In Context

Number 36 Fall 2016

The Newsletter of **The Nature Institute**

#36

Dear Friends,

Writing this letter once a year in the midst of New England's autumn colors, we find it hard not to repeat previous exclamations about the gorgeous brilliance of the display. But a rather contrary thought arises now, thanks to a pair of polarizing sunglasses I (Steve) was wearing a day or two ago while walking through the wooded countryside. These glasses made the oranges and reds much brighter and redder, and the blues even a deeper blue than what the naked eye perceives.

This raises an interesting question: is it just the colors as such that we marvel at in the autumn foliage? If so, why not be content to walk around all the time with glasses that produce one or another sort of dramatic effect—something we can do any time we want? Yet surely most of us would find this thought rather repellent, and would much prefer to take in the sights with our unaided senses. It is worth asking why.

Is it not that nature's performance strikes us as somehow significant? The autumnal show takes place as part of a profoundly life-shaping yearly cycle, and it seems to be saying something to us—or would do so if only we could pick up on it. We find ourselves wanting at least to give the performance a chance—to absorb the message unconsciously through our pores, so to speak, if that is all we can manage. Even a more or less blank sense of wonder is already an appreciation of *something*, despite our not knowing quite what it is. And it can stimulate us toward greater attention and a disciplining of our powers of perception.

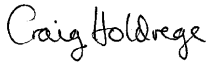
But this whole line of thought produces a darker reflection also. For it is evident—as others in our society of screen-delivered experiences have noted—that many people are indeed finding the lure of special effects and artificially produced sensation more powerful than the invitation of unmediated natural phenomena. These phenomena all too easily fade into insignificance beside the ever more vivid productions of our high-tech media labs.

For anyone attentive to the surrounding society today, the problems posed by this situation can seem so overwhelming as to bring on despair. How can nature's voice be heard amid the shrill and compelling Babel of the prevailing media, and how can any of us make a real difference on behalf of the natural world? A rather distant analogy may be relevant, for we can imagine there would have been a similar sense of helplessness among the first-century Christians if they had been asking themselves, "What can we possibly do to combat the presence and might of the Roman empire?" But, apparently, they were more inclined to ask what they could do in their own communities and for their own neighbors. And in the end *that* approach proved more powerful than the Roman armies.

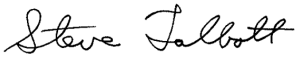
In such reflections, perhaps we may find a guiding thought for our work at The Nature Institute. We can at least continue trying, within our own sphere of influence, to bring people closer to nature—to help them experience the world ever more deeply and profoundly, until it is the artificial reality that pales beside all the richnesses surrounding us. Might it not be that, in the end, this sort of activity will prove more powerful than the high-tech legions competing to shape our daily experience?

With that hope, we would like to think that this issue of *In Context* is at least a step in the right direction. And we trust you will agree that the articles, each coming from a different angle, bring out aspects of nature, and ways of attending to them, that can lead to genuine appreciation and wonder.

Craig Holdrege



Steve Talbott



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An Anomalous *Fraxinus anomala*

Craig Holdrege

Figure 1. Left: Singleleaf Ash shrub (*Fraxinus anomala*). Right: Branch from same shrub showing simple, round leaves and dangling fruit.

Last spring Henrike and I were hiking in the canyon-lands of southern Utah. The immensity and beauty of this rock-dominated landscape were almost overwhelming, since no two canyons were alike. And the presence of each place changed throughout the day with the rising and sinking of sun and the play of clouds. The plants were often spaced and arranged as if a gifted and aesthetically minded gardener had been hard at work.

One rather inconspicuous shrub caught my attention. It grew between four and eight feet high with many branches and small round leaves (Figure 1). Noticing fruits on some of the shrubs, I looked more closely. To my amazement, I recognized the fruits as ones I knew as belonging to ash trees (the genus *Fraxinus*, Figure 2). Later I saw specimens with flowers that were also characteristically those of an ash. But ash trees always have divided leaves—so I thought—and the leaves of these shrubs clearly had simple round blades and long leaf stalks.

So back at our campsite I consulted a field guide and, yes, the shrub is an ash: *Fraxinus anomala;* its common name is Singleleaf Ash. The species designation "anomala" refers to the fact that its simple round leaves set it apart from all 65 other ash species. I enjoyed coming across this anomalous ash tree as we hiked through the canyons and over the ridges and plateaus—I'm thrilled by exceptions.

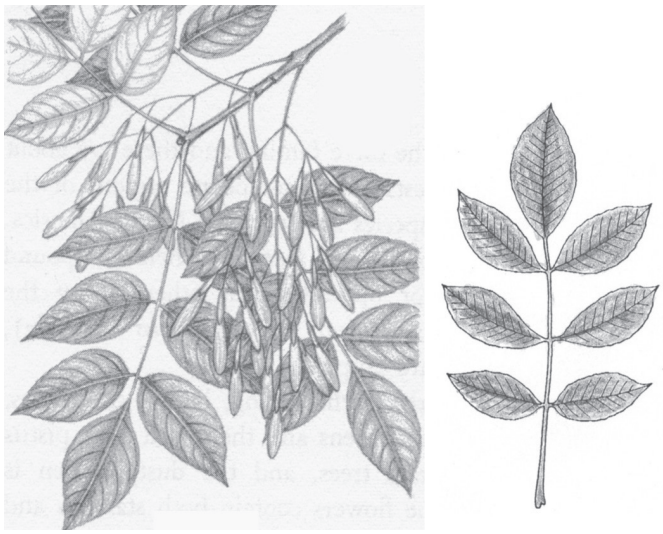

Figure 2. Branch of a white ash tree (*Fraxinus americana*) with leaves and fruits (left), and a single divided leaf (right), which is the typical form of leaves in ashes.

Figure 3. Left: all the leaves at the end of this branch were divided, most having three leaflets. Right: the two leaves that are unfolding at the end of the branch are divided (three leaflets each), while the leaves lower down on the branch are typical simple leaves.

On a subsequent hike, the anomalous ash outdid itself. One single specimen had a few branches with some *divided* leaves (Figure 3).

An anomalous *Fraxinus anomala*! Here the "ashness" of its fellow species broke through and showed itself. What a revelation. While this shrub normally keeps to its tendency to make simple leaves, it also has the potential to do differently and suddenly resemble its *Fraxinus* relatives. It was a joy to witness this species "being itself differently," to use Henri Bortoft's phrase. I kept an eye out for this shrub on the rest of our hikes and never again did I encounter an anomalous *Fraxinus anomala* with divided leaves.

Soil, Culture, and Human Responsibility

Bruno Follador

"Can you tell me where the Dust Bowl is?" "Stay where you are and it'll come to you"
(A puzzled tourist questioning a Kansas wheat farmer, quoted in Worster 2004, p. 29)

Less than a hundred years ago, the bounty of the Southern Plains still seemed endless. Kansas farmer Earl Owens remarked: "Boom, all you had to do was plant, and you had a crop. It was just no problem. In the 1920s… it was a cinch. You put the grain in the ground, and it grew" (Riney-Kehrberg 1994, p. 12).

Any calls to heed the delicate and complex ecology of the plains seemed ludicrous. After all, as the U.S. Bureau of Soils had stated in the beginning of the twentieth century, "The soil is the one indestructible asset that the nation possesses. It is the one resource that cannot be exhausted; that cannot be used up" (quoted in Montgomery 2007, p. 148).

But this was not the understanding of the U.S. Geological Survey. Citing the conclusion of the twenty-second annual report of the USGS (1900-1901), geologist David R. Montgomery has written:

> The semiarid High Plains from Nebraska to Texas were fatally vulnerable to rapid erosion if plowed: "The High Plains, in short, are held by their sod." With rainfall too low to support crops consistently, grazing was the only long-term use for which the "hopelessly nonagricultural" region was well suited. (Montgomery 2007, p. 148)

But, enticed by land speculation and competitive crop prices, farmers paid little attention to such warnings. The value of wheat as a new commodity grew rapidly after the outbreak of World War I. When the Turkish navy blocked the Dardenelles—the narrow strait in the northwestern part of Turkey—the shipment of Russian wheat to Europe was impeded. Suddenly American farmers had at their disposal a market that could match the abundant performance of the land. Backed by the government, farmers transformed the Southern Plains into a uniform, golden monoculture of wheat.

Remarkably, wheat acreages would continue to increase in the decade after the war—even as the price per bushel dropped and there was no longer a need for such production. In 1917, about 45 million acres of wheat were harvested nationwide. Two years later that figure had increased by nearly 70% to over 75 million acres (Egan 2006, p.43).

