Science Without Context

An Interview with Craig Holdrege

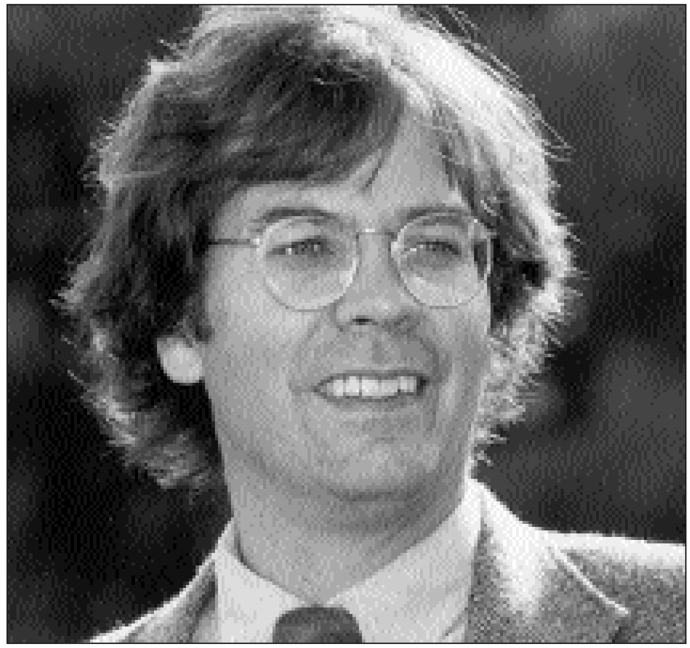
Casey Walker: As you've written in Genetics and the Manipulation of Life: The Forgotten Factor of Context, *there is a focus to genetic manipulation that ignores the role of context at a great cost to scientific inquiry and to our understanding of life. Will you begin by describing the problem of "context"?*

Craig Holdrege: In science we learn to approach the world in a powerful but very narrow fashion. We have particular questions about nature, frame hypotheses, and then carry out experiments to see if our hunches are correct or not. This brings us into greater and greater detail on the one hand and into the realm of abstractly formulated laws and theories on the other. We are always in danger of losing sight of the fact that we are continually decontextualizing nature in order to understand it. And when that happens, it is as though nature has slipped through our fingers: While we've built a grand picture that may be very consistent and yet have startlingly little to do with the actual phenomena we're trying to understand.

Let me give an example. In the 19th century scientists in England began to notice that a dark variety of the nocturnal peppered moth was becoming increasingly prevalent, mostly in forests around industrial areas. The question was, Why? Their conceptual framework to answer the question was the Darwinian theory of natural selection, which they could test through experiments. The scientists formed the hypothesis that the dark variety was becoming more prevalent in forests with trees that had lost a light -colored lichen covering on their bark, or that had been darkened by soot from air pollution. According to this hypothesis, the darker variety of moth would be better camouflaged against the darkened tree background, while the light specimens would be eaten by birdsbecause they stood out. To test this hypothesis, experiments were done - first breeding and then setting out dark and light moths out onto trees, then observing their consumption by birds, and finally recapturing marked survivors. In dark forests more dark moths were recaptured, and in lighter forests more light moths. The conclusion seemed logical that birds feed on poorly camouflaged specimens and thereby act as agents of natural selection, contributing to an evolutionary shift in the population from light to dark. The peppered moth came to be a classic textbook and classroom example of evolution via natural selection. It was viewed as "proof" of the Darwinian theory.

The problem is that no one knows where the moths live during the day! And this despite years of work. In the experiments everything seems (at least superficially) clear, but this clarity may have nothing to do with the actual lives of the moths in the wild, about which next to nothing is known.

This example shows drastically how one can gain so-called solid scientific knowledge and yet be far from any real understanding of the natural phenomenon. Scientific knowledge becomes dissociated from reality by losing sight of the fact that the experimental method changes the phenomena, as neurologist and holist Kurt Goldstein put it, through a procedure of isolation. The experimental process itself contributes to the results, and we can't naively act as though experiments tell us about the "world as it is." A first step in recontextualizing our knowledge is to become keenly aware of this fact.



