

Disturbance regimes, gap-demanding trees and seed mass related to tree height in warm temperate rain forests worldwide

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ABSTRACT

For tropical lowland rain forests, Denslow (1987) hypothesized that in areas with large-scale disturbances tree species with a high demand for light make up a larger proportion of the flora; results of tests have been inconsistent. There has been no test for warm temperate rain forests (WTRFs), but they offer a promising testing ground because they differ widely in the extent of disturbance. WTRF is dominated by microphylls *sensu* Raunkiaer and has a simpler structure and range of physiognomy than tropical or subtropical rain forests. It occurs in six parts of the world: eastern Asia, New Zealand, Chile, South Africa, SE Australia and the Azores. On the Azores it has been mostly destroyed, so we studied instead the subtropical montane rain forest (STMRF) on the Canary Islands which also represents a relict of the kind of WTRF that once stretched across southern Eurasia. We sought to find whether in these six regions the proportion of tree species needing canopy gaps for establishment reflects the frequency and/or extent of canopy disturbance by wind, landslide, volcanic eruptions (lava flow and ash fall), flood or fire. We used standard floras and ecological accounts to draw up lists of core tree species commonly reaching 5 m height. We excluded species which are very rare, very localized in distribution, or confined to special habitats, e.g. coastal forests or rocky sites. We used published accounts and our own experience to classify species into three groups: (1) needing canopy gaps for establishment; (2) needing either light shade throughout or a canopy gap relatively soon (a few months or years) after establishment; and (3) variously more shade-tolerant. Group 1 species were divided according the kind of canopy opening needed: tree-fall gap, landslide, lava flow, flood or fire. Only some of the significant differences in proportion of Group 1 species were consistent with differences in the extent of disturbance; even in some of those cases other factors seem likely to have had a major determining influence during evolution. We also sought to determine whether the species that are at least ‘short-term persistent’ in the soil seed bank (lasting 2–4 years) are all species needing canopy gaps for establishment. The answer was negative; large numbers of seeds of some shade-tolerants accumulate in the soil, and these species are able to benefit from soil disturbance in deep shade. We found a significant and strong positive relationship in Japan between mean seed mass and mature tree height, a weak positive relationship in New Zealand and no relationship in any of the other four regions. When comparing the seed mass values of Group 1 and Group 3 species we obtained different answers depending on whether or not we confined ourselves to taxonomically controlled contrasts. In only two of the four regions with an appreciable number of species in Group 1 is the mean seed mass of such species significantly lower than that of Group 3 species when taxonomic relatedness is ignored.

Key words: rain forest, disturbance, wind-throw, landslides, fire, flood, light-demand, shade-tolerance, seed banks, seed size.

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