Corn Culture

A Story of Intelligent Design

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In these days of ubiquitous debate about "intelligent design" and neo-Darwinian conceptions of evolution, it's hard to avoid the topic. I try to avoid it, though, because my beliefs about how the Earth's inhabitants got to be as they are differ from those of the die-hards in both camps. I believe that new species arise and change over time and that some of this evolution has been the result of random mutations contributing to an organism's fitness for its environment and ability to pass on its genes. But I doubt that most of the mutating has been the result of chance; rather, the organisms themselves have played important roles in inducing both the genetic mutations and other heritable changes that would help them function in their environments. And in some cases, humans have been a key component of the environment that fosters such changes.

While not an ardent believer in neo-Darwinism, I'm also unimpressed by the prevailing concept of "intelligent design," which implies the existence of one monolithic intelligent Designer. Thinking of my own species, for example: If humans' Designer were so smart, surely we wouldn't destroy the air, water, food, and energy supplies that are necessary for our own existence. Surely we wouldn't be so stupid—or so greedy—as to hoard resources for our short-term gain at the expense of others and at the expense of our own long-term well-being.

Perhaps the problem stems from the design of the human body, whose elaborate neural network is directed by a brain sporting hefty frontal lobes. While our nervous system prompts us to seek comfort and pleasure and avoid pain, our frontal lobes allow us to rationalize our behavior so that we can deceive ourselves—and sometimes others—

into believing that even selfish actions are altruistic or at least rational. This unique combination of neural fibers induces us to harm others to protect ourselves while believing our actions to be justified. Protecting ourselves from pain and seeking pleasure too often morphs into valuing ourselves (the bodies that we're neurologically wired into) more than others (the bodies that we're not neurologically wired into). In short, our neurocortical design spawns greed.

And greed destroys worlds—ask any Pueblo Indian.

For untold centuries Pueblo Indians have been acutely aware of the destructive potential of greed, so they have designed cultures that curtail the human tendency toward unmitigated selfishness. Let's look at a Hopi myth and then a Zuni one, both excellent examples of cultural products that extol humility and gratitude and warn against the dangers of greed. These ancient myths are as relevant to our twenty-first-century, hi-tech, genetically sophisticated lives as they have always been to the Pueblo people. Both myths feature corn, an extremely important plant, the design/evolution of which I'll return to shortly.

Both the Hopi and Zuni believe that the world has been cyclically created, destroyed, and re-created. Each destruction was the result of human greed. According to the Hopi, we now live in the Fourth World (and some say we're coming to the end of it). Hopi mythology tells of a time after the end of the Third World when most people had died; however, some people, including some Hopi, had been spared, kept safely inside the body of Mother Earth until the Earth's surface was again habitable. When the Earth was ready, these humans emerged. They met a being named Masaw, who was tilling the soil. Masaw offered the groups of people different kinds of corn by which they might make their livelihood in this new Fourth World. While others grabbed for the biggest ears of corn, the Hopi deliberately chose the smallest ear of blue corn.

The wise old Hopi ancestors' selection of the little ear of blue corn symbolizes their intent to live a life that would be hard—their harvest would be small for their efforts—but enduring. These ancient Hopi had observed that there are dangers inherent in an easy lifestyle. People become complacent, take their abundance for granted, and then lose their spiritual connection with the Source of their abundance. The end result is that, over time, such people do not endure. Their greed leads them to hoard goods and ruin their environments and go to war with each other. Choosing a difficult lifeway, a way that requires much hard work for relatively small harvest, guards against greed by keeping people humble and grateful for what they have. To survive, such people must stay spiritually in tune with the Earth and keenly aware of the plants and animals around them; consequently, they endure beyond the lifetimes of the people who live easier lives.

A Zuni Corn Maidens myth recorded by anthropologist Ruth Benedict (1935) suggests a resonant moral. This is a story of the long-ago times, when the radiantly beautiful Corn Maidens, Mother Goddesses of corn, lived among the Zuni people. These seven Corn Maidens were more beautiful than any mere human woman could ever be, and they kept the Zuni's corn storerooms full. In return, the Zuni people performed ceremonies and were grateful for the Corn Maidens' gifts. But one night the Bow Priest, whose duty it was to protect the Corn Maidens while they slept, snuck up behind Yellow Corn and tried to rape her. He dared to lay hands on Yellow Corn.

