



In Context

A Publication of **The Nature Institute**

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#46

Fall 2021



The Nature Institute

Dear Readers,

This issue of *In Context* has a lot to do with the theme of connectedness. It happens to be a theme that has been central to me personally since I was 16 years old. At that time I felt a stark sense of isolation and questioned whether I could find meaning in the world — whether there is meaning to find at all. So the search to discover connections between me and the world, and between the manifold features of the world, has been ongoing. I am glad to say that more and more threads of connection have shown themselves in the course of these 50-plus years. And as a result, disconnect in thought and action — in myself and in others — appears all the more vividly.

One way to characterize the mission of The Nature Institute is to say that we want to cultivate an increasing awareness of how things on earth are truly and inextricably interconnected, and thereby help counteract the increasing fragmentation we witness in the world. So in this issue you can read about different ways of working with this task.

Biologist and author Suzanne Simard is one of the scientists who, through painstaking research, has shown how plants are intimately and dynamically connected through underground fungal-root (mycorrhizal) networks. It has become glaringly clear that the way we habitually think about organisms being separate from each other is woefully inadequate. A central question that arises from her new book (reviewed on p.3) is: How do we move beyond that habitual attitude of mind, which just assumes that things *are* separate from each other, rather than being intrinsically connected?

This is an especially challenging task for geneticists and evolutionary thinkers who, despite ever-growing evidence to the contrary, still often cling to the idea that individual genes are what make things happen in organisms. Steve Talbott shows that it is impossible to understand hereditary, developmental, and evolutionary processes unless we acknowledge that the organism as a whole is the living and orchestrating context for all “part” processes (see p. 14).

This fall, the second part of Henrike Holdrege’s workbook in projective geometry is being published (see p. 5). This book is all about cultivating, in a rigorous way, thinking in transformations and polarities. Working with this kind of geometry can help us develop inner sensibilities that apprehend relatedness and transcend the boundaries of conventional thought.

While geometry cultivates sensibilities through pure thought, at the other pole of human experience we have the sense perceptible world. How to become more present and awake to what experience in the sense world can reveal to us? That is a central theme that Jon McAlice addresses in the feature article (p. 18). He characterizes a relation between ourselves and the world in which there is resonance — a mutual resounding of me-in-world and world-in-me. While we all have moments in which we sense a deeper connectedness with things, a speaking of the world in me, it is another matter to tread a disciplined pathway to cultivate capacities to allow the world to speak every more strongly. That is one way of characterizing the Goethean way of developing experience-based scientific understanding.

Craig Holdrege

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EDITOR: Elaine Khosrova
LAYOUT: Mary Giddens
COVER ART: Kristelle Esterhuizen

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The Nature Institute
20 May Hill Road
Ghent, New York 12075
Tel.: 518-672-0116
Email: info@natureinstitute.org
Web: <http://natureinstitute.org>

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Notes and Reviews

Suzanne Simard's Journey *Finding Connectedness in the Forest*

CRAIG HOLDREGE

“My instinct has always been to listen to what living things are saying”. With these words ecologist Suzanne Simard expresses the intention and passion that has guided her life-long striving to better understand the natural world. Her forebears and relatives lived from logging forests in western Canada. She knew the logging world well, and yet she was always interested in what makes nature thrive, in what brings more life. Throughout her training to become a scientist and in her later work as a Canadian forest service researcher and then professor, she often had to navigate between conventional forest practices and theories, and her underlying sense of their inadequacy. She describes this journey in her book, *Finding the Mother Tree – Discovering the Wisdom of the Forest* (New York: Alfred A. Knopf, 2021).

At the age of 20, she had a seasonal job working for a logging company. Her task was to assess the health of the prickly spruce seedlings that had been planted after large areas of subalpine fir forest had been clear cut. She was disturbed to find so many unhealthy seedlings with yellowing needles. The seedlings had hardly connected with the soil, making them easy to pull out of the ground. The contrast to a young healthy subalpine fir growing nearby was striking:

I uprooted it to compare. Unlike the planted spruce, which I'd plucked like a carrot out of the soil, these sprawling fir roots were anchored so tightly that I had to plant both feet on either side of the stem and pull with all my might.... I was amazed to see the same bright yellow fungal threads wrapped around the root tips as I'd seen in the old-growth forest.... Digging a little more around my fir excavation, I found the yellow threads infusing the organic mat that capped the soil, forming a network of mycelium that was radiating farther and farther afield.



She did not know what the significance of this mycelium network—which consists of fungal threads—might be. But the observation led to a question that motivated and guided her work for the next 40 years: “But what exactly were these branching fungal threads, and what were they doing?”

The manifold discoveries she (and later her students) made showing the connections between soil, fungi, and trees were not easily gained. She worked in a man's world of forestry with its emphasis on clear-cut logging. In an early job for the Canadian forest service she carried out experiments related to a practice called “free-to-grow plantations.” The theory behind this practice was that if you minimize competition with

other plants, the trees will grow best. Her first experiments involved applying herbicide (glyphosate) to all the plants that were growing around and above all the young seedlings that had been planted in a clear-cut a few years before. “I loved learning how to conduct an experiment in the forest but hated turning these plants into ghosts.” Her gut feeling was that the notion of getting rid of all the competition to improve the growth of the plantation trees was misguided. “Here I was, a soldier in a war I didn't believe in.”

In a related experiment, she eradicated assumed competitors and found that “all but one of the treatments would end up failing to improve conifer growth and, no surprise, native plant diversity was lowered. In the case of birch, killing it improved the growth of some of the firs *but caused even more to die*—the opposite of expectations.”

When she landed a permanent research position with the Canadian forest service, she was finally able to carry out research that focused on discovering how diversity might enhance rather than inhibit the healthy growth of trees. Simard carried out a variety of experiments over many years with ingenuity and great perseverance. Some led to her earning advanced degrees. Her doctoral work included

the study of the relation between the growth of birches (considered bad weeds by free-to-grow forestry) and valued Douglas fir seedlings. Along the way she discovered that these two species share a variety of mycorrhizal fungi. Their threads (mycelia) connect the roots of the two plants with each other. She planted paper birch, Douglas fir, and Western red cedar (as a control, since it doesn't share mycorrhizal fungi with the other two) in groups; she deeply shaded some of the Douglas fir seedlings, while others were lightly shaded or left unshaded. This was intended to mimic shade conditions that could occur naturally due to the growth of broad-leaf trees like birches.

Simard made a remarkable discovery. The intricate procedures applied in the experiment involved using two different isotopes (carbon-13 and radioactive carbon-14) in carbon dioxide. Carbon-14 was added to bagged air around birch and carbon-13 to bagged air around Douglas fir. The leaves of a plant take up carbon dioxide from the air to make sugars. If carbon-14 could be detected in the tissue of Douglas fir, or carbon-13 in the tissue of birch, then she would know if the plants were, via the mycorrhizal connection, exchanging sugar sap. The experiment, which spanned two growing seasons, showed that the carbon isotopes were in fact being exchanged. The Douglas fir seedlings received more sugar from the birch than vice versa. The greater the shade, the more transfer of sugar from birch to fir. "Birch was cooperating in lockstep with fir." Birches have a high rate of photosynthesis and were evidently passing on surplus sugar to the firs, especially in shady conditions when the firs on their own would only be able to grow slowly. This was the first field experiment to show that different tree species were exchanging substances via their fungi connection.

This research was featured on the cover of *Nature* in 1997 and drew lots of attention. It contributed to a burst in research into the underground interconnectedness of plants that continues to this day. In the second half of the book, Simard describes extensive research that she and her colleagues and graduate students have carried out. She also makes clear how the logging industry and regulatory agencies, with their focus on short-term gains and the rigid paradigm of eliminating competition to stimulate growth, have been very slow to acknowledge the reality of mutual enhancement through diversity in a plant community.

Her book culminates in the discussion of "mother trees." She and her students discovered extensive mycorrhizal networks connecting the trees within an area of a forest. And it is the biggest, oldest trees that have the most connections and they have the ability to share their substances with other trees and young saplings. So when we picture individual trees in a forest, we are picturing an abstraction. Below ground they are dynamically woven into each other.

Toward the end of the book, Simard summarizes vividly her journey as a researcher:

I'd been taught in the university to take apart the ecosystem, to reduce it into its parts, to study the trees and plants and soils in isolation, so that I could look at the forest objectively. This dissection, this control and categorization and cauterization, were supposed to bring clarity, credibility, and validation to any findings. When I followed these steps of taking the system apart to look at the pieces, I was able to publish my results, and I soon learned that it was almost impossible for a study of the diversity and connectivity of a whole ecosystem to get into print. There's no control! the reviews cried at my early papers. Somehow with my Latin squares and factorial designs, my isotopes and mass spectrometers and scintillation counters, and my training to consider only sharp lines of statistically significant differences, I have come full circle to stumble onto some of the indigenous ideals: Diversity matters. And everything in the universe is connected—between the forests and prairies, the land and the water, the sky and the soil, the spirits and the living, the people and other creatures.

