A plant present in Brazil is capable of colonizing deforested areas

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Tropical reforestation programs tend to prioritize native pioneer tree species, which colonize disturbed or cleared areas thanks to their high reproductive capacity and rapid growth, among other characteristics.

According to experts, these species facilitate the transition from deforested land to secondary forest. They stabilize terrain and enhance connectivity between remaining forest fragments by increasing soil permeability, as well as fostering the formation of networks of pollinators and plant seed dispersers.

Despite the ecological importance of pioneer tree species, little is known about their ability to maintain genetic diversity in native populations or the dynamics of gene flow between widely separated forest fragments, according to Rodolfo Jaffé, a researcher at the Vale Institute of Technology (ITV) in Brazil.

"Knowledge of these species' genetics is fundamental to more efficient reforestation or rehabilitation of key ecosystemic functions in the short and medium term. Ecosystems that are rehabilitated using native pioneer tree species will obviously never be the same as the original ones, but the goal is to get as close as possible," said Jaffé.

In partnership with colleagues at the University of Texas at Austin in the United States, Jaffé studied the genetic diversity and differentiation patterns of the native pioneer understory tree *Miconia affinis* in Panama, Central America. An evergreen with heights typically ranging from 3 m

to 6 m, *M. affinis* is widely distributed in the Neotropics from Mexico to Brazil.

"The Panama Canal region is a global biodiversity hotspot that has lost over 30% of its forest cover to agropastoral development during the past 50 years, leading to high levels of erosion and sediment deposition in streams and canals with adverse effects on the region's water-holding capacity," Jaffé said.

"The government of Panama wants to reforest degraded and cleared areas to reduce erosion and sediment buildup in the Canal. The native pioneer species present in the region are considered suitable candidates for use in restoration programs."

To find out whether deforested areas form a barrier to populations of *M. affinis*, the researchers collected leaf tissue from approximately 30 reproductive trees bearing inflorescences or infructescences in 11 different populations along the Panama Canal.

Next, they extracted DNA from the leaf tissue and genotyped the trees using microsatellite molecular markers, also called simple sequence repeats - short segments of DNA that indicate the most recent evolutionary variations in an individual organism.

They also estimated the influence of geographic distance, elevation and deforestation on the genetic structure and differentiation of the *M. affinis* populations studied. To do so, they used high-resolution maps of forest cover and elevation in the Panama Canal region, as well as landscape genetics tools.

Their statistical analyses showed that the genetic differentiation of this tree species, which frequently colonizes forest gaps, riparian areas and exposed hillsides, significantly increased with elevation and geographic

distance between populations.

"This result means populations of the species become more genetically differentiated as the distance between them increases, whereas the closer they are, the more similar they are genetically. This effect is called the isolation-by-distance pattern and is expected for most plant populations," Jaffé said.

The analyses also showed higher levels of genetic diversity within populations of *M. affinis* and lower levels of genetic differentiation between populations than for many other pioneer species.

"High genetic diversity within populations and low differentiation between populations are probably due to the species' propensity to colonize deforested landscapes, leading to increased connectivity among populations throughout the region," they say.

The researchers also found that elevation influences genetic differentiation in populations of *M. affinis*. Populations inhabiting relatively higher altitudes are more genetically differentiated than populations at lower altitudes regardless of the distance between them.

"One reason for this may be that the lower temperature and heavier rainfall at higher elevations compared with lower ones affect flying conditions and the abundance of pollinators and seed dispersers," Jaffé said.

M. affinis is visited by a wide array of social and solitary bees, and seeds from its fruits are dispersed by a variety of birds, bats and monkeys.

Temperature and precipitation also cause earlier flowering at higher altitudes. "As a result, pollinators tend to stay where flowering occurs first, instead of visiting populations at lower altitudes where flowering

hasn't begun. Differences in phenology, the timing of fruiting and flowering, can influence genetic structure," Jaffé said.

The researchers did not find evidence that deforestation affects genetic differentiation in populations of *M. affinis*. A potential explanation is that the high dispersal and colonization capacity of this species promotes gene flow across the region regardless of forest cover.

"Our results suggest human-altered landscapes along the Panama Canal do not limit gene flow between isolated forest populations. Pollinators and seed dispersers are able to visit the trees, crossing deforested areas and pollinating populations located in other areas," Jaffé said.

They estimated an average lifespan of 64.3 years for *M. affinis*, which generates seeds for the first time at an average of about six years old, and observed that the species is capable of maintaining a high level of genetic diversity regardless of the amount of surrounding forest.

"These characteristics in aggregate make *M. affinis* an excellent candidate for use in reforestation programs," Jaffé said.

More information: Antonio R. Castilla et al, Elevation, Not Deforestation, Promotes Genetic Differentiation in a Pioneer Tropical Tree, *PLOS ONE* (2016). DOI: 10.1371/journal.pone.0156694

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