

# 'Fantastic giant tortoise,' believed extinct, confirmed alive in the Galápagos

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Fernanda, the only known living Fernandina giant tortoise (*Chelonoidis phantasticus*, or “fantastic giant tortoise”), now lives at the Galápagos National Park's Giant Tortoise Breeding Center on Santa Cruz Island. Fernanda, named after her Fernandina Island home, is the first of her species identified in more than a century. Princeton geneticist Stephen Gaughran successfully extracted DNA from a specimen collected from the same island more than a century ago and confirmed that Fernanda and the museum specimen are members of the same species and genetically distinct from all other Galápagos tortoises. Credit:

## Galápagos Conservancy

A tortoise from a Galápagos species long believed extinct has been found alive. The tortoise, named Fernanda after her Fernandina Island home, is the first of her species identified in more than a century.

The Fernandina Island Galápagos giant tortoise (*Chelonoidis phantasticus*, or "fantastic giant tortoise") was known only from a single specimen, collected in 1906. The discovery in 2019 of a female tortoise living on Fernandina Island provided the opportunity to determine if the [species](#) lives on. By sequencing the genomes of both the living individual and the museum specimen, and comparing them to the other 13 species of Galápagos [giant tortoises](#), Princeton's Stephen Gaughran showed that the two known Fernandina tortoises are members of the same species, genetically distinct from all others. He is co-first author on a paper in the current issue of *Communications Biology* confirming her species' continued existence.

"For many years it was thought that the original specimen collected in 1906 had been transplanted to the island, as it was the only one of its kind," said Peter Grant, Princeton's Class of 1877 Professor of Zoology, Emeritus and an emeritus professor of ecology and evolutionary biology who has spent more than 40 years studying evolution in the Galápagos islands. "It now seems to be one of a very few that were alive a century ago."

When Fernanda was discovered, many ecologists doubted that she was actually a native *phantasticus* tortoise. She lacks the striking saddleback flaring of the male historical specimen, though scientists speculated that her obviously stunted growth may have distorted her features. Tortoises can't swim from one island to another, but they do float, and they can be

carried from one Galápagos island to another during hurricanes or other major storms. There are also historical records of seafarers moving the tortoises between islands.

"Like many people, my initial suspicion was that this was not a native tortoise of Fernandina Island," said Gaughran, a postdoctoral research fellow in ecology and evolutionary biology at Princeton.

To determine Fernanda's species definitively, Gaughran sequenced her complete genome and compared it to the genome he was able to recover from the specimen collected in 1906. He also compared those two genomes to samples from the other 13 species of Galápagos tortoises—three individuals from each of the 12 living species, and one individual of the extinct *C. abingdonii*.

"We saw—honestly, to my surprise—that Fernanda was very similar to the one that they found on that island more than 100 years ago, and both of those were very different from all of the other islands' tortoises," said Gaughran, who conducted the analyses after arriving at the University in February 2021.



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In 2019, he was in the lab of Adalgisa Caccone at Yale University, who is the senior author on the paper. "The finding of one alive specimen gives hope and also opens up new questions, as many mysteries still remain," said Caccone. "Are there more tortoises on Fernandina that can

be brought back into captivity to start a breeding program? How did tortoises colonize Fernandina, and what is their evolutionary relationship to the other giant Galápagos tortoises? This also shows the importance of using museum collections to understand the past."

"Part of my postdoc is developing a tool that analyzes DNA from ancient museum specimens so we can compare them to modern samples," Gaughran said.

His tool is flexible enough to work on almost any ancient specimen. "The software doesn't care if it's a seal or a tortoise or human or Neanderthal," he said. "Genetics is genetics, for the most part. It's in the interpretation where it matters what kind of creature the DNA comes from."

At Princeton, Gaughran is working with Andrea Graham and Bridgett vonHoldt to unravel the mysteries of pinniped (seal and walrus) evolution.

"Stephen solves conservation mysteries, in species ranging from tortoises to pinnipeds, with the deft and careful application of genetic and bioinformatic tools," said Graham, a professor of ecology and evolutionary biology.

"He has such a curiosity for discovering the messages and codes tucked away in ancient remains," said vonHoldt, an associate professor of ecology and [evolutionary biology](#). "Stephen has been collecting specimens from several hundred years old to a few thousand, and these really hold the keys for understanding the history of when and how genomes changed over time. It is not surprising to me that he also led the effort to unravel the mystery of Fernanda, the fantastic ghost tortoise that has been rediscovered through molecular research. What a cool discovery!"



