

***New Phytologist* Supporting Information**

Article title: Towards understanding resprouting at the global scale

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Table S1 Global P50-resprouting database

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Notes S1 Reanalysis of the global P50 in relation to resprouting ability

In a recent study, Zeppel et al. (2015) concluded that “trait differences between resprouting and nonresprouting species suggest that more intense and severe drought is required to induce mortality in resprouting species than in nonresprouting woody plants.” To support this conclusion, the authors used a dataset on species resistance to xylem cavitation (i.e., the water potential at which a plant loses 50% of xylem hydraulic conductivity; P50) compiled by Choat *et al.* (2012) and they searched for the postfire resprouting ability of species from different trait databases. From the 480 species in Choat *et al.* (2012) they were able to assign the resprouting ability (yes/no) to 269 species (56%; 172 angiosperms and 97 gymnosperms). Their analysis showed that angiosperm resprouters were more cavitation resistant than non-resprouters (they did not find differences for gymnosperms). Because the authors did not publish their resprouting classifications and declined a request to share their classification, their results are not easy to replicate. We performed a similar exercise with an improved P50 dataset and found a different result: the xylem of nonresprouter species was more resistant to cavitation (lower P50 values) than resprouters (figure below). Our results are consistent with numerous previous studies of cavitation resistance comparing resprouters to non-resprouters (Jacobsen et al., 2007b; Pratt et al., 2008; Pratt et al., 2012b; Vilagrosa et al., 2014). In addition, P50 is not always a good indicator of drought resistance, as extreme drought conditions can cause mortality to species with very low P50 (Fig 2 in main text; Hoffman et al. 2011; see Box 1 for the variety of responses depending on the drought regime).

The discrepancy in the results between the Zeppel et al. (2015) study and our new analysis could reflect some of the complexities in understanding resprouting. It is possible that we obtained the resprouting ability for a very different set of species, or that we found different resprouting responses for the same species, or both. Our approach was based on published references, and we assigned species as resprouter or non-resprouter only if there were clear evidences of postfire resprouting; we define postfire resprouters as those species that generate new shoots once the plant is fully scorched (Gill 1981, Pausas et al. 2004; Pausas & Keeley 2014). Observations of resprouting after light fires are not indicative of the resprouting ability of the plant because many typical non-resprouters, if they are only partially scorched (defoliated) can produce new shoots and survive. Different criteria on resprouting is a plausible explanation for the contrasted results, as illustrated in the genus *Abies*: most fire ecologist would suggest that *Abies* species are not postfire resprouters (e.g. FEIS database),

while Zeppel et al. (2015) explicitly said that this genus contain several resprouting species (in their words, “*Pinus*, *Juniperus* and *Abies* contain the most resprouting species within gymnosperms”). Their classification is probably based on the observation that under a light fire many non-resprouting species, including *Abies* (e.g., Hanson & North 2006), may survive and their crown recover from unaffected buds in branches. Deviations from the classification used in our analysis by the Zeppel et al. (2015) study could perhaps also be derived from their use of the Kelley et al. (2014) classifications; Kelley et al. (2014) classified some highly cavitation resistant Californian species as resprouters (*Ceanothus* spp. subgenus *Cerastes* and *Arctostaphylos glauca*) when they are unequivocally non-resprouters. Without the database used by Zeppel et al. (2015) for their analysis we cannot know the exact reason for the different results; nevertheless, our analysis suggests that the results by Zeppel et al. (2015) cannot not be supported (see Supplemental Table S1 for resprouting classification and references as analysed in the present study).

A second reason why the analysis by Zeppel et al. (2015) may potentially misrepresent the drought responses of resprouting versus non-resprouting species is that their analysis included studies which used different methods for constructing vulnerability curves and P50 values, which was confounded with resprouting type (Fig. S1, Table S1). This may especially influence the Choat et al. (2012) dataset because they reported only a single P50 value from a single study for a given species rather than an across study mean. Some researchers do not flush out emboli prior to generating a vulnerability curve, which generally has the effect to make P50 values more negative, i.e. more resistant to cavitation (Sperry et al., 2012; Hacke et al., 2015). It is currently debated as to whether it is best practice to flush or not flush stems prior to generation of a vulnerability curve (Wang et al., 2014; Hacke et al., 2015; Jansen et al., 2015), but that need not concern us here. The best practice to analyse resprouters and non-resprouters is to compare across data that are not confounded by errors introduced by differences in methods. Laboratories that consistently do not flush stems prior to analyses have primarily analysed resprouting species, thus in the Zeppel et al. (2015) analysis, the resprouter group contained a mix of flushed and unflushed curves. By contrast, the non-resprouters data were largely based on flushed curves.

