Adaptation in a Plant-Hummingbird Association

Temeles, E.J. & Kress, W.J. 2003.
Science 300:630-633

Presenter: Jeremiah Spiwak

Evolution (02:131) Spring 2013

Week 6: February 26th, 2013

Studying Adaptation

- Explanation of variation of a heritable nature
  - Within a population
  - Between multiple populations
  - Dimorphism within a species
    - Sexual dimorphism

Eulampis jugularis

The purple-throated carib hummingbird

High degree of sexual dimorphism

Male wings 8.6% larger than Female wings

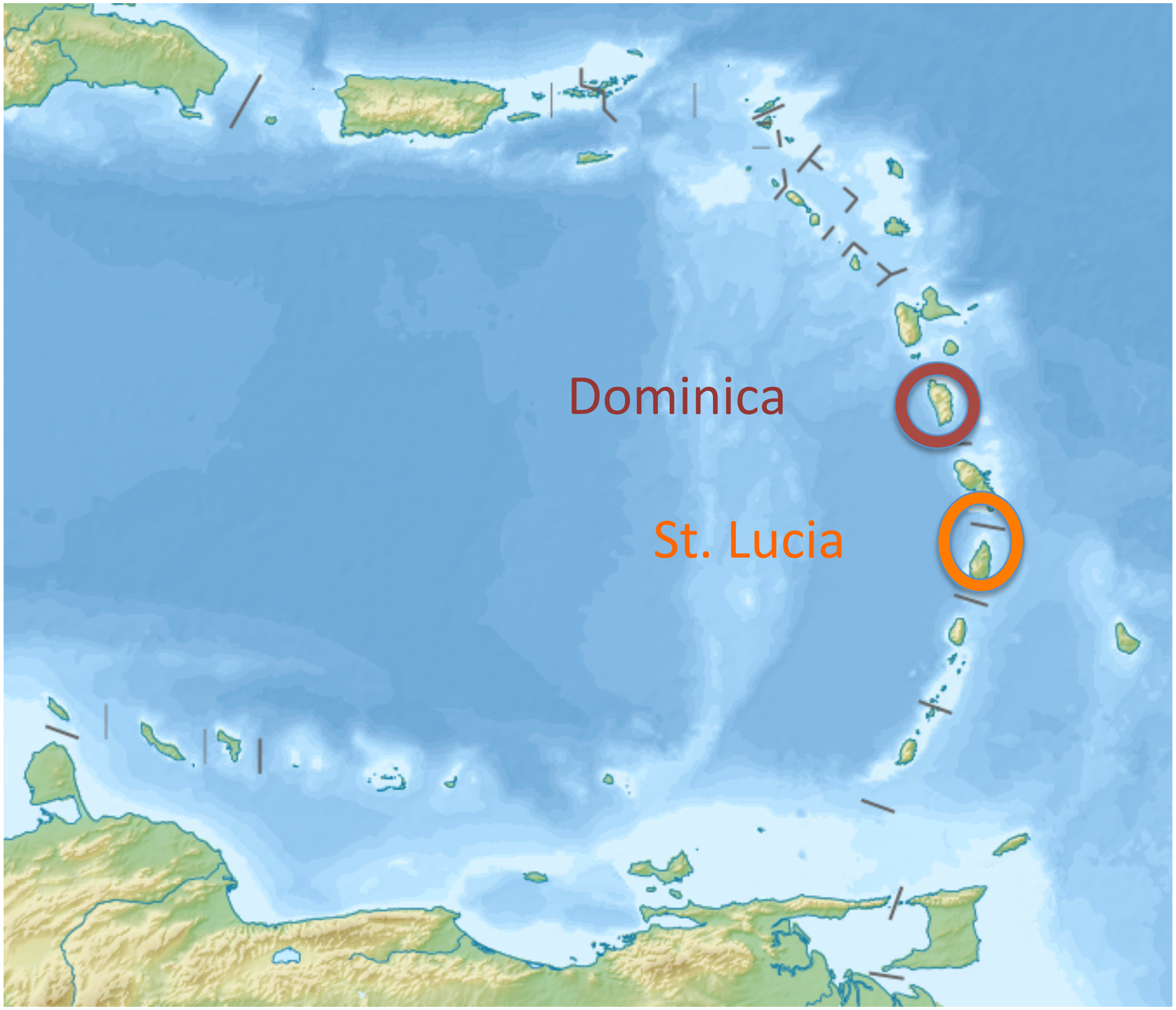
Male body 25% larger than Female body

Female beak 30% longer than Male beak

Female beak 100% more strongly curved than Male beak

Temeles et al,(2000)
Fig 1.