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### **A long-standing mystery**

Since 1906, scant but compelling evidence has hinted that giant tortoises

might still live on Fernandina Island, an active volcano on the western edge of the Galápagos Archipelago that is reputed to be the largest pristine island on Earth.

A single specimen of *C. phantasticus*—"the fantastic giant tortoise"—was collected by explorer Rollo Beck during a 1906 expedition. The "fantastic" nature refers the extraordinary shape of the males' shells, which have extreme flaring along the outer edge and conspicuous saddlebacking at the front. Saddlebacking is unique to Galápagos tortoises, and the *phantasticus* tortoise shows it more prominently than the other species.

Since its 1906 discovery, the survival of the Fernandina tortoise has remained an open question for biologists. In 1964, 18 scats attributable to tortoises were reported on the western slopes of the island. Scats and a possible visual observation from an aircraft were reported during the early 2000s, and another possible tortoise scat was seen in 2014.

The island has remained largely unexplored, due to extensive lava fields blocking access to the island's interior.

"Fernandina is the highest of the Galápagos islands, geologically young, and is mainly a huge pile of jagged blocks of brown lava; Rosemary and I once climbed to the top," said Grant, referring to his wife and research partner Rosemary Grant, an emeritus senior research biologist at Princeton. "At [lower elevations](#), the vegetation occurs in island-like clumps in a sea of recently congealed lava. Fernanda was found in one of these, and there is evidence that a few relatives may exist in others."

Scientists estimate that Fernanda is well over 50 years old, but she is small, possibly because the limited vegetation stunted her growth. Encouragingly, recent tracks and scat of at least 2 or 3 other tortoises were found during other recent expeditions on the island.



The Fernandina Island Galápagos giant tortoise (*Chelonoidis phantasticus*, or “fantastic giant tortoise”) was known only from this single specimen, collected in 1906, before “Fernanda” was found in 2019. Now, Princeton geneticist Stephen Gaughran has successfully extracted DNA from this specimen and confirmed that Fernanda and this individual are members of the same species and genetically distinct from all other Galápagos tortoises. Credit: California Academy of Sciences

## **Tortoises of the Galápagos**

Two or three million years ago, a storm carried one or more giant tortoises from the South American mainland westwards. Because they don't swim, the tortoises bred only with others on their own islands,



resulting in rapid evolution—following the pattern of the better-known Galápagos finches. Today, there are 14 different species of giant Galápagos tortoises, all descended from a single ancestor.

(Some scientists debate whether these should be considered species or subspecies, but the Princeton-Yale team concluded that they are different enough, with thousands of distinctive genetic markers, to be separate species.)

Diversification of Galápagos tortoises reveals a continuum of shell shapes, with the easternmost islands showing rounder, domed shells, and the westernmost island—Fernandina—showing the most dramatic saddlebacking. The domed tortoises live in more humid, higher elevation ecosystems, while their saddlebacked cousins inhabit drier, lower elevation environments. All 14 are listed on the IUCN Red List as either vulnerable, endangered, critically endangered or extinct.

The [tortoise](#) populations were decimated by European seafarers who hunted them for food, having discovered that they could keep tortoises alive on their ships with minimal effort, as the reptiles could survive with little food or water. "They were a great source of fresh meat for the sailors, but it meant that many of the species were severely overhunted," said Gaughran. "And because they have such a long generation time, the populations have a hard time recovering quickly."

"The genetic work provides intriguing hints of a mixing of genes with members of another population," said Grant. "It would be fascinating if confirmed by future detective work on the genome. Another thought-provoking finding is the nearest relatives are not on the nearest very large island (Isabela) but on another (Española) far away on the other side of Isabela. The question of how the ancestors reached Fernandina is left hanging."

Fernanda is now at the Galápagos National Park Tortoise Center, a rescue and breeding facility, where experts are seeing what they can do to keep her species alive.

"The discovery informs us about rare species that may persist in isolated places for a long time," said Grant. "This information is important for conservation. It spurs biologists to search harder for the last few individuals of a population to bring them back from the brink of extinction."

"The Galápagos [giant tortoise](#) *Chelonoidis phantasticus* is not extinct," by Evelyn L. Jensen\*, Stephen J. Gaughran\*, Nicole A. Fusco, Nikos Poulakakis, Washington Tapia, Christian Sevilla, Jeffrey Málaga, Carol Mariani, James P. Gibbs and Adalgisa Caccone, appears in the June 9 issue of *Communications Biology*, a *Nature* family journal.

**More information:** The Galápagos giant tortoise *Chelonoidis phantasticus* is not extinct, *Communications Biology* (2022). [DOI: 10.1038/s42003-022-03483-w](#)

Provided by Princeton University

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