Extendedness and Permeability – Core Gestures of the Living Organism

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We are used to thinking of the world as a collection of things. These are discrete, clearly separate from one another, they have a certain stability and express specific properties. We can observe a quartz crystal and a calcite crystal and clearly delineate where one ends and the other begins. Each expresses identity. Each maintains a distinct integrity. What is obvious in the world of minerals and machines is less so when we consider living organisms. A dandelion has quite a different relationship to its surroundings than a quartz crystal does. When we consider something that is alive, saying where it begins and where it ends becomes more difficult. Each living organism is embedded in and thus part of a larger context. To understand organisms, we have to move from a traditional notion of separateness "to the conception of a ecological organism of which each biological organism is a part" (Holdrege 2000).

Extendedness

Some years ago I was given a valerian plant for our garden. Each year now I discover new valerian plants, sometimes in unexpected places. I usually let them grow wherever they take root, grateful that the valerian has made the garden its own. In early spring, the valerian is a fairly tight bundle of small leaves close to the ground. The initial leaves are fairly simple. Those that follow quickly become more complex, with a tendency to reach upwards rather than outwards. They are pinnate. The number of lateral leaflets increases rapidly. The terminal leaflet is somewhat broader than the lateral leaflets in the basal foliage, but not so in the upper leaves. Most of the foliage is basal; the leaves diminish in size as they appear, one after the other, along the upright main stem. The uppermost leaves have a feather-like character. The leaves are markedly smaller and less frequent at the top of the stem where the flowers appear. The main stem emerges from the foliage and quickly grows upward, slender and graceful, branching as it does so. The flower clusters appear on the end of the main stem and on side branches. They bear tiny white and pale pink flowers.

The flowering of the valerian is accompanied by the appearance of a sweet fragrance in the garden. It surrounds the now tall slender plant with its myriad tiny flowers clustered upon the delicately branching stems. As they open, the flowers become a gathering place for insects. Even with my limited entomological skills, I once counted nine different types of insects in and around the flowers of a single valerian plant. These included tiny hover flies, native bees and butterflies. The insects partake of the plant's nectar and, as they move from flower to flower, support pollination. Although they are clearly not part of the plant as a physical entity, they are very much a part of the organism's life cycle as the valerian is part of their life process. As it extends upwards into the light and air, the valerian grows beyond the boundary of its spatial materiality. It displays new qualities of openness and inclusivity, extending into the context in which it grows.

This extendedness, or being beyond the boundary of materiality comes to expression in different organisms in different ways. As I walk through the woods, my first awareness of the presence of white-tailed deer often comes when I glimpse the flash of its up-lifted tail as it bounds away through the trees. The deer's awareness extends far beyond the reaches of its body and is sensitive to the slightest changes in its environment. It has a very different quality than the extendedness of the valerian plant. When I was a boy, my friends and I would try to wade through the shallow water at the edge of the pond to catch resting frogs. The challenge was to move through the water fluidly and slowly enough not to disturb it in any way. The slightest misstep would disturb the water and send frogs all along the shore into hiding.

The extended awareness we experience in the way the animals relate to their surroundings is quite different from what we experience in plants. The extendedness of the plant comes most often to expression in the way it grows out into its surroundings. The roots extend down and outward into the soil, becoming ever finer and more delicate. The foliage of the valerian is tightly packed at the base and grows ever finer and less frequent as the plant extends upward. The flowers bring then a completely new expression of openness, enclosing a space of finely differentiated, rich porosity alive with insect life and fragrance.

The bodily form of the deer or the frog is more clearly delineated. We experience their extendedness as a responsive sensitivity to what is around them, as well as in their movements. Each organism lives out into its surroundings in its own way. Its presence in the world is never confined to the limits of its physicality.

Permeability

A different characteristic of the "non-thingness" of the organism becomes apparent when we turn our attention to the way organisms "body," and we attend to the forms and processes through which they bring themselves to appearance in the world of matter and substance. In the following, I want to explore one aspect of this: the microbiome, including what has been termed the virome.

In 1681, when examining samples of his own fecal matter under a single lens microscope, Antonie van Leeuwenhoeck observed "more than 1000 living animalcules." This is probably the first mention of what we know of today as the human microbiome. The significance of the presence of microbiota in the gut for human health was first described in the late 19th century. Research by the German pediatrician Theodor Escherich into the development of intestinal flora in newborn infants showed that although the meconium was sterile, within hours after birth bacteria were present in the infants' fecal matter. Bacterial colonization of the intestine was attributable to the infant's environment, including the mother's milk and the air. He isolated 19 different bacteria and went on to describe in detail the common colon bacterium that now bears his name, *Escherichia coli*. He presented his findings in 1884 and 1885 to the Society for Morphology and Physiology in Munich. His discoveries sparked a wave of research that continued through the first World War at the center of which was the question of the role of the intestinal flora and fauna in human digestion and health. Henry Tissier, a French pediatrician introduced the first use of "good" bacteria as therapy for gastrointestinal disease in the early years of the 20th century. During this period of research, it became apparent that the microbiota in the intestines not only take advantage of the unique ecological niche presented by the human gut, but play an active role in human metabolism.