What Holds the Earth Together?

The Great Plains were home to several hundred grasses. There were tall grasses—some as tall as eight feet—like big bluestem, switch grass, and Indian grass. There were short grasses: blue grama, buffalo grass, wire grass, bluestem bunch grass, galleta, western wheat grass, salt grass, sand dropseed, needle grass, prairie three-awn, and others. But the apparent monotony of it all was deceiving. In the midst of grass country, one encountered many brightly colored flowers, including the pinkish-purple dotted gay feather, the rich wine-red cups of low poppy mallow, the red-orange of Indian blanket, and the yellow of broomweed.

Directly or indirectly, the grasses nurtured a rich animal life. There were hundreds of grasshopper and locust species; black-tailed jackrabbits; mice, pocket gophers, kangaroo rats, and prairie dogs; insectivorous moles, rattlesnakes, burrowing badgers, black-footed ferrets, and skunks; soaring hawks and eagles; coyotes, wolves, and pronghorn antelopes, not to mention the astonishing numbers of bison. The American painter and author, George Catlin, writing about his experiences in the 1830s, told how bison congregated so thickly in some places that they darkened the prairie for many miles. "As long as the grasses flourished," environmental historian Donald Worster has noted, "the plain was no silent, empty wasteland" (Worster 2004, p. 74).

But there were few settlers who marveled at and understood the intricacies of this landscape. In the early nineteenth century the Great Plains were described as a desolate waste of uninhabitable solitude. In maps—up to the end of the Civil War—they were marked as the Great American Desert. Not many settlers managed the perspective of one Texas sheepherder, who remarked, "Grass is what counts. It's what saves us all—far as we get saved … *Grass is what holds the earth together*" (Worster 2004, p. 78; my emphasis).

Between Earth and Sky

The High Plains is a land of volatile weather. Between earth and sky, living creatures and their landscape are exposed to sharply contrasting weather patterns: hot and cold, fierce winds and uncanny stillness, unyielding droughts and torrential floods. There are also blizzards, tornadoes, and cyclones.

Grass was indeed what held the earth together. The native grasses, some with roots six feet deep or more, protected the soil from the scorching sun, mighty winds, erosion, and heavy downpours. The grasses were a pacifying force: unable to tame the elements, they nevertheless moderated their effect and created a more benign world for other forms of life (Worster 2004, p. 71).

But in the early twentieth century the grasses began to be plowed under. The living tapestry of roots, "woven" by the buffalo, bluestem bunch, and other grasses, was torn apart. So thick was the sod that early accounts described the sound of the prairie being plowed as a "fusillade of pistols, the pistol-shot cracks of roots breaking" (Manning 1997, p. 143). By the mid-1930s, 33 million acres lay bare, ungrassed, and vulnerable to the winds. The dust storms that followed, in what came to be known as the Dust Bowl, created what Worster, a professor emeritus at the University of Kansas, has called "the most severe environmental catastrophe in the entire history of the white man on this continent":

> In no other instance was there greater or more sustained damage to the American land, and there have been few times when so much tragedy was visited on its inhabitants. Not even the Depression was more devastating, economically. And in ecological terms we have nothing in the nation's past, nothing even in the polluted present, that compares. (Worster 2004, p. 24)

The Dust Bowl was no natural disaster caused merely by an unfortunate drought. It was prepared by a world-view severed from any ecological and social context. The fate of the southern plains was already foreshadowed by the quality of language used by the settlers and speculators. The land, instead of being cultivated, was "broken" and its sod "busted." Wheat, once seen as a gift from the gods, became a "cash crop." And in lieu of farmers and agriculturalists, the land was shaped by "cash-grain operators," "grain dealers," "sodbusters," and "suit farmers." The farm, as Worster put it,

> … became an arithmetical abstraction, a quantity identified by number instead of a personality or history: "T 28-S. R 32-W, sw 1/4," for example, instead of "the old Briggs place" or "Maidenstone Farm." In Haskell County [Kansas] a farm often was merely a 160-acre expanse of soil, and by that definition a man might be said to operate six or seven farms, none of them carrying any special identity or allowing much emotional attachment. (Worster 2004, p. 143)

Haskell County itself was delineated as a perfect box—exactly 24 miles on each side—and inside this box were 580 smaller boxes, all of them full 640-acre sections of lands, divided and subdivided into smaller and smaller boxes.

It was not only counties in Kansas that were so arbitrarily shaped. The U.S. Rectangular Survey, launched by the Ordinance of 1785, would eventually impose the same abstract and homogeneous pattern on 69 percent of the land in 48 U.S. states.

No matter how ecologically diverse a region or landscape might be, the Rectangular Survey showed a complete disregard of the unique qualities and intricacies of each type of terrain. This enforced linearity allowed tractors to plow so unswervingly that real estate ads of the 1920s could boast: "A tractor can be driven in a straight line from corner to corner of the county." The grid pattern and the type of farming it encouraged were the antitheses of the vision of farming described by Wendell Berry:

> Farming becomes a high art when farmers know and respect in their work the distinct individuality of their place and the neighborhood of creatures that live there. (Berry 2010, p. 9)

The American gridiron hindered this high and respectful art. It fostered detachment from the land, making it easier to turn the land into a salable commodity. Having lost its distinctive character, the land could be worked and sold by farmers and speculators as interchangeable boxes.

Perhaps nothing illustrates this detachment better than the commodification of wheat and the creation of the grain market in Chicago.

Wheat

According to another leading environmental historian, William Cronon:

> To grasp the changes in grain marketing … one must understand several key features of this early waterborne trading system. All hinged on the seemingly unremarkable fact that shippers, whether farmers or merchants, loaded their grain into sacks before sending it on its journey to the mill that finally ground it into flour. As the sack of grain moved away from the farm—whether pulled in wagons, floated on flatboats or lofted on stevedores' backs—its contents remained intact, unmixed with grain from other farms. Nothing adulterated the characteristic weight, bulk, cleanliness, purity, and flavor that marked it as the product of a particular tract of land and a particular farmer's labor. (Cronon 1991, p. 107)

The railroads changed all this. Compared with the water-based system, where the grain sacks had to be handled multiple times, railroad cars were faster and more efficient. Instead of thinking of grain shipments in individual sacks, traders began to treat grain shipments as "carloads" consisting of about 325 bushels each, even though at first the grain was still being moved in sacks.

The counterpart of the railroad—and the solution for the storage problem—was the steam-powered grain elevator. The efficiency of the elevator hinged on one condition: the grain needed to be moved without the restraint of sacks.

Cronon states that elevator operators began objecting

to keeping small quantities of different owners' grain in separate bins—for an unfilled bin represented underutilized capital. This condition severed the bond between shippers and the individual farmers whose grain they shipped. The corn or wheat would cease to act like solid objects traceable to their origin, and behave more like liquids.

To regulate this golden flow of grain, the Chicago Board of Trade, founded in 1848, proposed a system of regulations designating three categories of wheat—white winter wheat, red winter wheat, and spring wheat. This decision laid the foundation for a radical transformation that would forever change how grain was to be sold in the world.

Before 1856, the wheat one purchased expressed, not only the characteristics of a particular landscape, soil type, and weather pattern, but also the fruits of labor from an individual farmer or family. The grain could always be traced back to "Farmer Tom's" place, or to "Farmer John's." It would never be mixed with grain from other places.

The new regulatory system solved the quandary of the elevator operator, who otherwise had to keep track of the owner of each sack of grain. William Cronon describes how this technical solution had deep consequences:

> As long as one treated a shipment of wheat or corn as if it possessed unique characteristics that distinguished it from all other lots of grain, mixing was impossible. But if instead a shipment represented a particular "grade" of grain, then there was no harm in mixing with other grain of the same grade. Farmers and shippers delivered grain to a warehouse and got in return a receipt that they or anyone could redeem at will. Anyone who gave the receipt back to the elevator got in return not the *original* lot of grain but an equal quantity of *equally graded* grain … the changes in Chicago's markets suddenly made it possible for people to buy and sell grain not as the physical product of human labor on a particular tract of prairie earth, but as an abstract claim on the golden stream flowing through the city's elevators. (Cronon 1991, p. 116)

This new cash-crop system soon proved not only destructive to the land, but also to community life. Haskell County offers a clear example of this:

> The land of Haskell is by and large as sterile and uninteresting as a shopping center's parking lot—almost every acre totally, rigidly, managed for maximum output … It is an environment that comes from and leads back to alienation—not a place that can stir much love and concern in the human heart. (Worster 2004, p. 238)

The Land's Perspective

The economic rationalization of plains agriculture might seem to have made a great deal of sense—until one looks at it from the perspective of the land, the less successful operators, later generations, or the taxpaying public (Worster 2004, p. 228). Only a severe drought and the resulting Dust Bowl would make widely visible the fruit of the political interests, new technologies, and economic order that took hold in the Great Plains during the early twentieth century.

