In Context

Number 14 Fall 2005

The Newsletter of **The Nature Institute**

#14

Dear Readers,

At The Nature Institute's founding ceremony almost exactly seven years ago, Henrike Holdrege offered the following words of dedication:

> When a seed is planted, it is up to us to do all the necessary work to support its growth—cultivating the soil, watering, weeding. But we cannot *make* the plant *grow*. We can do our part and we have to, but there is another part, the greater part, that is not in our hands. When we today found The Nature Institute, it is with the hope that it may find its rightful place in the world, and it is with the will to do what is given us to do.

It is customary upon the occasion of an anniversary, to recall all one's successes and make sure the world knows about them. But—especially when thinking of that part of the work "not in our hands"—we might also seize the occasion as an opportunity for inner quiet and receptiveness to a larger world of possibility. Instead of, or in addition to, announcing our achievements, we can look for how our work has fallen short or how it needs to change. Instead of trying to capsulize the past, we can regard the future with a fresh openness. Of course, these are not mutually exclusive alternatives. But it is worth keeping in mind that where we go from here is the only thing that will, in the end, give us a full and proper reading of where we have been.

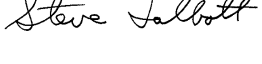
This openness is, among other things, a recognition of the world beyond ourselves. Our task is not simply to decide what *we* want to do, and then go out and try to do it. Rather, it is to connect realistically and constructively with whatever processes are at work in the world, and then try to respond both out of ourselves and in conversation with these processes.

At the end of his book on genetics Craig quotes a statement by Hegel that Henrike also cited in her remarks: "thinking inflicts the wound, but also heals it." The thinking that inflicts the wound has received much comment from us as well as from others. It is a mechanistic thinking that tends to isolate and abstract, losing the living context of the phenomena it studies. On the other hand, the thinking that heals is neither a cold, calculated thinking, nor a thinking born of our own hot passions. Rather it is a thinking faithful to all the inner and outer richness of the world's phenomena. This, too, is a reason for the quiet openness we just now spoke of. A serene and receptive stance is the only position from which we can "let the phenomena speak" and find the healing forms of thought allowing us to receive this speaking.

Actually, you might say that being receptive to the world by means of these healing forms of thought is what The Nature Institute is all about—and if we have "achieved" anything worth mentioning, it is precisely to have succeeded to some small degree in this work of becoming receptive. So we should not contrast too strongly the recitation of achievements, on the one hand, and openness to whatever might speak to us from the world, on the other. For any Goethean scientist, that openness is itself the major achievement.

Craig Holdrege

Steve Talbott



The Nature Institute

In Context is published twice yearly.

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Single copies of *In Context* are available free while the supply lasts. The Nature Institute's online *NetFuture* newsletter is available at: http://netfuture.org

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Wildlife Observations

Craig Holdrege

In early summer Henrike and I and our fourteen-year-old son, Martin, traveled to the Rocky Mountains of Montana and Wyoming. Our aim was to observe wildlife, and particularly the bison, which I have begun to study. We found unexpected abundance: in addition to the hundreds of bison we saw in different herds, we came across nineteen bears (mainly black bears and a couple of grizzlies), wolves (in Yellowstone), coyotes, pronghorns (a unique antelope of the American west), both white-tailed and mule deer, elk, moose, and the large numbers of small rodents whose tunnel openings you encounter nearly every step you take. This is to leave aside all the birds we saw. After two weeks, we felt we had not only bathed in the beautiful landscapes, but also participated to a small degree in a world where wild animals play a significant role.

National Bison Range, Montana (Photo by C. Holdrege)

When you watch animals as we did for only short periods of time, you try to take in as much as you can. You want to gain vivid impressions of the animals' appearance, movements and ways of behaving, which include what they are relating to. Usually I try to re-picture the encounters later and then make journal entries. These observations provide an essential background and context for my further studies of the animal—for my investigations of the animal's morphology and for the literature research I do to build up a many-sided picture of the animal.

Here is a selection of journal entries from the trip, lightly edited to provide the necessary context.

June 12, 2005, National Bison Range, Montana

We drove to the 19,000-acre National Bison Range, which lies north of Missoula, Montana, near the southern end of the broad Mission Valley. It had been a rainy June and the landscape was still green and seemed lush, despite the widespread presence of sage brush. The mountain peaks on both sides of this vast valley were still covered in snow. The bison range itself is hilly, the lower areas are prairie, and the tops of many hills also support Douglas fir/ponderosa pine forests.

Bison: Today we saw bison mostly at a distance and caught sight only of small groups (often one to five animals, once thirteen). Since my previous observations of bison were in zoos, it definitely felt "right" seeing them in this vast landscape, where they belong, as small black dots, grazing and moving slowly along the grass-covered hills. We observed one group of five bison up close—three males (one yearling, one juvenile and a large, older bull), a female, and her one to two-month-old male calf. The calf was a light, reddish brown in contrast to the deep dark brown of the other animals. It had not yet developed a hump or long hairs on the head and shoulders, so that it strongly resembled a domestic cow calf. If you saw it in a herd of cattle, you might not know it was a bison. The inimitable look of bison develops only over time.

The calf was more playful than the other bison, which were either lying and ruminating, or standing and walking slowly while grazing. The calf was also the only one of the group to take notice of us. At one point it ran around vigorously in a wide circle and repeated this jaunt a number a times. Periodically it bounded with all four feet in the air—the embodiment of youthful vigor. The juvenile male then walked to a roundish, plant-free depression in the ground—a wallow—and lay down on its side. Creating a cloud of dust, it rolled a number of times onto its side with feet in the air. But it never rolled over, since the hump on the

Lamar Valley, Yellowstone National Park (Photo by C. Holdrege)

back provides an insurmountable barrier. The calf watched the juvenile's wallowing and then it wallowed. If I have ever seen a case of imitation among animals, this was it. The calf clearly hadn't mastered wallowing yet. It could hardly roll on its side and its legs flailed around. Evidently, wallowing is not an inborn capacity!

The group grazed silently during the half hour we watched them. The yearling occasionally pushed a bit with its head at the calf in a playful, sibling-like way.

Close up, with their massive and compact bodies, bison make impressive forms. Calmness, yet also a kind of held strength radiates from them. The large head, with all its fur and the long, hanging beard, is always near the ground and makes a singular, hard-to-describe impression, as it weighs downward, full of gravity, from the raised hump between its shoulders.

Black Bear: A wholly unexpected site greeted us as we drove up the range's narrow dirt road near the edge of a Douglas fir/ponderosa pine forest. The forest was bounded by a lush meadow full of wildflowers—arnica, Senecio, geranium, lupine, butter and eggs, Echium, sunflowers, and many more species we didn't know. Out of the forest appeared a cinnamon and dark-brown-colored black bear. (Black bears, *Ursus americanus*, are by no means always black; many display this cinnamon coloring.) The bear's head was nearly black around the face and muzzle and then turned rich cinnamon brown in the rump and legs. It stood, four-legged, about three-feet high.

We were able to watch it for about forty minutes as it ambled around in the meadow. It would go up to a rock lying in the meadow and, with the claws of one its forelegs, flip the rock over. This occurred with the greatest ease and nonchalance, indicating the bear's immense strength. Once the rock was displaced, the bear poked its nose down into the opened-up soil, evidently feeding on grubs, ants, and other substonal delights. Sometimes it just tipped a rock to one onside, dropped it again, and moved along. Not every rock covered ample treats! A couple of times it looked our way, but didn't seem overly concerned or disturbed by us. After it had fed richly and moved many stones, it ambled off and up into the forest.

June 13, National Bison Range, Montana

Bison: We spent about eight hours on the range today. Driving along slowly on the dirt road we encountered a large herd of bison, perhaps three-hundred animals. They moved along the grassy hillside, grazing. The herd was mixed—all age groups and both sexes. There were many calves, most of which (we were told by the Range's biologist) had been born in April or May. The herd moved in segments down toward the gravel road we were on. In no time we were surrounded by bison. But we were not the focus of their attention. They were moving across the road toward a few watering holes and the neighboring wallows. Although separated by the walls of our car, it was often breathtaking to have a huge creature move by literally at arm's length, emitting deep guttural grunts as it walked.

Many of the bison walked into the watering holes and stood drinking for a while. Often they would then climb up the banks and wallow in the dirt. The most prolific wallowers were two-to-three-year-old bulls. They either just rubbed their heads back and forth in the dirt or lay down and rocked to and fro on their sides. These short and intense meetings with the earth seem an essential part of a bison's daily activity. The young bulls often wallowed next to each other, and then got up and sparred. The sparring usually consists of head to head pushing and then simply ends, sometimes with one of the bulls walking off. With their heads almost touching the ground and their humps rising above their powerful, forward thrusting shoulders, sparring bison display impressive strength.

The bison sometimes galloped while coming down the hillside into the valley. Otherwise they usually walked and, while walking, grazed. On the back of a bison we often observed cowbirds, whose black heads and brown body coloring somewhat mimics the coat of their giant companions. These birds would fly down off the bison and jump around on the ground in close proximity to the bison's hooves. It

seems remarkable that in this search for food they don't get trampled.

How to give expression to the feeling of being surrounded by bison? Their massiveness and of course the density of the presence of so many animals at one time grips you. There's an atmosphere of earnestness—only the calves are playful and "light."

