



FROM THE TROPICS TO THE
DRAWER AND BACK:
DIGITIZED NEW WORLD
SWALLOWTAIL BUTTERFLIES
INFORM DIVERSITY PATTERNS

Hannah Owens and Laura Brenskelle

Florida Museum of Natural History

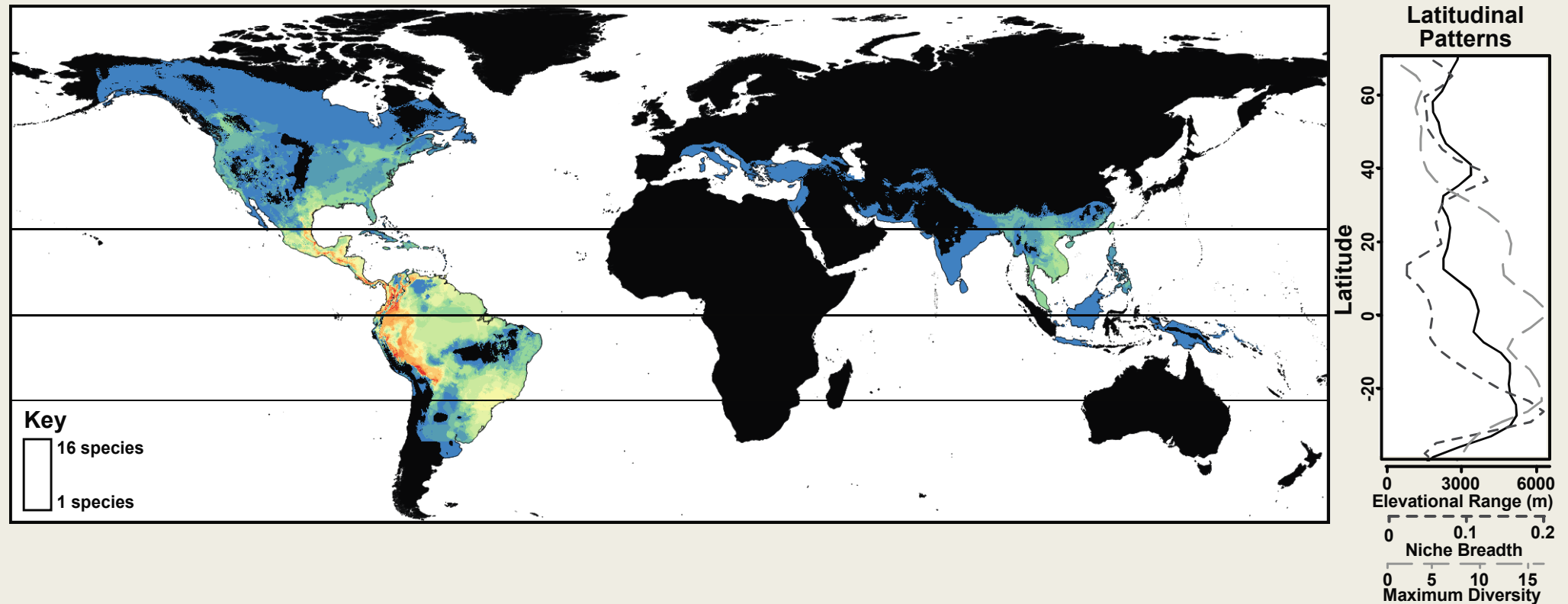
University of Florida



Tweets ok!

