

The Search for the Seed of Lehi: How Defining Alternative Models Helps in the Interpretation of Genetic Data

Dean H. Leavitt, Jonathon C. Marshall, and Keith A. Crandall

A CULTURE'S LEVEL OF SCIENTIFIC UNDERSTANDING significantly influences how its religious texts are interpreted. The interplay between scientific discovery and scriptural understanding has been controversial throughout history. For example, the Catholic church's response to scholars who disproved the geocentric understanding of the universe is well known. The studies of geology, astronomy, and organic evolution have all caused numerous problems with literal interpretations of the Biblical account of creation. Similarly, the Book of Mormon, a sacred text for a number of American religions, has been subject to reinterpretation in light of new scientific understanding. Its particular account of the history of the American continent has been intensely examined since its introduction by Joseph Smith, Jr., in the mid-nineteenth century.

BACKGROUND ON THE BOOK OF MORMON

The current introduction of the Book of Mormon states that it is a record of God's dealings with two ancient civilizations of the Americas. The earliest group, known as the Jaredites, arrived in the western hemisphere shortly after God confounded the languages at the Tower of Babel (about 2200 B.C.E.). The other group came to the Americas after a prophet named Lehi was directed by God to leave Jerusalem in 600 B.C.E. with a small group that included his family (two of his sons were named Nephi and Laman) and others. Upon arriving in the "Promised Land" (the Americas), Lehi's party split into two groups: the Nephites and the Lamanites. The Book of Mormon also includes the people of Zarahemla, who similarly left the Near East around 600 B.C.E. This group is

often referred to as the "Mulekites" because it included Mulek, a son of the Jewish king Zedekiah. The Mulekites were assimilated by the Nephites sometime between 279 and 130 B.C.E. The Book of Mormon further relates a personal ministry of Jesus Christ to these New World inhabitants. The prophets of these groups recorded their history on a series of metal plates. Around 400 A.D., the final Nephite prophet—Moroni—buried the records, so they would be preserved. In 1823 Joseph Smith, the founder of Mormonism, claimed he had been visited by a resurrected Moroni who showed him where the plates were hidden. A few years later, Joseph was allowed to retrieve the plates and translate them by the power of God. The Book of Mormon is that translation.

The Book of Mormon is considered sacred scripture by many faiths, the largest of which is The Church of Jesus Christ of Latter-day Saints (LDS), and is fundamentally important to their beliefs. Joseph Smith stated that "the Book of Mormon was the most correct book of any book on earth, and the keystone of our religion."¹

The Controversy

The introduction to the current LDS version of the Book of Mormon claims that the principal ancestors of the American Indians are the Lamanites, one of the groups descending from Hebrew colonists that arrived in the Americas slightly after 600 B.C.E. However, physical similarities, cultural and linguistic ties, and archeological and molecular data all indicate a Siberian/Asiatic origin for Native Americans, not a Hebrew one.² Molecular data, specifically DNA sequence data, have been particularly useful in illustrating the Siberian/Northeast Asian source for indigenous Americans. This apparent discrepancy has obvious significance to the LDS church, whose evangelization of Amerindian peoples is heavily tied to a particular interpretation of the Book of Mormon.

Recently, this controversial issue has received significant media attention.³ After reviewing the published data, one researcher concluded that the Book of Mormon—and the concept of Lamanite ancestry for Amerindians—is best understood as a work of fiction that originated in the cultural/religious milieu of

1. Joseph Smith, *History of the Church* (Salt Lake City: Deseret Book Co., 1973 edition), 4:461.

2. Jason A. Eshleman, Ripan S. Malhi, and David Glenn Smith, "Mitochondrial DNA Studies of Native Americans: Conceptions and Misconceptions of the Population Prehistory of the Americas," *Evolutionary Anthropology* 12, no.1 (2003): 7-18.

3. W. Lobdell Stammer and L. B. Stammer, "Mormon Scientist, Church Clash over DNA Test: Anthropologist May Be Ousted for Questioning Teachings about Native Americans," *LA Times*, December 8, 2002. See also P. Anderson, "Disciplinary Hearing for Mormon Writer Postponed Indefinitely," Associated Press article in the *Seattle Post-Intelligencer*, December 8, 2002, <http://seattlepi.nwsource.com/local/>.

early nineteenth-century New England.⁴ Naturally, this conclusion is discordant with traditional LDS theology and has put LDS apologists on the defensive. It has been argued that this conclusion oversteps the data and fails to take into consideration Book of Mormon scholars' current understanding of the book.⁵ Until this point, the genetic data have not been considered in relation to explicit models of Book of Mormon colonization. The aim of this paper is to present different models that have been suggested for the Book of Mormon and address them in relation to the available genetic data. This paper cannot address every suggested model, and admittedly the models presented in this paper may be over-simplified. However, these models attempt to accurately represent the principal suggested scenarios. Our intent is not to defend any particular perspective of the Book of Mormon, but rather to clarify the issue by an explicit description of a number of Book of Mormon models and the implications of the current genetic data for each.

MODELS OF BOOK OF MORMON COLONIZATION: MODELS THAT DO NOT ASSUME A PRE-BOOK OF MORMON ASIATIC COLONIZATION

"And behold, it is wisdom that this land should be kept as yet from the knowledge of other nations; for behold, many nations would overrun the land, that there would be no place for an inheritance" (2 Nephi 1:8).

