Digital morphometric analysis of North American *Vitis* growing in a common garden

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Introduction

- Species within the genus *Vitis* (Vitaceae) are the foundation of wine, table grape, raisin, and grape juice industries ($billions)
- Grapevine cultivation is based primarily on European *V. vinifera* which are grafted to North American *Vitis* species (*V. riparia, V. rupestris)*
- Since the Phylloxera infestion of the 1800s in Europe, N. American grapevines have been key genetic resources in developing biotic and abiotic stress resistant rootstocks

Phylloxera galls on *V. rupestris* at the Missouri Botanical Garden

Introduction

- Leaf morphology is very diverse in the genus *Vitis* and has been used to differentiate species and varieties
- Environmental conditions impact leaf morphology, it is sometimes unclear if leaf morphology corresponds to current species boundaries
- *V. riparia* and *rupestris* are 2 closely related N. American grape species with highly variable leaf morphology

V. rupestris in N. Missouri

Introduction

- Common gardens allow researchers to examine effects of environment on phenotypes among various taxa and genotypes from across the species' geographic range
- The purpose of this study was to quantify leaf shape in multiple accessions of *V. riparia* and *V. rupestris* in a common environment
  - null hypothesis: under common conditions there are no differences among species in leaf morphology

Methods

- A new leaf morphology analysis developed by Dan Chitwood at the Danforth Center to assess leaf shape in cultivated grapes was applied to wild species
- Leaves were collected from an experimental vineyard at the Missouri Botanical Garden (MBG)
  - total of 64 plants with 4 *V. riparia* genotypes, 5 *V. rupestris* genotypes

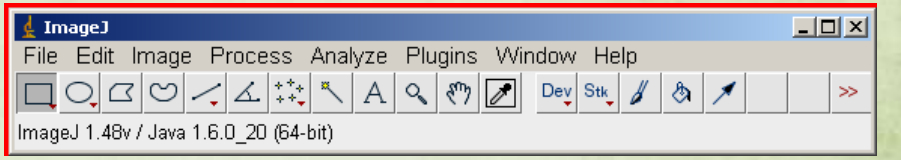
Methods

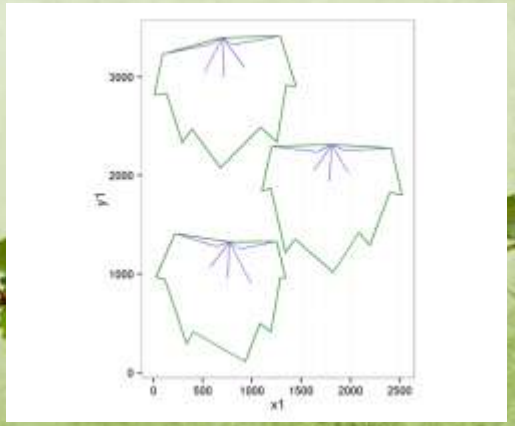
- One primary shoot was selected per plant, all leaves from that shoot were removed
- Leaf order along the shoot was maintained
- The leaves were numbered in the analyzed images so that leaf number corresponded to position along the shoot

Methods

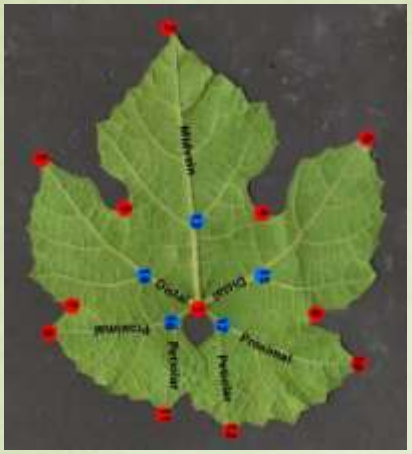
- Leaves were scanned
- Custom Image J macros were used to extract outlines of leaves and to measure circularity and aspect ratios of leaves