The Habitats



http://upload.wikimedia.org/wikipedia/commons/c/c3/Relief_map_of_Lesser_Antilles.png (Accessed 02-25-2013)

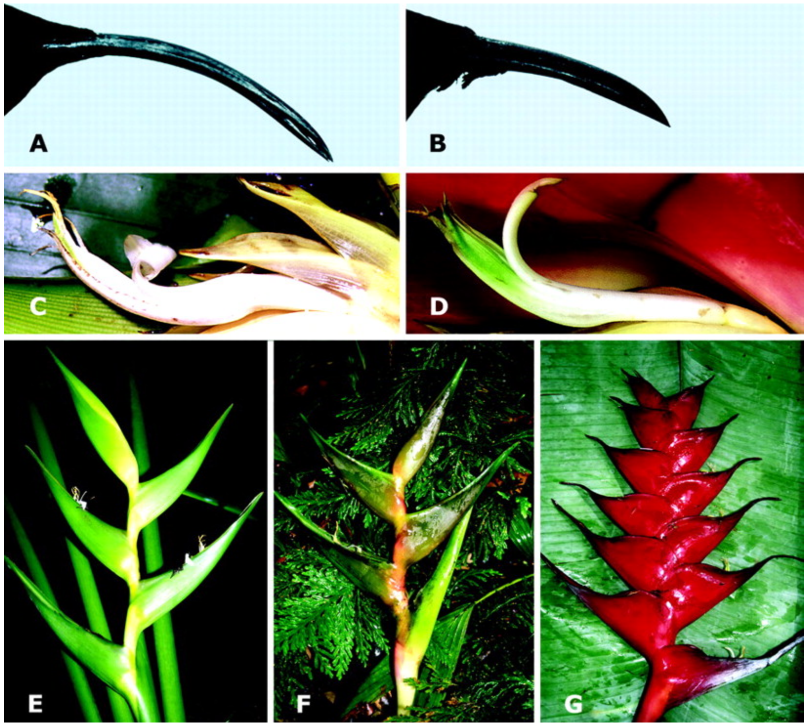
E. Jugularis Feeding Habits

On both Dominica and St. Lucia, the main food source for the purple-throated carib hummingbird is nectar from the plants of the Heliconia genus: H. caribaea and H. bihai

The purple-throated carib is also the sole pollinator of both of these Heliconia species.

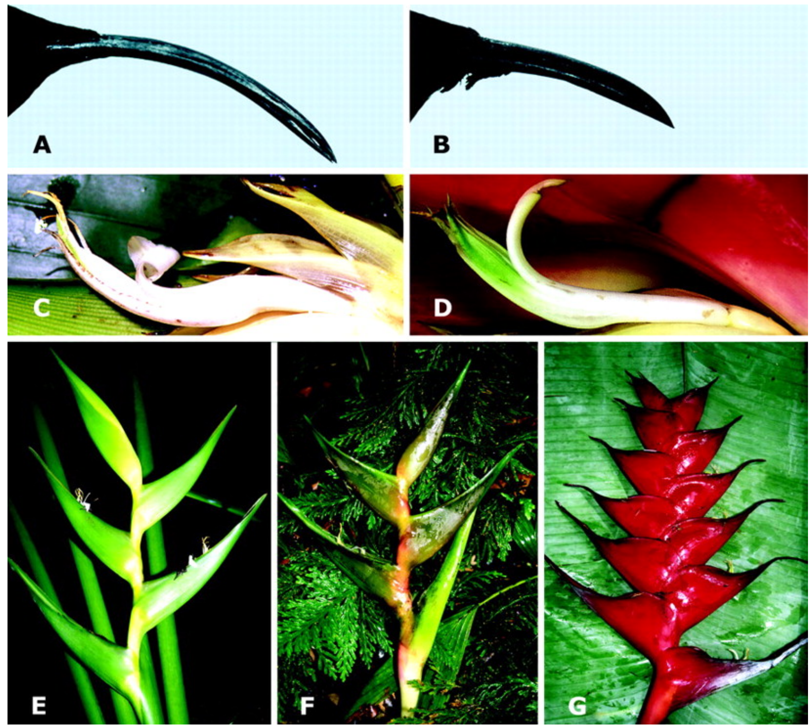
Morphologies

Heliconia Species on St. Lucia



Temeles and Kress (2003) Fig 1.

