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Introduction: Who Are We?

Our species arrived quite recently on the geological scene. Life on Earth is thought to have begun around 3.5 billion years ago, our hominin ancestors in Africa only appearing around 4 million years ago, and our kind of humans coming out of Africa only 70,000 to 50,000 years ago (Leakey 2020: 80, 138, 270–271, 306–332; Reich 2018: 6; Dennell 2009: 13–34; Smail 2008: 9).[1] *Homo sapiens* coevolved with every life-form now on Earth, and many others now extinct. We are literally made of the same elements, sharing genes with plants as well as bacteria, viruses, and all other living creatures. In fact, our bodies are colonies of symbiotic cells and viruses, each body a collective in dynamic cooperation (Yong 2016; Margulis 1998). We are not "strange strangers" as Timothy Morton (2010: 50) would have us believe (see also Clark 2013). We are biological kindred, with the same organs as other mammals. As Darwin (1981) pointed out more than 150 years ago, human fetuses begin looking very much like those of dogs, then develop gradually as they mimic evolutionary change from fish-like creatures with gills and tails to the distinct form of primates and finally human infants (10–17). Understanding this reality must be the central starting point for understanding our place in the living community. In order to think seriously about who we are, and what our future might be as the climate begins a drastic transformation, we need to go back much farther than the few hundred years, or perhaps the few thousand years, commonly reckoned to be our historical heritage, as Daniel Lord Smail (2008: 6–11) urges.

Perhaps, as Dipesh Chakrabarty (2009) asserts, recent climate change has collapsed the Humanist presumption that our species history is distinct from natural history; indeed, he seems to accept the Anthropocene concept that we have become actual shapers of the planet's geology. But the Humanist view is relatively recent, as is the realization of the environmental crisis we have wrought. The notion of the Anthropocene may itself be an expression of human exceptionalism, when a much broader and deeper look at the Earth's history reveals how late and minimal our impacts have been compared to the enormous dynamism of planetary life. Peter Ward and Joe Kirschvink (2015) claim that vast geological changes and planetary catastrophes have driven ecological/environmental change and shaped our relatively short experience as a species. And, indeed, the evolution of ecosystems has been more important

[1] The earliest known specimen of *Homo sapiens*, found at Kibish, Ethiopia, is dated at 195,000 years ago (Leakey 2020: 168–169). But see also Ann Gibbons (2017) and Ewen Calloway (2017), who describe very archaic specimens from Morocco, recently dated at 315,000 years old. This latter example is not accepted by some experts as *Homo sapiens* because of its primitive, elongated skull.

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than species in arriving at the forms of life we see at present. Most of Earth's past has been violently different from the relatively calm period of present life-forms. "The present is not a key to most of the past," Ward and Kirschvink (2015: 5) write,"Making it so has limited us in our vision and understanding." Others, such as Barry Cunliffe, Robin Dennell, David Quammen, David Reich, Maeve Leakey, and Jeremy de Silva, also consider increasing evidence from paleobiology, archaeology, ancient genome studies, and paleogeography in offering ways to freshly evaluate our experience and cultures.

The following narrative will show how archaic hominins developed before emerging as human-like types that migrated out of Africa, adapting to changing climates and landscapes. We will see how *Homo sapiens* moved into Europe and Asia 70,000 years ago, encountering and interbreeding with other forms of early humans such as Neanderthals and Denisovans. Following this long process will reveal the ways our ancestors created tools and cultural forms that led to our present situation. The final sections of the story will examine the remarkable appearance of sophisticated Paleolithic cave art in western Eurasia, the strange art of Neolithic Anatolian temples and towns, and two examples of archaic literary works that depict the tragic consequences of human efforts to control wild creatures and landscapes.