Traditional Hemispheric Model (T.H.M. Model)

The traditional model of Book of Mormon colonization is a hemispheric one—"traditional" because it is the model that has been most commonly taught historically and continues to be accepted by the majority of LDS members and leaders. In this scenario, two very small groups (probably <50 people, many of whom were members of the same family), the "Lehites" and "Mulekites," arrived somewhere in North or South America around 600 B.C.E. All Native Americans are assumed to have descended from these colonizers. While the Mulekites had contact with the sole survivor of the earlier Jaredite population (who had arrived earlier in the Americas, ~2200 B.C.E.), the Jaredites otherwise died out and had no input into the genetic component of contemporary Native Americans. The concept that the lands of the Book of Mormon include the entire Western Hemisphere is derived from a number of in-text references, including those to geographical features like the "land northward," the "land southward," and a "narrow neck of land," which have long been interpreted as North America, South America, and the Isthmus of Panama (Darien), respectively.

4. Thomas W. Murphy, "Lamanite Genesis, Genealogy, and Genetics," in Dan Vogel and Brent Lee Metcalfe, eds., *American Apocrypha: Essays on the Book of Mormon* (Salt Lake City: Signature Books, 2002).

5. Michael F. Whiting, "DNA and the Book of Mormon: A Phylogenetic Perspective," *Journal of Book of Mormon Studies* 12, no. 1 (2003): 24-35.

Statements by various church leaders and interpretations of many LDS scriptures also support this model. In a divine revelation for Oliver Cowdery, delivered through Joseph Smith, Jr., and recorded in the Doctrine and Covenants, the Lord states, "I say unto you that you shall go unto the Lamanites and preach my gospel unto them" (D&C 28:8). Here "Lamanites" refers to the native tribes of eastern North America. The Lord also later commands Joseph Smith and his followers to flee "unto the regions westward, unto the land of Missouri, unto the borders of the Lamanites" (D&C 54:8). Here "Lamanites" were also understood to be the Native American tribes living on the western frontier that was then Missouri.

Other quotes attributed to Joseph Smith give additional support for this model. For example, on one occasion while traveling in the Mississippi River drainage, Smith and some of his followers encountered a Native American burial. Upon observation of the remains, Joseph proclaimed that the skeleton was that of Zelf, a white Lamanite.⁶ Statements such as this indicate that Joseph Smith, Jr., and his contemporaries considered Native Americans throughout the western hemisphere to be descendants of the Lamanites.

The following statements by Spencer Kimball, the LDS church's twelfth president, are representative of traditional LDS understanding:

With pride I tell those who come to my office that a Lamanite is a descendant of one Lehi who left Jerusalem six hundred years before Christ and with his family crossed the mighty deep and landed in America. And Lehi and his family became the ancestors of all Indian and Mestizo tribes in North and South and Central America and in the islands of the sea, for in the middle of their history there were those who left America in ships of their making and went to the islands of the sea.

Not until the revelations of Joseph Smith, bringing forth the Book of Mormon, did any one know of these migrants. It was not known before, but now the question is fully answered. Now the Lamanites number about sixty million; they are in all the states of America from Tierra del Fuego all the way up to Point Barrows, and they are in nearly all the islands of the sea from Hawaii south to southern New Zealand. The Church is deeply interested in all Lamanites because of these revelations and because of this great Book of Mormon, their history that was written on plates of gold and deposited in the hill. The translation by the Prophet Joseph Smith revealed a running history for one thousand years—six hundred years before Christ until four hundred after Christ—a history of these great people who accompanied this land for those thousand years. Then for the next fourteen hundred years, they lost much of their high culture. The descendants of this mighty people were called Indians by Columbus when he found them here.⁷

6. Kenneth W. Godfrey, "The Zelf Story," *BYU Studies* 29, no. 2 (1989): 32-56.

7. Spencer W. Kimball, "Of Royal Blood," *Ensign* 1 (July 1971): 7-10.

The current LDS president, Gordon Hinckley, made the following remark during the dedication of a temple in Guayaquil, Ecuador:

[I]t has been a very interesting thing to see the descendants of Father Lehi in the congregations that have gathered in the temple. So very many of these people have the blood of Lehi in their veins and it is just an intriguing thing to see their tremendous response and their tremendous interest.⁸

Clearly, many LDS leaders have taught the hemispheric model, so it should be no surprise that this is the scenario accepted by the majority of church members. Students of the Church Education System learn that "In addition to being descendants of Jews in a national sense, there is also a blood relationship among the modern Lamanites."⁹ Further evidence that this interpretation has been the historically sanctioned view is the introduction found in the current edition of the Book of Mormon. This document of unspecified origin and authorship first appeared in the 1981 edition of the Book of Mormon and explicitly states that the Lamanites are the "principle ancestors of the American Indians."

