Tracking the journey of mangroves in southern Japan

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The species used in this study—Rhizophora stylosa—produces propagules that can survive at sea for several months. They have the potential to make the journey on the currents between Iriomote and Okinawa main island. Credit: OIST

Mangroves are salt-tolerant trees found in the coastal waters of the tropics and subtropics around the world. Mangrove forests play vital roles for both nature and society. They help protect coastal communities as they provide a natural barrier from tsunamis and storms. In the other direction, they filter pollution and soil runoff. These forests also provide a marine nursery ground as the juveniles of coastal fish can easily hide between the trees. And they have an important role as a carbon sink, thus mitigating climate change.

But today, around the world, mangroves are in decline. The forests are often removed to make way for farms and urban developments. To establish which of the remaining forests are the most important to protect, researchers from the Marine Biophysics Unit, led by Prof. Satoshi Mitarai, at the Okinawa Institute of Science and Technology (OIST) have conducted a study on how connected the mangroves are around the subtropical Ryukyu Islands in Japan.

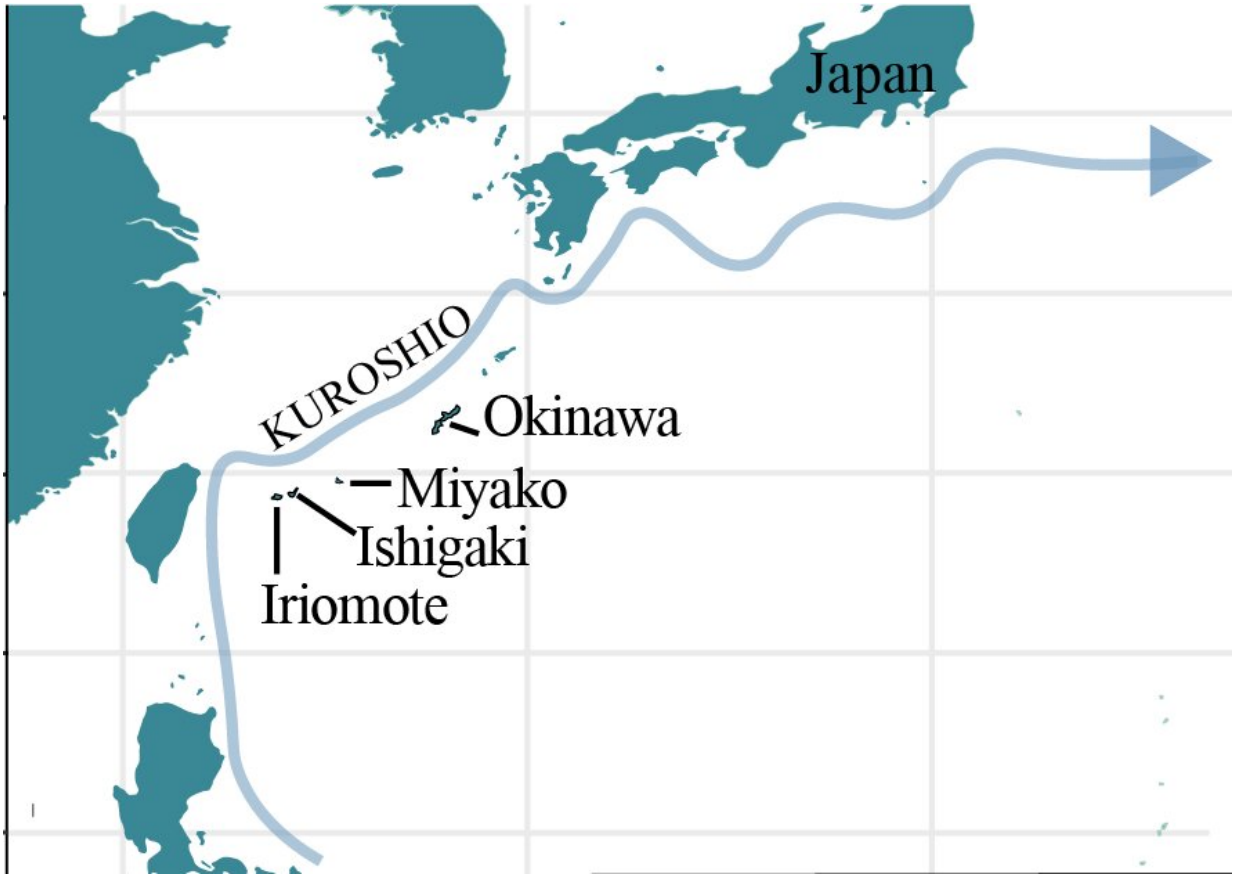
"My research is motivated by conservation outcomes," said Ph.D. candidate Maki Thomas, first author of this paper, which was published in *Frontiers in Marine Science*. "It would be ideal if we could protect all the mangrove forests, but this isn't realistic. Our goal is to find areas that should be prioritized for protection. For example, forests that are completely isolated and therefore won't regenerate naturally if destroyed."