Premises

To begin exploring this wide sweep of history as the context for our own emergence and flourishing, two main premises should be acknowledged. *First*, this is a story of the development of living forms and their remarkable changes and adaptations to violent environmental events such as volcanic eruptions, earthquakes, atmospheric changes – such as the Great Oxygenation Event of 2.1 billion years ago that poisoned most anaerobic organisms and thus created an atmosphere for oxygen-breathing creatures – and other radical changes in climate. These include two or three periods of Snowball Earth events during which the entire globe was frozen. One lasted from 2.35–2.22 billion years ago, and a succession of others occurred from 717–635 million years ago, imposing severe environmental filters on the evolution of life. No large land animals existed until after these vast changes, which were followed by meteor strikes that wiped out most creatures during the Cretaceous and Permian periods (Ward and Kirschvink 2015: 68–113, 212–224). No mammals resembling humans appeared until 1.9 million years ago with the emergence of *Homo erectus* or *ergaster* (Leakey 2020: 270; Sykes 2020: 36; Dennell 2009: 26–34). We have therefore not been a factor in most of the history of planetary life; the Anthropocene could be seen as an unfortunate blip. As Lynn Margulis

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(1998) wrote, "Humans are not even central to life. We are a recent, rapidly growing part of an enormous ancient whole" (120).[2]

Second, my approach will place major emphasis on the active semiosis (or meaningful communication) and sedimentation of information in the Earth and in all living forms. This understanding comes from the interdisciplinary movement of *biosemiotics* that recognizes sign processes as fundamental to life.[3] Biochemist Jesper Hoffmeyer (2008) explained that "the biosemiotics idea implies that life on Earth manifests itself in a global and evolutionary *semiosphere*,[4] a sphere of sign processes and elements of meaning that constitute a frame of understanding within which biology must work" (5). It includes communication in the form of sound, scent, movement, colors, forms, electrical fields, chemical signals, touch, and more. And the continual stream of these sign processes "that regulate and coordinate the behavior of living systems, depends upon the special receptivity that evolutionary systems over time have developed towards selected features of their environment" (Hoffmeyer 2008: 62). Biosemiotics thus assumes that meaningful communication has been part of all life as it has developed over millions of years, dynamically operating in bodies from cells and organs to organisms and communities of organisms such as forests and coral reefs, and that animal communication and specifically human language and culture are extensions of that semiosis. In other words, biosemiotics is central to the history of life.

2 Marco Armiero's (2021) *Wasteocene* Element in this series perhaps offers a better name for our effect on the ecosystem and geology.

3 Developed independently in Estonia in the late 1970s–1980s (the Tartu–Moscow School) and in Denmark in the late 1980s (the Copenhagen School), this movement has involved biologists, chemists, and linguists who realized that information, and indeed active meaningful communication, lie at the base of living systems, including human culture. In Tartu, cultural linguist Juri Lotman led a group of Estonian and Russian linguists in developing a theoretical approach to cultural semiotics, which became connected with the ecological studies of Kalevi Kull and his collaboration with Hungarian-American linguist Thomas Sebeok in the 1980s. In Copenhagen, biochemist Jesper Hoffmeyer, with a formative interest in ecological history, worked with Claus Emmeche in informational biology to develop a parallel semiotics of nature influenced by the semiotic theory of American philosopher Charles Sanders Peirce (Hoffmeyer 2008: 364–368). By the 1990s, these two loosely related groups began cooperative meetings and projects, including Thomas Sebeok and his studies of nonhuman communication. Hoffmeyer (2008) credits Sebeok with "the broadminded intellect and indefatigable energy to assemble all the threads that would serve as the foundation for the modern biosemiotics project, both intellectually and socially" (364). Younger scholars such as Timo Maran at Tartu (author of the Element on *Ecosemiotics* in this series) and Søren Brier at Copenhagen have become important contributors to the movement, along with Terrence Deacon at University of California–Berkeley. Almo Farina's Element on *Semiotic Landscapes* in this series also reflects his wide-ranging work in the biosemiotics movement. See the special Biosemiotics and Culture issue of *Green Letters: Studies in Ecocriticism* 19 (November 2015) for a collection of presentations by key biosemioticians at a May 2013 conference at the University of Oregon.

4 Cultural linguist Juri Lotman invented the term and concept of *semiosphere* (Lotman and Clark 2005); the original paper, in Russian, was published in 1984. See also Hoffmeyer (2008: 366).

