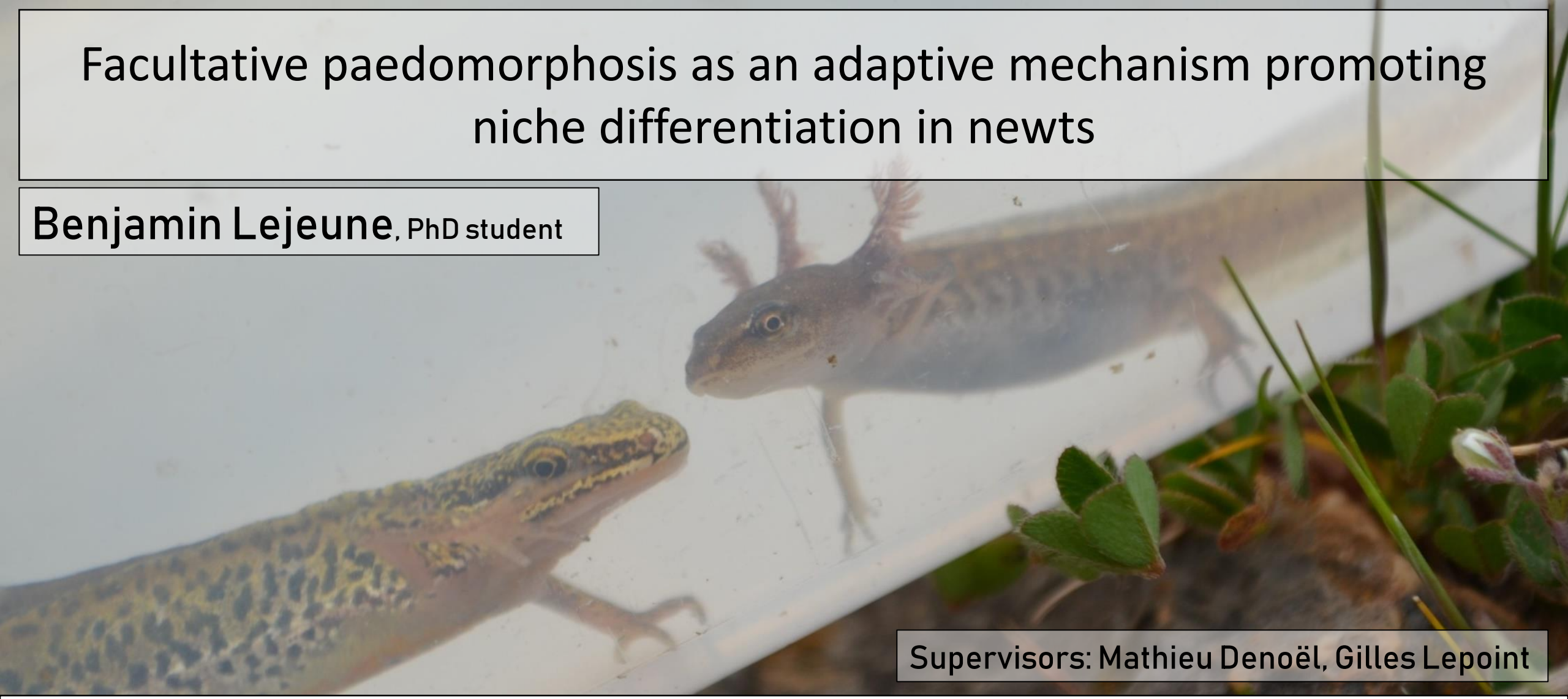
Facultative paedomorphosis as an adaptive mechanism promoting niche differentiation in newts

Benjamin Lejeune, PhD student



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Study path and PhD project

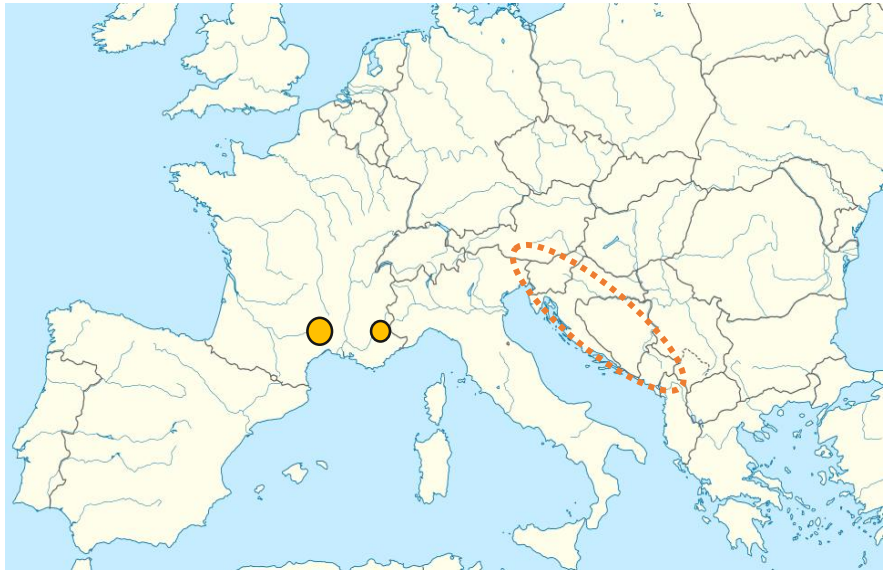
Bacs and masters at the University of Namur, Belgium
➔ Molecular Ecology

Internship at the Imperial College London (5 months)
➔ Host-Pathogen coevolution

PhD student at the University of Liège (FRIA: Sep. 2013 – Sep 2017) ~ 2018

➔ Stable isotopes : **Trophic ecology of newts**, **facultative paedomorphosis** and the impact of fish introduction in their native habitat in Europe