Simard refers to the knowledge and practices of Aboriginal peoples of western North America. They can speak of trees as "people," as beings, that have agency and are wise. This resonates strongly with her, and at the same time she must acknowledge that she cannot "presume to grasp Aboriginal knowledge. It comes from a way of knowing the earth—an epistemology—different from that of my own culture." I know this feeling well.

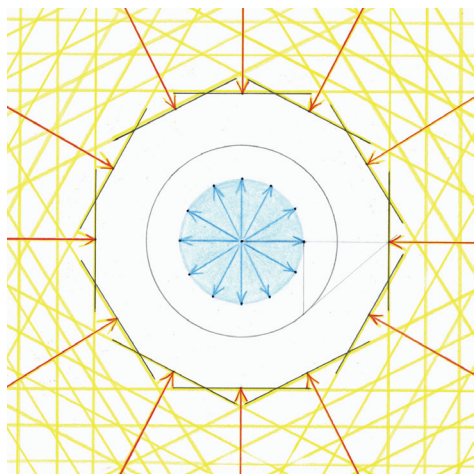
The epistemology of Western culture, which modern science epitomizes, starts with the implicit and sometimes explicit premise of separation or disconnect: I – world; subject – object; inner – outer; spirit – matter. In her scientific work, Simard embodies the epistemology of separation and at the same time, through her strong sense of the connectedness of things, she has been able to use science to show connectedness. And yet she realizes there is still a gulf between scientific knowledge that points to connectedness and a living awareness of being connected, such as that she feels in Aboriginal knowing.

For me this felt tension leads to important questions. Say I have begun to glimpse, as Simard has, the fundamental connectedness of things. In other words, I have begun to realize that separate "things" don't exist in the living world. Can I then begin to practice a way of knowing that takes, from the outset, connection as a reality? How, then, would world (me-in-world; world-in-me) appear? Only then might I understand and bring to realization my agency as part of world agency.

Exercises with Polarity

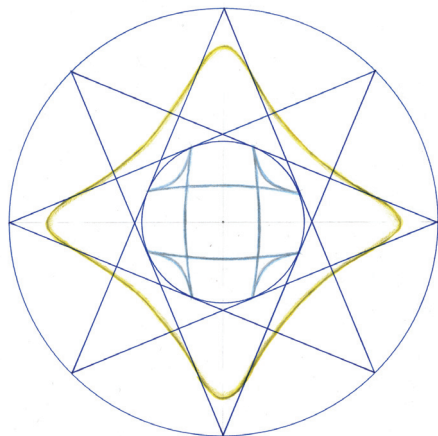
We're pleased to share an excerpt from Henrike Holdrege's new publication *To the Infinite and Back Again, Part II, A Workbook in Projective Geometry*, the companion volume to Part I published in 2019. To order (\$22), go to our online bookstore at natureinstitute.org/store, or call us (518-672-0116), or email info@natureinstitute.org.

Building on the first volume, in Part II of this practice-based introduction to projective geometry, Henrike introduces and works extensively and intensively with the fundamental idea of polarity. Through a wealth of exercises, illustrated with Henrike's drawings, the reader learns to see how every form has, implicitly, a polar opposite form that is related to it. Here we give you an intimation of the expansive tapestry of thought that those who work through the book can enter and begin to weave for themselves:



The blue disk is the “inner” of the growing point-circle. Shading the disk allows me to convey that all points within the circle have taken part in the growth process so far. The “inner” of the point-circle is “filled” with points. The “inside” of the corresponding tangent-circle is filled with lines and cannot be shown as easily. The figure shows only a few of the tangents of the tangent-circle itself. All lines that surround the circle make up its “inside.” All surrounding lines have taken part in the growth process so far.

This imagination exercise allows us to expand our concepts of “inside” and “outside.” We can develop the concept of an “inside” that is centered in the periphery. The peripheral perspective complements the point-centered one. It challenges us in our thinking. The reality of an “inside” centered in the periphery is difficult to express in words.



The characteristics of a curve determine in every detail the characteristics of the polar opposite curve. [The light blue curve inside the inner circle is polar opposite to the yellow curve.] In all of the exercises in this chapter, we realize how important the concepts of point at infinity and line at infinity are. Without them, a geometry of polar opposite curves would not exist. The concept “at infinity” is not a question of distance. It is not a question of something being very far away, something growing infinitely large, something being beyond measure. It is not a question of measurable quantity at all. Rather, it is a question of completeness or wholeness.

Through projective geometry, the wholeness of a parabola or of a hyperbola, for instance, become tangible. Even though we reach the limits of our ability of mental picturing, we can grasp these forms with full inner clarity.

A “whole,” as the saying goes, is more than the sum of the parts. But what does “more” actually mean? Wholeness is not available to us in the way the parts are. Wholeness is in and through the parts, but is not “another part.” Parts we can measure; wholeness we cannot measure. It is of a different nature, and we need to develop a new way of knowing if we wish to catch a glimpse of wholeness.



PHOTO CREDIT: Markus Bolliger

An ancient oak (*Quercus petraea*) near Wildenstein Castle, Switzerland.

Living Perenniality

CRAIG HOLDREGE

This article is a lightly edited excerpt from the new monograph Living Perenniality: Plants, Agriculture, and the Transformation of Consciousness, by Craig Holdrege (New Perennials Publishing; 2021). The book grew out of a collaboration between Craig and Bill Vitek, editor of New Perennials Publishing and director of the New Perennials Project. (Another fruit of the project, a corn and alfalfa study, was highlighted in the Fall 2020 issue of In Context #44, page 6-7.) At our website bookstore, natureinstitute.org/store, you can order a copy of the monograph (\$12), or find a link to freely download a pdf of the book.

The grove of over 500-year-old oak trees in Switzerland that I visited once has been a lasting presence in a landscape that has experienced the ebb and flow of much change. The trees too have transformed. Each year, living in an annual rhythm, they bring forth new roots, branches, leaves, flowers, and acorns; they form new buds and lose their leaves in the fall. Underground they weave with fungi and other plants; bacteria and fungi break down their discarded leaves and, together with myriad small animals, create a humus-rich soil that also supports the life of trees and other plants. While oak leaves feed the decomposers, acorns provide food for various animals. In a mast year, when they produce an overabundance of acorns, teeming animal life thrives, and this, in turn, brings new dynamics into the relations among other species. The trees respond to the changing

conditions of light, air, and moisture in the moment and over longer periods of changing climate. The trees are lasting and they are embedded; they are responsive and they are active. They are exemplars of living perenniality.

The long-lived oaks are enduring but not static. The annual ring of wood that each tree grew in its trunk in 1546 is still there. But it would not be there if the tree as a whole were not, day in and day out, living in receptive and active weaving with the changing world. The width of the ring and the quality of the wood reflect its relation to the larger ecosphere.

What is long lasting and alive is also responsive in the moment. What is long lasting in the sense of solidity, but not aliveness, will be broken down over time and disappear. What endures and is in touch with its context will transform. You don't have living perenniality in nature without continuity and without ongoing transformation.

Dynamic and healthy ecosystems are usually inhabited by a great variety of plant growth forms, from the short-lived to the long-lived. They are all active contributors to the long-term, vital coherence and transformation within a forest, prairie, or lake. Short-lived parts of creatures, such as root tips and root hairs or the hyphae of fungi, and creatures with short life cycles—spanning months in annual plants, weeks or days in nematode worms, to less than an hour in actively dividing bacteria—are all essential in nature's life processes.

Human life is dependent on this living perennality in the rest of nature. Nature is not a separate “other,” outside of me. I am woven into it as an organism and could not exist without it. And yet, in consciousness, I can be essentially oblivious to it. Nothing external can compel me to strive to learn from, honor, and act in relation to the wisdom at work in the world. It is a choice I can make—a choice that does not arise for trees, fungi, and squirrels.

Humanity has—whether we like it or not—a unique place on Earth. Over two hundred years ago J. G. Herder wrote that the human being is the first creature to be “set free” in creation. Clearly, I am not free to live without ground under my feet or the oxygen that plants create. “Set free” points to a state of consciousness—my ability to ponder, choose, strive for a better future, or ignore what’s going on around me. Humans can, in Herder’s words, “look to far horizons” and also “see much darkly and false. We forget our steps, only to be reminded when stumbling on what a narrow basis the whole head- and heart-edifice of our concepts and judgments rests.”¹

To take a perennial view as a human being is to attend to the long term. We consider—in the present—the past, and we look to the future. Grounding for living perennality in a human context lies in the growing insight into the currents of life that are at work in the present. We can learn from the life of nature—nature as measure—and we can consider how human thought and action have influenced and will influence the course of evolution. Humanity has strongly disrupted processes on the Earth. Much of this has to do with egocentric minds that think short term. And also with the drive to do the doable, which manifests in profit-seeking economics and immense developments in technology.