Later we observed a large, lone, old bull. He was grazing, extending his long pointed tongue and enwrapping tufts of grass. His head rose and descended as he grazed and slowly moved along, making such an impression of immensity that I can't think of anything comparable. The head is covered with a luxuriant growth of hair, especially the forehead and chin, and the dense, long pelage extends down (or up) the neck, over the shoulders and along the forelimbs. This impressive coat accentuates strongly the front part of the animal. The fur is much shorter in the rear half of the body and on the back legs. Since the tail is neither long nor furry, the rear part of the body seems to recede just as the front half protrudes and dominates in the bison's gestalt.

June 16, Lamar Valley, Yellowstone National Park, Wyoming

Bison: We drove out into Lamar Valley at 5 am. The valley is fairly broad with the flood plain of the meandering Lamar River surrounded by hillsides of sagebrush prairie (mainly on the southern exposures) and Douglas fir forests on the northern exposures and hilltops. We drove along and encountered small bison groups, a few lone males, and then a large herd that inhabits the valley at this time of year. The herd was on both sides of the road and once again we were surrounded by hundreds of animals. The herd consisted primarily of females with calves, as well as young males and females. The older males were mostly off on their own.

We watched extensively a cow and her almost newborn calf. The calf was much smaller than the other calves—little more than half their size—and we could see the remnants of the umbilical cord. It couldn't have been more than a few days old, a late birth in the herd. The calf was just tall enough to walk under its mother's chest, right behind the front legs! When we caught sight of it, it looked as though it might have been nursing, but then it stopped and didn't make any nursing attempts again. It always stayed close to its mother. Sometimes, after walking a while, it would lie down. When its mother moved along, it would stand up and walk to catch up with her. Its gait was still uncertain, and once it tripped, stumbling a bit forward before catching itself.

Another calf tried to get close to the newborn but the mother nosed it away; the same occurred with a yearling. Evidently, the cow was trying to keep others at a certain distance, although she and her calf were clearly within the herd and not separate from it.

We observed an older calf nursing. It forcefully shoved up against the udder and the (in our eyes) poor mother seemed almost lifted into the air. We noticed that quite a few of the bison here still had their winter coats of long-thick fur. Many looked straggly as they shed bunches of this thick fur in the rear half of their body. The cow with the newborn calf still had a complete winter coat. This herd moved continually along, grazing and grunting. In the distance on the other side of the river a large group of bison grazed and many animals were lying, ruminating.

June 19, Grand Teton National Park, Wyoming

Coyotes: Shortly before dusk, we drove along a back road in the flat country west of the Teton range—sagebrush openings, lodge pole pine forests, and aspen groves. There were also willow thickets along a stream where we hoped to find moose—but to no avail. On the way back to the main road I saw two grayish, light-brown, dog-like creatures moving along the road ahead of us. They turned out to be coyotes. One was chasing the other. They crossed over into a sagebrush field and were moving fast. Suddenly they stopped and turned head-to-head. Both reared up on their hind legs and pawed for an instant at each other. One of the coyotes broke off and raced away. The chase through the

Lamar Valley, Yellowstone National Park (Photo by C. Holdrege)

sagebrush resumed. They galloped off into the woods. Strange how such a fleeting glimpse—I'm sure we didn't watch them for more than a minute—into the life of two animals can be so powerful and stick with you so vividly.

Moose: After watching the coyotes we drove back to the main road. The willow-bottomlands along the Snake River seemed prime moose territory. We had just remarked that if you look for something too hard, you may well not find it, when we saw some cars stopped at the roadside. We also stopped, got out and looked down the steep ten-foot embankment to the wetland. There was a huge, chocolate-brown bull moose. He had a full rack of growing, velvet-covered antlers and was standing almost up to his chest in a small pool surrounded by willows. He would sink his long, barrel-shaped muzzle down into the water and submerge his head so that all you saw was the more-than-a-yard-wide spread of his antlers. When he raised his head, water cascaded off his fur, and white roots and stems dangled dripping from his mouth. He pulled these in and chewed. He steadily and calmly fed off the pool-floor vegetation for about an hour.

At times, when his head was submerged, he would blow out through his nose and the water would bubble up around him. (I'd never thought of moose contributing to water aeration!) Once a police car zipped by with siren screaming and the moose took no notice of it. Only when a car screeched briefly with its breaks did he lift his head and look up toward the source of the noise. Otherwise he seemed to have little interest in the humans and machines around him. His eyes were tiny compared to his long and blocky snout and his immense antlers. His ears were hardly visible near the base of the antlers.

From the pool he finally moved a few steps and began feeding on the willows. Sometimes he would strip a branch of its leaves by putting his mouth around it and pulling back with his head. Other times he bit off an entire twig. Finally, he moved off deeper into the willow thicket and out of sight.

Commentary on DNA Barcoding in *Bioscience*

In the last issue of *In Context* we reported on a letter by Malte Ebach and Craig Holdrege that was published in *Nature.* It dealt with DNA barcoding — the effort to identify every organism through a piece of its DNA. The letter was published in April and elicited critical response letters from barcoding enthusiasts in following issues of the magazine. The letter also caught the eye of the editor of *BioScience*, the journal of the American Institute of Biological Sciences. Recognizing that it addressed important concerns about the direction of biological research, he requested a viewpoint article from Malte and Craig, which will appear in an upcoming issue of the journal. Here are a few excerpts from that article:

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Imagine, for the sake of argument, that barcoders were able to tag each known taxonomic species with a DNA barcode, and that they discovered new and unique sequences that might indicate a hitherto unknown species. Since barcoders maintain that there exist "DNA species" that are impossible to tell apart from known species except through sequence comparisons, many new species identified by barcoding would not be morphologically distinguishable. The resulting, much larger number of "species" would be a number that means very little. What that number might tell us about actually existing species would have to be intensively investigated, because barcodes cannot reveal the types of their corresponding real species, those species' relationships, or their behavior. In the end, we will be left with a very large and arbitrary number of supposed species. Since barcoding does not classify or create readily usable knowledge, it remains simply a technique, and should not be taken for more than that. What science really needs is more naturalists and taxonomists, not more barcoders.

The CBOL Web site [Consortium for the Barcode of Life] claims that DNA barcoding is a "new and exciting addition to the taxonomists' toolbox." The observation prompts a question: What is already in a "taxonomist's toolbox"? It contains physical tools — such as a checklist, microscope, net, and plant press — and also years of training and experience gained from studying the taxonomy of one or more groups. If barcoding could be viewed and managed as one subordinate physical instrument to be implemented in specific instances, it would be a useful addition. The question, in the present climate of high-tech hype, is whether researchers will realize that barcoding cannot replace any of the already existing tools, especially

detailed knowledge of organisms. This is not a casual concern: wherever one looks in biology, molecular techniques are replacing the study of whole organisms and their relationships….

Yet, if DNA barcoding receives major funding as a high-output, "big science" program, and as a result is viewed (wrongly) as a modernized taxonomy, it will in fact begin supplanting taxonomic projects…. In a funding climate focused on promoting sexy new high-output "solutions" to global problems, a scientific field that progresses by investing much time, energy, and funding into training taxonomists, doing careful fieldwork, and carrying out detailed morphological studies may seem outmoded. According to this view, taxonomists are clearly soon to become fossils in the strata of scientific evolution themselves…. It is ironic that DNA barcoding is often portrayed as central to the effort to protect biodiversity. The implication seems to be that only enormous numbers of cataloged species, each with its own unique mitochondrial DNA sequence, will motivate human beings to gain, at last, respect for life. But this approach tells us next to nothing about the creatures we are supposed to care about. Would it not make much more sense to invest resources in getting to know better the whole organisms and their ecologies?

Aristotle's Opinion of Modern Physics

You may be forgiven for not having heard of Kurt Riezler. In fact, I have not yet even found a decent biographical summary of his life. I do know, however, that at the outbreak of the First World War he was the political warfare advisor to the German Chancellor — and was quite well-known in that capacity. A 1980 academic book entitled In the Eye of the Storm: Kurt Riezler and the Crises of Modern Germany *seems to have gotten some notice.*

In the Thirties Riezler came to the United States and joined the faculty of the New School for Social Research in New York City. His own books ranged from Grundzüge der Weltpolitik in der Gegenwart *("Outlines of Contemporary World Politics") to* Parmenides *(a commentary on the pre-Socratic philosopher) to* Man: Mutable and Immutable *(a philosophical attempt to frame a broad understanding of human social life) to* Physics and Reality: Lectures of Aristotle on Modern Physics.

This latter, published in 1940 (Yale University Press), was written as if it were a commentary by Aristotle on twentieth-century physics. Phenomenologically oriented readers of this work will immediately recognize the truth of Leo Strauss' statement that "Riezler represented to me, more than anyone else among my acquaintances, the virtue of humanity. I believe he was formed by Goethe more than by any other master" (from the essay, "Kurt Riezler," in Strauss' What is Political Philosophy?*).*

Riezler lived from 1882-1955. His book on physics remains virtually unknown — even in circles where it would be deeply appreciated. In an attempt to change this, we present here a few excerpts — intended merely to tantalize you — from the first two chapters of Physics and Reality.

