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Assessing the contribution of leaf respiration to the carbon economy of tropical rainforest tree species

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Tropical rainforests are among the most important biomes in terms of annual primary productivity; hence, assessing their sensitivity to potential shifts in global and regional temperatures patterns is a necessary step to model future local, regional, and global carbon cycling. However, how the changes in future climate including increased temperatures in short- and long-term basis might impact on the carbon cycling in these tropical rainforests is little studied and remain poorly understood. Given this, this study examined the impact of short and long term changes in temperature on leaf respiration in tropical lowland rainforest located in Far North Queensland, Australia. We quantified how leaf respiration responded to short-term changes in temperature and associated leaf chemical and structural traits in 16 tropical rainforest tree species at two canopy heights; upper and lower level of the tree canopy. Further we measured rates of photosynthesis (A) and leaf respiration (R) both in the dark and light, and relationships between those traits and associated leaf structural and chemical traits. Four of these species were subsequently exposed to three different growth temperatures of 25˚C, 30˚C and 35˚C under controlled environment conditions and ability of leaf respiration to acclimate to new temperature regimes was examined. In the field, upper canopy leaves showed higher rates of leaf respiration in darkness and in light than lower canopy leaves at a given set temperature (28˚C). Moreover, at any given leaf mass per unit area (LMA), leaf nitrogen [N] and leaf phosphorus [P] value, rates of respiration were higher in upper canopy leaves (compared to lower canopy leaves). The short-term temperature sensitivity of leaf respiration (Q_{10}) was found to be constant around 1.89 at 25˚C irrespective of species or canopy position.

Three out of four species subjected to different long-term growth temperatures under control environment conditions exhibited some ability to acclimate; acclimation resulted in homeostasis of leaf respiration measured at the prevailing growth temperatures. In conclusion, our findings highlight the importance of canopy position in determining rates of leaf respiration in this tropical forest, the ability of tropical rainforest species to acclimate to changes in temperature in future warmer world, and appropriateness of current climate models using Q_{10} of 2 to describe temperature sensitivity of leaf respiration for this forest type.

Key words: Respiration, carbon cycle, acclimation, tropical rain forests