In his novel, *The Caine Mutiny*, Herman Wouk describes a main character as “too clever to be wise.”² This is one conundrum of our situation today. In cleverness left to its own devices, a person can be caught up in a web of ideas—a “cool idea” comes and he wants to try it out. He follows that idea, helped by a cadre of smart people, and develops a product. While the product, considered in isolation, may be ingenious,

the larger context that it will in fact influence and change is usually given little consideration—except to the extent that it serves the limited goals of the creators. It is left to others to pay attention to and deal with all the unintended consequences. You can see this in technology, in laws that serve egotism, or in political and economic structures that reinforce the life-inhibiting status quo.

As human beings we are enmeshed in forms that stem from the past; we are active in the present, and we consider the future. Future is a “not yet” that is at work in our concerns, hopes, and ideas in the now. How can we further a healthy evolution of the planet so that diverse life on Earth—including human life—can thrive? This question embodies a striving beyond what is given today.

How the future should look is not written in the stars. While there is no script, there is much that we can learn from living perennality in the natural world. When we work to gain a deeper understanding of its qualities, we are not only learning new facts. The participation in how life is at work on Earth can enliven our perceptions, help our thinking become more dynamic, and let our doing become sensitive to the contexts in which we are working. We become more rooted in the life of the planet. The wisdom in the world provides guidance.

The study of living perennality in nature will not tell us what to do. It does provide fertile soil for intuitions and inspirations that have the potential to be in touch with what the Earth and humanity need. While we can decry so much that is out of sync in what we do, there are also, all around the globe, people who generate seed ideas, such as the idea of perennial polycultures or the farm as an individualized ecosystem. Such ideas can lead to new creations on the planet, born of human intentions that strive for integration into the large context of life.

When we plant seed ideas, their growth and transformation in the web of life need tending. This includes ongoing attention to process. Are we able and willing to continue to guide their development with a sensitivity to the context they are in and that they are transforming? Do we stay flexible and open to further change? Do we realize that organizational forms also need to be imbued with life and not become rigid structures? Do we continue to learn—and remain aware of our ignorance? These are the kinds of questions that can foster living perennality in human striving.

1. Herder, J. G. (1982). Herder’s Werke, Vierter Band: *Ideen zur Philosophie der Geschichte der Menschheit* [*Ideas Concerning a Philosophy of the History of Humanity*]. Berlin: Aufbau Verlag. (This book was first published in 1791.)

2. Wouk, H. (1951). *The Caine Mutiny*. Garden City, New York: Doubleday.

News from the Institute

Events



- This past June, an 11th and 12th grade science class from the **Waldorf School of Saratoga Springs** came to the Institute to study animal morphology with Craig, using our unique bone collection.

- Stephen Talbott gave a talk for the Linnean Society of London at their online conference, *Evolution 'On Purpose': Teleonomy in Living Systems*, held in June. His aim with the presentation, Steve shares, “was to do what I could to bring attention to the interiority of living things, while noting the distinctions, as well as the connections, between conscious human capacities, the capacities of the cells in our bodies, and the capacities of other organisms. I am convinced that recognizing the connections between conscious human activity and biological activity in general is fully as important as acknowledging the distinctions.” To link to a video of his talk entitled “**Toward a Thought-Full Teleology**” and some brief notes about Steve’s experience of the conference, go to the homepage at natureinstitute.org

- For the first time, we offered an **independent research residency** this past July to individuals



Independent Study group meets to share progress on individual programs.

who have participated in our programs and want to continue Goethean phenomenological research. Seven individuals came to the institute and worked for one or two weeks on an individual project. Projects ranged from studying local bobolinks and cedar trees to investigations of thermal radiation. The residency also included dialogue and study with Jon McAlice, Craig, and Henrike, and many fruitful individual conversations. Several participants were previous graduates of our yearlong Foundation program who returned to the institute for further support in practicing phenomenological science.



- In mid-July, with travel restrictions eased, we were able to host our two **Foundation Year** cohorts for their intensive at the institute; one group completed their training this past summer, the other group will finish next summer. We were pleased to see how the newest cohort, having had a pre-emptive year of remote learning (due to pandemic scheduling changes), had a good foundation to engage fruitfully in all the practical work during the two weeks. As a result, we will expand our program to have a period of remote learning before the first residency. We plan to enroll a new class of Foundation Year students in 2022 (for application information, see box on page 11).





Heather Rosenthal, an MC Richards student, observes Henrike's water pressure experiment.

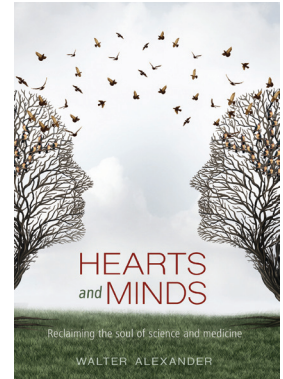
- Beginning in August, we resumed our collaboration with the **MC Richards Program** (freecolumbia.org/m-c-richards-program), a trans-disciplinary course from late summer through the spring for young adults, run by Free Columbia in Ghent, NY. Henrike and Craig will offer participants courses in Dynamic Morphology; Qualities of the Four Elements; Visual Experience; and Learning from Plants.



- Henrike gave an evening talk at the institute in September on "**Practicing Transformative Thinking — The Wisdom of the Cassini Curves**," followed by a workshop the next morning in which she guided participants in a variety of exercises. Astronomer Giovanni Cassini first investigated this geometric form in 1680 when he was studying the relative motions of the Earth and the Sun. Like other work in geometry, this work is a pathway that brings clarity in thinking, challenges the imagination, and can lead to surprising insights.

- In October, New York City-based medical journalist **Walter Alexander**, presented a talk on the findings in his book, *Hearts and Minds: Reclaiming the Soul of Science and Medicine* (Lindisfarne; 2019). He spoke on how the subjective side of human experience has been evicted from scientific processes that are evermore reductionist and mechanistic. While these modes of thinking continue to produce miracles in technology and medicine, Alexander states, they have

discredited the personal and human experience altogether — to great consequence. His work tells a tale of emerging discoveries — ones that restore our own self and consciousness as integral to the workings of the world.



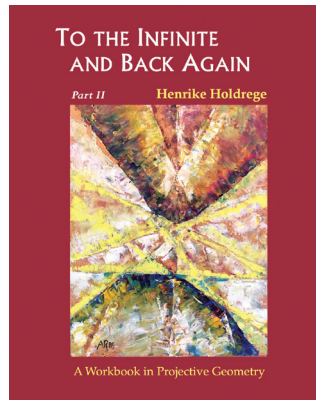
- In the fall, Craig gave a number of online presentations to educational organizations interested in the Goethean approach. The events included:
 - A talk on "How Green is Our Thinking" for the **Kadoorie Earth Programme** in Hong Kong
 - The keynote talk for the 2021 International Conference on Educational Innovation of the Center for **Waldorf Education at National Tsing Hua University in Taiwan**; the theme of the conference was "Facing the Challenges of the Future and Sustainable Development"
 - Three sessions, based on his book *Thinking Like a Plant*, for participants in an online studio that offers classes on **inner development for educators in Taiwan**;
 - A question and answer session about some of the topics in his book, *Seeing the Animal Whole*, with participants in an online course, "Goethe and the Language of Holistic Science" run by **Holistic Science Journal** and **Escola Schumacher Brasil**.

- On November 12 at 7:00 pm, Stephen Talbott will give his final (and just about only) talk at the institute on "**Gestures of Life**," which he describes unapologetically as an offering of "notes from desperately unsatisfactory encounters with the living interior of self and world, along with intimations of their meaning for science." Stephen has been a senior researcher at The Nature Institute since its inception in 1998. For more than 20 years he has been building a body of work (see his *Biology Worthy of Life* project, <https://bwo.life/org/index.htm>) that illuminates natural phenomena and calls for a qualitative approach to examining organisms. Steve's talk is free and open to the public; donations are appreciated.

- Craig has been asked to give a talk in February at the **Annual International Conference of Biodynamic Agriculture** in Dornach, Switzerland. The topic of the conference is: *The quality of biodynamic products and what it means for the earth and for human beings*. Craig's talk will focus on the concept of quality. Today quality is often assessed in purely quantitative terms. What is missing from such assessment? What kind of consciousness do we need to develop in order to perceive and understand quality in a more expansive way?

Publications

- After two years of writing and illustrating, **Henrike Holdrege's** new publication, Part II of *To the Infinite and Back Again — A Workbook in Projective Geometry*, will be available at our online bookstore this fall! A short excerpt is featured in this issue on page 5.

