

Protect Australia's Gondwana Rainforests

Recent fires in the Gondwana Rainforests of eastern Australia, a UN Educational, Scientific and Cultural Organization (UNESCO) World Heritage site (1), exposed the country's inability to protect these unique forests. Rich in diversity and global fossil heritage, the Gondwana Rainforests harbor the highest concentrations of threatened species in subtropical southeast Queensland and northern New South Wales, and they protect more than 40 million years of globally significant rainforest evolutionary history (2–9). Australia must take steps to ensure that these forests will not be lost in future natural disasters.

Australia began to break from Gondwana (Antarctica) around 40 million years ago (3), carrying its remnant of Austral paleorainforest and deep time evolutionary history. On its journey north, the Australian continent escaped the ravages of Antarctic freezing, only to heat up and dry out much later as it approached the tropics (4, 5). The Paleo-Antarctic rainforest lineages (PARLs) retreated to the few remaining, geographically restricted and still shrinking wet places (2, 4). PARLs are living plant taxa with fossil records in the mid-high latitude paleorainforests of the Cretaceous and Paleogene Southern Hemisphere (2, 3), and their existence in Australia's living World Heritage Gondwana Rainforests preserves a vestige of the mostly vanished, late-Gondwana rainforest ecosystems that once covered much of the southern half of the planet (4, 6–9). The greatest concentration of threatened rainforest plant species in Australia, many of them PARLs, now resides in the Nightcap Range in northern New South Wales (10). Efforts to protect this incredible concentration of diversity have proven inadequate (11).

Although the fires are now under control, more than 50% of the Gondwana Rainforests were affected by them (11). Australia must learn from this experience. Before the next threat arrives, Australian state governments should identify natural assets that are at risk and put policies in place to improve fire planning, streamline fire responses, and protect these forests. Legislation should prioritize areas of high conservation value, implement strategic fire planning to protect the forests, and avoid implementing broad-area industrial-scale controlled burns. Meanwhile, scientists must work to generate baseline scientific data for these areas immediately, which can be used to assess the damage from the recent fires and better predict fire behavior in the future. If policy-makers fail to heed the lessons of the recent fires, the world could lose Australia's ancient Gondwana Rainforests.

Robert M. Kooyman^{1*}, James Watson², Peter Wilf³

¹Department of Biological Sciences, Macquarie University, Sydney, NSW 2019, Australia. ²Centre for Biodiversity and Conservation Science, School of Earth and Environmental Sciences, University of Queensland, Brisbane 4072, Australia.

³Department of Geosciences, Pennsylvania State University, University Park, PA 16802, USA.

*Corresponding author. Email: robert.kooyman@mq.edu.au

REFERENCES AND NOTES

1. UNESCO, World Heritage List, Gondwana Rainforests of Australia (<https://whc.unesco.org/en/list/368/>).
2. R.M. Kooyman *et al.*, *Am. J. Bot.* 101, 2121 (2014).
3. L. A. Lawver, L. M. Gahagan, I. W. D. Dalziel, in *Tectonic, Climatic, and Cryospheric Evolution of the Antarctic Peninsula*, J. B. Anderson, J. S. Wellner, Eds. (American Geophysical Union, Washington, DC, 2011), pp. 5–33.
4. R. S. Hill, Ed., *History of the Australian Vegetation: Cretaceous to Recent* (Cambridge Univ. Press, Cambridge, UK, 1994).
5. R. Hall, *Geol. Soc. London Spec. Publ.* 355, 75 (2011).
6. P. Wilf, N. R. Cúneo, I. H. Escapa, D. Pol, M. O. Woodburne, *Annu. Rev. Earth Planet. Sci.* 41, 561 (2013).
7. L. Merkhofer *et al.*, *Am. J. Bot.* 102, 1160 (2015).
8. M. A. Gandolfo, E. J. Hermsen, *Ann. Bot.* 119, 507 (2017).
9. R. S. Hill, T. J. Brodribb, *Aust. J. Bot.* 47, 639 (1999).
10. NSW Government, Office of Environment and Heritage, Threatened species, South Eastern Queensland (www.environment.nsw.gov.au/threatenedspeciesapp/AreaHabitatSearch.aspx?cmaname=South+Eastern+Queensland).
11. NSW Government, Understanding the impact of the 2019- 20 fires (2020); www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/fire/park-recoveryand-rehabilitation/recovering-from-2019-20-fires/understanding-the-impact-of-the-2019-20-fires.