Mechanisms driving plant functional trait variation in a tropical forest

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Background

Tropical plant communities exhibit extraordinary species richness and functional diversity in highly heterogeneous environments. Albeit the fact that such environmental filtering shapes local species composition and associated plant functional traits, it remains elusive to what extend tropical vegetation might be able to acclimate to environmental changes via phenotypic plasticity, which could be a critical determinant affecting the resistance and resilience of tropical vegetation to projected climate change.

Methodology

We compiled a dataset obtained from 345 individuals and comprising 34 tropical tree species sampled in Costa Rica (**Fig. 1**). Based on the hypothesis that trait variation due to plasticity is driven by environmental variability between forest stands, whereas non-plastic variation increases with geographic distance due to adaptation of the plant community to the local environment, we applied multiple regression on distance matrices (MRM) to quantify respective amount of variation in key plant functional traits, such as wood specific gravity (**WSG**), maximum plant height (**Height**), leaf dry mass content (**LDMC**), leaf area (**LA**), specific leaf area (**SLA**), leaf thickness (**LT**), leaf nitrogen (**N**) and leaf phosphorus (**P**) content (**Fig. 2**).

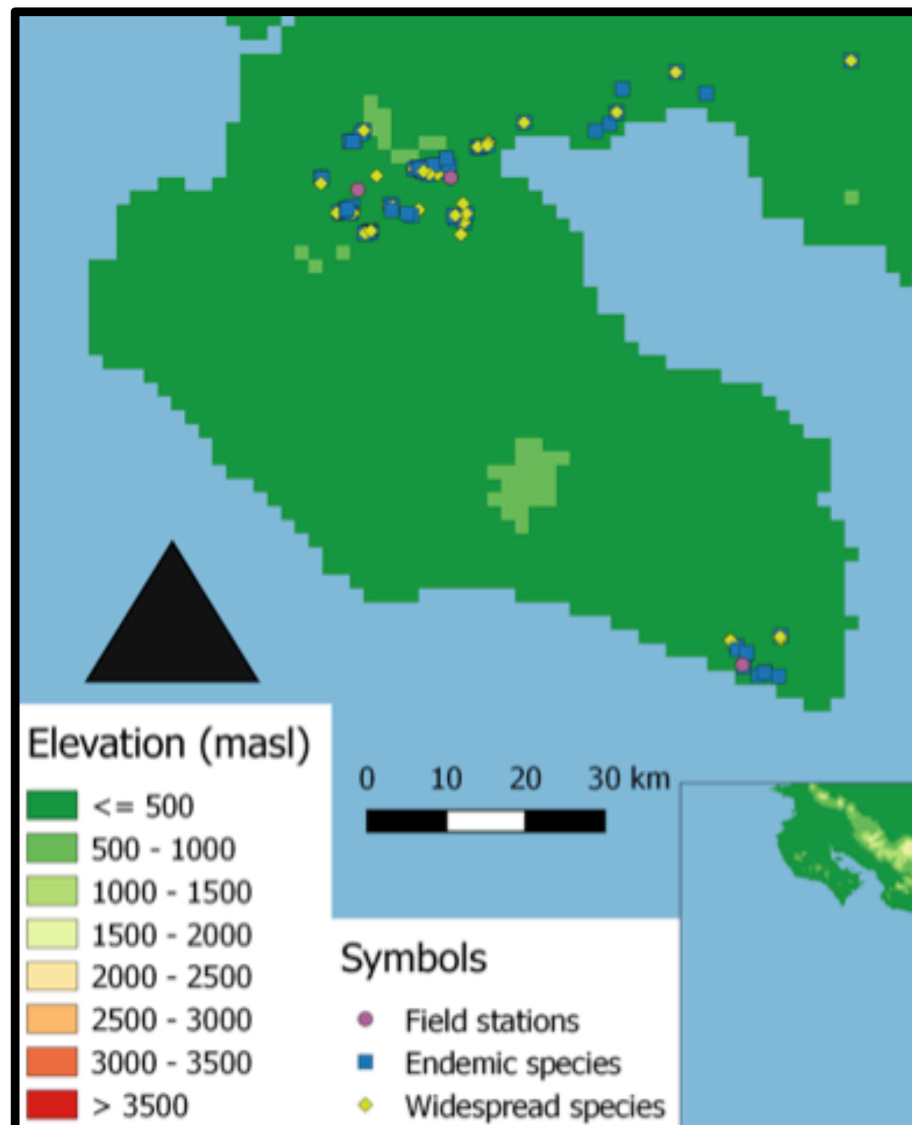

Figure 1. Geographic locations of field stations and sampling sites categorized to congeneric endemic and widespread tree species sampled for plant functional traits investigated in this study (Fig. 2).