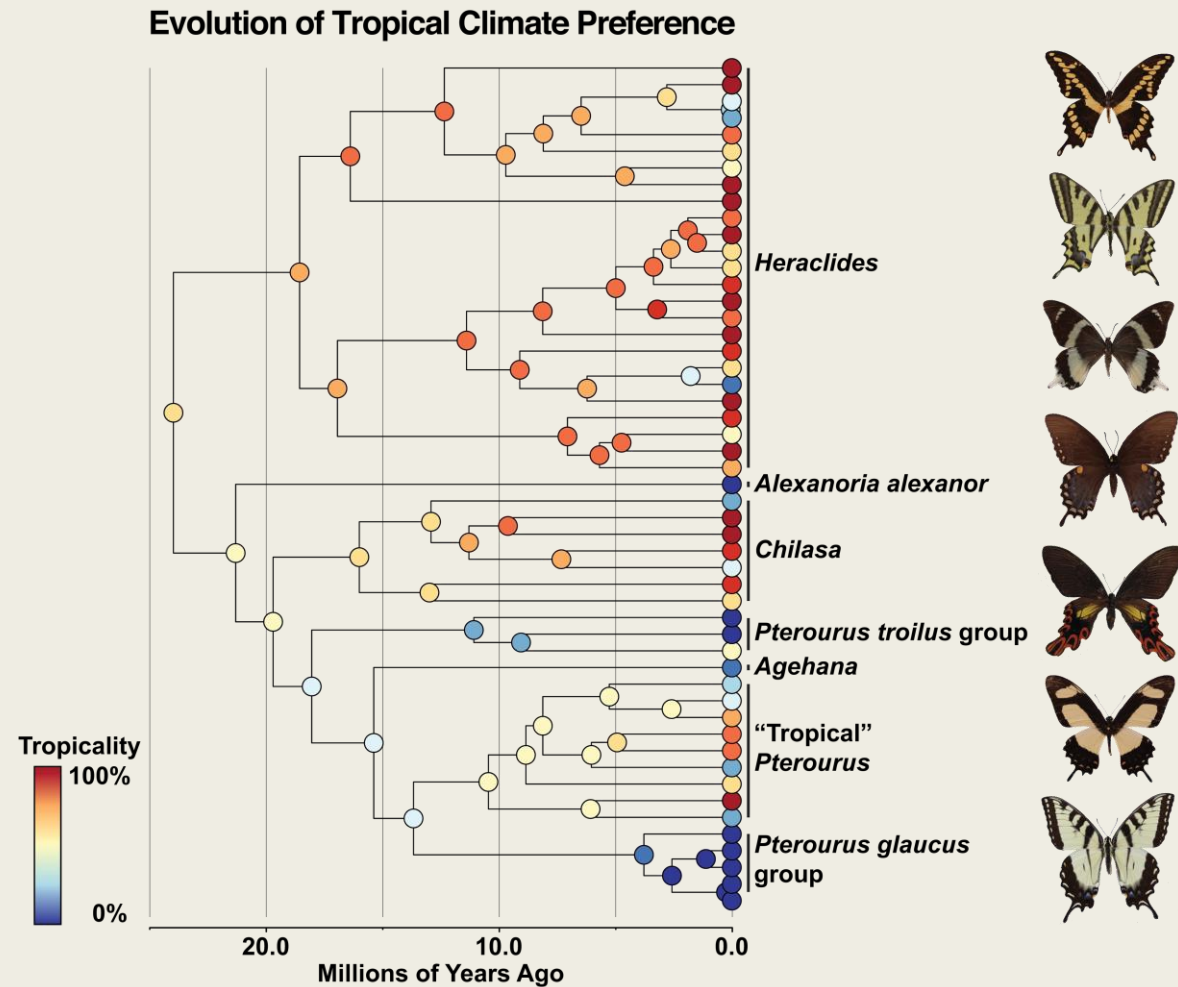
@hannahOish

“New World” swallowtail diversity



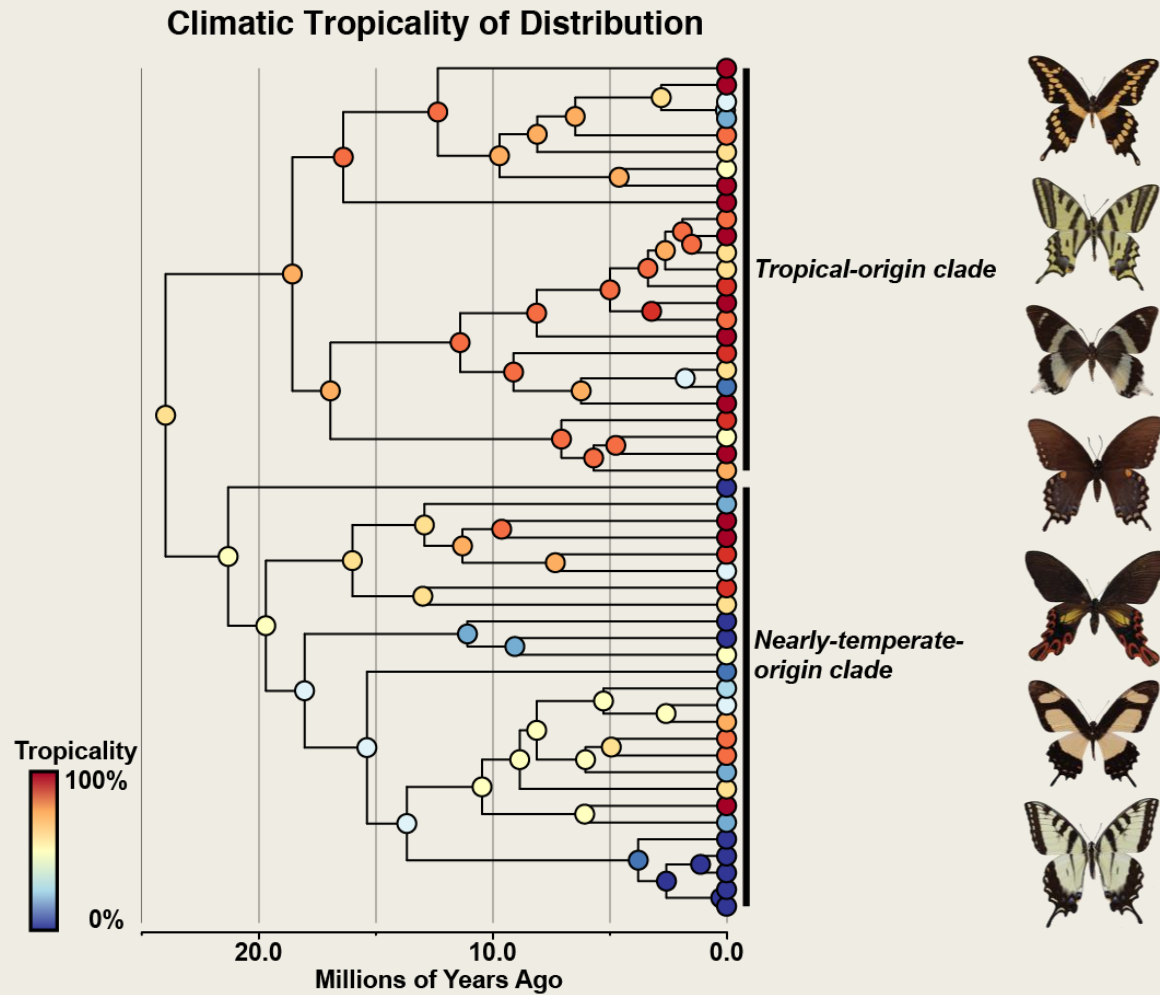
Owens *et al.*, in press

“New World” swallowtail diversity



Owens *et al.*, in press

“New World” swallowtails, simplified



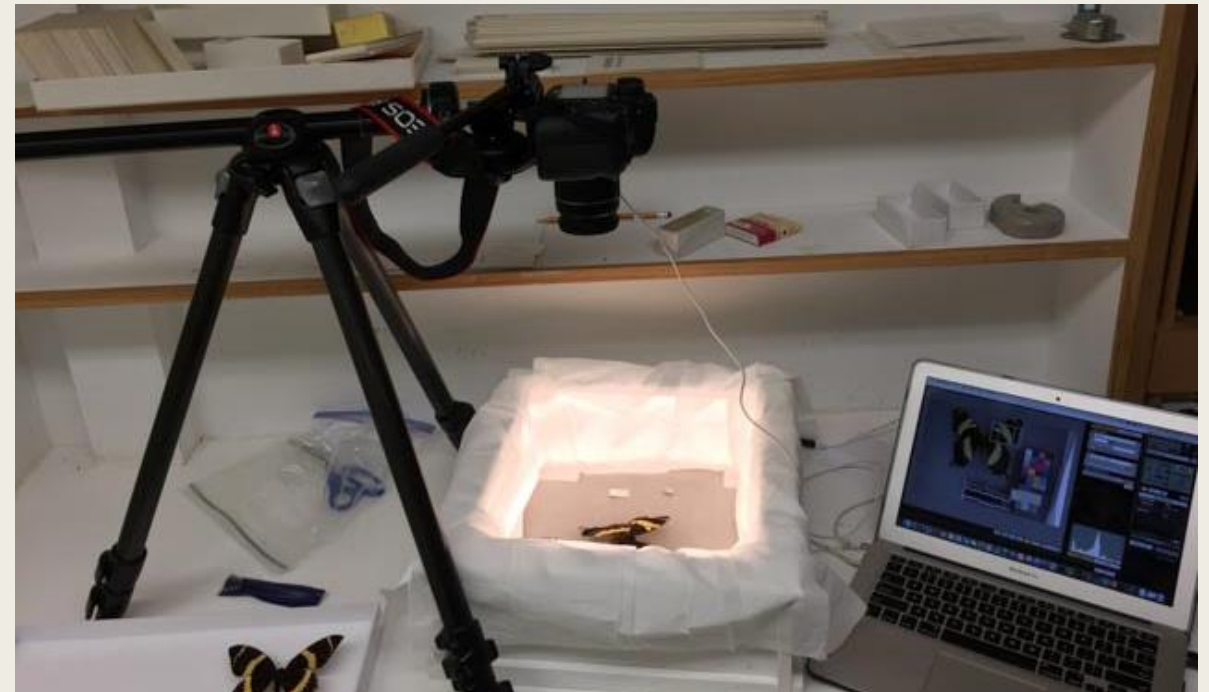
Owens *et al.*, in press

Hypotheses for this study

- H_1 : Morphospace breadth correlates with abiotic niche space volume
- H_2 : Morphospace breadth correlates with tropicality
- H_3 : Morphospace breadth correlates with mean number of congeners across range
- H_4 : Morphospace breadth correlates with geographic range size

