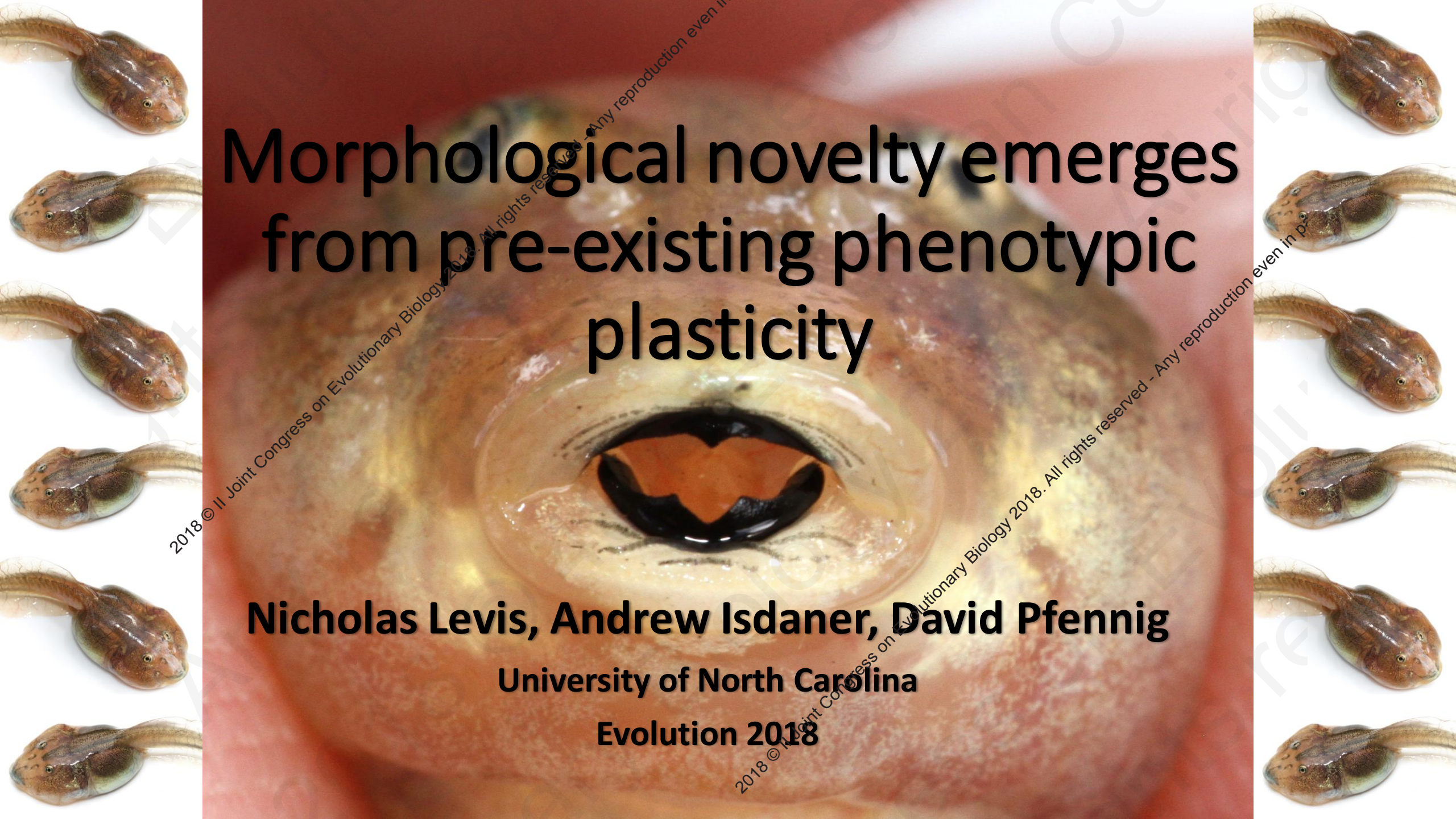
Morphological novelty emerges from pre-existing phenotypic plasticity