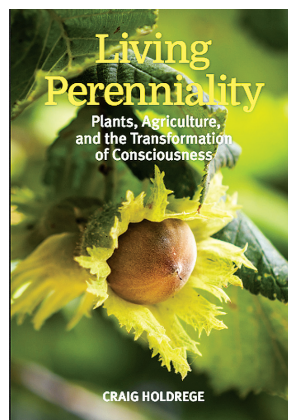


- As the experience of the pandemic continues to affect our lives, it also informs our work. For more than a year, Jon McAlice and Craig Holdrege have been examining viruses culturally and scientifically as a **'boundary phenomena'** — that which arises when we meet something not easily categorized, something that presents a plethora of riddles.

As Jon states, "In such situations, we often overlook the possibility that is being offered and simply tweak established forms to make space for the new appearance. This has certainly been the case in the development of our understanding of viruses. We try to find a way to make them fit into the modern scientific conception of what life is, rather than allowing the questions they raise lead us into broadening and deepening our understanding of life as it presents itself to us."

Craig and Jon will share their findings and insights in a new publication on our website.

- In his new monograph, *Living Perenniality — Plants, Agriculture, and the Transformation of Consciousness* (New Perennial Publishing; 2021), Craig Holdrege weaves together the study of annual and perennial plants, agriculture and its origins, and riddles of human consciousness. (A short excerpt is featured on pages 6-7.)



What connects these disparate topics is his striving to discover and articulate ways of moving beyond learning *about* nature, to learning *through* or *with* nature. In this way, the book proposes, it may

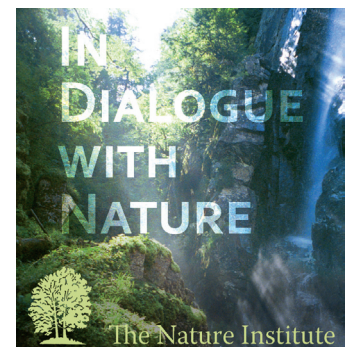
be possible to develop capacities to perceive, think, and act in ways that are in sync with the dynamics of the living world.

At natureinstitute.org/store, copies of the book can be ordered (\$12). A link to a free pdf of the text is also available.

- This past summer, **Resilience.org** published an excerpt from Craig's new monograph, *Living Perenniality* (New Perennials Publishing; 2021). The organization describes its mission as "building community resilience in a world of multiple emerging challenges."

In the fall, Craig's article, "Viruses in the Dynamics of Life," was reprinted in the November 2021 issue of the **Biodynamic** journal. The piece was first published in 2020 at natureinstitute.org and is one of our most popular and shared articles.

- Since the debut this past summer of our podcast, *In Dialogue with Nature*, we have shared episodes on various topics, including a conversation between staff on "Thinking Like a Plant;" a live public talk on "Resonant Space;" and Craig's presentation for his new book *Seeing the Animal Whole — And Why It Matters*. Future episodes are in production. We welcome your comments and suggestions at info@natureinstitute.org.



- The newest chapter, "**Development Writ Large**," in Stephen Talbot's online book *Evolution As It Was Meant to Be — And the Living Narratives That Tell It's Story*, fine-tunes the central conclusion of this seminal work, according to Steve: We already know more than enough to say that evolution is a purposive, or directive, or telos-realizing process. His aim in the new chapter and grounded in all the preceding chapters is to "facilitate the changed angle of vision that can enable the reader to grant full recognition to what is already known. I want to jog evolutionary thinking out of its customary pathways."

The chapter can be linked to from the homepage at natureinstitute.org, or you can freely access the chapter and entire book at our adjunct site, bwo.life.

From Our Mailbox



I wanted to share a recent project that we are neck deep in as a direct result of taking Craig's class. I was out speeding my way through garden tasks about two weeks ago, and there was a monarch fluttering about at the edge of my periphery in a very particular way. I thought to myself, "Craig would definitely tell you to stop your nonsense and quietly sit down and pay attention." And so I did. Turns out she was laying eggs in our small milkweed garden! And so now we are all getting to enjoy protecting those eggs until they get through the caterpillar stage and emerge as butterflies. It's such a delight to see how much bigger they are each morning!

Warmly, Kelsey J. London

Here at Camphill Ghent, we have been greatly enjoying issues of In Context. Our residents in Assisted Living [who have the features read to them] just loved hearing about the life of the bloodroot plant as a manifestation of early spring. We also really enjoyed learning about the buffaloes in a later issue. The depth of observation demonstrated by Craig through his true living experience of the natural world is inspirational. In our fast-paced society, it is a gift to have an organization like The Nature Institute to bear witness to natural phenomena. These cannot—or at least ought not—be hurried. For those in the later part of their lives it is so beneficial to learn about nature in this quiet, attentive manner. In Context has, in this regular, weekly way, become an important part of our cultural and learning activities.

Thank you kindly to all those who contribute to the making of such a valuable resource!

Kristina Labaty

*Resident Volunteer / Marketing and Fundraising Coordinator
Camphill Ghent, Chatham NY*

Applications for The Nature Institute's upcoming 2022 Foundation Course, *Encountering Nature and the Nature of Things*, are now available at natureinstitute.org.

Comprised of two residential summer intensives and 15 months total of guided practice before and between these residencies, our training is for people who are deeply interested in nature and serious about developing an understanding and practice of the science of phenomena. The program offers the challenge and the opportunity to move beyond the static, object-like abstractions of contemporary thought toward a fluid, transformative way of perceiving and thinking.

Comments from recent course participants:

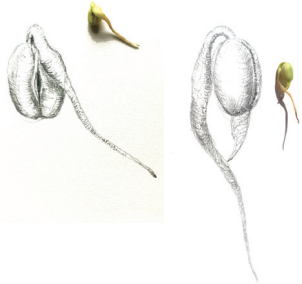
"The course has inspired me to weave more moments for mindful observation into my work with both adults and children. I feel much clearer about how I can bring elements of this practice to people who would not otherwise have access to it."

"This course was a reaffirmation that the senses are what I can keep turning to as a source of inspiration — and culture correction to my thinking. However, I also discovered how importantly disciplined thinking contributes to my world."

Seed Development

Drawing Progress

CECILIA EYSSARTIER



As a biologist and educator, I had the opportunity to participate in a fellowship program at The Nature Institute in 2017 and from this experience, realized that I needed to further focus my understanding of nature by unfolding a new way of seeing. Participating subsequently in the institute's year-long Foundation program in Goethean science with my colleague and husband, Luis Monterubianesi, greatly enriched my view of phenomena in nature, while also allowing for a cross-cultural exchange with participants from other parts of the world.

After our two-week intensive in the program, I studied seed development, creating many illustrations, a few of which you see here.

In order to conduct a thorough research project, I planned weekly observations over a period of one year, which was later extended to two years due to the pandemic. During this time, the drawing practice, which integrates science and art, deepened the quality of my observations. My ongoing experience encouraged by The Nature Institute has made me aware of the importance of practice and time in order to observe phenomena in process and in context.

As a result of our experience, coupled with our professional expertise in biology and nutrition, we developed the Pocket Garden Education Program (<http://qumara.net>) to promote quality food education. We are currently based in Germany and work in partnership with other organizations and universities to integrate the holistic science practice we learned at The Nature Institute. We strive to highlight the multiple possibilities that open up from this qualitative perspective, and for which we are grateful.



Thank You!

*We are privileged to thank all who have made donations or contributed goods or services
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Genes and the Single Organism

STEPHEN L. TALBOTT

This article comprises part of a chapter tentatively titled “Inheritance: The Whole Organism” in Steve’s book-in-progress, Evolution As It Was Meant To Be – And the Living Narratives That Tell Its Story. All the currently written chapters are available on The Nature Institute’s adjunctive website, BiologyWorthyofLife.org/bk/ (or bwo.life/bk/).

IN 1923, Wilhelm Johannsen, the Danish plant physiologist and pioneering geneticist who had earlier given biologists the word “gene,” expressed concern about the way genes were being conceived as neat, cleanly separable causal units. He made the following curious remark, which remains today as intriguing as ever, despite its never having prompted much serious discussion within the field of genetics as a whole:

Personally I believe in a great central ‘something’ as yet not divisible into separate factors. The pomace-flies in Morgan’s splendid experiments continue to be pomace flies even if they lose all “good” genes necessary for a normal fly-life, or if they be possessed with all the “bad” genes, detrimental to the welfare of this little friend of the geneticists (Johannsen 1923, p. 137).