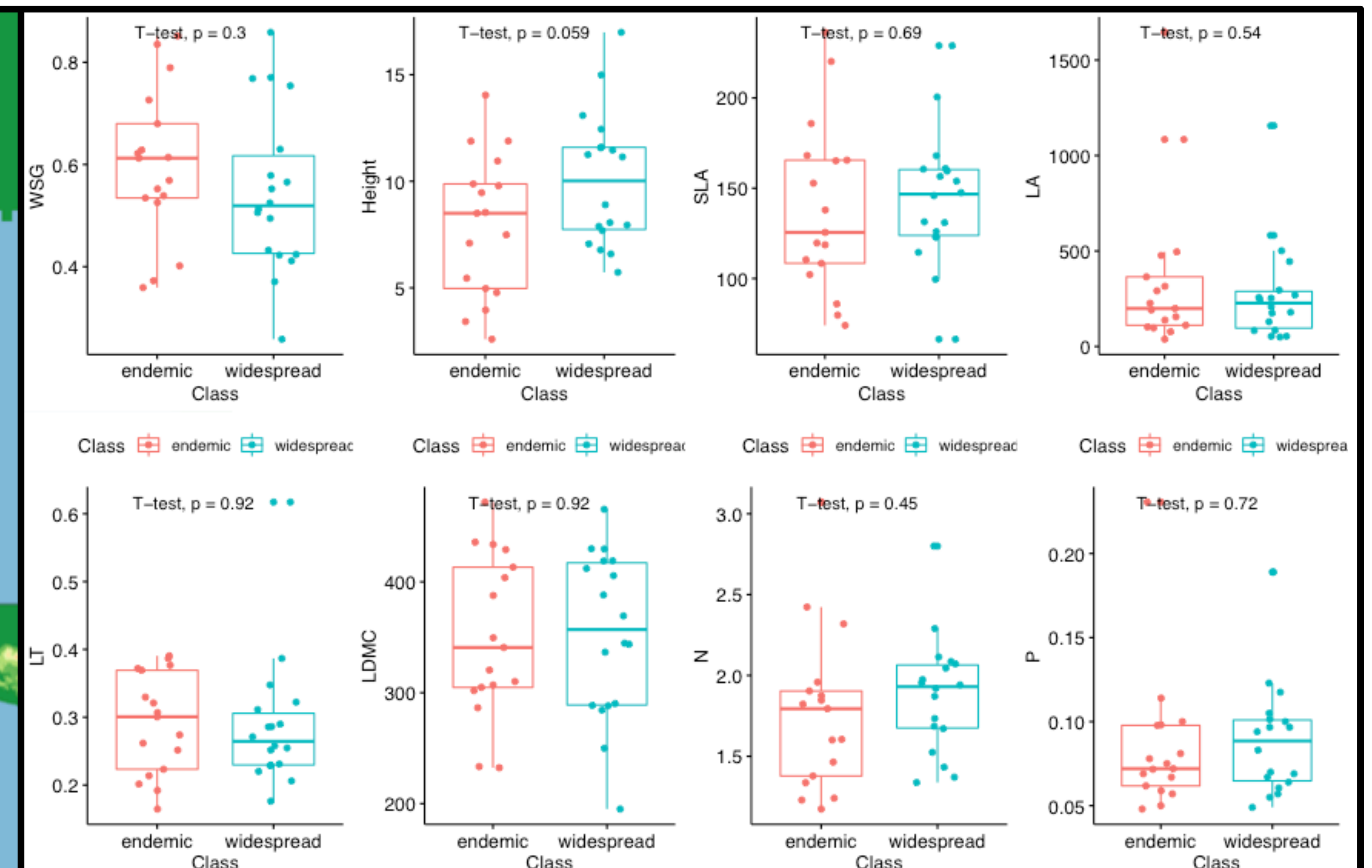

Figure 2. Boxplots showing mean and variance of plant functional traits, i.e. wood specific gravity (WSG), maximum plant height (Height), specific leaf area (SLA), leaf area (LA), leaf thickness (LT), leaf dry mass content (LDMC), leaf nitrogen (N), and leaf phosphorus (P) content for coexisting and congeneric endemic and widespread tree species, located in the study region (Fig. 1).