Nicholas Levis, Andrew Isdaner, David Pfennig

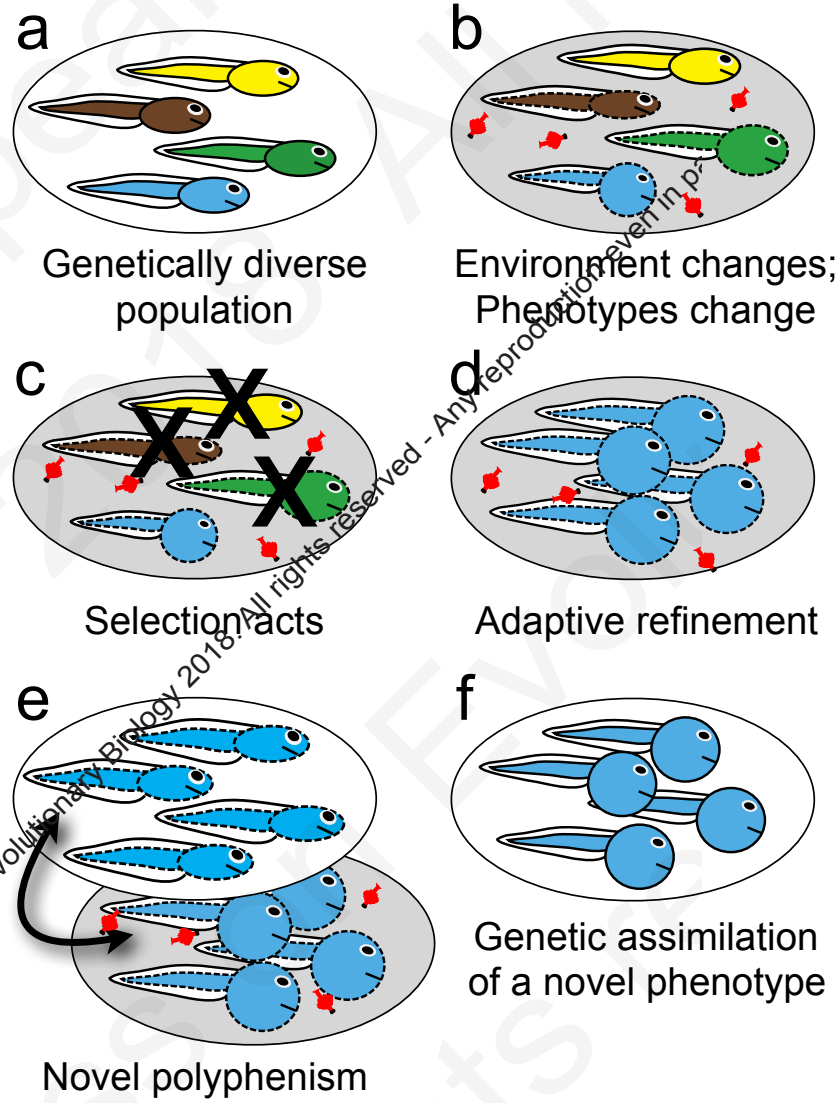
University of North Carolina

Evolution 2018

Phenotypic plasticity c

Plasticity-first evolution: Phenotypes ch
following a change in the **environment**

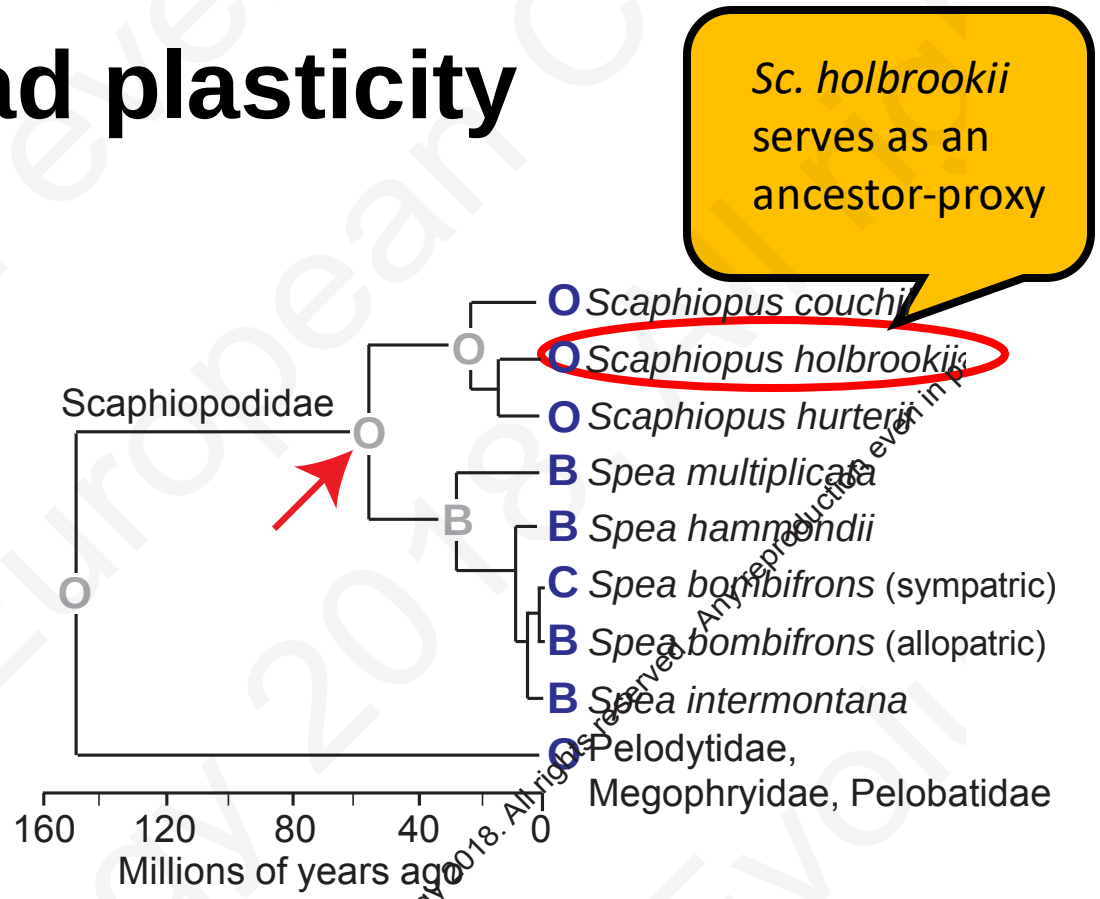
1) The existence of ancestral plasticit
2) Adaptive refinement of focal trait
3) Canalization of formerly induced tra



