Illinois, Urbana-Champaign (UIUC), who led his university’s saliva test development.

As early as 12 February, researchers in Hong Kong and China reported in *Clinical Infectious Diseases* that they could identify SARS-CoV-2 from saliva in 11 of 12 patients whose swabs showed virus. Since then, groups in the United States, Singapore, and Japan have confirmed and further simplified the procedures, cutting out costly steps such as adding specialized reagents to stabilize the virus and extract the genetic material.

In May, Wyllie and Yale colleagues teamed up with the National Basketball Association, which provided $500,000 to develop Yale’s saliva diagnostic; the test is now used for frequently testing players. On 4 August, the Yale team posted a preprint on medRxiv that said its saliva test agreed with swab results 94% of the time, at a cost of as little as $1.29 per sample, roughly 1/100 as much as commercial swab-based tests. On 15 August, FDA granted emergency approval for the test, called SalivaDirect, so that other FDA-approved labs can use the protocol. Last week, the agency extended approval to the UIUC test given its similarity to the Yale test. UIUC is now using its saliva test with all 60,000 students, faculty, and staff twice a week, in order to isolate infected individuals as quickly as possible. “Testing saliva makes sense scientifically, and it makes sense logistically,” Hergenrother says.

A new saliva test for RNA viruses, such as Zika and SARS-CoV-2, was reported last week in *Science Advances* by researchers at the University at Albany. It could be even faster and cheaper because it does not need expensive lab equipment such as PCR machines. Rather than amplifying RNA to identify the virus, the approach uses snippets of DNA that bind to short, unique sections of RNA and change them from linear strands to loops. That alters how the RNA behaves in a common lab procedure known as gel electrophoresis, making it easy to detect. “This is innovative,” Wyllie says. A relaxation of FDA rules announced last week could lead to still more variants. The new rules allow approved clinical labs to use tests they have developed without any additional approval step. In a tweet, Michael Mina, an epidemiologist at Harvard University’s T.H. Chan School of Public Health, called FDA’s decision “Huge news!!” because it would encourage labs to develop novel tests. It may also help speed development of rapid tests that look for viral proteins rather than genetic material—an efficient way to screen large numbers of asymptomatic people.

“We don’t need one test to be the end all and be all,” Wyllie says. “We just want options.”

**ECOLOGY**

Hidden web of fungi could shape the future of forests

Plants’ fungal partners can help their hosts resist drought and heat—or make them more vulnerable

*By Elizabeth Pennisi and Warren Cornwall*

T he future of the world’s flora may depend as much, if not more, on what’s below the ground as what’s above. Beneath 90% of all plants lies an invisible support system—subterranean fungal partners that form a network of filaments connecting plants and bringing nutrients and water to their roots. In return, the plants provide a steady supply of carbon to the fungi. Now, researchers are learning that these hidden partners can shape how ecosystems respond to climate change.

The right fungal partners can help plants survive warmer and drier conditions, according to a study reported earlier this month at the online annual meeting of the Ecological Society of America. But other studies at the meeting showed climate change can also disrupt these so-called mycorrhizal fungi, possibly speeding the demise of their host plants. “The picture is becoming clearer that we really cannot ignore the responses of mycorrhizal fungi to climate change,” says Matthias Rillig, an ecologist at the Free University of Berlin.

These fungal associates come in two forms. Arbuscular mycorrhizae (AM), common in tropical and some temperate forests as well as fields and meadows, invade root cells and extend thin hairs called hyphae into the soil. Ectomycorrhizal (EM) fungi, in contrast, associate with conifers as well as oak, hickory, alder, and beech. They settle on the outside of roots, and their networks of hyphae give rise to the mushrooms that pop up on moist forest floors.

Both types absorb phosphorus and other nutrients, capture nitrogen from decaying organic matter, and help store carbon in the soil. “Mycorrhizal associations are arguably the most important symbioses in terrestrial ecosystems because of their importance for plant productivity,” says

In an electron micrograph, mycorrhizal fungi (bright gray) penetrate root cells, where the fungi supply water and nutrients in exchange for carbon.
Christopher Fernandez, a soil ecologist at the University of Minnesota, Twin Cities.

Climate change might alter these associations, he says. Fernandez is part of the B4WARMED (Boreal Forest Warming at an Ecotone in Danger) project, a large-scale effort to monitor the impact of warming and drying on the boreal forests that stretch across northern latitudes. The study is also artificially warming and drying plots of forest, and Fernandez studied the impact of the simulated climate change on the hidden fungi by sequencing soil and root samples from plots.

As conditions became warmer and drier, the diversity of the EM fungi fell, and “weedy” EM fungi took over, Fernandez reported at the meeting. These “weeds” don’t devote a lot of energy to building extensive underground networks, causing their connectivity to break down. If the same disruption happens as climate change unfolds, fewer seedlings might establish their critical partnerships with fungi, which could deprive the trees of nutrients.

Monitoring conducted by B4WARMED has already shown that the warmer, drier climate of recent years is taking a toll on the boreal forest. What role any change in the EM fungi is playing is not yet clear, but “the alteration of mycorrhizal fungal communities in response to climate change is deeply concerning,” Fernandez says.