Before we get to the comments of "Aristotle," however, here is a statement from the book's preface:

> *This little book is a humble experiment in thought dedicated to those who, conscious of a widening cleavage between Nature and Man, are willing to inquire into its causes. It neither will nor can do any harm to others who feel safe only in the shelter of inherited habits.*
>
> *ST*

Certainly, from [the ancient Greek time of] my stammering to your [modern] calculating the progress has been extraordinary. You have the most ingenious instruments, you use the most efficient methods, you know the most astounding laws.... For this and still more you have my humble admiration....

The most intense of all your experiences is your desire for knowledge. In vain do I look for the place of this experience in your scheme of the universe. There is no place. This, not your successes, is what astonishes me most.... You have shut yourselves off from Nature. The further you penetrate into what you call nature the more elusive you become to yourselves.

The nature you talk about as scientists is not the nature you mean when you say "I am." Nature is one, immutable, eternally varying — the way of Being in all beings, revealed as eternal movement, formation, deformation, and transformation. You yourselves, your desire for knowledge, you are Nature. And yet you have opened between your comprehension of yourselves and your knowledge of Nature

a chasm that engulfs in darkness your common being.

You realize it. In all the splendor of your inventions this is your secret grief and the scandal of your science....

Man is your closest, your most authentic experience, which yet you put aside.

Ah, I well know what tempted you! The exciting experience of Nature submitting to Number first created an ideal of Truth in your souls: the certitude of mathematical statements. This ideal determined your conception of science; and this conception of science prompted your scheme of nature as object of this science. Nature became the nature of exact science....

No doubt there were other things that seduced you: The technician in you wanted to build machines, did not care about the essence of things in so far as they "are." To build machines it is sufficient to measure quantities and to know their relations.

* * * * * *

There is something in us and beyond, call it what you will: Nature, Being, Reality — something we can hit or miss, veil or unveil with words. And we both defer to that something as judge. So I shall get to the core of our difference by posing a specific problem: what is Motion? This question lies in the thick of my battle with the secret of Nature. It unleashes your innermost difficulties, compelling you to reconsider your own methods....

What is Motion? By Motion I mean not only motion in space, but change of any sort — variation in quality, waxing and waning, growth and decay, birth and death.... The answer to the question "What is Motion?" must be a statement about Being. Being is intrinsically mobile, changing. What does that mean?...

You do not want to ask what Motion "is," or even hear that this "is" is doubtful. You pretend that no answer whatever to this question could touch you and your science in any way.... "We pretend nothing about the nature of things — let alone about 'Being.' We do not care about interpretations of our statements. We coördinate. The agreement of calculation and perception is justification enough." Am I wrong in presuming that this modesty is only a way of defense? That you are all convinced or were convinced until a short time ago that your scheme of order is the basis of all knowledge about Nature since it is the scheme of Nature herself and the model of "Being"?...

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What is the subject of your perceptibility? Not the individual subject. You admit perceptions only if they can be confirmed by any possible perceiver. You eliminate the particular individuality of the perceiving subject. You assume one ever present anonymous observer, the possible observer.... You have then no right to pretend that you coördinate a totality of all possible or real perceptions with your model of nature, that your design of this model is confirmed by the totality of your perceptions. You have made a selection, and a very narrow one at that. You have limited the perceptible to the measurable....

You have emasculated this anonymous subject; now he is an odd creature, a robot without blood and heart, whose only being consists in reading numbers from the pointers of your instruments.

Your "objective" reality is merely an intersubjective order relative to this robot observer. All that is not measurement is closed to him. Your most intimate and impressive experiences mean nothing to him. He has no part in the colorful fullness of Being. Since he is not a number he cannot perceive himself. He does not belong to his own world....

This your objective world, a pointer-reading world of numbers, is no more the world of your eyes, hands, and hearts. With the growing distance between these two worlds uneasiness grows in you. In this feeling you realize half consciously that perhaps you have excluded from your world several things of which you remain firmly convinced that they "are."

Thus most of your notions change color in a twilight. You use the word "force" and, when queried, you define it by law, field, and vector; but what you really have in mind is the force you feel in commanding your muscles. Do not imagine, however, that you are uniting these two: you mix up unconnected notions, surreptitiously exchanging one for the other. All your thinking goes on in such ambiguity. You are aware of it; hence your discomfort.

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From this introductory chapter, Riezler goes on to consider the problem of motion, along with time, cause, and various other categories of science. The substance of his argument is too weighty to summarize here, but we offer a few additional, rather isolated excerpts from the second chapter:

You are able to calculate from the conditions of the system at any one time its conditions at any other time. This kind of order you call the causal structure of world occurrences. Thus your design of nature is of grand integrity, a marvel to behold. So you think. I must confess a tinge of admiration in my horror.

This world, however, is merely the world of your anonymous observer.... Its laws link possible pointer readings. It is

bleak and barren and lacks sun despite its lucidity. For centuries I have been wondering how you are able to live in this world without freezing. Even you might perhaps feel slightly chilly if you drew your own conclusions. This, however, you do not do. You relate the pointer readings of your anonymous observer to the perceptions of your own senses. Your naïve view of the world steals into the world of the anonymous observer and his figures. Now the numbers seem to take on life....

[But] your naïve world is no world. It is a muddle of rudiments of past ontologies, including my own. There is no ontology, no "logos" of Being as Being, no unity of design of an ordered totality.... In this world Law reigns supreme. Law has ever been, is, and will ever be. It is immutably the same. There is no creation, neither becoming nor decaying.... It seems to me that you gave your God too much work in the beginning of the world and too little during its course.

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Time, to you.... like space, is mere extension.... You call it rest when the points of space related to the points of time are the same; movement when they are continuously different. But this rest does not rest, this movement does not move.... The semblance of rest and movement is caused by your relating your inner knowledge of your own resting and moving to [mathematical extension]....

So it happens that field physics gives a strange answer to the question what Motion really is: Motion does not move. In your world there is no motion, therefore no rest, for the movable alone can rest. Time, which must determine motion, is not distinguished as time. The moving of motion is a mirage — even the unity of the moved, the subject of movement, is the observer's assumption.

I read indifference in your faces — all this cannot give you concern. It does not affect your discoveries. Your airplanes fly. Your wireless waves race through space, bringing the commonplaces of statement from the other side of the globe to the remotest hovel. You calculate the pressure of radiation on the surface of the sun, the temperature in its center, you destroy atoms of nitrogen. You follow the tracks of the ejaculated particles. You sort out the elements — you take hold of matter. And here somebody rises and says: "Your motion does not move." You do not trust your ears.

Permit me to justify myself.... I do not contest the knowledge of the physicist. I deny neither your laws nor your machines....

I do not dispute the numbers of the anonymous observer but only their claim to describe Nature....

* * * * * *

If your movement seems to move, your time to be Time, your substrate of movement to be Subject, it is only because you furtively slip your inner perception into the sense of your words....

Consider! The answer the world gives to your way of questioning is an order of pointer readings. Into that order you introduce vague thoughts interpreting those concepts by untested knowledge of the subject about itself. This answer is an answer neither of the world nor of your own Being. You can make it pass neither as one nor the other.

You have not examined the "Being" of the subject. Maybe from its knowledge of its own Being the subject would have given an entirely different answer. You have lost the ability to inquire in that way; you no longer even know that such a way of inquiry is possible and still less that you could obtain an objective answer to such questions....

Only when searching for this logos, embracing the testimony of your numbers and your own living Being in one question and in one answer — then only do you, striving with greater effort for a higher goal, face the secret of Nature. Never will that forlorn creature, Man, behold an image of Nature if he does not know what he is himself. Never will Man find himself if not in the image of Nature.

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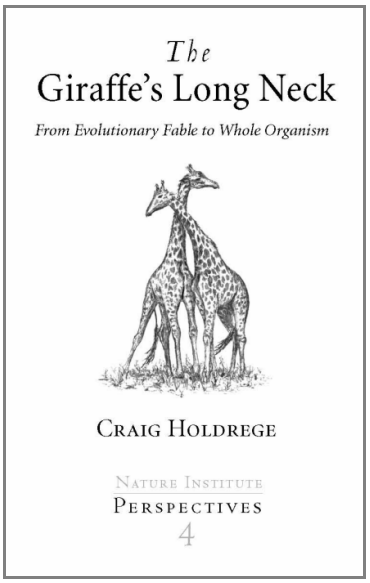
Physics and Reality *is out of print and difficult to obtain. We hope eventually to put the entire text on our website, but currently lack the resources to do this. (If you're a volunteer typist eager to tackle a 125-page book, let us know!)*



A New Perspective on the Giraffe

Craig's research on the giraffe will soon appear as the fourth booklet in our series of Nature Institute Perspectives. It is entitled, *The Giraffe's Long Neck: From Evolutionary Fable to Whole Organism. In Context* readers have gotten a glimpse of this work through articles in issues 10 and 12. The booklet provides a comprehensive picture of the giraffe's biology and ecology and also discusses the complex and controversial issue of its evolution. Since Craig's intention is to break through the strictures of narrowly confined conceptions of the giraffe and of evolution, neither card-carrying Darwinists nor Creationists will be happy with this book. His goal is not to explain the giraffe's characteristics and speculate about how they might have evolved, but rather to show how the giraffe's features are interconnected and to paint a picture of the giraffe as a whole, integrated organism.

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The book costs $10 and can be ordered directly from the Institute.