Levis and Pfennig. Evaluating 'plasticity-first' evolution in nature: key criteria and empirical app

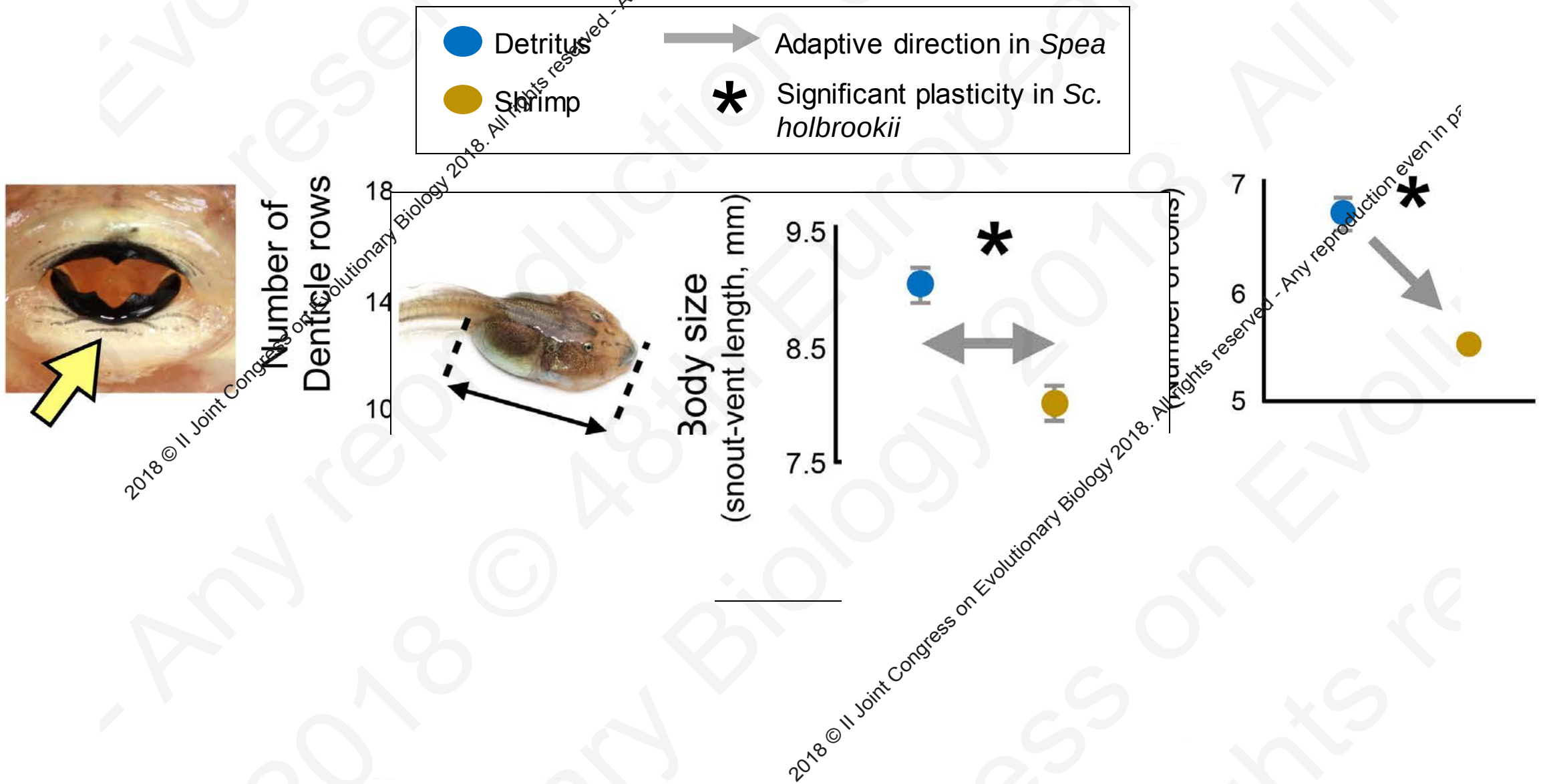
Spadefoot toad plasticity

1. *Scaphiopus* is the closest extant outgroup to *Spea*
2. *Scaphiopus* is ecologically similar to *Spea*
3. *Scaphiopus* does not express the carnivore-omnivore polyphenism



