

Using morphological features to distinguish between *Impatiens capensis* and *Impatiens pallida*

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INTRO

- *Impatiens capensis* and *Impatiens pallida* grow in similar regions¹
- similar appearance, but mainly distinguished by flower color and spur length²
- Demonstrated need for additional methods of identification
- Precedent has been set for morphological analyses
- Built on pilot study³ from 2018

METHODS

- Recruited citizen scientists for leaf collection of over 250 samples
- Scanned and digitally cleaned each leaf using FIJI⁴
- Quantified morphometrics using Momocs⁵ in R
- Measured shape using elliptical Fourier analysis⁶
- performed principal component analysis on resulting metrics
- Quantified color into 8-bit format and computed mode
- Compared metrics between *I. capensis* and *I. pallida* using Welch's Two Sample t-tests

RESULTS

- Leaves of *I. capensis* 1.78 cm shorter on average than leaves of *I. pallida* (95% confidence interval, $T = -6.57$, d.f. = 121.6, $P < 0.0001$)
- Leaves of *I. capensis* 0.742 cm narrower on average than leaves of *I. pallida* (95% confidence interval, $T = -5.497$, d.f. = 125.15, $P < 0.0001$)
- First PC demonstrated statistically significant difference between the two species (95% confidence interval, $T = -3.815$, d.f. = 174.93, $P < 0.0002$)
- Higher mode values of red and green in *I. capensis* than *I. pallida*

DISCUSSION

- Leaf morphometrics and color can be used to accurately identify *Impatiens capensis* and *Impatiens pallida*
- Allows for differentiation in non-flowering seasons
- Similar methods could be used to establish distinguishing traits between other species

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Differences in leaf shape, size, color, successful metrics for distinguishing between *Impatiens capensis* and *Impatiens pallida*



Impatiens capensis

Impatiens pallida

Trait	<i>Impatiens capensis</i>	<i>Impatiens pallida</i>	p-value
Length (cm)	5.085 ± 1.609	6.856 ± 2.125	< 0.0001
Width (cm)	2.687 ± 0.831	3.429 ± 1.056	< 0.0001
Area (cm ²)	9.787 ± 5.623	16.678 ± 9.750	< 0.0001
Perimeter (cm)	14.005 ± 4.132	18.931 ± 5.613	< 0.0001
PC1 (leaf roundness)	-0.005 ± 0.035	0.011 ± 0.030	< 0.001
PC2 (leaf base acuteness)	0.001 ± 0.034	-0.003 ± 0.034	0.38
PC3 (leaf apex acuteness)	-0.001 ± 0.018	0.002 ± 0.015	0.21
Red intensity (mode)	63.641 ± 68.546	32.675 ± 38.827	< 0.0001
Green intensity (mode)	79.120 ± 69.910	56.130 ± 41.718	< 0.001
Blue intensity (mode)	11.206 ± 35.385	5.948 ± 29.982	0.23

Table 1. Leaf trait means ± 1 standard deviation by species. All of the traits were measured on the uppermost leaf of the plant. Principal components refer to shape variation and are ordered in descending order of influence on overall leaf variation. The p-values refer to the results of Welch's Two-Sample t-tests with confidence intervals of 95%. Traits that were significantly different between species are bolded. Total sample size is 243.