Morphologies



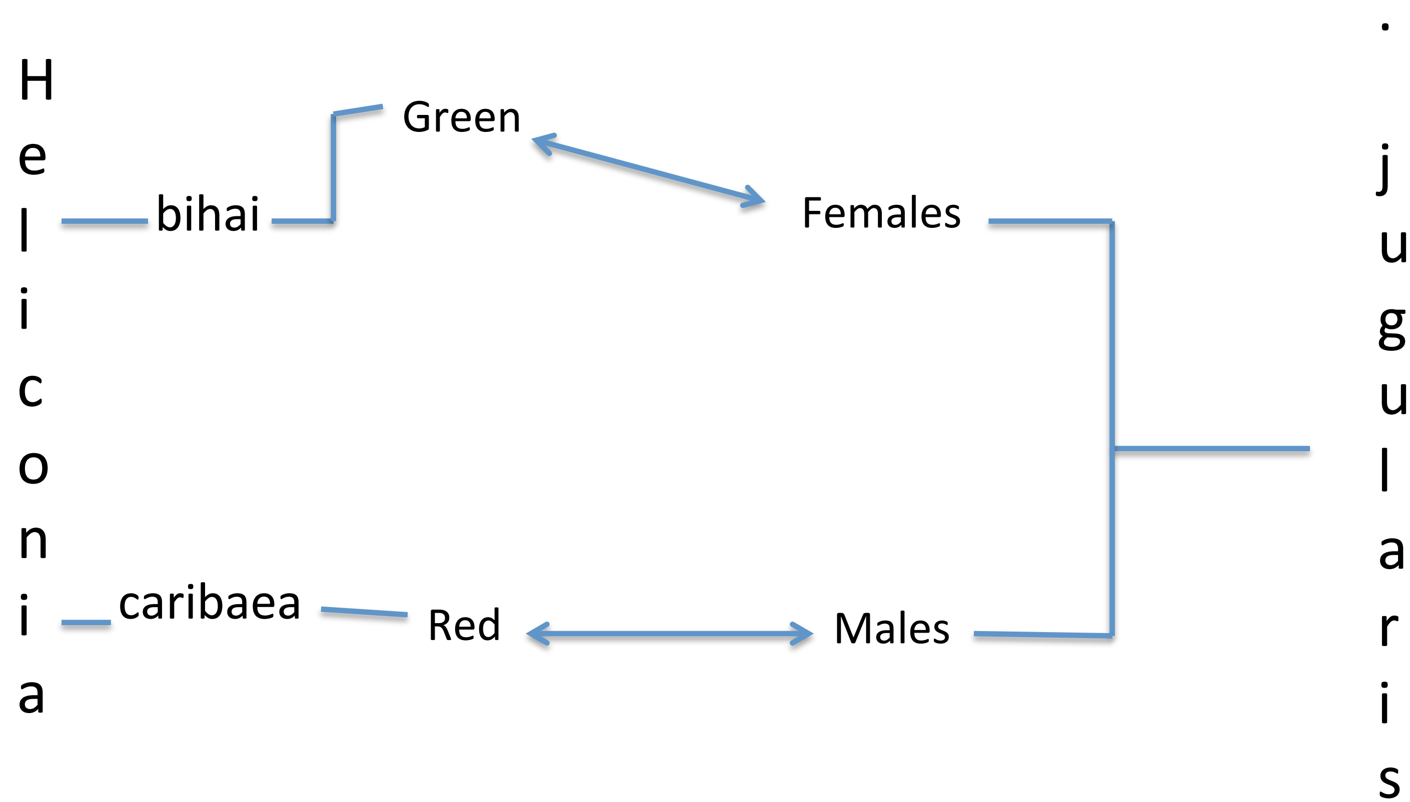
Heliconia Species on St. Lucia

Temeles and Kress (2003) Fig 1.

Plants grow sympatrically, in patches of species type or color morph type.

Male E. jugularis establish dominance over feeding patches, keeping out other males and females.

