Coevolution: a Dietary Example

by Tracy Schwartz

This paper summarizes parts of William H. Durham's
Coevolution: Genes, Culture and Human Diversity

At the dawn of the human species, when all people were hunter-gatherers, milk was not available as a food source, except of course for mother's milk fed to infants. Even if it had been available, fresh milk would not have been very useful because only a tiny fraction of the adult population at that time were genetically capable of absorbing lactose, the sugar found in milk. Today the portion of adults who can absorb lactose and therefore can digest fresh milk varies widely from one culture to another, ranging from almost zero in some groups to almost one hundred percent in others. What could account for this striking diversity? If the ability to drink milk were a survival advantage, would it not be equally beneficial for everyone?

In his book *Coevolution*, William Durham presents his theory that human evolution is a *dual inheritance* system, where attributes are influenced by the transmission of both genetic and cultural factors. (Environment and chance also play important roles, but they are not transmitted between people and so are not classified as inheritance.) Durham uses the genetically inherited trait of lactose absorption to illustrate how genetic and cultural forces can influence each other in a mutual feedback process over time. The coevolution theory better explains and predicts the actual distribution of lactose tolerance in the world than a strictly genetic or strictly cultural theory can do.

Before discussing the lactose tolerance example in more detail, it is worth noting some important points in Durham's theory with regard to the Human Journey:

- **Diversity**: The result of evolution is diversity, not purification.

- **Transmission**: Culture is transmitted as *ideational* factors (knowledge, values, beliefs, concepts, social pressures) rather than directly as traits and behaviors. This transmission is *non-deterministic*; for example, people receiving the same teaching may accept it to different extents, may behave in different ways with respect to the teaching, and may choose to pass it on or not to do so.

- **Choice**: Also called *cultural selection*, choice is the single most important force in cultural change. Choices can be conscious or unconscious, and can be made by an individual, by a group, or imposed on a group by external agents. The liberty of an individual to make choices for himself ranges from none, in heavily restricted cultures, to a considerable degree in cultures where people have some autonomy. (However, Durham rejects the notion of an individual exerting completely "free choice" in any society.)

- **Constraint**: In addition to the restrictions imposed by societies on personal autonomy, the available choices are constrained by beliefs and preconceptions, genetics, technology, environment and chance.

- **Influence**: In a relatively autonomous society, the strongest influences on choice are *secondary values*. Primary values are produced by feedback from the nervous system, while secondary values are socially transmitted cultural standards, derived from primary values through experience, history and rational thought. Through secondary values, choices that were made in the past have continuing influence over subsequent choices.

Returning to the lactose tolerance example, we noted above that milk was not available as a food source for early hunter-gatherer societies. Furthermore, the complex process of lactose absorption in the human body is somewhat wasteful metabolically, and consequently that genotype would probably not have had a survival advantage at that time. In fact no other mammals to this day, including domestic cats, have significant numbers of adult lactose absorbers, so there were probably only a very few humans with the randomly-occurring gene.

The percentage of absorbers in the population would not have fluctuated much until circumstances arose in which that genotype had a positive or negative survival value. When some groups began herding animals and then later developed dairying technology, a *combination of cultural, genetic and environmental circumstances* could arise in which lactose absorption would become a survival advantage. A group in such circumstances could be described as follows:

- They already had a dairying culture and thus had access to fresh milk.
- At least some of their members were able to digest milk beyond infancy.
- Milk drinking was a nutritional benefit because the nutrients found in fresh milk were not sufficiently available from other sources.
- Their culture did not discourage milk drinking.

Over time, lactose absorbers in such a group would have survived at greater rates than malabsorbers. In other circumstances, however, no similar genetic selection would have occurred. The result was that certain dairying cultures influenced the genetic makeup of their own populations toward high rates of lactose absorbers, while other groups continued to have low numbers of absorbers. Both kinds of groups made choices such as whether to practice dairying and whether to encourage milk drinking, influenced (but not dictated) by their genetic and environmental circumstances and by their pre-existing cultural values.

A distinction is made in this theory between fresh milk and processed milk products such as cheese and yogurt, which are based on soured milk. Souring breaks down the lactose to produce food that can be digested by many malabsorbers. Therefore, consumption of

processed milk is important in some cultures with low numbers of lactose absorbers, for example, Mediterranean pastoral cultures with long histories of dairying.

It is believed that milk processing technology was invented almost as early as dairying began, since fresh milk sours quickly. Why then, if virtually all people could eat processed milk, would there have been genetic selection in some groups to favor drinking fresh milk, to the point where lactose absorbers became the majority genotype? The answer is that in those groups, lactose itself provided a nutritional benefit that was otherwise unavailable. Both fresh and processed milk are sources of calcium, which is essential for strong bone development. However, the absorption of calcium is made possible by other agents. One such agent is lactose, but only in lactose absorbing individuals.

Another such agent is vitamin D. People with sufficient sources of vitamin D can absorb the calcium in processed milk without the help of lactose. A main source of vitamin D is its production in human skin in the presence of UV-B radiation from the sun. It is therefore no surprise that in low-latitude regions where UV-B is plentiful, the lactose absorption genotype did not increase, even though some groups produced significant quantities of milk; for example, Greek Cypriots consume large amounts of cheese but are predominantly lactose malabsorbers. A notable increase in lactose absorption is seen above 25 to 30 degrees north or south latitude, where the amount of UV-B reaches a plateau as a result of the earth's axial tilt. (There are some important exceptions to the latitude correlation. For example, the Inuit of Greenland are predominantly malabsorbers but do not get vitamin D from UV-B exposure because of latitude, dark skin, and a climate which requires extensive clothing. Instead, their diet of seafood provides sufficient quantities of both calcium and vitamin D.)

Studies have shown that lactose plays a vital role in calcium metabolism in infants everywhere, regardless of whether vitamin D is plentiful or not. It is reasonable to conclude that, under the right circumstances, genetic selection favored the *extension* of lactose absorption beyond infancy when there were no other sufficient sources of calcium and vitamin D.

Studies show a correlation between the importance of milk consumption in a society and milk images in their mythology. Not surprisingly, myths in high lactose absorbing cultures contain images of nurturing with milk, female bovines, and special nutritional benefits of milk. For example, in Gaelic and Old Norse myths there are milk-fed gods and giants. Conversely, the myths of malabsorbing cultures do not contain such images.

Durham theorizes that genetic selection for lactose absorption would not have taken place without the cultural factors of dairying technology and the encouragement of milk drinking. Similarly, the more that milk was seen to be beneficial in a society, the more they would have come to value it and support it through dairying and dietary choice. The increased availability of milk, in turn, contributed further to genetic selection, and the pattern of mutual enhancement continued.

Both genetic and cultural diversity increase the chances that people will survive when conditions change, while a narrowly specialized population is vulnerable to any change that undermines its specialty. Because our environment varies over time and throughout the world, there can be no "perfect" strategy for survival that suits all groups in all places for all time. Lactose tolerance is an example of how the coevolutionary process results in diversity. If choices (changes) made by a group confer a survival advantage in particular circumstances, they may influence genetic selection in that group. And as the genetic makeup of the group changes to reflect that advantage, the cultural choices can in turn be reinforced, in a continuing pattern.