Methods: Digitizing

- Home digitization
 - Florida Museum
 - 914 specimens
- Museum visits
 - Field Museum
 - 120 specimens
 - Smithsonian
 - 376 specimens
 - American Museum
 - 155 specimens
- Total: 1,565 specimens
 - 50 of 66 species



Methods: Digitizing

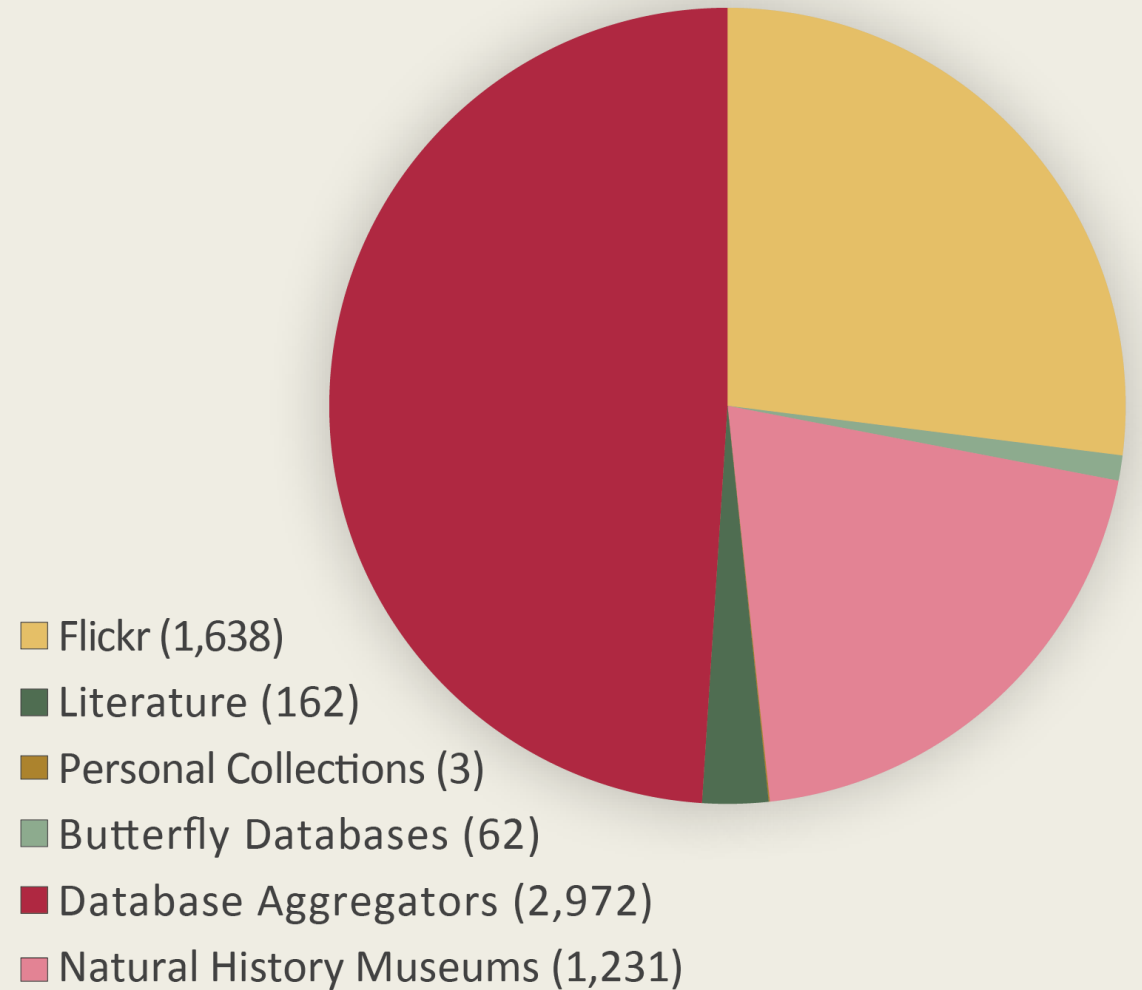
The screenshot shows a web-based digitization interface. At the top, there is a navigation bar with a profile icon and links for "VISIT NOTES FROM NATURE", "CLASSIFY", "TALK", "COLLECT", "BLOG", and "FIELD BOOK". The main content area is titled "Hannah Owens" and "IMG_40_NMNH_Ventral". It features a central image of a butterfly specimen with a 24ColorCard, a ruler, and several labels. To the right of the image is a form with fields for "Geographic Location", "Country" (with a "Select..." dropdown), "State/Province" (with "N/A"), and "County" (with "N/A"). Below the form are buttons for "Need some help with this task?", "Back", "Next", and "Show the project tutorial". At the bottom right, there is a notification that says "You should sign in!".