But even more fundamentally, the Dust Bowl was the result of our way of seeing, thinking, and speaking about agriculture and the world. For what we meet in the rectangular land survey, in unvarying monocultures, in grain elevators and the sterile landscapes are not only elements of a mechanized agriculture. They are also, and decisively, an expression of human consciousness. In an essay entitled "The Mystery of the Earth," the Dutch physician, Ita Wegman, wrote in 1929:

> Nature is becoming a mirror of chaotic human behavior, as is evident in catastrophes and anomalies; we perceive them in nature's mirror without recognizing them as our own reflection.

Could other forms of thinking and speaking about the land, instead of fostering alienation and destruction, engender a contextual way of seeing that promotes responsible and conscious actions? Could we have a kind of agriculture and land cultivation that neither imposes on nature a preconceived plan, nor allows things simply to take their own course?

Already in 1924 Rudolf Steiner approached this need for a renewed relationship to nature and agriculture when he gave a cycle of lectures on the *Spiritual Foundations for the Renewal of Agriculture*. This course became the basis for what is now known as "biodynamic agriculture."

During this course it became clear that what Steiner was offering was not simply another agricultural system and set of techniques. In this course he raised questions that still go far beyond our contemporary frame of reference. He pointed to the need for a much broader way of looking at the life of plants and animals, and also at the life of the Earth itself. He invited farmers to expand the scope of their vision even to include the cosmos.

Steiner urged the importance, for each farmer, of developing a personal relationship to everything on the farm. Far from reducing the land to abstract units and unrelenting monoculture, the farmer should conceive the farm as a self-contained individuality.

Biodynamic agriculture invites the farmer to develop new images, questions, and ideas of what agriculture could be. One might, for example, ask:

- How do I participate—inwardly and outwardly—in the development of my farm and all that lives in its landscape?
- How can I become more conscious of the different qualities of my place?
- How do I create the space and conditions for my farm to realize its perhaps unrecognized potential?
- How do I foster and contribute to the health of our soils and community?

Agriculture indeed, as we heard Wendell Berry say, can become a high art when farmers know and respect in their work the distinct individuality of their place and the neighborhood of creatures that live there.

Awakening to our Farms

As important as it is to describe the consequences of the Dust Bowl and illuminate current destructive practices, Ehrenfried Pfeiffer, renowned soil scientist and pioneer of biodynamic agriculture, suggested that this is not enough:

> A description of possible future hardships does not induce people to change their way of life. And the change to a self supporting agricultural life must be preceded by corresponding training and education, for no one can become a farmer or gardener merely by picking up a spade or putting on heavy boots. Another incentive is needed … (Pfeiffer, 1983, p. 29)

According to Pfeiffer the essential thing is to awaken in young people and those interested in starting to farm a feeling for the forces of growth, for the eternally creative forces of Nature. He further wrote:

> The next step is to awaken in them a sense of responsibility toward these forces of growth, towards the health of the soil, of plants, of animals and of men, and also an inner sense of satisfaction in progressing towards this goal.

A radical and inspiring initiative launched by the Biodynamic Association (BDA) in 2009 goes exactly in this direction. The North American Biodynamic Apprenticeship Program (NABDAP) helps aspiring farmers develop the skills and knowledge they need to build successful organic and biodynamic farms. An internationally recognized program of the Biodynamic Association, NABDAP combines on-farm training and mentoring with a course of classroom study to provide a strong foundation in both the practical and theoretical aspects of biodynamic agriculture. This program began with a handful of apprentices and mentor farms. Since then, the program has blossomed and grown, with mentor farms across the United States and Canada, and nearly forty apprentices currently enrolled.

Pfeiffer was one of the founders of the BDA in 1938. Today the BDA is the oldest nonprofit, sustainable agriculture organization in North America. I dare say that Pfeiffer would have been delighted to see the flourishing of this agricultural training program and read the statement made from NABDAP graduate, Megan Durney, who today is the head gardener at the Pfeiffer Center in Chestnut Ridge, New York.

> I entered into biodynamics because I wanted to participate in an agricultural activity that was conscious, where farmers are awake to the true impact they have on the land and the earth as a whole. (https://www.biodynamics.com/nabdap-graduate-profile-megan-durney)

What biodynamic agriculture teaches us is that we need not only a shift in agricultural practices, but also a shift in human consciousness out of which new ways of interacting with nature in agriculture can develop. To awaken to our farms also means to awaken to ourselves and to our personal responsibility. In this light, the renewal of agriculture is an accomplishment waiting to be achieved.

The author gratefully acknowledges the works cited here by Donald Worster and William Cronon, from which he drew extensively in researching and writing this article.

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In Gratitude

I met Georg Maier for the first time in 1981 during a course for young science teachers in Stuttgart, Germany. In one particular class session he laid out for me—as I now know—the foundation for a radical transformation in my approach to optics and the phenomena of the visual world, and, more generally, to all of natural science.

What did we do that afternoon? Imagine a group of young teachers and students sitting in a circle in an otherwise bare room with just one rather small, rectangular window. Georg asks us to pay attention to the various shades of darkness and brightness on walls and ceiling. It is dark in that corner up there and much brighter here on the wall opposite the window. We learn to see the window from any spot in the room in its visual size and shape: either we walk to a spot and look at the window from there, or we imagine it as seen from that spot. From the dark corner, the window appears as a thin sliver; from the wall opposite, it is a much larger rectangle.

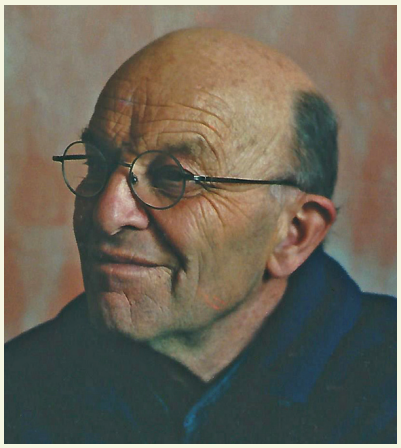
Why were these simple observations—led by a highly trained physicist—so powerful for me? Through my middle school, high school, and college education I habitually explained and understood optical phenomena in the usual ways: I referred shadow, mirror, and refraction phenomena to the ray model of light; diffraction, polarization and color phenomena to the wave theory; and I grasped other phenomena, such as light absorption or emission, with the aid of quantum mechanics. In this one afternoon session, Georg introduced us to an experience and understanding of illumination that made no use of any of these conceptual frameworks. Rather, we looked and learned to see.

When we planned the new addition to the building of The Nature Institute in 2011, I made use of what I had learned that day in Stuttgart. I poured over the completed architectural drawings and imagined the illumination of each room. That our staircase and downstairs foyer today has good daylight owes to the fact that I then discovered the need for another window, and we changed the plans.

From that first meeting with Georg, it was for me a long path to unlearn what I had learned before. In the early years of The Nature Institute, I began working with Georg's book *Optik der Bilder*, which was first published in 1986. This book was a last minute purchase before I emigrated to the United States twenty-four years ago. It stayed put on my book shelf until after The Nature Institute was founded in 1998. With the help of this book—and with the help of other authors, Goethe being one of them—I found a new relationship to the visual world and its many manifestations that has been continuously nourished by growing interest and joyful wonder, new observations and discoveries, and a deepening understanding.

This work has led to numerous workshops and courses at The Nature Institute and elsewhere in the past decade. I hear from participants that for them also interest is roused and eyes are opened, and a respectful and joyful experience of the colorful world is called forth. That is not a small thing. It can be life-giving.

I am deeply glad that Georg knew that his life's work was bearing fruit in America—for instance also in the work and teachings of his colleague Michael D'Aleo, a physics teacher and trainer of physics teachers. As a teacher himself, Georg was not always easy to understand; it was often difficult to appreciate what he was pointing to. His above-mentioned book, like others of his published writings, is not easy to read. But it is worth the effort. *HH*



GEORG MAIER (1933 - 2016)

Georg Maier was born in Stuttgart, Germany, on May 26, 1933. With his mother and older sister he emigrated to Great Britain in 1939, where he went to the Wynstones Rudolf Steiner School in Gloucester. After the war, when his family was reunited in Germany, Georg and his sister attended the Waldorf School Uhlandshöhe in Stuttgart. Georg studied physics and earned his Ph.D. in Munich in 1960. He did research on neutron diffraction at the nuclear reactor in Jülich, Germany, before he took a position at the Natural Science Section at the Goetheanum in Dornach, Switzerland, in 1969. There he worked for more than 30 years as a scientist and teacher. He enjoyed his connections to America and found colleagues in Stephen Edelglass, Ron Brady, and Michael D'Aleo.

