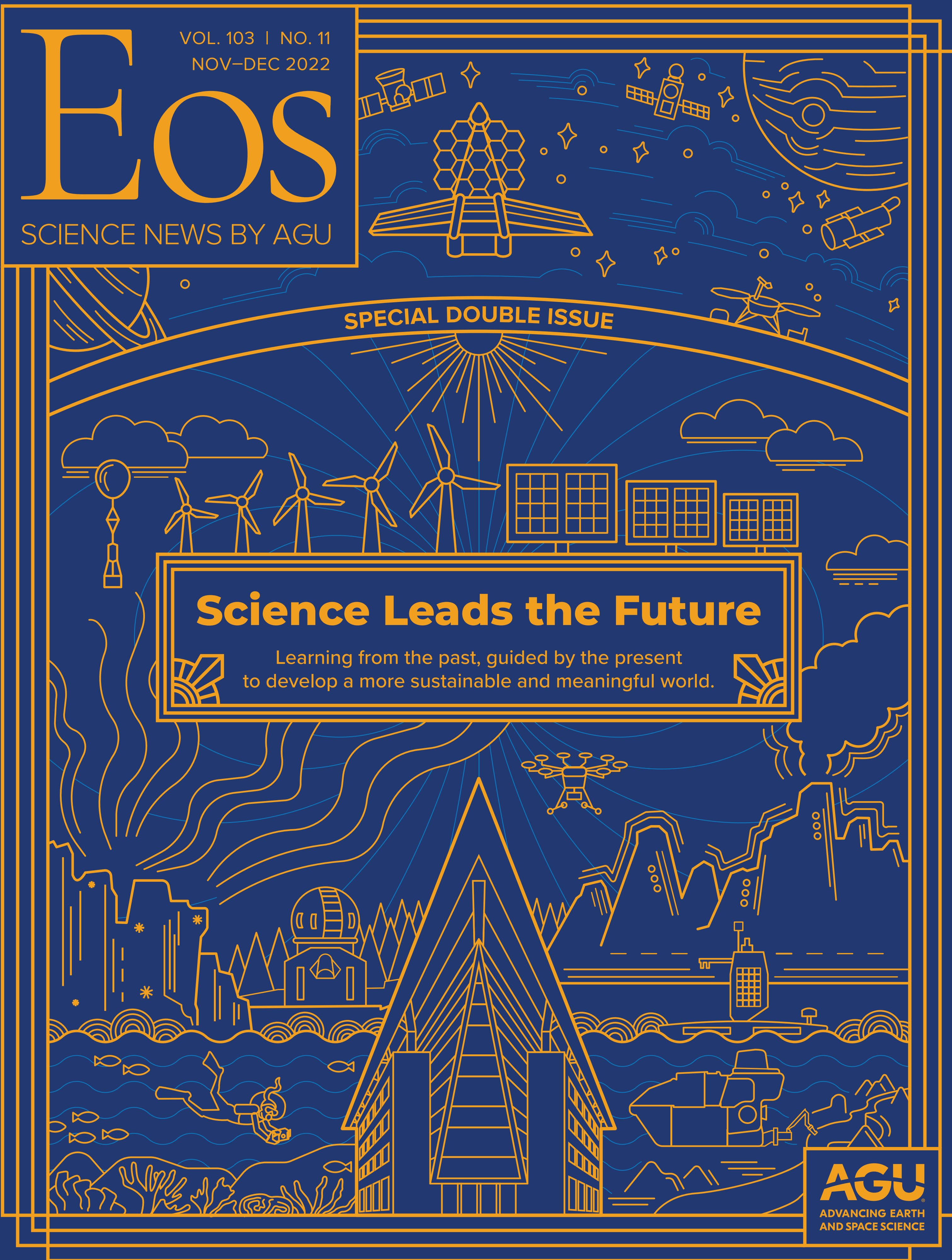
Eos

SCIENCE NEWS BY AGU

VOL. 103 | NO. 11

NOV–DEC 2022



SPECIAL DOUBLE ISSUE

Science Leads the Future

Learning from the past, guided by the present to develop a more sustainable and meaningful world.