Hemispheric Model with Jaredite Remnants (H.M.J.R. Model)

Some Mormon scholars are skeptical that all Native Americans could have descended exclusively from the Lamanites. The variety and number of Native American languages indicated that people had lived in the Americas long before Lehi's party first arrived in the New World.¹⁰ The Jaredites seemed like the natural answer to the "pre-Lehite" populations. While the traditional model implied that the Jaredites were almost entirely killed off in a war of annihilation, Nibley has suggested a different model, according to which many Jaredites survived to perpetuate a strong Asiatic element in the culture and blood of the American Indian.¹¹

The place and time of origin of the Jaredites is not explicitly stated in the Book of Mormon, as it is with Lehi's group and the Mulekites. Emerging from the resulting confusion of the Tower of Babel, they are usually dated at about 2200-2100 B.C.E.¹² While this group most likely originated from somewhere in Mesopotamia (modern Iraq), Nibley has suggested that the Jaredites migrated east through the steppe region of Asia.¹³ As they journeyed, they likely assimilated

8. Gordon B. Hinckley, 1999, <http://www.ldschurchtemples.com/cgi-bin/pages.cgi?guayaquil&geographical>. See also *Church News*, August 7, 1999.

9. *Book of Mormon Student Manual: Religion 121 and 122* (Salt Lake City: The Church of Jesus Christ of Latter-day Saints, 1989), 41.

10. Brigham H. Roberts, *Studies of the Book of Mormon*, ed. B. Madsen (Salt Lake City: Signature Books, 1992).

11. Hugh Nibley, *Lehi in the Desert; The World of the Jaredites; There Were Jaredites*, in J. W. Welch, ed., *The Collected Works of Hugh Nibley*, vol. 5 (Salt Lake City: Deseret Book Co., 1988).

12. See the *Book of Mormon Student Manual*, cited previously.

13. Nibley, *Lehi in the Desert*.

lated into their group a number of individuals from the different regions. By the time they reached the eastern coast of Asia, the composition of the Jaredite group could have significantly altered from what it had been when they left their place of origin, including more "steppe" Asians (e.g., Mongolians) than Mesopotamians. As these immigrants came to the New World in a small group of barges, the founding population would have been small, but then quickly expanded. While Nibley states, "It is nowhere said or implied that even the Jaredites were the first to come here,"¹⁴ in this model we will assume they were the first for simplicity's sake.

MODELS THAT ASSUME A PRE-BOOK OF MORMON ASIATIC COLONIZATION

Generic Limited Geography with Admixture 34 AD (G.L.G.A. Model)

In addition to the linguistic evidence (~1,500 Native American languages), the growing archaeological evidence of Asian migrations across the Bering Strait into the Americas that certainly pre-dated the Jaredites necessitated a change from the traditional hemispheric model.¹⁵ Geographic clues from the text of the Book of Mormon (e.g., time required to travel between cities) indicate an area of perhaps several hundred square miles—a significantly smaller scale than that required by the hemispheric model. A number of candidates for Book of Mormon lands have been proposed, such as the Finger Lakes region of New York.¹⁶ However, the most popular region suggested for the Book of Mormon lands has been Central America.

The Book of Mormon Student Manual, prepared by the Church Education System,¹⁷ provides a commonly accepted model of the Lehites: Soon after their arrival to the New World, Lehi's descendants split into two groups, those who followed Nephi and those who followed Laman. The Book of Mormon teaches that God bestowed a "sore cursing" upon the Lamanites, which was designated by a "skin of blackness" (2 Nephi 5:21). God discouraged the Nephites from mingling with the cursed Lamanites by promising the same curse upon "the seed of him that mixeth with their [Lamanites'] seed" (2 Nephi 5:23). Daniel Peterson, a researcher at FARMS (Foundation for Ancient Research and Mormon Studies), discussed a possible mechanism of this curse:

Of course we don't know exactly what the mechanism of that "curse" in quotes, was. It may well have been something like inter-marriage of the original descendants of

14. *Ibid.*, 249.

15. Earl M. Wunderli, "Critique of a Limited Geography for Book of Mormon Events," *Dialogue: A Journal of Mormon Thought* 35, no. 3 (Fall 2002): 161-97.

16. Phyllis C. Olive, *Lost Lands of the Book of Mormon* (Springville, Utah: Cedar Fort, 2000).

17. *Book of Mormon Student Manual*, cited previously.

Laman with the populations out there coming from groups that we know nothing about. Presumably the Nephites would have been careful about not marrying outside of the covenant. But I don't know if Laman and Lemuel cared all that much about such things. One striking thing is that very early in the Book of Mormon, very, very soon, the Lamanites vastly outnumber the Nephites which makes you think that something funny has gone on there. Unless they've had some really unprecedented population boom.¹⁸

In this scenario, the Lehite colonists did not arrive to an empty continent; the land was already inhabited by a large resident population of Asiatic/Siberian origin whose skin color was darker than their own. The new colonizers had a founding population of Middle Eastern (Hebrew) descent that underwent a significant population expansion as they multiplied in the land (2 Nephi 5:14). This group split, with the Lamanites intermarrying with the native population and the Nephites avoiding intermarriage. Of course, it must be remembered that the Nephites merged with the Mulekites, who were also purportedly of Israelite origin and colonized at about the same time. For the sake of this model and in consideration of the Nephites' alleged aversion to intermarrying with the darker-skinned Lamanites, one must assume the Mulekites had experienced little or no admixture with the native Amerindian population before they merged with the Nephite population.

