EARTH & ENVIRONMENT

Stranded red mangroves thrive inland

Ancient sea level rise displaced a group of normally coastal trees

BY TRISHLA OSTWAL

Nearly 200 kilometers from the sea, red mangroves thrive in the rainforests along the San Pedro Mártir River on the Yucatán Peninsula. But how did these tangled trees that typically grow in salty water along coasts end up trapped so far inland and in freshwater?

Carlos Burelo has been mulling a version of that question ever since he visited the river on a fishing trip with his father 35 years ago. As a kid, he saw how the mangroves with their twisted aboveground roots were different from other trees in the area, an observation that has stuck with him. He is a biologist at the Universidad Juárez Autónoma de Tabasco in Villahermosa, Mexico.

Now, genetic analyses, surveys of vegetation and sediments, and simulations of shifts in sea levels show that the red mangroves (*Rhizophora mangle*) are part of a "relict ecosystem" that has existed for more than 100,000 years. During the last interglacial period, which peaked about 130,000 years ago, warming raised sea levels about nine meters above current levels, and the lowlands of what's now the Yucatán Peninsula flooded. As a result, the mangrove forest was displaced and transplanted inland by today's standards, Burelo and colleagues report in the Oct. 12 *Proceedings of the National Academy of Sciences*. When sea levels dropped as the world cooled again, the trees were left far from the coast.

"The remarkable resilience of these trees, in particular, is striking — that although they're normally adapted to seawater, they've survived all this time inland is incredible," says Holly Jones, a conservation biologist at Northern Illinois University in DeKalb who wasn't involved in the study.

To estimate where the mangroves may have been displaced from, the team collected leaves from the trees and from other mangrove forests along the coasts of the Caribbean Sea and Gulf of Mexico. Comparisons of the plants' DNA pinpointed the origins of the inland mangroves to about 170 kilometers away along the Gulf of Mexico.

By comparing the number of DNA mutations in the inland population with that in other mangroves and by estimating the ages of the trees using tree cores, "we were able to infer [that the inland mangroves] have been isolated for 120,000 years," says Felipe Zapata, an evolutionary biologist at UCLA. The calcium-rich river water and riverbed have buttressed the survival of these red mangroves over the years, Zapata says.

In addition to the mangroves, other plants in the inland area have a coastal heritage, the team found. More than 30 percent, or 112 species, of the total flora growing along the river, including orchids and legumes, are typically found in coastal lagoons or along shorelines.

With those findings in hand, the team looked at the soil too. A geologic survey of sediments near the mangroves revealed coastal gravels, shells of marine gastropods, large oyster shells and clay sediments rich in shell fragments.

Those finds, along with simulations of past sea levels, confirm that at some point during the last interglacial period, the ocean must have merged with the lower basin of the San Pedro River, pushing the red mangroves and other coastal species inland, the researchers conclude.

Discovering this relict ecosystem highlights the widespread impact past climate change has had on the world's coastlines, says study coauthor Exequiel Ezcurra, an ecologist at the University of California, Riverside, and it provides a chance to better understand how future sea level rise may affect these ecosystems. ■

FROM TOP: BEN MEISSNER; OCTAVIO ABURTO

Red mangroves grow in the San Pedro Mártir River on the Yucatán Peninsula. Calcium in the water helps the trees survive farther inland than where mangroves typically grow.

Aquatic life finds refuge in the submerged roots of a red mangrove forest on the Yucatán Peninsula. It's part of a "relict ecosystem."