Identifying fruit traits that are predictors of predispersal seed predation in *Ruellia humilis*

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Abstract

As predispersal seed predators can significantly reduce seed recruitment and population growth rates (reviewed in Kolb et al. 2007), it is important to identify plant morphological traits related to seed predator attack. Using the model species *Ruellia humilis*, quantified fruit morphological traits and incidence of attack by the specialist seed predator, *Tripudia rectangula.* We found that fruit length was a significant predictor of seed predator attack. Future work should examine whether *T. rectangula* acts as a selective agent on *R. humilis* fruit morphology.

Introduction

Predispersal seed predators negatively affect plant fitness by consuming seeds still attached to a maternal plant. This process can significantly reduce seed recruitment and population growth rates and serve as potent agents of selection on plant traits (Kolb et al. 2007, Sousa et al. 2003). Fruit morphology, including traits such as length and width, may be an important determinant of predispersal seed predator attack (Beckman and Mueller-Landau 2011), and thus, may help explain intraspecific variation in rates of attack. In some systems, seed size is positively correlated with insect seed predation (Mucunguzi 1995, Espelta et al. 2009). In addition, larger fruits tend to be attacked at a higher rate than smaller fruits (Gomez and Zamora 1994). Seed size is predicted to be positively correlated with insect seed predation due to their higher energy reserves than smaller seeds of the same species (Mucunguzi 1995, Espelta et al. 2009). The model used in our study is *Ruellia humilis* (Acanthaceae), an herbaceous perennial native to North America. It is common in prairie ecosystems of the central U.S. and has a heteromorphic flowering system in which an individual plant can produce both closed, selfing cleistogamous and open-pollinated chasmogamous flowers. Fruits of *R. humilis* are attacked by a specialist seed predator, *Tripudia rectangula* (Lepidoptera) larvae, that feed on seeds before fruits are dispersed (Pogue 2009). The overall goal of our study was to determine whether fruit morphological traits are significant predictors of predispersal seed predator attack in *R. humilis*. We hypothesized that larger fruits with thinner fruit walls would be more likely to be attacked by predisperal seed predators.

Methods

Fruits were collected from two wild populations of *Ruellia humilis* in Oklahoma. One population was located at Lake Carl Blackwell in Stillwater and the second at the Tall Grass Prairie Preserve in Pawhuska. After collection, the fruits were dissected and photographed using a Leica dissecting microscope with an attached digital camera feature. Of the fruits collected, 36 were attacked by the predipsersal seed predator (*T. rectangula*) and 156 were not. We used ImageJ to measure fruit length, fruit width, and fruit wall width. Using the measurements collected, correlation analysis was preformed to determine whether the

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three fruit morphological traits were related to one another. We tested whether predispersal seed predator attack by *T. rectangula* was related to the fruit traits via a stepwise logistic regression. The model included the three fruit traits and their interactions. Individual factors were entered into the model when $P \leq 0.05$. The computational algorithm of Lawless and Singhal (1978) was used to determine whether variables were removed.

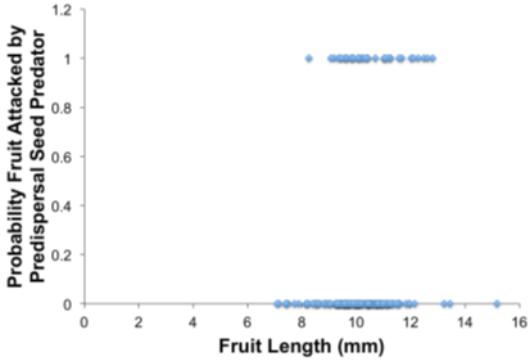

Figure 3 - This figure uses the specialized stepwise logistic regression model to display that length was the only significant indicator in predispersal predator attack from the results of our study.

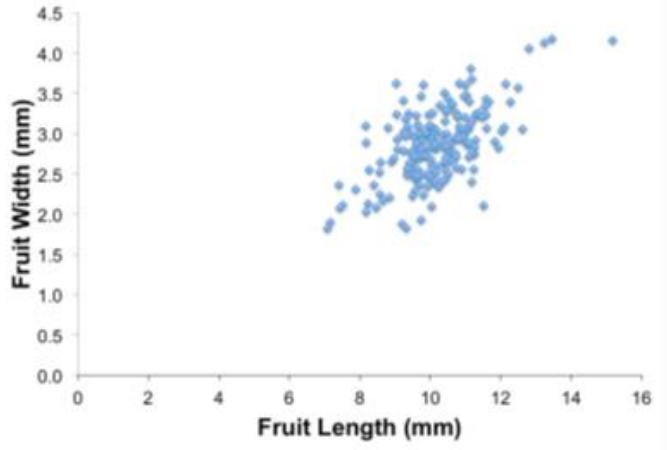

Figure 1 - This figure shows a positive correlation between fruit traits of width and length from analyzed data

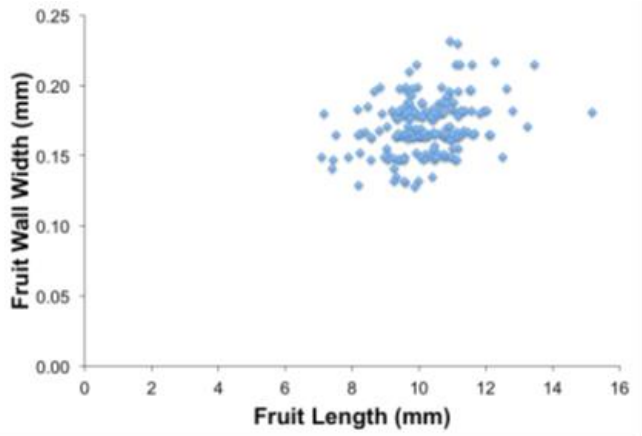

Figure 2 - This figure shows shows a positive correlation between fruit traits of fruit wall width and length.

Results

In *R. humilis*, we found some of the measured fruit traits were correlated with one another (Figures 1 and 2). In particular, longer fruits tend to be wider fruits ($r = 0.61$, $P < 0.0001$). Longer fruits also tend to have thicker fruit walls ($r = 0.30$, $P < 0.0001$). However, fruit width and fruit wall width did not correlate with one another ($r = 0.09$, $P = 0.23$).

In the stepwise logistic regression analysis, we found that fruit length was the only morphological trait associated with predispersal seed predation (Parameter estimate = 0.36; Wald Chi-Square = 4.72; $P = 0.029$). Fruits attacked by seed predators were longer than those not attacked by the seed predator (Figure 3). No other measured fruit traits were significant determinants of predispersal seed predator attack.

Discussion

Our study found that fruit length is a significant predictor of predispersal seed predator attack in *R. humilis*. As Beckman and Mueller-Landau (2011) also found a similar response in tropical species; larger fruits were more susceptible to attack by predispersal seed predators. Although, contrary to our hypothesis, we did not find that thicker walled *R. humilis* fruits were

less likely to be attacked by *T. rectangula*. Only longer fruits were more prone to attack in our conducted study. Across seven plant species, Beckman and Mueller-Landau (2011) also found that physical defenses of a fruit (e.g., fruit wall thickness) did not influence predispersal seed predator attack. *T. rectangula*, seed specific predator, also being a boring insect, not influenced by fruit wall thickness was contrary to our hypothesis. Future work should examine whether there is genetic variation within *R. humilis* populations for fruit length and whether *T. rectangula* is a selective agent on this trait.

Acknowledgements

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