After the schism, the Nephites essentially remained distinct from the Lamanites until the visitation of Jesus Christ (although various small groups of Nephites did defect to the Lamanites before that) at about 34 A.D. Following this visitation, there was no distinction between Nephites and Lamanites for almost two hundred years: "There were no . . . Lamanites, nor any manner of -ites; but they were in one, the children of Christ" (4 Nephi 1:17), and "the two lines [Nephites and Lamanites] had become as one" (Larson 1966). Importantly this meant that the once relatively pure gene pool (the sum total of the genetic material of a population) of the Nephites would have mixed with the Lamanites who by now would have been primarily composed of people from the original Siberian/Asiatic populations. At this point (around 201 A.D.), those who broke away from the church took on the name of Lamanites. This was apparently an ideological/political designation and not one of ancestry: "It is significant that the name 'Lamanite' here appears to become a generic term. That is, it refers to a general classification of people—those who revolted from the church. These people may or may not have been the direct descendents of Laman and Lemuel."¹⁹ These "new" Lamanites, with their mixture of Hebrew and Siberian genes, would then become the principal ancestors of contemporary Native Americans.

18. Daniel Peterson, August 12, 2003, http://tungate.com/whiting_panel.htm.

19. Dean L. Larson, *You and the Destiny of the Indian* (Salt Lake City: Bookcraft, 1966).

The Limited Tehuantepec Model (L.T.M. Model)

John L. Sorenson's *An American Setting for the Book of Mormon* has been perhaps the most influential work in establishing a concrete model for Book of Mormon geography.²⁰ Sorenson's model is essentially the only current hypothesis with any consensus of support from those Book of Mormon scholars who defend the historicity of the book. This model identifies the Isthmus of Tehuantepec as the "narrow neck of land," the Mexican states of Oaxaca and southern Veracruz as the "land northward," and the Mexican states of Chiapas and Tabasco along with Guatemala forming the "land southward."

With this model, the three immigrating groups mentioned by the Book of Mormon would have arrived at an already inhabited continent. Population growth within both groups of Lehi's descendants would indicate recruitment from a pre-existing native population.²¹ The Jaredites were a relatively small group that would have been assimilated by, or would themselves have assimilated, surrounding peoples (again, ~2200 B.C.E.). Sorenson and others link the Jaredites to the Olmec culture in southern Veracruz. Lehi's party contained around seven couples, a small number of single adults and an undisclosed number of children.²² Both Nephites and Lamanites would have incorporated native peoples into their respective tribes.

The record on the Mulekites is also scant. In Sorenson's model, Mulek arrived via a Phoenician ship(s) with a crew of more than twenty men.²³ Sorenson says nothing is known about women on board, but he seems to suggest there would have been few if any, and the crew would have been ethnically heterogeneous. Of the crewmen, Sorenson states, "their genes would have continued only by their finding native women in the new land."²⁴

While not part of Sorenson's own views of the Mulekites, a variation of his model would minimize genetic input from the Near East even more. It has been suggested that the Mulekites were not actual descendants of Judeo-Phoenician immigrants, but were natives who invented the story of descending from King

20. John L. Sorenson, *An American Setting for the Book of Mormon* (Salt Lake City: Deseret Book Co., 1985).

21. John L. Sorenson, "When Lehi's Party Arrived in the Land, Did They Find Others There?" *Journal of Book of Mormon Studies* 1, no. 1 (Fall 1992): 1-34; James E. Smith, "Nephi's Descendants? Historical Demography and the Book of Mormon," in Daniel C. Peterson, ed., *Review of Books on the Book of Mormon* (Provo, Utah: Foundation for Ancient Research and Mormon Studies, 1994); James E. Smith, "A Study of Population Size in the Book of Mormon," paper read at FARMS Book of Mormon Lecture Series, 1994; John C. Kunich, "Multiply Exceedingly: Book of Mormon Population Sizes," in Brent Lee Metcalfe, ed., *New Approaches to the Book of Mormon* (Salt Lake City: Signature Books, 1993).

22. Sorenson, "When Lehi's Party Arrived."

23. John L. Sorenson, "The Mulekites," *BYU Studies* 30, no. 3 (Summer 1990): 6-22.

24. *Ibid.*, 10.

Zedekiah in an attempt to establish the right to rule.²⁵ This practice has a precedence in Mesoamerica, as seen when the Aztecs claimed Toltec ancestry to validate their position of power.

The L.T.M. model specifies a particular geographic region for the Book of Mormon peoples. It should be noted that many different models of limited geography could be proposed. One non-testable (genetically, archeologically, linguistically, etc.) model would be that of limited geography with no specified geographical region. Since this is a non-testable model, it will not be part of our review.

GENETIC PREDICTIONS

Genetic Markers and Theory

Genetic data can be used to investigate the origin, time, and size of the Americas' founding population(s). The question of origin is addressed by surveying the genetic material of Native American populations (both modern and ancient) and determining which regions of the world share more closely related genes. It is assumed that populations with more similar genetic material are also more closely related and share a more recent common ancestor. The time and size of a colonizing population are investigated by assessing the genetic variation of contemporary Native American populations. Other factors, such as the movement of genes from one population to another, population sizes, and the associated random sampling errors, etc. can affect estimates of variation, so studies of these types must take these effects into consideration. The general assumption is that smaller founding populations, as well as more recent colonizing events, will give rise to contemporary populations with much smaller genetic variation. Therefore, large founding populations and colonizing events in the more distant past give rise to populations with higher genetic variation.