Notes from Nature label transcriptions

Methods: Niches

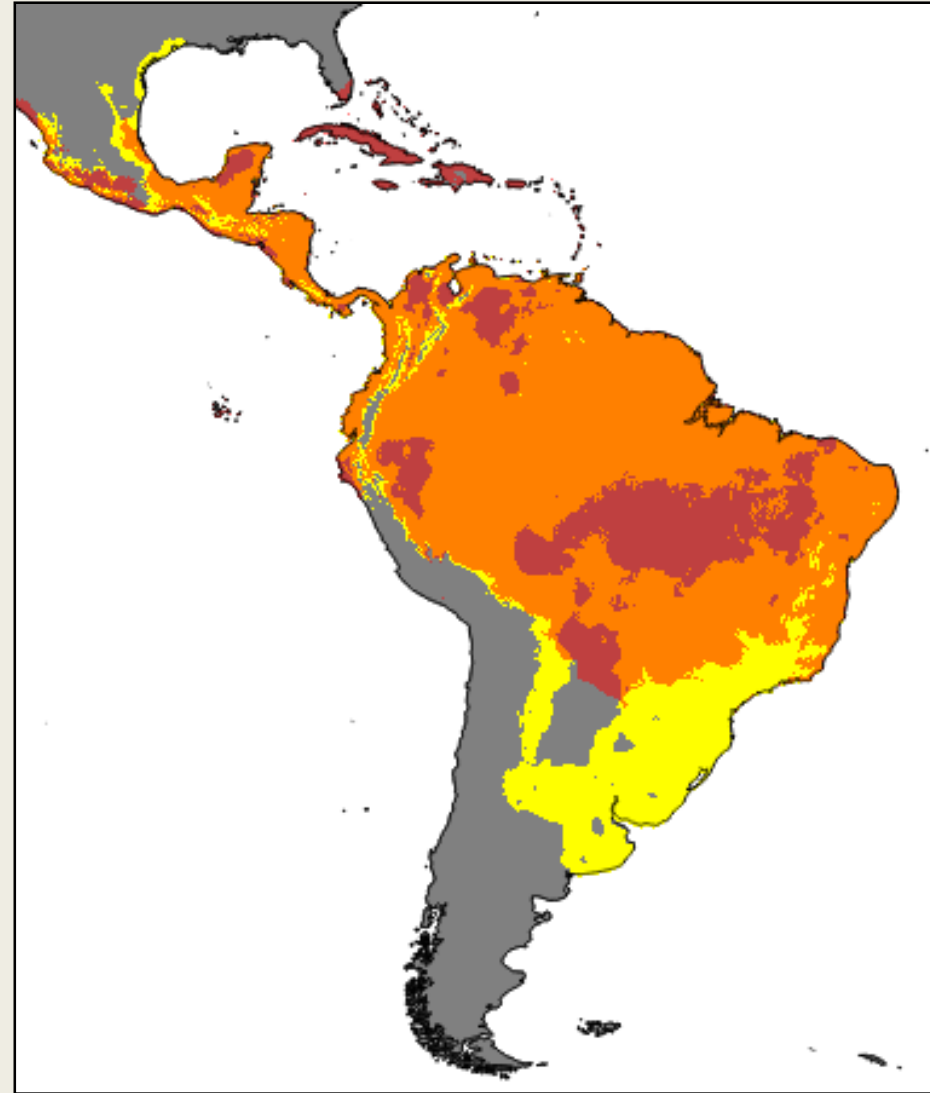
- Model ecological niche of each species
 - Collect points
 - Databases, georeferencing
 - 6,068 total
 - Ecological Data
 - WorldClim
 - Maxent
 - Individualized parameters

Summary of Point Sources



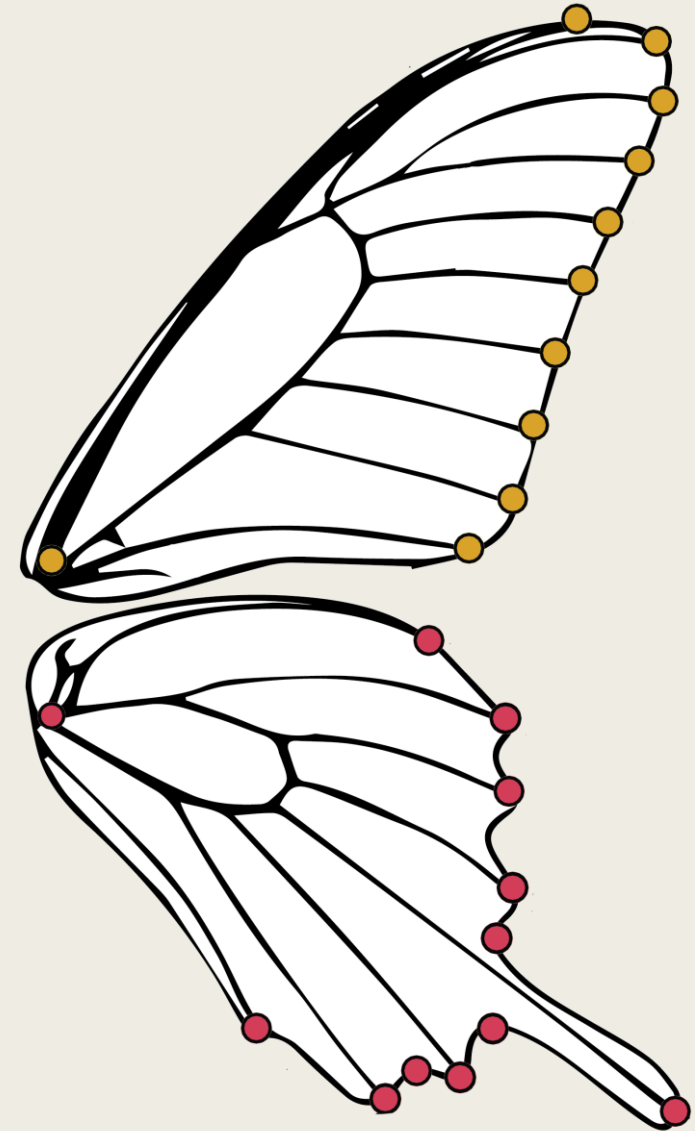
Methods: Niches

- Model ecological niche of each species
- Infer distributions
- Calculate niche stats
 - Niche breadth
 - Tropicality
- Calculate geographic stats
 - Range size
 - Mean swallowtail diversity



Methods: Morphology

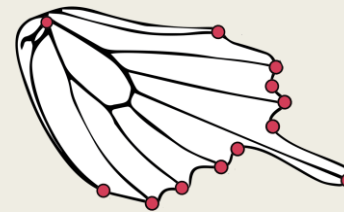
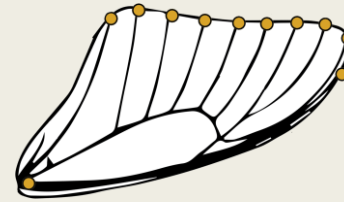
- Landmarks
 - ImageJ



