

THE LOST COLONY

Some 900,000 king penguins vanished without a trace. Why?

By **Eli Kintisch**

Where on Earth, wondered Henri Weimerskirch, were all the penguins? It was early 2017. Colleagues had sent the seabird ecologist aerial photos of Île aux Cochons, a barren volcanic island half-way between Madagascar and Antarctica that humans rarely visit. The images revealed vast areas of bare rock that, just a few decades before, had been crowded with some 500,000 pairs of nesting king penguins and their chicks. It appeared that the colony—the world’s largest king penguin aggregation and the second biggest colony of any of the 18 penguin species—had shrunk by 90%. Nearly 900,000 of the regal, meter-high, black, white, and orange birds had disappeared without a trace. “It was really incredible, completely unexpected,” recalls Weimerskirch, who works at the French national research agency CNRS.

Soon, he and other scientists were planning an expedition to the island—the first in 37 years, and only the third ever—to search for explanations. “We had to go see for ourselves,” says CNRS ecologist Charles Bost.

As the researchers prepared for the journey, they had to grapple with the logistical, political, and scientific challenges that have long bedeviled biologists trying to understand Antarctica’s remote ecosystems. The vast distances, rough weather, and rugged terrain make travel difficult and expensive. They needed a ship—and a helicopter, because frigid seas and rocky shores make for perilous boat landings on Antarctic islands. Complying with the tough permitting and biosecurity rules governing the French-controlled island—

meant to prevent researchers from disturbing fragile ecosystems—required careful planning and paperwork that took months to complete. And once they arrived, they would have precious little time: just 5 days to investigate a multitude of suspects in the disappearance, including disease, predators, and a warming Southern Ocean.

In all likelihood, they would never be able to return. “We knew this was going to be a one-shot expedition,” recalls conservation biologist Adrien Chaigne, an expedition organizer who works for the National Nature Reserve of the French Southern and Antarctic Territories, which manages the island. “It was a real kind of pressure.”

CONSTRAINTS LIKE THAT have long faced biologists seeking to understand life at the remote bottom of the planet. Two centuries ago, researchers wanting to visit the region had to tag along with explorers, whalers, or seal hunters. The Adélie penguin, for example, was first identified by a naturalist who joined an 1837 expedition to southeastern Antarctica led by the French explorer Jules Dumont d’Urville, who named the place Terre Adélie after his wife. The harrowing voyages rewarded them with surprises: In 1895, botanists certain no plant could survive the frigid Antarctic were shocked to discover lichens on Possession Island, near Île aux Cochons.

Today, modern research budgets and a network of polar research stations have made Antarctica more accessible. Biologists have flocked to the region to tackle an array of fundamental questions, including how animals evolved to survive subzero temperatures and how ecosystems are organized in the vast, productive Southern Ocean. Cli-



The king penguin throngs on Île aux Cochons in November 2019 were a fraction of their past size.

mate change, which has made the Antarctic one of the fastest changing places on Earth, has inspired studies of shifting ice and acidifying seas. The potential for discovery makes the region addictive, says marine biologist Deneb Karentz of the University of San Francisco. “Once you go as a scientist you always want to go back.”

But even today, Antarctic research is challenging. “If it takes you 2 hours to collect samples back home, it could take 10 in Antarctica,” Karentz says. Holes drilled in sea ice to collect samples, for example, often need poking to remain open. The harsh conditions can claim valuable gear. In 1987, shifting sea ice swept away a plexiglass frame Karentz was using to study microorganisms beneath the surface. She scrambled to replace it with materials scrounged from a nearby research station. In Antarctica, she says, “You have to be resourceful.”

SUCH LESSONS weren’t lost on Weimerskirch and Bost, both veterans of Antarctic research, when a helicopter from the *Marion Dufresne*, a French research vessel, delivered the pen-

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guin researchers and their 700 kilograms of gear to Île aux Cochons in November 2019. It was the middle of king penguin nesting season, and they were greeted by the raucous honking and chirping of tens of thousands of chicks. They also saw vast empty swaths of bedrock, where previous generations of birds had scraped away the soil. The scientists estimate penguins once stood flipper to flipper on some 67 square kilometers of ground that is now abandoned.

