



LINGUISTICS

New Method Puts Elusive Indo-European Homeland in Anatolia

Among all the world's language families, Indo-European is by far the most global. Today its more than 400 languages are spoken by some 3 billion people on every inhabited continent. But who were the first Indo-European speakers, and where did they come from? Researchers have argued fiercely over two major competing candidates: Neolithic farmers who carried their agricultural know-how with them as they pushed out from Anatolia, chiefly in modern Turkey; or Bronze Age horse masters from the Eurasian steppes, who spread into Asia and Europe with advances such as the wheel.

Now an international research team has borrowed a computational approach from biology to shed new light on the problem. Using models originally created to trace the origins of viral pathogens, such as avian influenza, during outbreaks, evolutionary psychologist Quentin Atkinson of the University of Auckland in New Zealand and his colleagues report on page 957 of this issue that they have found decisive support for the Anatolian hypothesis. "I think we've put forward the best case yet for where the Indo-European languages came from," Atkinson says. "And we've also shown that languages can be used to retrace human history in both time and space."

If the findings stand, they hold key implications for everything from human migrations to the role of agriculture in ancient language expansion. "This is a major breakthrough," says archaeologist Colin Renfrew of the University of Cambridge in the United Kingdom. But in this divisive field, the team's methods and findings are already drawing fire. "This article raises more questions than making

substantive points," says archaeologist David Anthony of Hartwick College in Oneonta, New York. "There are a lot of curious and surprising results that they don't explain."

Charles Darwin noted in 1871 that languages, like plants and animals, could be classed into related groups. Each language arose only once, in one place, and modern languages descended with modification from ancestral ones. The proofs of language and species evolution "are curiously parallel," he wrote in *The Descent of Man*.

Atkinson and colleagues applied Darwin's analogy to the Indo-European language family, which includes varied but related tongues such as English, Italian, Albanian, Persian, and Hindi. Linguists have long sought clues to the origins and spread of these languages by analyzing their vocabulary, sounds, and grammar, and by studying the archaeology of ancient migrations. Evidence marshalled by Renfrew in the 1980s suggested an Anatolian homeland, the same land from which the first farmers spread 8000 or 9000 years ago. But recent archaeological and linguistic data have pointed to an origin on the steppes north of the Black and Caspian seas, where seminomadic herders known as the Yamnaya expanded into Europe and Asia with domesticated horses and wheeled carts beginning perhaps 5000 years ago.

Enter Atkinson and a research team drawn largely from the fields of biology, computer science, and psychology. They focused on vocabulary, specifically the gain and loss of cognates, or words in related languages—such as "mother" in English and "mutter" in German—that stem from a single ancestral root. The team used cognates

Ground zero? With tools from the study of virus outbreaks, a team traced Indo-European languages to an ancestral homeland chiefly in modern Turkey (red).

from other studies on 103 ancient and modern Indo-European languages. They considered this data set analogous to molecular sequence data, with the rate of cognate gain and loss akin to the rate of nucleotide substitution in viral evolution.

Atkinson's team also added published data on the geographical ranges of all 103 languages, plus historical dates for language divergence, such as the breakup of the Roman Empire, which triggered the evolution of Romance languages from a type of Latin. The computer model then worked back in time, inferring possible ancestral relationships and patterns of diffusion, and generating possible homelands. Then the team compared "how often the origin locations fell into the range proposed for the Anatolian theory versus the Steppe theory," Atkinson says. The Anatolian hypothesis won hands down.

The analogy to virus evolution is "clever and insightful," says linguist Paul Heggarty of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, who thinks the study will prompt other linguists to try the method. He says the study will give supporters of the Steppe hypothesis "plenty of explaining to do."

Other researchers, however, take strong issue with the findings. Anthony notes that Atkinson and his colleagues limited their study to vocabulary, just one of three subsets of linguistic data, "something you are really not supposed to do," he says. In addition, the authors rooted their model in geography mainly using modern distributions of languages. "The results don't tell you much about the past," Anthony concludes.

The paper makes many inferences on matters such as the rates of language change and how languages diffuse, says Victor Mair, a Chinese language expert at the University of Pennsylvania. "There is so much about this paper that is arbitrary," he says. By comparison, he says, the Steppe hypothesis "is based heavily on archaeological data such as burial patterns, which are directly tied to datable materials."

Atkinson counters that archaeologists struggle to link their finds to particular cultures. "Peering back into human prehistory is not easy," he says. "It's like holding a dim candle over a dark abyss, and you need to use every piece of information that you can."

—HEATHER PRINGLE

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