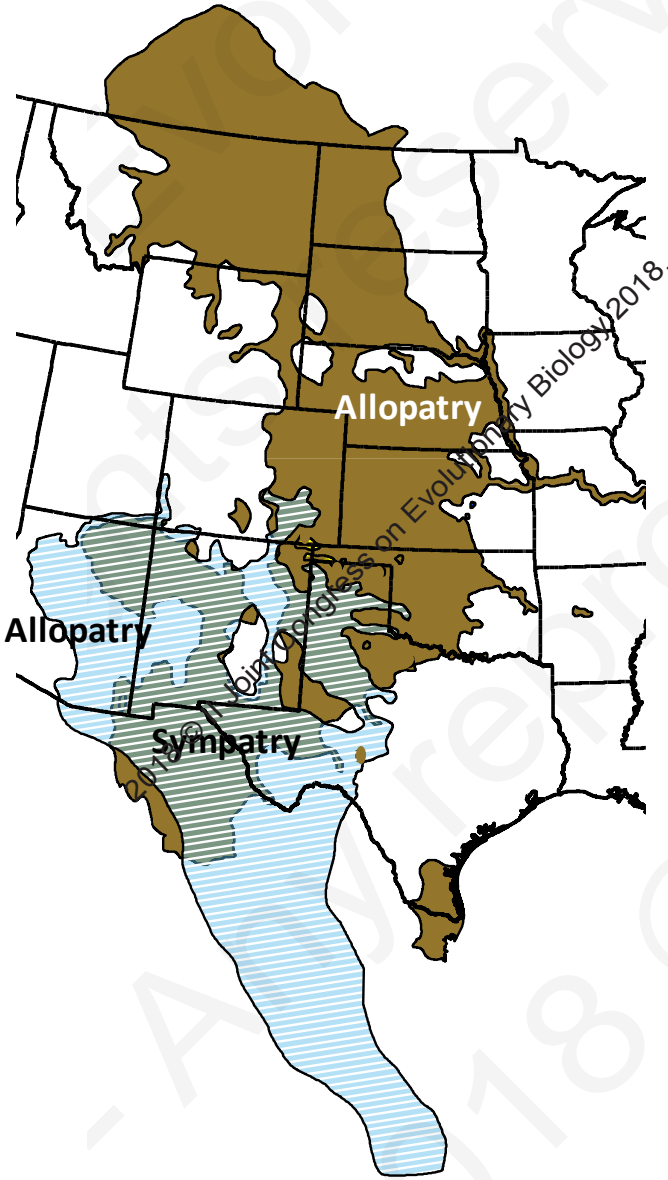
Levis, Isdaner, and Pfennig. Morphological novelty emerges from pre-existing phenotypic plasticity. 2018. *Nature Ecol. Evol.*

Sc. holbrookii shows diet-dependent plasticity



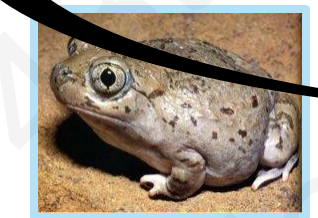
Levis, Isdaner, and Pfennig. Morphological novelty emerges from pre-existing phenotypic plasticity. 2018. *Nature Ecol. Evol.*

Character displacement in spadefoot toads



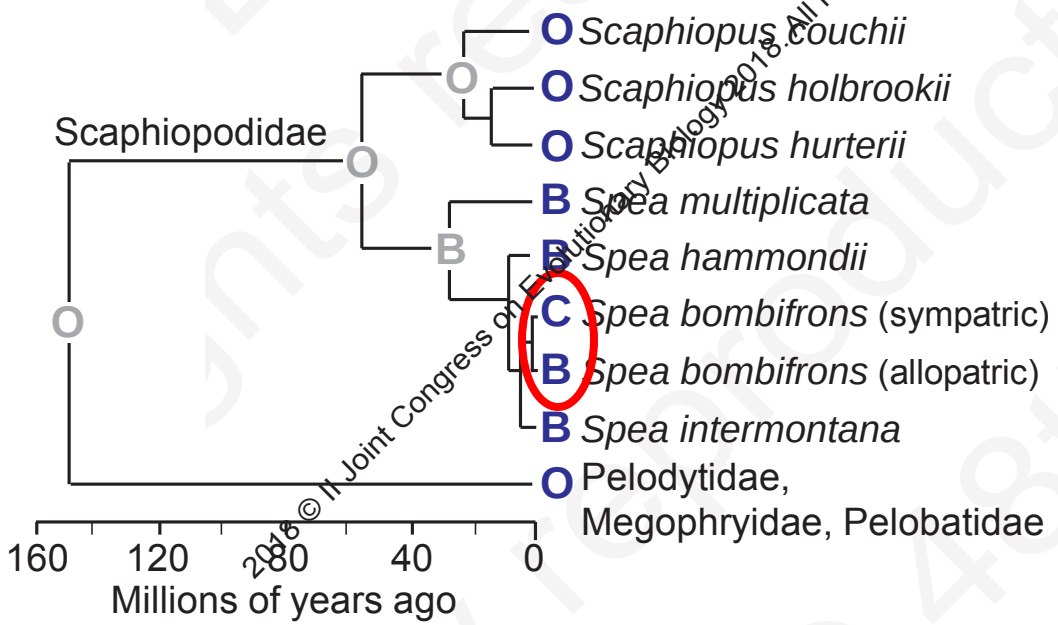
Spea bombifrons

Spea multiplicata



Pfennig and Murphy. A test of alternative hypotheses for character divergence between coexisting species. 2003. *Ecology*;
Pfennig and Martin. Evolution of character displacement in spadefoot toads: different proximate mechanisms in different species.2010. *Evolution*

