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Title: Phenotypic Plasticity in Dog-Strangling Vine and Coleus.

Introduction: Phenotypic plasticity is the change in the phenotype expressed by a single genotype in different environments. Even though all somatic cells in an organism have the same DNA, cells may develop different final phenotypes in response to environmental factor variability (Sack et al. 2006); this may be tremendously beneficial when an individual is likely to experience a broad range of environmental conditions. Phenotypic responses may be the consequence of resource limitations, specifically light availability. Light is critical for plant growth and survival as low light intensity can limit photosynthesis (Lichtenthaler et al. 1981). Depending on the amounts of light available during growth, plants are categorized as sun or shade organisms and can differ in their structure, development, and overall leaf morphology (Carpenter and Smith 1981). An organism's ability to assess environmental conditions that will increase or decrease its fitness is an important factor in evolution. Thus, studying the adaptations and phenotypic responses of these species is of enormous ecological importance.

Vincetoxicum rossicum, or Dog-Strangling Vine, is a perennial species that is found growing naturally outside and thrives in high intensity light environments. On the other hand, *Solenostemon scutellarioides*, or Coleus, is a perennial species that was experimentally grown in the greenhouse and prefers moderate light intensity. The purpose of this study was to investigate phenotypic plasticity and the effects of sun and shade environments in two different plant species - Coleus and Dog-Strangling Vine - as well as the potential advantages that these effects may confer to the plant in that environment. We hypothesized that the differing light conditions would result in varying morphological features such as size and weight, and may also have an effect on photosynthetic capacity in sun and shade leaves in both the plants.

Figures:

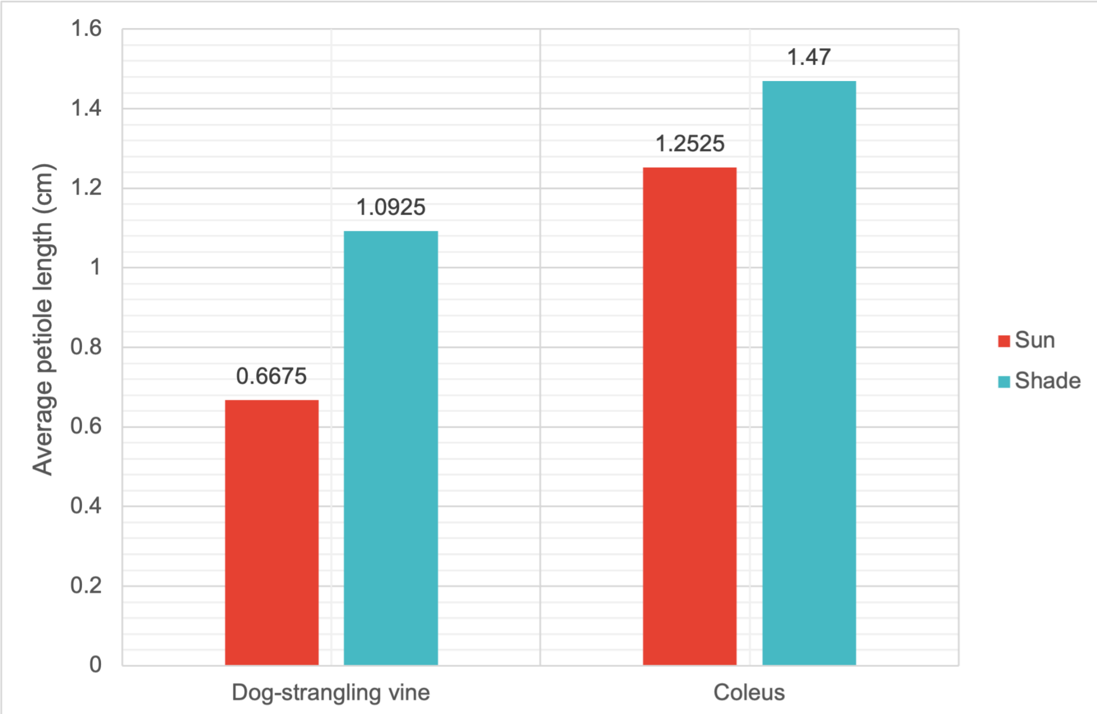

FIG. 1. Average petiole length (cm) in sun vs shade leaves in Dog-Strangling Vine and Coleus.

