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A theory of plant function explains leaf-trait and productivity responses to elevation

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An emerging theory predicts photosynthetic traits and primary production as consequences of optimal acclimation and/or adaptation to the physical environment. Several publications have examined trait and carbon-cycling shifts along an Amazon-Andes transect, spanning >3 km elevation and 16 K temperature. The data allow tests of theoretical predictions. Photosynthetic capacity has previously been shown to increase with elevation, counteracting enzyme-kinetic effects on photosynthetic rates; declining production has instead been attributed to decreasing light availability. Re-analysing published data in the new theoretical framework, we correctly predict the declining leaf-internal/ambient CO_2 ratio (χ) and increasing carboxylation (Vcmax) and electron-transport capacities with elevation, and increasing leaf nitrogen due to increasing Vcmax and leaf-mass-per-area (LMA). Leaf and soil phosphorus covary, but no nutrient metric accounts for any additional variance in photosynthetic traits. Finally, gross and net primary production gradients are predicted successfully – unifying leaf and ecosystem observations, and explicitly predicting the temperature-insensitivity of primary production.