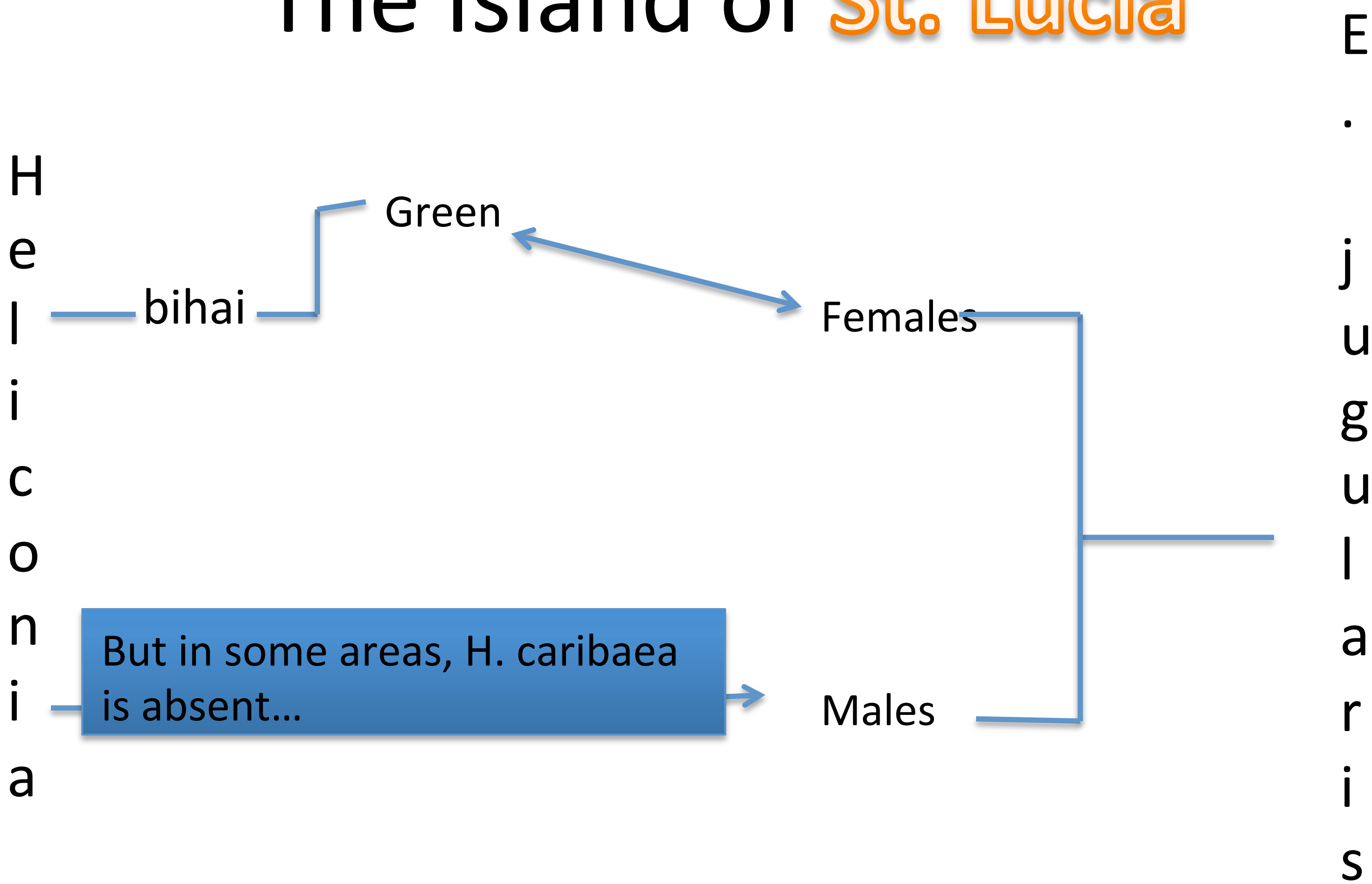
The Island of St. Lucia



Temeles et al (2000)
table 1.

Heliconia species		
	Barre de L'Isle (flower length)	**Barre de L'Isle (flower curvature)**
H. bihai	44 ± 0.5 (15)	30 ± 1.2 (16)
H. caribaea	38 ± 0.6 (10)	20 ± 0.9 (9)