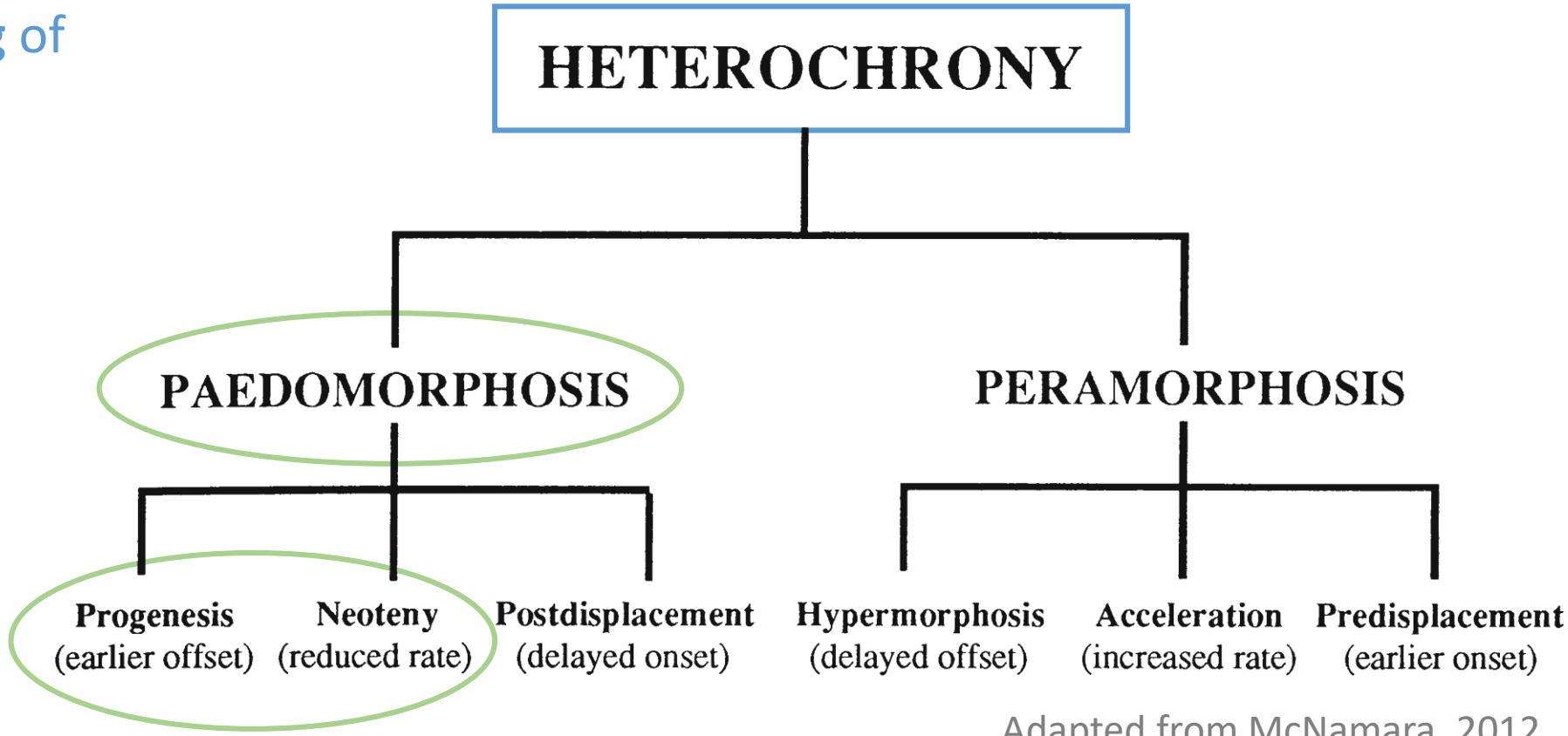
Motivation: Expand my 'toolkit' as an ecologist, Field work, links to conservation issue



INTRODUCTION – What is facultative paedomorphosis ?

Change in **rate** and **timing** of developmental events

Retention of **larval traits** at the adult stage



Adapted from McNamara, 2012

→ Morphological differences without extensive genetic modification

McKinney and McNamara, 1991

INTRODUCTION – Newt metamorphosis

Example: Alpine newt (*Ichthyosaura alpestris*)
Salamandridae

Larvae

Metamorphic Adult

Biphasic life-cycle:

Strictly Aquatic Larvae

1. **Metamorphosis**
2. **Terrestrial phase**
3. **Sexual maturity**

Semi terrestrial Adults (aquatic breeding)

INTRODUCTION – Facultative paedomorphosis in newts

Larvae

1. ~~Metamorphosis~~
2. ~~Terrestrial phase~~
3. Sexual maturity

Metamorphic Adult

Paedomorphic Adult

INTRODUCTION – Different species and environmental contexts

2 habitats:

Semi-permanent ponds in mid-elevated lands

Deep oligotrophic high altitudinal **lakes**

Denoël and Ficetola 2015
Denoël et al. 2001

INTRODUCTION – The **'Trophic advantage'** hypothesis

Classically viewed as a response to environmental risks (e.g. risk of drought) … But…

Metamorphic Adult

No gills, semi-terrestrial

Paedomorphic Adult

Gills, strictly aquatic

INTRODUCTION – The **'Trophic advantage'** hypothesis

Classically viewed as a response to environmental risks (e.g. risk of drought) … But…

Metamorphic Adult

RESOURCE PARTITIONING

Paedomorphic Adult

Feeding by snapping
Insectivorous

Feeding by suction (unidirectional flow)
Zooplanktivorous

Denoël and Joly, 2001

INTRODUCTION – The **'Trophic advantage'** hypothesis

Classically viewed as a response to environmental risks (e.g. risk of drought) … But…

<u>Hypothesis:</u> In a heterogenous environment, devoid of competitors, facultative paedomorphosis may promote trophic differentiation between phenotypes

Denoël and Joly, 2001
Denoël et al. 2005

Main questions:

Question 1: Does facultative paedomorphosis promote niche differentiation in lakes ?
(using time and space integrative tools)

Question 2: Can paedomorphosis generate niche partitioning in the absence of strong environmental heterogeneity ? Does niche expansion increase with environmental heterogeneity ?

QUESTION 1 – Trophic niche differentiation in lakes

Let's go investigate !

QUESTION 1 – Methods

Lejeune et al. 2018 Oikos

‘La Cabane’ Lake

SAMPLING:

3 months after the start of reproduction:
amphibian skin turnover 2~3 months (Cloyed et al 2015)

- 2 phenotypes – 2 sexes

- Food sources

Stomach flushing + Caudal skin sample

Both techniques are non lethal !