Our preliminary analyses suggested that the P50 estimated using both flushed and unflushed studies tended to be more negative than the P50 estimated from studies that only included flushed studies; although the magnitude of the difference was not large. To address this confounding factor, we generated a new database that differed from that of Choat et al. (2012) in three ways: First, we included many more studies than the Choat et al. (2012) database. In many cases the newly included data were from species already in the database for which we took an average from across additional studies to arrive at a value for a particular species. Second, we specifically identified studies that reported data from flushed vulnerability curves, so that the present study and future studies can control for disparities in methods. Lastly, we added additional studies that have been conducted in the last three years, which added many new species to the database. Our results are consistent across analyses, but they are strengthened by the inclusion of only studies that are controlled for flushing (figure below;

Table S1 for a complete list of species P50s, references for these values, and flushing identifications).

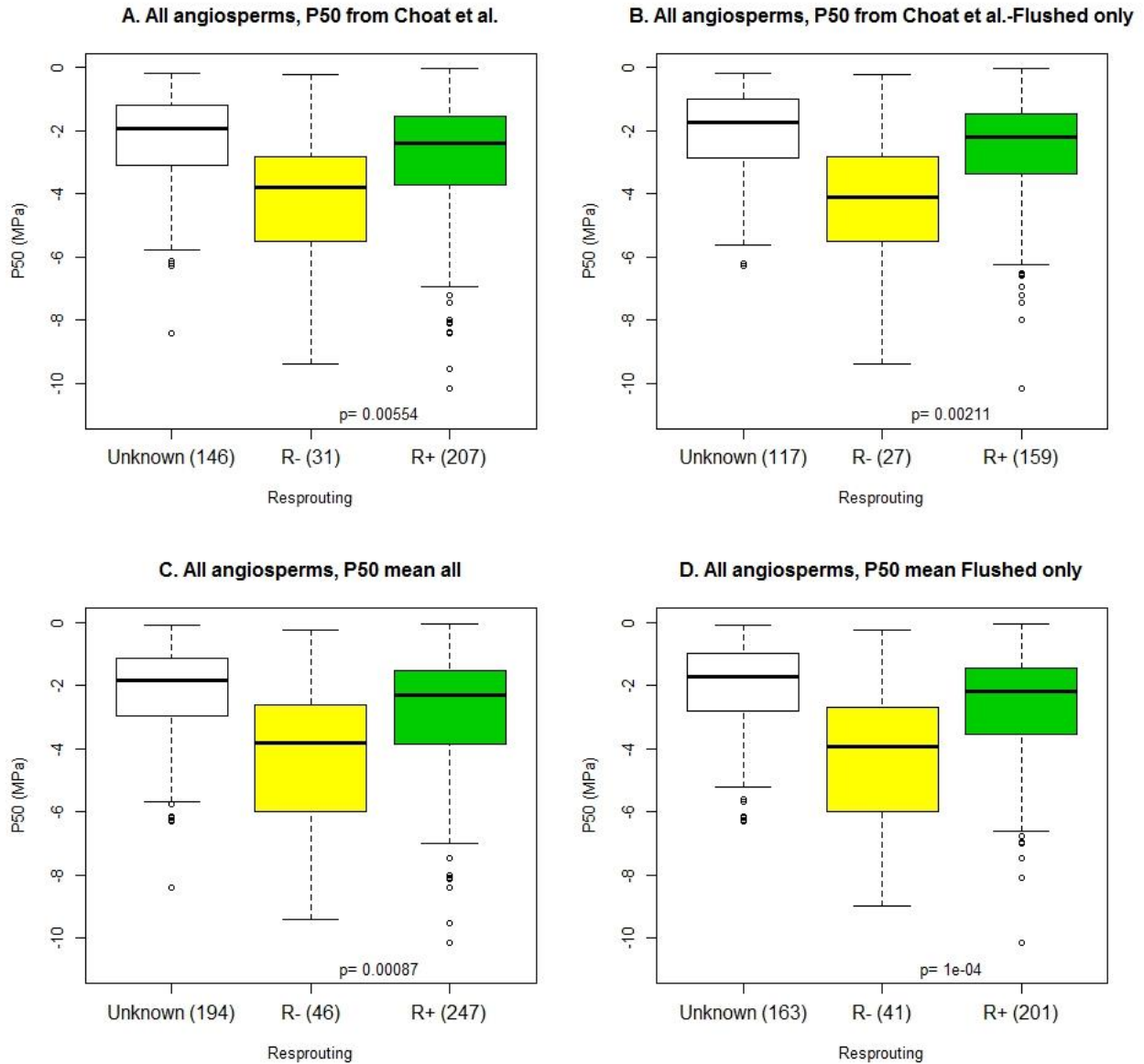


Figure Notes S1. Relationship between resistance to xylem cavitation (P50, MPa) and resprouting ability in angiosperms. Species are grouped in resprouters (R+), non-resprouters (R-), or 'Unknown' (with the number of species in brackets) from bibliographic references (see Table S1 for details). P-values refer to the difference in P50 between resprouters and nonresprouters. Different plots refer to different sets of P50 data as follows: (A) P50 from Choat et al. (2012); (B) Selected cases from Choat et al. (2012) that use flushed curves methods; (C) An enlarged dataset (more species and using means for species for which P50 have been reported across multiple studies); and (D) as C but only using values obtained using flushed

methods (this is the dataset used in Figure 1 of the main text and in Notes S2). The data is available in Table S1 (file Table_S1_Global-P50-Resp-Data_2015.06.xls).

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Notes S2 Statistical comparison of P50 between resprouting life histories

Table: Mean P50 values (n: number of species considered) for resprouters (R+) and non-resprouters (R-) considering plants from all biomes, from the Mediterranean biome only, and from all biomes excluding the Mediterranean. The statistical tests refer to the comparison of P50 values (obtained using the flushed methods) between R+ and R- in standard cross-species analyses (ANOVA) and in phylogenetically-controlled analyses (phy). See Fig. 1 and Notes S1 for visualizing the variability.

| | R+ | | R- | | test | |