Craig Holdrege *is the director of The Nature Institute in rural upstate New York. The Nature Institute is dedicated to research and educational activities applying phenomena-centered, holistic methods. Craig has been a high school biology teach in Waldorf schools for the past 19 years; curretnly he teaches part-time at the Hawthorne Valley School. He is involved in teacher training, and gives seminars and lectures on a phenomena-centered approach to science. He is the author of* Genetics and the Manipulation of Life: The Forgotten Factor of Context *(Lindisfarne Press, Hudson, NY, 1996).*

You wrote: "While it may sound simple to restore context in order to gain understanding, it is not. Our contrary habits run deep." Will you describe those contrary habits?

Because the experimental, hypothesis-driven approach is in its way so successful–you get results–there is little reason, once you've got going, to question the direction you've taken. Anyone who's done experiments knows well the drive to just keep going: one experiment stimulates new questions, a next experiment is conceived and carried through, which in turn raises new questions, and so forth. The process takes on a life of its own. It is then extremely difficult to step back and ask: What am I doing? How is my approach affecting the phenomena? What am I leaving out? How do the "genes" I discover through an elaborate experimental setup, which is based on a particular theoretical framework, actually relate to the organism out of which these genes have been isolated? Exactly these kinds of questions need to be asked in order to move from reductionism to a knowledge that puts things back into context.

We can't, I believe, get around analysis if we want clear knowledge, since reducing allows us to focus our attention on details so that we can be precise. But if we are interested only in our hypotheses and not in understanding the actual organism, then we get decontextualized knowledge. The interest in the organism as such is key to the ability to see things in their context.

Another problem is that we tend to view nature as consisting of discrete entities–separate organisms, separate factors, separate causes, separate substances, etc. This view is itself the result of taking things out of context; that is, isolating them in the lab and in the mind. The moment you turn to a concrete organism and take it seriously, this world of separate entities that interact in monocausal fashion shows its highly abstract nature.

We all "know" the lowly dandelion. But if we take the trouble to actually observe different specimens, we are confronted with an extraordinary variety of forms and sizes. We learn to see how these differences are related to a particular place (a microenvironment with all its qualities) but also to heredity. The dandelion gradually becomes for us a dynamic process in time that is in continual and subtle interplay with its past - heredity - and its environment. The tiny dandelion growing in a crevice on a mountain reveals to us a wholly different world from that revealed by a large and lush specimen in the clearing of a woods. We see the environment through the plant, and in this way the plant continually points beyond itself. It shows us, if we care to look, that it's part of a vibrant context in which no one can delineate fixed boundaries. But because the intellect thrives on fixed boundaries, achieving a contextual approach is very difficult.

Will you describe "object thinking," as you call the non-contextual approach to science in your book, and suggest how it might be overcome?

> *How might people see that as these technologies race ahead of us, we are forced to wake up, to ponder how life and death are experienced as our own processes? If we can become aware of our own selves as part of the project, as part of the inquiry, then everything switches.*

An essential step is for scientists to become aware of themselves as part of the process. The project is not out there. Organisms aren't out there in isolation. You would think that an endeavor built on an experimental method, which is all about human beings interacting with nature, would be exceedingly sensitive to this. Instead, it is ironic that scientists are as unaware as they are of their own participation. The moment they begin to see themselves as participants, as questioners and as doers everything changes. It is liberating to move past the restriction of science as we've come to know it-not to reject science but to use it in the pursuit of wisdom. Science can then become a highly interesting and open-ended discussion-a conversation with various organisms in various contexts that runs back and forth and continually reveals, continually surprises.

What happens in this process is that we become increasingly interested in the richness of the concrete world and general abstractions lose their appeal. The more we see the world in terms of abstractions, the more we're seeing only our own concepts. The concrete appearances are dynamic, variable, and ever changing. This demands that our thinking become more flexible. I've spoken of "fluid thinking" in my book. It is a thinking that stays with the phenomena, moving between them and connecting them. We can then build up living pictures of biological processes that at least lead us much nearer to reality than do our models of mechanisms.

This has very practical consequences. Working within the framework of mechanistic models, we aim to achieve specific, clearly defined results. Becauselife isn't linear but multidimensional, however, contemporary scientific and technological applications set all kinds of biological (and other) changes in motion that were in no way foreseen - the world of unintended consequences. The moment we take a contextual view, we expect that any particular manipulation will have an effect on the whole organism or system and that there will be surprises. We become much more conscious of the responsibility we have for the way we view and interact with the world.