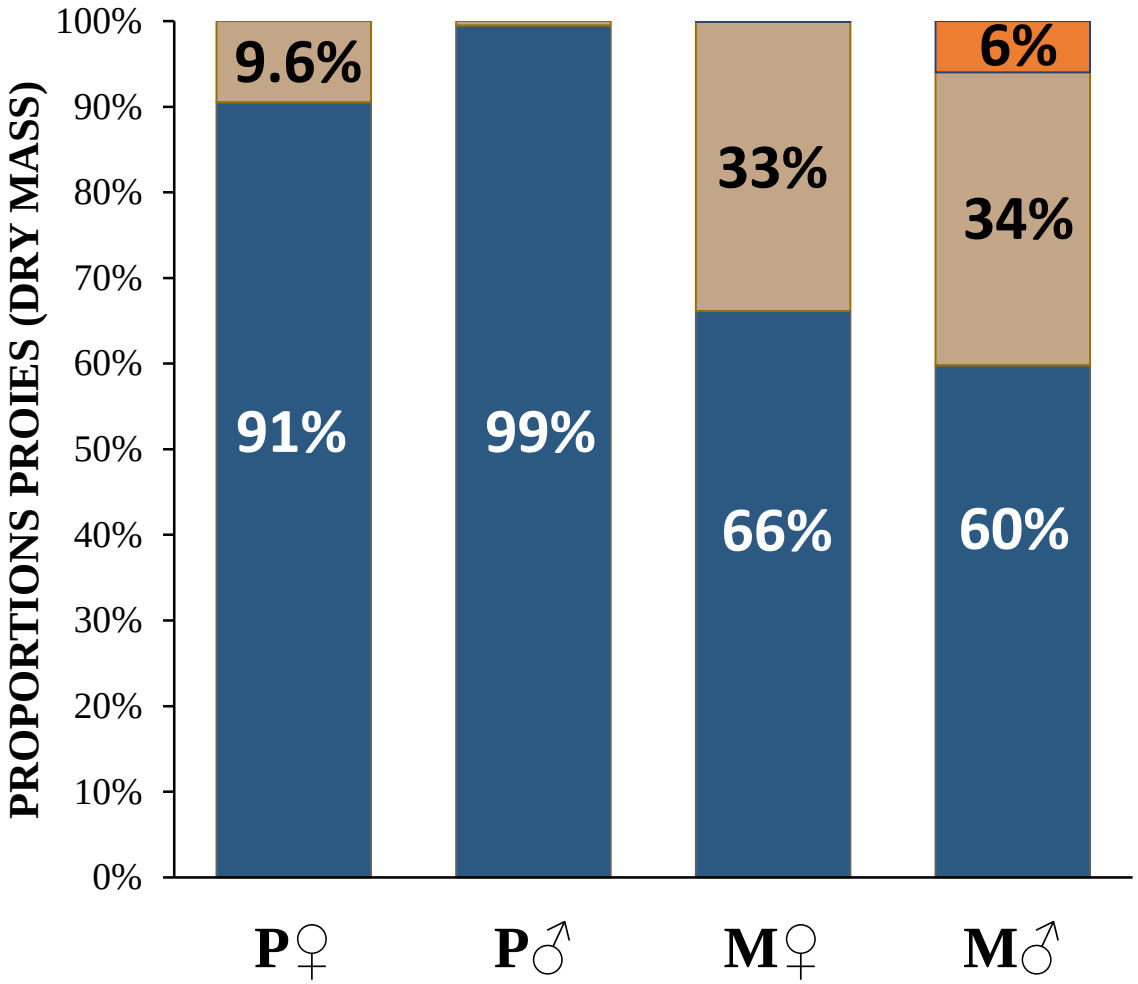
ANALYSIS:

➔ **Stomach content analysis**

➔ EA-IRMS : Bulk $\delta^{13}C$, $\delta^{15}N$: **Isotopic Niches, Mixing Models**

QUESTION 1 – Stomach content analysis

Lejeune et al. 2018 Oikos



Terrestrial prey

Littoral-benthic prey

Pelagic prey

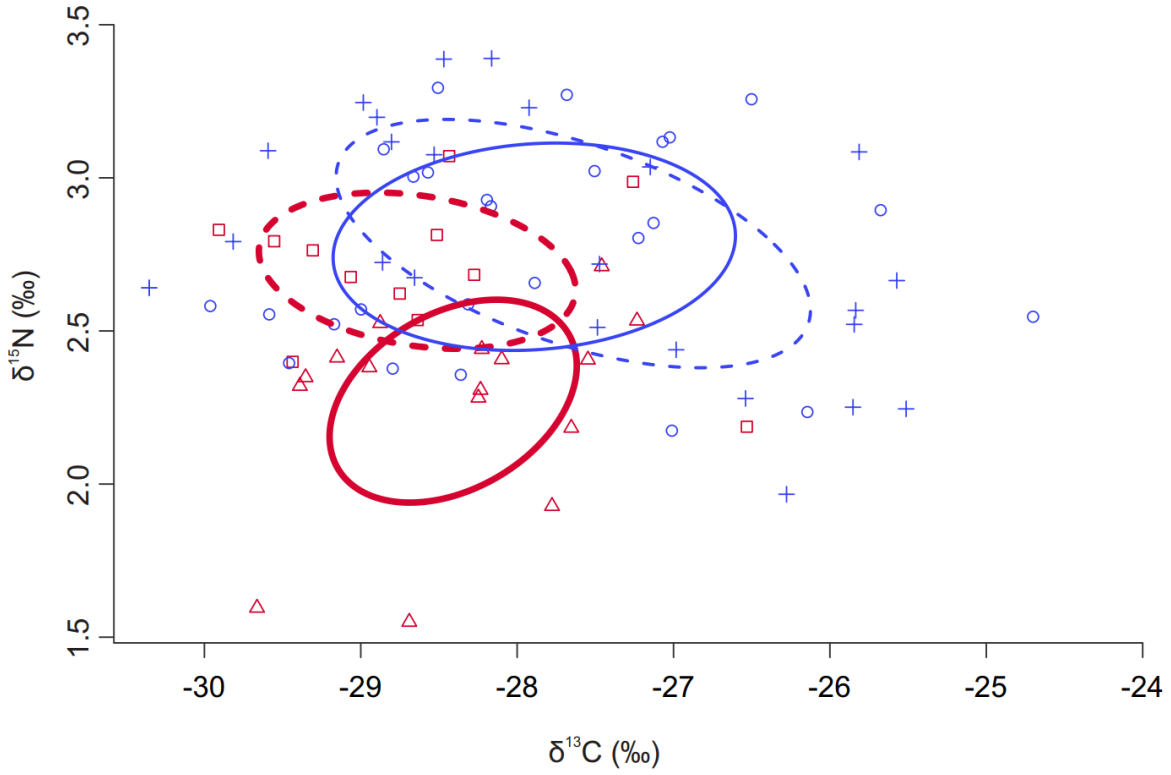
Diet: Phenotype **p<0.01** (Permanova)

Diet breadth: Paedomorphs < Metamorphs (**p<0.001**)

QUESTION 1 – Stable isotope analysis

Lejeune et al. 2018 Oikos

Isotopic niche analysis



Paedomorphic ♂ overlap more with Metamorphs than with Paedomorphic ♀ !