Yellow Corn rebuked the Bow Priest for attempting to "lie with his Mother," and then she hurried to tell her sisters what had happened. All the Corn Maidens agreed that they must leave the people lest they be made "less valuable" by such foolish behavior. When the Corn Maidens left, all the corn in the storerooms followed them. The people got by for a while by hunting deer and eating cactus, but after six increasingly difficult years—drought, a killing frost, depletion of game, one hardship after another—they were dying of starvation. Desperate, the Zuni priests asked Eagle and other birds to help them find the Corn Maidens, but the beautiful sisters remained secluded.

Finally, the Zuni priests called on Newekwe Youth, a young initiate from a neighboring village who had special skills. Newekwe Youth flew up to the Milky Way, from where he could see the Corn Maidens hiding in the ocean far to the southeast of Zuni. He reported this sighting to the Zuni priests who had summoned him, but Newekwe Youth warned them that he could not retrieve the Corn Maidens alone. He would need the priests' help. They must neither talk, nor eat, nor drink, nor pee; they couldn't even move. They could only sit in the kiva with their arms folded across their chests and pray and meditate while he planted the prayer sticks along the path to where the Corn Maidens were hiding. And he couldn't just take the prayer sticks all at once: he planted the first a short distance away from the village and then returned and prayed with the priests awhile. Then he took the second, planted it farther away, returned, and prayed even longer with the priests. This went on until Newekwe Youth had planted a path of seven prayer sticks reaching all the way to the ocean where the Corn Maidens were staying.

Suffice it to say that this was an arduous process that taxed the priests' abilities to endure deprivation and stay focused, but they did it because otherwise the whole village would die. The Corn Maidens, who know such things, were aware of the priests' sacrifice, so when Newekwe Youth found them and asked them the requisite four times to return, they agreed—but only on the condition that the Zuni people would "be happy all the time" and perform their ceremonies as they had since time immemorial.

When the Corn Maidens returned to the village, the people performed the welcoming ceremony. That night their storerooms were filled, but because the Bow Priest had laid hands on Yellow Corn, the Corn Maidens would now live among the Zuni in spirit only rather than in the flesh, and from that time on Zuni corn was never perfectly kerneled.

Like the Hopi myth of the creation and destruction of worlds, this story points to the devastating consequences of greed. The Bow Priest wasn't satisfied with what he had—he wanted more, all for himself. His unmitigated selfishness caused the whole village to suffer extreme hardship. The Corn Maidens' condition that the Zuni people "be happy all the time" points to the antidote for such greed. The meaning of "happiness" here is not smiley-face giddiness; rather, it refers to the contentment that rests on gratitude for what one has been given—the direct opposite of greed. If the Bow Priest had been happy with the bounty that was his, he would not have tried to reach out and grab still more for his own pleasure. So now, if the Zuni people stay happy, such a transgression will not happen again, and they will all have enough corn.

Let's think about this wonderful plant that the Corn Maidens gave to the people. How did they create corn? Or, for those of us who don't take myth literally, how did corn, which is now the single largest food crop in the world, come to be? Scientists are not sure. Until recently, there were two competing genetic theories, one maintaining that corn had been teased out of a wheatlike grass called teosinte (genus *Zea*), the other contending that one now-extinct ancestor of corn had crossed with another grass, *Tripsacum,* several millennia ago. More recently, a Duke University plant geneticist, Mary Eubanks, presented evidence that corn arose from a cross between teosinte and *Tripsacum*—no extinct ancestor involved (Eubanks 2001; Meredith 2004). This would have been an amazing feat; neither teosinte nor *Tripsacum* looks anything like corn. Moreover, these ancient grasses are not different species of the same genus but members of different genera. Crossing *Tripsacum* with teosinte would be analogous to a human mating with a gorilla.

Even today the scientific community is not of one mind on the genetic heritage of corn. In any event, as I'll suggest below, the genetic script does not tell the whole story.

