



Ukrainian civilians evacuate from the embattled town of Irpin, a suburb of Kyiv.

EUROPE

Ukrainian researchers flee war trauma and terror

Refugees find aid and jobs, but many remain to fight Russian invaders

By Richard Stone

At this time of year Maryna Kravchenko, a population ecologist at Kharkiv National University (KNU), normally heads into the forests of eastern Ukraine to track frogs and toads emerging from hibernation. Instead, after 1 week sheltering from bombs in a basement, she fled with her young children to Germany, where colleagues at Ludwig Maximilian University of Munich had found them an apartment. Her husband, KNU zoologist Dmitry Shabanov, stayed to defend Kharkiv. “We’ve all stopped wishing each other good morning,” Kravchenko says. “Instead, it’s now ‘How are you?’ to both check whether the other person is still alive and show that you still care about them.”

The humanitarian toll of an increasingly brutal war is rising. More than 3 million refugees have fled since Russia began its invasion on 24 February, according to the Office of the United Nations High Commissioner for Refugees. Scientists like Kravchenko are among the dispossessed. Others are staying put, hunkering down or taking up arms in the war zone. The upheaval is touching the Russian science community as well. Cut off from many international collaborations

and, in some cases, opposed to the war, some Russian scientists are fleeing their own country.

Before the invasion, Ukraine had nearly 80,000 scientists, says Brokoslaw Laschowski, a Ukrainian-Canadian postdoctoral fellow at the University of Toronto. He’s volunteering for an impromptu international effort, Science for Ukraine, that has lined up hundreds of jobs for refugee scientists—mainly women, as Ukraine forbids most men under 60 from leaving the country. When war broke out, “My first thought was that one generation or two generations of scientists were going to be destroyed,” says Sergio Ponsá Salas, a chemical engineer at the University of Vic-Central University of Catalonia who’s helping coordinate Science for Ukraine in Spain. His university has already thrown a lifeline to three food scientists and a hydrologist who have escaped.

Others want to stay. The day after fighting began, KNU astronomer Oleksiy Golubov, 36, rushed to the local office of the Territorial Defense Forces. A recruiter took one look at his left hand—limp from a hereditary nerve disorder—and turned him away. “He told me I’m not fit. That I wouldn’t be able to hold a weapon properly,” says Golubov, his voice hoarse with emotion.

On 7 March, Golubov and a group of fellow scientists escaped the besieged city, only half an hour’s drive from the Russian border. He’s now holed up at the home of a family friend in Batkiv, a village in western Ukraine. There he pulled off a second escape—this time, an intellectual one—when he joined a virtual poster session last week at the Lunar and Planetary Science Conference in Houston to present research about an iron meteorite recovered in 2021 in Sweden. When attendees learned about his plight, he says, “it became impossible to speak about science.” On the spot, several European colleagues offered to host him in their labs. “I’m grateful,” Golubov says, but he doesn’t intend to leave Ukraine.

As the Russian onslaught intensifies, civilian casualties are mounting and infrastructure is taking a pounding, including scientific facilities. One day after a deadly missile strike on a maternity hospital on 9 March in Mariupol, shells fell on the city’s Pre-Azov State Technical University and on the Kharkiv Institute of Physics and Technology, damaging a linear accelerator and a subcritical nuclear reactor that generates neutrons for experiments. That same day, Russian forces overran and destroyed the Institute of Irrigated Agriculture in Kherson, its director told local media.

Several days earlier, a rocket strike on Kharkiv's city administration building blew out the windows of a KNU building on the other side of Freedom Square. "Broken glass everywhere and not a soul," Vadym Kaydash, director of KNU's Institute of Astronomy, emailed staff after visiting the scene the next day. When the missile hit, says Glib Mazepa, who lives three blocks from the square, "Our building started swaying like a ship in a storm." A graduate student at the University of Lausanne and Uppsala University, Mazepa returned to his native Kharkiv last year to save money, he says, as he finishes a Ph.D. on frog evolution.

As the Russian bombing of Kharkiv grinds on, Mazepa is working with friends to secure collections in the city's museums and universities, one of a number of frantic efforts nationwide to safeguard specimens and research samples (see story, p. 1210). Mazepa and his wife have also learned a grim new skill that's in high demand in Kharkiv these days: making Molotov cocktails.

Veronika Lipatova, a KNU astronomer and member of Golubov's asteroid modeling group, initially served as a volunteer medic, sourcing medicines and triaging wounded soldiers while her colleagues moved computers and astronomical cameras into a cellar that was used to safeguard equipment when Nazis occupied Kharkiv during World War II. Last week, Lipatova evacuated with Golubov to western Ukraine, but keenly regrets that decision. "I'm here, safe. My friends in Kharkiv aren't. I feel bad," she says, fighting back tears. "Like I'm not a good human for leaving."

