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The intraspecific variability of short- and long-term carbon allocation, turnover and fluxes under different environmental conditions

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Carbon allocation strategies differ clearly between functional plant groups (e.g. grasses, shrubs and trees) and to a lesser extent between different species of the same functional group. However, little is known about the plasticity of carbon allocation within the same species.

To investigate the variability of carbon (C) allocation, we induced different allocation pattern in the Mediterranean shrub *Halimium halimifolium* by changing growing conditions (light and nutrition) and followed the plant development for 15 months. We analyzed morphological and physiological traits, and changes in C allocation and δ^{13}C values in seven tissue classes: 1st generation leaves, 2nd generation leaves, emerging leaves, lateral shoots, stem, main roots and fine roots. We used a soil/canopy chamber system that enables independent measurements of above and belowground $\delta^{13}CO_2$-exchange, enabling total estimates of carbon gain during photosynthesis and the carbon loss during respiration on a whole plant level. Moreover, we followed the fate of recently assimilated carbon in all plant tissues by $^{13}CO_2$ pulse labeling for 13 days.

A reduction of light (*Low L* treatment) increased allocation to stems by 84% and the specific leaf area (SLA) by 29%, compared to control. Reduced nutrient availability (*Low N* treatment) enhanced carbon allocation into fine roots by 57%. We found high intraspecific variability in turnover times of C pools. The *Low N* treatment enhanced transport of recently assimilated C from leaves to roots in quantity (22% compared to 7% in control plants) and velocity (^{13}C peak in main roots after 5h compared to 18h in control). The treatments differed also in fractions of ^{13}C recovered within leaves: 48%, 28% and 41% of ^{13}C from labeling were found after 13 days in leaves of control, *Low N*, and *Low L*, respectively.

Through the combination of natural carbon isotope analysis, $^{13}CO_2$ labeling and whole-plant chamber measurements we obtained information about long and short-term C allocation to different tissues and respiration. The results give valuable new information to understand the total plant C balance and to characterize its intraspecific variability due to environmental factors.