



and a member of the constitutional assembly that created the draft. The causes of the unrest that led to the reform process have yet to be fixed, she adds.

In October 2019, what began as protests against a metro-fare increase in Chile's capital, Santiago, rapidly evolved into a nationwide outcry against decades-long social and economic inequalities. Thousands of Chileans rallied in the streets, demanding political reform. They saw the current constitution as the source of many problems. And a year later, the country voted to replace the document.

For Laura Ramajo, a climate scientist at the Centre for Advanced Studies of Arid Zones in La Serena, the vote against the draft can't be the end of the story. "Many of those articles in the new constitution regarding the environment were necessary," she says.

Chile is particularly vulnerable to the effects of global warming, research has shown. In northern Chile, food insecurity and water scarcity have become major issues<sup>1</sup>.

In central Chile, longer and more frequent heatwaves have been taking a toll: since 2010, a rainfall deficit has created a 'mega-drought' there, affecting the livelihoods of more than ten million people<sup>1</sup>. And in the southern region, Patagonia, the number of wildfires has grown at an alarming rate<sup>2</sup>.

And yet, Chileans voted against the draft. Preliminary surveys suggest some did so because they thought the changes would bring instability to the nation. Others saw the constitutional assembly that drafted the document – mostly made up of citizens such as scientists, students and artists, including representatives of Indigenous groups – as flawed. An August survey by Paris-based market-research firm Ipsos suggests that people would be more accepting of a document crafted by experts in constitutional law, with only help from citizens. Many more disagreed with some of the proposed articles – such as those that would have protected reproductive rights, given autonomy to at least 11 groups of the nation's Indigenous peoples or eliminated the Senate.

"Any of the 388 articles you didn't like were 388 opportunities to reject" the new constitution, says Andrea Peroni, a historian and public-policy researcher at the University of Chile in Santiago.

### Chileans still want change

Felipe Paredes, a Chilean biochemist at Emory University in Atlanta, Georgia, was one of the millions of people who disliked the proposed document. He agreed with some of it, such as the way it prioritized social and human rights, but he also felt things were missing.

For example, the draft did not include any mention of funding for science. "I needed a clear signal that there was going to be more investment. I did not see that," Paredes says.

He also wanted to see explicit protection of patents and industrial property rights, which is included in the current constitution. Without that, private investment might be driven away from Chilean science, he says.

Still, he strongly supports replacing the 1980 constitution. Even though the proposed text was rejected, he hopes politicians will realize that Chileans still want change.

At the very least, researchers say, the process of drafting a new constitution has initiated talks about science and how it should

be linked to the country's development. "Everything we discussed about the role of science in the climate emergency, how we do science, at what pace, for whom – that's never happened before," says Vera Gajardo. "We can't lose that."

1. Hagen, I. et al. *Environ. Res. Lett.* **17**, 033002 (2022).
2. Castellanos, E. J. et al. in *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (eds Pörtner, H.-O. et al.) Ch. 12 (Cambridge Univ. Press, 2022).

## PREHISTORIC CHILD'S AMPUTATION IS OLDEST SURGERY OF ITS KIND

Skeleton missing its lower left leg provides the earliest known evidence for surgical limb removal.

By McKenzie Prillaman

**T**he skeleton of a person who lived 31,000 years ago bears hallmarks of the deliberate removal of their lower left leg – the earliest known evidence of surgical amputation<sup>1</sup>.

Found on the island of Borneo, the remains pre-date the previous oldest known case of limb amputation<sup>2</sup> by more than 20,000 years. They suggest that the individual survived for several years after the surgery. The finding was published on 7 September in *Nature*.

Archaeologists once described southeast Asia "as a cultural backwater", says study co-author India Dilkes-Hall, an archaeologist at the University of Western Australia in Perth.

"There's always been this trope that not a lot happened there." But the find challenges this idea, showing that people living in Borneo millennia ago were highly skilled at medicine.

### Written in the bone

The researchers found the remains in a limestone cave in the Indonesian part of Borneo. They uncovered an ancient grave containing a human skeleton that was surprisingly complete – except for the left foot. "All of us were like, 'well, where is it?'" says Dilkes-Hall.

Radiocarbon dating of charcoal found in the layers above, below and inside the grave, as well as analysis of one of the buried individual's teeth, suggests that the person died between 31,201 and 30,714 years ago. Their age



Human leg bones dated to some 31,000 years ago show healed amputation sites.

at death was estimated to be 19 or 20 years old. The team could not determine the individual's sex, but their height was similar to that of men who lived in that time and place.

The lower third of the person's leg was missing, and the bones between the knee and ankle ended in a clean cut. This level of precision indicates that the limb was not lost in an accident or an animal attack. The bones lacked the type of mark typically left by an infection, suggesting that the wound had been cleaned and protected from contamination. Furthermore, the small size of the left tibia and fibula compared with the right ones, as well as the healing of the bones, show that the amputation occurred during childhood and at least six to nine years before death.