While scientists still wrangle over corn's genetic lineage, they largely concur that the evolution of corn (*Zea mays*, or simply maize) depended on intense intervention on the part of Central American humans some seven to eight thousand years ago (Fussell 1992, 80). Such intensive human interaction was necessary because corn can't regenerate by itself. Wrapped in its snug husk, if an ear falls onto the earth, the seeds rarely find conditions conducive to germination; and when they do, all the seeds on a cob sprout simultaneously, competing with each other for nutrients, with the result that none survive.

In Mexico today the result of this cooperative relationship between the Corn Maidens and humans is that there are, according to Charles C. Mann, "more than fifty genetically distinguishable maize 'landraces' . . . or families of local varieties, each of which may have scores of 'cultivars,' or cultivated varieties. As many as five thousand cultivars may exist in Mesoamerica" (2005, 197). How could such astonishing maize diversity have evolved from the crossing of two genetically distant grasses?

Nobel Prize–winning cytogeneticist Barbara McClintock, who studied corn for many decades, offered insights that may yet prove helpful in deciphering the origin and history of corn. McClintock's intimate way of working with corn plants has been described in detail in *A Feeling for the Organism*, Evelyn Fox Keller's biography of this remarkable woman. McClintock's patient research led to the discovery of transposable genetic elements, which eventually—after decades of dismissal because the theory sounded too outlandish—led to her receiving the Nobel Prize in 1983.

McClintock's way of studying the corn was to work with it carefully, respectfully, and lovingly. She cared for each plant herself, from seedling through adult stages, leaving no tasks to the hands of assistants, as was typical of other researchers (Keller 1983, 103, 198). She wanted to get to know each plant individually. McClintock's meticulous, attentive observation of the plants and of their chromosomes as she studied them under the microscope led her to infer that bits of chromosome were "jumping off" and moving to other locations on the genome. When these bits, later called transposons, jumped off their original place in the chromosome and landed in another place, they turned "on" or "off" the adjacent gene (Keller 1983, 121–38). McClintock discovered that this process of transposition accounted for variation in leaf and seed color in maize as well as other traits.

McClintock's theory of transposition sounded heretical to the 1950s scientific community for several reasons. The genetic model during the 1950s and 1960s was that genes are like beads on a string; as such, they don't "pop off" and move to another location on the chromosome. But perhaps even more iconoclastic was McClintock's claim that these transpositions may not be random. Instead, she argued, they are evidence of the organism itself, via the cell, responding to external cues in the environment (Keller 1983, 101, 144).

The nonrandomness of McClintock's theory of transposition was particularly problematic because it seemed to lend support to Lamarckism, which had little scientific respect. (Lamarck, you may recall, was the nineteenth-century French naturalist and predecessor of Darwin who theorized that organisms evolve as they do because of inheritance of acquired characteristics. The caricature example often used to illustrate Lamarck's theory is that giraffes have such long necks because adults stretched their necks to reach ever-higher leaves in trees, and they then passed the trait of longer necks on to their offspring.) Then in 1953 Watson and Crick's discovery of the double helix further supported neo-Darwinian notions of random mutation and natural selection, seeming to put the final nail in the coffin of Lamarck's theory. Lamarck and his followers became persona non grata in the world of science.

Nowadays, McClintock's discovery that some genes can move from their original location to another spot on the chromosome and turn on or turn off adjacent genes is accepted genetic theory. For better or worse, the idea has facilitated genetic engineering of organisms, including corn. However, the Lamarckian-tinged aspect of McClintock's theory—that the plant responds in nonrandom ways to the environment, ways that suggest that the plant, via the cell, exerts some control over even its progeny's destiny—has drawn less scientific attention.

McClintock's discovery of the way genetic transposition contributes to changes in the organism describes only one way in which the cells respond to the environment, changing not only the development of the organism but also the inheritance of its offspring. For a couple of decades some scientists have been studying epigenetic mechanisms (i.e., mechanisms outside the genome) by which Lamarck may have been right after all. These researchers have had a hard time getting the community to recognize their work because, of course, it sounds so . . . Lamarckian. Since the discovery of the double helix, legitimate scientists have had to be neo-Darwinian, and in this binary, with-us-or-against-us world it's hard to be both neo-Darwinian and neo-Lamarckian. But a few brave scientists have managed, and, according to Leslie Pray, who has written extensively about this topic, "in the last twenty years investigators have uncovered enough molecular detail to convince the scientific community at large that the epigenome matters," at least in the organism's development (2005, 71).

