Multi-stemmed trees:

Mortality rates, Biogeographic patterns, and biomass dynamics

John L. Godlee
john.godlee@ed.ac.uk

THE UNIVERSITY of EDINBURGH
School of GeoSciences

My background

- Applied functional ecologist
  - Ecosystem productivity, biogeography, structure
  - Tropical savannas, dry forests, temperate woodlands

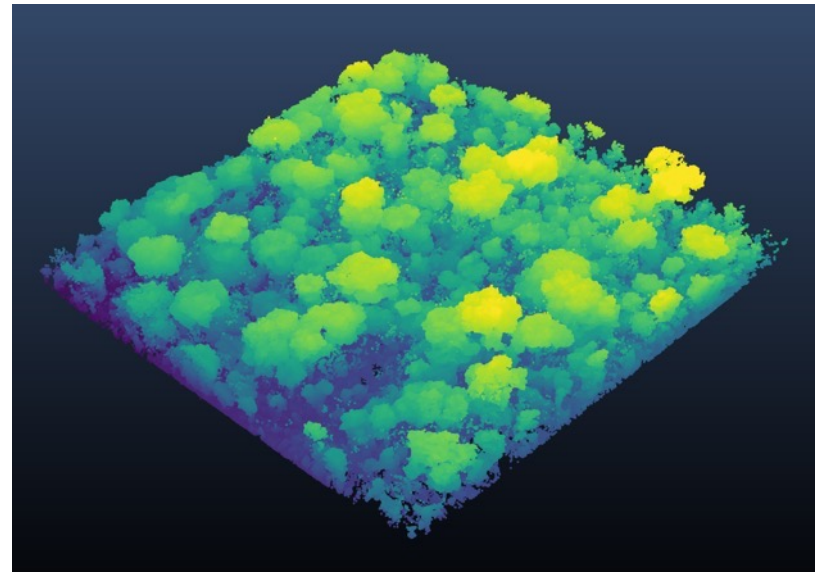
- PhD (2021) at University of Edinburgh
  - Biodiversity and ecosystem function in African savannas

- Post-Doc (2021-now) SECO: dry tropical carbon dynamics
  - Global multi-network plot analyses
  - Where and why is woody biomass changing?
  - How does biogeography affect responses to change?

SEOSAW } Plot database manager
Manage two field sites (Angola, Namibia)

Bicuar National Park, SW Angola, long term vegetation monitoring

Terrestrial LiDAR, canopy occupancy

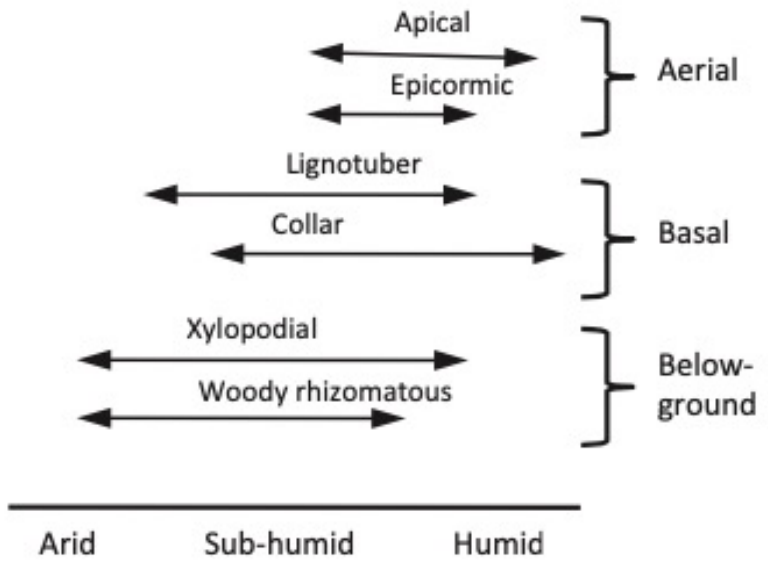


Resprouting and multi-stemmed growth

Resprouting: New shoot growth triggered by disturbance.