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1 Life Emerges

The earliest forms of life (archaea – ancient cells) were formed by an enclosing lipid membrane which distinguished and protected them from their surroundings while simultaneously remaining in communication with the exterior and controlling most of what happened within the cell. Taking in nourishment and expelling waste, the membrane (cell wall) was originally, and remains, a semipermeable barrier (Noble 2017: 39–51; Hoffmeyer 2008: 25–38; Margulis 1998: 81) that is always responding to and interacting with its environment, clearly in a kind of communication. In effect, "the surface membrane of a unicellular organism is therefore its nervous system" (Noble 2017: 59; see also Margulis 1998: 82–85). Hoffmeyer (2008) explains that "the biological orchestration of an organism is created by a well-tuned symphony of biosemiotic relationships across the membranes which in each instant of an organism's life controls and coordinates the biochemical, physiological, and even cognitive processes that together constitute life" (31). As organisms evolved and proliferated, they profoundly changed the environment (Noble 2017: 49; Lewontin 2000: 53–55, 125–126; Margulis 1998: 107–111). Life is always changing the Earth, as it did so dramatically in the Great Oxygenation Event.

This is the kind of dynamic *Chiasm* or intertwining that French philosopher Maurice Merleau-Ponty (1973) described as the central ontological fact (133–143; see also 114–115). It includes cosmic and geophysical forces, weathers, fluid systems, physical and chemical relationships as well as the interactions of living beings that evolved within those forces on the Earth and are made of the same elements. What distinguishes "life" from "nonlife" is the "aboutness" of living things, their dynamic orientation toward or away from, openness or rejection of, substances and situations and beings according to their own needs. This continuous activity requires agency combined with the interpretation of stimuli from outside the cell or organism. And it implies some kind of intersubjectivity from its beginnings (Hoffmeyer 1996: vii–viii; Wheeler 2016: 158–159). Gradually the necessary communication between inside and outside the first single-celled living things (prokaryotes, without nuclei) began to involve closer relationships, and alliances eventually produced complex cells and new creatures (eukaryotes, cells with nuclei, such as those found in plants, fungi, and animals).

Intersubjectivity must underlie this process, for it involves a profoundly intimate intercorporeality dynamically unfolding between two or more organisms that requires purposiveness, some kind of intentionality, no matter how primitive (Hoffmeyer 2008: 57, 94, 311). Edmund Husserl understood this when he defined various forms of empathy (*Einfühlung* – feeling with another)

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as the only mode through which animals can have sense. "This subjective element also guides everything in the world that we call organic life" (Husserl 2013: 6). This is not primarily a self-conscious process or one activated by "mind" as we understand it in ourselves or in complex animals like birds or octopuses, whales or primates. Rather, it results from differential energy flows, tendencies toward equilibrium, self-catalyzing and self-organizing properties of chemical systems, attractions to food, or movements away from danger. In larger organisms it develops from experimental play of various kinds and the ways organs evolved to interact and bodily parts to emerge and coordinate as a whole. Hoffmeyer (2008) predicts that biologists and biosemioticians are only at the beginning of discoveries that will reveal "a nearly inexhaustible stock of *intelligent* semiotic interaction patterns taking place at all levels of complexity from cells and tissues inside the bodies up to the scale of ecosystems" (50–51). He thinks that the evolution of species is likely to be dependent on whole systems of semiotic relations within the environment in which organisms are nested. This requires the consideration of a new integrative level between the species and the ecosystem – "i.e., the level of the *ecosemiotic interaction structure*" Hoffmeyer (2008: 195–196). Such research is already well underway, as Timo Maran (2020) explains so cogently in his Element in this series: *Ecosemiotics: The Study of Signs in Changing Ecologies*. He and his colleague Kalevi Kull have defined ecosemiotics as "a branch of semiotics that studies sign processes as responsible for ecological phenomena" (Maran and Kull 2014: 41).