Frequency of carnivore expression drives extent of adaptive refinement



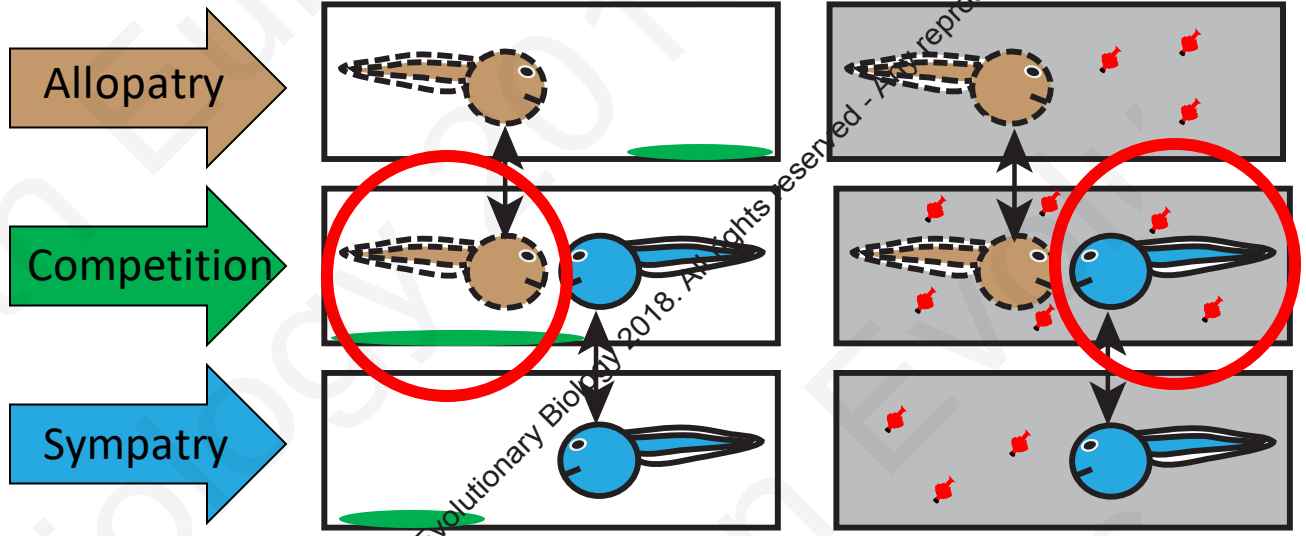
Tadpole phenotype

O/O–omnivores only (observed/inferred)

B/B–both morphs (observed/inferred)

C–carnivores mostly (observed)

Experimental design:



Predictions:

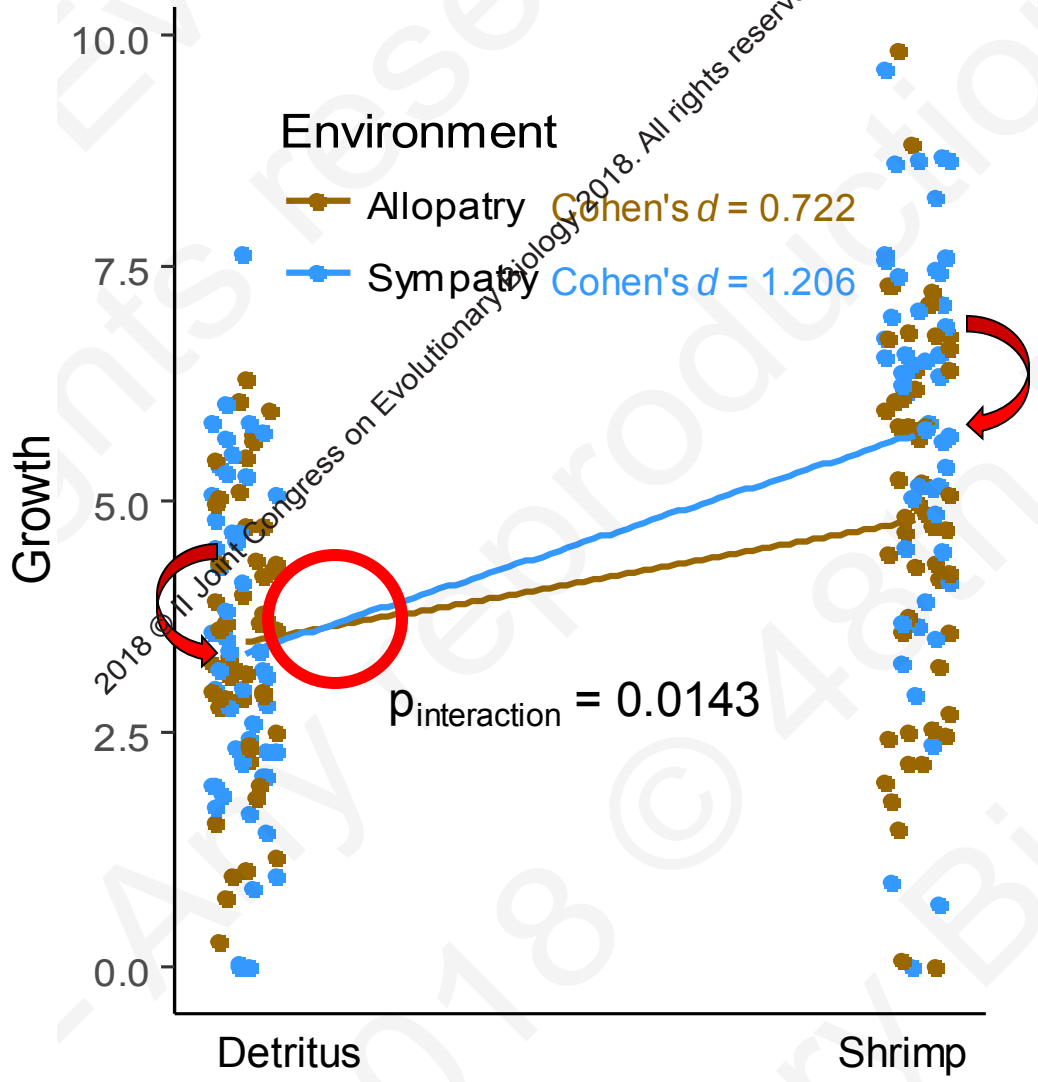
Sp. bombifrons

Detritus diet competitively

Sp. multiplicata

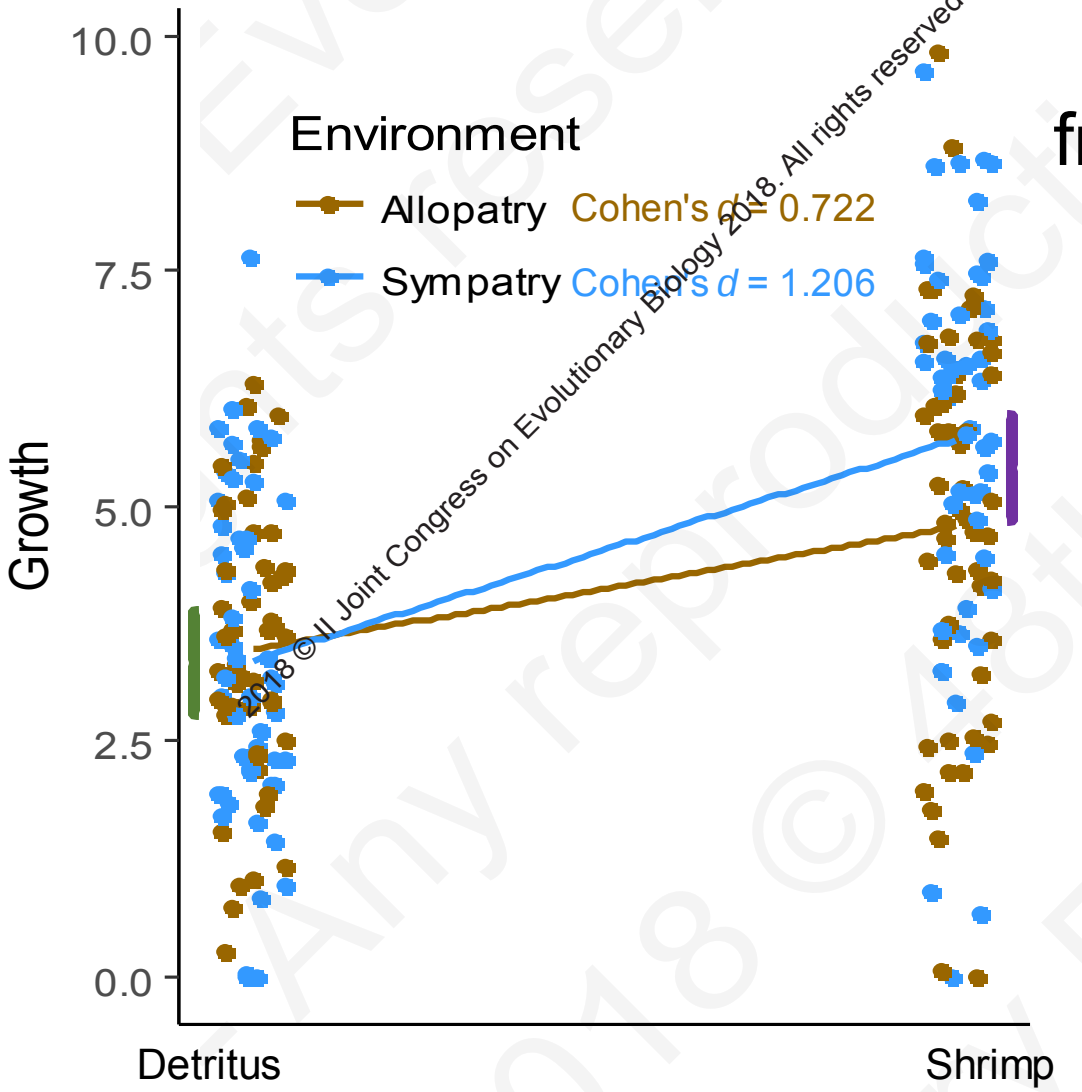
Detritus diet competitively

Morph production in nature predicts growth on alternative diets during competition



- Slopes are not parallel
- Sympatric tadpoles have a greater benefit on shrimp and a greater cost on detritus
- Allopatric tadpoles consume detritus more frequently in nature
- Sympatric tadpoles consume shrimp more frequently in nature

Allopatry wins on detritus, sympatry wins on shrimp



Winner of competition matches frequency of morph production (and thus diet consumption) in nature