Sprouting is common and might be the ancestral state of woody angiosperms (Bond and Midgley 2001).

Basal and below-ground resprouting leads to multi-stemmed trees:



(Clarke et al. 2012)

Multi-stemmed Terminalia sp.

Post-fire epicormic sprouting in Eucalyptus sp.

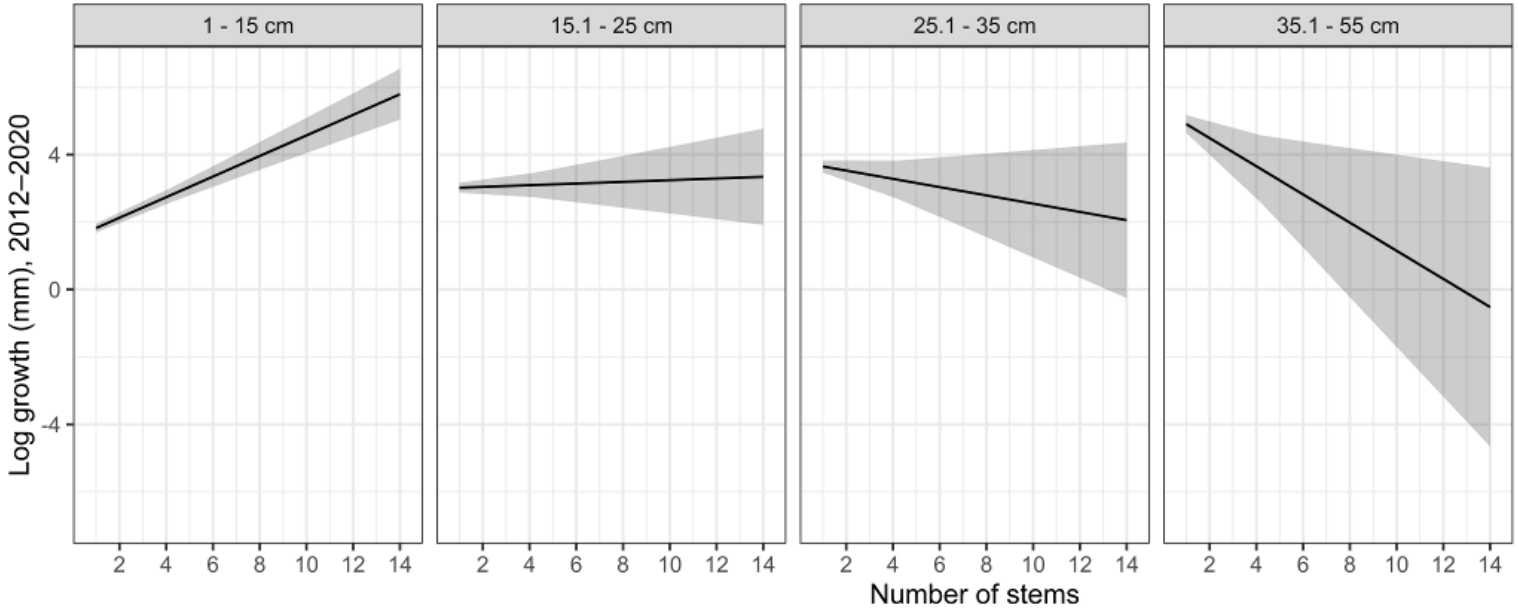
Post-fire basal sprouting in Fraxinus ornus