Symbiosis

Lynn Margulis was the first to introduce the concept of symbiosis as the key evolutionary force for increasingly complex life-forms. Unsatisfied with the rigid neo-Darwinist claims that natural selection and random mutation are the only drivers of organic change, she explored mid-nineteenth-century ideas about the role of symbiosis in the work of such scientists as Konstatin Meresczhkowski, Boris Kozo-Polyansky, and Ivan Wallin, and then discovered the genetic basis for supporting them. "A major theme of the microbial drama," Margulis (1998) wrote, "is the emergence of individuality from the community interactions of once-independent actors. . . . The tendency of 'independent' life is to bind together and reemerge in a new wholeness at a higher, larger level of organization" (11). Such processes result in *symbiogenesis*, "the emergence of new living forms, bodies, organs, and species" (25–26, 33). At first derided and dismissed by mainstream biologists, she persevered and continued publishing more and more studies that began to gain acceptance. Her work has now become

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the dominant view – she is "the mother of symbiogenesis in evolution," acknowledges Oxford biologist Denis Noble (2017):

> We don't know how rapidly the symbiogenetic events leading to eukaryotes may have happened. A simple stage of ingestion of a bacterium by a prokaryotic cell would have been virtually instantaneous of course: just gobble the goody! But there must have been many other stages. Instead of being eaten up for fuel, the ingested bacterium would have needed to survive inside and prove beneficial to its host, while the host would have needed to be beneficial to the bacterium. We know also that much of the DNA of bacterial origin subsequently moved to the nuclear genome. . . . Only a small amount of DNA now remains in mitochondria and chloroplasts. That would have involved many steps of natural [internal] genetic engineering (204–205).

So it seems that the working inner parts of eukaryotic cells such as organelles, mitochondria, ribosomes, chloroplasts, perhaps even the nucleus, were once free-floating individual creatures. And part of these processes was reorganization of genomes that occurred naturally within organisms as they evolved. Thus, contrary to earlier reductionist emphasis on competition, many leading biologists now see internal agency and cooperation as also being central features of complex dynamics; such a view is obviously congruent with biosemiotics.[5]

All complex organisms contain such networks. Lynn Margulis's (1998) claim that "each one of us is a massive colony of microorganisms" (65) is now well-accepted, with Ed Yong's (2016) book, *I Contain Multitudes*: *The Microbes within Us and a Grander View of Life* providing a lively description of the present understanding of our situation as well as for many different animal bodies. He explains that most microbes (viruses, bacteria, phages, yeasts, fungi) in our bodies are not pathogens but instead behave like a hidden organ. Human cells have between 20,000 and 25,000 genes, but our symbiotic microbes have around 500 times more. Their genetic richness and adaptability respond to the challenges both outside and within us, helping to digest food, produce vitamins and minerals, neutralize toxins, and attack more dangerous microbes that could cause disease. We now know that they guide in the construction of our organs and educate our immune system, even affecting the development of the nervous system and eventually shaping moods and mental states in some cases. This is true not just for humans but for all animals. Many of those close to us such as mice have similar cooperative arrangements that can be experimentally studied in ways not easily managed for humans. In animals, from elephants to protozoa, microbes help maintain a steady internal environment in multiple

[5] But David Quammen (2018) reports that recent work in horizontal gene transfer reveals a number of unwelcome fusions of new genetic material caused by disease or other kinds of invasive conjunctions (336–342). See also Cédric Feschotte (2008).

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ways. In mammals, they clean vascular systems, help replenish the linings of gut and skin, affect the storage of fat, and even influence the continual remodeling of skeletal systems. And their presence in our immune systems is a profound and complex communicative network that shapes the system early in life and then works to react to threats by attacking some of them but also calming the body's responses to others (Yong 2016: 11–12, 63–64, 70–71; see also Quammen 2018 336–342).