Summer Encounters

Our summer courses bring intense interaction with people. The Institute is full of life during those weeks. This summer brought even more human encounters, due to a number of visitors who came our way. Many intense conversations ensued as we got to know our guests and experienced how their concerns and work overlap with ours. Such human meetings are essential, because the work we're trying to do is not an isolated venture of a few individuals, but connected with the strivings and concrete work of others around the country and globe. So in these meetings we become conscious of these connections, forge new relations and go away strengthened in our commitment. Even if we can't all interact with each other as much as we'd like, any awareness we can gain of what others are doing is important.

Here's a snapshot of some of these encounters.

** You will recall that neurologist and medical researcher, Siegward Elsas, wrote about "Brain Activity and Conscious Experience" in *In Context* #13. Prior to that, we had enjoyed an all-day seminar with Siegward, dealing with the material and themes of his article. This past July Craig and Steve sat down with Siegward again for a full day's further exploration of the relation between brain and consciousness. The conversation was shaped in part by our awareness that, in the coming years, human behavior will very likely be widely discussed in terms of brain function rather than ethics, religion, social values, and so on.

Among other things, Siegward clarified the methods of operation, the advantage, and the limitations of various techniques for observing brain activity — functional MRI, PET scan, electro-encephalograph (EEG), and several others. Then we considered the much-discussed experiments by Benjamin Libet and his colleagues — experiments leading many to conclude that our experience of conscious will is secondary to, and determined by, brain activity. This led us into general philosophical and epistemological considerations regarding the relation between consciousness and physical substance.

Along the way, Siegward noted that it can be threatening to refine and discipline our powers of introspection, because this leads to an encounter with our own negative emotions and shortcomings. In particular, double blind studies enable us to avoid dealing with our prejudices and limitations. But this drive for value-neutrality can become naive, as when we

forget how thoroughly we must rely on our own judgment about the value or relevance of the publications and work of other researchers.

We anticipate further conversations with Siegward, who is now an affiliate researcher of The Nature Institute.

** Florian Theilman is a phenomenological physicist who works at a sister organization, the Science Research Institute at the Goetheanum in Dornach, Switzerland. Florian was visiting America for the first time and came to the Institute for several days after a working conference on themes in phenomenological physics in Saratoga Springs, New York. The conference was organized by our affiliate researcher, Michael D'Aleo. Henrike Holdrege also participated, along with Nature Institute friend, Mark Gardner.

Afterward we spoke with Florian about how one can truly take one's lead from the phenomena at a time when so many "facts" of science turn out to be intensely theory-laden. We asked Florian to describe to us how physicists come to the notion of the speed of light. It was a revelation to see how one can interpret the phenomena differently. We hope some day to share Florian's insights with *In Context* readers.

** At the end of September we received a visit from Arie Ben-David of Israel, along with his wife, eurythmist Jan Ranck. An artist, poet, teacher, therapist, and social entrepreneur, Arie also maintains many interests connected to science. He has played a major role in bringing individuals and organizations together in a network known as Integrative Life Sciences (ILS). The aim is to nurture and support a wide range of innovative, ethical, and sustainable services in finance, insurance, consulting, marketing, and health care. In addition, Arie has been seeking to facilitate novel programs of scientific research. In connection with this, he is interested in the possibilities for collaboration with The Nature Institute. Various Friends of the Nature Institute have already become associated with ILS, and we look forward to learning more about the network and its potentials for encouraging creative scientific work.

** Martin Lockley is one of the world's experts on dinosaur tracks. But in addition to traveling the globe searching for and interpreting the footprints of dinosaurs, Martin has been working with Wolfgang Schad's Goethean approach to animal morphology, applying it to dinosaurs. Martin gave an impromptu presentation to Institute staff and friends on his work. It was refreshing to see a scientist looking so carefully at *patterns* in animal morphology, without reducing his understanding to causal explanations. Through such attention animal form may suddenly come alive in new ways and one sees relationships between very different kinds of organisms. Discoveries along these lines suggest that there are formative principles at work in nature that cannot be reduced to chance convergence or adaptation.

Martin will be a guest teacher in our spring Goethean science course. He is the director of the Dinosaur Tracks Museum , University of Colorado at Denver.

** Hugh Ractliffe is a biologist and gardener who visited from Foyer Michael, an adult education center in France. A founder of the CSA (community-supported agriculture) movement in the United States, Hugh has worked for many years doing Goethean plant studies. He brought to us the question how such work might be deepened, and suggested that people who teach the Goethean approach should get together occasionally for intensive plant observation and discussion. In this way, they could learn and profit from each other—something that doesn't happen often enough. We hope to have a first such meeting next summer here at The Nature Institute.

Out and About

** In September Craig gave a talk at the annual Prairie Festival of the Land Institute in Salina, Kansas. He spoke on "Can We See With Fresh Eyes: Wonder, Bias, and the Conundrum of Knowledge." Other speakers included Bill McKibben, Sue Halpern, Carl McDaniel, Strachan Donnelly, and the Land Institute's founder and director, Wes Jackson, who is also on The Nature Institute's Advisory Board.

** In October Craig gave a half-day workshop on "The Metamorphosis of Plants and Knowledge" at the Groh Biodynamic Farm in Wilton, NH.

** In January Henrike travels to the Eugene, Oregon, to give a workshop on projective geometry for Waldorf teacher trainees and the public. She will also give a public talk.

** Between March 22 and 25, 2006, Craig will give a number of talks and workshops in Los Angeles and Pasadena, California. He will speak on Goethean science and also genetic engineering.

** Craig has been invited to teach and give a public talk on his approach to genetics and genetic engineering at the Trinity Preparatory School in Winter Park, Florida, as part of the school's "Visiting Writers Series." He will be at the school from March 27 to March 30.

Goethe's Delicate Empiricism

Goethe's approach to science received central billing in a special issue of *Janus Head,* which appeared in late summer. Craig was a guest editor of the issue. A surprising number and array of articles were submitted, so that it was a difficult task to choose a selection for the journal. As editor-in-chief Brent Robbins wrote in his editorial, "I think it is fair to say this volume of papers represents the most thorough and interdisciplinary collection of papers on Goethean science since the publication of Goethe's Way of Science (SUNY Press, 1998), edited by David Seamon and Arthur Zajonc over seven years ago. I am hopeful the volume—and its wide availability through *Janus Head*—will help serve the purpose of spreading Goethe's message far and wide, most especially to those who might not have otherwise heard his call."

Authors include friends and collaborators of The Nature Institute such as Bill Bywater—who co-edited the issue with Craig—Christina Root, David Seamon, Allan Kaplan, and Malte Ebach. The issue is available online at http://www.janushead.org. Copies of the bound version of the issue can be ordered from the website or by writing to *Janus Head* (P.O. Box 1259, Amherst, NY 14226).

In addition to the articles on the Goethean approach listed below, the special issue includes poetry and book reviews.

"Doing Goethean Science," by Craig Holdrege

"'Zarte Empirie': Goethean Science as a Way of Knowing," by Daniel C. Wahl

"Goethe's Way of Science as a Phenomenology of Nature," by David Seamon

"New Organs of Perception: Goethean Science as a Cultural Therapeutic," by Brent Dean Robbins

"Goethe and the Refiguring of Intellectual Inquiry: From 'Aboutness'-Thinking to 'Withness'-Thinking in Everyday Life," by John Shotter

"Goethe, Husserl, and the Crisis of the European Sciences," by Eva-Maria Simms

"Place, Goethe and Phenomenology: A Theoretic Journey," by John Cameron

"Goethe and the Poetics of Science," by Dennis L. Sepper

"The Proteus Within: Thoreau's Practice of Goethe's Phenomenology," by Christina Root

"Anschauung and the Archetype: The Role of Goethe's Delicate Empiricism in Comparative Biology," by Malte C. Ebach

"Goethe and the Molecular Aesthetic," by Maura C. Flannery

"Goethe: A Science Which Does Not Eat the Other," by Bill Bywater

"Emerging Out of Goethe: Conversation as a Form of Social Inquiry," by Allan Kaplan

We Have a New Kitchen and Library!

This spring we completed the renovation of the events kitchen on the ground floor and converted the old kitchen into a space for our library. We finished the work just in time for our summer courses, so we could welcome participants into these new rooms. We're now making optimal use of the space that our building provides. The renovation was carried out by a number of able craftsmen who gave their quiet attention to many details: our warm thanks to Mark Gardner, Thomas Tommi, and Steve Dorresteyn. The electrical work was executed by David Gallardo and the plumbing by Bill Schmolz. College students Edmund Muller and Christina Holdrege painted the rooms. The work was funded by grants from the Berkshire Taconic Foundation, the Hudson River Bank Foundation, the Golub Foundation and gifts from individuals.

Come by and enjoy the new spaces!

Events at the Institute

We note briefly these events taking place at The Nature Institute during the Fall and Winter of 2005–2006:

** *Projective Geometry — Extending Our Boundaries and Experience of Thought*. A weekly course with Henrike Holdrege, beginning September 20.

** *The Cow and the Cowherd in the Context of a Biodynamic Farm*. A talk by Steffen Schneider, the farmer and farm manager of Hawthorne Valley Farm. October 27.

** *Celebration of the first seven years of The Nature Institute*. The celebration will include a talk by Craig Holdrege about the American bison. Saturday, November 18, at 7:30 p.m. in the Hawthorne Valley School Hall.