The researchers were eager to find out what had caused those losses. King penguins, numbering 3.2 million birds in the Antarctic region, aren't in immediate danger; in fact their numbers are mostly rebounding from centuries of human hunting. By contrast, half the world's penguin species are threatened (see graphic, p. 1320), and several have recently experienced disturbing die-offs. But big losses of even relatively healthy species could point to broader threats, which is why the calamity on Île aux Cochons triggered alarm bells.

King penguins should be relatively easy to study. Unlike their ice-bound cousins,

such as emperor penguins, king penguins live on islands dotting the subantarctic region. That means they can be reliably and repeatedly counted in satellite images over time, and scientists can camp alongside their breeding colonies to observe them. (Other ice-dependent species, like emperor penguins, are more peripatetic.) During

the lengthy breeding season, the parents trade off tasks, with one incubating eggs or rearing fluffy brown chicks while the other heads to sea to catch fish and other sea creatures. These foraging round-trips can cover 500 kilometers or more, electronic tags attached to the birds have shown.

The researchers' first priority was to attach such tags to 10 penguins, to see whether foraging changes might have contributed to the losses. It wasn't easy.

The team's permits stipulated they utilize just one well-trodden trail and operate only on the edge of the colony. Breaks in the rain allowed the scientists to glue transmitters on the birds' feathers.

Other researchers, meanwhile, set up traps, cameras, and night-vision optics to look for cats and mice, which were introduced by whalers or sealers long ago and are known to eat seabird eggs and chicks. The scientists also took samples of penguin blood, to be screened later for diseases and other data. And they collected feathers and dug up penguin bones that



could yield further ecological clues, including dietary changes.

"The first 2 days were intense," Chaigne says. "We knew it was possible that bad weather could end the expedition any day." Luckily, they avoided serious storms, and by the end of their fifth day the researchers had tagged the penguins and gathered the samples they sought.

REAMS OF DATA remain to be digested. But the researchers have already ruled out some possible explanations for the massive penguin decline. Land predators, for instance, don't seem to have played a role. Examinations of chicks and adult penguins, as well as excavated bones, revealed no signs of cat or mouse bites, and the team's cameras recorded no attacks. (Rabbits, seen on previous expeditions, were curiously missing.)

Nor, it seems, had the penguins simply moved somewhere nearby. A second smaller colony on the island, a natural site for relocation, had just an estimated 17,000 pairs, not enough to explain the massive drop-off in the main group. And Bost says there's no obvious indication—in satellite images, for instance—that the colony relocated to some other island.

That leaves one main explanation, Bost says: "If the penguins are not here, they died." But what killed them?

Not disease, apparently. The team is waiting on final blood analyses, but they saw few ailing birds or fresh corpses. "We thought we'd see carrion, individuals in bad condition," Chaigne says. But the birds looked healthy.

Instead, he and his colleagues suspect that changes in the surrounding ocean forced the penguins to swim farther to find food. Studies of other king penguin colonies suggest foraging birds from Île aux Cochons normally swim toward an oceanic feature hundreds of kilometers to the south known as the polar front or Antarctic convergence. The front marks the northern extent of the colder Antarctic waters. The penguins are attracted by the many sea creatures that gather at such thermal edges—especially the bird's main prey, lanternfish, which form huge schools some 100 meters or more below the surface.

The polar front doesn't stay in the same place every year. During some years, climate anomalies known as the El Niño-Southern

Oscillation and the Subtropical Indian Ocean Dipole cause ocean waters in the region to warm, and the polar front shifts south, closer to the pole and farther from Île aux Cochons. During the longer foraging trips, hunger might force the parent left back at the colony to leave the nest to feed—leaving chicks vulnerable to predators or starvation. The longer swims might also make the adult penguins more vulnerable to deadly stress and predation. And those anomalous years offer a preview of how the Southern Ocean is expected to warm in the coming decades, steadily shifting the polar front farther south.