The pomace-fly, of course, was the fruit fly (*Drosophila melanogaster*) that Thomas Hunt Morgan, in his Princeton University laboratory, was famously converting into a “model organism” for genetic studies. Thanks to procedures for mutating genes, controlling the mating of the flies, and tracing the inheritance of traits, this was the fateful period during which “genetic” was becoming synonymous with “heritable.” The fact that whole cells — and not merely genes — pass between generations was progressively losing its significance in the minds of biologists interested in inheritance and evolution.

Johannsen saw that this new genetic work was based on an analysis of the organism into separate and distinct traits, and therefore left untouched what might easily be seen as the central problem of inheritance: the faithful reproduction of kind, or type. While mutated genes might result in (often pathological) *differences* in certain narrowly conceived traits, this sort of change never reached through to the fundamental identity of the organism. Whatever the introduced variations (mutations), the pomace-flies always remained pomace-flies.

But what sort of *differences* are we talking about? In his brilliant, and still decisively relevant 1930 book, *The Interpretation of Development and Heredity*, the British marine biologist E. S.



Fruit Fly (*Drosophila melanogaster*)

Russell took up Johannsen’s point. “When we say that a child shows a hereditary likeness to its father,” Russell wrote, “we mean that it resembles its father more closely than it does the average of the population. *The likeness is observable in respect of those individual characteristics that distinguish the father from the rest of the race*” (emphasis added).¹ Much the same can be said of the child’s resemblance to its mother.

It’s also possible that there will be no particular resemblance to either parent. “But yet in all three cases the child would show the characteristics of its species and its race — it would be a human child, distinguishable as belonging to the same racial type as its parents.” As Russell then noted, this general resemblance in type, whereby all members of a species *share* an entire manner of development and way of being, can hardly be compared to the inheritance of this or that inessential feature wherein a parent happens to *differ* from most other members of the species. This distinction between a fundamental, shared nature and individual peculiarities has practical implications for genetic research:

The broad general resemblances of type give no hold for experimental or statistical treatment, and have accordingly on the whole been ignored. But it is this *general* hereditary resemblance which constitutes the main problem. [The gene theory] deals only with *differences* between closely allied forms, and with the modes of inheritance of these differences; it leaves the main problem quite untouched as to why, for example, from a pair of *Drosophila* only *Drosophila* arise. It takes for granted the inheritance of Johannsen’s “great central something” — the general hereditary equipment of the species (Russell 1930, pp. 269-70).

Whole versus Part

The issue here concerns the distinction between, first, individual features of an organism imagined as discrete and more or less separable parts (traits or “characters”) somehow *caused* by particular genes; and, second, the integral unity whereby every organism exists and functions as a single whole. Isolated “characters” — for example, the color of a pea or of an animal’s eyes — are much more easily assessed and compared than the *character* of two whole organisms of different types. The usual genetic breeding experiments that compare differences in isolated traits of closely related organisms can hardly be applied to the different natures and ways of being of an antelope and a bison — let alone an eagle and a pig — if only because the fact of infertility between fundamentally different types normally renders routine experimental inter-breeding impossible in such cases.²

You might think that, given the broad fact of infertility between different types, biologists would have cast around for new approaches to the problem of an organism’s inherent governing nature, even if it required quite different methods from those they were trained in. What is at stake, after all, is our understanding, not only of the organism, but also of evolution. We certainly cannot answer all the questions we have about fundamental evolutionary change — for example, questions relating to the origin of basic body plans — merely by looking for how specific genes correlate with differences between closely allied forms of the same general type.

The picture I have been developing in this book shows us that organisms are in fact coherent, qualitative, story-telling wholes that inform and define their own parts. Being so informed, the parts share in each other’s identity and become inseparable features of a larger unity. Some such picture has been acknowledged by many biologists throughout the history of their discipline. *If the picture is accurate, then the power to maintain this larger unity across generations — which also suggests a power to transform the unity — would seem to be central to our understanding of heredity and evolutionary change.*

The issue here is truly decisive. Have biologists in our day lost sight of the whole organism because of their fixation upon the molecular parts known as genes? And have they lost sight of evolutionary dynamics because of their fixation upon the hereditary transmission of genes rather than entire living cells?

Russell laid direct hold of this matter when he considered what it meant to realize that the activity of an organism cannot be reduced to the actions of its individual parts. If it is truly the case that the organism as a whole plays a governing role whereby it continually informs its parts with its own

character and “catches them up” within its own activity, then the performance of the whole “can be [hereditarily] transmitted only by a whole, i.e. by the egg in its entirety, which at the very beginning of development *is* the new individual” (Russell 1930, p. 283).

Russell then cited a 1903 comment by the German botanist F. Noll (who was writing before the word “gene” came into usage):

If the egg-cell of a lime tree is already a young lime tree, there is no need of any idioplasm, germ-plasm, pangens, or heredity-substance to render possible its development into a lime tree; the egg-cell *as a whole* is the heredity-substance (Russell 1930, pp. 287-8).

Change and Continuity

In the drama of human cell differentiation, hundreds of cell types, sometimes outwardly differing from each other as much as an eel differs from a goldfinch, are woven with almost infinite attention, intricacy, and complexity into the integral, ever-adapting unity of the organism as a whole.

Is this not one angle from which to view Johannsen’s “great central something”? The *something* in this case is not in fact a *thing* at all, nor is it a steady state, or stasis. It is an activity — and always an activity with counter-balancing tendencies. In a developing organism we find ourselves looking at change within continuity — the ongoing transformation of an enduring unity. All the cell lineages (including the germ-cell lineage) undergo differentiation even as they continue to participate in the forward-looking and adaptive way of being of the whole organism.

Change and continuity: every organic whole embodies — *lives* — a harmonization of these contrasting principles. But these are exactly the principles that any theory of evolution must somehow reconcile. It’s obvious enough that you can’t have evolution without change. But so, too, without continuity there is only the arbitrary substitution of some elements of a mere aggregate for others, with nothing that lends significance to the result. If the change is to be non-arbitrary or coherent, there must be a persistent character attributable to the whole. Without continuity no enduring, nameable entity or being exists of which we can meaningfully say, “Yes, *this* is evolving.”³

So every organism already shows us the sort of reconciliation, or harmonization, of change and continuity that evolution requires. And yet, because the complex developing organism generates its stunning diversity of cell lineages after having received but a single inherited genome, we cannot point to random genetic changes, or mutations, as the explanation for the dramatic and observable differences between lineages.⁴

The whole-cell transformation of a differentiating lineage just does not represent the kind of power evolutionary theorists are interested in. It is too living, too complex, too holistic — and therefore too difficult to analyze into a set of unambiguous, discrete causes. In the spirit of reducing the whole to experimentally tractable parts, theorists have, bizarrely, insisted on regarding mutations in the heritable genetic sequence as the primary or sole basis for all evolutionary change. They somehow feel more comfortable dealing with the neat, statistically manageable occurrence of supposedly particulate, difference-making mutations than they do when facing the transformative capacities of living beings.

On the face of it, the failure of biologists to explore the powerful explanatory potentials of the organism's more-than-genetic, whole-cell capacity for directed change seems to reflect one of the most egregious and crippling blockages of thought in all the history of science. Why should a forward-looking, adaptive capacity, natural to all organic activity and powerfully evident in all the cell lineages of the body, cease altogether at just one decisive point: namely, the point where the germ cell lineage contributes a gamete to the next generation?

If anyone is appealing to mysticism or magic, presumably it is those who posit such an otherwise unexplained hiatus in the organism's routine management of its differentiating cells.⁵

An Extraordinary Power

Think of it this way. In a young human embryo there are slightly differentiated cells of many distinct types, called *progenitor cells*. A progenitor cell of any given type can, by dividing, initiate a particular cell lineage. Through a process of repeated division and differentiation, the lineage “evolves” toward one of the many, often strikingly diverse cell types of the body. So each progenitor cell possesses a potential to enlist all its resources, including its genes, in a journey often extending over many cell generations, leading to a particular sort of “creature” — a living entity such as a muscle cell, a liver cell, a kidney cell, a skin cell, a neuron, and so on.

Now think of the zygote. It is formed from the fusion of two gametes, followed by their profound metamorphosis into a single-celled, functioning organism. This zygote is the *progenitor of all progenitor cells* in the new organism, possessing in itself all their combined potentials. This vast range of potentials, *held by the zygote as a carrier of inheritance*, is actualized and manifested as a power of whole-cell reorganization involving all present and future cellular resources, first, in the zygote itself, and then in all descendent cells along their many lineage trajectories.

We can hardly help acknowledging the overwhelming reality of this inherited power of whole-cell transformation

— a power that proves highly adaptive in the presence of novel circumstances, and a power that vividly demonstrates the organism's ability to employ its one inherited genome in the service of radically divergent living entities (cells). And yet, in the face of this reality, generations of biologists have almost unanimously declared that the only things passed through inheritance that can account for evolutionary change are differences (mutations) in the genetic sequence. The transformational power of the inherited cell as a whole, extending vastly beyond the influence of its genes, can, they've told us, be disregarded. All this without any effort actually to investigate the evolutionary significance of the power of the whole cell, and even with an occasional acknowledgment that “we wouldn't know how to begin pursuing such an investigation.”

