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Victor D. Carmona

Loyola Marymount University, vcarmona@lmu.edu

Stephen Line

Kevin Hong

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Author(s): Stephen Line , Kevin Hong , and Víctor D. Carmona-Galindo

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Preliminary Report

The relationship between castor bean stem diameter and extrafloral nectary gland size

Stephen Line, Kevin Hong, and Víctor D. Carmona-Galindo

Biology Department, Loyola Marymount University, Los Angeles, CA 90045

Abstract. This project sought to characterize plant defense investment in the castor bean (*Ricinus communis* L.), an exotic myrmecophyte in southern California, with respect to life history strategies. Experimental evidence suggests that exotic myrmecophytes can form mutually beneficial associations with exotic ants regardless of the differences in shared evolutionary histories. Castor bean plant investment in defense was evaluated by measuring the area on extrafloral nectary (EFN) glands. Life history strategies may change with respect to plant size and was therefore evaluated in terms of basal stem diameter (<50mm). We hypothesized that smaller and younger castor bean plants would have bigger EFN glands than larger and older plants. We found that EFN gland size was not correlated to castor bean class size. This suggests that in southern California, biotic plant defense is not optimized in castor bean plants. As an r-selected species, the castor bean plant compromises investment in plant defense favoring investment in growth and early reproduction.

Introduction

The castor bean plant (*Ricinus communis* L.) is a myrmecophyte native to Africa and Asia that engages ants in a facultative mutualistic relationship. In southern California, the castor bean plant attracts Argentine ants (*Linepithema humile* Mayr), an ant species native to South America. Koptur (1984) documents that it is possible for exotic myrmecophytes to form mutualisms with ants despite differences in evolutionary histories. The castor bean plant attracts ant species with extra-floral nectary (EFN) glands, which secrete sugar. In turn, the ants serve to defend the plant. Increased resources, such as larger

EFN glands, attract more ants and increase the protection of plant tissues from herbivores (Carroll and Janzen, 1973). Depending on the species and the location of the plant, EFN glands may function to illicit a simple response or they may serve in a much more complex mechanism (Beattie, 1985). More research is needed to characterize EFN gland morphology and the role of the environment on population dynamics (Goss et al., 2011). Our objective was to determine if investment in plant defense changes with the life history strategy of the castor bean plant. Since developing leaves are more vulnerable to herbivory than mature leaves (Coley and Aide, 1989), we hypothesized that younger castor bean plants would have larger EFN glands than older plants. The base of the Castor bean plant was measured in order to differentiate young plants (small in diameter) from old plants (large in diameter). We could then

Correspondence to: vcarmona@lmu.edu.

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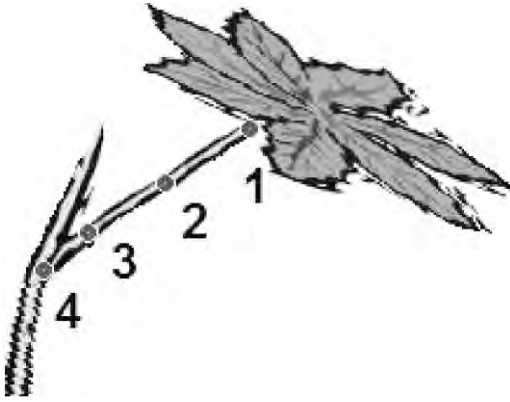


Figure 1. This image shows the relative positions of EFN glands on the *R. communis* petiole. We selected only the Castor bean individuals that had one EFN gland at relative position one, which is located on the petiole region closest to the leaf lamina.

evaluate any underlying optimization strategies by comparing this information with the data of the EFN gland sizes.

EFN glands may play various roles according to the species and location of the plants that produce them. They may form the basis of a relatively simple ant-guard system in some situations, or the core of a complex ant-guard, wasp-guard, pollinator-attractant system in others.

