

## Earth & Space

# Gone but not forgotten – plant extinction in modern times

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### ABSTRACT

*New review of plant extinction in modern times shows clearly elevated rates globally. Highest rates are for shrubs and trees and in biodiverse areas with many unique species, such as oceanic islands – areas particularly vulnerable to human activities.*



*Santalum fernandezianum*  
Image credits: Carl Skottsberg (1908)

What do you think of when you hear the word 'extinction'? Chances are you think of dinosaurs or dodos. You'd be hard-pressed to find someone who thinks of plants. This contrast reflects that, until recently, we lacked a global overview of ongoing plant extinction.

Extinction occurs when the last living individual of a species or population dies. This process occurs naturally, and it has shaped life on Earth: researchers have estimated that the species alive today represent less than 1% of all species that ever lived. Biologists distinguish two types of extinction events: mass extinction and background extinction. Mass

extinctions are 'pulses', high levels of extinction that occur relatively quickly (over tens of thousands to a couple of million years). In contrast, background extinction is the spontaneous replacement of one species with another in cycles of species formation and extinction. These replacement cycles typically last 1-10 million years (or longer). Mass extinctions are striking because they eliminate entire groups of organisms and reshape ecosystems. However, they have not accounted for most species disappearance throughout evolutionary history. Up to 90% of all extinctions have occurred as background extinction.

The last major mass extinction occurred around 65 million years ago and famously led to the extinction of dinosaurs. Recent millennia have again witnessed elevated extinction rates, illustrated by the disappearance of almost all large birds and mammals in Australia, America, and on isolated islands. Plant extinction has also increased during this time, the best-known example being the *Rapa Nui* palm that once dominated the forests of Easter Island. Scientists are still debating the causes of this increased extinction. The main suspects are altered climates or excessive hunting and harvesting, or possibly both. In any case, each extinction wave has coincided with the arrival of modern humans in each area.

Most of what we know about past extinctions is based on information in the fossil record. In recent centuries, naturalists have been collecting specimens of living animals and plants for formal description as species. These specimens, stored in herbaria and museums, provide a new source of information about extinction: species we know were alive when they were collected but are now presumed extinct. Evidence of these 'modern extinctions' is scarce but most complete for birds and mammals. However, designing sustainable conservation programs requires knowledge of ongoing extinction for many different types of organisms, including plants, given their pivotal role in all ecosystems.

Enter Rafaël Govaerts at the Royal Botanic Gardens, Kew. He has been collecting published information on extinct seed plants for three decades. We recently reviewed this information to provide the first global overview of what plants are going extinct, where, and how fast. We tallied almost 600 plant extinctions since Linnaeus pioneered scientific botany in the 18th century. This is a much higher figure than the previous listing of extinct plants and the number of

extinct amphibians, birds, and mammals combined. If all extinction during this time had occurred as normal background extinction, we would expect 4, or possibly as many as 20, extinctions to have happened. Instead, we calculated that plants are disappearing *500 times faster* than the normal background rate. However, we think these figures are low. This is partly because our knowledge of plant diversity is incomplete (meaning some extinctions go undetected), partly because some known extinctions remain unpublished, and partly because many plants are already doomed to extinction by being 'functionally extinct' – alive but not producing new generations (flowering and setting seed).

We didn't study *why* current extinction rates are higher than normal. However, we found the highest rates for shrubs, trees, on islands, and in areas with a tropical or Mediterranean climate – areas home to many unique species vulnerable to human activities. Therefore, current extinction is most likely driven by the same factors that threaten the survival of many living plants: loss of natural habitat due to deforestation and land-use change.

If you only remember one aspect of our research, let it be that plant extinctions are happening. They are happening all over the world, and they are happening fast. That may be easy to ignore if you are reading this in the middle of an urban area, seemingly disconnected from nature. But remember, plants provide the oxygen we breathe and the food we eat, as well as making up the backbone of the world's ecosystems. Plant extinction is bad news for all life, including us. Our study will improve predictions of future extinctions of plants, as well as other organisms, and aid the development of conservation strategies to prevent them.