Another body of theory is also used when estimating colonization dates, one that can be described as a backwards-looking gene genealogy. It uses mutation rates and the sum of genetic differences to estimate the time of divergence between two alternative forms of the same gene. This estimation is commonly known as coalescent time.²⁶ The complexity of population histories can give rise to a diverse array of genetic patterns, but genetic studies have proven quite useful, especially when used in concert with other independent evidence, such as archeological data, when investigating general large-scale events in a popula-

25. Orson Scott Card, "The Book of Mormon—Artifact or Artifice?" from a speech given at the BYU Symposium on Life, the Universe, and Everything Else, February 1993, <http://www.nauvoo.com/library/bookofmormon.html>.

26. R. R. Hudson, "Gene Genealogies and the Coalescent Process," in P. H. Harvey and L. Partridge, eds., *Oxford Surveys in Evolutionary Biology*, vol. 7 (Oxford: Oxford University Press, 1990), 1-44.

tion's history.²⁷ Some of the above models predict such general large-scale events with predictable patterns of genetic structure.

The two markers most commonly used in studies of human population genetics, including the study of Native Americans, are mitochondrial DNA (mtDNA) and the Y-chromosome. As opposed to the vast majority of our nuclear genes, neither of these genetic markers recombines (mixes sections of genetic material during the formation of sex cells). This provides a number of advantages when one is using these markers to detect population history, but their mode of inheritance prevents a complete genealogical reconstruction. Mitochondrial DNA only allows reconstruction of the maternal line, and the Y-chromosome the paternal line. Recently scientists have begun to use fast-evolving nuclear markers such as microsatellites and single nucleotide polymorphisms in conjunction with these traditional markers. This has resulted in an impressive arsenal of diverse molecular tools that can be used to address questions of population's movements, relationships, origins, etc.

Assumptions of Genetic Makeup

One potential problem in testing the above hypotheses is that we must make assumptions about the genetic makeup of the immigrant parties. Uncertainty over the exact genetic makeup of Lehi's party has led some to suggest that this lack of knowledge presents a considerable obstacle in resolving the Book of Mormon controversy.²⁸ While the genetic data reflect the Middle East's crucial role in human dispersal,²⁹ Y-chromosome data have revealed remarkable genetic continuity among both contemporary Jewish populations as well as their historic Middle Eastern neighbors.³⁰ The Book of Mormon gives little or no reason to suppose that the genetic makeup of Lehi's group was drastically different from that of other Middle Eastern groups historically or contemporarily.

Genetic Predictions of Models

We are now in a position to address specific predictions of the four general models of Book of Mormon history. The predictions that follow are the most likely results of the given models. As mentioned above, all possible scenarios can not be addressed, and random sampling events such as occur with genetic drift and founder effect can result in less probable results. However, our predictions are based on the principle of parsimony and address only the more likely results.

27. Eshleman et al., "Mitochondrial DNA Studies."

28. Brant Gardner, "The Tempest in a Teapot: DNA Studies and the Book of Mormon," <http://www.fairlds.org/apol/bom/bom/bom07.html>.

29. N. Al-Zahery, et al. "Y-chromosome and not DNA polymorphisms in Iraq, a crossroad of the early human dispersal and of post-Neolithic migrations," *Molecular Phylogenetics and Evolution* 28, no. 3 (September 2003): 458-472.

30. Almut Nebel, et al. "The Y Chromosome Pool of Jews as Part of the Genetic Landscape of the Middle East," *American Journal of Human Genetics* 69, no. 5 (November 2001): 1095-1112.

First, in the T.H.M. model of Book of Mormon colonization, the expected genetic make-up of Native Americans is straightforward (Table 1). Genetic markers should show affinity to modern Jewish and/or other Middle Eastern populations. The colonization of an entire continent from such a small group of immigrants in the relatively recent past (~ 600 B.C.E.) should result in extremely low estimates of genetic variation, and estimates of the peopling of the New World should be in the neighborhood of 2,500 years before present (Y.B.P.).

The predictions of the H.M.J.R. model are not as straightforward (Table 1). This model is less clear on the ethnic make-up of the colonizing Jaredites. Nibley has suggested that the Jaredite colonizing population had significant contact with Asiatic people during their long journey to the Western Hemisphere.³¹ Possible gene flow into the population could have given it a mixed genetic signature such that one would expect to find DNA in current Native American populations resembling both Middle Eastern and "Asian steppe" markers (Table 1). Like the first hemispheric model the founding population of Jaredite colonization model is also relatively small and in the recent past (~ 2200 B.C.E.). However, according to this model, Lehi's party could have contributed to the genetic make-up of the founding Jaredite population when they arrived some 1,500 years later. It is uncertain how much Lehi's party would have contributed, because few references to Jaredite population size at that time exist. A significant genetic contribution from Lehi's party would have increased both the genetic variation and proportion of Middle Eastern genes in the current Native American population. Variation within founding gene types due to mutation since colonization would again point to two relatively recent immigrations.

With the G.L.G.A. model, the admixture of several hundred thousand Middle Easterners with a larger native population derived from ancient Siberian stock two thousand years ago would likely be detectable (Table 1). While the size of the "native" Siberian population was significantly larger than that of the Nephite culture and would affect the frequency of the Middle Eastern markers, it is highly probable that such Middle Eastern markers would still be present at some detectable frequency level. How densely one must sample to detect this marker, however, depends on population sizes at the time of admixture. An estimate of genetic variation for this model would reflect more the timing and size of the founding Asiatic population, rather than the Book of Mormon populations of interest. Estimates of the time of colonization should, at a minimum, predate the arrival of Book of Mormon peoples.

