the steppes. But the authors of the new papers argue the Black Sea steppe wasn't the birthplace of Indo-European, but rather a stop along a journey that began earlier and farther to the south, perhaps around modern-day Armenia.

Because of similarities between Indo-European and Anatolian languages such as ancient Hittite, linguists had guessed the Yamnaya had left both genes and language in Anatolia, as well as Europe. But the new analysis finds no Yamnaya ancestry among ancient Anatolians. The team suggests they and the Yamnaya instead share common ancestors in a hunter-gatherer population in the highlands east of Anatolia, including the Caucasus Mountains. That area, they argue, is the most likely place for people to have spoken an Anatolian-Indo-European root language, perhaps between 5000 and 7000 years ago. "That Caucasus component is a unifying type of ancestry we find in all places where ancient Indo-European languages are spoken," says Lazaridis, who is first author on all three papers.

However, Guus Kroonen, a linguist at Leiden University, says this contradicts linguistic data. The early people of the Caucasus would have been familiar with farming, he says, but the deepest layers of Indo-European have just one word for grain and no words for legumes or the plow. Those speakers "weren't very familiar with agriculture," he says. "The linguistic evidence and the genetic evidence don't seem to match."

> **"The beauty of this is it's bringing it all together in a bigger narrative."**
> **Wolfgang Haak**, Max Planck Institute for Evolutionary Anthropology

Lazaridis says it's possible the root tongue "was originally a hunter-gatherer language," and so lacked terms for farming. The team agrees more evidence of "Proto-Indo-Anatolians" is needed, but says the Caucasus is a promising place to look.

Throughout, the papers address some critiques of previous ancient DNA work. Some archaeologists have complained that earlier research attributed almost everything—status, identity, power shifts—to pulses of migration recorded in DNA. But the new papers acknowledge, for example, that some migrations into Anatolia may not have been relevant or even perceptible to those living at the time. "That's a response to criticisms coming from the archaeological literature," says Hartwick College archaeologist emeritus David Anthony, who is not a co-author but has worked with the team. "It's really healthy."

In another example, Yamnaya were buried in elite tombs after they moved into the region north of Greece, suggesting a link between ancestry and social status. But during the later Mycenaean period in Greece—the time Homer mythologized—the new data suggest Yamnaya descendants had little impact on Greek social structure.

Evidence comes in part from the spectacular Mycenaean burial of the Griffin Warrior, a man who died in 1450 B.C.E. near Pylos, Greece. He carried no traces of steppe ancestry, though dozens of both elite and humbler graves in Greece did. University of Cincinnati archaeologist Shari Stocker, who helped excavate the tomb in 2015 and collaborated on the new studies, says the lack of correlation between social status and steppe ancestry is no surprise—and a welcome dose of nuance from geneticists.

The papers also acknowledge the nuances of identity in later periods, for example in Imperial Rome. Previous genetic studies had shown that as the empire coalesced, the ancestry of people in and around the city of Rome shifted, with most having roots not in Europe, but farther east.

After obtaining dozens of additional Roman-era genomes from the region, the team zeroed in on the source of those newcomers: Anatolia. But the researchers agree that people with "Anatolian" DNA moving to the Italian peninsula likely saw themselves as citizens or slaves of Rome, rather than as part of a distinct "Anatolian" ethnic group. Contemporary chroniclers remarked on the new faces in Rome—and referred to many of them as "Greeks," perhaps because the eastern peoples had spoken Greek for centuries, Lazaridis says.

Some archaeologists still think the papers claim too much influence for ancestry. "DNA cannot tell us anything about how people shape their life worlds, what their social status was," says archaeologist Joseph Maran of Heidelberg University. He says terms like "Yamnaya ancestry" suggest the Yamnaya spread by moving directly from place to place, rather than through a complex mingling of their descendants with local populations over centuries or more. "Equating history with 'mobility' and 'migrations' is … old-fashioned."

And although the studies are a big step forward, in covering 10,000 years with 700 samples, they leave plenty of questions unanswered, with large stretches of time and space represented by a handful of samples.

All the same, several archaeologists including Horejs think this injection of DNA data will shape research going forward. "It's our task now, and obligation as archaeologists, to use this new data to rethink archaeological models," she says. ■

PLANT ECOLOGY

Global drought experiment reveals the toll on plant growth

Artificial droughts sharply cut carbon storage

By **Elizabeth Pennisi**

Europe and many other parts of the world are currently grappling with extreme drought—and that could be bad news for efforts to curb climate change, concludes a new global study of how shrubs and grasses respond to parched conditions.

Grasslands and shrublands cover more than 40% of Earth's terra firma, and they remove hefty amounts of carbon dioxide from the air. But by deliberately blocking precipitation from falling at 100 research sites around the world, researchers found that a single year of drought can reduce the growth of vegetation by more than 80%, greatly diminishing its ability to absorb carbon dioxide. Overall, plant growth in the artificially drought-stricken grassy patches fell by 36%, far more than earlier estimates. But the study, presented last week at the annual meeting of the Ecological Society of America in Montreal, also found great variability: Vegetation at 20% of the sites continued to thrive despite the lack of water.

"I was surprised at how much drought impacts varied," says Drew Peltier, a physiological ecologist at Northern Arizona University who was not involved in study. "This suggests there is some resilience in these systems; the question is how much and for how long."