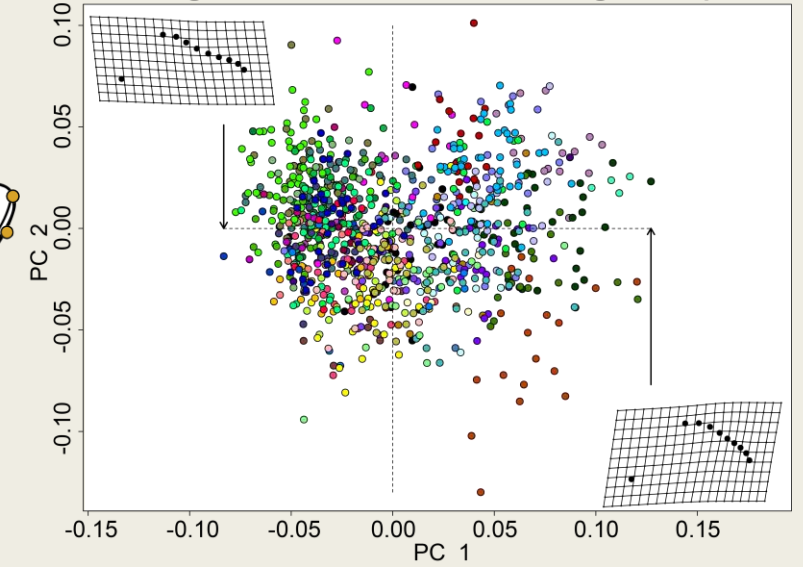
Adapted from Lewis *et al.*, 2014

Methods: Morphology

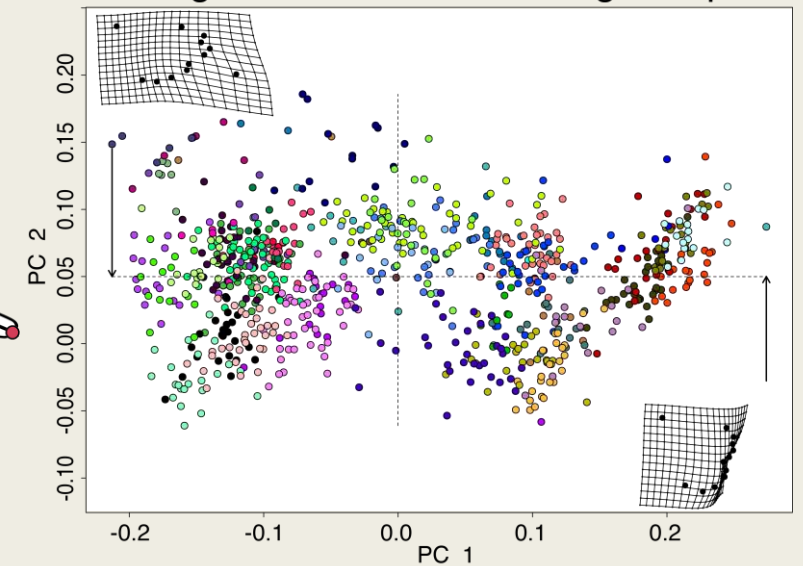
- Landmarks
- Geomorph
 - Align
 - Calculate principal components
 - Calculate shape space occupied by each species



Forewing Measurements in Tangent Space

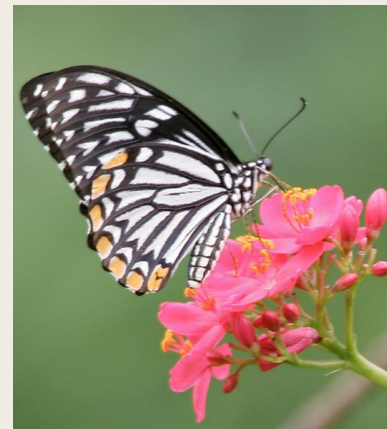


Hindwing Measurements in Tangent Space

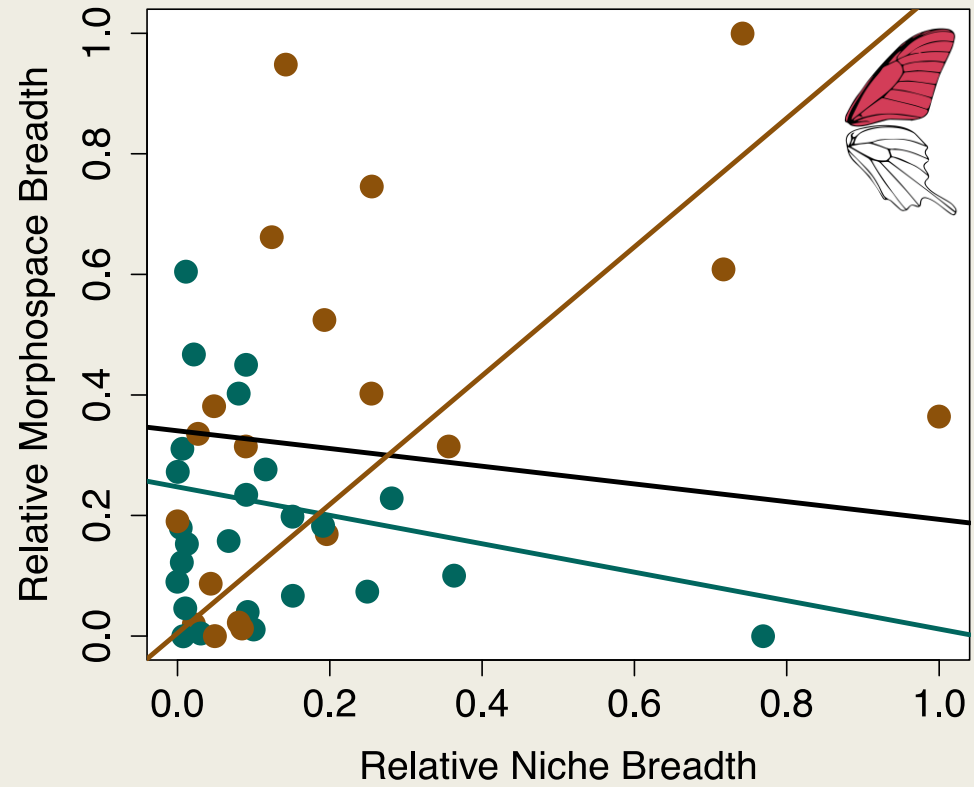
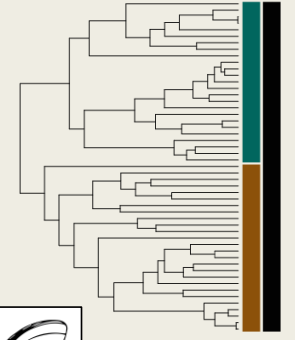