Some Russian scientists are ashamed of the war their nation is waging. "It's a very bad feeling when you can't do anything to stop it," says Ilya Schurov, a mathematician with the Higher School of Economics University in Moscow. "It's a moment in which you find yourself in hell." He and his wife joined a street protest on 27 February that he had publicized on social media. He also signed two letters denouncing the war. After learning the police were looking for him, the couple found seats on a flight to Tajikistan, and then flew on to Istanbul. "My professional life is ruined," Schurov says. But he doesn't regret taking a stand—nor does he plan to return to Russia anytime soon.

With President Vladimir Putin's increasingly totalitarian regime cracking down on protestors, many Russian scientists may be too frightened to speak out. KNU astronomer Irina Belskaya, who knows many Russian scientists from conferences and past collaborations, says she heard from just one,

in Moscow, who congratulated her on International Women's Day on 8 March. "I replied, 'Do you realize now there's a war? Russia is bombing Kharkiv University.' He wrote back simply that he did not vote for Putin."

Others may be oblivious to the true nature of the war, with Russian state media pushing propaganda and disinformation. The National Research Foundation of Ukraine says it emailed 49,000 Russian scientists with an appeal to speak out against the war. The vast majority did not respond; many who did sent responses the foundation claimed were "obscene, full of imperial malice and chauvinism." Mazepa says he got a similar reaction when he emailed Russian friends and colleagues from joint expeditions and projects. "These people don't respond, or [they] say, 'Bullshit, you are not being bombed, it's a liberation,'" Mazepa says. "I always imagined it

would be the role of scientists and artists to speak out, but to me it looks like the majority of Russian scientists are supporting this nightmare."

Although he has not taken up arms, Golubov is engaged in the fight. After wrapping up his conference presentation, he got back to posting war updates on Facebook and reassuring worried friends that he's still alive. (KNU's Facebook page notes that two of its professors and a student have been killed.) He's particularly proud of some computer jocks in his institute who he claims hacked into a Russian state TV broadcast to show brief video clips of atrocities committed against Ukraine—and dead Russian soldiers. "At the moment, this is more important than creating computer programs for simulating astronomical objects," he says.

The war's scars are likely to linger. After 1 week huddling in a bunker, Volodymyr Nemchenko, a 73-year-old computer scientist from Kharkiv National University of Radio Electronics, escaped with his wife to Luxembourg, where his son lives near an airport. "Every time a plane comes near, we're afraid," Nemchenko says. When they hear a loud noise, like a door slamming, "we're shocked," he says.

The outcome of the war is far from certain. But Kravchenko, for one, knows what she will do if Ukraine prevails. "I'm crystal clear that I want to go home," she says. "My city may be ruined, but we will build it back." Golubov too is optimistic. "Ukrainians are more united than ever," he says. "When the war ends, and we're able to return to science, it will be the best science we've done in our lives." ■

With reporting by Andrew Curry and Rodrigo Pérez Ortega

EUROPE

Ukrainians rush to save 'irreplaceable' collections

Researchers hide ancient weapons and bat skulls, upload data as bombs fall

By Andrew Curry

On the morning of 24 February, conservation biologist Anton Vlaschenko awoke to the sound of shelling outside his apartment in Kharkiv, Ukraine. The first thing he did was eat a big breakfast. Then, he headed straight to the Ukrainian Bat Rehabilitation Center, the largest bat rescue and research facility in Eastern Europe. "I didn't know if we would return home, or what would happen next," he says. "But I understood the war had begun, and we needed to do something."

Worried that the city's power would be cut, Vlaschenko spent the next 24 hours transferring hundreds of rescued bats hibernating in the center's refrigerators to special cages for release. As the winged mammals flew into the frigid night to look for new spots to spend the remaining winter, Vlaschenko heard gunfire: the first Russian troops to enter the city outskirts were clashing with the Ukrainian army.

Next, Vlaschenko moved the center's collection of more than 2000 *Nyctalus noctula* bat skulls—each carefully padded with shredded newspaper and labeled and stored in a numbered matchbox—to his apartment, an hour's walk away. More than a week later, the skulls were still there, wrapped in plastic shopping bags by the door in case they need to be moved again in a hurry. He also brought home rescued bats too sick to release.

"We had a huge explosion close to my home 2 days ago," Vlaschenko said in a call last week from his apartment, the peeps of bats audible in the background. "You never know what moment you could be hit."

As war rages, Vlaschenko and researchers across Ukraine are scrambling to protect, hide, or evacuate irreplaceable specimens, collections, and data, and uploading 3D scans of specimens to colleagues abroad. For heritage experts, the threat to Ukraine's

"My city may be ruined, but we will build it back."