A decade ago, with droughts forecast to become more frequent and severe in a warming world, three ecologists—Melinda Smith of Colorado State University; Osvaldo Sala of Arizona State University, Tempe; and Richard Phillips from the University of Indiana, Bloomington—grew frustrated with their field's inability to come up with consistent results about how dry weather affects plant productivity, particularly in grasslands and shrublands. So, they and their colleagues hammered out a standardized procedure for creating artificial droughts in the field and put out a call for researchers willing to participate in what they dubbed the International Drought Experiment (IDE).

"We expected to have about 20 sites," Smith recalls, but what's called Drought-Net has grown to 139. Some are in places, such as Iran and parts of South America, where scientists had conducted little drought research. Most are in shrub- and grasslands, where it's easier to erect structures to block precipitation.

Each team agreed to re-create the conditions of the worst drought documented in their region over the preceding century. Most blocked precipitation by mounting plastic roofing slats over 1-meter squares of ground; the slats were spaced according to how much rain, sleet, or snow needed to be diverted. On average, the roofed plots received less than half of their typical precipitation.

Each team tallied the kinds and numbers of plants in the covered areas, as well as in similar plots left open for comparison. After a year of treatment, the researchers surveyed the plants again and harvested, dried, and weighed all of the aboveground plant material in the roofed and open plots.

dominated plots fared better than those dominated by grasses, Wilkins reported. Shrubs tend to have more extensive roots that can reach moisture deep in the soil. The average decline seen in the grassy plots—36%—is "almost twice as much of a reduction as other studies have shown," notes Elsa Cleland, an ecologist at the University of California, San Diego. But she and others think the data are believable because the study used standard methods across a wide variety of sites.

Many researchers have continued to monitor their plots, with some planning to collect data for four or more years, in part to simulate prolonged droughts. The additional data could help climate modelers sharpen estimates of how much less carbon is absorbed by shrub- and grasslands in a drought, says Sarah Evans, an ecologist at Michigan State University's W.K. Kellogg Biological Station. IDE results could also help ecologists forecast which ecosystems are most at risk during dry spells, as well as broader ecological ripple effects. Less plant matter can mean less food for grazing animals such as rodents and for

This year, drought scorched these soccer fields in London and stressed shrubs and grasses across the globe.

Last week, the researchers reported initial results from 100 shrubby and grassy sites. At some, such as plots of shortgrass prairie in Colorado, there was "catastrophic loss," reported Kate Wilkins, a grassland ecologist now at the Denver Zoo who worked with Smith. Plant productivity in the water-starved area declined by 88%. "What surprised me was just how dead it was," Wilkins said.

In contrast, in a temperate grassland in Germany the simulated drought "did not have any significant effect," says disturbance ecologist Anke Jentsch-Beierkuhnlein from the University of Bayreuth. In general, the climate at the German site was wetter and the drought less severe than on the prairie.

Overall, plants in wetter environments withstood this short-term drought better than those in drier climes, and shrub-

their predators, Evans notes. "The health of many ecosystems and their biodiversity relies on plant production," she says.

Farmers, ranchers, and land managers might also benefit. Jentsch-Beierkuhnlein notes that during the current European drought, intensively managed grasslands with relatively few species, such as hayfields, have been hard hit. Planting more diverse assemblages might enable such grasslands to "keep delivering ecosystem services even under severe drought," she says.

That's an important insight, says Andrew Hector, an ecologist at the University of Oxford, given the extreme heat and drought of recent years. "The main message of these extreme conditions is that climate change … is happening already," he says. They "show just how relevant [the IDE] is." ■

ATMOSPHERIC SCIENCE

Researchers watch how Arctic storms chew up sea ice

Airborne campaign to study summer cyclones could reveal air-ice interactions

By **Eric Hand**

The storm began somewhere between Iceland and Greenland, as disturbances high and low in the atmosphere united into a full-fledged cyclone. One day later, the vast spiral of winds had grown nearly as big as Mongolia. It was on a beeline for Svalbard, the archipelago between Norway and the North Pole, and heading for the thin floes girding the Arctic's vulnerable pack of summer sea ice. And that made John Methven very, very happy.

Last week, Methven, an atmospheric dynamicist at the University of Reading, flew through the storm as part of an airborne campaign based out of Svalbard's Longyearbyen, the world's northernmost town. As his Twin Otter plane shuddered through tropical storm–force winds of 100 kilometers per hour, flying just 15 to 30 meters above the sea surface, Methven and the crew took measurements of the ice, water, and air before returning to a bumpy landing on Svalbard. It was the third, and strongest, cyclone that U.K., U.S., and French teams had captured in a monthlong effort.

"It's really exciting to get this sequence [of cyclones]," says Methven, leader of the U.K. component of the Thin Ice campaign, the first airborne project to study how these summertime storms affect sea ice. "People are going to be pretty pleased."

With data from the ice-skimming plane, a second aircraft flying through the tops of the storms, and dozens of weather balloons, the Thin Ice teams hope to learn how these common but poorly understood storms form, function, and chew up sea ice. They also plan to gauge how the properties of the sea ice—smooth, rough, or missing—feed back into the storms themselves. The data should help improve Arctic weather models and sharpen the picture of how summer cyclones may be accelerating the retreat of

PHOTO: CARLOS JASSO/AFP/GETTY IMAGES

Science

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