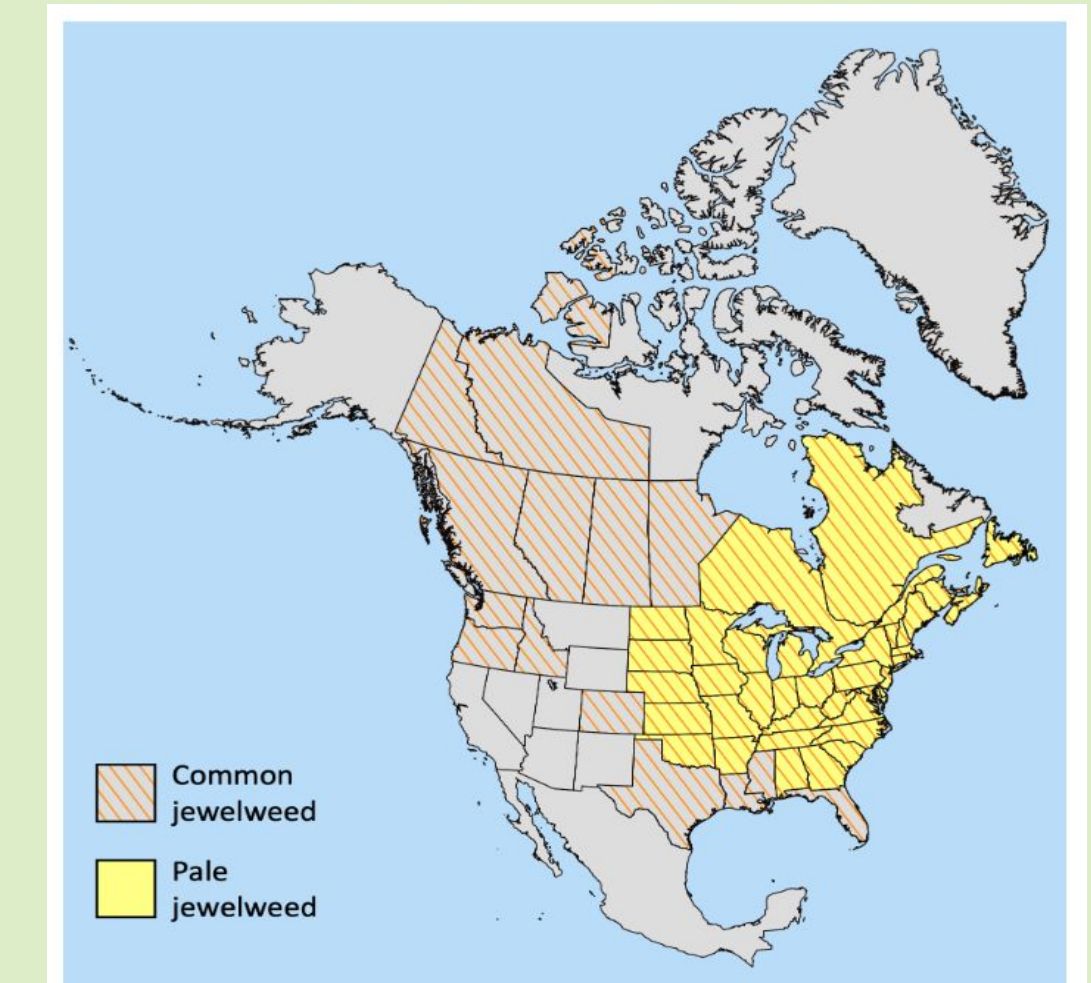


Fig. 1. Geographic range of *Impatiens pallida* (pale jewelweed) and *Impatiens capensis* (common jewelweed).