This reversal is key. The rigor here is greater, and is, contrary to knee-jerk criticism, anything but passive, spiritual, or unscientific.

It's ridiculous to imagine, as some do, that the opposite of scientific reductionism is that I could go outside and sit down in front of a tree and to await illumination. A contextual approach demands that we take rigor a step further than in traditional science. We have to become more conscious of our own participation and of the boundaries of any particular method or framework we apply. This is a kind of internalization of the rigor that science traditionally achieves by using outer controls.

Moreover, everything that I'velearned, not only about a particular species of tree but also about air temperatures, migrating birds, hatching insects, soil microbes, pesticides, fertilizers, the arc of the sun, the lay of the land, other trees, and the sum of my past experiences comes into play. I must imagine more and more complexity as both possible and observable in the presence of any organism. I don't want to imply that we need to–or ever could–know all the "facts" concerning any given organism. Complete cognizance of all the facts would not necessarily be contextual understanding. It's the way of viewing, not just the content, that's contextual. It's the search for the wholeness or integrated nature of the organism, landscape, or whatever the phenomenon may be. We have to be awake and active inwardly with the intention of meeting the phenomena with open receptivity, knowing that they will always hold more and always point us beyond what we can grasp at the moment.

Will you address human capacities that occur at different ages-such as concrete logic, magical thinking, self-agency, or abstract thought–and how these capacities create age-appropriate learning and teaching? Is our ability to transcend the barrier of mental vs. sensory perception dependent on an education of a certain kind?

We have to be awake and active inwardly with the intention of meeting the phenomena with open receptivity, knowing that they will always hold more and always point us beyond what we can grasp at the moment.

Yes. It's important to lead children into an immersion in phenomena, such as a night of stars. I'm always saddened when adults expound on their "knowledge" of galaxies, light-years, and black holes in the presence of young children. Children, if we have not corrupted them already, live in the sensory world and can gain rich meaning and joy from it. We can point out things they might overlook, like the different nuances in colors in different parts of the sky, the shape and direction of the Milky Way, the reddish hue of Mars, and so on.

Each age has its own kind of questioning, its own kind of cognitive and emotional development, which is critical for adults and teachers to understand. If we stuff certain abstractions down the throats of kids, particularly before about age seventeen, the abstractions will be taken in literally and naively; they will be mistaken for reality. Takechemistry, for example,. How many students "know"" about molecules and atoms before they've ever observed a chemical transformation in a flask? Students , in elementary and middle schools, should get to know how warmth, solutions, and different substances act and interact. They need a rich phenomenology of the world of substance and transformation. Then in high school, teachers can begin to focus on, say, the lawfulness of relations and reactions of substances and introduce chemical formulae. Finally, teachers can introduce the concepts of molecules and atoms - an historical introduction often provides the best context for understanding these concepts. In this way the concept of molecule or atom is embedded in the students' lives. If, in contrast, teachers begin with atoms in middle school, they are educating for dogmatic materialism later on. An atom is not anything like a solar system of billiard balls, but it exists in this form in the minds of far too many people.

The real tragedy in our educational system is that by prematurely teaching various concepts or abstractions as facts, we're ruining our children's faculty for a contextual approach, which should mature through experience well into adulthood. We need the faculty of abstraction, but its use should be based on previous immersion in the world, which is exactly what gets cut short in our technological society. But we must also be able to get beyond abstraction - we must not get stuck in a dichotomy of self as distant from world or in the virtual reality of the pseudo-science that we have around us. I'm amazed at what my students think they know because they've heard or seen it on the Discovery channel. They cannot say how they or anyone else would know whether a rock is a billion years old or not. But if students are taught to become aware of statements as judgments in or out of context, if they learn how concepts arise out of a living interaction between human beings and their world, then they become sensitive to empty generalities. They can begin to discern the difference between the literal and the metaphorical. They become aware of knowledge as a process and develop an antenna for a decontextualizing vs. contextualizing approach. Awareness of context makes all the difference when we get around to speaking about black holes and big bangs or genetic engineering.