The Island of St. Lucia



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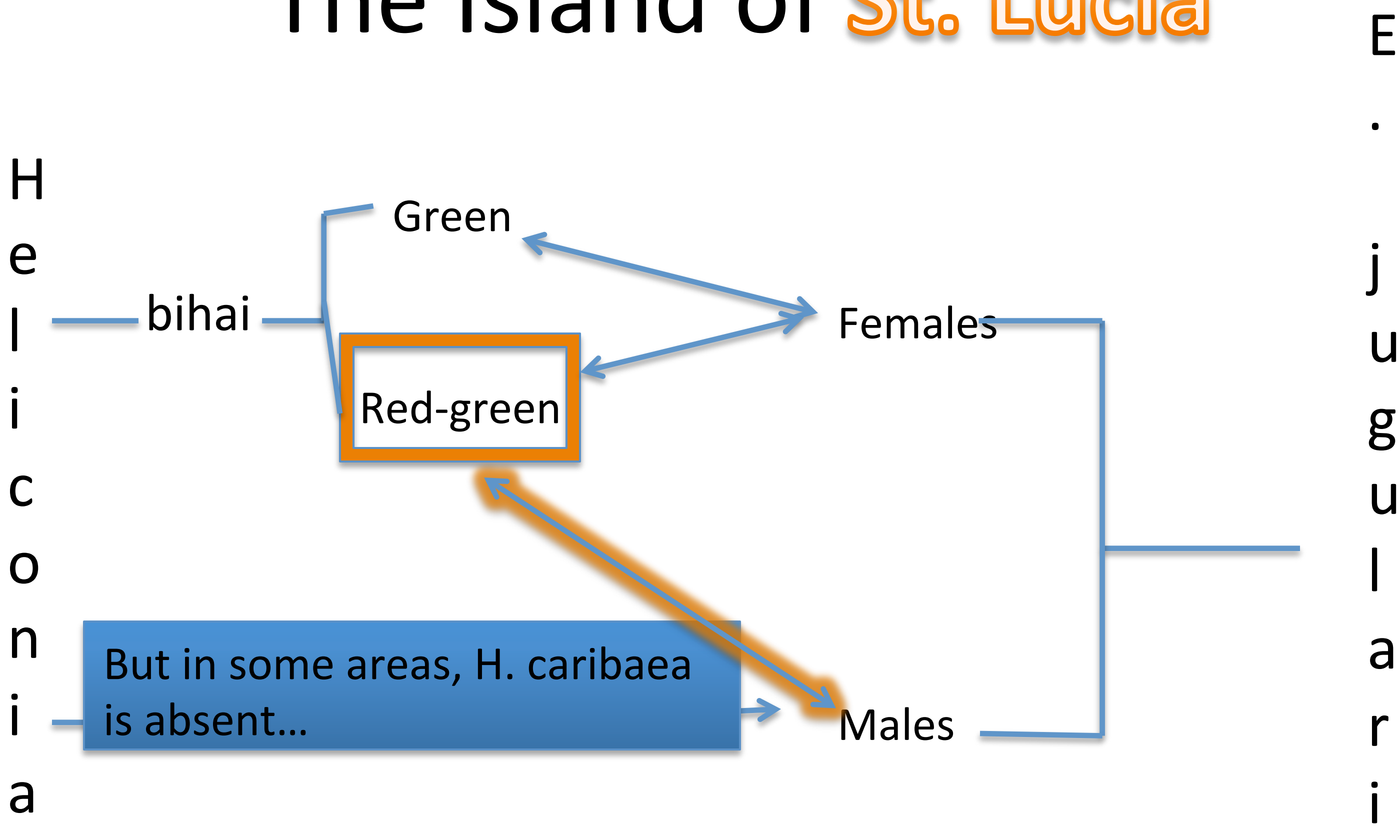

H. Bihai Morph	Flower length (mm)	Flower curvature (mm)
Green	42.0 ± 0.4 (21)	29.0 ± 0.8 (21)
Red-green	39.5 ± 0.9 (23)	25.5 ± 0.9 (22)

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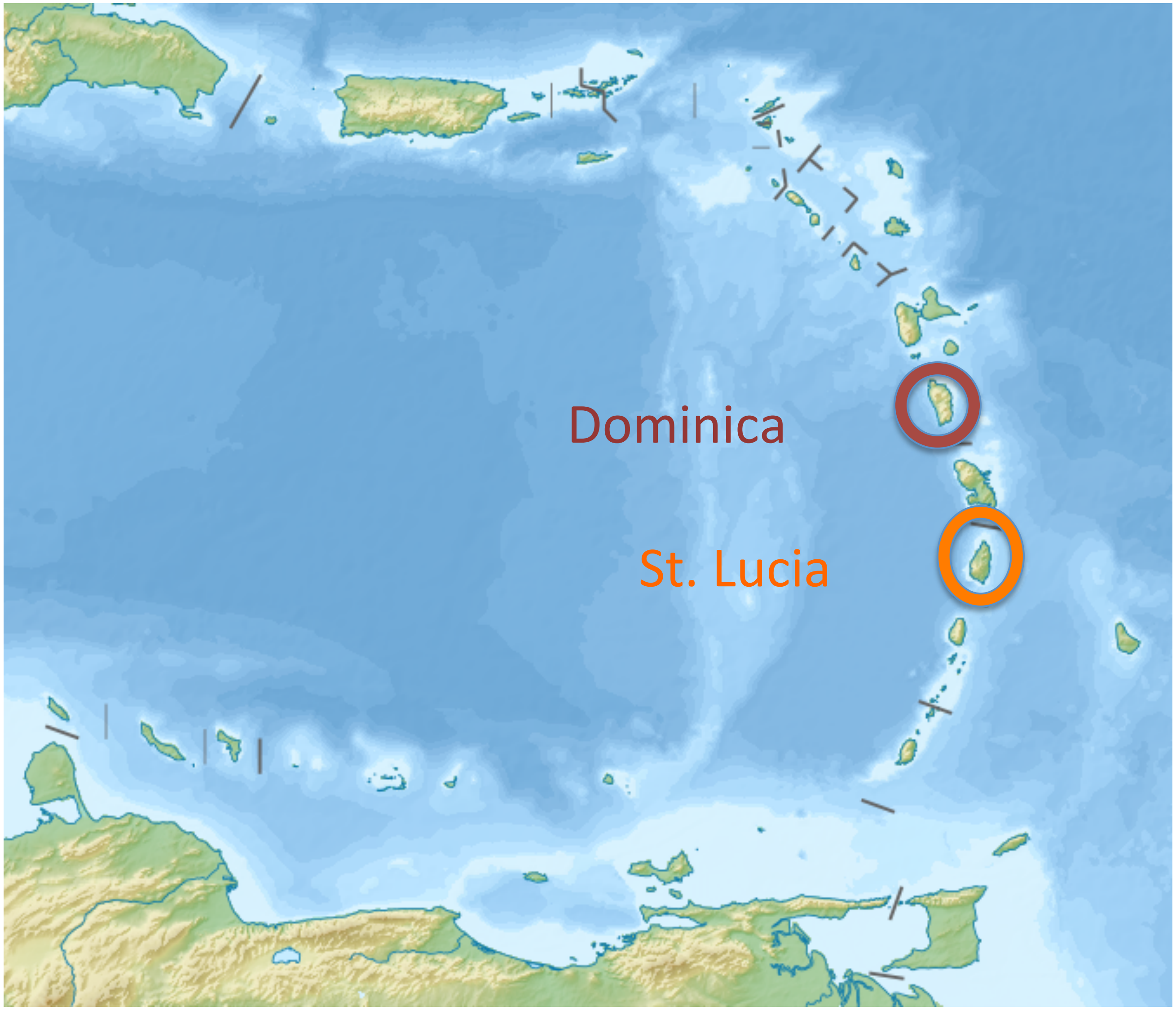
Temeles et al (2000) tables 1 and 2.