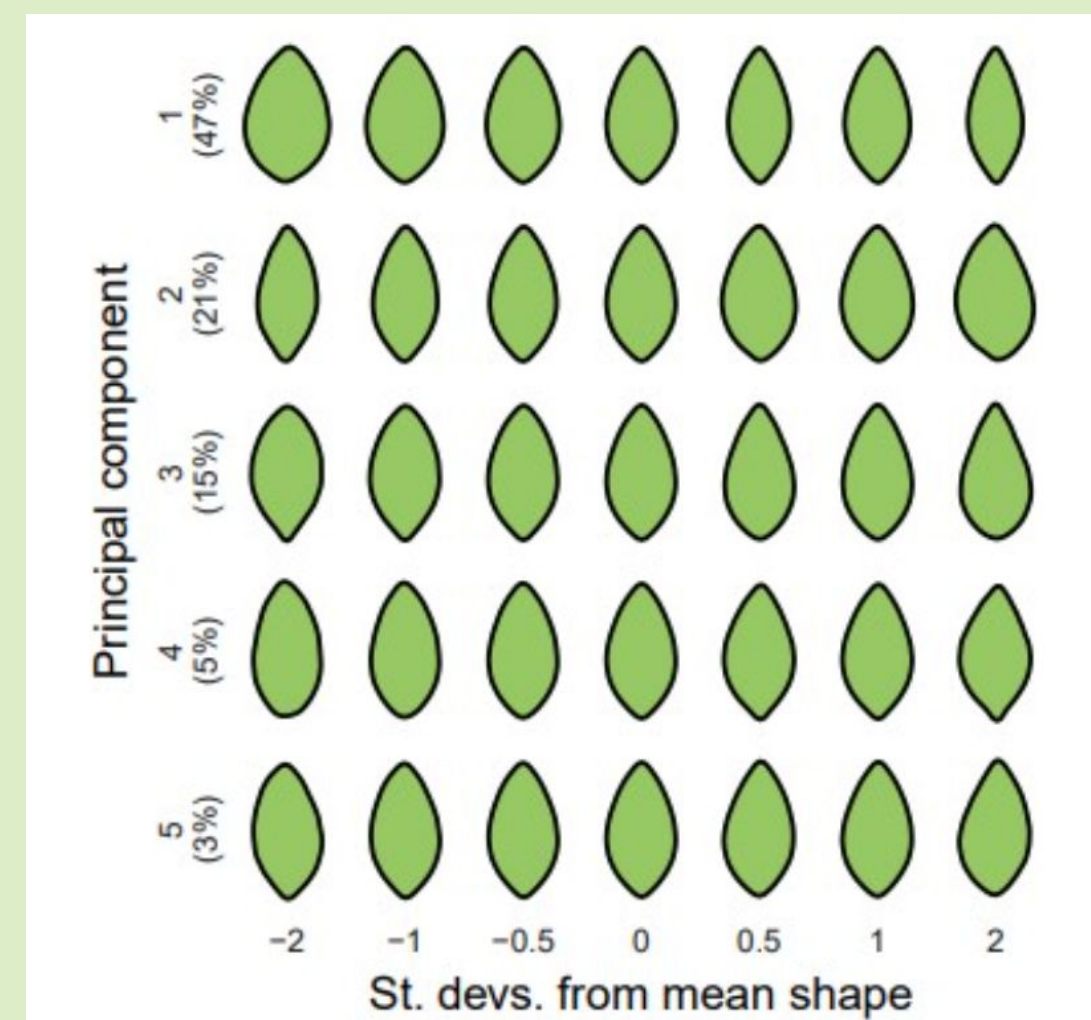


Fig. 3. First five principal components of all leaf shapes calculated using elliptical Fourier analysis. Each principal component accounts for a certain percentage of trait variation. The shape at 0 shows the average of that specific principal component.