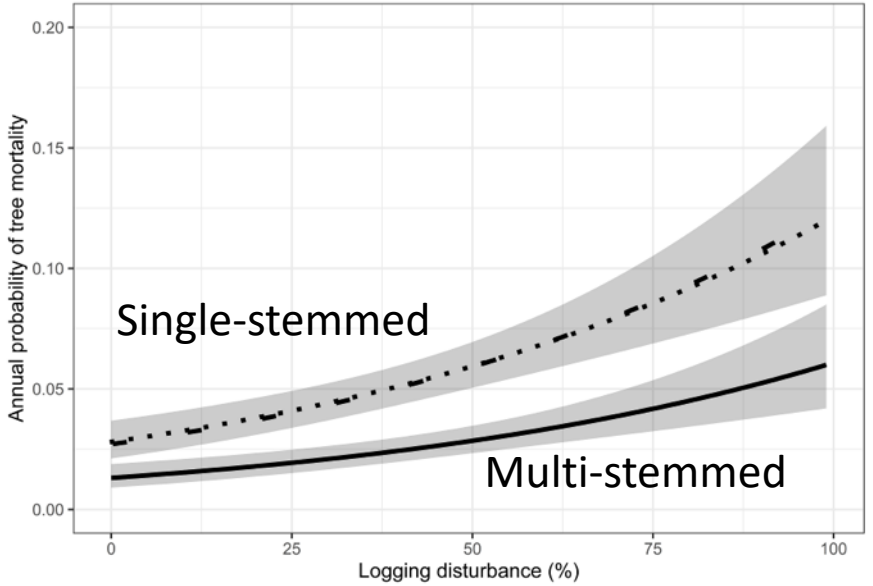
Previous research

Multi-stemming enhances tree survival and growth in Borneo's logged forests

Jakub Kvasnica[a,*], Radim Matula[b], Martin Rejžek[a], Robert M. Ewers[c], Terhi Riutta[d], Edgar C. Turner[e], Reuben Nilus[f], and Martin Svátek[a] [Preprint]

- Borneo, secondary forest
- Multi-stemmed trees get growth benefit only when small.
- Multi-stemmed trees experience reduced mortality





Previous research

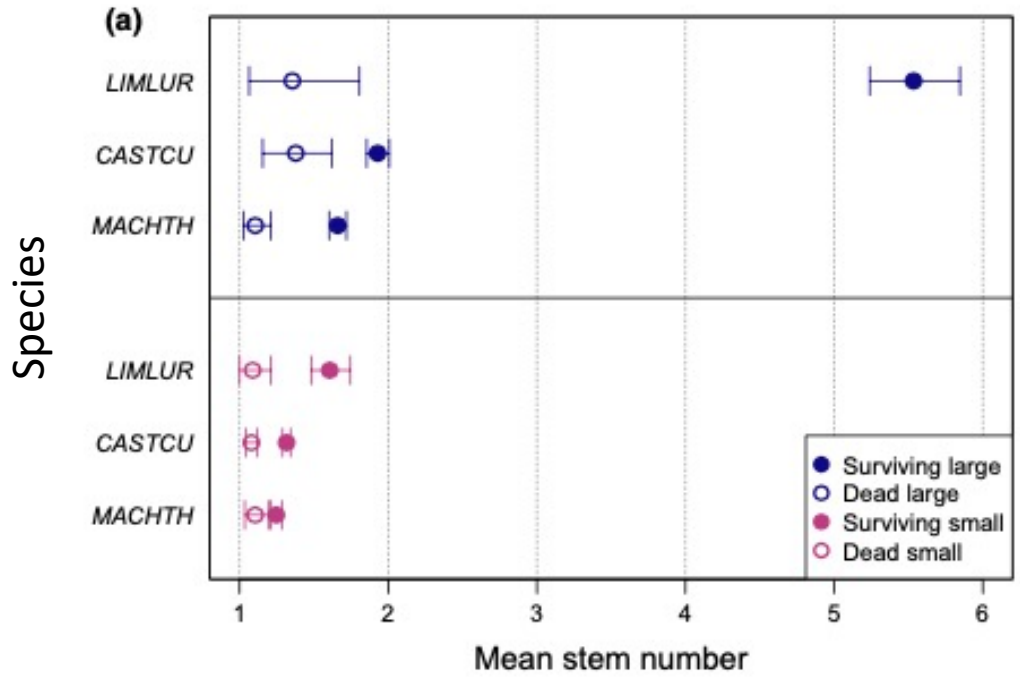
DOI: 10.1111/jvs.12858

RESEARCH ARTICLE

Journal of Vegetation Science IAVS

Multi-stemming and size enhance survival of dominant tree species in a frequently typhoon-disturbed forest