Methods: Hypothesis testing

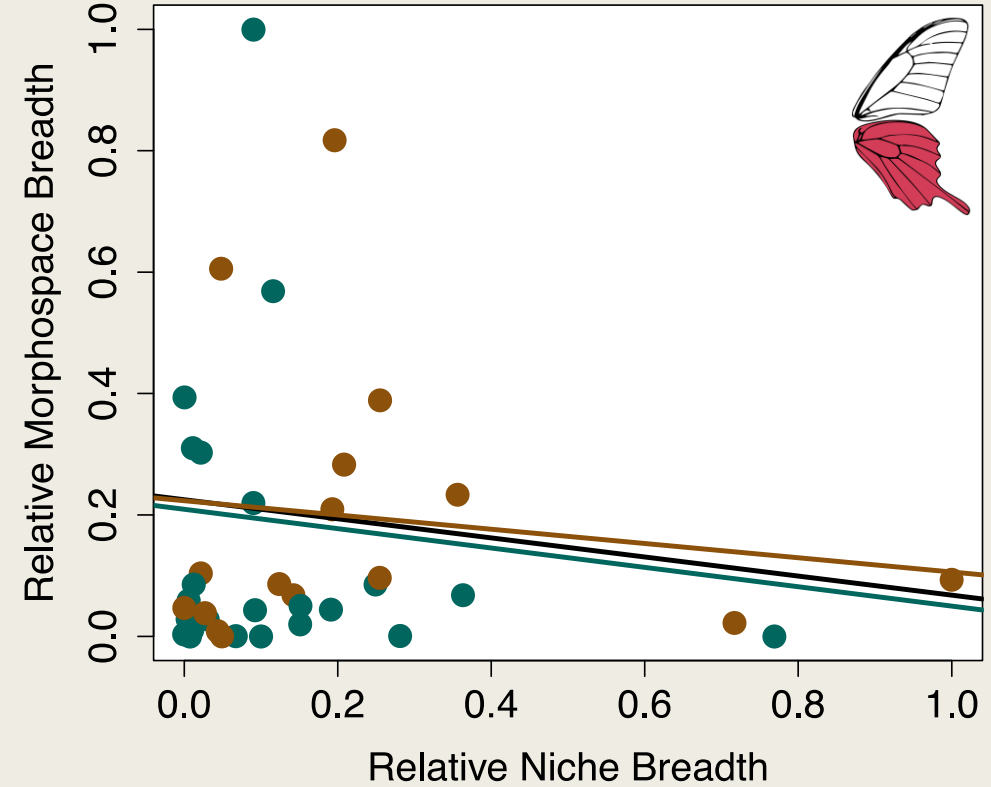
- Phylogenetic generalized least squares
- Response variable
 - Intraspecific morphospace volume, aka shape variation
- Explanatory variables:
 - Abiotic niche breadth
 - Tropicality
 - Mean co-occurring diversity
 - Geographic range size



Results: Niche Breadth

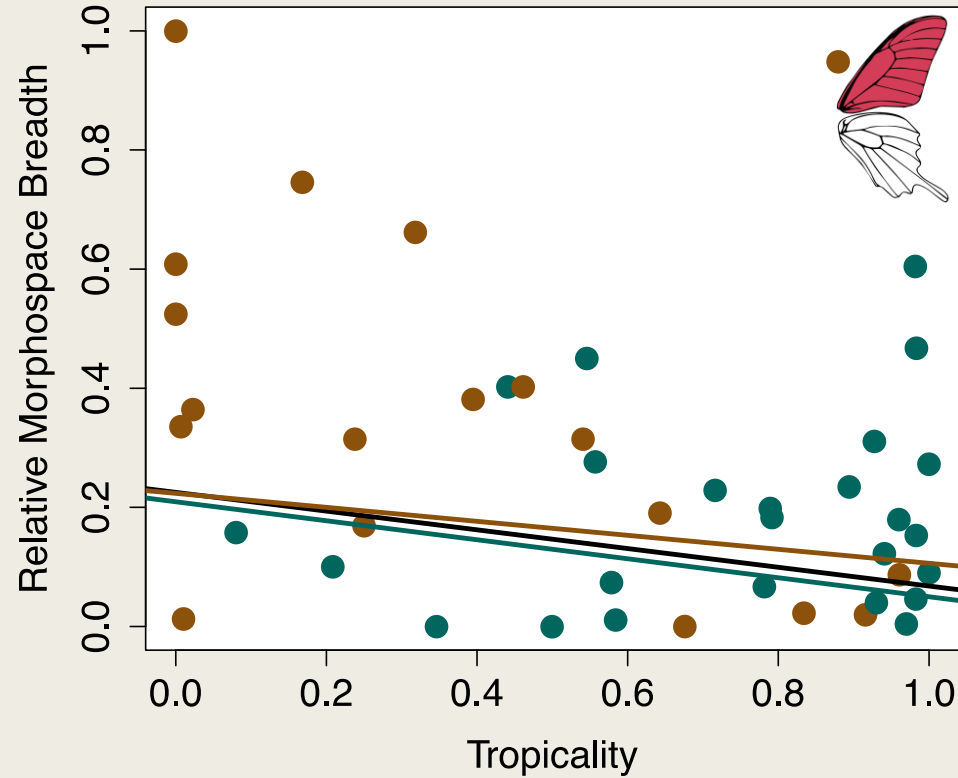
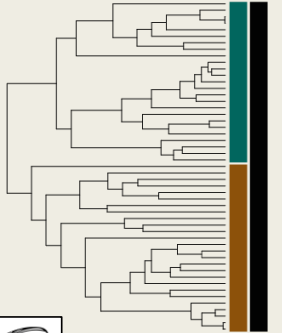