And this is the “settled science” that everyone interested in evolution is required to accept at risk of being called a “science-denier”?

The sort of complex, circular, “everything-affects-everything” causal interplay of whole cells and whole organisms is readily observable by every researcher, and has been recognized ever since Immanuel Kant first drove the point home in his *Critique of Judgment* in the late eighteenth century. So why has it been such a struggle, throughout the subsequent history of biology, for biologists to hold on to an awareness of the wholeness and self-transforming activity of organisms? And why have evolutionary biologists allowed their judgment to be so distorted by a simplistic preoccupation with randomly mutated genes as difference-makers?

As we have seen, E. S. Russell rejected the gene fixation that has now bedeviled geneticists and evolutionists for a century. His work was part of a broad, international effort among biologists during the first half of the twentieth century to found biology upon facts of the organism that anyone could see. But then came the “Modern Synthesis” with its gene-centered view of evolution, followed at mid-century by the molecular biological revolution, which, so it was thought, powerfully reinforced the gene-centered view of the organism. So the organism that anyone could see disappeared, giving way to an imagined organism viewed through a purely conceptual, gene-shaped lens. And with the triumph of the gene, the proponents of whole-organism biology were erased from biological narratives, except as quaint historical examples of “mystical” or “vitalist” thinking.

If there has ever been a greater example of willful refusal to face obvious truths within a major field of science, I am not aware of it. In the remainder of this chapter, I will look at some of the underlying inclinations behind what I am calling “the genetic distraction,” which has so powerfully wrenched evolutionary biology away from any reckoning with the actual life of organisms.

NOTES

1. On the relevance of Russell's work today, see "Heredity, Development and Evolution: The Unmodern Synthesis of E. S. Russell" by Maurizio Esposito (2013).
2. Hybridization does in fact sometimes occur between distinctly different species and, as I pointed out in Chapter 20 ("Development Writ Large"), it is possible that this contributes to rather dramatic evolutionary change. But such instances hardly lend themselves to the usual search for genes that make particular differences, since hybridization is likely to generate massive genetic change and cellular reorganization — changes far too extensive and global to allow for conventional genetic approaches. So one is still left with the unsolved "problem of the whole" — the problem that genetic analyses were designed to steer clear of by focusing on particular genes causing particular trait differences.
3. Many biologists would doubtless say, "We don't *want* to speak of the organism as a meaningful entity or being. It really *is* just a mere material aggregate that happens by chance and natural selection to have the features it does." But this is not honest, since every biologist, so far as she is doing biology and not physics, speaks of organisms as living beings with a recognizable, sustained, and consistent nature — and speaks with a vocabulary overflowing with the meaning of that nature. On this, see the discussion of a dog and its corpse in Chapter 2 ("The Organism's Story"). If one felt oneself really to be speaking of a mere aggregate, one could no more talk about its evolution than one could talk about the evolution of an arbitrary arrangement of pebbles upon a patch of ground. Moreover, it is impossible to cite natural selection without invoking all the capacities of active beings who strive for life, assemble inheritances, and, in general, carry out all the performances implied by their particular natures.
4. Evolutionists are interested in germline (heritable) genetic mutations as the primary basis for evolutionary change. No one will quarrel with the fact that we lack any such mutational basis for the very great changes that can occur in the differentiating cell lineages of a complex, multicellular organism. But we *can* ask whether there are non-germline ("somatic") mutations along the various paths of cellular differentiation, and whether these are important for the success of differentiation. The question is being actively explored today. But we can already say

this much: to whatever degree somatic mutations do occur and are important to cell differentiation, the fact would show that the organism manages and directs its own genetic mutations. Why? Because cell differentiation (and development in general) are such obviously *directed* processes. If mutations are an essential part of these processes, we can hardly believe they play their roles in a random manner.

5. The tendency of evolutionary biologists at this point is to claim there is no evidence for anything like a whole-organism, future-oriented, transformative capacity taking hold of germ cells or gametes. This is to ignore the fact that the development and specialization of the germ cell lineage is at least as dramatic and well-directed as the differentiation of any other cell lineage in complex organisms. But, just as important, the claim of "no evidence" for more-than-genetic, whole-cell inheritance usually reveals itself as spectacularly circular, being based on the argument that, whatever the transformation we witness in germ cell lineages, we don't see corresponding changes in the genetic sequence. In other words, an insistent *assumption* that all heritable change must take the form of germline genetic mutations is being used to refute the claim that there is more-than-genetic, whole-cell, heritable change.

When confronted with the problem of the character of the whole cell, biologists have a tendency to cite the impossibility of carrying out their usual analyses wherever one insists on speaking of "wholes." In self-defense they sometimes add that the very idea of a whole invites vitalist or mystical thinking. And so there has never been a major research program aimed at tracking how whole-cell inheritance might play into evolution.

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Resonant Space

JON MCALICE

This is a revised version of a public talk given by Jon on April 25, 2021 at The Nature Institute (and available for listening at our podcast, In Dialogue With Nature, natureinstitute.org/podcast). Here the oral character of the presentation has been retained.

I WOULD LIKE TO SPEAK about a topic that appears to cross many of the arbitrary boundaries we draw in our ongoing attempt to make sense of the world we experience. Resonance is a phenomenon well known among physicists. Yet it also seems to play a role in living organisms. It is also something we speak about in relationships between people. I feel a sense of resonance for certain people. Others don't resonate at all. Ideas can also resonate with us. I'd like to explore with you the question of resonance as it relates to the way we understand things — resonance as an aspect of human consciousness.

I am going to begin in 17th century Holland. In 1655, Christian Huygens, the Dutch inventor of the pendulum clock, placed two ladderback chairs back-to-back about three feet apart. He laid a board across them and hung two identical pendulum clocks from it. Why? Huygens was searching for a means of determining longitude. At the time, sailors who ventured beyond the sight of land had no way of determining exactly where they were at any given time. Whereas latitude, relative north-south position, could be determined by observing the stars, there was no comparable reference point for determining longitude. Huygens quite rightly thought that the key lay in clocks but had yet to design or find a clock able to keep time accurately during a long ocean crossing.

The discovery Huygens made as he observed the two clocks did not help him solve the riddle of determining longitude. As he watched, the swing of the two pendulums became synchronous, although in opposition to one another. When he wrote of his discovery to the Royal Society of London, he described it as “an odd kind of sympathy.” Through a felicitous combination of luck and ingenuity, Huygens had stumbled onto a phenomenon that continues to challenge physicists to this day. What he described as an “odd kind of sympathy” is a resonance phenomenon. Sympathetic resonance occurs under varied conditions. Common to all of them is movement. In the world of acoustics, it appears when we take two similar tuning forks, one of which is mounted on a sounding body. If we strike one fork and bring it into proximity

with the other, the latter will also begin to sound. This can be demonstrated quite beautifully using a cello or other stringed instrument. If one fork is held against the top of the cello, then the second fork struck and brought close to the first, the entire instrument begins to sing. Even when we then quiet the first fork, the instrument continues to resonate.

Although there is no direct, mechanical connection between the two vibrating metal forks, the second fork begins to sound when the first is brought close to it and continues to sound when the fork initially struck is stilled. The resonance is sympathetic: the second fork vibrates in sympathy with the first. We have a specific relationship between two bodies in which one picks up the vibration of the other and continues to let it sound. They do not touch one another. There must be a space between them. This space is known as the resonant space.

In what follows, I'd like to take a closer look at this space “in between.” I am not going to focus on its physical properties. What interests me is to what extent this question of resonance and the characteristics of resonant space can cast light on the riddle of human consciousness and how the world comes to have meaning for each of us.

In recent years there has been an awakening interest in how we relate to and come to know the world around us. The way we experience the world and our relationship to what we encounter contrasts starkly with the dominant paradigm we use to explain this relationship. Common to neuroscience is the conviction that what we experience is, in reality, a construction, perhaps an illusion, created by the brain. I was recently speaking with a young man, an apprentice gardener who asked, “Do you really think people believe that?” I answered no, I don't think most people believe that. Most of us trust that the world is real and intuitively recognize that the answer to the riddle of consciousness and meaning is not to be found in the complex chemistry of neural networks. It is time we learned to trust our experience. Perhaps it is the key to a better understanding of how we bring the world to consciousness.

If we reflect on the growth of our own understanding, we soon recognize that there is a quality of reciprocity between the world and ourselves. Consciousness grows out of encounters. We must be in the world to come to know anything about it. At the same time, the world we are in changes as we come to understand it. The challenge we face is to learn to characterize this relationship in ways that do not place the person experiencing world — ourselves — outside of what is taking place. Our consciousness of the world and the world itself are not two separate discrete entities. We are in the world and of the world, a relatedness that includes human consciousness. Relatedness is innate in the act of knowing. The way we experience this relatedness colors the way we know.