Sheng-Hsin Su[1,2] | Biing T. Guan[1] | Chia-Hao Chang-Yang[3] | I-Fang Sun[4] | Hsiang-Hua Wang[2] | Chang-Fu Hsieh[5]



- Fushan, Taiwan - ForestGEO site (25 ha)
- Old-growth oak–laurel wet forest
- Multi-stemming common by basal sprouting (<1.3 m).
- Multi-stemmed trees grew shorter.
- Shorter trees are sheltered from high winds.

Previous research

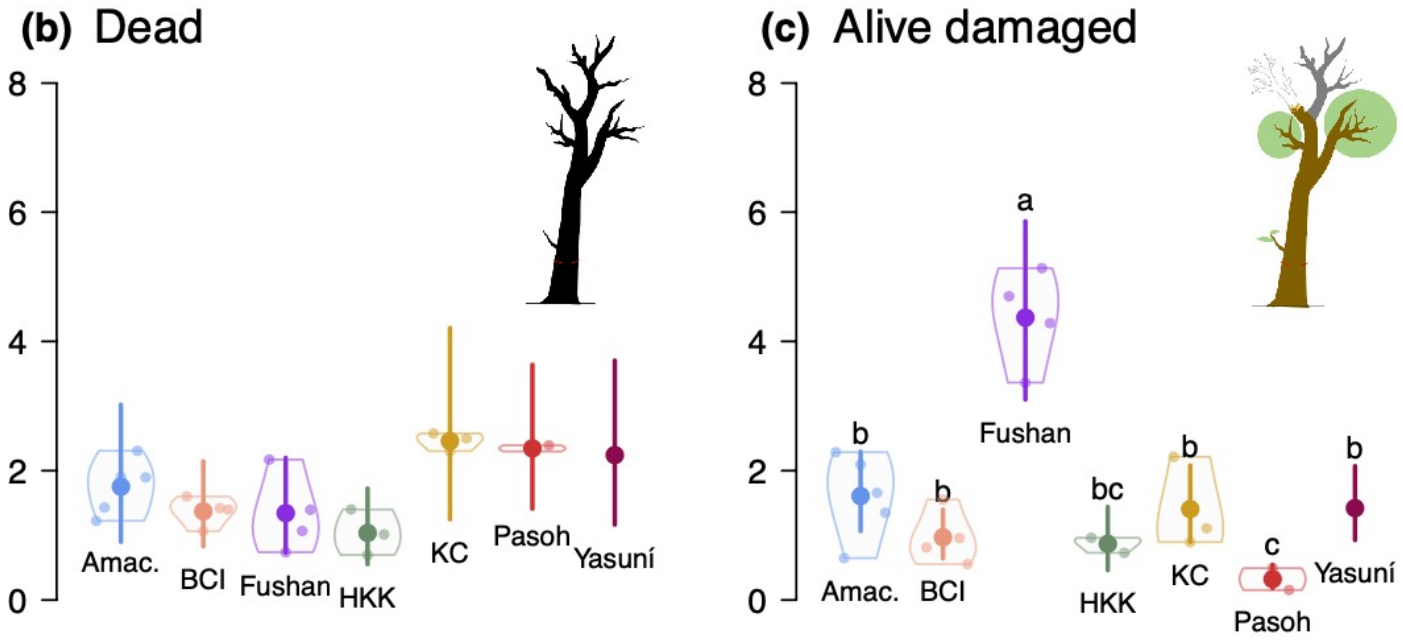
DOI: 10.1111/gcb.16687

RESEARCH ARTICLE

Global Change Biology WILEY

Damage to living trees contributes to almost half of the biomass losses in tropical forests

Daniel Zuleta[1] | Gabriel Arellano[2,3] | Sean M. McMahon[1,4] | Salomón Aguilar[5] |



- 7 tropical ForestGEO sites (Neotrop. and Asia)
- Old-growth oak–laurel wet forest
- Disturbance-prone forests had high branch and stem loss, but very low individual mortality.
- Does multi-stemming mediate biomass turnover through non-lethal biomass loss?