"The probability of this happening by accident was so infinitely small that it had to be in some sort of controlled environment," says study co-author Melandri Vlok, a bio-archaeologist at the University of Sydney in Australia.

"It is an incredible discovery," says Cécile Buquet-Marcon, a bio-archaeologist at the French National Institute for Preventive Archaeological Research in Paris who, in 2007, described the amputation of a person's limb that had occurred 7,000 years ago, which was at the time the oldest known evidence of this type of surgery<sup>2</sup>. She adds that the survival of the individual in Borneo indicates care-giving by the community and medical skills that few people possess even now.

### Changing times

This proof of early human habitation in Borneo is especially important for Indonesian archaeologists, says study co-author Adhi Agus Oktaviana, an archaeologist at the National Research and Innovation Agency in Jakarta. He hopes that the study will help the United Nations cultural organization UNESCO to designate the region where the remains were found – also home to 40,000-year-old rock art<sup>3</sup> – as a World Heritage Site.

Sofia Samper Carro, an archaeologist at the Australian National University (ANU) in Canberra, who was not involved in the research but was part of the same doctoral programme at ANU as study co-author Tim Maloney, commends the researchers for their meticulous scientific efforts and their collaboration with local authorities and people. Several of the study's co-authors are from Indonesia.

In many past archaeological efforts, "Western Europeans would go to places and steal their knowledge", she says. "In the last 10–15 years, things have been changing."

Because the field is now recognizing the work of local people, Samper Carro adds, "we are getting much better results".

1. Maloney, T. R. et al. *Nature* **609**, 547–551 (2022).

2. Buquet-Marcon, C., Philippe, C. & Anaick, S. *Nature Prec.* <https://doi.org/10.1038/npre.2007.1278.1> (2007).

3. Aubert, M. et al. *Nature* **564**, 254–257 (2018).

# FISHING GEAR FROM JUST A FEW PLACES FILLS OCEAN 'GARBAGE PATCH'

The bulk of large plastic bits in the North Pacific garbage patch were lost or discarded by fishers.

By Freda Kreier

**F**ishing gear from just five regions could account for most of the floating plastic debris in the 'North Pacific garbage patch', a vast swathe of the North Pacific Ocean that holds tens of thousands of tonnes of plastic.

A study published on 1 September in *Scientific Reports* found that up to 86% of the large pieces of floating plastic in the garbage patch are items that were abandoned, lost or discarded by fishing vessels (L. Lebreton et al. *Sci. Rep.* **12**, 12666; 2022). The finding is counter-intuitive, given that most marine plastic makes its way into the ocean through rivers.

These findings "change our understanding of the sources of plastic in the North Pacific garbage patch", says Matthias Egger, an ocean plastic researcher at the Ocean Cleanup, a non-profit organization based in Rotterdam, the Netherlands, that develops techniques for removing plastic from the ocean. The information could shape policy to reduce marine plastic pollution, he says.

### A sea of plastic

The contaminated area was discovered in 1997 when a ship's crew noticed plastic littering a remote stretch of the open ocean. The plastic accumulates where ocean currents converge, forming a 'garbage patch' that

some researchers estimate includes 1.8 trillion pieces of plastic. Turtles and animals sometimes mistake the plastic for food.

In 2018, a survey found that fishing nets made up nearly half of the debris (L. Lebreton, et al. *Sci. Rep.* **8**, 4666; 2018). The nets clearly came from fishing vessels, but the researchers couldn't determine the source of the rest of the area's plastic. So, in 2019, the Ocean Cleanup collected more than 6,000 floating items from the patch, and analysed the debris for letters and logos to pin down its origins.

The team was able to track down the regions of origin of 232 objects. One-third of the identified debris came from Japan – possibly in part because of the tsunami that hit the country in 2011 – with the rest split between Taiwan, the United States, South Korea and the Chinese mainland, Hong Kong and Macau.

Notably absent from the debris were items from nations with lots of plastic pollution in their rivers. This was surprising, says Egger, because rivers are thought to be the source of most ocean plastic. Instead, most of the garbage-patch plastic seemed to have been dumped into the ocean by passing ships.

This suggests that "plastic emitted from land tends to accumulate along coastal areas, while plastic lost at sea has a high chance of accumulating in ocean garbage patches", Egger says. The latest results and the large proportion of the debris made up by fishing nets indicate that fishing – spearheaded by the five countries and territories identified in the study – is the main source of plastic in the North Pacific garbage patch.

### Fishing for rubbish

"What this paper and other investigations have shown is that there is really one sector – fishing – responsible for this plastic," says Lisa Erdle, director of science at the 5 Gyres Institute, an ocean-research organization in Los Angeles, California. Knowing how plastic ends up in various environments can help to inform clean-up tactics, she says.

This information could also be used to shape the United Nations Treaty on Plastic Pollution, which has been under negotiation since March 2022, says Egger. But more directly, "the findings highlight the vital role of the fishing and aquaculture industries in making ocean garbage patches a relic of the past", he says.



Japanese text on a crate from the North Pacific garbage patch indicates its origin.