Detritus

Winner

	No	Yes
Allopatry	20	**31**
Sympatry	31	20

p = 0.0236

Shrimp

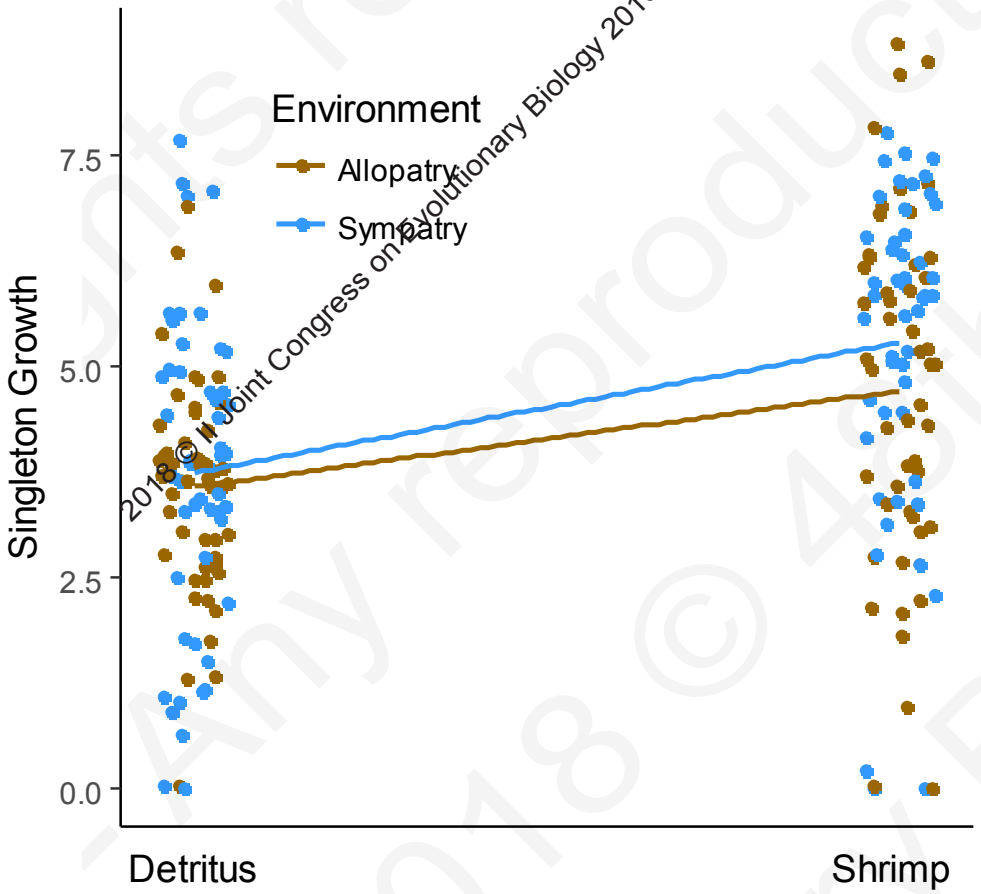
Winner

	No	Yes
Allopatry	35	16
Sympatry	16	**35**

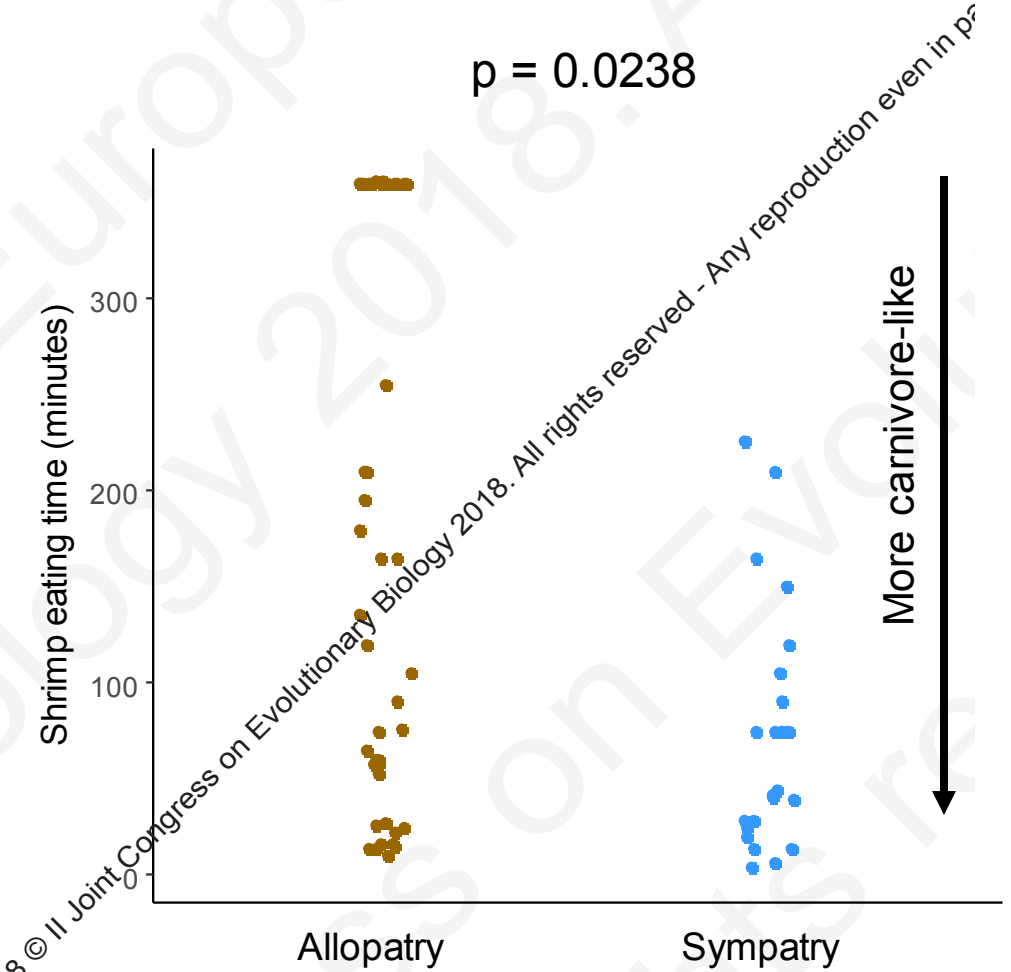
p = 0.0002

Mechanism of refinement?