Briefly, the epigenome consists mostly of methyl groups that attach themselves to nucleotides; such attachments may prevent the corresponding gene from being active. In other words, they are nongenetic molecules that influence gene expression. These epigenetic methyl switches "play a vital role in most, if not all, cellular activity, from metabolism to fertilization" (Pray 2005, 70). If the cell's environment is healthful, a normal methylation pattern allows individual genes to operate in such a way that the tissue/organ functions normally. But if, say, the cells are bombarded with toxins or other "unusual environmental signals," an abnormal methylation pattern ensues. Today scientists have linked abnormal methylation patterns with tumor growth and "such conditions as diabetes, obesity, autoimmune diseases, and psychiatric diseases" (Pray 2005, 70).

For an organism to respond to an immediate environmental condition by turning a gene off is, in the words of Pray, "a much faster way of adapting to an environment than natural selection is" because epigenetic changes allow for adaptation to "happen over the course of a lifetime" rather than only appearing in one's offspring (2005, 70–71). Moreover, and of particular relevance to the evolution of corn, is that there is now substantial evidence that adaptations resulting from such methylation patterns can be inherited and passed through successive generations. The June 2005 issue of *Science* magazine reported:

> Researchers from Washington State University showed that pregnant rats exposed to pesticides not only suffered epigenetic damage but also passed it down three generations, to the great-grandoffspring. More than 90 percent of male offspring, across all three generations, were born with infertility problems, all of which were due to that initial pesticide exposure. The study . . . rule[d] out DNA mutation. (Pray 2005, 71)

Today, the evidence for epigenetic inheritance in plants and animals—from paramecia and yeast to humans and corn—is abundant (Jablonka and Lamb 1995). Both these epigenetic studies and McClintock's now-classic work with transposons strongly suggest that the organism, via the cell, responds to the environment in ways that can pass traits on to future generations. These responses are *not* random mutations in the genome.

With these genetic and epigenetic points in mind, let's reconsider the origins of corn: how did teosinte and *Tripsacum* mix and mingle so as to become the thousands of varieties of corn that now feed humans and other animals across the globe? How did corn coevolve with humans in the Americas? My answer is only speculative, of course, but I suspect that future research will confirm that corn evolved through an intimate dance of mutual interaction between ancient American Indians and ancient grasses. Humans were an *essential* element of the environment that teosinte and *Tripsacum*—and the corn that arose from their interbreeding—responded to. In scientific terms both genetic and epigenetic factors were likely involved in these early plants' responses to their human-influenced environments. In Pueblo Indian terms these Indians' careful, attentive relationship with the Corn Maidens bore bountiful fruit. I envision the ancient Indians' approach as that of a loving companion, a cooperative, McClintock-like partner with the Corn Maidens that has resulted in a plethora of diverse types of corn.

Today modern Pueblo Indians still maintain a respectful, appreciative attitude toward corn, and they still foster its diversity. They recognize that mutual nurturance is necessary for both corn and humans to survive and that the point of farming corn is not to select for varieties with the highest yield. When naturalist and Native Seeds/SEARCH founder Gary Nabhan asked a Hopi woman who was sorting corn seeds whether she selected only the biggest kernels for planting, her answer was blunt and instructive. "She snapped back at me," Nabhan relates, "'It is not a good habit to be too picky . . . we have been given this corn, small seeds, fat seeds, misshapen seeds, all of them. It would show that we are not thankful for what we have received if we plant just certain ones and not the others'" (1983, 7). This Hopi woman is echoing wisdom gleaned from millennia of working with the Corn Maidens to produce an astonishingly bountiful array of maize varieties.

It may be challenging for us now to imagine the kind of intimate relationship between humans and plants that would have been required to create corn from crossing two genetically distant grasses, neither of which resembles corn. When we think about corn, we focus on consuming it. We buy it in handy cans or frozen boxes, or, if we're lucky, in long ears ensconced in strong, green husks. Perhaps it's precisely because we in the United States today are wealthy enough to take our food for granted that we have difficulty imagining humans being so tuned into plants that they would know how to create corn out of a cross between teosinte and *Tripsacum*. Unless we're genetic engineers, we wouldn't have a clue about how to induce a cross between different genera to create a radically different plant and then to develop its diversity into thousands of varieties.