Georg passed away in Dornach on June 14, 2016.

Georg Maier's book, *An Optics of Visual Experience,* is available in a sturdy paperback edition for $35 from Adonis Press at http://adonispress.org/product/optics-visual-experience/.

Also you will find another book, *Being on Earth: Practice In Tending the Appearances,* available free on our website: http://natureinstitute.org/txt/gm/boe/. Chapter 5, authored by Georg, contains more about his life training as a physicist.

Tending the Roots of Sustainability

The Significance of Experience-based Learning and Our Responsibility to Children and the Earth

Twenty educators from the US, India, and South Africa joined us for this week-long intensive in June. Here are some comments from the educators who attended:

"This week has been an incredible gift, one that held unexpected treasures, connections and experiences. I felt a need for deeper knowing at the start, 'tools' to take back to the 'real world', but am leaving with a stronger sense of questioning, the importance of dwelling and the time needed for reflection. My inner turbulence has been given new direction and affirmation of the need to return to the curious state of thinking like a child, doing, feeling and sensing rather than thinking what comes next. The course provided a wonderful balance of structure and fluidity, content and experience, silence and conversation. I feel this is the start of a very important 'Experience Continuum' that I hope will continue to weave others into the journey."

"The course was outstanding in all regards. I deeply appreciated the "lessons" because not only were they relevant to learning how to design lessons to invite students into a relationship with the natural world, but they were conducted in the teaching style which allows for the development of attention and the lasting and true relationship with that which is being observed. So many teacher development courses are done in a lecture style which is *not* what will be effective with the students or the teachers!"

"A great experience! I look forward to reviewing and sharing with my colleagues. I am tired and renewed simultaneously. Thank you so much for sharing and allowing us to share."

Fall at The Nature Institute

In addition to our ongoing research, writing, and topic-based meetings and colloquia, we offered a few public events at the Institute this fall.

• On September 30 Craig gave a talk on "Truth, Beauty, and Goodness." On the following day, Henrike and he led an all-day workshop on "Living in Our Senses." Each year at this time we make such an event a free offering to the local community.

• On October 11 we screened the film "Just Eat It: A Food Waste Story." This was part of a collaboration between the Institute and the neighboring Hawthorne Valley Association aimed at broadly rethinking compost and waste management. Bruno Follador led a conversation after the film.

• October 19 Craig gave a talk with slides that honored the work of the painter Franz Marc and his intention to bring the being of animals to expression. Marc once wrote: "How does a horse, or an eagle, or a deer, or a dog see the world? How miserably soulless is our convention of placing animals in the landscape as we perceive it, rather than seeking to penetrate the soul of the animal so as to glean something of its own world of images." Franz Marc died one hundred years ago at the age of 36 in World War I.

Out and About

• In June, Craig traveled to the Land Institute in Kansas. He had been invited by Wes Jackson, the Land Institute's now-retired director, to be one of twelve founding core faculty members for a new effort to develop a transformative, transdisciplinary curriculum for higher education. For two intense days, the core faculty members—primarily university and college professors—were joined by about fifteen other individuals to discuss "Ecosphere Studies." There was much exchange about what may be missing from conventional environmental studies courses, and what is needed to bring about educational experiences that are more fully integrative and holistic.

• The first two weeks of July found Henrike and Craig teaching a course,"Seeing Nature Whole," in Florianopolis, Brazil. The course was attended by 25 people who work in a variety of professions (e.g., educators, consultants and health care providers). Evidently the announcement of the course struck a chord, since the Sagres Association, which offered the course, had 32 people on the waiting list. The course is an introduction to the epistemology and practice of Goethean science. This year we focused on projective geometry and plant study, all the while considering how we can expand our ways of knowing to come to a more whole and living understanding of ourselves and the world. It was an intense work over the two weeks and we are looking forward to continuing the work with the same group next July.

• Bruno has been active working with farms to improve their composting, land use, and cultural practices, and also giving workshops. In addition to working with farms in our area, he has traveled widely. He was in France in May to consult at Biodynamie (Biodynamic) Services, and in mid-September he went to Vera Cruz, Mexico, to consult at the biodynamic Cafetal El Equimite. There he also gave a public workshop to local farmers on "More Humus, More Humanity: Biodynamic Compost and Soil Health." In July he gave a talk on "The Possibility of a Science of Qualities" at the fifth Regional Anthroposophical Medical Congress of Zona da Mata, in Juiz de Fora, Brazil, and participated in a round table discussion about "Soil and Human Health." In October he gave a weekend workshop at the Josephine Porter Institute for Applied BioDynamics, Virginia, on "Practices and Insights of Biodynamic Composting: Developing Dynamic Ways of Seeing and Working with Compost and Ehrenfried Pfeiffer's Chromatography."

Still Ahead

• In November Bruno will be presenting at the National Biodynamic Conference in Santa Fe, New Mexico. He will be one of the presenters at the pre-conference workshop "Bridging the Americas." He will also give a workshop on "Experiencing Soil and Compost through Color, Form and Pattern," and he will be part of a Q&A session on "Biodynamic Composting and Preparation Making."

• Craig will travel to California and present at "From Phenomena to Insight," a conference for high school and middle school science teachers from February 21 – 25.

• On March 17 – 19, Henrike and Marisha Plotnik will offer a weekend "Mathematics Alive!" workshop at The Nature Institute for teachers. The focus will be on algebra and geometry in the middle school.

• In April, Craig and Henrike will spend a good part of the month teaching in Australia. Craig will give talks and workshops in Sydney. Then Craig and Henrike will give courses at week-long conferences for science and math educators in Mullimbimby and in Perth.

For a notice about our **2017 Winter Course**, see the back cover

A New Collaboration: The Evolving Science Association

The Myrin Institute of Great Barrington, Massachusetts, and The Nature Institute have joined forces in a new, collaborative enterprise called the Evolving Science Association. The organizations have jointly resolved to

> promote holistic scientific practice that is receptive to the manifold voices of nature in all their variety. Such an evolution of science involves the development of human capacities through which we discover ourselves in nature and nature in ourselves. This enables us to rise above both materialism and the temptation to treat natural phenomena merely as occasions for manipulation. Building on the achievements of both organizations and the synergies of collaboration, the Association aims to strengthen the foundations of holistic knowing and to expand its reach into broader culture.

The Myrin Institute, the original publisher of *Orion*, is a nonprofit organization founded in 1953 by H. A. W. Myrin, an international businessman and humanitarian, and Franz E. Winkler, a physician and author. It began as a forum in which scientists, educators, political leaders, economists, and religious leaders could exchange views on matters of current interest and offer constructive criticism of each others' initiatives. Its current activities are rooted in the belief that "a genuine reconciliation of the modern scientific attitude with a spiritual world concept is by far the most essential need of modern man. Such a reconciliation will open the way for a philosophy of human freedom which is the safest protection against destructive ideologies and our only valid hope for lasting peace."

The Evolving Science Association will, among other things, pursue publications, conferences, fundamental research, and the training of young researchers. Program decisions will be made by the four members of the Association. The members from the Myrin Institute are George Russell, an emeritus professor of biology with forty-five years of teaching experience at Adelphi University on Long Island, New York, and Mark Gardner, an independent researcher and student of the history and philosophy of science. The Nature Institute is represented by its director, Craig Holdrege, and senior researcher Stephen L. Talbott.

In France: The Science of Soil Improvement

This past May Bruno Follador spent time in Château, France, a town in the wine-growing region of Burgundy. While there, he gave a public workshop on "Practices and Insights of Biodynamic Composting: Developing Dynamic Ways of Seeing and Working with Compost." Among other things, the participants worked with chromatograms intended to bring out features of soil or compost. This particular form of chromatography was pioneered by the soil scientist, Ehrenfried Pfeiffer. Chromatography offers a fresh and engaging possibility for farmers and gardeners to learn more about the biological processes taking place in their compost piles and fields.

As part of the Living Soils project, The Nature Institute has established a small laboratory for employing Pfeiffer's Chromatography in support of research, workshops, and consultations.

While in Château, Bruno also consulted with Biodynamie (Biodynamic) Services, an organization supporting biodynamic farmers and gardeners, particularly through their work with the biodynamic preparations. After this, he led a workshop at a neighboring farm for the students of the French biodynamic training school.