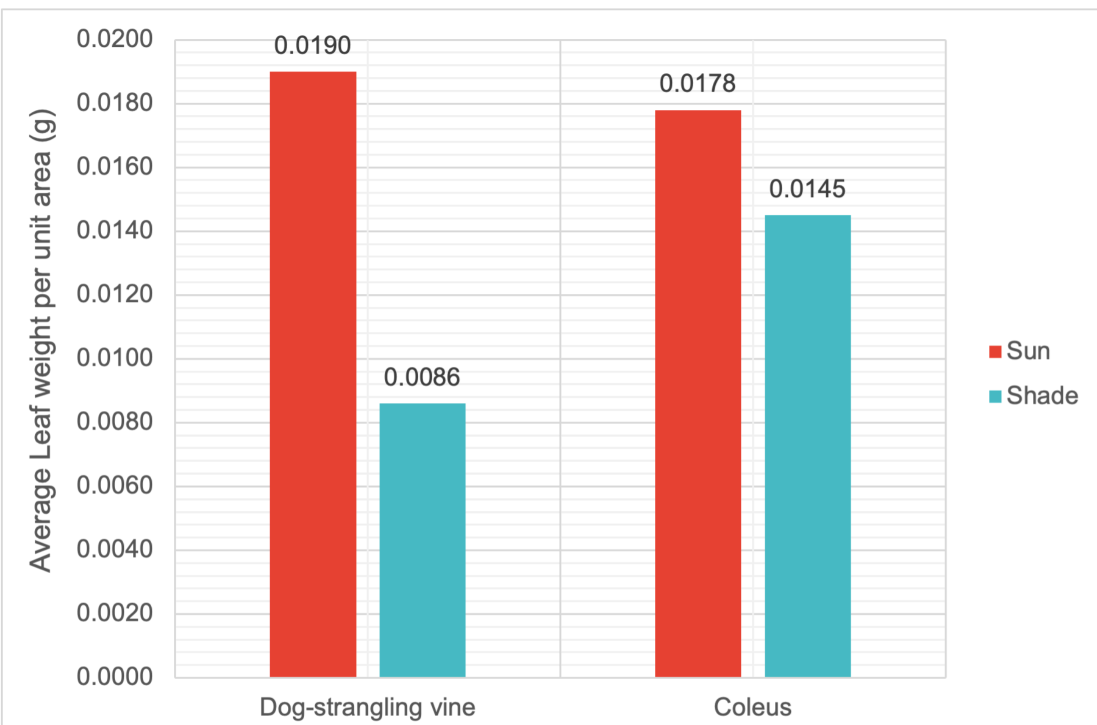

FIG. 2. Average leaf weight per unit area (g) in sun vs shade leaves in Dog-Strangling Vine and Coleus.