DNA data are much less useful in investigating the L.T.M. model, because the historical events of this model occurred on a much smaller scale. Book of Mormon events and people would have been largely overshadowed by the much larger and widespread native Asiatic population. With such small parties inte-

31. Nibley, *Lehi in the Desert*.

Table 1
A Summary of Predictions for Genetic Data from Various
Common Book of Mormon Models

| Model | Origin of Genes | Size of Founding Populations | Timing of Colonization |
|--|---|---|---|
| Traditional hemispheric model | Genetic material should be most closely related to Middle Eastern genes | Small founding population should result in low genetic variation among descents | Relatively recent colonization ~ 2,500 YBP ¹ |
| Hemispheric model with Jaredite remnants | Genetic material should be predominately Middle Eastern with some Asiatic genes | Small founding population should result in low genetic variation | Relatively recent colonization ~ 4,700 YBP |
| Generic limited geography with admixture 34 A.D. model | Genetic material should be predominately Asiatic with some Middle Eastern genes | Should represent size of migrating Asiatic populations for which the Book of Mormon makes no prediction | Should represent timing of Asiatic colonization, but should at least predate Book of Mormon peoples (~ 4,700 YBP) |
| Limited Tehuantepec model | Genetic material should be overwhelmingly Asiatic with some possible Middle Eastern DNA in the Tehuantepec area | Should represent size of migrating Asiatic populations for which the Book of Mormon makes no prediction | Should represent timing of Asiatic colonization, but should at least predate Book of Mormon peoples (~ 4,700 YBP) |

1. YBP = years before present

grated into a larger population of natives descended from northeastern Asia, Middle Eastern markers would either exist in very low frequencies or would be lost altogether. If this were the case, a researcher would not expect to find much Middle Eastern DNA in current Native American populations. It is even possible that a researcher may never find Middle Eastern DNA, regardless of sampling intensity. Under this scenario, Book of Mormon people would have had little effect on the genetic variation of current Native American populations, and colonization dates would again reflect the original migration(s) from Asia rather than Book of Mormon peoples (Table 1). In this paper, we deliberately avoid the debate on whether this model accurately reflects Book of Mormon history³² and instead comment only on the implications, if any, that DNA evidence has for this model.

AVAILABLE GENETIC DATA

One reason relationships among groups of people are difficult to discern using genetic data is the ubiquity of genetic interchange between human populations.³³ Human genetic differences are relatively small, and gene flow compounds the issue. Despite these problems, DNA evidence has confirmed archeological, linguistic, etc. data for an Asian origin for Native Americans.³⁴ Five principal haplogroups of mtDNA have been found in the New World: A, B, C, D and to a lesser extent, X, all of which connect North America with Eastern and Central Asian regions.³⁵ While debates rage over the number of migrations to the New World and the specific Asiatic region of origin for each of these migra-

32. Wunderli, "Critique of a Limited Geography."

33. Alan R. Templeton, "Out of Africa Again and Again," *Nature* 416 (March 2002): 45-51.

34. Antonio Torroni et al., "mtDNA and Y-Chromosome Polymorphisms in Four Native American Populations from Southern Mexico," *American Journal of Human Genetics* 54, no. 2 (1994): 303-18; Theodore G. Schurr, "Mitochondrial DNA and the Peopling of the New World," *American Scientist* 88 (May-June 2000): 246-53; Murphy, "Lamanite Genesis"; Eshleman et al., "Mitochondrial DNA Studies."

35. D. C. Wallace, K. Garrison, and W. C. Knowler, "Dramatic Founder Effects in Amerindian Mitochondrial DNAs," *American Journal of Physical Anthropology* 68, no. 2 (October 1985): 149-56; Theodore G. Schurr et al., "Amerindian Mitochondrial DNAs Have Rare Asian Mutations at High Frequencies, Suggesting They Derived from Four Primary Maternal Lineages," *American Journal of Human Genetics* 46, no. 3 (1990): 613-23; Joseph G. Lorenz and David Glenn Smith, "Distribution of Four Founding mtDNA Haplogroups among Native North Americans," *American Journal of Physical Anthropology* 101 (November 1996): 307-23; Michael D. Brown et al., "mtDNA Haplogroup X: An Ancient Link between Europe/Western Asia and North America?" *American Journal of Human Genetics* 63 (December 1998): 1852-61; Smith et al., "Distribution of mtDNA Haplogroup X among Native North Americans," *American Journal of Physical Anthropology* 110 (November 1999): 271-84; Miroslava V. Derenko et al., "The Presence of Mitochondrial Haplotype X in Altians from South Siberia," *American Journal of Human Genetics* 69 (July 2001): 237-41; Ripan S. Malhi et al., "The Structure of Diversity within New World Mitochondrial DNA Haplogroups: Implications for the Prehistory of North America," *American Journal of Human Genetics* 70 (April 2002): 905-19.

tions, virtually no evidence exists to support a Middle Eastern connection.³⁶ Notably, Southerton has reviewed data from forty-six scientific papers and found that nearly all Native American maternal DNA originated in Asia and are unrelated to Israelite maternal lineages.³⁷