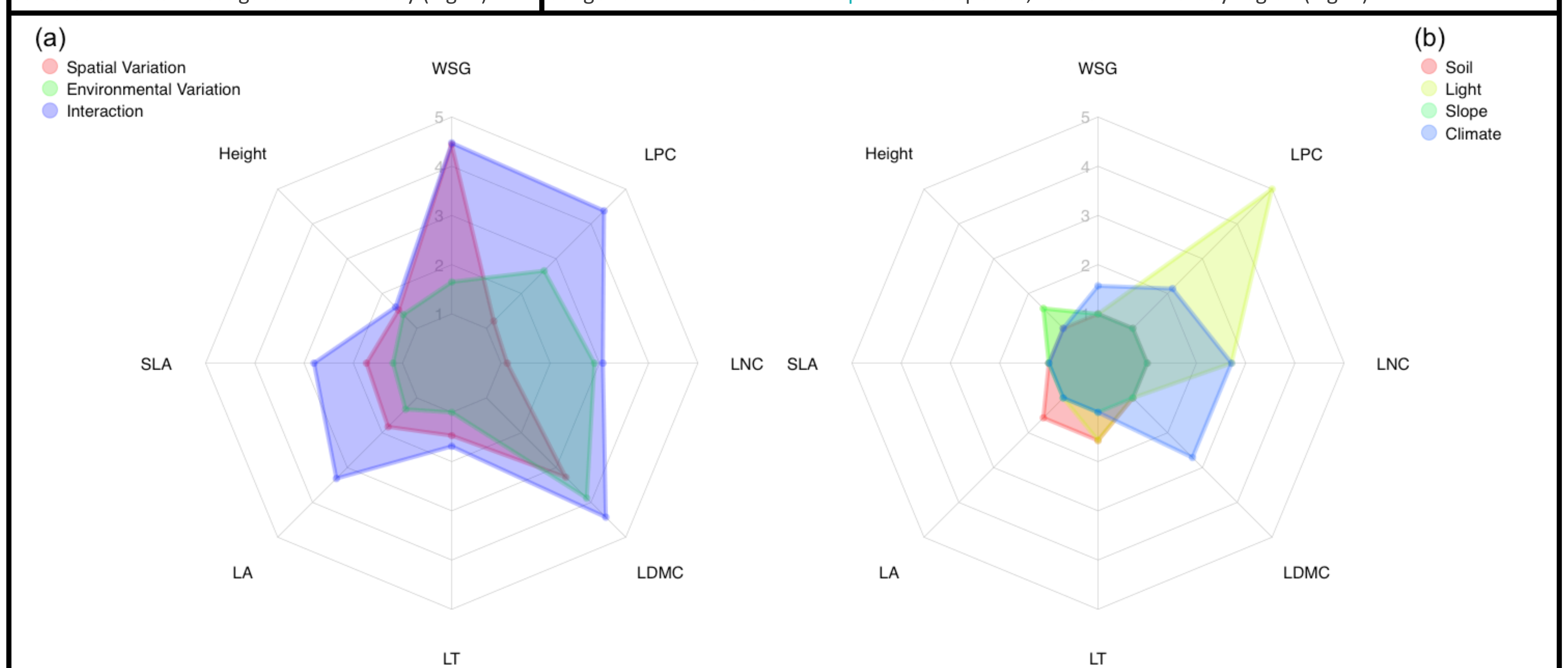

Figure 3. Variance partitioning showing respective amount of variance explained due to different controlling factors, such as spatial and environmental factors driving the observed variation in key plant functional traits, i.e., wood specific gravity (WSG), maximum plant height (Height), leaf dry mass content (LDMC), leaf area (LA), specific leaf area (SLA), leaf thickness (LT), leaf nitrogen (LNC) and leaf phosphorus (LNP) content) across the study region (Fig. 1).

Results

Our findings mirror obvious differences between congeneric and range-restricted **endemic** tree species (with higher wood density), and their **widespread** congeners (with relatively larger maximum plant height), both in line with their life-history strategy (**Fig. 2**). We further found that trait variation was strongly related to spatial factors, thus often masking phenotypic plasticity in response to environmental factors (**Fig. 3a**), and that environmental controls differed between plant tissues, such that leaf traits varied in association with canopy **light** regime and **soil** edaphic properties, whereas wood traits were related to local **topography** and **climatic** variables (**Fig. 3b**).

Conclusions

Our results indicate that the functional response of neotropical tree species to projected climate change might differ among coexisting neotropical tree species even when congeneric plant individuals have been sampled from the same genus and sampling site. Our findings highlight that **endemic** species with conservative ecological strategies could be especially prone to competitive exclusion by invasive and more **widespread** species. We conclude that species with more conservative ecological strategies could be especially threatened by projected climate change conditions and thus would require special conservation efforts in the future.

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