** *Winter Wildlife Tracking*. Workshops with Michael Pewtherer and Jonathan Talbott, co-sponsored with Woodland Ways and Hawthorne Valley School. Four Saturday mornings in January and February.

A Spring Course on Goethean Science

The Nature Institute will conduct an eleven-week, full-time Goethean Science Studies course from April 2 to June 16, 2006. The course will provide the day-to-day immersion needed to acquire and internalize new capacities. The springtime scheduling will allow us to take advantage of the Northeast's rapidly and richly unfolding plant life.

In addition to Nature Institute staff (Craig and Henrike Holdrege, Steve Talbott), teachers for the course will include a number of guest faculty: Michael D'Aleo (physics teacher, Spring Hill Waldorf School, Saratoga Springs, New York); Gertrude Reif Hughes (professor of English, Wesleyan University); Martin Lockley (paleontologist and director, Dinosaur Tracks Museum, University of Colorado); Douglas Sloan (professor emeritus of history and education, Columbia University); and Arthur Zajonc (professor of physics, Amherst College).

Since practice is key to learning the Goethean approach to science, the individual project is a central feature of the course. Each student will choose an area of study (a plant species or family, multiple species for comparison, a specific habitat, and so on) in which he or she applies the methods learned during the seminars. Each student will give a project presentation at the end of the course.

For more information or a brochure, please contact us at 518-672-0116 or info@natureinstitute.org. You can download an application form from our website: http://natureinstitute.org.

Application deadline: January 15, 2006.

Gloria Kemp Joins the Institute

We feel very fortunate that Gloria Kemp joined the staff of the Institute in September. With our growing workload, we knew we needed more help. But we hardly dared hope for someone as well fitted to our needs as Gloria is. She comes to us most immediately from her position as class teacher at Hawthorne Valley School, just down the road — a role in which she has twenty-four years' experience spanning her tenure at two schools. During these years she also served as a chairperson of the board of the Association of Waldorf Schools of North America and as a consultant to Waldorf schools nationwide. In addition she was director of Waldorf teacher training for the summer teacher development institute in Ann Arbor, Michigan. Waldorf schools, of course, have a special openness to the Goethean approach to science.

Currently Gloria is chairperson of the Waldorf Schools Fund, Inc., and also of the Rudolf Steiner Foundation's Global Community Fund. Before her connection with Waldorf education, she was an associate dean of students at New York University's Graduate School of Business. There she coordinated and supervised the operation of admissions, recruitment, public relations, publications, financial aid, academic advising, career counseling, housing, international students' services, exchange programs, and student activities. She has an M.A. from NYU as well as a B.A. in literature and philosophy from California State University at Los Angeles.

In her spare time Gloria is a "fanatic" handworker, using natural fibers for knitting and crocheting. She is beginning to explore plant dying. Possessed of a love for traveling, she has visited several continents and, for one summer, taught English in China.

Gloria will help at the Institute with a variety of tasks related to administration, outreach and development. We value Gloria's calm and warm presence at the Institute and her energy and will to make things happen. Welcome Gloria!

The Gene

A Needed Revolution

Craig Holdrege

This short essay is about the gene. I have gathered many statements about this central concept of modern biology from geneticists and from historians and philosophers of science. The quotes I cite here are like footprints, indicating the pathway and evolution of modern genetics. A fascinating biography of a concept emerges. And, as I will try to show, the results of research in the past few decades have brought biology to a threshold that calls for a long-needed revolution in the way we interpret life.

The concept of the gene was first conceived by Gregor Mendel in the 1860s. He never used the term "gene," but spoke of "factor," "Anlage," or "element" to point to the underlying cause of differences in inherited characteristics of different offspring. He writes, for example:

> *The distinguishing characteristics of two plants can only be due to the differences in the make-up and grouping of those elements that stand in vital interaction within the germ cells.*
>
> Gregor Mendel (1866)

In 1909, Danish biologist Wilhelm Johannsen coined the term "gene" to refer to discrete determiners of inherited characteristics:

> *The word gene is completely free of any hypothesis; it expresses only the evident fact that, in any case, many characteristics of the organism are specified in the germ cells by means of special conditions, foundations, and determiners which are present in unique, separate, and thereby independent ways—in short, precisely what we wish to call genes.*
>
> Wilhelm Johannsen (1909)

Most people today are familiar with the term "gene" and have learned in school and through media that genes determine the characteristics of organisms. There are genes for hair and eye color, genes that direct the formation of our body's substances, and many genes that are somehow defective and cause disabilities and illnesses—genes for diabetes, cancer, schizophrenia, and more. No one talks about human, animal or plant physiology today without ascribing a central role to genes.

This deterministic gene is essentially the gene of the first half of the twentieth century. It is the gene most people have in mind today, over a half a century later. This gene has been described in the following terms:

> *In a specified environment, genes determine what kind of an individual a representative of a given species is going to be. There can be little doubt that genes also determine to what species a given individual will belong. By logical extension, it can be argued that genes determine whether an organism is a plant or an animal, as well as what kind of a plant or animal. And, to carry these deductions still further, genes determine whether or not an organism is going to develop at all.*
>
> Geneticists A.H. Sturtevant and G.W. Beadle (1939)

> *Mendelian inheritance is essentially atomistic, the heritable qualities of the organism behaving as if they were determined by irreducible particles (we now [1956] call them genes).*
>
> Geneticist Norman H. Horowitz (1956)

> *It has been known since about 1913 that the individual active units of heredity—the genes—are strung together in one-dimensional array along the chromosomes, the thread-like bodies in the nucleus of the cell.… In recent years it has become apparent that the information-containing part of the chromosomal chain is in most cases a giant molecule of DNA.*
>
> Geneticist Seymour Benzer (1962)

The Watson-Crick double helix-model of DNA (1953) and subsequent discoveries from the late 1950s into the 1970s relating DNA to protein synthesis provided a mechanistic model of the gene and of gene action that inaugurated the age of molecular biology. This was the time of boundless optimism concerning the ability of the reductionist approach to decipher the mechanism of life. As James Watson stated in his classic and influential textbook, *The Molecular Biology of the Gene*:

> *We have complete confidence that further research of the intensity given to genetics will eventually provide man with the ability to describe with completeness the essential features that constitute life.* (1973)

With advances in geneticists' knowledge, gene action has come to be viewed as an increasingly complex process, so that to state what a gene is requires longer statements filled with technical terms that no one but a specialist can understand. Witness the definition in their comprehensive textbook about the gene by Singer and Berg:

A [eukaryotic] gene is a combination of DNA segments that together constitute an expressible unit, expression leading to the formation of one or more specific functional gene products that may be either RNA molecules or polypeptides. The segments of a gene include (1) the transcribed region (the transcription unit), which encompasses the coding sequences, intervening sequences, any 5' leader and 3' trailer sequences that surround the ends of the coding sequences, and any regulatory segments included in the transcription unit, and (2) the regulatory sequences that flank the transcription unit and are required for specific expression.

Biochemists Maxine Singer and Paul Berg (1991)

But the advances in genetics have not only refined the mechanistic model. The complexity at the molecular level reveals that the simple mechanisms one imagined in the 1960s simply do not exist in that form. It has become less and less clear what a gene actually is and does. And although the deterministic gene is still the gene that lives in the minds of many students, lay people, and—at least as a desire—in the minds of many biologists, the findings of late twentieth century genetics show one thing clearly: the simple deterministic gene, the foundational "atom" of biology is dead. There is no clear-cut hereditary mechanism—no definite sequence of nitrogenous bases in a segment of a DNA molecule that determines the make-up and structure of proteins, which in turn determine a definite feature of an organism.

What follows is a series of statements about the contemporary gene—the gene of the past two decades. This gene looks very different from one described above:

The more molecular biologists learn about genes, the less sure they seem to become of what a gene really is. Knowledge about the structure and functioning of genes abounds, but also, the gene has become curiously intangible. Now it seems that a cell's enzymes are capable of actively manipulating DNA to do this or that. A genome consists largely of semi-stable genetic elements that may be rearranged or even moved around in the genome thus modifying the information content of DNA. Bits of DNA may be induced to share in the coding for different functional units in response to the organism's environment. All this makes a gene's demarcation largely dependent on the cell's regulatory apparatus. Rather than ultimate factors, genes begin to look like hardly definable temporary products of a cell's physiology. Often they have become amorphous entities of unclear existence ready to vanish into the genomic or developmental background at any time.

Peter Beurton (historian of science),
Raphael Falk (geneticist) and
Hans-Jörg Rheinsberger (historian of science) (2000)

The gene is no longer a fixed point on the chromosome…producing a single messenger RNA. Rather, most eurkaryotic genes consist of split DNA sequences, often producing more than one mRNA by means of complex promoters and/or alternative splicing. Furthermore, DNA sequences are movable in certain respects, and proteins produced by a single gene are processed into their constituent parts. Moreover, in certain cases the primary transcript is edited before translation, using information from different genetic units and thereby demolishing the one-to-one correspondence between gene and messenger RNA. Finally, the occurrence of nested genes invalidates the simpler and earlier idea of the linear arrangement of genes in the linkage group, and gene assembly similarly confutes the idea of a simple on-to-one correspondence between the gene as the unit of transmission and of genetic function….

Geneticist Peter Portin (1993)

Whether a particular gene is perceived to be a major gene, a minor gene or even a neutral gene depends entirely on the genetic background in which it occurs, and this apparent attribute of a gene can change rapidly in the course of selection on the phenotype.