Previous research

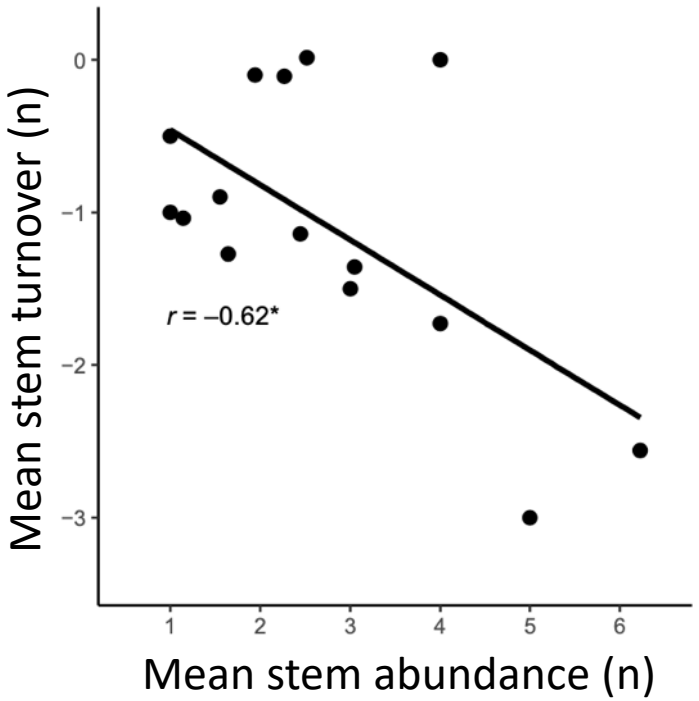
sustainability

MDPI

Article

Multi-Stemmed Habit in Trees Contributes Climate Resilience in Tropical Dry Forest

Ian M. Ware [1,*], Rebecca Ostertag [2], Susan Cordell [1], Christian P. Giardina [1], Lawren Sack [3], Camila D. Medeiros [3], Faith Inman [1], Creighton M. Litton [4], Thomas Giambelluca [5,6], Grace P. John [7] and Christine Scoffoni [8]



- Hawaii tropical dry forest with frequent droughts.
- Multi-stemming resulted in increased stem turnover
- Following drought, multi-stemmed species accumulated stems faster.
- Multi-stemmed trees exhibit traits which confer drought resistance.