The Habitats



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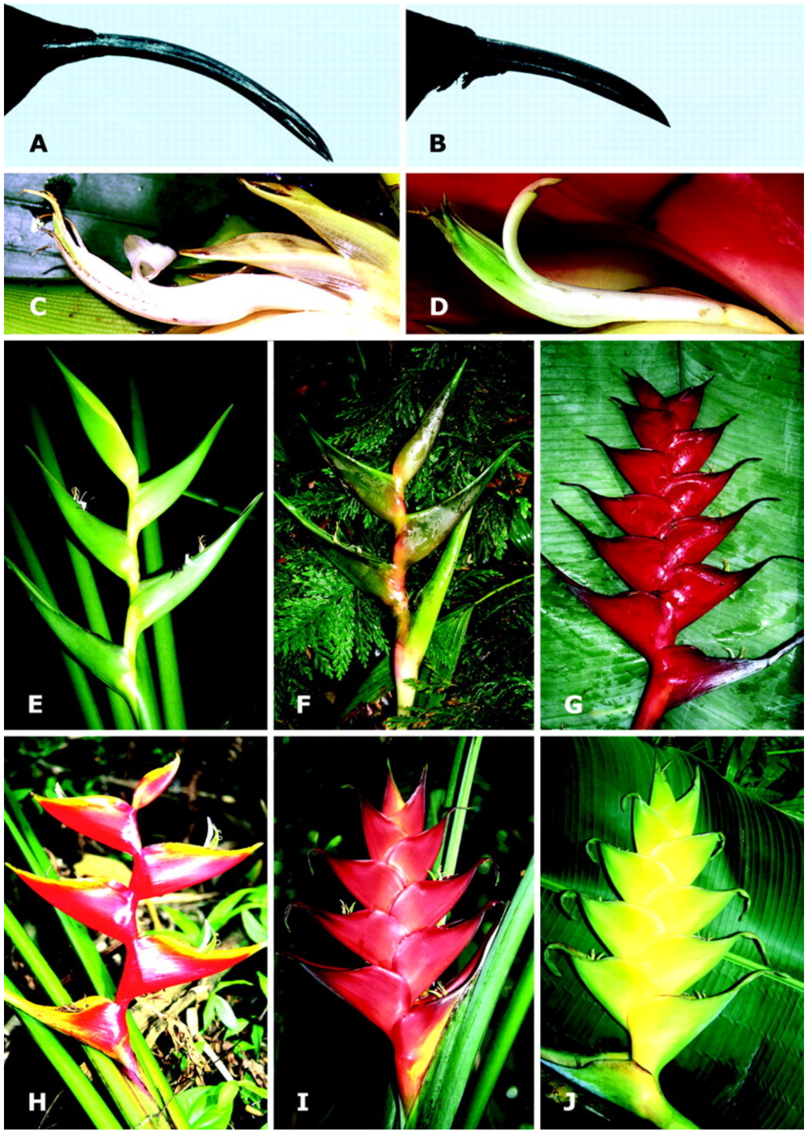
Morphologies

