

87. “Animals maintain a valued self-identity as they cope through the world. Valuing is intrinsic to animal life.” Holmes Rolston III, “Value in Nature and the Nature of Value,” in Light and Rolston, *Environmental Ethics,* 145.

88. Ibid.

89. Ibid.

90. Hans Jonas, quoted in Thompson, *Mind in Life,* 156.

91. Carol Kaesuk Yoon, “Loyal to Its Roots,” *New York Times,* June 10, 2008, http://www.nytimes.com/2008/06/10/science/10plant.html.

92. Ibid.

93. Charles Birch, “Why Aren’t We Zombies?” in Cobb, *Back to Darwin,* 259.

94. Keekok Lee, “The Source and Locus of Intrinsic Value: A Reexamination,” in Light and Rolston, *Environmental Ethics,* 155.

95. Light and Rolston, *Environmental Ethics,* 173, 219.

96. Ibid., 167.

97. Eugene Hargrove, “Weak Anthropocentric Intrinsic Value,” in Light and Rolston, *Environmental Ethics,* 181.

98. Christopher D. Stone, *Earth and Other Ethics,* 96.

99. “Afterword,” in David R. Keller and Frank B. Golley, eds., *The Philosophy of Ecology: From Science to Synthesis,* 320.

100. “A sentient valuer is not necessary for value. Another way is for there to be a value-generating system able to generate value.” Rolston, “Value in Nature and the Nature of Value,” in Light and Rolston, *Environmental Ethics,* 152.

101. The fallacy was first identified by David Hume in the eighteenth century and then described by G. E. Moore in *Principia Ethics* (1903). International Society for Complexity, Information, and Design, “Naturalistic Fallacy,” *ISCID Encyclopedia of Science and Philosophy,* http://www.iscid.org/encyclopedia/Naturalistic_Fallacy.

102. Light and Rolston, *Environmental Ethics,* 232.

103. Rolston, “Value in Nature and the Nature of Value,” 146.