How did this happen? It would be impossible to recover the exact details of the evolutionary dance of symbiogenesis over more than three billion years, but some possible developments have been hypothesized. Margulis (1998) describes the proposal of "fungal fusion" by two Canadian botanists, K. A. Pirozynski and D. W. Mallock, to help explain the evolution of plants 450 million years ago. They suggested that fungi and algae coevolved in a symbiogenesis that combined them in a mutually beneficial partnership: "Ultimately plants then provided sap for internalized fungi whose mycelial threads developed tough branching and roots" (107–108). This idea was extended by Peter Astatt of the University of California to suggest that by long association, plants adopted and retained fungal genes in their root tissue. It is now well established that mycorrhizae extend in huge networks from the roots of plants, supplying the plants with minerals such as phosphorus and nitrogen (Margulis 1998: 107–108).

More recently, forestry scientist Suzanne Simard (2021) has established how these plant networks communicate in intricate ways, sharing nutrients among various plants "in a web of interdependence, linked by a system of underground channels, where they perceive and connect and relate with an ancient intricacy and wisdom that can no longer be denied. . . . The evidence was at first highly controversial, but the science is now known to be rigorous, peer-reviewed, and widely published" (4–5). Simard has revealed this vast network of fungal life in more than twenty years of experimental work in American and British Columbian forests as well as in laboratories, beginning with her PhD dissertation research in the 1990s and now documented in many scientific publications. These demonstrate how seedling plantations are nurtured by fungal networks made up of varied species that trade sugars and proteins, protect against infections, provide shade to each other, and together create healthy symbiotic ecosystems of insects, bacteria, and other organisms (Simard et al. 2015; Simard et al. 2013; Simard 2012). They define ways in which trees communicate, learn from each other, and pass on information from the past (Simard 2018). Her most recent book makes an analogy between animal neural networks and the movement of chemical information among plants.

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> Molecules move not just through the cross walls of adjacent plant cells and the end pores of back-to-back fungal cells, but also across synapses at the apices of different plant roots, or different mycorrhizas. Chemicals are released into these synapses, and the information must then be transported along an electrochemical source-sink gradient from fungal-root tip to fungal-root tip, similar to the workings of a nervous system. (Simard 2021: 230).

Jakob von Uexküll (1934)[6] had used the forest as an example of multiple interlocking life-forms and the varied perspectives and activities of its creatures in his *Stroll through the Worlds of Animals and Men*. In *Ecosemiotics: The Study of Signs in Changing Ecologies* in this Elements series, Timo Maran (2020) also uses the forest as a model for the semiotic relations between ecosystems and human culture that parallels Simard's description of the web of life in British Columbian forests. Maran (2020) emphasizes the interconnected structural layers and distributed communication codes involved in ecological meanings that create the rich ecological relationships in the forest (53–58). This astonishingly complex ecosystem could only have coevolved among billions of organisms in mutual responses to each other and their changing environments since life began. This vast mutualism continues to evolve and change in the present. As Merleau-Ponty (1973) asks in *The Visible and the Invisible* concerning our own bodies in relation to the wider living world, "why would this generality, which constitutes the unity of my body, not open it to other bodies? . . . Why would not the synergy exist among different organisms if it is possible within each? Their landscapes interweave, their actions and their passions fit together exactly" (142).

An example of mutualism still underway is the bladderwort described by Hoffmeyer, a carnivorous plant commonly found in freshwater lakes. This plant feeds on zooplankton that in turn graze upon the *periphyton*, a film of bacteria, diatoms, and blue-green algae that covers the leaves of the plant and attract bacteria like the zooplankton. In this indirect mutualism all the involved species benefit from the arrangement. Even as the bladderwort nourishes itself by eating the zooplankton, the zooplankton at the same time gain great benefit from the opportunity to graze upon the phytoplankton layer. For its part, the phytoplankton layer profits by broadening its living space when the bladderwort's surface area increases. Thus, by ensuring the bladderwort's growth, the periphyton increases its own biomass, even through the process in which it is itself eaten (Hoffmeyer 2008: 47–48). Moreover, the situation is even more complex, because larger creatures such as ducks, muskrats, and turtles eat bladderworts

6 This translation is used instead of the more recent one because it retains the crucial use of the word *Umwelt* in the particular way Uexküll intended, whereas it is omitted in the later version.

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