During the same period, a number of researchers, most notably Louis Pasteur, Ferdinand Cohn and Sergei Vinogradskii, turned their attention to the microscopic organisms themselves. One primary focus of their work had to do with microbial metabolism, specifically the exchange of matter and the transformation of energy. Both Pasteur and Cohn were focused on better understanding the "cycle of life" as it appeared in the ever-recurring processes of life and death, decay and new birth. Cohn wrote:

> "Bacteria cause dead bodies to come to the earth in rapid putrefaction, they alone cause the springing forth of new life, and therefore make the continuance of living creatures possible."

Both he and Pasteur assigned bacteria a central role in the cycle of life and death that underlies all life on earth (Ackert 2007).

Vinogradskii began his research as a plant physiologist, but quickly began to focus on microorganisms. Some of his most important discoveries were made when researching a bacterium (*Beggiatoa*) found only in hot sulfur springs. He soon became convinced that these organisms behave differently under sterile lab conditions than they do in their natural environments. He trekked to natural hot springs throughout the Alps to collect samples and developed ways to culture them in the laboratory by recreating the conditions under which they existed in nature. His work brought the contextual or ecological aspects of microbial life to light. Although each microorganism has a specific role to play within the greater ecological whole, no one can fulfill its role in isolation. Bacteria behave differently in the "wild" than they do in the laboratory.

These early insights into the ecological relationships among microorganisms laid the foundation for recognizing what later would come to be termed the microbiome — "the ecological community of commensal, symbiotic, and pathogenic microorganisms" that is present in every bodily organism and appears to play a significant role in the greater organism of Earth as a living whole (Paez-Espino et al. 2016). Our growing understanding of the delicate, dynamic relationships that exist within microbial communities and between them and their host organisms has led to a shift in perspective among researchers. In a 2016 paper, philosopher John Dupré wrote:

> "The boundaries of the organism, which may or may not be taken to include some or all of these symbionts, may be to some extent indeterminate. The realization of the integrated nature and blurred boundaries of organisms has led to claims that traditional (substance-based) metaphysical accounts of individuality should be replaced with a process ontology, as the only 'philosophy of organism' that can make sense of the biological phenomena as we now know them" (Dupré 2016).

Since the late 1980s there has been growing interest in the human microbiome. Like the genome, each person's microbiome is unique. In contrast to the genome, it is not something that comes from the past. As Escherich's research first showed, we acquire microbiota through our interactions with the environment. The infant acquires its first microbiota at birth.[1] As the body matures, the inner microbiotic ecology becomes more complex. Food, outdoor play, dirt, encounters with people, childhood diseases, and more contribute to the growth and development of our microbiome. What lives in the world around us not only becomes an integral part of our bodily organism, but also appears to develop a unique ecology that is not only specific to the individual human being, but also responsive to the individual's mental and psychological state.

Since 2000 microbiome research has expanded to include the presence of viruses in living organisms

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[1] This has been questioned recently in a number of studies. In 2014, Kersti Aagard, a researcher for the Human Microbiome Project identified bacterial DNA in placental tissue. She questioned whether the placenta served as an organ of mediation between mother and child rather than a sterile barrier.

— the virome. Although estimates as to the number of viruses in the human virome vary widely, there are thought to be around 10 viruses for every bacterium[2] in the human organism. Research into the presence of viruses in organisms and the roles they play in the ecology of life has increased rapidly since the end of the 20th century. This is due in part to the development of research techniques that provide metagenomic data. Much of what has been published on the virome of various organisms and ecological communities is based on the presence of viral DNA or RNA in the sample genome. New examples of viral genetic sequences are discovered regularly (Gregory et al. 2019). Although the role of the genome in the life process is still a matter of debate (Holdrege/Talbott 2008, Holdrege 1996), it is clear that the global virome is a major reservoir of genetic diversity (Paez-Espino et al. 2016) and seems to play a central role in the transfer of genetic material between organisms (Villarreal, 2011).