Studies of genetic variation have produced a variety of coalescence times and colonization dates, with relatively large confidence intervals. This variation results partly from the selected markers and methods used to calculate molecular divergence and molecular clocks. This process is problematic when trying to determine very specific historical events but can be effective for more general estimates of historical events. In the above models, both the T.H.M. and the H.M.J.R. models couple small colonizing populations with relatively recent colonization events. This should result in at least some recent estimates of colonization dates. Therefore, estimates of colonization should prove useful in determining the validity of these two models. Using 574 mtDNA control region sequences, Forster et al. estimated the major migratory wave occurred 20,000-25,000 years ago.³⁸ Stone and Stoneking used ancient DNA from 108 individuals who lived around 700 years ago and concluded there was a single wave with a signature of expansion 23,000-37,000 years ago.³⁹ Starikovskaya et al. hypothesized that the first humans expanded into the Americas ~34,000 YBP, with a second wave coming in 13,000-16,000 YBP.⁴⁰ Lell et al. also found support for two Siberian migrations based on the Y chromosome.⁴¹ Also of interest, Ward et al. found considerable diversity in one Northwestern tribe that predates their entry into the Americas; they conclude that the data don't support a dramatic founder effect during the peopling of the Americas.⁴² Table 2 summarizes a number of these studies.

Estimating specific population sizes from the available genetic data may prove difficult due to the above reasons. Coupled with the fact that the Book of

36. Eschleman, "Mitochondrial DNA Studies."

37. Simon Southerton, "Re: Lamanite DNA," e-mail to Dean Leavitt, January 23, 2003. See also Southerton, *Losing a Lost Race* (Signature Books, in press).

38. Peter Forster, Rosalind Harding, Antonio Torroni, and Hans-Jurgen Bandelt, "Origin and Evolution of Native American mtDNA Variation: A Reappraisal," *American Journal of Human Genetics* 59 (October 1996): 935-45.

39. Anne C. Stone and Mark Stoneking, "mtDNA Analysis of a Prehistoric Oneota Population: Implications for the Peopling of the New World," *American Journal of Human Genetics* 62 (May 1998): 1153-70.

40. Yelena B. Starikovskaya et al., "mtDNA Diversity in Chukchi and Siberian Eskimos: Implications for the Genetic History of Ancient Beringia and the Peopling of the New World," *American Journal of Human Genetics* 63 (November 1998): 1473-91.

41. Jeffrey T. Lell et al., "The Dual Origin and Siberian Affinities of Native American Y Chromosomes," *American Journal of Human Genetics* 70 (January 2002): 192-206.

42. R. H. Ward, Barbara L. Frazier, Kerry Dew-Jager, and Svante Paabo, "Extensive Mitochondrial Diversity within a Single Amerindian Tribe," *Proceedings of the National Academy of Sciences of the United States of America* 88, no. 19 (October 1, 1991): 8720-24.

Table 2
Range of Colonization Dates Estimated from
mtDNA Haplogroups¹

| Study of Haplogroups | Range of Estimated Colonization Dates |
|-----------------------------|--|
| Torrioni et al. 1994 | |
| Haplogroup A | 25,862-34,091 YBP ² |
| Haplogroup B | 11,724-15,456 YBP |
| Haplogroup C | 33,105-43,636 YBP |
| Haplogroup D | 18,276-24,091 YBP |
| Schurr et al. 1999 | |
| Haplogroup A | 26,969-35,550 YBP |
| Haplogroup B | 13,483-17,773 YBP |
| Haplogroup C | 40,972-54,009 YBP |
| Haplogroup D | 19,483-25,682 YBP |
| Forster et al. 1996 | |
| Haplogroups A, B, C, D | 19,180- 21,180 YBP |
| Horai et al. 1996 | |
| Haplogroups A, B, C, D | 14,000-21,000 YBP |
| Brown et al. 1998 | |
| Haplotype X | 12,000-17,000 or 25,000-57,000 YBP |
| Stone and Stoneking 1998 | |
| Haplogroup A | 12,000-30,000 or 25,000-57,000 YBP |
| Haplogroup B | 8,000-21,000 or 16,000-41,000 YBP |
| Haplogroup C | 6,000-21,000 or 13,000-40,000 YBP |
| Haplogroup D | 9,000-27,000 or 19,000-51,000 YBP |

1. Table is redrawn from Eshleman et al. 2003.

2. YBP = years before present

Mormon makes teasing out population numbers from the text very problematic,⁴³ the task of estimating population size (as opposed to estimating the origin and colonization dates of Native American peoples) becomes less promising with regard to insights that might be gained from genetic data. The inadequacies of estimating population sizes based on archaeological data also compound the issue.