Evelyn Fox Keller's biography of Nobel prize-winning scientist Barbara McClintock, A Feeling for the Organism, *is exceptional in documenting a life in science that was radical and brilliant for precisely this reason-Barbara McClintock approached genetic organization contextually. Two crops of corn each year yielded more in complex processes than she could integrate, whereas geneticists in the mainstream were studying rapidly reproducing fruitflies and bacteria to isolate genetic outcomes from single material causes.*

Right. Mainstream genetic science pursued Crick's central dogma of single material cause, of a one-to-one correspondence between gene and outcome. Once scientists exclusively sought a determining mechanism, they found determining mechanisms. The price was, of course, that they were blind to all of the phenomena excluded from the inquiry. It's a classical, wonderful example of the power of reductionism. There is no question that we got an exceedingly clear-cut picture of how DNA structures protein and how the structure of proteins determines function. There's no question that the discovery of DNA is the result of a single trajectory of inquiry. But that inquiry does not include an awareness of the decontextualization that occurs through the experimental method, nor does it include the importance of processes over time, the importance of environmental conditions, or, for that matter, the importance of organisms themselves.

The concept of "gene"" is perhaps the most decontextualized concept in biology today. It is reified as an all-powerful entity in the organism. But genes do not really "belong" to organisms; rather, they "belong" to our repertoire of abstracted information based on experiments. By ignoring qualitative differences between organisms, scientists have isolated genes as ubiquitous and interchangeable information packets. It isn't too far a leap to perceive growth hormone genes as categorically present in humans, chickens, or salmon and then to launch the exchange of growth genes–placing, as we have, human growth hormone genes into salmon. In this approach we render each organism an abstraction that can be filled with new qualities as we see fit.

I try to emphasize in *Genetics and the Manipulation of Life* that the activity in the organism as a whole determines a gene's function. It is impossible to understand a gene without its context. The "same" gene can have a different function if it changes its place in the chromosomes and can also have different functions in different organisms. We understand a gene only inasmuch as we understand its context. Because the relation of the gene to the whole has largely been ignored, the actual success of genetic experimentation is small. Very few genetic experiments work in the narrowly circumscribed way they are supposed to. One often gets very different results from what one would expect. All indications are that we need to look at genetic information with an eye for a larger system, a living context.

One good example is the experiment of trying to make female mice into male mice by injecting them with the DNA tied to sex determination. It worked in one case, which put it on the cover of *Nature* magazine, but there were three or so other cases in which the same transformation should have worked but didn't. These riddles persist, and they're present in every single genetic experiment. Geneticists will say, that it's just because we haven't perfected the method yet. In one sense, that's certainly true, and I'm sure they'll get better at it. But it's also true that the success rate is about 1% and has been that way for the last twenty years. That indicates to me that viewing and manipulating biological processes as mechanisms has its boundaries, which is not to underestimate its ability– when it "succeeds"–to affect the whole, often in unhealthy ways.

Some of the most interesting work that could be done, but would probably never get funded, would be to look at the genetics of "normal" people to see how many normal people have "abnormal" genes. Instead we focus on the abnormal, pick out a symptom, then maybe a malformed chromosome, and focus on genetic causes. Of course, we completely lose sight of everything in that person and his or her life that contributed to the symptom.

With time, the euphoria around new technologies and what they promise pales in the light of day. It's always interesting to note that with the extremely materialistic sciences come extremely euphoric ideas of the metaphoric-the holy grail of DNA-that have no real correspondence to the actual world.

In the meantime, the search for a disease-free existence, accidents without consequence, and immortality is going to drive people to do certain kinds of research and to continue coming up with new and enticing technologies. And because these searches become motivational, they do create change. Maybe we will eventually have the ability to extend human life to an age we can't imagine today. I don't even doubt this could happen, with enough research and design.

But another set of questions remains. How might people see that as these technologies race ahead of us, we are forced to wake up, to ponder how life and death are experienced as our own processes? If we can become aware of our own selves as part of the project, as part of the inquiry, then everything switches. We don't need to get rid of getting ill or old. People hope to avoid death because they have absolutely no sense of living processes. I would say that acquiring that sense is number one on the agenda of changing our culture toward a contextual approach to life: people need to understand the processes of life by consciously returning to them, not by manipulating or denying them.

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