This, she continued, will allow policy makers and environmental managers to identify important areas for conservation.

The trees will drop propagules into the water and, depending on the species, the propagule will float for a few days to a few months, sinking once it's reached a good environment to germinate. The species used in this study—Rhizophora stylosa—produces propagules that can survive at sea for several months.

The research used two separate methods to answer their question on population connectivity—one stemming from genetics and the other, oceanography.

First the researchers collected mangrove samples from 16 different sites across four islands in the Ryukyus—the Okinawa main island, Miyako, Ishigaki, and Iriomote.



The researchers looked at how connected the mangrove forests are across four of the Ryukyu Islands—the Okinawa main island, Miyako, Ishigaki, and Iriomote. Credit: OIST

Ms. Thomas wanted to see if propagules from Iriomote would travel all the way to Okinawa's main island, and vice versa. She used micro-satellite DNA—small fragments of DNA—taken from each mangrove sample to see how closely related the different populations were. If, for example, a mangrove from Iriomote and a mangrove from Okinawa had a very similar genetic structure, it would suggest that propagules from Iriomote are traveling on the currents to Okinawa. On the other hand, large differences in the genetic structure would suggest that the populations are isolated from one another.

Then the researchers deployed 31 GPS equipped buoys that mimic propagules from Iriomote to see if they would travel between the different islands on the currents, and how long they would take.

Both methods found that the mangrove populations in the Ryukyu Islands have very little connectivity. In fact, even the mangroves on the west coast of Iriomote were quite isolated from those on the east coast. The results of genetic and oceanographic analyses suggest that Okinawa's main island recruits almost no mangrove propagules from the other sites. However, some of the genetic traits of the mangroves on Okinawa's main island were seen in the mangroves on other islands. For example, although the research found that west Iriomote is isolated, there's the potential of migration from Okinawa to east Iriomote. Overall, the genetic exchange in the archipelago is rare and random. As for the GPS buoys, some of them made it to Ishigaki and Miyako and even South Korea and south China, around one third beached on Iriomote, but most of them were taken out into the Pacific by the Kuroshio current.

So what does this mean for conservation?

"Efforts from local conservation groups are really important," said Ms. Thomas. "These forests aren't particularly connected so, if one is removed, it's unlikely to regenerate naturally. It's much easier to protect

the existing forests than restore them. We need site specific conservation plans and local monitoring of each mangrove forest."

Ms. Thomas went on to say that Iriomote, which is part of a national park and, last year, was named a UNESCO world heritage site, showcases the importance of protecting these mangrove forests.

"Iriomote has been protected for such a long time and the mangroves there are thriving."

More information: Maki Thomas et al, Extremely Stochastic Connectivity of Island Mangroves, *Frontiers in Marine Science* (2022). DOI: 10.3389/fmars.2022.827590

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