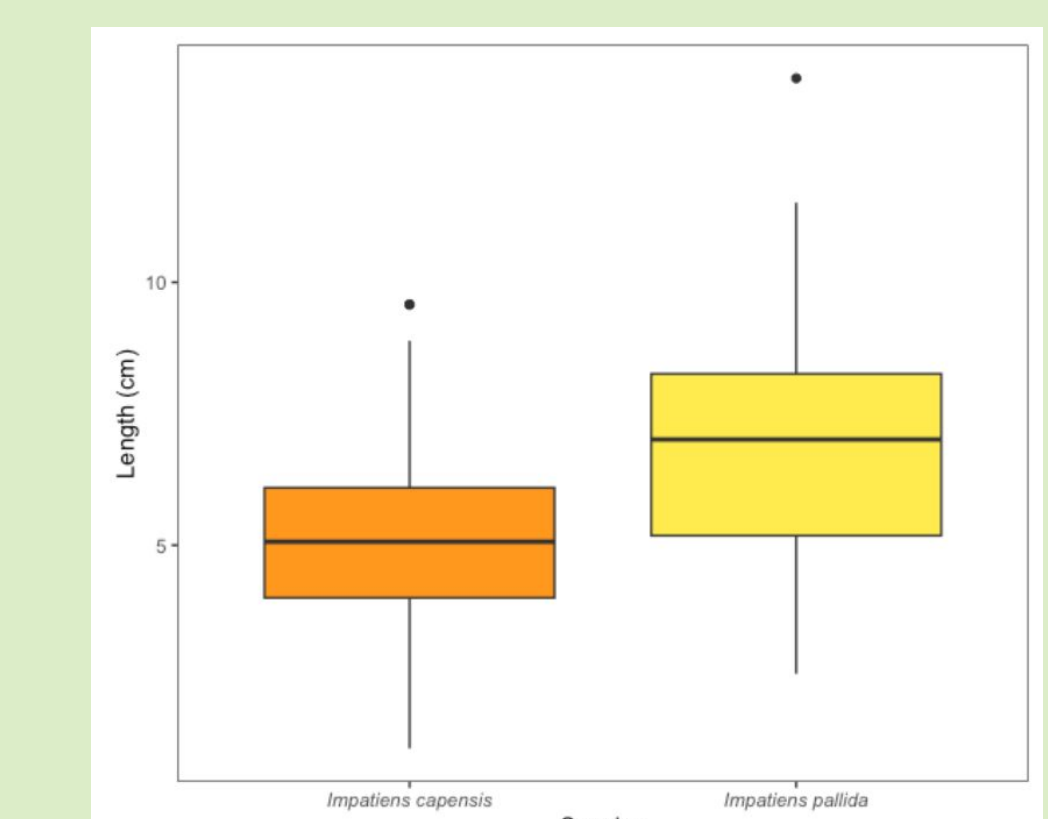


Fig. 4. Average length (cm) of an individual leaf by species. *Impatiens pallida* (yellow) leaves are shorter on average than *Impatiens capensis* (orange) (95% confidence interval, $T = -6.57$, d.f. = 121.6, $P < 0.0001$).

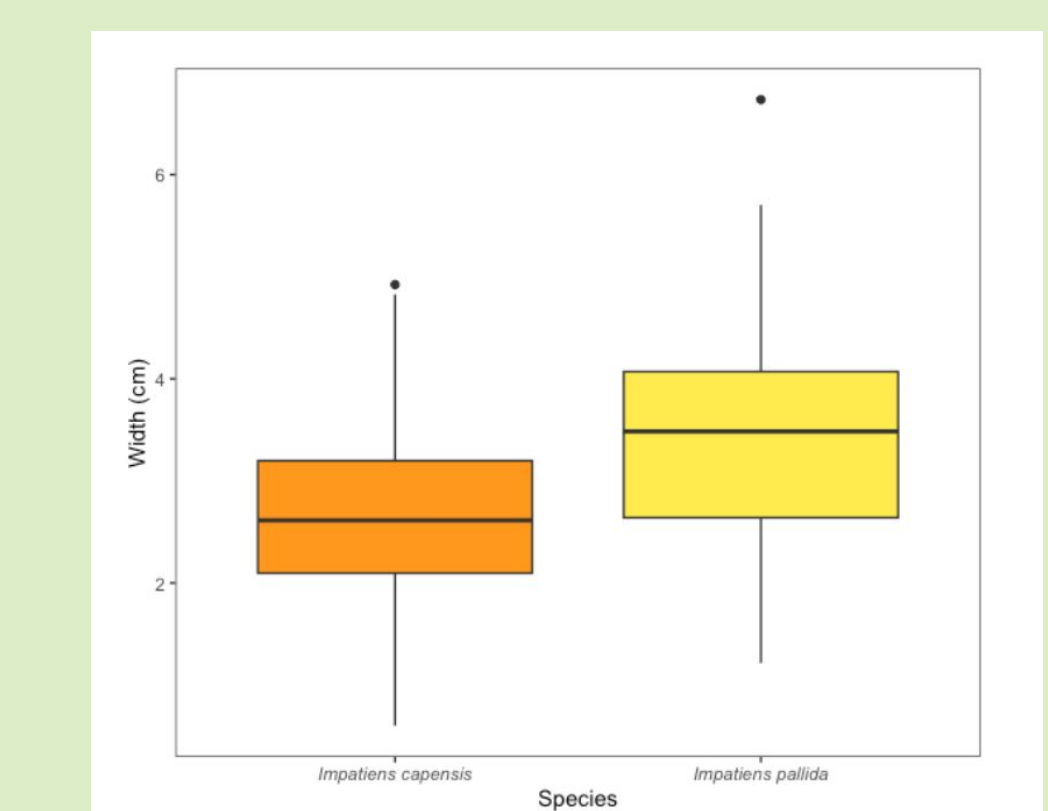


Fig. 5. Average width (cm) of an individual leaf by species. *Impatiens pallida* (yellow) leaves are narrower on average than *Impatiens capensis* (orange) (95% confidence interval, $T = -5.497$, d.f. = 125.15, $P < 0.0001$).

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