Thank You!

We are full of gratitude toward our friends who have supported our work by contributing money, goods, or services between April 1, 2016 and September 30, 2016. We offer a special thank you to the two individuals who generously offered to donate up to $5,000 as a matching gift last spring. And thanks to all who took up the challenge — your gifts exceeded $5000!

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Meeting Nature as a Presence

Aldo Leopold and the Deeper Nature of Nature

Craig Holdrege

We were eating lunch on a high rimrock, at the foot of which a turbulent river elbowed its way. We saw what we thought was a doe fording the torrent, her breast awash in white water. When she climbed the bank toward us and shook out her tail, we realized our error: it was a wolf. A half-dozen others, evidently grown pups, sprang from the willows and all joined in a welcoming mêlée of wagging tails and playful maulings. What was literally a pile of wolves writhed and tumbled in the center of an open flat at the foot of our rimrock.

In those days we had never heard of passing up a chance to kill a wolf. In a second we were pumping lead into the pack, but with more excitement than accuracy: how to aim a steep downhill shot is always confusing. When our rifles were empty, the old wolf was down, and a pup was dragging a leg into impassable slide-rocks…. I was young then, and full of trigger-itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise. (Leopold 1949/1987, pp. 129-30)

With these words, the 56-year-old Aldo Leopold reflected back on an experience he had at the age of 22. It was 1909 and Leopold was leading a crew for the newly formed United States Forest Service that was carrying out an inventory of the locations, quantity, and quality of timber in Arizona and New Mexico.

After shooting the wolves, Leopold and his crew climbed down to the banks of the river and found the old wolf. She was still alive but unable to move. Leopold put his rifle between himself and the wolf, she grabbed the rifle in her jaws and then died.

> We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. (Leopold 1949/1987, p. 130)

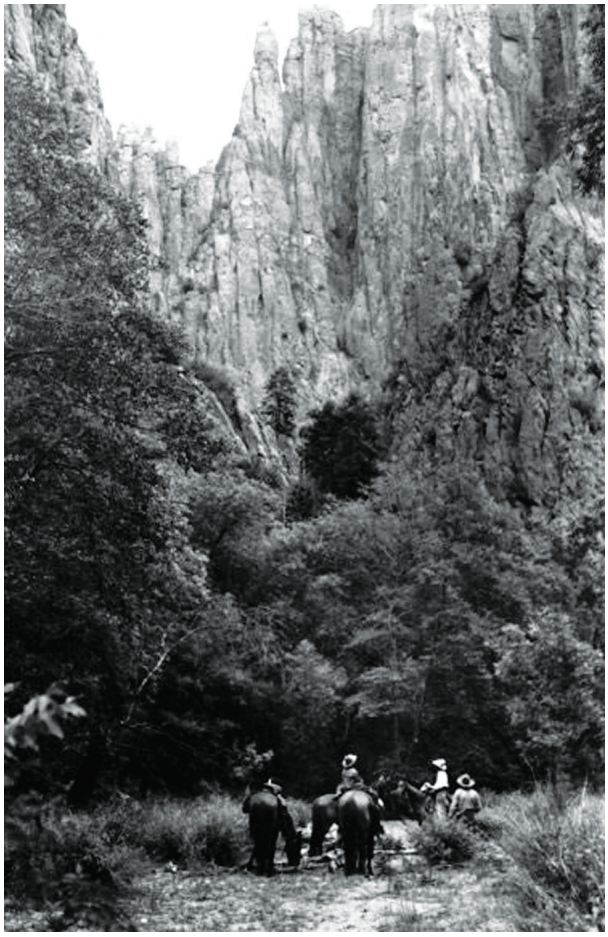
As he watched the light in those eyes disappear, Leopold met the wolf for the first time. For a split second he glimpsed the wolf as a being in its own right. The impression stayed with him. In a sense the wolf became part of Aldo Leopold on that day.

And yet it took many years for the wolf to become a force in his thinking. He could still write in 1920, eleven years after the encounter: "It is going to take patience and money to catch the last wolf or [mountain] lion in New Mexico. But the last one must be caught before the job can be called fully successful" (quoted in Meine 1988, p. 181). Leopold was trained as a forester and was an avid hunter. Working for the Forest Service, his goal was, in part, to manage forests for the maximum quality and yield of timber. He held to the principle of "maximum use," which for him included managing forests and other wild lands in such a way that they provided food for livestock, game (such as deer) for hunters, and recreation for people. Predators that killed livestock and game simply did not fit into the world view of the young forester and game manager. His thinking about nature was centered on human interests.

For most of 15 years following the encounter with the wolf, Leopold worked in the southwest (New Mexico and Arizona) for the U.S. Forest Service. He rode thousands of miles on horseback and observed first-hand the ecology, wildlife, and human use of the land in this arid part of North America. He also studied scientific literature and philosophy. These were years of expanding experience and thought. Leopold's biography and writings reveal tensions, contrasting perspectives, and shifting alliances as his view of the world became more centered in nature's concerns (see Meine 1988, Lutz Newton 2006).

In an unpublished 1923 essay, Leopold writes about the economic rationale for conservation: the wise use of resources will ensure their long-term service to humanity. It makes economic sense to take ecology into account in human planning and action. His years of observation showed him that overgrazing by cattle and sheep were causing widespread erosion and habitat destruction. "Erosion eats into our hills like a contagion, and floods bring down the loosened soil upon our valleys like a scourge. Water, soil, animals, and plants—the very fabric of prosperity—react to destroy each other and us" (Leopold 1923/1991, p. 93).

But in the very same essay he also disparages a narrow anthropocentric, economics-driven view: "In past and more outspoken days conservation was put in terms of



The Gila wilderness in New Mexico, 1922. It became the world's first designated wilderness area in 1924; Aldo Leopold played an instrumental role in its formation. (Photo by W.H. Shaffer)

decency rather than dollars" (Leopold 1923/1991, p. 94). He contrasts the economic perspective with a moral one that is rooted in something "felt intuitively," namely that there is "between man and the earth a closer and deeper relation than would necessarily follow the mechanistic conception of the earth as our physical provider and abiding place" (Leopold 1923/1991, p. 94). Referring to the Russian philosopher P. D. Ouspensky's view of the earth as a living organism, Leopold writes:

> Possibly, in our intuitive perceptions, which may be truer than our science and less impeded by words than our philosophies, we realize that indivisibility of the earth—its soil, mountains, rivers, forests, climate, plants, and animals, and respect it collectively not only as a useful servant but as a living being …
> (Leopold 1923/1991, p. 95)

The respect for nature and the desire to protect the earth into the far future is rooted for Leopold in a budding recognition of the living quality of the earth as a whole. And while he remained comfortable until the end of his life expressing ecological relations in quantitative and causal terms (he speaks, for example, of the "land mechanism"), he also strove to give voice to a depth of nature that transcends the grasp of the kind of scientific ecology in which he was steeped.

Leopold's description of killing the old wolf is part of his seminal essay "Thinking Like a Mountain," which he wrote when he was 57 (in 1944) and which was published only in 1949, a year after his death. He begins the essay with vivid imagery:

> A deep chesty bawl echoes from rimrock to rimrock, rolls down the mountain, and fades into the far blackness of the night.... To the deer it is a reminder of the way of all flesh, to the pine a forecast of midnight scuffles and of blood upon the snow, to the coyote a promise of gleanings to come, to the cowman a threat of red ink at the bank, to the hunter a challenge of fang against bullet. Yet behind these obvious and immediate hopes and fears there lies a deeper meaning, known only to the mountain itself. Only the mountain has lived long enough to listen objectively to the howl of a wolf.
>
> Those unable to decipher the hidden meaning know nevertheless that it is there, for it is felt in all wolf country, and distinguishes that country from all other land. It tingles in the spine of all who hear wolves by night, or who scan their tracks by day. Even without sight or sound of wolf, it is implicit in a hundred small events: the midnight whinny of a pack horse, the rattle of rolling rocks, the bound of a fleeing deer, the way shadows lie under the spruces. Only the ineducable tyro can fail to sense the presence or absence of wolves, or the fact that mountains have a secret opinion about them.
> (Leopold 1949/1987, p. 129)

What is this quality of nature Leopold is depicting here? The wolf is no longer only a predator to be killed for our benefit. It is also not simply part of the food web or a top-level predator. It is a presence in the landscape. This presence makes itself known through all the interactions between wolves, deer, spruce trees and rocks. What reveals itself in the interactions is not what the conventional science of ecology speaks of:

> Everybody knows, for example, that the autumn landscape in the north woods is the land, plus a red maple, plus a ruffed grouse. In terms of conventional physics, the grouse represents only a millionth of either the mass or the energy of an acre. Yet subtract the grouse and the whole thing is dead. An enormous amount of some kind of motive power has been lost.
> (Leopold 1949/1987, p. 137)

When Leopold uses the phrase "motive power" to characterize the grouse, he is pointing to the living presence of the bird that ramifies into the larger whole of the landscape. I could also say, perhaps more appropriately, that he sees the landscape expressing itself in and through the grouse or through the wolf.

