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Genetics: the Not-So-New Thing

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GENETICS

the not-so-new new thing

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ABSTRACT Practical knowledge of heredity predates history. Indigenous peoples laid the foundations of modern agriculture by developing plants such as corn. However, the language and metaphors of the Human Genome Project treat modern genetics as if it had no historical antecedents and fail to acknowledge these early contributions to the science of heredity. The results of this blindness are twofold: it exacerbates reluctance of native peoples to take part in genetic research and to garner the benefits of genetic medicine, and it encourages "biopiracy," as modern scientists "discover" and patent native plants.

THE STUNNING 2001 EXHIBIT at the American Museum of Natural History was entitled "The Genomic Revolution," and everything about that stylish installation lived up to its revolutionary premise. The hall was bathed in black light, the exhibits were unrelentingly futuristic, and there was nifty stuff to play with. One exhibit, the delight of small boys, allowed museum-goers to manipulate the steps of a DNA "ladder" while a giant fruit fly manifested the eye-popping results of their choices; in a particularly startling mutation, a leg suddenly grew out of the fly's head. The exhibit brochure announced that "The genomic revolution is changing our understanding of our identity as a species and our

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place in the natural world" and predicted "a dramatically different future for us and our children."

This futuristic depiction of our recent genetic successes is everywhere. Scientists have likened the Human Genome Project to putting a man on the moon. The analogy refers primarily to the money and coordination required to pull it off, but also signals the sheer *newness* of it all: the Genome Project, like the Star Trek mission, would seek to go where no man has gone before. The January 17, 1994, cover of *Time Magazine* blared: "Genetics: The Future Is Now." In 2000, Francis Collins proclaimed that "We have caught our first glimpse of our own instruction book previously known only to God" (Nelkin 2001). This notion of a "first glimpse" of something "previously" unknown to humans emphasizes the sharp disconnect between past scientific knowledge and our current genetic efforts. Nelkin reminds us that metaphors affect the way we "perceive, think, and act" and structure our attitudes toward public issues. Rather than being understood as a gradual accretion of knowledge over time, genetic science is portrayed as springing full-blown from the foreheads of Watson and Crick in their famous "Eureka" moment, with a polite nod to Gregor Mendel and his sweet peas. As biologist Roger Gosden (1999) puts it: "the door to the genetic treasure chest swung open." Where genetics is concerned, we are like adolescents who believe we have invented sex.

In fact, the study of heredity may be one of the oldest of the sciences, and it certainly predates the elegant geometry and physics of the ancient Greeks. In *Guns, Germs, and Steel*, Jared Diamond (1997) says: "all crops arose from wild plant species. How did certain wild plants get turned into crops? That question is especially puzzling in regard to the many crops (like almonds) whose wild progenitors are lethal or bad-tasting, and to other crops (like corn) that look drastically different from their wild ancestors." He describes a complex process in which people both consciously and unconsciously mold the plant's evolution by both natural and planned selection, until it attains a more useful form. Diamond reminds us that Darwin devoted the whole first chapter of *On the Origin of Species* to a description of how domesticated plants and animals got that way through artificial selection by humans.

We do not have far to look to see evidence of how ancient peoples used their knowledge of heredity. Many examples of traditional understanding and use of the principles of heredity come from indigenous peoples of the Americas. Indeed, the close of the last century saw a dawning appreciation among "conventional scientists" of the creativity and innovation of rural societies. For example, scientists have studied the contribution of African farmers to the management and development of genetic resources in agriculture (Crucible II Group 2000).

Here in North America, we know that Indians have lived off the land, in one fashion or another, for thousands of years. To do that successfully, people have to be good observers of nature, and they have to organize and act on their observations. There is no doubt that when Indian farmers noticed that some of their corn, beans, or squash seemed to survive drought better than others, they tried to plant more of that sort of corn the next year, and observed to see whether their strategy was working. In the same fashion, people learned that some plants do really well growing next to each other, while some cross-pollinate with negative results. The Hopi people have strictures against mixing corn of different colors when planting, strictures that are part of the traditional Hopi knowledge base.[1] The Hidatsu people of North Dakota did the same. Buffalo Bird Woman, a Hidatsu, explained that her people understood the need to plant different strains of corn in fields far away from each other. They knew that planting white and yellow corn in adjoining rows would produce ears of mixed variety. "We Indians did not know what it was that caused this. We only knew that it was so" (Fussell 1992).