Evidence that a warming ocean could threaten the penguins comes from a 2015 study that Bost and his colleagues did at a smaller king penguin colony, on Possession Island, some 160 kilometers west of Île aux

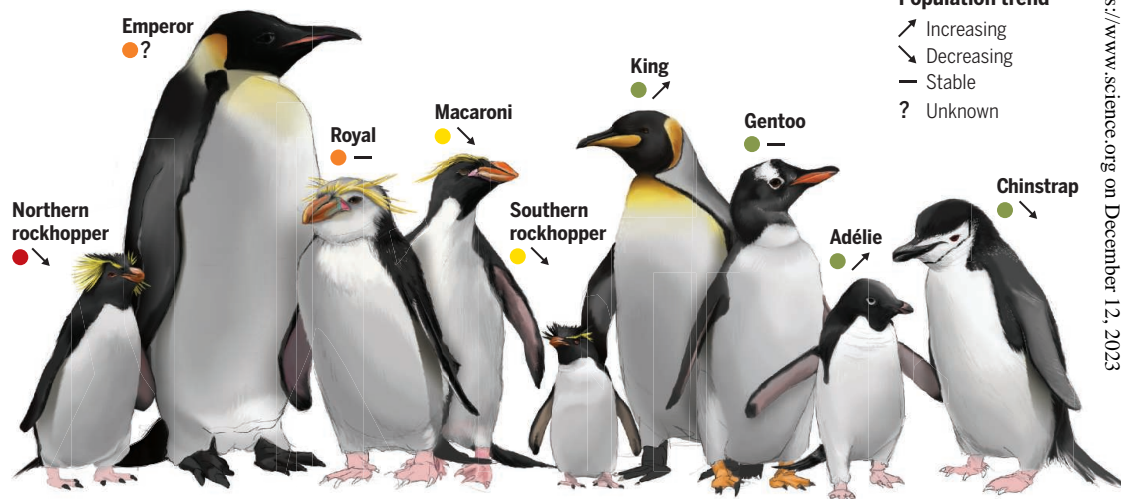
changes could cut king penguin numbers by half by the end of the century.

Whether that scenario explains the Île aux Cochons crash may never be entirely clear. (Another possibility is that the colony just grew unusually large during some bountiful decades, then fell back when conditions became more typical.) But the tags the researchers placed on the 10 penguins during the expedition could offer some new clues. Five are still transmitting and could continue to provide data into early 2021.

Already, the tags have offered some surprises: They show that a few of the penguins headed north—not south—from the island to forage. That could mean the birds are hunting at a different thermal edge, known as the sub-Antarctic front. "It's a small sample size of course," Weimerskirch says, "but it's very interesting." The tag data

Antarctica's birds in plight

"Penguins are in trouble," researchers warned last year in *Conservation Biology*. Populations of more than half of the world's 18 species are declining, they noted, including several of the nine species that live in Antarctica and the sub-Antarctic (below). Threats include habitat loss, drowning in fishing gear, and climate change.



Cochons. The island hosts France's Alfred Faure research station, and less strict biosecurity rules allow researchers to continually monitor the colony and climate and oceanographic conditions. The study, published in *Nature Communications*, analyzed 124 foraging routes taken by 120 tagged birds over 16 years. It found that in years when the polar front moved south, the penguins had to travel hundreds of kilometers farther. During "these very unfavorable environmental conditions," the researchers wrote, "the penguin breeding population experienced a 34% decline."

Building on that study, a 2018 paper published in *Nature Climate Change* forecast that warming seas and other environmental

might also reveal a trend toward longer foraging trips, which could suggest the worrisome forecasts about the impact of climate change are accurate.

The unexpected calamity on Île aux Cochons could be a harbinger of that dire future, researchers fear, and perhaps of declines at other penguin colonies as well. But after their frenzied 5 days on the island, the scientists are resigned to monitoring its birds from afar, knowing that the authorities aren't likely to approve another expedition any time soon. The only glimpses of the penguins' fate will come from occasional helicopter flights over the island and, when clouds cooperate, images snapped by satellites orbiting far above. ■



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Science **367** (6484), . DOI: 10.1126/science.367.6484.1318

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