This calls attention to another aspect of the indeterminate nature, the non-thingness of the organism. The substance or materiality of any organism — plant, animal, or human — includes a community of bacteria, archaea, fungi and viruses. These are integrated into the bodily organism and play vital roles in the processes of life specific to that organism. In a recent article in *The Financial Times*, essayist and novelist Siri Hustvedt wrote:

> "The human virome is in intimate interaction with the bacteria in our bodies, the microbiome. We need these fellow travellers to live. Every person is a multiplicity, a community of symbiotic relations that includes a diversity of DNA. In light of this, philosophers of biology have begun to question how to draw the lines between 'us' and 'them' and whether such divisions make any sense at all" (Hustvedt 2020).

Dynamic Boundaries

This double gesture of extendedness and permeability[3] is intriguing. On the one hand, the organism reaches out beyond the boundaries of its own physicality into the world. This gesture of extendedness changes during the life cycle of the organism and comes to expression differently in different organisms. On the other hand, the living organism allows the surrounding world to participate in its own physicality and integrates it into organism-specific life processes. Both gestures are specific to the type of organism and, within this specificity, individualized. The specificity is both ontogenetic and phylogenetic. Neither gesture is static. The qualities of relatedness they express are embedded in a constant process of being brought into existence. For instance, the microbiome — this delicately balanced ecology of microbial life — is continuously recreating itself within the context of the organism in which it exists. And although we are only beginning to fathom the role viruses play in these ecologies, it appears that this role is essential.

A New Virus

Since last December, a new virus — SARS-CoV-2 — has appeared within the context of the human virome. Its appearance has had a major global impact on human society. Fear of the effects the presence of the virus can have on individual health has led to a response that has placed severe restrictions on human interaction and freedom of movement. There is some indication that certain

[2] Canadian scientist Curtis Suttle estimates that there about 10 million viruses per liter of seawater or 10^{30} viruses in the oceans. Nature Reviews Microbiology gives an estimate of 10^{31} viruses on Earth. (https://www.nature.com/articles/nrmicro2644)

[3] In an earlier draft of this essay I used the term hospitality to denote the gesture of permeability. In rethinking the nature of organism-specific gestures of permeability, I realized that hospitality is a uniquely human expression. It is the expression of a quality of intentionality or individual agency. Extendedness and permeability can perhaps be seen as the evolutionary conditions for the expression of specific gestures of intentionality. When viewed from this perspective, extendedness can be seen as the basis for the gesture of intentionality we call interest, permeability for what we term hospitality.

restrictions will continue indefinitely. Schools, universities, even theater and dance ensembles are moving online, since digital technologies appear to offer the possibility of social interaction without the danger of viral infection posed by people being together in the same space. However we look at it, this new presence in the human virome is going to have a lasting impact on how we think about and coordinate human expressions of extendedness.

According to current understanding, the virion — the physical "body" of a virus — is inert. It exhibits no metabolic activity nor mobility. The virion does not appear to have the aspects of agency attributed to viruses in the popular media. Virions do not attack, they do not highjack, they do not trick their way into cells. Until they come into relation to the life processes of a cell, they don't actually *do* anything (Holdrege 2020). What is clear, however, is that certain organisms have affinity for certain viruses. This affinity comes to expression, for instance, in the complementary molecular structure of the spike protein of SARS-CoV-2 and the receptor protein ACE2 present on the membrane of cells in a variety of human tissues (Yan 2020). As a group of researchers from Aix-Marseilles University in France phrased it, if a virus is to infect a human being, certain conditions must be met "foremost among which is the encounter with humans and the presence in *Homo sapiens* of a cellular receptor allowing the virus to bind" (Devaux et al. 2020) If this complementary structure were not present, the virus would not be able to pass through cell membranes and enter into the life processes of the human organism. In the specific expression of its permeability, the human bodily organism offers this new corona virus a gateway into its life processes. SARS-CoV-2 "belongs" to us in a way it does not appear to "belong" to the valerian plant.

We are only now beginning to fathom the role of viruses within the delicate and complex tapestry of relationships that support life on Earth. The appearance of this new virus in the context of the human virome has reminded us that we too are an essential part of this tapestry. Perhaps it is time to take the question of "belonging" seriously and, in doing so, challenge the assumption of linear causality in the relationship between the presence of a virus and the bodily organism's response to this presence. The challenge we face is not how to hold this new presence at bay, but rather to understand the significance of its appearance in our experienced life-world. We will have to choose how we intend to live with our new "fellow traveler." The way we think about the nature of boundaries — about the expressions of extendedness and permeability in living organisms — will play a decisive role in how we make this choice. SARS-CoV-2 belongs within a larger context of which we are also a part. We have to ask whether the way we think about and place ourselves in this context plays a role in bringing this new virus into our lives.

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