Corn has been called humans' first and greatest feat of genetic engineering (Fedoroff 2003). Corn, or maize, was developed from teosinte, a wild grass indigenous to Mexico. Teosinte has a hard kernel that allows it to pass unscathed through an animal's digestive tract, a good strategy for propagation, but one that makes it useless for human consumption. Humans, by selective breeding, developed a mutation that made the plant more nutritious for consumers, with larger ears and more tender kernels, but also one that needed human help to propagate. Scientists now believe that the ancestor of modern maize arose over 9,000 years ago, in the Balsas River basin of southern Mexico (Fedoroff 2003).

Over 2,000 years ago, the indigenous farmers of what we now call New Mexico created hybrid corn by crossing two existing varieties. The result was a hardy and adaptable crop that grew well in a variety of southwestern conditions and that "provided the subsistence base for southwestern civilization," especially for the Hohokam-Basketmaker (Anasazi) peoples (Hurt 1992). The Hopi developed a variety of maize that is especially suited to their arid conditions: it reaches maturity quickly but grows in a low, sturdy bush that presents less resistance to the southwest winds than the tall varieties of the Great Plains; a long taproot exploits every possible source of moisture (Hughes 1996). The Huron Indians developed varieties of flint and flour corn that did well in their short, cool, and humid growing season. In Nebraska, farming tribes such as the Pawnee developed many different varieties of corn; like the Hopi, they understood the importance of retaining the purity of these strains by careful selection of seeds and by planting different varieties far apart from each other (Hurt 1994). As geneticist Walton Galinat observed: "The American Indians were not simply the first corn breeders. They created corn in the first place" (Fussell 1992).

One technique that Western settlers to the New World adopted from Indian farmers was the practice of selecting seeds and planting them in the ground, rather than grabbing a handful from the seed bag and scattering them widely. Most grains, the staple food of Europe, had tiny seeds that had to be broadcast by the handful. Corn, by contrast, has large seeds, and by choosing them care-

[1] Leon Nuvayestewa, personal communication.

fully and placing them deliberately, Native Americans were able to develop hundreds of varieties. Indigenous Americans also knew that "by taking the pollen from one variety of corn and fertilizing the silk of another variety, they created corn with the combined characteristics of the two parent stalks. Today, this process is known as hybridization and scientists understand the genetic reasons behind this process; the Indian farmers developed it through generations of trial and error" (Weatherford 1988).

Cultivated and genetically manipulated potatoes are another New World crop, developed thousands of years before the Incas. The earliest Peruvians saw the value of diversity, as they aimed to create a different kind of potato for every combination of soil, moisture, altitude, and sun. At the time of European contact, Andean farmers were producing about 3,000 varieties of potatoes, in contrast to the 250 varieties now grown in North America (Weatherford 1988).

Clan relationships, for example among the Navajo, are another example of traditional indigenous genetic knowledge. What most non-Indians think of first when they think of the clan system are the intricate incest taboos that restrict many people from being possible mates for each other. We know that every culture has some sort of incest taboo, although the details work themselves out differently. (In some cultures, for example, marriage between first cousins is strongly *preferred*.) The reasons for incest taboos are multiple and many-layered, and they cannot simplistically be attributed to knowledge of heredity alone. But certainly one reason for the taboo is to create a certain genetic distance that makes it less likely that people who carry the same deleterious alleles will mate. It is a good system because, although a person's phenotype is not visible to the naked eye, her clan membership, while complex, can be ascertained before a courtship relationship gets started, and without the help of a laboratory or the Human Genome Project. There are now computer programs that help Navajo people to figure out whether attractive members of the opposite sex are taboo for them or not.[2] The clan system is echoed by a process developed recently by some Orthodox Jews, in which young people are tested for their carrier status for genetic diseases known to be prevalent among the Ashkenazi Jewish community, and ill-fated matches are avoided.