In an essay written near the end of his life, the "Song of the Gavilan" (a river in Mexico), Leopold's writing culminates in a powerful portrayal of the living presence—the music— that permeates the whole of nature. But you have to learn to perceive it:

> This song of the waters is audible to every ear, but there is other music in these hills, by no means audible to all. To hear even a few notes of it you must first live here for a long time, and you must know the speech of hills and rivers. Then on a still night, when the campfire is low and the Pleiades have climbed over rimrocks, sit quietly and listen for a wolf to howl, and think hard of everything you have seen and tried to understand. Then you may hear it—a vast pulsing harmony—its score inscribed on a thousand hills, its notes the lives and deaths of plants and animals, its rhythms spanning the seconds and the centuries. (Leopold 1949/1987, p. 149)

Here Leopold articulates a sensory-supersensory experience of the natural world. This is no longer science in the ordinary sense; one commentator calls it "poetic science" (Berthold 2004). It is clear that this kind of experience cannot be described in discursive language. Leopold applies the artistry of his writing to paint vivid images that suggest what is at work in nature. It is something, he says, that we can perceive if we learn to attend in the right way.

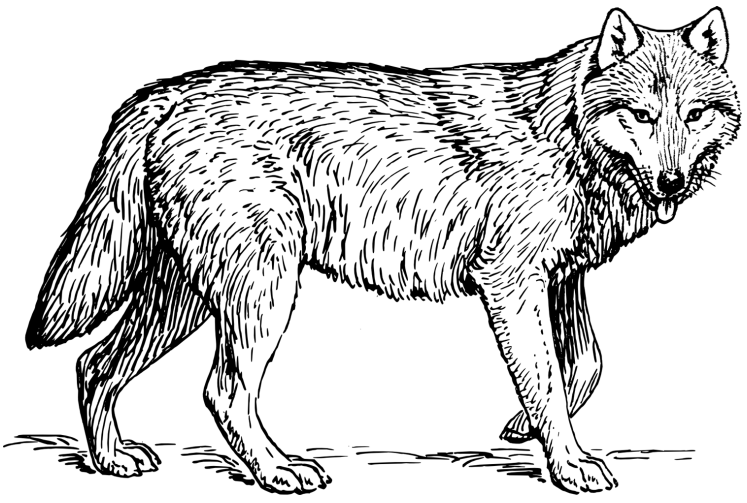
Leopold hints at what is needed to prepare for such experiences. You need to "live here for a long time." This means to connect yourself with a place by being in it and being wakefully attentive, by noticing and taking in what's happening. Since his childhood Leopold loved being in nature—observing, thinking, camping, riding, hunting. He knew places firsthand and he was attentive.

But this is not enough—you "must know the speech of hills and rivers." What kind of knowledge is he talking about here? As a forester and game manager, Leopold had learned much about nature, but he always saw things in terms of their service to human beings—the value of trees for timber or deer for hunters. This is not the speech of rivers or hills, but of human beings and their needs. As an ecologist, Leopold learned to see how hills, rivers, trees, fires, cattle, deer, and wolves are all dynamically interwoven. Increasingly he didn't just *think about* nature in terms of human needs, but he was able to *think with* nature.

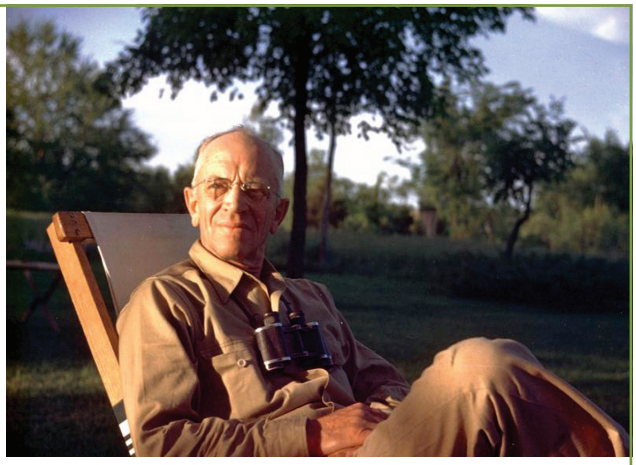
But to know the "speech" of nature requires a further quality of thinking. Conventional ecological thinking, which Leopold had secure command of, considers nature's beings and happenings in terms of causes and effects, and aims to explain all the connections. Leopold could never have written about the wolf or the landscape of the Gavilan River in the way he did had his mind been confined to seeing nature only in terms of causal links, food webs or energy flows. In these essays he is portraying and not explaining nature. To do this you have to step back from causal thinking, renounce the drive to explain, and focus your mind on what shows itself, what speaks in the connections. This is the kind of thinking that permeated Goethe's efforts in science.

Perceiving and portraying relations in nature so that they speak is no simple matter, especially for anyone who is fully at home in discursive scientific thought. This is what is remarkable about Aldo Leopold. He acknowledged and gained from everything that conventional science could contribute to understanding, but he was also able to go beyond it.

Leopold points to a way of strengthening our ability to learn the speech of nature when he encourages us to "think hard of everything you've seen and tried to understand." We've dwelled in a landscape, attended to it, and striven to understand its speech. Now we turn inward and we revisit in our mind's eye our experience of all that we have taken in. We vividly imagine the wolf, the stars and the river as presences. We move in a concentrated fashion through our thought-filled experiences. I know out of my own experience that this activity forges a deeper connection with the world and it becomes a source of insight.



Aldo Leopold (1887 to 1948)



Aldo Leopold was one of the greatest ecological thinkers and conservation biologists of the twentieth century in the United States. His collection of essays, *A Sand County Almanac*, was published 1949 only after his untimely death from a heart attack at the age of 61. The book contains the mature fruits of his thinking and writing. It became an important source of thought and inspiration for the environmental movement that began in the 1960s, and it has been a widely read classic ever since (with over two million copies sold).

After completing his studies in forestry at Yale University, Leopold worked for the U.S. Forest Service in the southwestern United States. Here his practical and theoretical knowledge of ecology grew and took form. While initially focusing on forest management, he became increasingly concerned about human destruction of natural habitats. He was active in various conservation organizations and played a key role in the establishment of the first wilderness areas within national forests. From 1924 until his death he lived in Wisconsin. In 1933 he became the first professor in the newly formed discipline of Game Management at the University of Wisconsin, which under Leopold became in 1939 the department of Wildlife Management. In 1967 the department was renamed Wildlife Ecology, reflecting the shift in attitude toward wild animals that Leopold in his own lifetime went through.

And then, if we become inwardly quiet and actively attentive, we may in a moment of heightened awareness perceive some feature of the deeper nature of nature—the pulsing harmony, the forceful presence of the wolf, or the motive power of the grouse. This is "thinking like a mountain." But here the thinking has become a form of perceiving. When we have activated our own being in this way, the presences of nature can express themselves through us. The experience of the sensory world becomes a spiritual experience.

Such experience also becomes the basis of an ethical relation to the natural world. Leopold recognized that "no important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions" (Leopold 1949/1987, pp. 209-10). He himself evolved inwardly, and toward the end of his life he formulated what he called a land ethic:

> A land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such. (Leopold 1949/1987, p. 204)

Our humility as human beings grows when we experience other creatures or qualities in nature as beings or presences in their own right. We can then see ourselves, as Leopold did, as part of a community of beings in which all members enjoy our respect. And this connection with other beings is strengthened each time when, in Ralph Waldo Emerson's words, we have moved beyond a merely profane relation to the sense world and have truly "given heed to some natural object," perceiving that it is more than meets the eye.

