

The authors' preferred model, in which the icebergs remained intact and upright after initial breakout, also contrasts with the modern Larsen B ice shelf, where icebergs capsized during collapse⁸.

It is particularly noteworthy that, as Jakobsson *et al.* emphasize, the corrugated ridges and furrows on the floor of Pine Island Bay occur widely on the Antarctic continental shelf, including in the Ross and Weddell seas. This suggests that tides may be a more pervasive influence on the record of Antarctic ice-sheet deglaciation than has hitherto been recognized, and it raises the interesting question of whether spatial and temporal variability in tidal range could act as a control on ice-sheet retreat⁹. Clearly, much remains to be discovered about the complexity of the geological record of West Antarctic Ice Sheet deglaciation and the associated controls. ■

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LINGUISTICS

Deep relationships between languages

Tracing a common ancestry between languages becomes harder as the connection goes further back in time. A new test has revealed a surprisingly ancient relationship between a central Siberian and a North American language family.

JARED DIAMOND

Humans crossed from Siberia into Alaska some 14,000 years ago, long before the 5,000–10,000-year barrier beyond which most linguists think that language evolution erases traces of shared ancestry. Efforts to break this barrier by establishing a relationship between Old World and New World languages have been unconvincing until now. The change is due mainly to the efforts of Edward Vajda, who offers evidence in *Anthropological Papers of the University of Alaska*¹ for the first convincing link, over an astonishingly large distance, between Old World and New World languages.

Most of the world's 7,000 present-day languages fall into language families — such as the Indo-European family, to which this journal's English, along with 140 other languages, belongs. Languages of the same family resemble each other because they arose from a common ancestor and then diverged.

The difficulty in detecting ancient linguistic relationships — those beyond the 5,000–10,000-year barrier — is that all languages share the same pool of consonants, vowels and grammatical structures. Therefore, some resemblances are expected to occur by chance if one compares lists of thousands of words

for two unrelated languages. For instance, the word for 'eel' is almost the same in Japanese and in New Guinea's Haruai language, despite a lack of other similarities between the two languages and the impossibility that one could have borrowed the word from the other¹.

To address this problem, linguists scrutinize word lists for putative cognates — phonetically similar words with the same meaning in two related languages, and differing by regular sound correspondences — such as English and Spanish cognates beginning with 'f' and 'p', respectively (father, fish and foot versus padre, pez and pie). The late Joseph Greenberg emphasized the value of multilateral comparisons, in which many related languages are simultaneously compared to identify ancestral roots preserved in only some of the daughter languages. He concluded that most Native American languages belong to one large ancient family, termed Amerind², and that Indo-European and other established families form a superfamily, termed Nostratic. Twenty-seven shared worldwide etymologies suggested even more ancient shared ancestry among all the world's languages³. However, most linguists reject these conclusions, in part because of a lack of statistical tests to prove that the claimed similarities are not due to chance.

There are two methods for testing the role



50 Years Ago

On the whole the average alcohol consumption within a species of animal is constant. It can be said that each species has its own specific liking for alcohol ... In this work the consumption of 10 per cent alcohol and water in free-choice experiments in six animal species has been studied ... The hedgehogs preferred water to alcohol solution. Sometimes, however, the animals drank considerable amounts of alcohol, and it could at times be judged from their movements that they were slightly drunk. The hamsters preferred alcohol. They seldom tasted the water and, when they did so, only until they found out that they were drinking from the wrong bottle.

From *Nature* 19 August 1961

100 Years Ago

On the publication of the final report of the Royal Commission on Tuberculosis the view was frequently expressed that those in authority ought, long ago, to have taken precautions against the dangers arising out of the use of milk containing tubercle bacilli ... Now that the commissioners have reported, and in no uncertain voice, that tuberculosis, especially in the child, may be the result of infection with tubercle bacilli conveyed in the cow's milk, it is essential that the question of regulations relating to milk and meat supply should be carefully reconsidered, and that, as the commissioners put it, "Government should cause to be enforced throughout the kingdom food regulations, planned to afford better security against the infection of human beings through the medium of diet derived from tuberculous animals."

