

Model Document: Research Proposal

Title page, unnumbered, includes specific and informative title, your name, and other relevant information, all centered on the page.

Field Measurements of Photosynthesis and Transpiration
Rates in Dwarf Snapdragon (Chaenorrhinum minus Lange):
An Investigation of Water Stress Adaptations

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Short title and page number in upper right corner.

Introduction provides background on the scientific issue and cites other relevant studies.

In the citation-sequence system of the CBE documentation style, superscript numerals indicate cited material.

Abbreviation of genus and species used after spelling out initially.

Top, bottom, right and left margins should be between 1 and 1.5 inches.

INTRODUCTION

Dwarf snapdragon (Chaenorrhinum minus) is a weedy pioneer plant found growing in central New York during spring and summer. Interestingly, the distribution of this species has been limited almost exclusively to the cinder ballast of railroad tracks,¹ a harsh environment characterized by intense sunlight and poor soil water retention. Given such environmental conditions, one would expect C. minus to exhibit anatomical features similar to those of xeromorphic plants (species adapted to arid habitats).

However, this is not the case. T. Gupta and R. Arnold (unpublished) have found that the leaves and stems of C. minus are not covered by a thick, waxy cuticle, but rather with a thin cuticle that is less effective in inhibiting water loss through diffusion. The root system is not long and thick, capable of reaching deeper, moister soils; instead, it is thin and diffuse, permeating only the topmost (and driest) soil horizon. Moreover, in contrast to many xeromorphic plants, the stomata (pores regulating gas exchange) are not found in sunken crypts, or cavities in the epidermis that retard water loss from transpiration. Despite a lack of these morphological adaptations to water stress, C. minus continues to grow and reproduce when

morning dew has been its only source of water for up to five weeks (R Arnold, personal communication). Such growth involves fixation of carbon by photosynthesis, and requires that the stomata be open to admit sufficient carbon dioxide. Given the dry, sunny environment, the time required for adequate carbon fixation must also mean a significant loss of water through transpiration as open stomata exchange carbon dioxide with water. How does C. minus balance the need for carbon with the need to conserve water?

AIMS OF THE PROPOSED STUDY

The above observations have led me to an exploration of the extent to which C. minus is able to photosynthesize under conditions of low water availability. It is my hypothesis that C. minus adapts to these conditions by photosynthesizing in the early morning and late afternoon, when leaf and air temperatures are lower and transpirational water loss is reduced. During the middle of the day, its photosynthetic rate may be very low, perhaps even zero on hot, sunny afternoons. Similar diurnal changes in photosynthetic rate in response to midday water deficits have been described in crop plants.^{2,3} There appear to be no comparable studies on noncrop species in their natural habitats.

Aims and scope of proposed study provide framework.

Citation to two sources at same point.

Thus, the research proposed here should help explain the apparent paradox of an organism that thrives in water stressed conditions despite a lack of morphological adaptations. This summer's work will also serve as a basis for controlled experiments in a plant growth chamber on the individual effects of temperature, light intensity, soil water availability, and other environmental factors on photosynthesis and transpiration rates. These experiments are planned for the coming fall semester.

METHODS

Simultaneous measurements of photosynthesis and transpiration rates will indicate the balance C. minus has achieved in acquiring the energy it needs while retaining the water available to it. These measurements will be taken daily at field sites in the Hamilton, NY, area, using a LI-6220 portable photosynthesis system (LICOR, Inc., Lincoln, NE). Basic methodology and use of correction factors will be similar to that described in related studies.⁴⁻⁶ Data will be collected at regular intervals throughout the daylight hours, and will be related to measurements of ambient air temperature, leaf temperature, relative humidity, light intensity, wind velocity, and cloud cover.

Proposed methodology is clearly described.

Citation to three consecutive sources at same point.

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BUDGET

1 kg soda lime, 4-8 mesh (for absorption of CO ₂ in photosynthesis analyzer)	\$70
1 kg anhydrous magnesium perchlorate (used as desiccant for photosynthesis analyzer)	\$130
SigmaScan software (Jandel Scientific Software, Inc.) (for measurement of leaf areas for which photosynthesis and transpiration rates are to be determined)	\$195
Estimated 500 miles travel to field sites in own car @ \$0.28/mile	\$140
CO ₂ cylinder, 80 days rental @ \$0.25/day (for calibration of photosynthesis analyzer)	\$20
TOTAL REQUEST	\$555

REFERENCES

1. Wildrlechner MP. Historical and phenological observations of the spread of *Chaenorrhinum minus* across North America. *Can J Bot* 1983;61:179-87.
2. Boyer JS. Plant productivity and environment. *Science* 1982;218:443-8.
3. Manhas JG, Sukumaran NP. Diurnal changes in net photosynthetic rate in potato in two environments. *Potato Res* 1988;31:375-8.

Budget is as specific as possible.

References, listed numerically, correspond to callouts in text, following the CBE documentation style.

4. Doley DG, Unwin GL, Yates DJ. Spatial and temporal distribution of photosynthesis and transpiration by single leaves in a rainforest tree, Argyrodendron peralatum. Aust J Plant Physiol 1988;15:317-26.
5. Kallarackal J, Milburn JA, Baker DA. Water relations of the banana. III. Effects of controlled water stress on water potential transpiration, photosynthesis and leaf growth. Aust J Plant Physiol 1990;17:79-90.
6. Idso SB, Allen SG, Kimball BA, Choudhury BJ. Problems with porometry: measuring net photosynthesis by leaf chamber techniques. Agron 1989;81:475-9.