AGU

ADVANCING EARTH AND SPACE SCIENCE

Specimens of the shaggy, soft-haired mouse Abrothrix hirta *show differences in size based on which side of the Andes Mountains they live. Credit: Pablo Teta*

rain shadow effect. This study "adds to a growing literature that uses mountain systems for understanding the effects of climate and vegetation change on species evolution and adaptation," said Anderson Feijó, a bioecologist at Beijing's Institute of Zoology at the Chinese Academy of Sciences. "The rain shadow effect is one of several examples of how mountains shape the environment of a region and ultimately affect the animals and plants living there." Feijó was not involved with this research.

As with all environments, climate change will likely have significant impacts on the ecologies of mountain regions and thus on the evolution of mountain species. Some climate models predict that the western Andean slopes will become wetter at higher elevations, resulting in larger mice farther up the mountains, de la Sancha said, whereas the Patagonian grasslands will become warmer and more arid, resulting in even smaller eastern mice. Mice that adapted to the ecologies of their side of the mountain might soon find that their environments no longer meet their needs.

"Their finding…reveals the strong connection between animals and their habitats, even across a short scale," Feijó said. "Consequently, one may expect that environmental changes, such as those linked to global warming, might reduce the fitness of animals in their own natural habitats."

By **Kimberly M. S. Cartier** (@AstroKimCartier), Staff Writer

Impact Crater off the African Coast May Be Linked to Chicxulub

In the world of impact craters, Chicxulub is a celebrity: The 180-kilometer-diameter maw in the Gulf of Mexico was created by a cataclysmic asteroid impact at the end of the Cretaceous that spelled the demise of most dinosaurs. Now researchers have now uncovered another crater off the coast of Guinea that might well be Chicxulub's cousin.

The newly discovered feature is also about 66 million years old. That's a curious coincidence, and it has scientists wondering whether the two impact structures might be linked. Perhaps Chicxulub and the newly discovered feature—dubbed Nadir crater—formed from the breakup of a parent asteroid or as part of an impact cluster, the team suggests in a new study in *Science Advances* (bit.ly/impact-structures).

Rocks of Concern

Every day, tons of cosmic dust rain down on our planet. That microscopic debris poses no danger to life on Earth, but its larger brethren are very much cause for concern: A space rock measuring hundreds of meters in size is apt to cause regional destruction, and the arrival of something measuring kilometers in size could spell global havoc.

That's what happened 66 million years ago when a roughly 12-kilometer-wide asteroid slammed into a shallow reef in the Gulf of Mexico. That event, now known as Chicxulub after the small town that's grown up nearby in Mexico, launched shock waves, powerful tsunamis, and blasts of superheated air that decimated life in the vicinity. Airborne particles—bits of dust, soot, and sulfate aerosols born from the sulfur-rich rocks that existed at the Chicxulub impact site—choked the atmosphere and plunged the entire planet into a sunlight-starved "impact winter" that lasted for years. When the air finally cleared, more than 75% of all species had gone extinct.

The newly discovered Nadir crater appears to have formed around the same time as that cataclysm. Uisdean Nicholson, a sedimentary geologist at Heriot-Watt University in Edinburgh, Scotland, and his colleagues discovered the candidate crater while they were poring over observations of seafloor sediments originally collected for oil and gas exploration. The team spotted the roughly 8-kilometer-wide structure in seismic reflection imaging data obtained off the coast of West Africa. "It was pure serendipity," said Nicholson.

Signs of an Impact

The putative crater is buried under roughly 300 meters of sediments topped by 900 meters of water, and its appearance strongly suggests it was created by a hypervelocity impact, said Nicholson. For starters, it's circular in shape, with a pronounced rim. Second, it contains a small central peak, a feature that often arises in large impact craters. And perhaps most important, there's clear evidence of deformed sediments—caused by faulting and folding—persisting hundreds of meters below what would be the crater's floor. "There are a lot of things that suggest it's an impact," said Gavin Kenny, a geochemist at the Swedish Museum of Natural History in Stockholm who was not involved in the research.