The extremely disturbing, frighteningly ambiguous *koyemshi*, or mudheads, of the Zuni are ritual clowns who depict beings descended from the union of a sister and brother in the Zuni creation story. Because of their incestuous beginnings they are impotent and idiots, but they are also beings of great power. Their outrageous and colorful behavior renders them very visible in Zuni ritual. The *koyemshi* are a complex, multilayered phenomenon, but it seems plausible that one explanation for their behavior is that their presence is a strong reminder of the incest taboo and the likely consequences (malformed children) that stem from breaking it.

[2]http://www.navajopage.com/clan.html.

The Navajo clan system highlights that tribe's understanding of genetics by shedding light on the way traditional Navajos understand the contribution of a person's forbears to his or her own biological development. In *Molded in the Image of Changing Woman*, Maureen Trudelle Schwarz (1997) quotes a Navajo man, Avery Denny, as follows:

> Your mother's clan, your father's clan, and then your maternal grandfather's clan and paternal grandfather's clan. You represent four people. Through your mother's clan, you were born for your father's clan, and then your maternal and paternal grandfather. So you represent four bloods, there are four types of blood in your system. . . .
>
> The nervous system, the skeletal, and then your digestive system and then your respiratory system. There are four, so you have four bloods, and then you have the four clans, everything is four. So everything is four in your body. So, the vital parts, you can't separate the heart from one another, or the lungs this way, and say that, that is the one, the main one. It all works together as one. Just like this natural order. . . . Your mother would be your nursing, you're fed on your mother's milk, so that is the digestive system. And then your father is the one that gives you that support to stand up, that would be your skeletal system. . . . Your respiratory system, would be your paternal grandfather, meaning he is the one that is going to teach you how to pray and all that stuff. And your maternal [grandfather] would be your nervous system.

Although modern medicine would reject the one-to-one pairings in this description, it clearly expresses the traditional Navajo awareness that all four grandparents have a role to play in the inherited qualities of each person.

Reading the creation stories of various Indian tribes, one is struck by the wisdom they show about evolution. In the Zuni story, for example, the first people looked quite different from human beings. They lived deep within the earth, in the body of Earth Mother, where it was very dark. They were covered with slime, they had webbed feet and hands, and they had tails. When the Sun Father told the twin War Gods to lead the people to the surface of the earth, their bodies changed, casting off their amphibious qualities. This is a sophisticated way of representing both human embryonic development and the evolution of species. In the Navajo story, the beings whom we know today as Navajo begin as 12 varieties of Insect People—and not only that, but insect people who were able to talk, intermingle, and have sex with, for example, swallows. These stories are one way of expressing our recent "discovery" that humans share 98% of our genes with chimpanzees, 90% with mice, 21% with worms, and even 7% with the "lowly" *E. coli*.

Certainly, traditional knowledge did not include the idea of chromosomes, genes, or DNA; people did not understand, as we are beginning to do today, exactly *how* certain traits got passed on. As Buffalo Bird Woman said: "We Indians did not know what power it was that causes this. We only knew that it was so."

But these few examples, only some among many, show that a science of heredity, both as observation and as intervention, predates recorded history. A portrayal of genetics as the absolutely "new thing," without roots in traditional knowledge, betrays our modern ignorance and our arrogance.

Why does our hubris matter? Two reasons. For one, the arrogant depiction of genetic science as a modern Western invention exacerbates the hostility and distrust between genetic researchers and members of traditional societies, such as Native Americans and Alaskan Natives (Dukepoo 1998). Indigenous people have often themselves acceded to the idea of genetics as an entirely modern type of knowledge and fail to see the connections with their own knowledge base. A handbook developed by the Indigenous Peoples Council on Biocolonialism (2000) notes that "knowledge of genetic phenomena has a history that is thousands of years old," but then claims that

> the incredibly fast growth of the "new genetics" is another story altogether. It started when it was found that humans could move portions of DNA between organisms . . . and so the genetic engineering revolution began. . . . Life forms are viewed as mere machines, in that the research tries to change one part of the "subject" organism in order to get different "output" in terms of, for example, disease resistance or food production. . . . This view is in conflict with a view that recognizes the interrelatedness and interdependence of all living things.

