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Temperature driven changes on composition of leaf lipids in deciduous and evergreen species covary with light quantity

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Understanding temperature along with light influencing changes of leaf lipids in deciduous and evergreen species is crucial for reconstructing paleotemperature and paleoecology. Presently, there are few quantitative temperature and light proxies derived from terrestrial leaf lipids. Here we demonstrated that temperature along with light are the major drivers of changes of leaf lipids in a tree species. We attribute changes of composition and distribution of leaf lipids to genetic regulation of lipid biosynthesis in response to the temperature- and light-induced stresses. Leaf samples of *Quercus buckleyi* (drought avoidant) and *Juniperus ashei* (drought tolerant) were collected monthly (April 2019 to January 2020) in central Texas (31.5837° N 97.1563° W). Climate data (e.g., air temperature) were acquired from National Oceanic and Atmospheric Administration. For quantification of light that was received by the leaves, we measured leaf level irradiance and leaf area index (LAI) using LAI-2000 plant canopy analyzer. Our results demonstrated that ratios of unsaturated to saturated fatty acids, phytosterol ratios and average chain length values of *n*-alkanols ($ACL_{n\text{-alkanols}}$), have significant relationships with the temperature and light variables, although the relationships are species dependent. The ratio of unsaturated fatty acids (C18 series) to saturated fatty acids was significantly decreased with the temperature increasing ($r^2>0.4$, $p<0.001$) in both *Q. buckleyi* and *J. ashei* leaves. The campesterol/β-sitosterol ratio was significantly and positively related with the increased temperature in *J. ashei* leaves ($p<0.001$) but the trend was not observed in *Q. buckleyi* leaves. The stigmasterol/β-sitosterol ratio in *Q. buckleyi* leaves declined with the light transmittance increasing. The decline mainly occurred in a closed canopy and then the ratio remained below 0.06 in relatively open canopy. Similarly, the $ACL_{n\text{-alkanols}}$ increased with LAI decreasing ($r^2=0.51$, $p<0.0001$), implying that the chain lengths shifted to the longer chains in relatively open canopy settings. Therefore, we hypothesized that the changes of leaf lipid ratios could be signals for indicating the variations of temperature and light.