The B4WARMED results “show that there may be some major shifts in both above- and belowground communities in the future,” says Sarah Sapsford, an ecologist at the University of Canterbury. “What we see now we may not see again.”

A different ecosystem, the pinyon pine forest of the U.S. Southwest, shows that existing variations in mycorrhizae can also influence trees’ resilience. Decades ago, a moth infestation stunted some of the pinyons (Pinus edulis) growing near Arizona’s Sunset Crater Volcano National Monument. The hard-hit trees have different EM fungi from their taller neighbors, suggesting the two types of trees may differ genetically.

When a megadrought struck the region in 2002 and 2003, twice as many of the taller trees died. To see whether the mycorrhizae made a difference, Catherine Gehring, an ecologist at Northern Arizona University, Flagstaff, and her colleagues grew seedlings from the two types of plants with and without their fungi in a greenhouse, under different watering regimens.

“We found that ectomycorrhizal fungi played a critical role in drought tolerance,” Gehring reported at the meeting. Sanna Sevanto, a biophysicist at Los Alamos National Laboratory, watched the fungi in action by dousing seedlings’ roots in heavy water, which served as a tracer. Water moved into the drought-tolerant roots infected with their fungus much faster than when they were sterile, Gehring reported.

She and her colleagues are working with local researchers to replant pines in the Navajo Nation, not far from Sunset Crater, and they are applying what they learned. Because genetic differences among the trees seem to determine which of the two groups of EM fungi colonizes them, the team will be careful to plant seedlings with the right genotype to attract the drought-resistant fungi. That “could mean the difference between life and death during drought,” Gehring says.

A third study suggests mycorrhizae could shape how not just trees but entire ecosystems respond to environmental change. Because AM and EM fungi are associated with different tree species, Colin Averill, an ecologist at ETH Zurich, wondered whether the fungi themselves help determine which kind of forest grows in a particular region.

Earlier researchers had suspected they do, but Averill and his colleagues searched for evidence in a vast set of U.S. Forest Service data tracking the species, growth, and death of every tree bigger than a sapling in 69,655 forest plots across the eastern United States. They found that many plots are dominated either by AM-related trees or by EM-related trees; a mix of the two is rarer.

A statistical analysis found fungi were key to this stark split, and the researchers found a likely reason: The dominant mycorrhizae can help lock a forest into a stable state. Tree measurements taken at 5-year intervals at each plot showed an AM tree was at least 10 times more likely to take root in an AM forest than in an EM forest and twice as likely to survive. Meanwhile, EM trees were more likely to thrive in EM forests.

The fungi may enforce this monopoly by altering the soil in ways that favor specific species—for example by controlling nitrogen levels. A more established fungal network could also help young trees endure heavy shade that interferes with photosynthesis, or older trees withstand drought or diseases. “If you’re an EM tree you can plug into an EM network, and that can help you survive,” Averill says.

The grip of those fungi could slow forests’ response to external pressures such as climate change. AM-affiliated trees tend to fare better in hotter temperatures, for example, but they might be slower than expected to colonize an EM-dominated forest as the climate warms, Averill says. “These types of dynamics might become really important as we try to forecast how the global forest system will change in the future.”

CLIMATE CHANGE

New feedbacks speed up the demise of Arctic sea ice

Wave action and a growing underwater blob of heat add to impact of warming air

By Paul Voosen

In March, soon after arriving aboard the Polarstern, a German icebreaker frozen into Arctic sea ice, Jennifer Hutchings watched as ice broke up around the ship, weeks earlier than expected. Even as scientists on the research cruise scrambled to keep field instruments from plunging into the ocean, Hutchings, who studies ice deformation at Oregon State University, Corvallis, couldn’t suppress a thrill at seeing the crack up, as if she had spotted a rare bird. “I got to observe firsthand what I studied,” she says.

Arctic sea ice is itself an endangered species. Next month its extent will reach its annual minimum, which is poised to be among the lowest on record. The trend is clear: Summer ice covers half the area it did in the 1980s, and because it is thinner, its volume is down 75%. With the Arctic warming three times faster than the global average, most scientists grimly acknowledge the inevitability of ice-free summers, perhaps as soon as 2035.

“It’s definitely a when, not an if,” says Alek Petty, a polar scientist at NASA’s Goddard Space Flight Center.

Now, he and others are learning that a warming atmosphere is far from the only factor speeding up the ice loss. Strengthening currents and waves are pulverizing the ice. And a study published last week suggests deep heat in the Arctic Ocean has risen and is now melting the ice from below.

Ice has kept its grip on the Arctic with the help of an unusual temperature inversion in the underlying waters. Unlike the Atlantic or Pacific oceans, the Arctic gets warmer as it gets deeper. Bitter winters and chilly, buoyant freshwater from Eurasian rivers cool its surface layers, which helps preserve the underside of the ice. But at greater depths sits a warm blob of salty Atlantic water, thought to be safely separated from the sea ice.

As the reflective ice melts, however, it is
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