Legend:

Paedomorphs, **metamorphs**

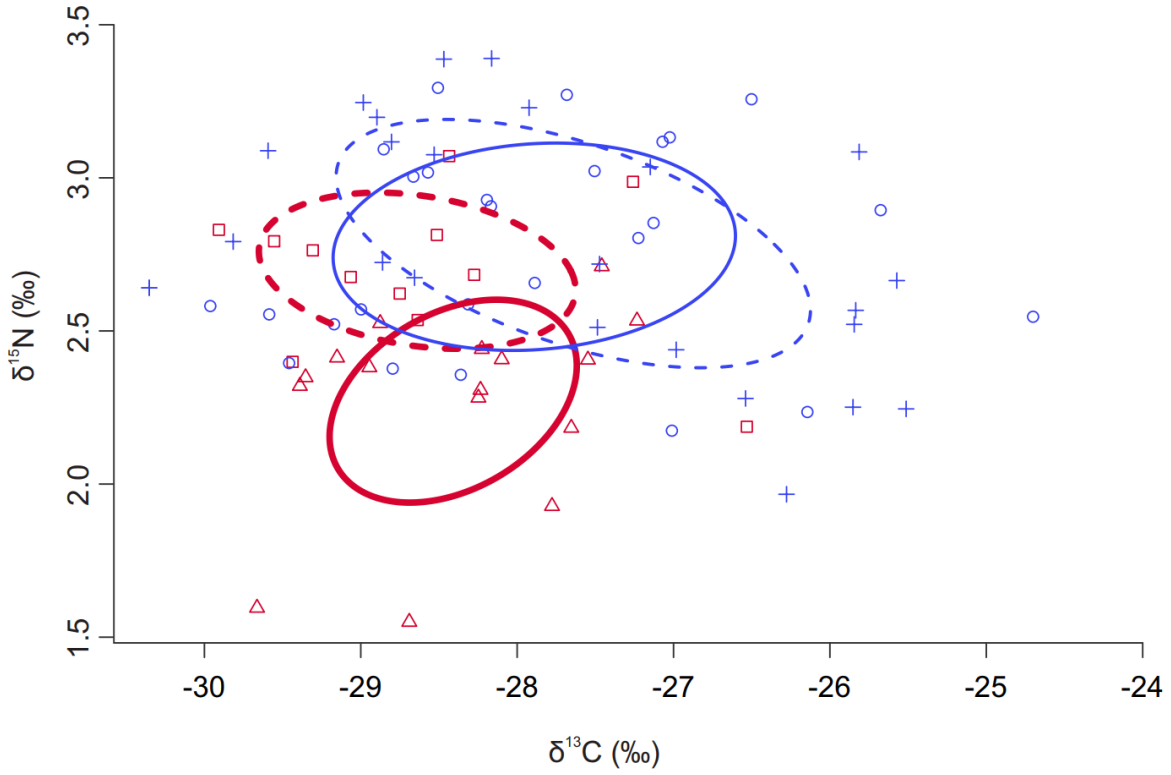
Full lines = **Females**

Dashed lines = **Males**

QUESTION 1 – Stable isotope analysis

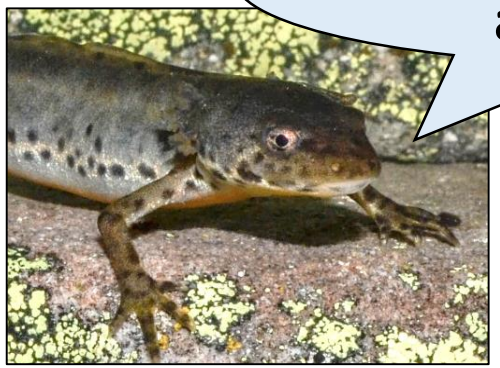
Lejeune et al. 2018 Oikos

Isotopic niche analysis



Dude, why do you behave like a metamorph ?

Sex mate, it's all about sex !



Legend:

Paedomorphs, **metamorphs**

Full lines = **Females**

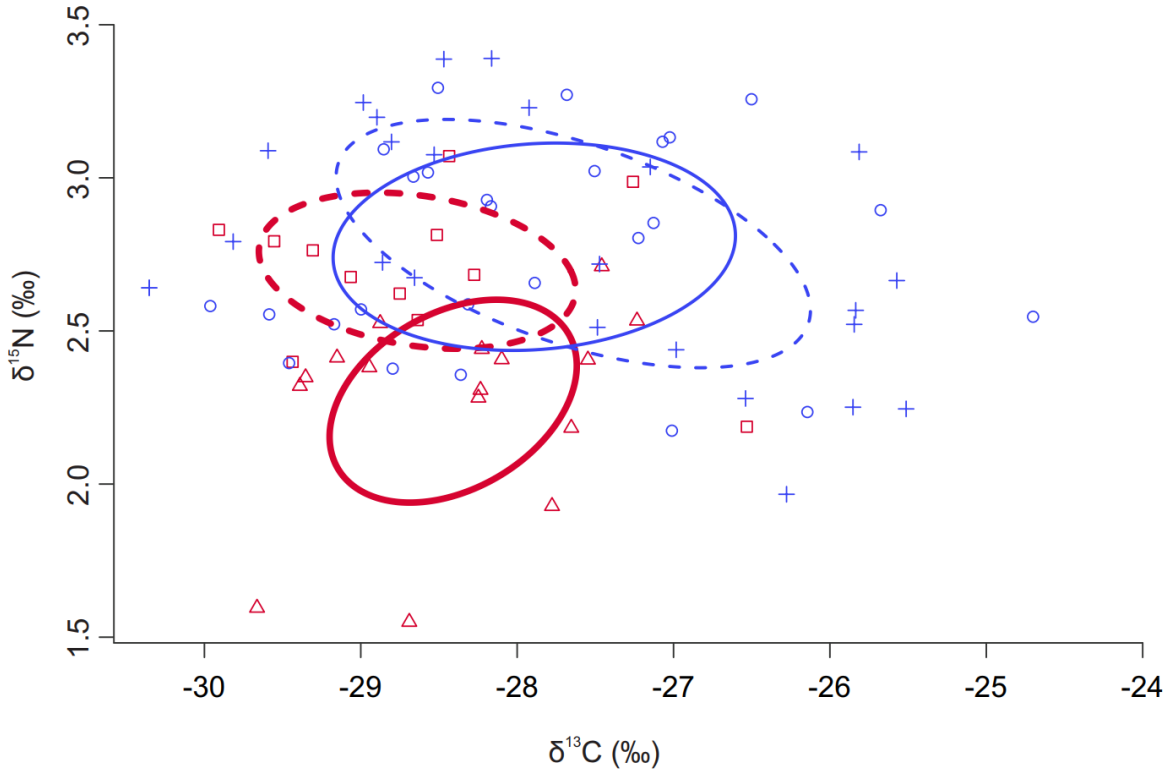
Dashed lines = **Males**

Courtship behaviour = LITTORAL ZONE

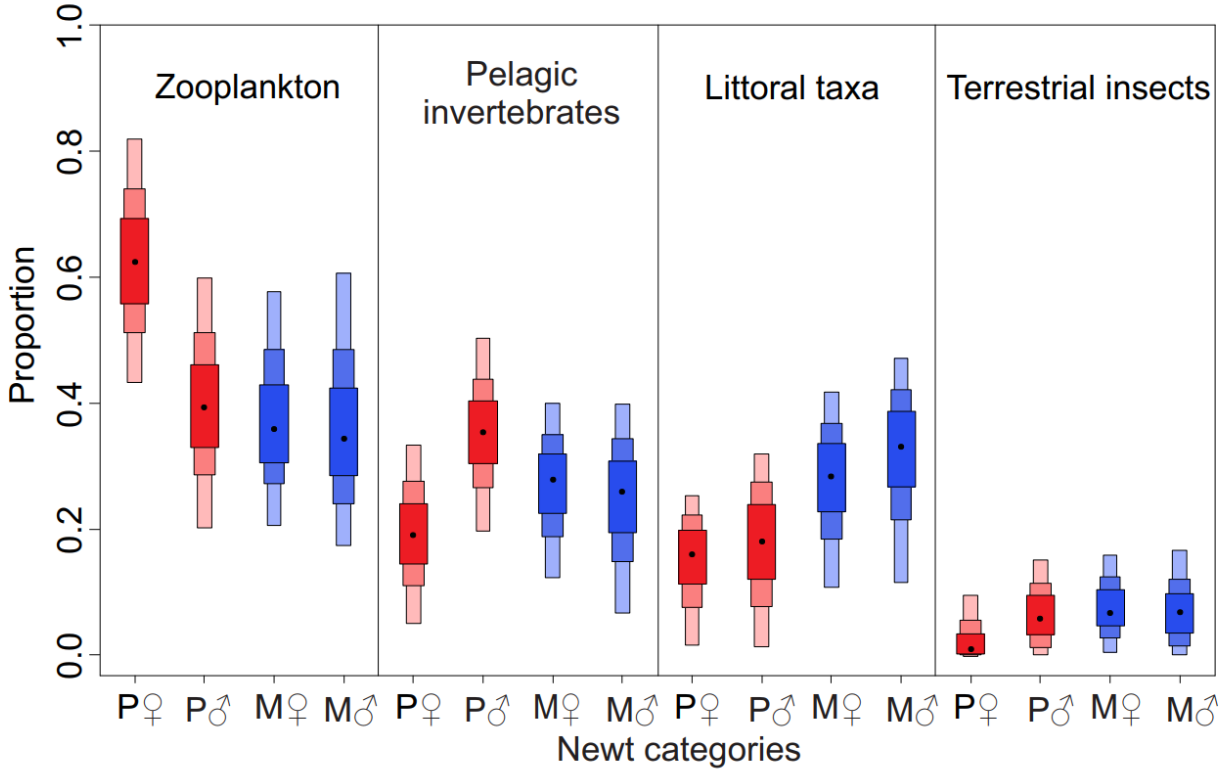
QUESTION 1 – Stable isotope analysis

Lejeune et al. 2018 Oikos

Isotopic niche analysis



Diet analysis using mixing models



Legend:

Paedomorphs, **metamorphs**

Full lines = **Females**

Dashed lines = **Males**

Niche expansion by paedomorphs = **30%**

towards ‘underused’ pelagic resources

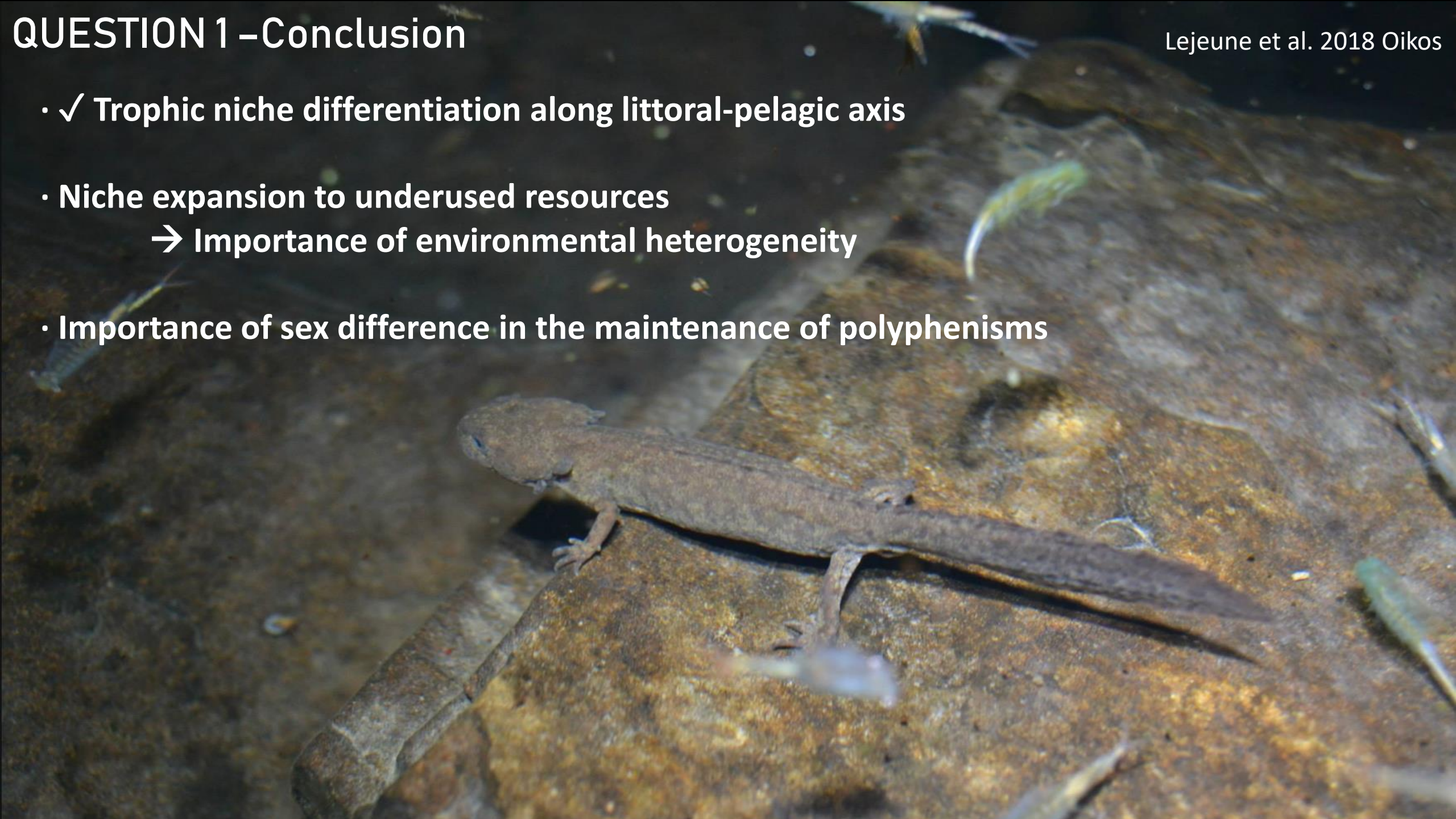
QUESTION 1 – Conclusion

Lejeune et al. 2018 Oikos

- ✓ **Trophic niche differentiation along littoral-pelagic axis**

- **Niche expansion to underused resources**
  → **Importance of environmental heterogeneity**

- **Importance of sex difference in the maintenance of polyphenisms**



QUESTION 2 – What about species-rich, less heterogeneous environments … ?

QUESTION 2 – Methods

Lejeune et al. *in prep*

Larzac region (France)
Hotspot for facultative paedomorphosis

4 permanent ponds

Pond A → D (↑ dimensions and resource div.)
Palmate newt (*Lissotriton vulgaris*)

SAMPLING and ANALYSIS:

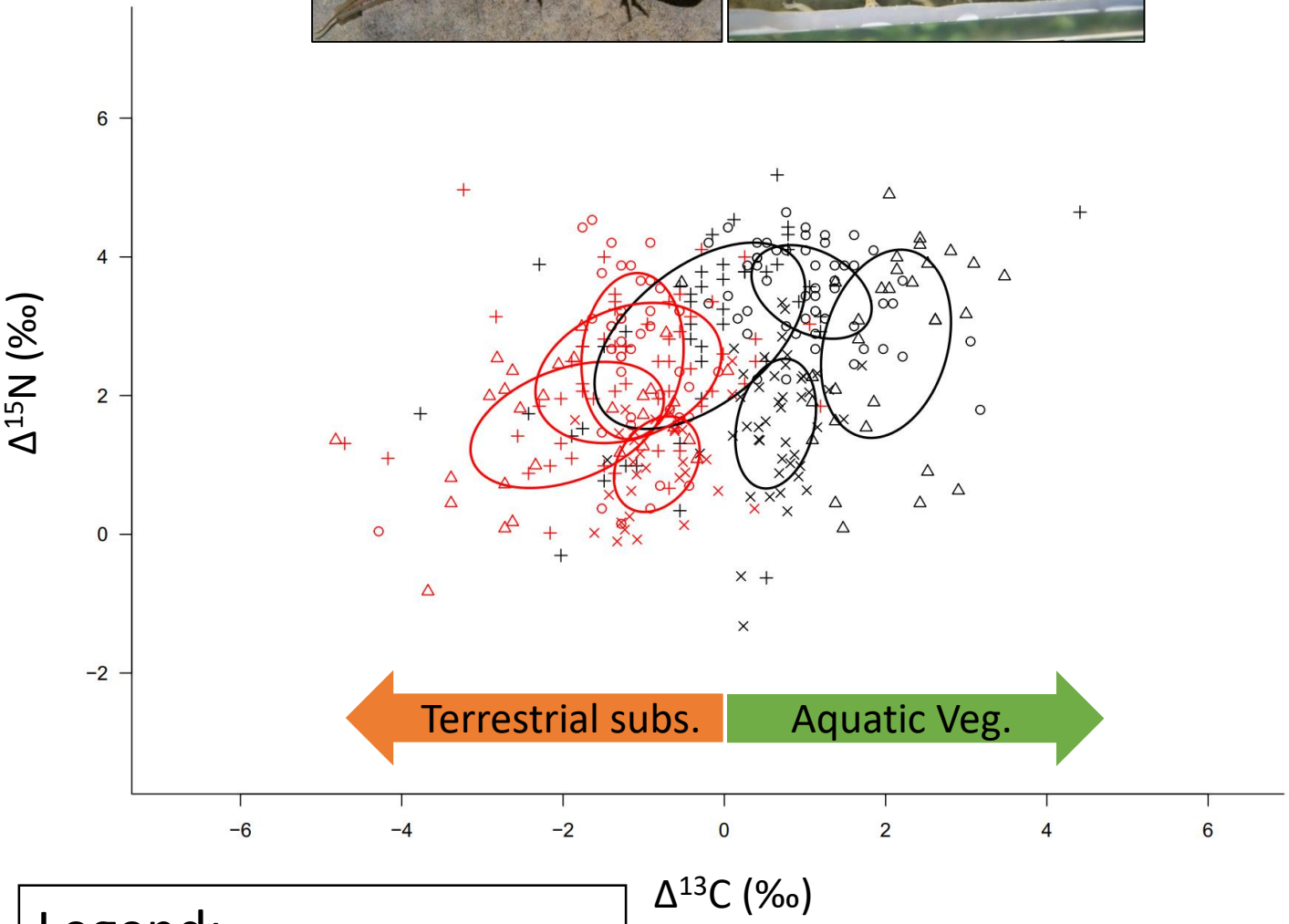
Idem QUESTION 1

QUESTIONS:

- **Niche differentiation ?**
- **Importance of environmental heterogeneity ?**

QUESTION 2 – Isotopic niche differentiation across sites

Lejeune et al. *in prep*



Legend:

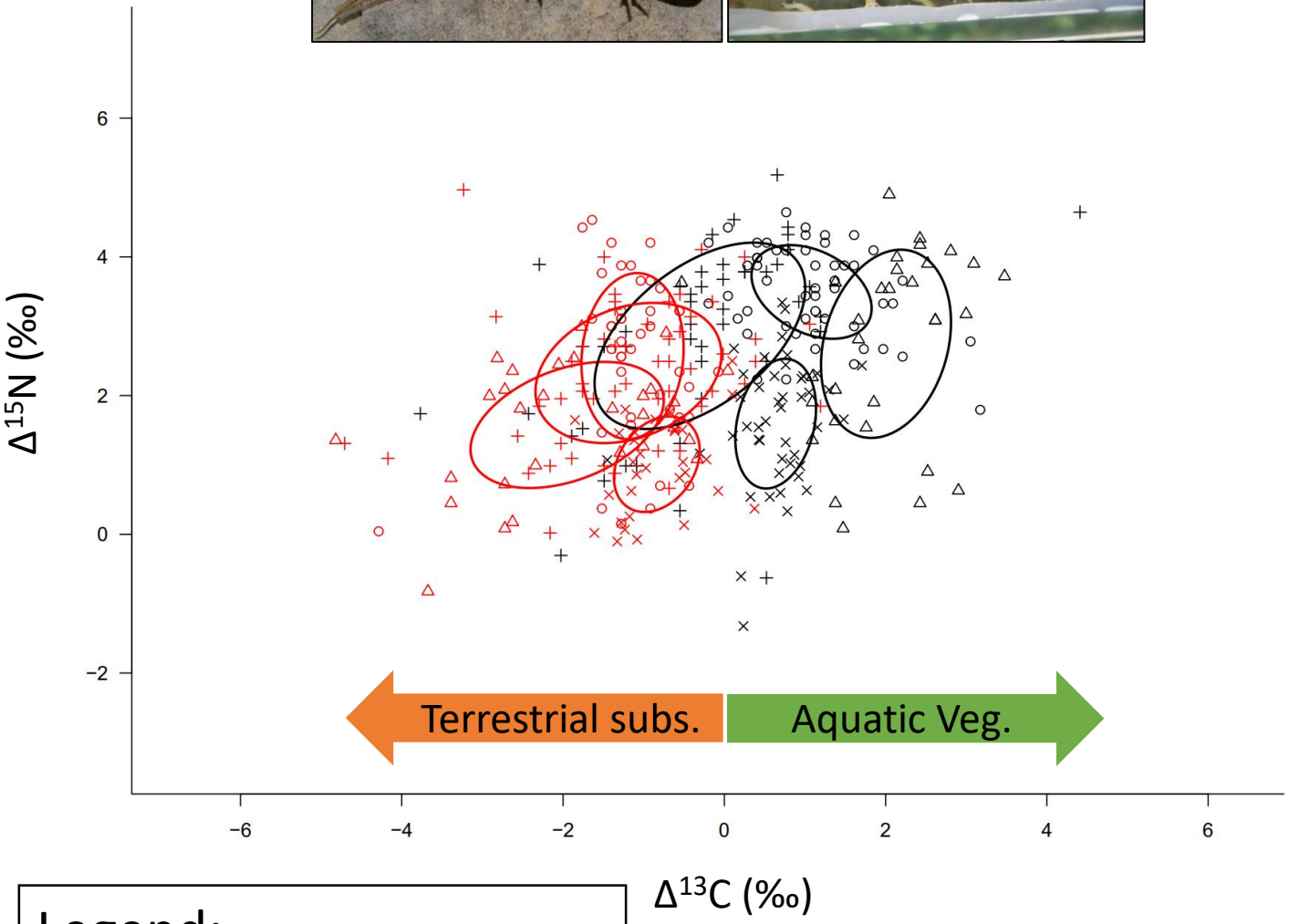
Metamorphs, **paedomorphs**

➔ Niche differentiation in all ponds

➔ Paedomorphic niche shifts across sites

QUESTION 2 – Isotopic niche differentiation across sites