Heliconia Species
on St. Lucia

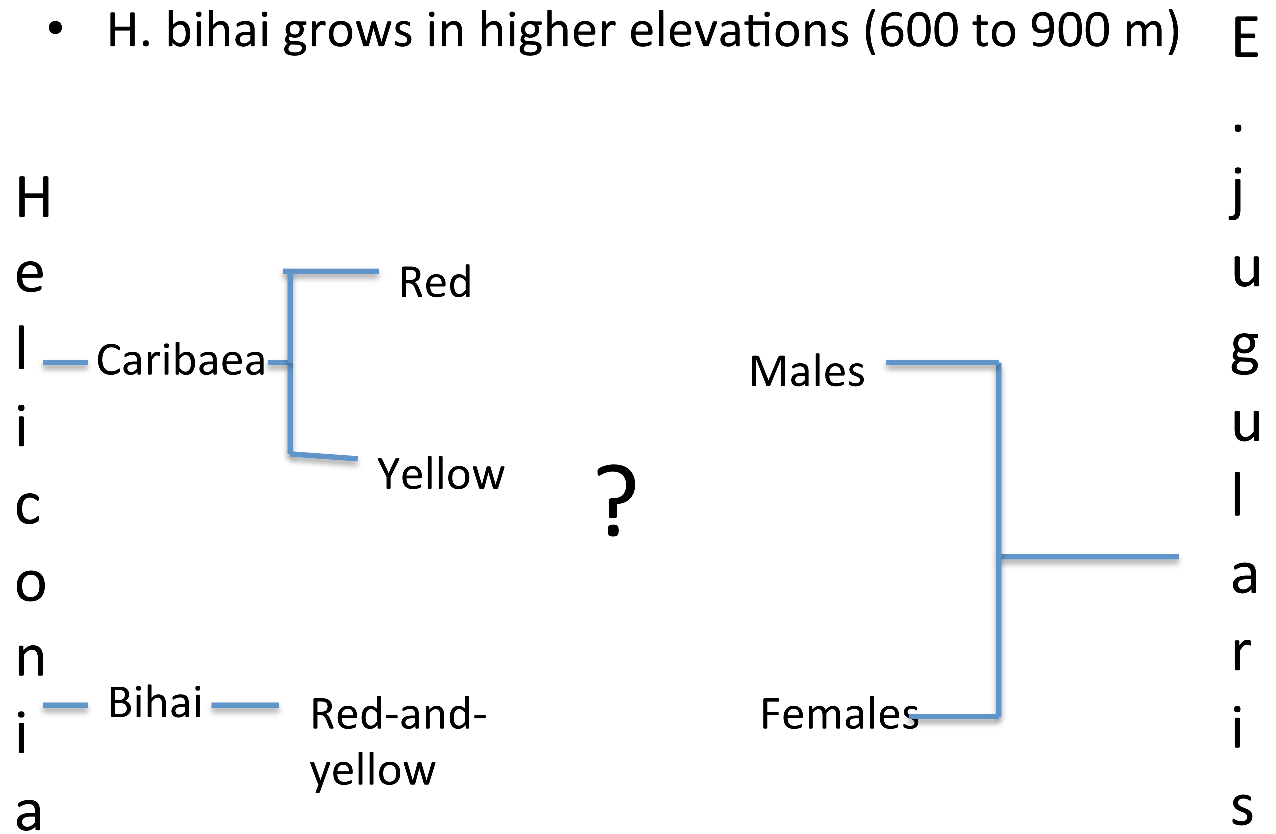


Heliconia species
on Dominica

Temeles and Kress
(2003) Fig 1.

The Island of Dominica

- Heliconia species grow allopatrically divided by an altitudinal gradient
  - Both the red and yellow H. caribaea grows in lower elevations (100 to 600 m)
  - H. bihai grows in higher elevations (600 to 900 m)



Paper Questions

A. Is there a difference in food plant preference between E. jugularis sexes on Dominica?

B. What are possible mechanisms driving the sexual dimorphism and different feeding strategies in E. jugularis?

Methods

- Conduct population censuses along transects
  - Observe birds and contrast plant preferences between sexes at different sites
  - Observe plants and contrast between species and color morphs
    - Bract number per inflorescence
    - Nectar energy per inflorescence
    - Flower length
    - Flower curvature

Is there a difference in food plant preference between E. jugularis sexes on Dominica?