A Space of Learning

One person who has turned his attention to these questions in recent years is a German sociologist and political scientist from the University of Jena. I first discovered Hartmut Rosa through a friend in Germany who sent me the link to an essay on *Resonance Pedagogy*. This essay bears the subtitle, *When it crackles in the classroom*.¹ Rosa and his colleague Wolfgang Endres took a look at school culture from the point of view of resonance. The central question had to do with learning and the conditions under which students learn and are able to retain what they learn. They point out that learning is something that happens between child and world. It is dependent on a quality of experienced relatedness between the child and “world.” Rosa and Endres characterize the resonant classroom as a learning space where the reciprocal nature of the relationship between the learning child and the world holds sway. Teachers are on the whole quite aware of this. The best moments in a classroom are the ones that crackle, where the space is rich with shared attentiveness and students are completely caught up in the wonder and joy of discovery and insight.

I recently introduced a group of middle school students to the riddle of the circle. When I teach, I ask myself what series of experiences will allow my students to enter fully into the task at hand? What sequence of events will allow the students to internalize the question to the point that it comes alive in them and between them? With this group of students I began by giving them a long rope and asking them to measure the driveway. To do so, they first had to measure the rope, organize themselves, stretch the rope,

mark the end point, re-stretch the rope and so on. I think you can picture the process. This is a full-body activity. I continued then along the same lines. Once they knew the length of the driveway, I asked them to walk it off and keep track of their paces. Each of them walked it three times down, then three times back up, counting their paces each time. We averaged the six trips, then divided the total length of the driveway by the average number of paces, giving each student a sense of how far they travel each time they take a step. This is something that is very individual. Taller students tend to have longer paces, shorter students shorter ones. But even then there are differences that reflect the student’s attitude towards the world. The way we each

place ourselves on the earth and move across it is individual.

Having calculated our paces, we took shorter ropes, measured them and with one student standing at the center of an imaginary circle other students took turns holding the end of the

rope and walking around her while they counted their paces. The rope was the radius, and the students paced the circumference. We did this a number of times with ropes of different lengths until the students began to get a feel for the relationship. From there we moved on to smaller circles where they could measure the diameter, then find the circumference using a bit of string. All the measurements were written up on the board. The students divided them up and began to calculate the ratio of the circumference to the diameter.

If you ever want students to practice their arithmetic, don’t give them work sheets. Get them involved in something real. Let them measure real things in the real world. They become involved with what they are doing and the work of figuring out what they have found also becomes something real. By engaging with the world, the riddles that are there come to life for them. They are neither distant nor abstract. The space between child and world becomes fuller and richer. The atmosphere in the classroom shifts. You can see the students sitting a little straighter, leaning forward as they work. Their cheeks take on color. The boundary between the children and the circle has become somewhat fluid. The space that has opened up between “world” in the form of a circle and the students learning to know it — of being engaged with it — that space takes on a different feel. This atmosphere is what Rosa describes as resonance or a resonant space of learning.

If we reflect on the growth of our own understanding, we soon recognize that there is a quality of reciprocity between the world and ourselves.

Recognizing Reciprocity

How can we work today to consciously or intentionally enliven this space between subject and object, between individual and world?

It is very clear that the last year has highlighted the need to work more intentionally with questions of knowing and meaning. We have experienced first hand how difficult it is to cultivate a resonant relationship with what is happening in the world. How do we begin to sift through the various opinions and bits and pieces of information to gain a meaningful relationship to SARS-Cov-2, to Covid-19, to the different streams of intent shaping public consciousness? Leaving out all the problems caused by media and government: How *is* a person supposed to find a resonant relation to a virus? Many aspects of our civilization cripple the ability of the individual to engage. This is a challenge we face as a society. Can we begin to recognize engagement and resonance as necessary forms of relatedness? Perhaps resonance is not simply a metaphor, but an essential aspect of being part of the world.

In his more recent work, Rosa focuses expressly on resonance as a fundamental gesture of consciousness. In *Resonance*, his most comprehensive work on the topic to date, he gives us four characteristics of this gesture of relatedness. He begins by saying that "... resonance is a kind of relationship with the world in which subject and world are mutually affected and transformed."² In his view, the resonant relationship is such that not only the subject, but the individual who meets and becomes engaged with the world is changed. The world, the other, also changes. He speaks thus of a reciprocal relationship between the knower and what is known. This is immediately evident in interpersonal encounters. "Resonance is not an echo, but a responsive relationship requiring both sides to speak with their own voices."³ This is to some extent what we hear when we listen to the tuning forks. The second fork doesn't merely echo the first one. It is its own voice that we hear.

Rosa then points out that this only occurs under certain conditions: "Resonant relationships require that both subject and world be sufficiently closed or self-sufficient to

each speak in their own voice while also remaining open enough to be affected or reached by the other."⁴ This is a significant statement. The experienced boundary between world and self is essential for the development of resonance in a relationship. The possibility of resonance rests on the experience of discontinuity. World begins where I experience my own boundaries. The experience of boundedness awakens me to the space between myself and the world that I encounter.

This is, for Rosa, a completely objective experience. "Resonance is not an emotional state but a mode of relation that is neutral to the emotional content. We can love sad stories."⁵ It is a mode of relatedness in which we can be and are touched by what we experience. The world does not leave us unmoved.

In contrast to the mode of relatedness he terms resonant, Rosa describes its polar opposite: the experience of alienation. "Alienation denotes a relation of relationlessness in which subject and world find themselves inwardly unconnected from, indifferent toward, and even hostile to each other."⁶ The experience of alienation is one of the great challenges of modern times. Whereas a resonant relationship can be seen



as a reciprocal movement of shared growth, alienation tends towards an increased sense of distance and isolation. The world grows mute, and we become less and less able to engage with it in ways that allow us to hear what it has to tell us.

The experience of alienation is relatively new. The late writer and thinker, Barry Lopez, spent much of his life exploring the way human beings relate to nature. He was a very fine observer of nature and of the way different peoples place themselves in relation to the natural world. He spent a great deal of time with indigenous communities in various parts of the world. He speaks of the dichotomy Rosa describes in a slightly different manner. He speaks of it in terms of place, suggesting that we as modern individuals often have the tendency to not truly *be* anywhere, even if we are physically present in a given space. He suggests that we would rather *think* about the fox slinking through the meadow, than *be with* the fox slinking through the

meadow.⁷ It is this habituated inner distance from the sensuous, tangible world that, when taken to the extreme, leads to the mode of alienation that Rosa speaks of. It is an embodied gesture of distance through which we rob the world of her voice. We make her mute.

In consequence, the individual human being also experiences their self as inconsequential. When the world ceases to speak, we lose our voice. When the world ceases to mean something to us, we experience meaninglessness. This lack of meaning, the loss of the experience of meaning, is the inner expression of a lack of a sense of connectedness. Alienation is the enactment of an embodied sense of separateness.

There is a need today to learn to move intentionally into a new space of relatedness. To be able to experience ourselves as conscious individuals in connection with the world. Can we craft spaces of resonance? Experienced spaces resonant with interest in which the world can bring herself to expression in me?

Living into Attention

I'd like to describe a series of resonance-making steps that I first became aware of in an encounter with a cactus in a desert in Southern California. The details are not necessary to relate here, but it was a close encounter, an intimate encounter. It was one of those moments in my biography when the world taught me something important about being a self. It awakened the questions in me: What are the stages of crafting an intimate relationship with the natural world? How do we learn to move in the right way to become resonant with what is alive in the natural world? The movement I am speaking of is inner movement. What is the quality of inner movement that allows me to *be with* world in such a way that world can resonate in me?

The first step is, of course, that we have to get out into the world in order to meet what is there. This means we also have to quite literally get out and move. Encounters with the world do not take place in front of a computer. Moving through the world is a fascinating experience. If we are attentive, we realize that the world is constantly changing as we move. It never stays the same. Imagine a tree. As you move past the tree, its shape, its coloring, the play of light and darkness — all change constantly. The tree as a perceptual reality is in constant flux. You can stand at a distance and see the whole tree from one perspective. As you draw closer the tree changes. You are able to see a part of it more clearly but you see less of the tree.

This dynamic relationship between the changing world and the moving human is something we don't often pay attention to. The world is constantly showing us different aspects of herself as we move through her. If we are attentive

to the changing world as we walk, we realize that she always shows us some new aspect. There is a very gratifying practice of walking the same path every day while being attentive to what the world is going to show me anew each day. These are often little things, things that are easy to overlook.