Maryna Kravchenko,
Kharkiv National University



Anton Vlaschenko holds a rescued bat at his home in Kharkiv while news coverage plays on his cellphone.

scientific collections and cultural monuments is frighteningly familiar from recent conflicts in Iraq, Syria, Mali, and elsewhere. “How do you protect museums? You can’t move the buildings, or the infrastructure,” UNESCO World Heritage Centre Director Lazare Eloundou Assomo says. “You try to protect collections by relocating them to shelters or refuges, where you have to hide and store them until the war is finished.”

But not all collections can be easily moved. With colleagues, Kharkiv National University herpetologist Oleksandr Zinenko helps curate 20,000 birds and 8000 amphibians and reptiles collected over the past century, many stored with countless invertebrate specimens in wood and glass cases lining the arched halls of the university’s natural history museum. “The collection is a time machine to look at the changing conditions of the past. It’s irreplaceable,” says Zinenko, who is now in Lviv. “It needs to be protected, but you cannot just put it in your pocket and go away. How do you choose what to save?”

Colleagues still on the ground in Kharkiv says the museum building, built in 1905, is still standing, but bomb strikes blew out many of its windows, and temperatures have plummeted to -10°C as snow blankets the ground outside. “Some employees [are] living in the museum and guarding the collections right now,” Zinenko says. “Part of me feels I should be there too.”

In a blog post days after the Russian invasion began, National Museum of the History of Ukraine Director Fedir Androshchuk said his museum in central Kyiv had dismantled exhibitions with artifacts such as Scythian weapons and a mammoth tusk bracelet from the last ice age and moved them to secure spots. Androshchuk fears “eventual damages caused by rocket strikes, shelling and bombing,” he wrote in an email to *Science* last

week. “There is no guarantee that Ukrainian heritage will be safe.”

In the early days of the war, when some predicted Kyiv would fall quickly, it wasn’t clear how much time museum staff had. “They were working against the clock,” says Mads Holst, director of the Moesgaard Museum in Aarhus, Denmark, who has been in touch with Androshchuk since the war began.



A plinth from the 10th century C.E., now on exhibit in Denmark, bears the trident emblem used as a Ukrainian national symbol today.

In what Holst calls a “happy accident,” more than 1000 objects from the National Museum of the History of Ukraine and regional museums had already been shipped to his museum for an exhibit, *Rus—Vikings in the East*. “There are burial assemblages, hoard finds—they’re quite significant objects,” Holst says. “There’s still quite a lot to be explored and researched about [them.]”

Many Ukrainians view the period between

800 and 1050 C.E., when Kyiv was founded as a Viking trading outpost, as the beginning of their national identity—an interpretation many Russians, including President Vladimir Putin, deny. Now secure and on display in Denmark, “these objects are part of this conflict, which is partly about whether Ukraine is allowed to have an independent historical identity,” Holst says.

Other researchers are turning to fragile internet connections to save their collections digitally. Pavel Gol’din, an evolutionary zoologist at the Schmalhausen Institute of Zoology in Kyiv, is far from the front lines—for now—in the southwestern Ukrainian city of Chernivtsi. His work relies in part on massive cetacean fossils 10 meters long or more, which would be nearly impossible to move.

Over the past 2 years, he led a project to scan marine mammal fossils from collections housed across Ukraine. “We created a 3D archive of extinct and extant specimens, some unique, ... [including] four terabytes of data—it’s quite a big collection.”

When war broke out, the scans were mostly on hard drives in Kyiv and Kharkiv. Last week, to make sure at least the scans survive, Gol’din’s graduate student Pavlo Otriazhy, then in Kharkiv, transferred data to colleagues in France in the midst of Russian bombardments, a gigabyte every 10 minutes or so. When his internet connection became too unstable, Otriazhy took regional trains to reach Dnipro, 200 kilometers to the south, hard disks in his bag, and kept uploading. “If something happens to me, other scientists can still access [the scans]. That’s much safer than on a hard disk.”

Gol’din and Otriazhy are working to help avert a repeat of the catastrophes that befell paleontology during World War II, when bombs and fire destroyed countless fossils in museums from Munich to Milan and Kyiv. “I think we will win,” Gol’din says. “We will be able to start again.”

Back in Kharkiv, Vlaschenko’s bat center has lost just a few windows and its power is still on. The center’s veterinarian and a few volunteers have stayed in the city to care for bats too sick to release. Vlaschenko says the bat collections in his apartment and at the center represent decades of work—and the hope that Ukrainian science can recover after the war.

“When something like this happens the specimens that survive are crazy important for future research,” Vlaschenko says. “You can buy new equipment or build new buildings, but you can’t get back individual specimens.” ■