|---------------------------|-------|-----|-------|----|------------------|------------|
| | Mean | n | Mean | n | ANOVA (F, p) | phy |
| All biomes (Fig. 1a, S1d) | -2.71 | 201 | -4.32 | 41 | 28.7, p < 0.0001 | p < 0.0001 |
| Mediterranean (Fig. 1b) | -3.07 | 94 | -4.89 | 25 | 8.75, p = 0.0003 | p < 0.0001 |
| Non-mediterranean | -2.40 | 107 | -3.40 | 16 | 7.5, p = 0.0006 | p = 0.26 |

Phylogenetically-controlled analysis: We first generated the topology of a phylogenetic tree for the species considered in each analysis using the Phylomatic software (Webb et al. 2008) on the basis of a magatree (APG III 2009). Then, nodes were dated based on Wikström et al. (2001) and Verdú & Pausas (2013); undated nodes were adjusted using the BLADJ algorithm available in Phylocom. We tested the differences between resprouting abilities by means of a generalized estimating equation (GEE), which is a procedure that uses a GLM approach incorporating the phylogenetic relatedness among species as a correlation matrix in the model (Paradis and Claude 2002).

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Notes S3 Functional differences between resprouters and nonresprouters

Summary of functional differences between resprouters (R+) and non-resprouters (R-) in Mediterranean-type ecosystems.

| Functional trait | R+ | R- | References |
|--|---------|--------|--|
| Cavitation resistance | Lower | Higher | Jacobsen et al. 2007b, Pratt et al. 2007b, Hernández et al. 2011, Pratt et al., 2012, Vilagrosa et al. 2014 |
| Vessel length | Shorter | Longer | Jacobsen et al. 2007b |
| Vessel density (number/area) | Lower | Higher | Vilagrosa et al., 2014 |
| Specific leaf area (SLA) | Higher | Lower | Paula & Pausas 2006, Hernández et al. 2011, Pratt et al. 2012, Pratt et al., 2007b, Ramirez et al., 2012, Pugnaire et al., 2006 |
| Leaf area to xylem area of shoots | Higher | Lower | Ackerly 2004 |
| Carbon assimilation per area when water is available | Lower | Higher | Hernández et al. 2011, Galle et al. 2011; Pratt et al. 2012, Pugnaire et al., 2006 |
| Stomatal conductance (g_s max) | Lower | Higher | Hernández et al. 2011; Galle et al. 2011; Vilagrosa et al., 2014; Ramírez et al., 2012b; Pratt et al., 2012, Pugnaire et al., 2006 |
| Instantaneous water-use efficiency (WUE) | Higher | Lower | Hernández et al. 2011; Vilagrosa et al., 2014 |
| Specific root length (SRL) | Lower | Higher | Paula & Pausas 2011 |
| Seedling root/shoot ratio | Higher | Lower | Pratt et al., 2012; Pugnaire et al., 2006 |
| Xylem water storage capacity | Higher | Lower | Pratt et al. 2007a |
| Minimum seasonal Ψ_w | Higher | Lower | Jacobsen et al., 2008; Pratt et al., 2007b; Paddock et al., 2013 |

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Notes S4 References for Figure 5

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