IMPLICATIONS OF GENETIC DATA

Genetic data are most useful when used in conjunction with cultural, archeological, and linguistic data.⁴⁴ The T.H.M. and the H.M.J.R. models both predict a relatively recent colonization by smaller populations that would contain predominately or exclusively Middle Eastern DNA. Based on genetic studies to date, these models are highly improbable. No significant link between Middle Eastern and indigenous Native American genes has been discovered. None of the estimates of colonization dates is concordant with the 2,500-4,500 Y.B.P. predicted by these two models (Table 2). The genetic evidence in conjunction with the abundant archeological evidence pre-dating 4,500 Y.B.P. make fairly certain conclusions against the plausibility of these first two models. Table 3 summarizes conclusions for each of the four general Book of Mormon models. Neither model that assumes a pre-Book of Mormon Asiatic colonization is seriously threatened by the deeper colonization dates, as these dates would reflect an early Asiatic arrival. The strong relationship between Native American DNA and Asian DNA poses less of a problem for the L.T.H. model than it does for the Generic Limited Geography model.⁴⁵ The L.T.H. model reduces Book of Mormon peoples to minor players in the continent's archaeological history and to nearly non-contributors to the continent's gene pool. Under this model, Middle Eastern DNA would not necessarily be found because of its limited nature. It should be remembered, however, that genetics represents only one approach to testing models. This theory may in fact have other significant shortcomings.⁴⁶ Under the G.L.G.A. model, one would expect a much larger potential contributor of Middle Eastern DNA. Although no Middle Eastern DNA has yet been found

43. James E. Smith, "Nephi's Descendants?" and "A Study of Population Size," both cited previously; John C. Kunich, "Multiply Exceedingly: Book of Mormon Population Sizes," in Brent L. Metcalfe, ed., *New Approaches to the Book of Mormon* (Salt Lake City: Signature Books, 1993).

44. Eshleman, "Mitochondrial DNA Studies."

45. Murphy, "Lamanite Genesis."

46. Dan Vogel, *Indian Origins and the Book of Mormon* (Salt Lake City: Signature Books, 1986); see also "Dan Vogel's Reply to Kevin Christensen," http://www.xmission.com/~research/central/reply.htm#N_51_; Grant H. Palmer, *An Insider's View of Mormon Origins* (Salt Lake City: Signature Books, 2002); John L. Sorenson, "Viva Zapato! Hurray for the Show!" in Daniel C. Peterson, ed., *Review of Books on the Book of Mormon* (Provo, Utah: Foundation for Ancient Research and Mormon Studies, 1994); Deanne G. Matheny, "Does the Shoe Fit? A Critique of the Limited Tehuantepec Geography," in Brent L. Metcalfe, ed., *New Approaches to the Book of Mormon* (Salt Lake City: Signature Books, 1993); Wunderli, "Critique of a Limited Geography."

Table 3
Summary of Genetic Implications for
Each of the General Book of Mormon Models

| Model | Origin of Founding Population | Timing and Size of Founding Population |
|--|---|---|
| Traditional Hemispheric Model | Predicts a Middle Eastern origin. DNA evidence indicates a Middle Eastern origin highly improbable. | Genetic diversity of Native Americans and estimated colonization dates argue strongly against a colonizing event by a small population ~ 2,500 YBP |
| Hemispheric Model with Jaredite Remnants | Predicts a Middle Eastern/Asiatic origin dominated by Middle Eastern DNA. DNA evidence collected until now makes this model unlikely but not impossible. | Genetic diversity of Native Americans and estimated colonization dates argue against a colonizing event by a small population ~ 4,500 YBP |
| Generic Limited Geography with Admixture 34 A.D. | Predicts a Middle Eastern/Asiatic origin dominated by Asiatic DNA. DNA evidence collected until now makes this model more probable than HMJR model, but some Middle Eastern DNA should have been identified with current sampling. Model unlikely but not impossible. | Genetic diversity and colonization date estimates pose no serious challenge to this model since most genetic material would reflect DNA from the pre-Book of Mormon populations of Asiatic origin |
| The Limited Tehuantepec Model | DNA evidence poses less of a threat to origins in LTM model than any other model reviewed, because Middle Eastern DNA could have been swamped out by the "native" Asian genes as Book of Mormon peoples outbred with the original inhabitants. | Genetic diversity and colonization date estimates pose no serious challenge to this model since most genetic material would reflect DNA from the pre-Book of Mormon populations of Asiatic origin |

in Native American populations, it is reasonable under this model to expect that some could be detected with more extensive sampling.

FUTURE WORK

Of all the models, work remains to be done principally with the G.L.G.A. model. More definite population estimates can be incorporated to determine the expected frequency of Middle Eastern DNA. Of nearly five hundred native Central Americans sampled so far, over 99 percent are clearly descended from Siberians, and no individual has been linked to the Middle East.⁴⁷ Since it is dependent on population estimates of Nephites and also of the total inhabitants of a specified region at 34 A.D., the G.L.G.A. model seems questionable given the current sampling in Central America, but the issue remains unresolved conclusively.

This review has examined a few general models of Book of Mormon peoples and the implications that current DNA data have for each. As mentioned before, many possible models exist since numerous interpretations of Book of Mormon text are possible. It is unreasonable to expect that a thorough investigation of all models is possible. We reviewed here some of the more widely accepted ones. Some readers will note that we have obviously omitted an alternative model accepted by some LDS scholars and nearly all non-LDS scholars, one that views the Book of Mormon people as literary and not historical figures. As no specific genetic predictions can be made for such a model, it was left to other areas of investigation. Scholastic endeavors help us to better identify the historical, allegorical, and spiritual aspects of religious text. Only when the faithful are open to these separate sources of knowledge can scripture be fully appreciated and understood.

47. Southerton, "Re: Lamanite DNA."