This article is a slightly revised version of an article published in Elemente der Naturwissenschaft *(#104, 2016). It is loosely based on a talk Craig gave at the "Evolving Science" conference in the fall of 2015 at the Goetheanum in Dornach, Switzerland.*

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Reviving the Organism

Stephen L. Talbott

If you have ever watched horror movies, you will have experienced the shock of seeing what you thought was an inert and inanimate object begin to move—glide sinuously across a surface, or raise itself upright, or slowly open an unsuspected eyelid. Such scenes play upon the fact that, when something moves of its own accord, we naturally see it as living. According to Aristotle, *self-motion* is a defining feature of animals.[1]

Despite the fact that the fastest way to kill a conversation among scientists may be to begin by saying, "According to Aristotle …," nothing about his insight is foreign to modern biology. More than one eminent authority has argued that the organism is not a collection of things, or parts, but rather is, most essentially, an activity. Canadian-born theoretical biologist Brian Goodwin could even refer to the *familiar proposition* that "life is process and transformation."[2] The twentieth-century cell biologist and National Medal of Science recipient, Paul Weiss, put it decisively when he wrote:

> Life is a dynamic *process*. Logically, the elements of a process can be only elementary *processes*, and not elementary *particles* or any other static units.[3]

The idea is a radical one—or would be, if only we could take it seriously and hold to it consistently. It suggests that we miss life entirely if we imagine it to result from a combination of particular things, or parts, whether they be portions of a DNA molecule, or neurons, or organs, or bones. The organism is not a material result, but an initiating power. It is constrained by material conditions, not produced or explained by them. As a being expressing its own specific nature, it grows, forms, and uses its bodily structures. Whatever is capable of forming and using a collection of "parts" cannot be a mere result of them.

So here is a simple and self-evident idea that has by no means been altogether hidden from the community of biologists: *the organism is an activity*. So far as I am aware, its truth has never been explicitly disputed, as opposed to being ignored. And its implications are both huge and unsettling, which may help to account for its being ignored.

Anyone who reflects upon the idea for a while might think it would strike with explosive force into any contemporary conversation about the life of organisms. Surely, in this era of molecular biology, the question pressing upon researchers is, "How do we reconceive our own work when we must understand the organism, not as a product of its molecular constituents, but rather as an originating activity and a power of self-expression?"

But, no, if any such inquiry is being reported in the standard literature today, I have missed it. Happily, however, nothing prevents us now from taking a few moments to consider the organism as an activity—which is to say, the organism as actually *living*.

On Moving and Being Moved

If we turn a machine off, it remains the same machine, undiminished. It hasn't temporarily disappeared. When we turn it on again, it will continue doing whatever it was designed to do. Its active identity, given by its physical parts and the way they have been articulated together, endures despite the temporary shutdown. *The parts are primary; they determine the machine's activity.*

Schuyler Shepherd; Creative Commons

If, on the other hand, an organism discontinues its activity, it is no longer there. It ceases to exist. A live organism just *is* its living activity, and even when it appears to be still, we assume it must be doing something—it is resting (something the heaviest boulders don't do), or perhaps preparing to pounce. *The activity of the living being is primary and determines the parts—by growing them.*

The difference could hardly be more fundamental. Yet the necessity for considering it does not lie in esoteric metaphysical cerebrations. It arises from our straightforward experience.

When an animal moves, we never doubt that, in physical terms, its performance is unexceptionable. There is no lack, no gap, anywhere in the web of lawful physical relations. Yet we cannot help seeing in the movement something that is, in a sense, incommensurable with the physical laws and causes —something "over and above" them. No matter how closely we examine the lawfulness of the animal's limb movements, organ activity, metabolism, and so on, we cannot get from *that sort of lawfulness* to our most routine understanding of what the animal is actually doing.

Even when an animal is responding to a clear and precise physical stimulus, its response is not in any evident way *physically* demanded by the stimulus. As a useful picture of this fact, we need only consider how the negligible force producing an image on the retina—say, the image of a charging lion—can set the entire mass of a quarter-ton wildebeest into thundering motion. There certainly is a continuity of physical causation between that retinal impact and the subsequent muscular upheaval. But nothing within that continuity tells us what is happening from the animal's point of view. Its movements seem to *originate* within itself in a way that we do not see in inanimate objects.

So the physical laws that tell us how one object impinges upon another are inadequate to the explanatory task. Activity originates in the organism; it has no physical explanation of the sort we seek in the inanimate realm.

Not Just Movement, But Meaning and Motivation

This last fact can lead us further. E. S. Russell, a British marine biologist who reflected deeply upon the character of organisms during the first half of the twentieth century, wrote that what the organism is responding to "is not the stimulus *qua* physico-chemical, but the stimulus as perceived, and not the stimulus merely as perceived, but as interpreted. Response is really to the meaning ... of the perceived stimulus, not to the stimulus itself."[4]

In other words, an organism's activity is *motivated* rather than physically caused. While physical interactions are clearly involved, they do not explain the *reasons* for the activity. The image of a charging lion on the retina means a very different thing to the wildebeest from what it means to another lion, even if the immediate physical stimulus is very much the same. Specific actions are always giving expression to the "force" of the complex meanings in terms of which the organism experiences its world, and the actions in turn contribute further to that world of accumulating significances.

In the 1960s the American philosopher, Susanne Langer, wrote that "the only way an external influence can produce an act [in the organism] is to alter the organic situation that induces acts; and to do this it must strike into a matrix of ongoing activity, in which it is immediately lost."[5] Then there arises a response that, as we have just seen, is physically and causally incommensurable with the environmental stimulus leading to it.

Yet, if we look at both stimulus and response in terms of their *meanings* for the organism, we find them harmonious and unproblematic; nothing at all is "lost." Perhaps this tells us something about the most appropriate sorts of explanation for living, as opposed to inanimate, processes.

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What Is Meant by an "Intentional Agent"?

I like to say that every organism is spinning out a kind of biography—the story of its life. The truth in this seems to me more literal than metaphorical.

An organism perceiving the world in light of its own interests and carrying out narrative intentions rooted in its own particular needs and expressive tendencies—its own *character*—is what we might reasonably call an "intentional agent." Its activity suggests both a kind of wisdom and skill, and also a directed, willful striving. But while we can certainly think of intentional agency in terms of such features, I am content here to define the phrase as open-endedly as possible: an intentional agent is simply "that which exercises a power to weave the kind of narrative every organism makes of its life."

The narrative, implying also the power to weave it, is there for us to see. It is an inescapable given, and is already enough for our understanding to work with. We do not need to speculate about things we neither directly perceive nor understand—archetypes, souls, vital forces, entelechies, or whatever—in order to recognize and rigorously characterize a meaningful story when we see one.

At the same time, we should be as clear as possible about what we are in fact seeing, because it has dramatic implications for biology. While the events of a story can be presented truthfully, if narrowly, as nothing but a series of physical interactions in a reductionist sense, reading them this way misses the story entirely. Narrative threads are never mere chains of physical causation, and their meaningful coherence cannot be explained by such causation. Rather, they testify to motivation and unfolding intentions, which in turn express character.

This narrative of character is the only explanation we have for the overall coordination of the physical events of a life. (Go ahead and try coming up with a different sort of explanation.) The organism's intentions *govern* its physical interactions, all the way down to the molecular level. The interactions do not in the same sense govern the intentions.[6]

We Find Governing Intentions Even at the Molecular Level

Biologists certainly do recognize stories, even if the recognition is repressed in their conscious theorizing. Looked at closely, biology turns out to be *nothing but* meaningful narrative. Molecular biologists are always concerned with how means are coordinated in the service of ends—how tasks get accomplished, how stories get told. Organs need to be formed and to function properly; cells must replicate their DNA and then divide; molecular complexes within cells—whole galaxies of them—must interact in just the right way to perform tasks whose intricate movement toward the desirable, tortuously interwoven results is very often beyond the current capacity of the human mind to survey.

These directed activities are what researchers explore, as long as they are doing biology rather than physics and chemistry. That's why no one raises an eyebrow when the abstract of a technical paper, not unlike thousands of others, routinely begins,

> The ability of a cell to transform an extracellular stimulus into a downstream event that directs specific physiological outcomes, requires the orchestrated, spatial and temporal response of many signalling proteins.[7]

Scientists do not talk in the same way about the *abilities* of ocean waves or clouds or mountain ranges. Nor do they talk about how puddles or solar systems *signal* each other or orchestrate *responses*. And they would never say that inanimate physical entities *direct outcomes*.

Nor again would any scientist refer to the *discernment* of an inanimate system. But: "The coordinated development of multicellular organisms requires that cells be able to discern their relative position within the organism."[8]

Then there is this:

> In three of the cases covered in this article, the cell under study has to "make" decisions that will determine its developmental fate and function . . . In all three cases, a choice is determined by the balance between epigenetic silencing and activation, but the mechanistic details differ depending on specific regulatory needs.[9]

The authors understandably put scare quotes around "make," since it would surely be absurd to consider a cell as a conscious center for making decisions. Yet we shouldn't forget that the "choices" confronting the cell are nevertheless skillfully negotiated. While the cell is certainly not like a human decision-maker, it just as certainly is *caught up within* the play of an agency with extraordinarily skillful powers of meaningfully directed activity, however we choose to understand the sources of this agency or its center of action.