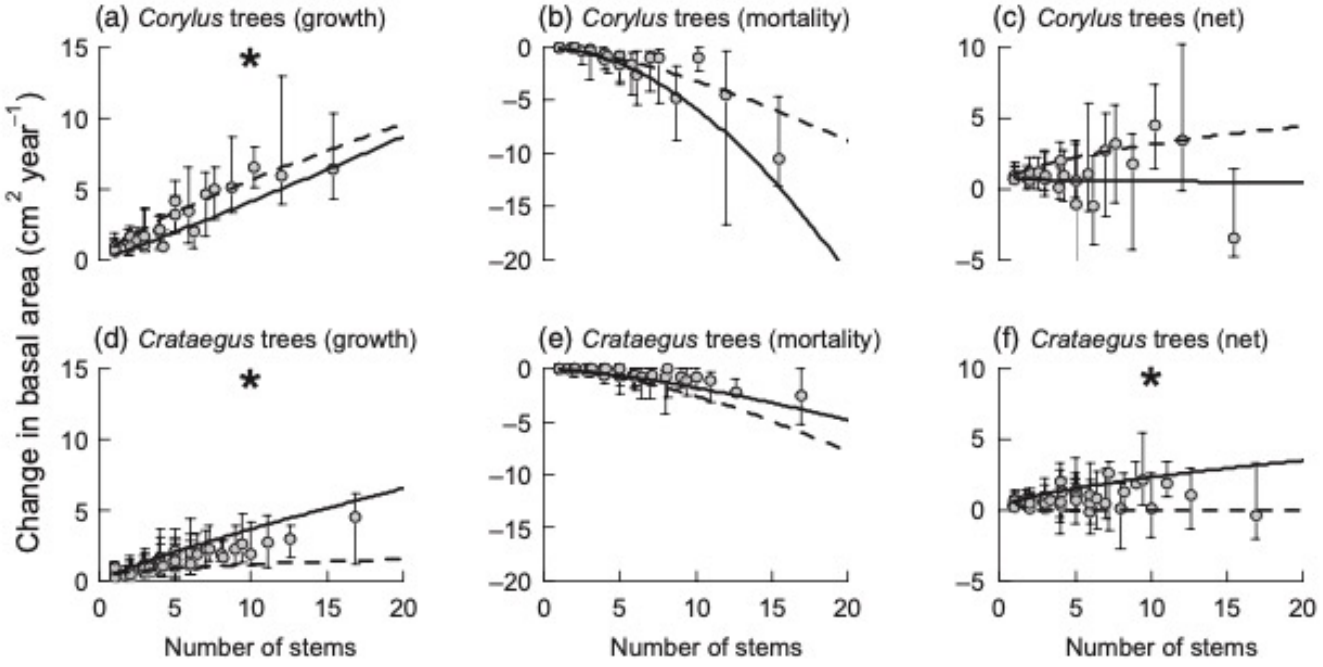
Previous research

Journal of Ecology

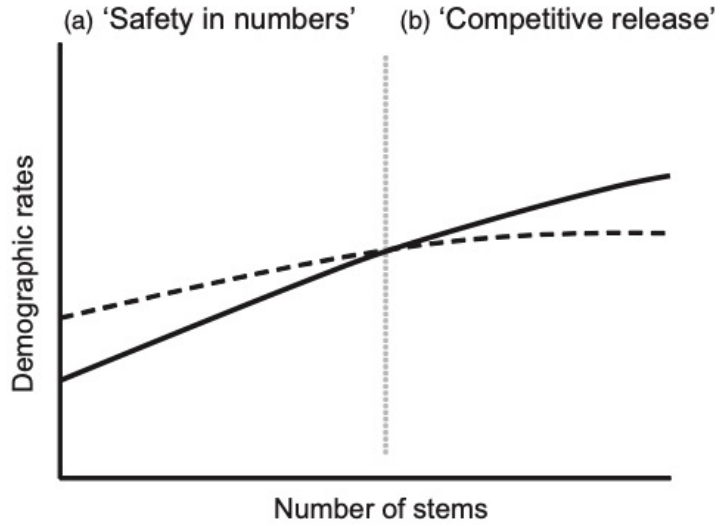
Journal of Ecology 2012, **100**, 171–183 doi: 10.1111/j.1365-2745.2011.01879.x

The more stems the merrier: advantages of multi-stemmed architecture for the demography of understorey trees in a temperate broadleaf woodland

Andrew J. Tanentzap[1]*, Edward P. Mountford[2], Arnold S. Cooke[3] and David A. Coomes[1]



- Temperate UK woodland (mixed ash)
- Multi-stemming increased tree growth and survival under herbivory.
- When browsers removed, stem survival reduced in multi-stemmed trees.



Summary – research gaps

Multi-stemming:

- is common in disturbed systems.
- consistently reduces mortality in disturbed systems.
- can increase growth in small understorey trees.
- generally produces shorter trees.
- generally increases biomass turnover.