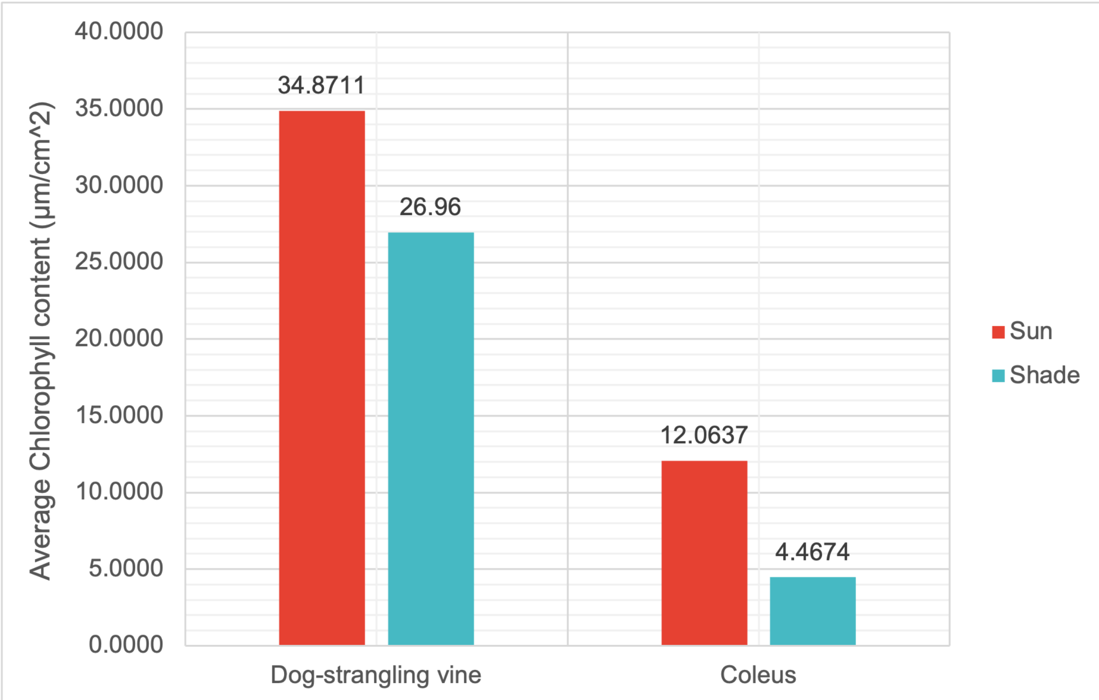

FIG. 3. Average chlorophyll content (µm/cm^2) in sun vs shade leaves in Dog-Strangling Vine and Coleus.

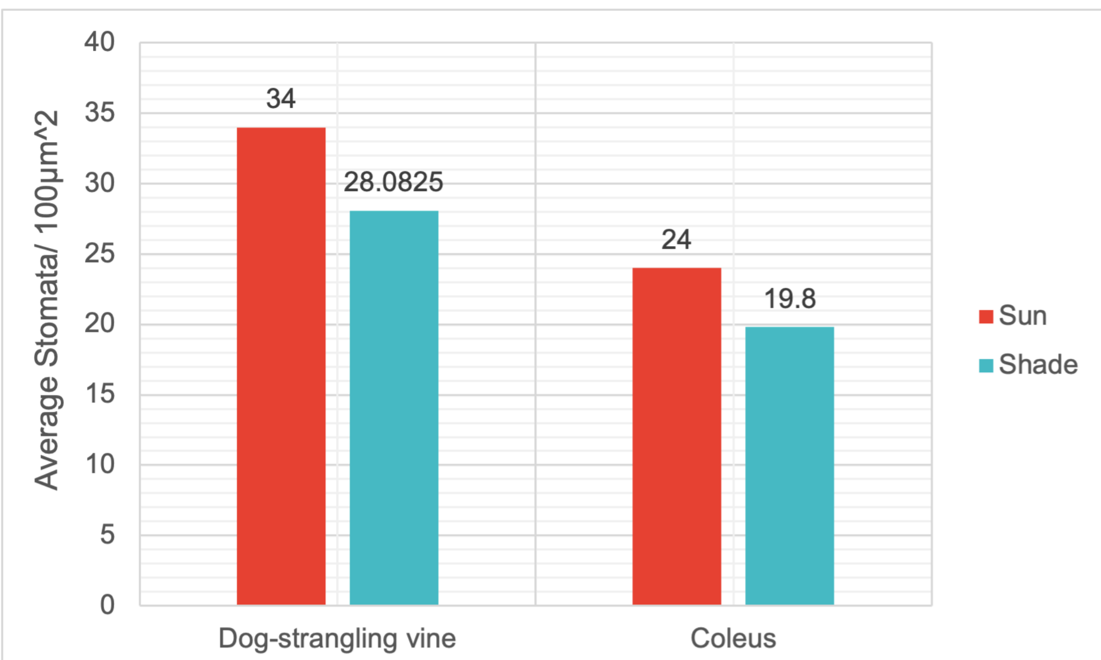

FIG. 4. Density of Stomata, as measured by Average Stomata/100µm^2 in sun vs shade leaves in Dog-Strangling Vine and Coleus.