This first step of going out into the world and attending to what comes to meet us I would like to call "encountering." It demands of us a combination of wakefulness and openness, the willingness to meet the world and notice what it has to offer in this place, in this moment. Inherent in this attitude is the recognition that the world comes towards you. It comes to meet you. Goethe spoke of it as the world thrusting itself upon you.⁸ I experience this when noticing something causes me to slow down. Something in the world comes to meet me, I notice it, I slow down. This is a key moment. I need to make a decision. I can either turn towards what has come to meet me or I can turn away. I am free to do either one. Encountering and noticing are in a certain sense given; they happen. The decision to turn towards, however, is not given. It is something I choose to do. By choosing to do so, I place myself in a new relationship to the world. It is a relationship that bears a gesture of intentionality.

Early one morning, I found two geese swimming on our pond. It is not uncommon to find geese there at this time of year. Rather than walk by and continue on my usual path into the woods, I paused and listened to their calls. The rhythm of their back and forth caught my attention. The two geese were in sync with each other. They were engaged in a rhythmic call and response. I lingered and listened into the exchange wondering what it was that I was party to. Was this the beginning of a mating ritual? Were they telling each other stories?

Not long ago, I had a similar experience. We had had a late winter snow, enough to cover and soften the landscape. The ground was once more pure white. I was walking along a small stream. The water was very dark against the whiteness of the fresh snow. It was flowing along through hillocks and tufts of snow, sometimes seen, sometimes unseen. The flowing water, dark against snow, has a sinuous quality. As I was watching it I noticed another dark sinuous movement, as fluid as the water. My first thought was that there was another arm of the stream that I hadn't noticed before. But that thought didn't feel quite right; dissatisfaction with my initial judgment drew me to look more closely. I turned towards it, following the movement and sure enough, when it emerged from behind a rock just downstream of where I was standing, I saw that it was an otter, the first I have seen since moving here years ago. It was a deep, rich black and its movement was so fluid, so sinuous that it was hardly discernable as being different than the water with which it moved. Yet its presence in the landscape was very different than that of the water.

The moment of dissatisfaction is often present when we choose to turn towards something. It is the recognition of something new, something that is not yet a part of our accustomed sense of the world. We can also speak of it as a moment of productive discomfort, the presence of something new, something that asks us to make space, to grow.

The act of turning towards what the world has extended to us rests on an openness for what comes to meet us, our willingness to be open for an “other.” Turning towards is the affirmation of this openness.

Now something new comes into play. We focus our attention, we attend to.

Something in the world draws our attention and we respond by focusing our attention.

The response strengthens the stream of attention that draws us into relationship with what we are attending to. Taking the example of the otter, I found myself observing, trying to anticipate where its movements would take it.

It drew my attention along with it, yet it could only do so because I gave it my attention.

Something like a dialogue emerges. I found myself listening to the movement of the otter, quite consciously living into it.

The practice of these first four steps — encountering, noticing, turning towards and attending to — not only shifts our relationship with the natural world, it also changes how we meet one another. The world would be a different place if our general attitude was one of joyful anticipation for what each turning, what each new moment, has to offer. I think that it would be fair to say that many of the changes we hope for in the world would become possible if we were to develop a life practice based on these first four steps, if we were to go out into the world open for new encounters, if we were awake enough to notice what the world brings to meet us, if we were to choose to turn towards what we meet and to attend to it and enter into dialogue with it.

Resonant Science

We can also, however, take this a number of steps further. If we choose to do so, this life practice becomes a discipline and the basis for a new kind of science. The first four steps lead me to a relationship with the world that is enriching and through which I develop a sense of trust, a sense of belonging. It can awaken in me the question whether the world also is enriched. If I attend closely to a certain plant

and begin to know it, the world grows richer for me. I notice the plant in many different settings. When I attend to the plant and find joy in its presence wherever I meet it, does something also change for the plant?

Does the way we engage with the living world have an impact on its vitality? If we take our own experience as embodied beings in a living world, we recognize that the plant, for example, is only there for us if we engage with it. The presence of the plant is dependent on our being conscious of it. Does the way we are conscious of the plant in its *plantness* make a difference? This is a question we will have to take

seriously in the coming years. We use the living world without ever considering whether it also needs something of us. Over the course of time, using nature for our own needs has evolved into various forms of abuse or exploitation. We have come to act as though the world were something foreign to us and we to it. If friends lose interest in one another the friendship dies. What happens to the earth if we lose interest in it? Is human interest an in-



tegral part of the vitality of the living world?

When we attend to the world, we begin to realize that certain things stand out for us. Different people meet and notice different things within the same context. Certain things speak to each of us more strongly than other things do. And some things awaken in me as a question, a riddle. Engaging with the experience of the world as riddle, as something to be solved through your own engagement opens up a next stage in the crafting of resonant space. It is one thing to meet an otter, be moved by its presence and enriched by the experience. It is another thing to engage with the otter, to live with it or let it live on in me — to begin to wonder about the nature of otterness. The otter is a remarkable creature. Have you ever watched an otter move? It flows, in and out of the water, along the banks of the stream. What is the nature of an animal that brings itself to expression in this sinuous, flowing movement?

I can choose to give my attention and interest in an ongoing manner to this riddle of being an otter. I can live with it and return to it. The encounter with an otter does not have to merely be an isolated incident in life. I can begin to cultivate a relationship with the otter's way of being in the world. I can think about it, I can reimagine it. I can go back, sit quietly on the bank of the stream and hope that the otter shows itself again. Perhaps it will, perhaps not.

The choice I make is to let the otter become a part of me. I wonder about the otter, and embody this wonder. I learn to know the otter's tracks, its den, where it fishes and where it swims. With time, I gain a sense of the otter's bodily form, its physiology, I learn to know what it eats, the way it lives: it begins to make sense. I begin to keep track of what I observe and discover. Others have also studied the otter. What have they observed? I engage with the riddle of 'otterness' intentionally. And I deepen my relationship with the otter.

This deepening has consequences. I begin to catch glimpses of the unique way the otter has of being in the world. In other words, I begin to hear the otter's voice. Each glimpse widens my sense of the otter and sharpens my ability to observe the otter anew. The dialogue that ensues becomes increasingly dynamic and also curiously intimate. I find myself caring about the otter. I feel a growing sense of responsibility for it. The more deeply I understand the otter's way of being, the more resonant the otter's voice becomes in me, the more I care about the otter.

The experience of the reciprocity between understanding and caring casts a light on an essential aspect of a Goethean approach to a scientific understanding of nature. It is not simply a different way of coming to knowledge about the world. It is a way of approaching knowledge that expresses itself in me as the impetus to care. It is a science of caring rooted in the capacity to understand.

The possibility for resonance rests on the experience of separateness. Without the experience of distance, we would not be able to choose to care. As the philosopher Emmanuel Levinas pointed out, hospitality is only possible when one has something to give and knows that they have it.⁹ A scientific approach that does not engender in the scientist a deeper sense of responsibility may provide valuable knowledge but will ultimately lead to a way of knowing that is barren of human warmth.

This is something we can recognize in many of the arguments concerning the ecological consequences of modernity. If we only think of bees and the problem of apian mortality in terms of the loss of pollinators and the possible effects on the global food supply, we will not be able to make the life choices needed to share the earth with them. We can only learn to live with the bees in a way that allows the bees to also thrive if we are able to experience them not as things but as living presences: when we are able to hear them, when their way of being in the world resonates within our own. This is the practice Goethe enacted and described. By doing so, he demonstrated a path of scientific understanding that leads to greater intimacy with the world. He teaches us to see in ways that also allow us to hear in the language of the phenomena themselves.

I'd like to return to Barry Lopez for a moment. One of his

last essays is titled "The Invitation."¹⁰ In it he describes traveling through the Arctic with a group of indigenous friends. At one point they came across a grizzly bear eating a caribou. Lopez describes the difference between his friends' response to this incident and his own. One of the remarkable things about Lopez's writing is his honesty and lack of sentimentality. He writes,

Their framework for the phenomenon, one that I might later shorten to just meeting the bear was more voluminous than mine and where my temporal boundaries for the event would normally consist of little more than the moments of the encounter itself, theirs included the time before we arrived as well as the time after we left. For me the bear was a noun. The subject of a sentence. For them it was the gerund bearing.

He goes on to describe how they follow this *bearing*, the being of the bear enacting itself in the landscape. They have a sense of where the bear has come from and where the bear will go. He concludes:

A grizzly bear stripping fruit from blackberry vines in a thicket is more than a bear stripping fruit from blackberry vines in a thicket. It is a point of entry into a world most of us have turned ours backs on in an effort to go somewhere else, believing we'll be better off just thinking about a grizzly bear stripping fruit from blackberry vines in a thicket. The moment is an invitation and the bear's invitation to participate is offered without prejudice to anyone passing by.

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