Materials and Methods

The study was conducted on November 8, 2011 in the Riparian woodlands on the bluff of Loyola Marymount University, Los Angeles, California. Fifty plant specimens that possessed a single EFN gland at the top of the petiole near the leaf lamina (Figure 1) were selected. Plants with more than one EFN gland in the given position were not included in the study. Extrafloral nectary glands were digitally photographed along with a reference scale to measure total area (mm^2) using SigmaScanPro (v.5). The base of the castor bean plant was measured with a dial caliper (mm) at the soil line. We conducted a Shapiro-Wilk test to test for normality and a Spearman-Rank correlation between EFN gland size and plant stem diameter using Statistica (v.9).

Results

The observations for castor bean EFN gland size ($w = 0.90836$, $p = 0.00092$) and plant stem diameters ($w = 0.88731$, $p = 0.00019$) were not normally distributed. Extrafloral nectary gland size was not correlated with castor bean stem diameter ($r = 0.10045$, $p = 0.385$, Figure 2).

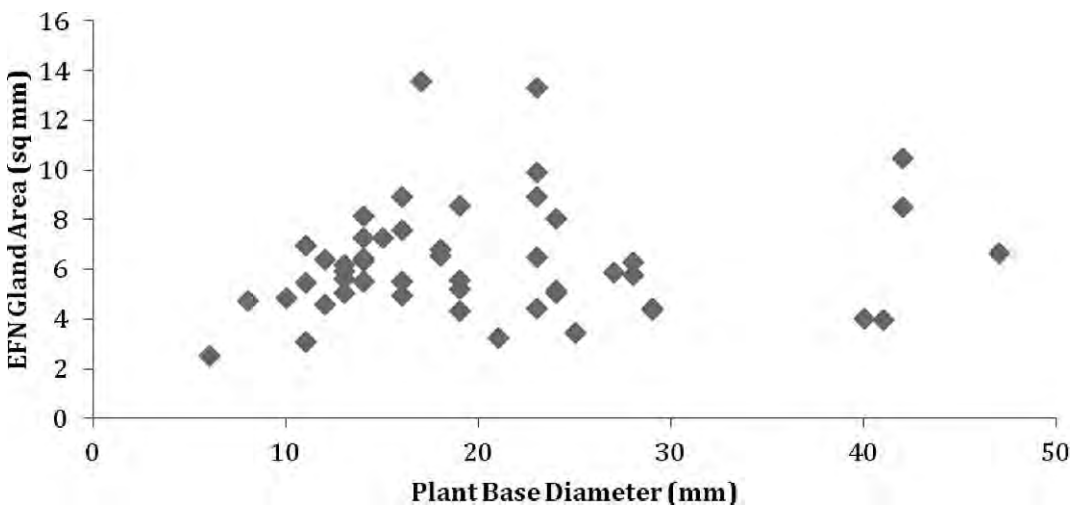


Figure 2. The relationship between castor bean plant base diameter and EFN gland size is not correlated ($r = 0.10045$, $p = 0.385$).

Discussion

We found that EFN glands remain the same size throughout the life history of a plant that is less than 50 mm in basal diameter. The principle of allocation explains that if an individual distributes energy to a function, like growth or reproduction, any additional functions, such as defense, must utilize only the energy that remains available. An r-selected life history strategy focuses on rapid growth and reproduction when favorable environmental factors exist in an unpredictable environment. As an r-selected species, castor bean plants are typically short-lived individuals with an opportunistic life strategy (Ferreira et al., 2011). They display semelparity, where they will mature quickly, breed at a young age, and produce many offspring. Our findings support the idea that investment in biotic plant defense may remain static with plant age because r-selected life history strategy dictates an increased investment in reproduction and growth. While this study focuses on the biotic interactions of the castor bean plant, chemical mechanisms of defense may also be involved in the survival strategy. Future studies should consider this potential relationship between biotic and chemical de-

fense strategies. They should also evaluate the relationship between castor bean plant base diameter and EFN gland size across exotic environments. Characterizing factors that shape the outcome of facultative mutualism between exotic species may be of interest as well.

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