	P Value	AIC Score
All	0.14	46.70
"Tropical"	0.00	-18.50
"Temperate"	0.04	33.72

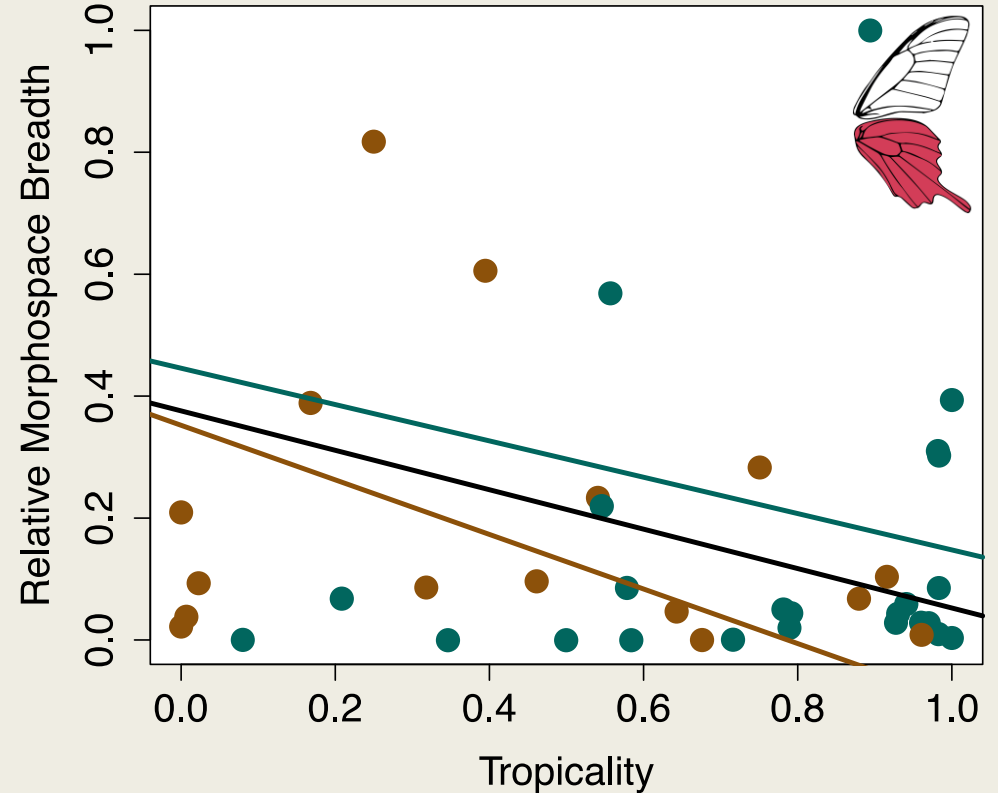


	P Value	AIC Score
All	0.03	19.23
"Tropical"	0.04	8.28
"Temperate"	0.70	15.43

Results: Tropicality

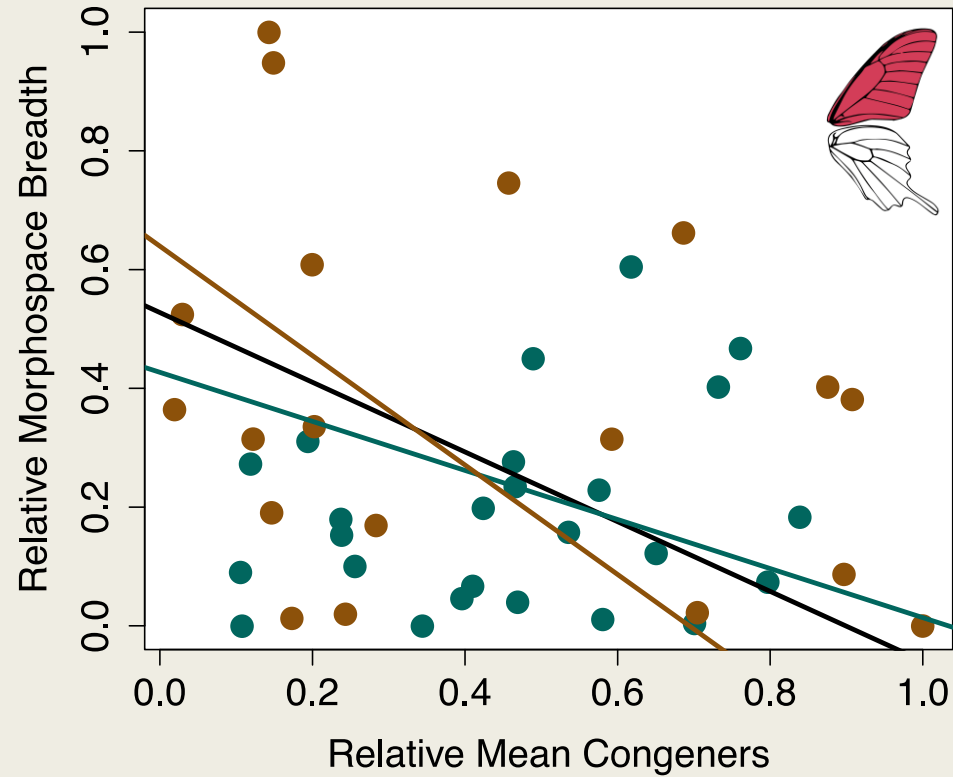
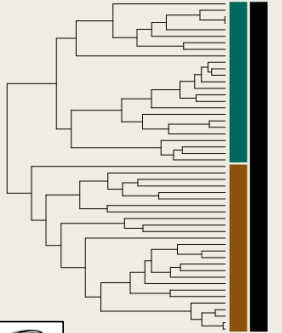


