New gene study enters Indo-European fray

Analysis of DNA from modern humans supports other indications that a northward migration of farmers from ancient Turkey and the Middle East, beginning around 9,000 years ago, shaped Europe's genetic geography. The DNA data also bolster a controversial theory that links this agricultural expansion to the spread of Indo-European languages, contend Alberto Piazza, a geneticist at the University of Torino, Italy, and his colleagues.

However, the genetic finds may also lend weight to a contrary proposal, the researchers add: that nomads from the central Eurasian Yamna culture spread Indo-European languages shortly after they invented wheeled vehicles approximately 5,500 years ago (SN: 2/25/95, p.120).

"It is possible that both expansions were responsible for the spread of different subfamilies of Indo-European languages, but our genetic data cannot resolve their relative importance," the researchers conclude in the June 20 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

Their investigation employs blood samples gathered earlier as part of an analysis of worldwide human genetic variation. Study coauthor L. Luca Cavalli-Sforza, a geneticist at Stanford University, directed the international project. Cavalli-Sforza and his colleagues describe those findings in *The History and Geography of Human Genes* (1994, Princeton University Press).

Piazza's team analyzed DNA from people in Europe and adjacent parts of central Eurasia and the Middle East. The researchers calculated the frequency of certain structural variations in 95 genes. They then used a statistical procedure to sort through the catalog of measured genetic differences, looking for geographic patterns of variation.

From about one-quarter of the measured genetic differences they extracted a pattern of numerous DNA changes in Turkey and the Middle East, with genetic mutations gradually declining in northern locales. Since such changes accumulate over time, early farmers moving north and settling the European continent probably left this genetic legacy, the scientists argue.

This pattern of DNA changes also appears to jibe with the theory that farmers moving northward from ancient Turkey spread Indo-European languages, Piazza's team holds.

A map developed from about one-fifth of the observed gene differences shows a trend toward a genetic split between populations in the extreme north and those in southern regions. The researchers suggest that this split may have two causes. It could result from differing adaptations to cold climates as well as the separation of northern groups, which spoke Uralic languages, from Indo-European speakers.

A third map, derived from about one-tenth of the entire set of gene differences, displays DNA changes that peak in central Eurasia and tail off throughout Europe. This pattern corresponds roughly to the movement of Yamna people into Europe.

Despite the new findings, controversy over Indo-European origins seems unlikely to diminish anytime soon. Available genetic data cannot untangle the roots of Indo-European languages, asserts Robert R. Sokal, a biostatistician at the State University of New York at Stony Brook.

However, the new evidence corroborates earlier genetic studies that found traces of an expansion of early farmers from Turkey into Europe, according to Sokal (SN: 8/22/92, p.117).

A study directed by Sokal, slated to appear later this year in HUMAN BIOLOGY, finds no linguistic evidence of an Indo-European origin in ancient Turkey. His team examined geographic patterns in the number of related words in known Indo-European languages.

"At this point, I can't substantiate any hypothesis of Indo-European origins," Sokal remarks. —*B. Bower*

Carbon dioxide marches to an uneven beat

As the global population of people and cars climbs ever higher, so do emissions of carbon dioxide, the notorious greenhouse gas. Since 1958, when scientists first started monitoring its concentration, carbon dioxide has accumulated in the atmosphere almost in lockstep with the growing use of gasoline and other fossil fuels.

But in the last 15 years, the carbon dioxide buildup has surged ahead of fossil fuel emissions and then lagged behind—changes that have puzzled atmospheric scientists and hampered efforts to predict climate.

A team of researchers now reports measurements that may explain why concentrations of this gas have followed such an uneven upward path. Charles D. Keeling of the Scripps Institution of Oceanography in La Jolla, Calif., and his colleagues blame the carbon dioxide antics on Earth itself. Minor climate fluctuations significantly alter the ability of ocean water and land surface to absorb and emit carbon dioxide, they report in the June 22 NATURE.

The large swings exhibited by the ocean and continents caught scientists off guard, says Keeling: "So far, everything that's happened has been a surprise."

Keeling and his cohorts measure carbon dioxide concentrations at Mauna Loa, Hawaii, and at the South Pole. In the 1980s, they noticed that the accumulation of carbon dioxide accelerated even as high petroleum prices slowed the rise in fossil fuel use. After 1990, the pattern reversed. Carbon dioxide continued to accumulate in the atmosphere, but at a rate slower than that predicted from fossil fuel emissions.

To trace the cause, the researchers turned to measurements of carbon isotopes in air. Carbon dioxide produced from fossil fuel combustion and from land vegetation is isotopically light—it has a low ratio of carbon-13 to carbon-12, compared to the carbon dioxide in air. Carbon dioxide released from the oceans, however, has an isotopic ratio close to that of air.

From the isotopic measurements, Keeling and his colleagues conclude that the oceans and land surface swing between accelerating and slowing the carbon dioxide buildup in air. The two tend to balance each other: During El Niño events, for instance, the oceans absorb more carbon dioxide than usual, but the land surface emits more.

According to the researchers, the carbon dioxide surge seen in the 1980s resulted from an oceanic warming, which depressed the amount of gas absorbed by the upper layer of water. When global temperatures reached record highs in 1990 and 1991, the warming spurred vegetation on the continents to absorb additional carbon dioxide, causing the slowdown in accumulation witnessed in 1992 and 1993. The eruption of Mt. Pinatubo in mid-1991 could also have put a temporary brake on the carbon dioxide rise by cooling off the globe.

The findings have important implications, says Keeling, because researchers must understand how carbon dioxide accumulates in the atmosphere before they can forecast how much climate will warm in response to the buildup of greenhouse gases.

Other researchers question the new study, however. Pieter P. Tans of the National Oceanic and Atmospheric Administration in Boulder, Colo., says the isotopic data do not provide a clear picture because the observed changes are small. He remains unconvinced that the oceans and land surface vary so widely in the amount of carbon dioxide they absorb and emit. "I'm not sure such anomalies can be real," says Tans.

Whatever the cause, carbon dioxide has continued to surprise scientists. Last year, the rate of accumulation of fossil fuel emissions surged ahead once again, ending the 2-year slowdown.

—*R. Monastersky*