Plants in the Cerrado combine at least two strategies to survive fire, study shows

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Different below-ground organs analyzed in Cerrado species: (a) xylopodium in Stryphnodendron rotundifolium; (b) xylopodium and possible tuberous root in Annona crassiflora; (c) root crown in Miconia albicans; (d) woody rhizome in Handroanthus ochraceus. Credit: Marco Antonio Chiminazzo/UNESP

In an article published in the journal *Flora*, researchers at São Paulo State University (UNESP) in Brazil examine some of the strategies developed over eons of evolution by plants in the Cerrado, Brazil's savanna-like biome, to protect themselves and resprout quickly after fire.

The article is commended by the journal as Highlighted Student Research. Its first author is Marco Antonio Chiminazzo, a Ph.D. candidate at UNESP in Rio Claro. The co-authors are Alessandra

Fidelis, a professor in the Department of Biodiversity at the Rio Claro Institute of Biosciences (IBRC-UNESP); Aline Bombo, a postdoctoral fellow at the same institution, and Tristan Charles-Dominique, a researcher at the Paris Sorbonne and Montpellier University in France. All three are Chiminazzo's thesis advisors.

"Fire plays an important role in the history of the Cerrado's savanna-type vegetation. To survive fires, these plants have developed various strategies, which the different lineages have refined during a long evolutionary process," Chiminazzo said.

"We've known since we began studying the biome that the Cerrado's plants have thick bark to protect their internal tissues. They also have a wide array of below-ground organs that enable them to resprout because they're protected by being under the surface. However, these two strategies require plants to deploy a lot of resources. Our key question was whether they could do both at the same time—whether typical species of the Cerrado with below-ground organs were also able to produce significant amounts of above-ground bark."

The researchers also set out to discover whether there were differences between clonal and non-clonal species in terms of bark production and bud protection and whether maximum height correlated with the ability to propagate clonally, given that clonal plants are generally smaller because their resources must be used to fuel both vertical and lateral growth.

"The first step was a review of the literature to identify woody species in the Cerrado whose below-ground organs and above-ground bark production rates had been described. We then went out into the field to dig and collect plants in areas of grassland with scattered shrubs [campo sujo] and dense woodland or shrubland [cerrado sensu stricto] in order to analyze their organs," Chiminazzo said. The field trips were to the Santa

Bárbara Ecological Station, an environmental protection unit in Águas de Santa Bárbara, São Paulo state.

"We grouped the species on the basis of clonality or non-clonality and of types of below-ground organ, especially woody rhizomes, which promote clonal growth, or xylopodia and root crowns, which do not," he said.

By comparing below-ground organs and bark production rates, the authors of the study were able to show that plant species in the Cerrado can produce large amounts of bark (up to 0.9 millimeters per unit of growth) and at the same time develop below-ground organs that specialize in resprouting. In other words, they can protect themselves from fire by hiding a large proportion of their biomass below ground.

"We also found a clear division between clonal species and species that occupy the same space throughout their life cycle [in a phenomenon termed on-spot persistence]. Specifically, clonal species with woody rhizomes tend to produce more bark, protect themselves better and grow taller than species with xylopodia and root crowns," he said.

These differences suggest that the plants have evolved two distinct strategies for resprouting from underground buds: clonal growth associated with a considerable effort to protect aerial branches; and on-spot persistence, possibly linked to a stronger focus on protecting buds in organs below ground.

"The findings show that plants in the Cerrado are capable of investing in different strategies to protect themselves against fire," Bombo said. "The usual view is that that they invest either in above- or below-ground strategies. The ability to invest in both reflects the extent to which woody plants have adapted to fire in the Cerrado. Having both aerial and underground fire-related strategies for regeneration and persistence enables these species to survive fire events of varying intensities."

Next steps include examining which fire regimes favor regeneration and persistence strategies that are aerial, underground or a combination of both. "This can help us understand better the differences between above- and below-ground carbon stocks in the Cerrado," Bombo said. "Furthermore, a comparison with different savannas around the world will show whether the results of this study might also apply to other types of vegetation exposed to fire events."

Threatened biome

The Cerrado is now the most threatened of Brazil's biomes. Deforestation in the Amazon has decreased significantly in 2023, while destruction of native vegetation in the Cerrado has risen to record levels. In the first five months of the year, it increased 35% compared with January-May 2022.

The increase corresponded to 3,532 square kilometers of destruction. These numbers, which come from the National Space Research Institute (INPE), are highly alarming because the Cerrado is the world's most biodiverse savanna, contains 33% of Brazil's biodiversity, and is the birthplace of the three largest river basins in South America.

As the destruction advances, important scientific research has been conducted to predict and prevent fire propagation or use fire as a land management and conservation strategy.phys.org/news/2023-04-trees-sa … as-cerrado-bark.html

Other studies have also highlighted the extraordinary resilience and regenerative power of Cerrado plant species, which have evolved over millions of years in the presence of fire.

More information: Marco Antonio Chiminazzo et al, To protect or to hide: Why not both? An investigation of fire-related strategies in

Cerrado woody species, *Flora* (2023). DOI: 10.1016/j.flora.2023.152350

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