We don't know:

- global spatial patterns and causes of multi-stemmed architecture.
- how multi-stemming affects ecosystem function across environmental gradients.
- does multi-stemming affect forest functioning in the same way, everywhere?

The plan?!

1. When is multi-stemming (MS) beneficial?

H_1: MS reduces mortality in disturbed systems.

H_2: MS reduces mortality risk in juveniles can increase risk in large trees.

2. How does MS affect biomass dynamics?

H_3: MS increases biomass turnover.

H_4: MS increases carbon storage in highly disturbed systems.

3. Where is MS prevalent?

H_5: Prevalence of multi-stemming is a function of disturbance regime and biogeography.

Data requirements:

- Multi-census tree stem growth:
  - Species identity
  - Stems grouped into trees
  - Plot locations and census dates
- Tree species phylogeny
- Remote sensed disturbance regime:
  - Drought
  - Fire
  - Herbivory (?)

References

SECO: Resolving the current and future carbon dynamics of the dry tropics (https://blogs.ed.ac.uk/seco-project/)

SEOSAW: A Socio-Ecological Observatory for Studying African Woodlands (https://seosaw.github.io/)

Bond, W. J., & Midgley, J. J. (2001). Ecology of sprouting in woody plants: the persistence niche. In Trends in Ecology & Evolution (Vol. 16, Issue 1, pp. 45–51). Elsevier BV. https://doi.org/10.1016/s0169-5347(00)02033-4

Clarke, P. J., Lawes, M. J., Midgley, J. J., Lamont, B. B., Ojeda, F., Burrows, G. E., Enright, N. J., & Knox, K. J. E. (2012). Resprouting as a key functional trait: how buds, protection and resources drive persistence after fire. In New Phytologist (Vol. 197, Issue 1, pp. 19–35). Wiley. https://doi.org/10.1111/nph.12001

Kvasnica, J., Matula, R., Rejžek, M., Ewers, R. M., Riutta, T., Turner, E. C., Nilus, R., & Svátek, M. (2023). Multi-Stemming Enhances Tree Survival and Growth in Borneo's Logged Forests. Elsevier BV. https://doi.org/10.2139/ssrn.4326512

Su, S., Guan, B. T., Chang-Yang, C., Sun, I., Wang, H., & Hsieh, C. (2020). Multi-stemming and size enhance survival of dominant tree species in a frequently typhoon-disturbed forest. In K. Woods (Ed.), Journal of Vegetation Science (Vol. 31, Issue 3, pp. 429–439). Wiley. https://doi.org/10.1111/jvs.12858

Tanentzap, A. J., Mountford, E. P., Cooke, A. S., & Coomes, D. A. (2011). The more stems the merrier: advantages of multi-stemmed architecture for the demography of understorey trees in a temperate broadleaf woodland. In Journal of Ecology (Vol. 100, Issue 1, pp. 171–183). Wiley. https://doi.org/10.1111/j.1365-2745.2011.01879.x

Ware, I. M., Ostertag, R., Cordell, S., Giardina, C. P., Sack, L., Medeiros, C. D., Inman, F., Litton, C. M., Giambelluca, T., John, G. P., & Scoffoni, C. (2022). Multi-Stemmed Habit in Trees Contributes Climate Resilience in Tropical Dry Forest. In Sustainability (Vol. 14, Issue 11, p. 6779). MDPI AG. https://doi.org/10.3390/su14116779

Zuleta, D., Arellano, G., McMahon, S. M., Aguilar, S., Bunyavejchewin, S., Castaño, N., Chang-Yang, C., Duque, A., Mitre, D., Nasardin, M., Pérez, R., Sun, I., Yao, T. L., Valencia, R., Krishna Moorthy, S. M., Verbeeck, H., & Davies, S. J. (2023). Damage to living trees contributes to almost half of the biomass losses in tropical forests. In Global Change Biology. Wiley. https://doi.org/10.1111/gcb.16687