No evolved differences in intrinsic growth rate

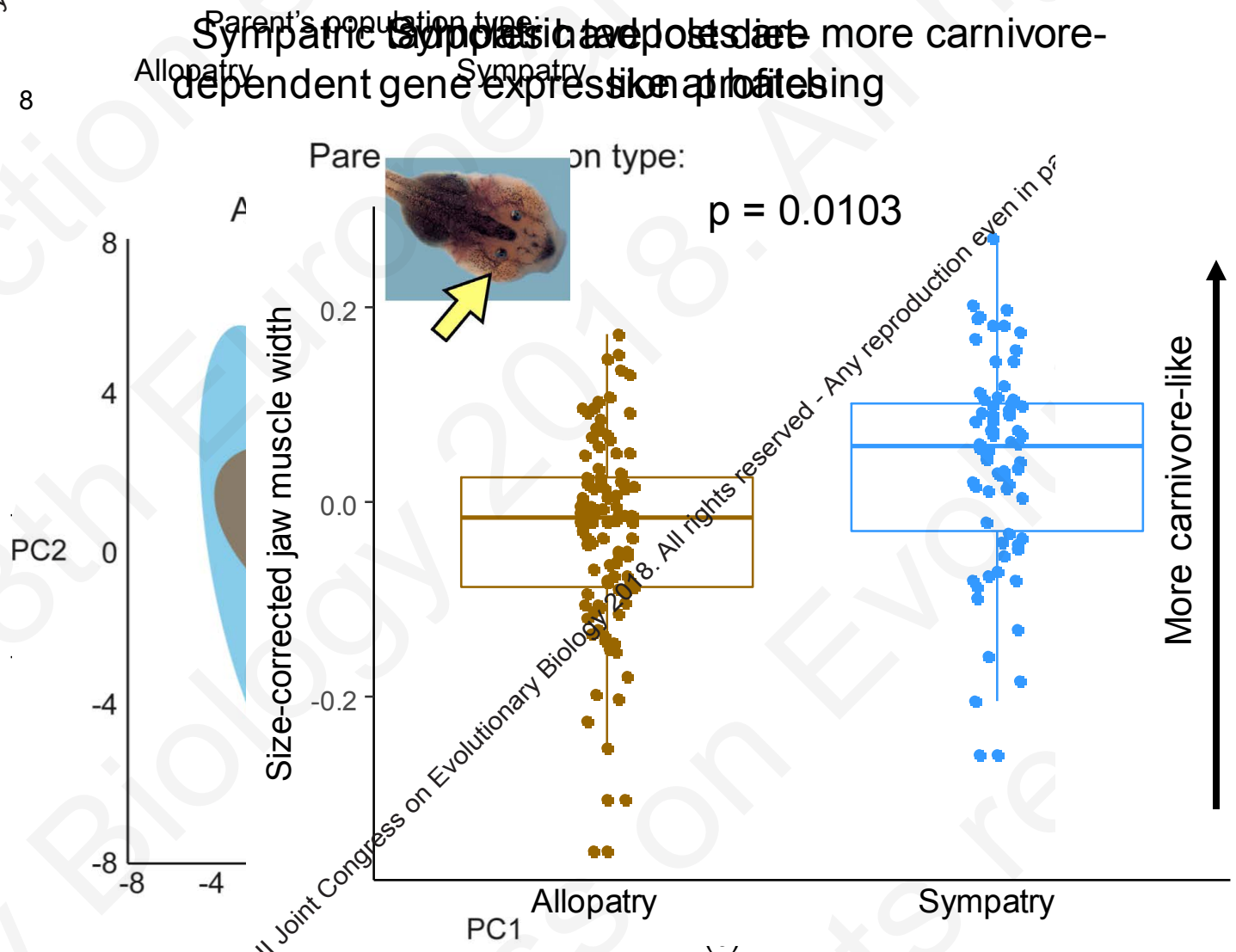


Evolved differences in ability to capture and consume shrimp



Genetic assimilation of carnivores in sympatric *Sp. bombifrons*?

Sympatric tadpoles have lost their more carnivore-dependent gene expression plasticity



Levis, Serrato-Capuchina, and Pfennig. Genetic accommodation in the wild: evolution of gene expression plasticity during character displacement. 2017. *J. Evol. Biol.*

Plasticity-first evolution in spadefoot toads

- Uncoordinated ancestral plasticity
- Adaptive refinement of plasticity and carnivore morph
- Frequency of trait expression drives magnitude of refinement
- Fixation of carnivore morph