Developmental biologists H. Frederik Nijhout
and Susan Paulsen (1997)

The preceding descriptions point to the contextual nature of the gene: if you "have" a gene at one point in time, it may become, both structurally and functionally, something quite different at another time or place. As a result, it is no longer possible to speak of the gene in a straightforward manner:

There is a fact of the matter about the structure of DNA, but there is no single fact of the matter about what the gene is. [Genetics today] provides strong, concrete support for the claim that the concept of the gene is open rather than closed with respect to both its reference potential and its reference.

Philosopher of science Richard M. Burian (1985)

Paradoxically, in spite of the new, sometimes overwhelming, concreteness of our comprehension of the gene as a result of DNA technology, we seem to be left with a rather abstract

and generalized concept of the gene that has quite different significances in different contexts…. It should, however, be strongly emphasized that our comprehension of the very concept of the gene has always been abstract and open as indicated already by Johannsen [in 1909].

Geneticist Peter Portin (1993)

[In the molecular gene concept] 'gene' denotes the recurring process that leads to the temporally and spatially regulated expression of a particular polypeptide product…the gene is identified not with these DNA sequences alone but rather with a process in whose context these sequences take on a definite meaning.

Paul Griffiths (philosopher of science) and Eva Neumann-Held (biologist and philosopher of science) (1999)

Because the gene has become something so very different from the clearly circumscribed determinant it started out as, some geneticists think it is time to leave it behind:

For biological research, the twentieth century has arguably been the century of the gene. The central importance of the gene as a unity of inheritance and function has been crucial to our present understanding of many biological phenomena. Nonetheless, we may well have come to the point where the use of the term "gene" is of limited value and might in fact be a hindrance to our understanding of the genome. Although this may sound heretical, especially coming from a card-carrying geneticist, it reflects the fact that, unlike chromosomes, genes are not physical objects but are merely concepts that have acquired a great deal of historic baggage over the past decades.

Geneticist William Gelbart (1998)

Our knowledge of the structure and function of the genetic material has outgrown the terminology traditionally used to describe it. It is arguable that the old term gene, essential at an earlier stage of the analysis, is no longer useful, except as a handy and versatile expression, the meaning of which is determined by the context.

Geneticist Peter Portin (1993)

The gene concept, I believe, is unlikely to be discarded, since it is far too deeply entrenched in the minds of scientists and the public. But we need to realize that the popular usage of the term, which still implicates the gene as the definitive causative agent in biology, simply does not coincide with biological reality.

As geneticist Peter Portin remarks in one of the above quotes, "the very concept of the gene has always been abstract." In other words, the gene is not a thing at all, but a way of ordering and interpreting phenomena. This may be surprising to anyone used to thinking about genes as concrete biological substances that make things happen. The gene as a robust "thing" is a figment in the materialist mind, a mind that can only conceive the world as governed by mindless material entities that (somehow) carry out meaningful processes.

I do not want to suggest that the concept of the gene has no relation to material happenings. But the gene concept was not, in the first place, derived from engagement in the richness of hereditary phenomena. It was a pre-conceived notion that framed scientists' thinking and action. Experiments were designed with the gene concept in mind, and investigators then interpreted the results in terms of the particulate conception of inheritance they presupposed in the first place. In the best case (for example, Mendel's experiments with peas or many experiments in the early twentieth century with the fruit fly), experiments showed a partial fit with the conceptual framework. Researchers homed in on the fit and delved ever more into biological minutiae. The gene concept opened up worlds and seemed to be supported by a great number of experiments.

As different researchers pursued a variety of directions of inquiry, the phenomena at the molecular level showed increasing complexity and variation. As a result, any schematic representation of the gene just didn't work, and a colorful array of definitions of the gene emerged, as the above quotes show.[1] In view of the plethora of gene definitions, philosopher of science Philip Kitcher concludes:

A gene is anything a competent biologist has chosen to call a gene. (1992)

This statement does not indicate a fall into total relativism. It is simply the indirect acknowledgement on the part of contemporary genetics that there is no particular *this* (gene) determining a particular *that* (trait). So to retain a connection to the actual phenomena, geneticists have come to describe the gene as a potential, as a process, and as dependent on the organismic context. In other words, the mechanistic conception of the gene as a power unto itself, elevated above the turmoil and complexity of day-to-day cellular life and doing its thing under any and all

1. I'd be remiss if I didn't mention that the history of genetics, from the early twentieth century on, provides many examples of observations and experimental results that did not fit with the dominant gene paradigm. But only within the past couple of decades has the evidence become so glaring that it can no longer be ignored by the scientific establishment.

conditions, has to be discarded. Scientists are trying to adapt the static gene concept to the dynamic reality of the organism.

A great gift of recent genetic studies is that they show in a rich and varied way at the microlevel what we could have known all along from a study of organismic life at the macrolevel if our minds had been open: every organism develops from an open potential and forms over time in dynamic interaction with its own developmental process and its (changing) environment. Only insofar as the mechanistic paradigm holds the human mind captive do we come to think of and believe in genes as neatly circumscribed material determinants.

The gene is an abstraction—a product of a process of isolation, as neurologist Kurt Goldstein would have said—that has guided the development of genetics for over a century. The idea of a fundamental unit of inheritance, the idea of the grand mechanism that determines life, a mechanism that the human mind can fathom and eventually control, has fired the minds of modern geneticists.

But the research itself—the immersion in the phenomena mined from living organisms via experimentation—brings scientists and their concept of the gene to a boundary. It is a boundary one can ignore, as is largely the case in commercialized genetic engineering. It is a boundary that can stimulate scientists to tweak existing models to better fit experimental results. But it is also a boundary that can be felt existentially and become a stimulus for a mental and methodological revolution:

* Can we take reality so seriously that we actually give up—in our heart of hearts and in our innermost thought forms—rigid conceptions like that of the gene?
* Can we do without the security of a guiding notion that imagines discrete entities working in chains of cause and effect to constitute the stuff of life?
* Can we get beyond the "thing" mindset altogether, which is informed by fixed concepts, and learn to consciously swim in and adapt ourselves to a new medium, namely the fluidity and dynamics of the organic world?

These are radical questions. If we answer them with "yes," and our swimming exercises begin in earnest, we will encounter wholly new facets of the world. It seems to me that the phenomena themselves are calling for this revolution.

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The Forming Tree

Craig Holdrege

The trees you see on the opposite page are in their winter habit. Without leaves, the form of the crown displays itself through the intricate branching pattern of the limbs. Each of these trees has a history behind it and the crown form reveals some of that history. But the history is no straightforward matter. It has different facets and in each particular tree is unique.

First, each tree belongs to a species. As a red oak or a white ash, a tree is part of a specific hereditary current that connects it with all other members of the species. Although a species has considerable plasticity and shows an often surprising variety of forms, it is nonetheless usually possible, with a bit of practice, to identify a tree species in the winter through its bark, branching pattern, buds, and so on.

The particular shape of the crown and the size of the trunk relative to the crown in an individual tree express a different facet of the tree's history. A tree's crown develops over time and no broad-leafed tree maintains the same shape when it grows from a sapling to a twenty-or hundred-year-old tree (see Figure 1). While growing, the shape transforms. All the trees you see in the figure on the opposite page had, as young trees, branches growing out of the trunk near to the ground. But all of these branches have since died off. As the trunk grew in diameter, the bark grew around the scar where the branch had separated from the trunk. The branchless lower stretches of the old trunk therefore no longer reveal outwardly the tree's growth history. The tracks are present, however, as knots deeper within the wood.

The trees in Figure 2 vary greatly in shape, and the crown of some trees is markedly asymmetrical. You might even call them misshapen. To understand these forms you have to look not only at the growth process of the individual tree, but also at its growth in relation to the environment. Figure 3 provides a partial solution to the riddle of these enigmatic forms—you no longer see each tree by itself but within a group of trees. Each tree can in reality only be understood when you see it as part of a larger whole. Viewing the tree forms in isolation (Figure 2), you recognize that something isn't quite right, but then, seeing them in context, you realize—with an element of surprise, relief and a sense of resolution—that everything *is* right. The individual trees fit together and form, as a group, one large crown.