Although there may well be some irreconcilable differences between many Native Americans and genetic scientists, it is important that those differences not be magnified unnecessarily. In common with all peoples, Native Americans suffer from genetic diseases and can benefit from thoughtful research. But many experiences with unscrupulous and dishonest scientists have given research in general, and genetic research especially, a bad name among native peoples (Bowekaty 2002). That bad reputation can be lived down by a new generation of respectful scientists who view Native Americans as research partners and who take into account the special cultural, religious, and economic concerns presented by genetic research (Bowekaty and Davis 2003). It would be a tragedy if a misrepresentation (by scientists and by indigenous activists) of genetic science as sharply disconnected from traditional knowledge about heredity contributed to a wholesale rejection by Native Americans of all genetic research.

Indian leader Vine Deloria (1995) makes a similar point when he shows how new directions in Western science are often instances of researchers "discovering" fields of knowledge of which indigenous peoples had long made use. Deloria cites a panel at a 1992 meeting of the American Association for the Advancement of Science, which was written up in *Newsweek*, on a new field of "zoopharmacognosy," in which scientists observed the use of medicinal plants by animals:

> For Western peoples, the announcement of zoopharmacognosy may be an exciting breakthrough on the frontiers of science, but getting information from birds and animals regarding plants is an absurdly self-evident proposition for American Indians. It gives substance to the idea that all things are related, and it is the basis for many tribal traditions regarding medicinal uses of plants. . . . Why didn't people take Indians seriously when we said that animals and birds give us information on medicinal plants? Why is such knowledge only valid and valuable when white scientists document and articulate it?

This disregard of indigenous contributions alienates Native Americans from modern science, especially genetics. A representation of current genetic research and medicine that truthfully portrays it as one more milestone in a history of knowledge that includes the contributions of indigenous peoples could arguably result in more openness among Native Americans toward the fruits of genetic medicine.

The second result of our hubris is that our willed ignorance of the contribution of traditional peoples to the development of modified agricultural products, such as corn, makes it easier for "biopiracy" to occur. Just as Europeans imagined themselves as "discovering" the "New World" and behaved accordingly, so Western scientists and entrepreneurs today are patenting "discoveries" such as quinoa, naturally colored cotton, and other agricultural products, with no recognition of the fact that these products are the result of generations of work by indigenous people (Benjamin 1997). Debra Harry, Executive Director of the Indigenous Peoples Council on Biocolonialism, explains:

> Colonization is an age old process of theft and control facilitated by doctrines of conquest such as the Manifest Destiny and Terra Nullius, that claim the land as empty . . . and nonproductive. . . . And as the self-proclaimed "discoverers" of crops, medicinal plants, genetic resources, and traditional knowledge, these bioprospectors become the new "owners." Intellectual property rights are being used to turn nature and life processes into "private property." As private property, it is alienable; that is, it can be owned, bought and sold as a commodity. The result is a legitimized process for thievery, which we call "biocolonialism." (Harry, n.d.)

In one instance, two U.S. scientists patented a variety of the indigenous grain quinoa that they say they "just picked up" while on a trip to Bolivia. The patent included all hybrids created from this variety now and in the future, completely cutting out the native agriculturalists from all access to profits from their work. More than 40 varieties of this grain are now the exclusive property of Colorado State University (Benjamin 1997).

This "new colonialism" feels to indigenous peoples like simply the next step in a process that began with theft of land, went on to theft of culture, and now threatens to steal traditional knowledge as well. The "common thread," says Harry, is "that we're dealing with a white society that feels that anything that exists in indigenous territories is up for grabs." For example, one anthropologist calculated that "less than 0.001 of the profits from drugs that originated from traditional medicines have ever gone to the indigenous peoples who led researchers to them" (Coombe 1998). Approximately 90% of the world's biological resources can be found in underdeveloped regions of Asia and Africa, but 97% of the patents are held by multinational corporations (Knowles 2003). Recently, a project funded by the National Institutes of Health and the University of Georgia to inventory and evaluate plants and fungi in Chiapas, Mexico, was permanently derailed because the indigenous Maya Indians feared that the researchers would keep the profits, despite a stated plan by the researchers to return 25% of the profits to native villages (Southwick 2001). If indigenous peoples are to cooperate voluntarily with projects to exploit their knowledge, it must be within a framework of a regimen that protects their interests. Genetic entrepreneurs need to understand that