From *Nature* 17 August 1911



Figure 1 | Circumpolar map of the Arctic showing the locations of Yeniseian and Na-Dene languages. There are two small groups of outlying Na-Dene populations in North America, far south of those depicted, in the United States southwest and on the California and Oregon coasts. Vajda¹ has found evidence of a link between the Yeniseian and Na-Dene languages. (Figure based on ref. 1.)

of chance in assessing deep relationships^{1,4–7}. One is also used by biologists to test evolutionary trees: the Monte Carlo simulation. This involves taking word lists for two or more languages, repeatedly and randomly scrambling the meanings within each list, recounting the number of cognates in each randomized pair of lists, and then calculating statistically whether the observed number of cognates exceeds that expected by chance, according to the randomized lists.

Such tests have been extended by Kessler and Lehtonen⁴ to multilateral comparisons, after first confirming statistical significance among 11 languages already known to belong to the Indo-European family. This was true even for Albanian, a language whose Indo-European affinities had proved difficult to establish by bilateral comparisons. This success vindicates Greenberg's view that multilateral comparisons can uncover evidence of a relationship that is obscure in bilateral comparisons (because any single Indo-European language alone happens to lack certain Indo-European roots retained in Albanian).

Unhappily for those multilateralists who consider Indo-European to have an ancient relationship with Uralic languages (which include Finnish and Hungarian), the two families turned out to be related at a significance level of only $P = 0.45$, far from the $P < 0.05$ required for significance⁴. It seems likely that the few sharings between the two families are due to chance or to borrowing.

The other, more approximate, set of methods

for assessing the role of chance depends on 'individual-identifying thresholds'^{1,5,6}. With about 7,000 languages in the world, one could estimate $P = 1/7,000 = 0.000143$ as a level of rarity to suggest a unique individual language, or $(1/7,000) (0.05) = 7 \times 10^{-6}$ as a level of rarity significant at $P < 0.05$. Johanna Nichols¹ uses this test to support Vajda's remarkable new evidence for a relationship between central Siberian Yeniseian languages and North American Na-Dene languages.

Yeniseian is a tiny family of less than a dozen languages that were formerly spoken along Siberia's Yenisei River, and now survive only as the Ket language, which has fewer than 200 speakers. Na-Dene languages (that is, the Tlingit, Eyak and Athabaskan languages) are spoken across much of Alaska and northwest Canada, with outliers in the southwestern United States, California and Oregon. Four intervening language families and 5,200 kilometres separate the nearest Ket and Na-Dene speakers today (Fig. 1).

In 1923, one possible cognate was found between Ket, Athabaskan and Tlingit, and other similar words were later identified (see ref. 3 for examples). Vajda has now placed this postulated relationship on a rigorous footing. He was struck by how Ket's system of tones and bewilderingly complex strings of eight verb prefixes were utterly out of place in Siberia — otherwise occupied by toneless suffixing languages related to Turkish and Finnish — and by how those tones and prefixes corresponded in detail to Na-Dene languages. The parallels

he identifies include a dozen grammatical prefixes and about 100 cognate words with sound correspondences. Because the prefixes appear in the same sequence between Yeniseian and Na-Dene verbs, and because Vajda analysed all prefixes and didn't just fish for one matching pair, both his prefix comparisons and his word lists comfortably pass Nichols' significance tests. Vajda's evidence is judged to be plausible by linguists previously sceptical of claimed relationships between language families¹.

The reported Yeniseian–Na-Dene link raises many questions. Where was the common ancestral language spoken (Siberia or North America), and did Yeniseians move west or Na-Denes move east across the Bering Strait? Are there archaeological correlates of such a movement? (The only plausible candidates are archaeological horizons at around 12,000 and 5,000 years ago.) Do Yeniseian and Na-Dene form a superfamily by themselves, or do they belong to a larger superfamily that includes Sino-Tibetan and Basque? Are Yeniseian and Na-Dene people more closely related genetically to each other than to other Siberians and Native Americans? (Apparently not, possibly because of millennia of intermarriage with surrounding peoples.) Why did Yeniseian speakers have such a tiny geographical range in modern times?

But there are two questions that most trouble linguists. Why do Yeniseian and Na-Dene languages still show such a strong relationship if they diverged 12,000 years ago, when other languages diverge beyond recognition after 5,000–10,000 years ago? Either Yeniseian and Na-Dene languages really diverged only 5,000 years ago, or they are unusually conservative and evolve especially slowly. And how did Yeniseians and Na-Denes get separated by 5,200 km in only 5,000 or 12,000 years, making their overland migration the longest and fastest recorded by hunter-gatherers? In coming years, we can watch as these questions are debated — and perhaps as other links between Old and New World language families are revealed. ■

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