Evidently, trees growing up in close proximity relate to one another. A tree does not have a predestined shape that it has to achieve. Rather, it develops in relation to a specific constellation of organisms and qualities (light, water, soil, exposure) constituting its environment. It is a remarkable phenomenon that different tree species can grow in concert to form an overriding crown of which each is a part. When

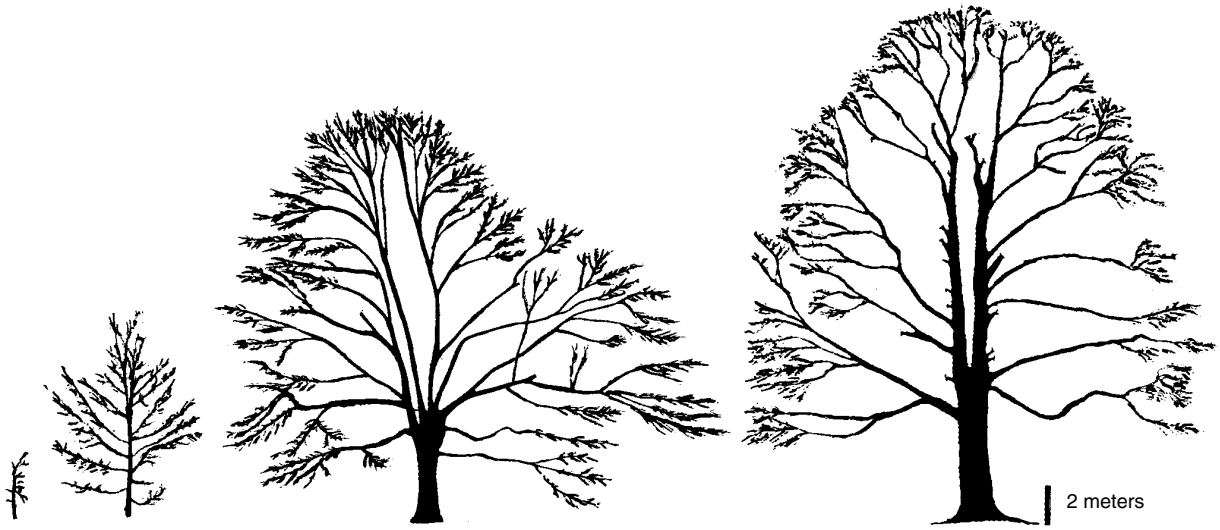

Figure 1. Schematic depiction of the growth of an individual tree, a European beech *(Fagus sylvatica)*. (After Gleissner 2005, p. 66)

you study tree growth, you recognize that this co-development occurs largely in relation to light.

All plant growth is connected with light. In trees, the trunk brings the tree up into the light-filled atmosphere. But, as a rule, a tree trunk grows straight up; it is not directed toward the sun as a source of light, which in fact moves daily across the sky. This growth straight upward is known as negative geotropism, since the trunk grows directly away from the center of the earth. The blossoms of numerous wildflowers, in contrast, follow the path of the sun during the day; they exemplify positive phototropism—growing toward the light source.

As the tree trunk grows straight upward, it sends off side branches and, eventually, in most broad-leafed trees, the main trunk itself divides into smaller branches (unlike conifers such as spruce, fir, and hemlock, which usually maintain a central vertical trunk throughout their lives). Through this ongoing upward growth and branching, the tree form arises. Exactly how it arises depends on the particular context. (For more

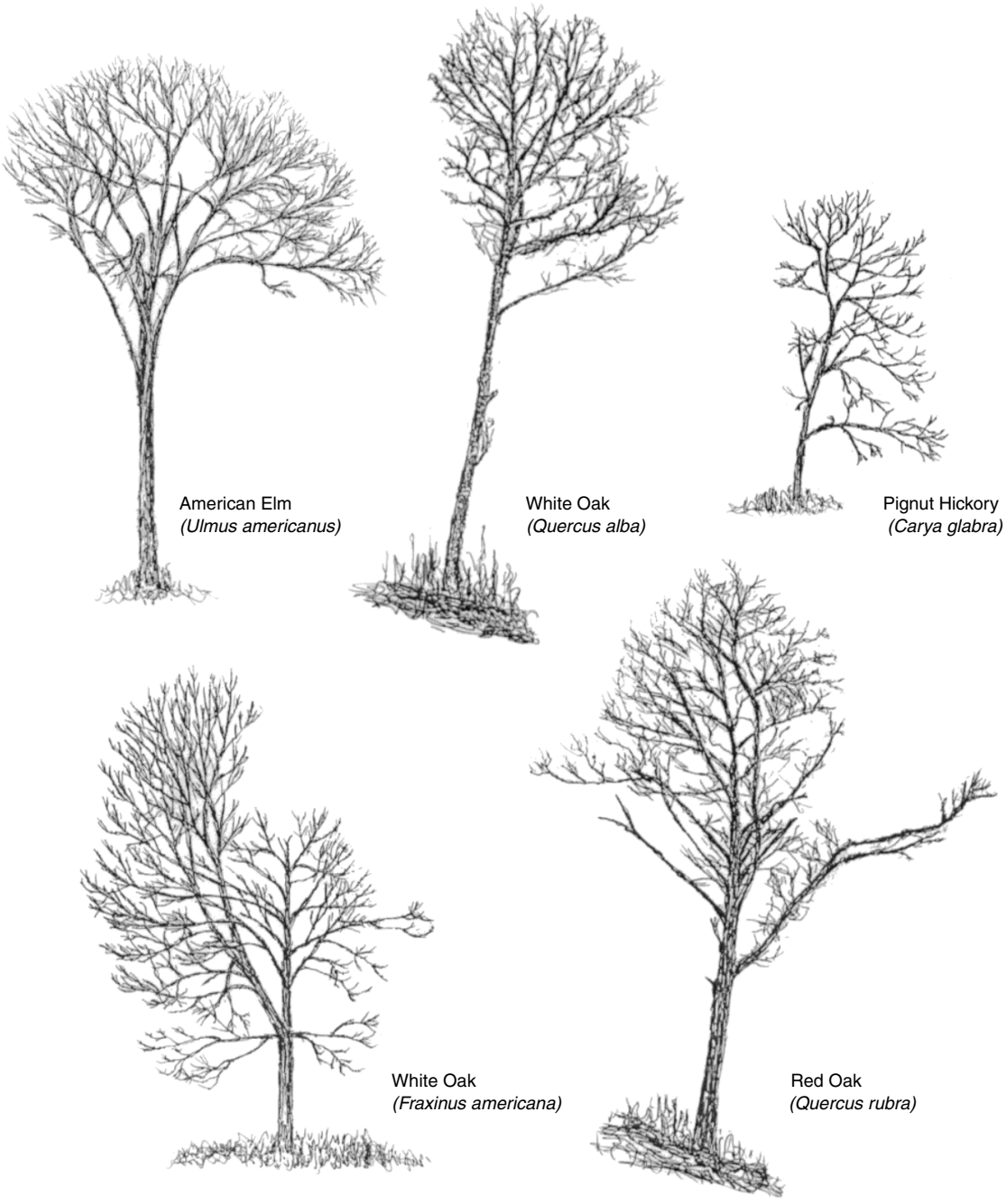

Figure 2. A variety of tree forms. (Sketches by C. Holdrege)

Figure 3. The five trees from Figure 1 depicted in context—as tree groups in which the trees together form a crown. Left: white ash, American elm, and pignut hickory; right: red oak and white oak. (Sketches by C. Holdrege)

examples of trees forms within the context of their habitat see Buess 1992.)

Figure 4 depicts two white oaks with dramatically different forms. The broad-crowned oak grew as a free-standing tree at the edge of a pasture. It had, as a young tree, no neighbors growing close by. As is typical for a solitary tree, the crown gradually spread out broadly in all directions, attaining a relatively spherical shape. In general, branches grow outward and ramify into the space of greater brightness surrounding them. The leaves and branches themselves create darkness so that the outward spreading is toward greater brightness. The crown as a whole is not growing toward the light source (the sun), but toward the brightness of the surrounding atmosphere. In our latitudes, the northern side of a tree will, in more or less subtle ways (leaf-size and shape, for example), differ from the southern side, which is exposed to more brightness. Similarly, leaves that are at the outermost edges of the tree differ from leaves situated in the darker interior of the crown. By creating shade, a tree creates an environment for itself, influencing its own growth pattern. A tree is, in part, its own context.

What about the small-crowned white oak with its long, upward-soaring trunk? This specimen grew in the woods. It partnered in growth with red oaks, sugar maples, and red maples. You have to imagine this single tree surrounded on all sides by other trees of similar height. All trees together form one large crown—the forest canopy. By growing up together, perhaps out of an abandoned pasture about eighty to a hundred years ago, these trees began growing upward and unfolding. They produced shade for each other, and the dominant growth direction was upward into the light-filled space. The lower branches, which never grew to great size, died off in the increasingly shady environment of the upward-shooting trees. In this way, the long, branchless trunk developed, and we need to imagine the seemingly meager crown of the individual trees as part of the larger, dense, green canopy of the whole forest.

We can now better understand the tree groups in Figure 3. The group consisting of the white ash, American elm, and pignut hickory is a free-standing group in a pasture. The group forms one common crown that resembles that of a single free-standing tree. The common crown of the white oak and the red oak reveals a different context. This pair grows within a relatively bright oak-hickory forest at the edge of a small clearing in moderate light conditions, neither surrounded by brightness from all sides nor illuminated only from above. The common crown form reveals this intermediate situation: the trunks only divide at a considerable height, but then together branch out into a fuller crown than if they had grown in shadier woods.

Directing our gaze toward the form of trees leads us beyond the tree itself. It leads us to a web of relations of which the tree is part. Once you begin to see in such an organic form the tracks of its history and its relations to its surroundings, every meeting with a new tree is a source of excitement, a riddle waiting to be appreciated and deciphered.

Competition, Cooperation—or Neither?

In describing the trees in this article I have consciously avoided the terminology of competition often applied to biological phenomena. Virtually all contemporary ecological and evolutionary studies use competition as the central explanatory framework. On this view, a tree's genetic propensity is to capture as much light as possible, which maximizes its ability to do photosynthesis, grow, and produce fertile offspring that guarantee the survival of the species. Since every tree has this propensity, and growth creates shade that brings about death, each tree competes with its neighbors to maximize light-uptake. Such competition is what brings about the "struggle for existence" that Charles Darwin placed at the heart of his evolutionary theory.