Discussion: The overall petiole length of the shade leaves was higher than that of sun leaves in both Dog-Strangling Vine and Coleus (FIG. 1), perhaps because longer petioles may enable plants to grow laterally and reach more favorable light conditions. This could be corroborated with the qualitative data regarding leaf size and the study by Carpenter and Smith (1981), which indicated that shade leaves in both plants were larger than the sun leaves. The larger shade leaves provide a larger area for absorbing light energy for photosynthesis in a place where light levels are low, allowing them to intercept more light. As such, smaller sun leaves will provide less surface area for the loss of water through transpiration (Carpenter and Smith 1981). It is interesting to note that the petiole length of the sun and shade leaves in Coleus were both bigger than any leaves of the Dog-Strangling Vine, which may be simply attributed to innate differences between the species.

The average leaf weight per unit area was higher in the sun leaves than in shade leaves in both plants; this could be due to longer palisade cells, smaller surface area and a thicker dorsal cuticle, developed to minimize water loss (Carpenter and Smith 1981). The study by Carpenter and Smith (1981) suggests that light-demanding species, like the Dog-Strangling Vine, have more light-induced plasticity than shade-tolerant species, like Coleus. This could explain the larger difference observed between sun and shade leaves in Dog-Strangling Vine relative to that in Coleus when studying both petiole length and average weight per unit area.

The average chlorophyll content was greater in sun leaves than in shade leaves in both plants (FIG. 3). This data is consistent with the study by Lichtenthaler et al (1981) that concludes sun leaves, on an average, have a higher photosynthetic rate on a leaf area basis; this is associated with a higher chlorophyll a/b ratio. The qualitative data supports this as a darker green color was observed in the sun leaves of both plants. Overall, the chlorophyll content in Coleus, ranging between 4-12μm/cm^2, was significantly lower than in Dog-Strangling Vine, ranging between 24-36μm/cm^2 (FIG. 3). This may be because Coleus, being a shade-tolerant species, can survive with a lower photosynthetic rate.

The higher photosynthetic rates of sun leaves are supported by higher stomatal density, or average stomata per 100μm^2, in both the plants (FIG. 4), perhaps to maximize CO_2 absorption, reduce evaporation and water loss (Sack et al. 2006). This is important in environments with high rates of gas exchange due to higher light intensity. The overall stomatal density was observed to be greater in Dog-Strangling Vine as compared to Coleus, which could be because Coleus was grown in a controlled environment where there was lesser water loss, reducing the need for a higher number of stomata.

Penultimately, this study supported the hypothesis as well as the qualitative trends highlighted by the sun-shade leaf dichotomy; however it has strengths and limitations. The general trends of phenotypic plasticity for petiole length, average weight, chlorophyll content, and stomatal density were consistent with results in previous studies. A potential limitation could be the lack of consideration of other factors such as wind, competition, and weather conditions, all of which could be different in sun and shade environments and have a significant impact on the adaptations of these species. Moreover, many other factors may be studied as an extension, one of which is temperature. Plants could be grown in two different temperature controlled environments: the same quantitative data can be collected with regards to morphological differences and additional data about rate of transpiration could be collected and correlated with the stomatal density in sun and shade leaves. This can give us an idea of the functional differences and the effects of varying light conditions on the fitness of these fascinating plant species.

References:

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2. Sack, L., P.J. Melcher, W.H. Liu, E. Middleton and T. Pardee, 2006. How strong is intracanopy leaf plasticity in temperate deciduous trees?. Am. J. Bot. 93: 829-839.
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