V. riparia *V. rupestris*

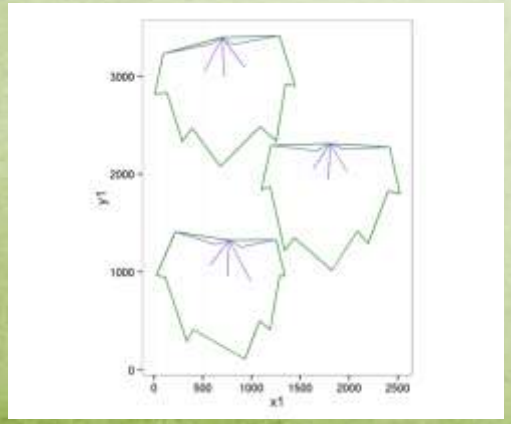




Methods



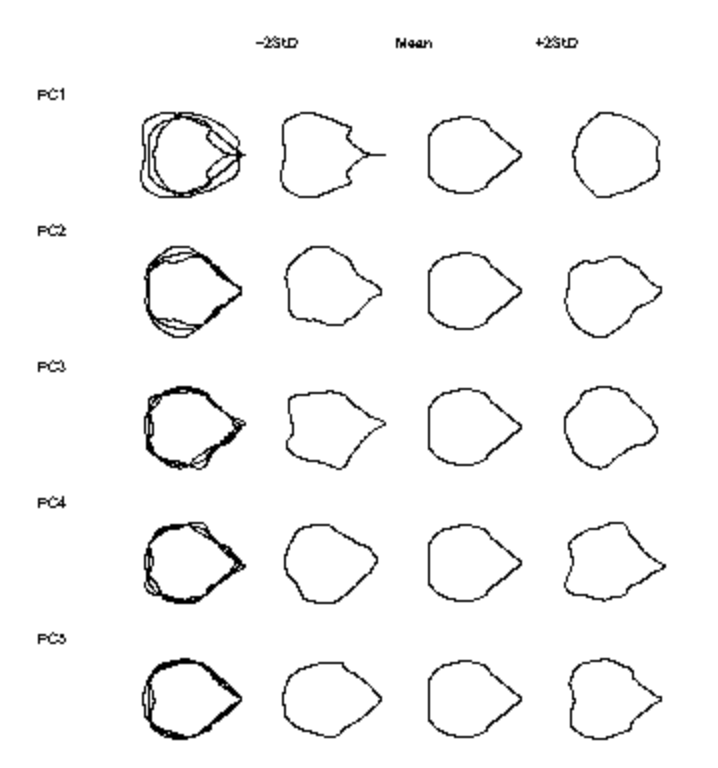
- "Landmarked" leaf images were used for General Procrustes Analysis (GPA) in R



- Analysis of leaf outlines was conducted using Elliptical Fourier Descriptors (EFDs) followed by Principal Components Analysis (PCA) using the program SHAPE