"It was pure serendipity."

Numerical simulations run by team member Veronica Bray, a planetary scientist at the University of Arizona, have suggested that the impactor was about 400 meters in diameter. The arrival of such an object moving at roughly 20 kilometers per second would have produced tsunami waves more than a kilometer high and ground shaking equivalent to that of a magnitude 7 earthquake, Bray estimated. But the mayhem that ensued, intense as it was, was mostly limited to a regional scale, said Bray. "This wasn't a global killer."

On the basis of assemblages of microfossils unearthed close to Nadir crater, Nicholson and his colleagues estimated that this feature formed at or near the end of the Cretaceous period. But it's too simplistic to assume that a pair of gravitationally bound asteroids—a binary asteroid—formed Chicxulub and Nadir crater in a one-two punch, the authors suggested. That's because of the extreme distance between the two sites 66 million years ago: roughly 5,500 kilometers. (They're even farther apart now—about

Scientists hope to drill into a newly discovered impact crater off the west coast of Africa to explore whether and how it's linked to the famous Chicxulub impact 66 million years ago. Credit: iStock.com/guvendemir

8,000 kilometers—because of spreading of the Atlantic seafloor.) Binary asteroids tend to hit much closer to one another: The one example on Earth of a so-called "impact doublet" formed by a binary asteroid is characterized by craters just a little over 10 kilometers apart. "So Chicxulub and Nadir couldn't have formed from a direct hit of a binary asteroid," said Nicholson.

"There are a lot of things that suggest it's an impact."

Looking to Jupiter

A more likely scenario, Nicholson and his collaborators suggested, is something akin to what happened to comet Shoemaker-Levy 9. In 1992, the roughly 2-kilometer-diameter comet fragmented into more than 20 pieces after passing very close to Jupiter. Two years later, those fragments slammed into the gas giant over the course of several days, creating a series of dark scars that stretched across a wide swath of the planet.

Perhaps a similar breakup of a common parent asteroid occurred near Earth 66 million years ago, Nicholson and his colleagues proposed. An asteroid—there's good evidence that the Chicxulub impact was due to an asteroid rather than a comet—orbiting Earth could have been torn apart by our planet's gravity. Those fragments could have then dispersed sufficiently in space to smash into Earth within days of each other yet in widely separated locations, the researchers suggested.

Another possibility is that one or more asteroids collided somewhere in deep space—most likely in the asteroid belt between Mars and Jupiter—and an ensemble of cosmic shrapnel traveled en masse to Earth. The result would have been an uptick in cratering that persisted not over days, as in the case of the breakup of a common parent asteroid, but over a million or so years. Scientists are aware of only one such event—known as an impact cluster—in Earth's history, and it occurred roughly 460 million years ago. "We think an asteroid parent body broke up somewhere in the solar system and sent material flying toward Earth," said Kenny.

The impact cluster scenario might be more likely, Nicholson and his colleagues suggested, because a third large crater—the 24-kilometer-diameter Boltysh crater in central Ukraine—also dates to around 66 million years ago. Research published last year suggested that Boltysh formed just 650,000 years after the Chicxulub impact (bit.ly/Boltysh-crater).

There's also the possibility that Nadir crater was simply created by an unrelated impact, Nicholson and his colleagues acknowledged. Perhaps a stroke of bad cosmic luck led to Earth being pummeled twice in relatively close succession.

Going Deep

It's clearly key to more precisely constrain the age of Nadir crater, Nicholson and his collaborators maintain. Right now, the uncertainty in the structure's age is about a million years, too large to discriminate between the breakup of a common parent asteroid and impact cluster scenarios.

Drilling sediment cores from the crater would allow scientists to look for stratigraphic signatures like the iridium layer from Chicxulub that could yield a much more precise date. Nicholson and his colleagues recently submitted a drilling proposal to the International Ocean Discovery Program to do just that.

By **Katherine Kornei** (@KatherineKornei), Science Writer