	P Value	AIC Score
All	0.03	19.23
"Tropical"	0.04	8.28
"Temperate"	0.70	15.43

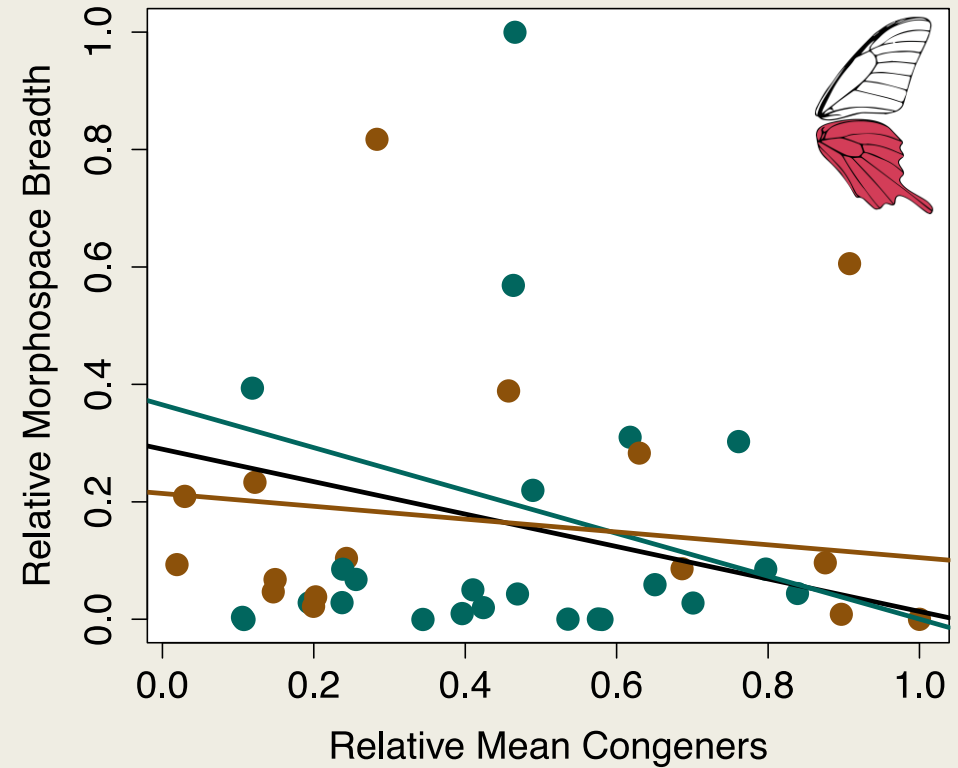


	P Value	AIC Score
All	0.01	16.19
"Tropical"	0.04	8.12
"Temperate"	0.06	11.46

Results: Co-occurring diversity

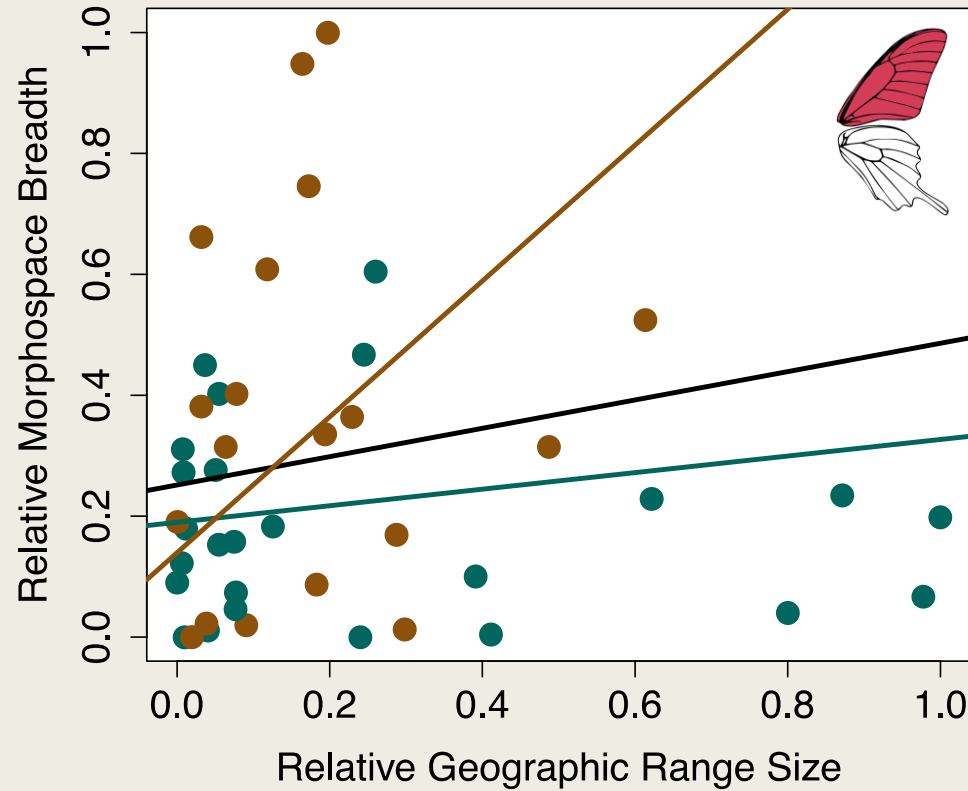
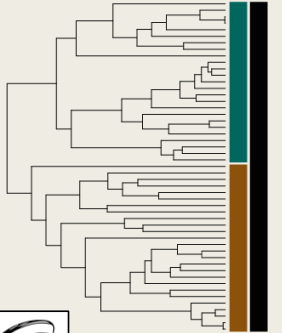


	P Value	AIC Score
All	0.01	41.66
"Tropical"	0.02	-4.29
"Temperate"	0.08	35.33

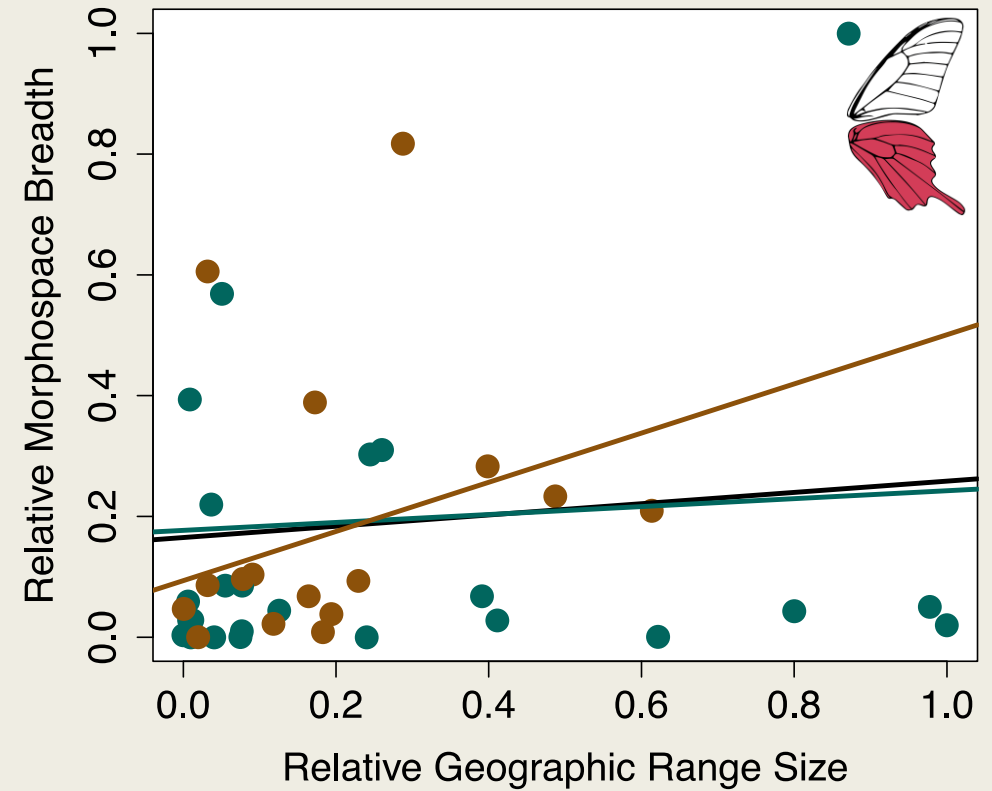


	P Value	AIC Score
All	0.12	21.70
"Tropical"	0.11	10.09
"Temperate"	0.71	15.44

Results: Geographic range



	P Value	AIC Score
All	0.10	46.20
"Tropical"	0.15	-0.07
"Temperate"	0.07	34.92



	P Value	AIC Score
All	0.39	23.54
"Tropical"	0.59	12.54
"Temperate"	0.25	14.05

General trends

- For all hypotheses, clade-based models fit better than full-dataset based models
- For all hypotheses, tropical-origin clade models fit better than temperate-origin clade models
- Range size was not significantly correlated with shape variation

	Temperate clade		Tropical clade		All species	
	Fore	Hind	Fore	Hind	Fore	Hind
Niche breadth	+	-	-	-	-	-
Tropicality	-	-	-	-	-	-
Co-occurring diversity	-	-	-	-	-	-
Range size	+	+	+	+	+	+

The future



- Finish up digitization
 - Shameless plug!
- Integrate georeferences with morphometric data
- Does forewing shape evolve less across phylogeny than hindwing?
- Does shape evolve less in the temperate-origin clade than the tropical clade?

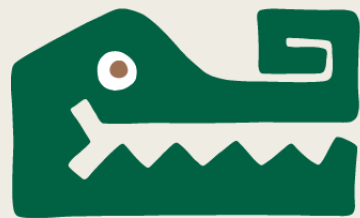
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- Delano Lewis



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