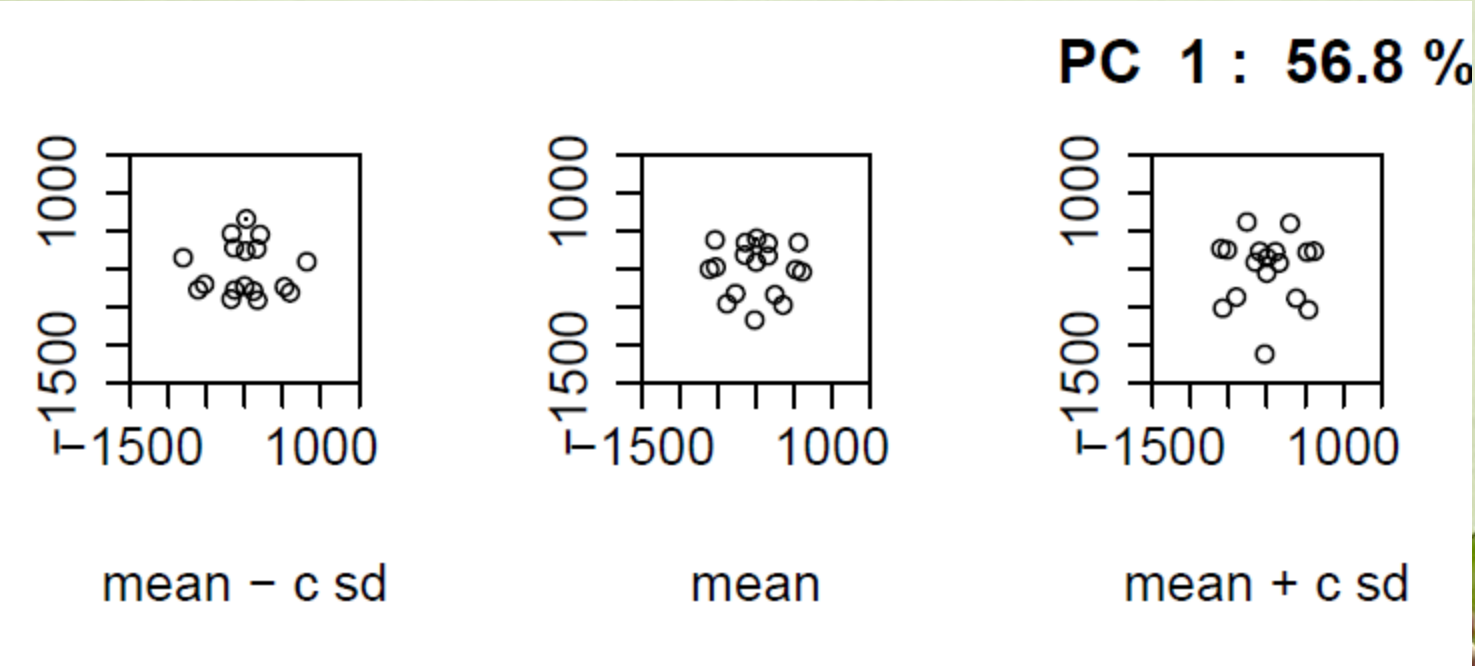
Results

EFDs display differences in *V. riparia and V. rupestris* leaf shape.



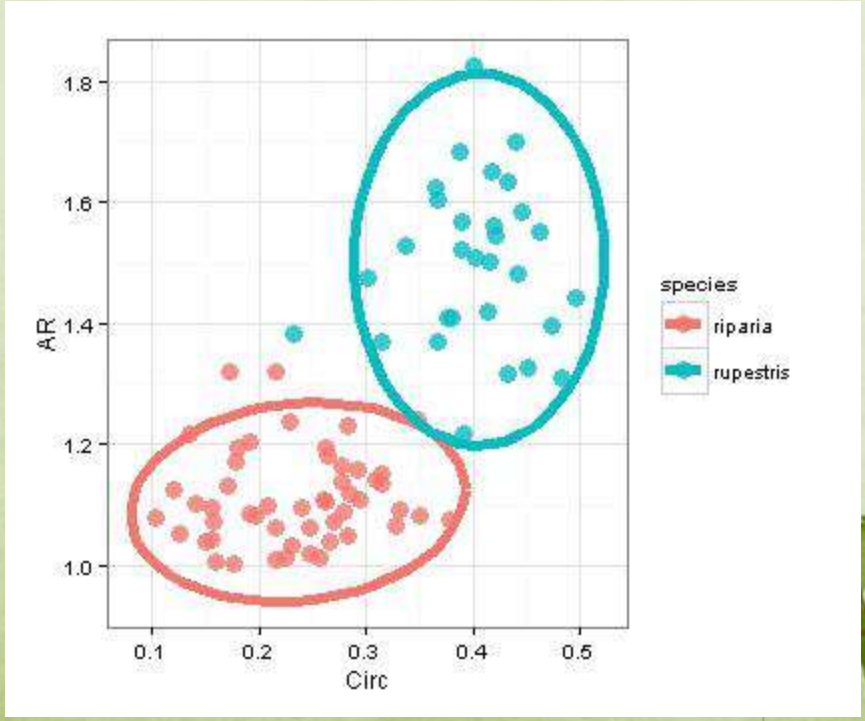
Results

GPA demonstrated differences in vein branch points, sinus valleys, and lobe tips.



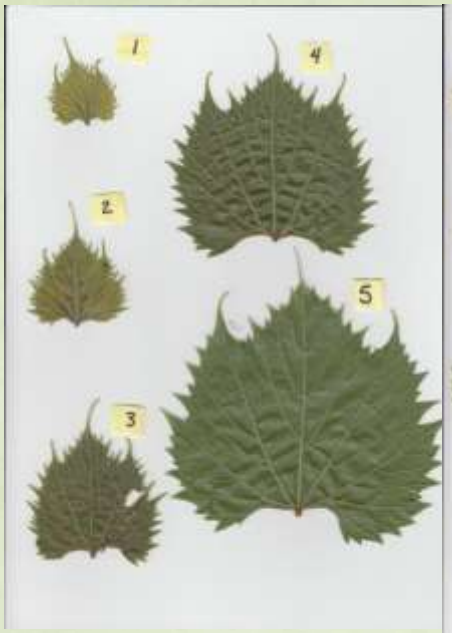
Results

Aspect ratio and circularity measurements indicate that under common conditions these species differ in leaf shape, but there is a range of variation of leaf shape within each species. *Rupestris* leaves had higher aspect ratios; *riparia* had lower circularity values.



Conclusions: Circularity and Aspect Ratios

- AR: *rupestris* had lower length-to-width ratios
- Circ: *riparia* had increased lobing and serration



V. riparia

V. rupestris

Conclusions

- Digital leaf morphometrics developed for cultivated *V. vinifera* ssp. *vinifera* can be used to differentiate closely related *Vitis* species
- Under common conditions, multiple genotypes of *V. riparia* and *rupestris* differ in leaf shape

Future Work

- Leaf shape data from the common garden will be integrated with transcriptome data, ion concentration data, and water use efficiency data to understand how perennial plants respond to fluxuating climatic conditions

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