Observational data indicate that yes, there seems to be a correlation between food preference and sex.

- "Males were associated exclusively with H. caribaea, which they defended against conspecifics, and were not observed to visit H. bihai" (631).

- "20 of 49 females, but 0 of 21 males, were observed to visit H. bihai" (631).

Is there a difference in food plant preference between sexes?

Yes, though it depends on where you look.

Transect	H. bihai	Red H. caribaea	Yellow H. caribaea
	Flower length (mm)		
Salisbury Loop	47.6 ± 0.3 (16)	39.7 ± 0.4 (23)	36.2 ± 0.3 (15)
Mt. Diablotin	47.2 ± 1.2 (8)	40.0 ± 0.4 (20)	37.2 ± 0.2 (15)
Layou River	Absent	36.4 ± 0.2 (19)	35.8 ± 0.2 (15)
Central Forest	Absent	36.2 ± 0.4 (16)	36.4 ± 0.4 (12)
	Flower curvature (degrees)		
Salisbury Loop	28.8 ± 0.5 (16)	24.0 ± 0.7 (12)	20.2 ± 0.4 (13)
Mt. Diablotin	30.0 ± 0.4 (8)	22.6 ± 0.6 (15)	19.4 ± 0.7 (12)
Layou River	Absent	20.0 ± 0.3 (19)	19.2 ± 0.3 (15)
Central Forest	Absent	20.8 ± 0.4 (7)	20.4 ± 0.5 (7)

"15 of 19 females were associated with red clumps of H. caribaea at contact zones, whereas only 2 of 13 males were associated with red clumps of H. caribaea at contact zones" (631).

"At low elevation sites lacking a contact zone between H. bihai and H. Caribaea, equal proportions of males and females visited the red and yellow morphs" (631).

Temeles and Kress (2003) Table 1.

What are possible mechanisms driving the adaptations witnessed?

There are nutritional advantages to H. caribaea, and males have larger bodies and greater energy requirements

Temeles and Kress (2003) Table 2.

Transect	**H. bihai**		**Red H. caribaea**		**Yellow H. caribaea**	
	Bracts	Joules	Bracts	Joules	Bracts	Joules
Contact Zone Present						
Salisbury Loop	4.3 ± 0.2 (51)	2128	6.0 ± 0.2 (52)	2138	7.3 ± 0.4 (31)	2312
Mt. Diablotin	4.8 ± 0.1 (34)	2376	6.3 ± 0.2 (76)	2245	7.4 ± 0.3 (45)	2344
Freshwater Lake	3.6 ± 0.1 (92)	1782	5.5 ± 0.2 (55)	1960	6.3 ± 0.2 (66)	1996
Morne Trois Pitons	3.5 ± 0.6 (26)	1732	7.0 ± 0.3 (30)	2494	7.9 ± 0.2 (32)	2503
Contact Zone Absent						
Layou River	Absent		5.2 ± 0.3 (41)	1853	4.6 ± 0.4 (14)	1457
Central Forest	Absent		8.3 ± 0.3 (46)	2958	7.2 ± 0.5 (13)	2280

General Conclusions

- Sexual dimorphism can be driven by ecological factors, not just sexual selection

- Coadaptation can occur in multiple patterns in similar ecosystems
  - Red-green H. bihai morph approximates H. caribaea phenotype on St. Lucia
  - Red H. caribaea morph approximates H. bihai phenotype in contact zones on Dominica

References

E. J. Temeles, I. L. Pan, J. L. Brennan, J. N. Horwitt. Evidence for Ecological Causation of Sexual Dimorphism in a Hummingbird. Science **289:** 441-443 (2000).

E.J. Temeles, W.J. Kress. Adaptation in a Plant-Hummingbird Association. Science 300: 630-633 (2003).

Supplement

Reserve	Green H. bihai		Red-green H. bihai		H. caribaea	
	Bracts	Joules	Bracts	Joules	Bracts	Joules
H. caribaea common						
Quilesse	3.9 ± 0.1 (863)	1900	4.1 ± 0.5 (10)	1843	9.6 ± 0.2 (161)	4304
Barre de l'Isle	3.7 ± 0.1 (171)	1803	4.2 ± 0.5 (26)	1887	9.4 ± 0.2 (150)	4125
H. caribaea rare						
Des Cartiers	4.3 ± 0.1 (610)	2095	5.0 ± 0.2 (186)	2247	8.0 ± 0.4 (18)	3787
Forestière	3.5 ± 0.1 (261)	1705	4.6 ± 0.2 (103)	2067	Absent	

Temeles and Kress (2003) Table 3.