You will have noted that the authors neglected to put "choice" and "needs" inside quote marks, although exactly the same justification applies to these terms as to "making decisions." This neglect is understandable, however, since it would be unbearably tedious to quote all such terms. Whether more or less explicit, they are omnipresent in every biological text.

So the nagging question becomes: don't we owe our science and our public a disciplined reckoning with the kind of language we find ourselves forced to use—the kind we can forsake only at the cost of unconvincing circumlocutions and biological irrelevance? Without such a conscious coming to terms, are we not pushing a great deal of our science outside the bounds of responsible awareness?

There Is No Escape from the Most Difficult Questions of Science

A further consideration gives these questions even greater force. Beyond activity, motivation, intention, agency, and character, there is the issue already implicit in all these: can we reckon with—or are we forbidden from reckoning with—the intelligence, willful striving, and mindlikeness implied by these terms?

And here, too, it's not as if no one has ever pointed to the problem. In fact, sometimes the pointing seems much too easy, as when botanists speak, as they increasingly do

these days, of the "mentality," "learning," and "decision-making" of plants.[10] They almost invariably mean by this something like the programmed performance of a machine. But a *living* intelligence, capable of *being aware in the present* (rather than merely having been programmed in the past) and engaging in fresh judgment moment by moment, even if quite unlike conscious human judgment, never seems to be recognized as a problem to come to terms with.

We can recognize the problem in Sir Roger Penrose's description of the mindlike intelligence in organisms without neurons. For example, the "humble paramecium" swims about, "darting in the direction of bacterial food which she senses using a variety of mechanisms, or retreating at the prospect of danger, ready to swim off in another direction. She can also negotiate obstructions by swimming around them. Moreover, she can apparently even learn from her past experiences, though this most remarkable of her apparent faculties has been disputed by some."

Penrose, who is an Oxford physicist, goes on:

> How is this all achieved by an animal without a single neuron or synapse? Indeed, being but a single cell, and not being a neuron herself, she has no place to accommodate such accessories.
>
> Yet there must indeed be a complicated control system governing the behavior of a paramecium—or indeed other one-celled animals like amoebas—but it is not a nervous system. The structure responsible is apparently part of what is referred to as the cytoskeleton. As its name suggests, the cytoskeleton provides the framework that holds the cell in shape, but it does much more. The cilia themselves are endings of the cytoskeleton fibres, but the cytoskeleton seems also to contain the control system for the cell, in addition to providing "conveyor belts" for the transporting of various molecules from one place to another. In short, the cytoskeleton appears to play a role for the single cell rather like a combination of skeleton, muscle system, legs, blood circulatory system, and nervous system all rolled into one![11]

A key point here is that the usual reduction of mindlike capacities to the functioning of networked neurons doesn't work for an organism like the paramecium.[12] In fact, as we have already seen, it doesn't work even for the intelligently directed molecular activities within your and my cells.

Yet Penrose can't seem to help himself: he demands a physical "control system" for the paramecium's intelligence, and if neurons can't do the job, he will look for that control system somewhere else. And he finds it in the cytoskeleton.

Hernan Toro; Creative Commons

A group of paramecia (*Paramecium caudatum*)

Yes, the cytoskeleton is centrally caught up in manifestly intelligent, mindlike activity. But it is necessary to recall yet again that "mindless" physical interactions cannot give us the reasons and coherence—the expressive qualities and meanings—we require in order to make sense of intelligent behavior.

We make sense of all natural occurrences by recognizing their ideal (relational, conceptual, ideational) contents, whether those contents are the mathematical laws and relations in terms of which we often try to understand physical events, or the more qualitative idea-complexes we discover underlying the behavior of each particular sort of organism. Never, whether in physics or biology, do we find ourselves able to explain the ideal content—the laws or motivations—by invoking the substance given form by that content.

How Then Should We Proceed?

All this reminds us that the so-called "mind-body problem" confronts us, not just in human psychology, but in every cell of our bodies and at the very roots of all biological inquiry. Already when we consider the wildebeest responding to the image of a charging lion, we are up against the seemingly miraculous fact that animals *perceive* their environment, which is to say, they encounter the environment within consciousness.[13] There is nowhere

else for the encounter to take place. Even bacteria have their own, remarkably intelligent forms of perception and cognition:

> It is now realized that bacteria facilitate surprising collective functions. They can develop collective memory, use and generate common knowledge, develop group chemical identity, distinguish the chemical identity of other colonies in their environment or even higher organisms, learn from experience to improve their collective state and more.[14]

It is no minor issue. Any honest researcher working in the field of cognitive science will readily admit that no solution to the problems of mind and body, perception and consciousness, thought and object of thought—no consensus of even a minor sort—is currently within sight. The entire discipline of cognitive science is in a state of ferment amid a wide-open search for possibly new and unexpected solutions. This has now been the case for decades, with no prospective end to it.

No one can doubt that, depending on how the mind-body problem is resolved, biological theories dealing with everything from the molecular performances of cells to human cognition could become unrecognizable relative to the unadventurous philosophical rigidity of today's routine biological thought. We have every right to wonder about this rigidity, and to ask how it is distorting current thinking. Where is the scientific open-mindedness required in the face of questions no one pretends to have resolved?[15]

The foregoing is the main part of the introductory chapter Steve has written for a forthcoming book consisting of translations into Norwegian of a number of his articles written over the past several years. The publisher is Paradigmeskifte forlag: http://paradigmeskifte.nu.

Notes

1. I do not speak of plants here, but it is worth noting that plant growth is also a kind of self-motion. As for Aristotle, he considered motion in general to be of four kinds. Philosopher Sarah Byers elaborates:

> "motion" (*kinêsis*) means change (*metabolê*) generally, and has four distinct senses, two of which are locomotion and alteration. Thus we find: "It is always with respect to substance or to quantity or to quality or to place that what changes changes." In other words, something may "move" by coming into or passing out of existence (movement/change with regard to substance), by diminishing or increasing in overall size (movement/change with regard to quantity), by altering its state (movement/change with regard to quality), or by changing its location (movement/change with regard to place). (Byers 2006)

According to Byers, Aristotle considered the forms of self-motion particularly definitive of living things to be locomotion, growth/diminution, and alteration (or nourishment, which can be thought of as metabolism). But since Aristotle saw both locomotion and growth/diminution as presupposing nourishment, he viewed self-nourishment as the basic power distinguishing the living from the non-living.

2. Goodwin 1989.

3. Weiss 1962, p. 3.

4. Russell 1924, pp. 76-7.

5. Langer 1967, p. 283.

6. Many have recognized that if we were to try to understand biological events—say, the performance of the heart and circulatory system—solely by noting the motions and interactions of astronomical numbers of molecules, we would find it impossible to discover various biologically significant, higher-level regularities. But those who say this almost always still believe that, regardless of the level of observation, there is nothing but "meaningless physical interactions" to describe. The biologist is simply offering a "higher level of description."

My own point here is quite different. The intentions of an organism-agent are not physical forces; they are more like shaping ideas. But they are necessary to account for the observed narrative coherence of biological phenomena. Or, rather, the intentions, or ideas, *are* the coherence. We have no basis for claiming that the physical interactions, considered in the usual way as utterly meaningless and conceptually empty, are the cause of the observed coherence. See also the two paragraphs (beginning "Yes, the cytoskeleton...") in the main text above.

7. McCormick and Baillie 2014.

8. Benkovics and Timmermans 2014.

9. Lomvardas and Maniatis 2016.

10. For discussion of some rather startling recent work on plants—and the problem of mindlike intelligence in biology generally—see Talbott 2015.

11. Penrose 1994, pp. 357-8.

12. This ought, in the first place, to unsettle all discussion of brain-based intelligence. If intelligence is not essentially and necessarily a product of neural activity, what *is* the relation between intelligence (mind) and brain? Given the primacy of every organism's intelligent activity over fixed structures, shouldn't we consider the likelihood that this activity not only grows the brain expertly, but also employs it for its own thoughtful purposes? This is indeed the relation between the whole organism and all its other organs.

13. Actually, the environment is not something "just there," which the organism then looks out upon. What counts as its environment is determined by the organism's capacities and predilections for perceiving. "When one speaks of the living individual as responding to environment one really means by environment that which is sensed by the individual organism" (Russell 1924, pp. 59-60).

14. Ben Jacob 2006.

15. In this regard, see "Let's Loosen Up Biological Thinking!" (Talbott 2014b).

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