> No plant breeder or genetic engineer starts from scratch when they develop a new plant variety. They are building on the accumulated success of generations of farmers and indigenous people. Biotech companies claim that they "invented" their genetically engineered plants or new pharmaceuticals. In reality, they are fine-tuning and modifying plants that were developed by anonymous farmers and improved by the more recent contributions of institutional breeders. To claim exclusive monopoly control of these plants (or genes, or traits) is unjust and immoral. (Crucible II Group 2000)

Until recently, it was impossible to patent "products of nature" such as plants and animals. However, beginning with the rights of plant breeders to protect new varieties developed by traditional cross-breeding, that situation began to change. In 1980, the U.S. Supreme Court allowed the patenting of "non-naturally occurring" living substances.[3] The result is that "virtually any living thing that can be reproduced by human intervention has become patentable" (Knowles 2003).

It is important to understand the different kinds of protection of indigenous knowledge that are currently in contention. One cluster of concerns involves cultural knowledge (such as the rituals of Hopi religion) that the practitioners wish to keep secret. Another cluster involves the misuse of Indian names, art, and symbols to sell items that have little to do with the tribes, and for which they receive no compensation (Brown 2003). Traditional Western intellectual property regimes seem quite ill-suited as weapons of protection for this kind of knowledge and cultural property, as the rationale behind granting rights to intellectual property is to *foster* its dissemination and use.

A concern close to, but distinct from, the topic of this paper is the protection of indigenous scientific knowledge. Ethnobotanists, for example, have been having some success in using traditional herbal knowledge of healers and shamans to

[3] *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

"discover" plants that become marketable Western drugs. Here, the indigenous people's claim is to the discovery, not to the development, of the plant in question. We might call that "medicinal knowledge," rather than "genetic knowledge."

It is beyond the scope of this paper to lay out a plan of action to honor and protect traditional genetic knowledge. I leave that to colleagues more versed than I in the complexities of intellectual property law. However, examples abound of possible paths toward this end. The Mataatua Declaration on Cultural and Intellectual Property Rights of Indigenous Peoples (1993) calls on the United Nations to

> Recognise that Indigenous Peoples are capable of managing their traditional knowledge themselves, but are willing to offer it to all humanity provided their fundamental rights to define and control this knowledge are protected by the international community;
>
> and
>
> Insist that the first beneficiaries of indigenous knowledge (cultural and intellectual property rights) must be the direct indigenous descendants of such knowledge.

The Declaration includes a number of recommendations to indigenous peoples, states, international agencies, and the United Nations.

Lori Knowles (2003) points out that there are opposing strands of thought on protection of property rights in biological resources. The Trade-Related Aspects of Intellectual Property Rights (TRIPs) agreement, a product of the World Trade Organization, exhibits markedly different values from the 1998 United Nations Convention on Biological Diversity (CBD). The TRIPs agreement emphasizes protection of economic value, the pursuit of profit in a capitalist society, and individual property rights. The CBD, by contrast, is grounded in values of conservation, benefit sharing, and recognition of the value of communities. In addition, the CBD acknowledges and provides for compensation of indigenous peoples who have contributed to the development of plants that yield patentable properties. The CBD has been ratified by over 170 countries, but not yet by the United States.

International property rights systems are complex and difficult to navigate, and thus raise serious obstacles for indigenous and rural populations. Financial and technical assistance will surely be needed if goals of fairness are to be attained. Developing countries (and indigenous peoples within developed countries such as the United States) often lack access to this expertise. A new endeavor, Public Interest Intellectual Property Advisors, was created in 2002 to provide a Web-based referral service to improve the ability of developing countries to manage intellectual property in the public interest (Gollin 2003).

The Human Genome Project is a phenomenal endeavor of staggering proportions. Its possibilities for good (and ill) are beyond our imaginations. It in no way diminishes the scope of our modern genetic advances to understand the ways in which they are the next steps in a human journey of discovery that began before recorded history. In fact, to see ourselves as part of a "great chain of being," in which we follow in a path that our ancestors began, is to truly grasp the significance of the Project. One could call that understanding a salutary humility, but I would prefer to call it pride—the right kind of pride, the kind that rejoices in the limitless ingenuity and perseverance of the human race.

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