One advocate of corn engineering was delighted to learn about the research that demonstrates the crucial role that ancient Indians played in the creation and development of corn. Nina Federoff, a University of Pennsylvania geneticist, writes that the ancient Indian development of corn was "arguably man's [*sic*] first, and perhaps his greatest, feat of genetic engineering" (2003, 1158).

There are two problems with Federoff's comment. First, Federoff's use of the generic term "man" suggests the image of Indian men performing this astonishing feat. However, since prior to the development of maize the Indians would have been hunter-gatherers, the women would probably have had more familiarity and more interaction with the grasses; Indian women were therefore more likely responsible for the origin and development of corn. Second, the ancient Indians were *not* genetic engineers. Genetic engineers force plants to produce the individual traits they want (resistance to the funding corporation's herbicide, for instance), and they do so by violating the plant's genome. Genetic engineers use a "gene gun" to insert genes that seem likely to result in the desired trait, or they send a piece of alien genetic material into an organism via a vector such as a bacterium—a sort of Trojan-horse method of invading the genome (Celec et al. 2005, 532). By contrast, Indian breeding practices work with whole plants, not just their genomes, in their natural contexts. Such methods neither violate the plants nor force them to produce according to the humans' desires. Instead, the humans work *with* the plants' inherent breeding systems, and the plants respond as they will, not as they must. Indian farmers were and are partners with the corn, not its engineers.

It should come as no surprise that a method that abstracts an organism from its ecological context and violates its genome at the microlevel brings macrolevel risks. As any environmentalist—or Pueblo Indian farmer—will tell you, one of the most dangerous side effects of genetically engineered (GE) corn is increased monoculture, and therefore decreased diversity, and therefore increased susceptibility of crops to being wiped out by just one successful pathogen. Today, one such opportunistic pest could destroy vast tracts of cornfields across the continent. The impact on all who depend on that corn would be devastating.

Among the many indigenous people throughout the Americas who oppose genetic engineering of food is Clayton Brascoupe of Tesuque Pueblo. At a press conference at La Montanita Co-op in Albuquerque, New Mexico, Brascoupe informed others about the dangers of eating GE foods as well as the risks posed to the survival of indigenous strains of corn. At that event he said, "When I first heard about the corruption of the genes of our Corn Mother, it frightened me because corn is at the heart of our survival as Indigenous peoples of North, South and Central America." Brascoupe explained that corn "takes care of" the people; corn is both food and medicine. He warns, "Our mother is being corrupted by scientists and corporations, and if we don't stop it, she won't have the ability to heal us any longer" (Taliman 2002).

Brascoupe's view is radically different from that of biotech corporations like Monsanto, which claim that genetically engineered corn is needed to feed the starving masses. However, many scholars who have no financial stake in biotech companies counter that there's already enough food produced to feed the hungry worldwide; hunger is a problem of distribution, not production (Altieri 2004, 2–5). But under this pretext Monsanto craftily ushered in the Age of GE Crops by planting thousands of acres of the stuff in the United States. Then in 1992 Monsanto got one of their own employees onto the FDA panel that would consider regulation of genetically engineered foods. As journalist Jennifer

Kahn explains, that FDA panel "ruled that consumer labeling and safety testing were unneeded unless the genetic modification altered the nutritional content or posed a known health risk. The policy was written by an FDA deputy commissioner who had worked for Monsanto for seven years" (1999, 73). That same Monsanto employee/FDA commissioner subsequently returned to work for Monsanto. And, protected by classic Catch-22 logic spawned by rationalizing frontal lobes at their finest, since there had *been* no long-term safety testing for risks to human health, there *was* no "known" health risk. Ergo, Monsanto and other biotech companies are free to plant GE crops wherever they want and to use them in food products without labeling the food as GE until such a "known" health risk arises.

As a result of genetic engineers' work and Monsanto's crafty manipulation of government agencies, we've all eaten GE food now, and GE crops are all over the place. In 2004 "40% of the corn, 70% of the canola, and 80% of the soybeans" grown in the United States were genetically engineered (Darlington 2004, 12). Widespread use of unlabeled GE food crops makes proving that an illness is due to consumption of such food extremely difficult. We are all unwitting, involuntary subjects of a vast, uncontrolled experiment that cannot even yield useful data to trace the source of the illnesses that the genetically engineered food may well produce.