An opposing, much less common interpretation of the trees is that they are cooperating: each tree in a group survives and in so doing does not compete against its neighbors, but rather works together with them, adjusting its growth in relation to the others.

Both modes of interpretation are decidedly anthropocentric. Competition and cooperation are concepts drawn from human experience. Shouldn't we examine critically whether such concepts have any relevance to plants, which are such different creatures from ourselves? Imagine for a moment that we had no first-hand experience as ego-centered agents striving to secure and expand our own existence—the experience that underlies our concept of competition. Would the phenomena of tree growth I have described suggest out of themselves that we are dealing with competing agencies? I don't think so. Rather, the

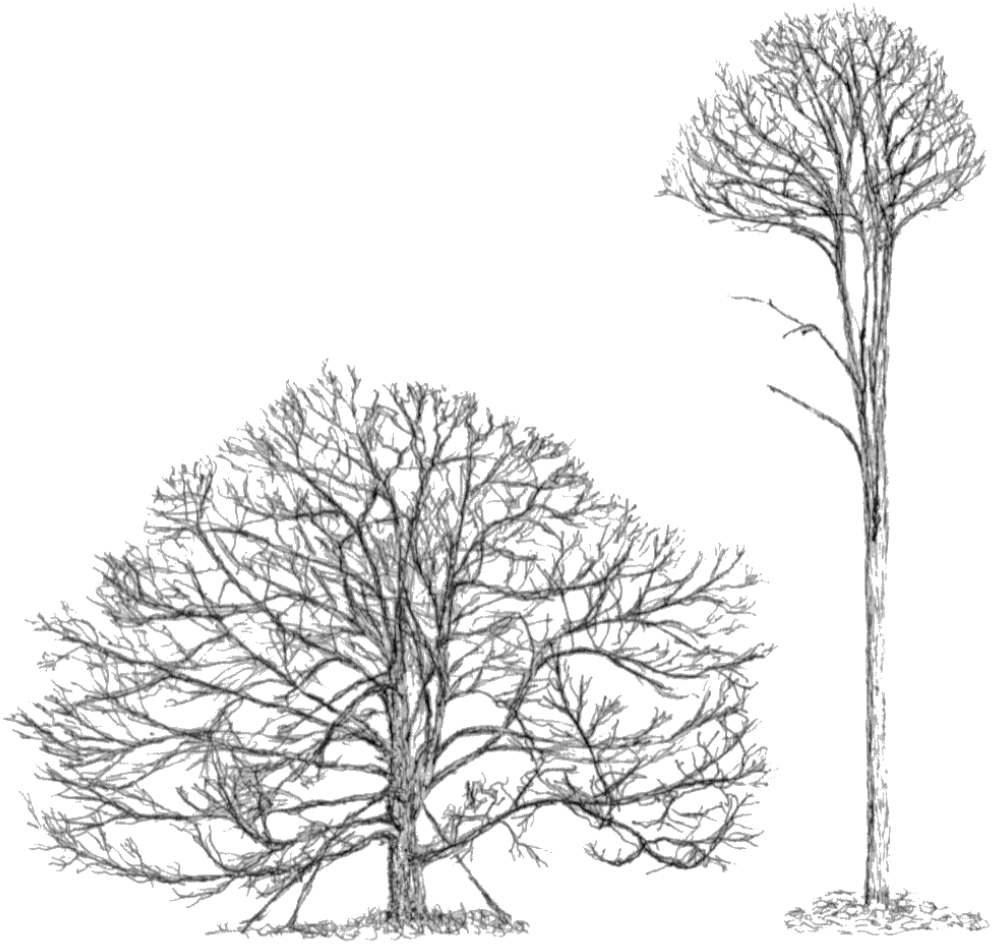

Figure 4. Two different specimens of white oak *(Quercus alba)*. The specimen on the left is a free-standing tree, while the tall, slender tree on the right grew in a forest. (Sketches by C. Holdrege)

genetic propensity we ascribe to the plant to maximize light uptake as a survival strategy is a concept we project onto the plant, unaware that we are conceptually infusing its biology with an all-too human psychological characteristic. If we are interested in understanding the trees and not our own reflection in the trees, then we would do well to avoid such an interpretative framework.

Darwin noted that he was using the term "struggle for existence" (what we today call competition) in a "large and metaphorical sense." He writes in *Origin of Species*:

> A plant on the edge of the desert is said to struggle for life against the drought, though more properly it should be said to be dependent on the moisture. (Darwin 1859)

What a difference between these two ways of expressing the same phenomenon. The first projects competitive agency into the plant. The second simply states in a matter-of-fact way an essential quality of the plant in relation to its environment, namely its reliance on water. I would say, in agreement with Darwin, that the second formulation is undoubtedly more proper because it stays closer to the phenomena themselves and in so doing has the added virtue of leaving one open to further insights that may come with more study of the relations between plant, water, and desert. The idea of competition, by contrast, forces the phenomena into a closed frame shaped by our own, unrelated experience.

To avoid misunderstanding: I am not saying that Darwin or modern ecologists and evolutionary scientists believe plants are intelligent agents scheming to increase the survival of their species. In the barest terms, Darwinian competition is merely the result of the fact that all organisms produce more offspring than can survive. Individual organisms and species have to compete because there is no way all can survive with the limited resources a habitat, an ecosystem, or, in the end, the whole biosphere provides. But even this way of stating the relationships is more interpretive than you might think. It presupposes that you focus on the individual plants or species as things unto themselves that relate to each other as "others." As a consequence, species survival is assumed to be writ large in each genome, with competition a necessary outcome and therefore the dominant mode of species-interaction. If you take this approach far enough, you end up with Richard Dawkins' "selfish genes," which become the competing atoms of biology (Dawkins 1990).

Charles Darwin writes,

> A plant which annually produces a thousand seeds, of which on average only one comes to maturity, may be more truly said to struggle with the plants of the same and other kinds which already clothe the ground. (Darwin 1859)

If Darwin hadn't been guided only by the metaphor of competition, he might just as well have emphasized that many seeds and seedlings provide nourishment for birds, soil nematodes, slugs, woodchucks and other creatures. The species does not exist merely "in and of itself;" it is part of a larger whole. This is what we have seen in the development of tree forms. We may be tempted to say that the plants are sacrificing themselves for the greater whole. Do you recognize the strong anthropocentrism? It might be an uplifting thought that touches our feelings to think of self-sacrifice in nature, but it may have little to do with the plants.

To employ concepts such as competition and cooperation is in one way easy and fulfilling. We know these qualities from the inside and we can wield them as a framework within which we place all the phenomena we encounter. If we could use the concept of competition in a free and playful manner, just to see what might show itself through this particular lens, and then shift to another point of view such as the one involving cooperation, we wouldn't need to worry much about the misuse of these concepts. Their limitations would be counterbalanced by the variety of perspectives, and we would gain through a dialectical process a richer understanding of the world.

But competition is the one reigning perspective used to interpret life. It has become a rarely questioned, unconscious habit of mind. People don't even notice they are using an interpretative framework and assume that competition is a fact of nature. A concept that is used habitually and unconsciously colors the world we see and limits our understanding. It no longer illuminates. If we want to cast ever new and fresh light on the nature of things, we need to become much more conscious of the concepts we use and apply them in a discerning and, to use Goethe's words, "delicate" manner. This effort will help keep science a vital, evolving human enterprise.

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Thank You!

Our heart-felt thanks go out to all of you who have contributed money, services, or goods to The Nature Institute or to its online publication, *NetFuture*. In particular, we would like to thank those who have contributed between March, 2005, and the end of September, 2005:

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The Paradox of Physics Envy: The Mental Universe

In its July 7 issue the leading scientific journal, *Nature*, published a remarkable essay by Richard Conn Henry, professor in the department of physics and astronomy at Johns Hopkins University. The essay ran under this rubric:

> The only reality is mind and observations, but observations are not of things. To see the Universe as it really is, we must abandon our tendency to conceptualize observations as things.

Leave aside Henry's silly statement that "the 1925 discovery of quantum mechanics solved the problem of the Universe's nature"—a remark that sounds surreal when set beside his further statement that physics can't help us to decide whether to "descend into solipsism, expand to deism," or take up some other position about the nature of the universe. What strikes one is his final conclusion: "The Universe is immaterial—mental and spiritual. Live, and enjoy."

As unusual as such an essay may be for a major scientific journal, what really interests us is that prominent physicists have been making statements not far removed from this for several decades, arguing, for example, that consciousness is a fundamental aspect of the physical world. And yet, right into our own day biologists, for example, have continued speaking as if the rock-bottom reality of the world consisted of little mechanistic devices of one sort or another. This is clearly the picture that philosopher Daniel Dennett has in mind when he tells us that evolution occurs by means of "mindless and mechanical" processes.

One wonders how long this great disconnect can be sustained, and what has made such irrationality possible among researchers who pride themselves on their hardheadedness and the sophistication of their intellectual work, as well as the compatibility of their discipline with the truth of physics. You'd think you would at least occasionally hear caveats from biologists: "What we've been saying assumes those physicists are wrong who speak of consciousness as fundamental to the universe." That we don't hear such caution and openness—traits normally taken as basic to science—suggests that something quite other than the scientific spirit has a grip on biology. ST

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