Though impacts of GE food on human health are difficult if not impossible to trace, contamination of non-GE crops by wind-transported GE pollen has already been demonstrated. Four years ago, when the Union of Concerned Scientists tested non-GE corn grown in the United States, they found that at least half the samples contained traces of biotech seeds (Jacobs 2004, 4C). Such contamination is even more devastating for organic farmers, who risk losing their organic certification, and in the Midwest 100 percent of organic corn tested seven years ago already showed some GE contamination (Charman 2001, 43–44). Even corn grown in Mexico has been contaminated with GE pollen, as demonstrated by UC Berkeley assistant professor of microbial ecology Ignacio Chapela (Vidal 2005; Garcia 2004). Chapela and many of his colleagues believe that his publication of this research in the journal *Science*, coupled with his opposition to a proposed fifty-million-dollar donation to the university by the multinational GE company Novartis, cost him his job there. Such instances demonstrate that GE companies work swiftly to silence opposition to the spread of both their polluting pollen and their hegemony in the world of biotech research (Garcia 2004).

Not surprisingly, President Bush's endorsement of ethanol as a way to lessen our dependency on foreign oil pleased Novartis, Monsanto, and other agricultural biotech companies because a greater demand for ethanol increases demand for GE corn. Midwestern senators and representatives made sure that the 2007 energy bill contained plenty of financial support for research and development of corn-based ethanol, already a heavily subsidized industry. However, some researchers argue that, once all the energy required to grow and harvest the corn and produce the ethanol is taken into account, ethanol costs more energy than it saves (Kinnan 2007; Bryce 2005). David Pimentel, professor emeritus at Cornell, and Tad W. Patzek, associate professor of chemical engineering at UC Berkeley, have both made this case, also noting that corn-based ethanol contributes to global warming and could not contribute significantly to U.S. fuel needs (Pimentel and Patzek 2005). Conservative Congressman Roscoe Bartlett (R-MD) has repeatedly cautioned Congress that even the most optimistic estimates of ethanol's efficiency demonstrate that it would do practically nothing to assuage our fossil-fuel crisis (Bartlett 2006).

To these concerns about the efficiency and environmental impacts of ethanol I would add that there is just something disturbing about feeding a sacred plant like corn to our cars and trucks, especially when tens of thousands of people worldwide are starving. Increased demand for ethanol has already caused Mexican corn prices to spike, making that centerpiece of the Mexican diet unaffordable to poorer people.

The push for ethanol appears to be yet another product of industry-government collusion (and frontal-lobe rationalization of greed) without regard for how the financial benefits to GE companies would be offset by the pollution of air, water, and soil, the possible impacts on human and animal health, the risks of widespread monocrop devastation, and the costs to organic farmers and to people who need to eat corn to survive.

Those schooled in Pueblo Indian mythology see here the playing out of an old, old story: genetic engineers of crops and the multinational corporations that profit from their work share much in common with the mythic Zuni Bow Priest. They, too, have "laid hands on yellow corn." Like the Bow Priest, their motive is greed. Like the Bow Priest, their methods combine stealth with use of force. And, also with uncanny similarity, the results of their efforts jeopardize the whole community's welfare—only today that community spans continents.

Unfortunately, we live in a culture that not only fails to curtail greed but rests its whole economic system on it, exploits and encourages it with every advertisement. As I look at the environmental problems created by our own greed, at the economic system that feeds on it, and at the political climate that seems hell-bent on perpetuating it, I can't help but wonder whether humanity and this Fourth World will survive. But I imagine that at least a few Hopi and Zuni will endure no matter what catastrophes await us. In Darwinian terms these Puebloans are better fitted to their environment than members of the dominant culture that surrounds them. But that fitness is not genetic; it's cultural. Pueblo Indians designed not only sustainable food systems centered on increasingly diverse types of corn but also cultures that foster respect and appreciation for the plants that give them life—cultures that counter the human propensity for greed.

Now *that's* intelligent design.

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