Lejeune et al. *in prep*



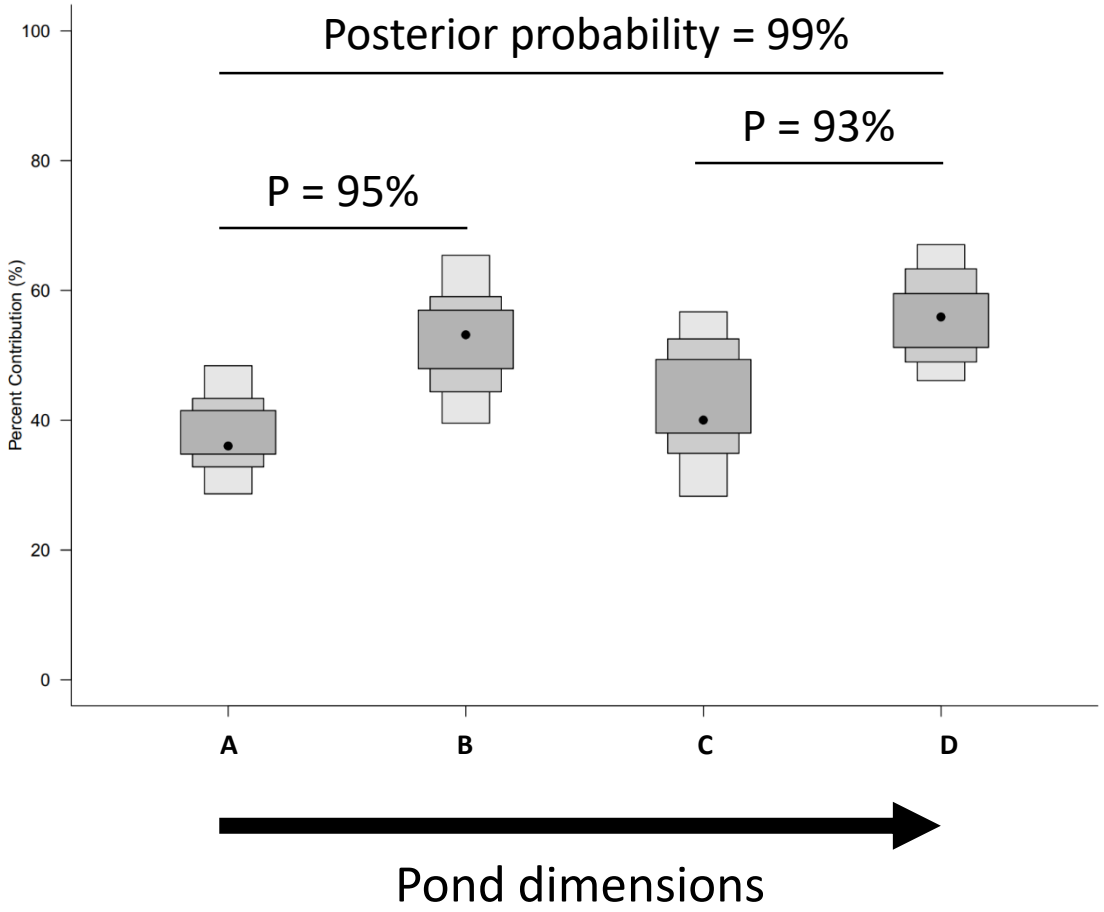
Legend:

Metamorphs, **paedomorphs**

➔ Niche differentiation in all ponds

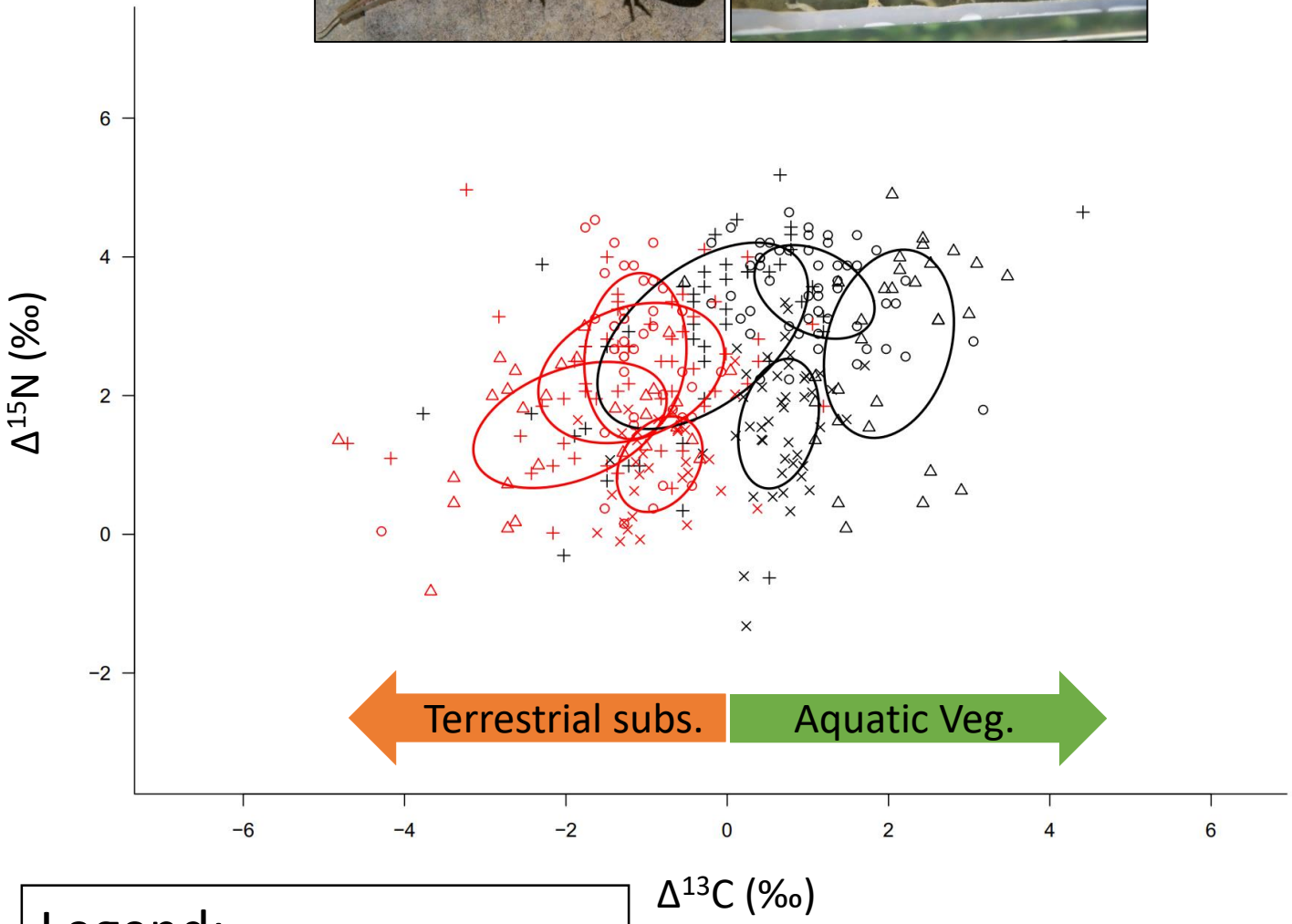
➔ Paedomorphic niche shifts across sites

% Niche expansion by paedomorphosis:



QUESTION 2 – Isotopic niche differentiation across sites

Lejeune et al. *in prep*

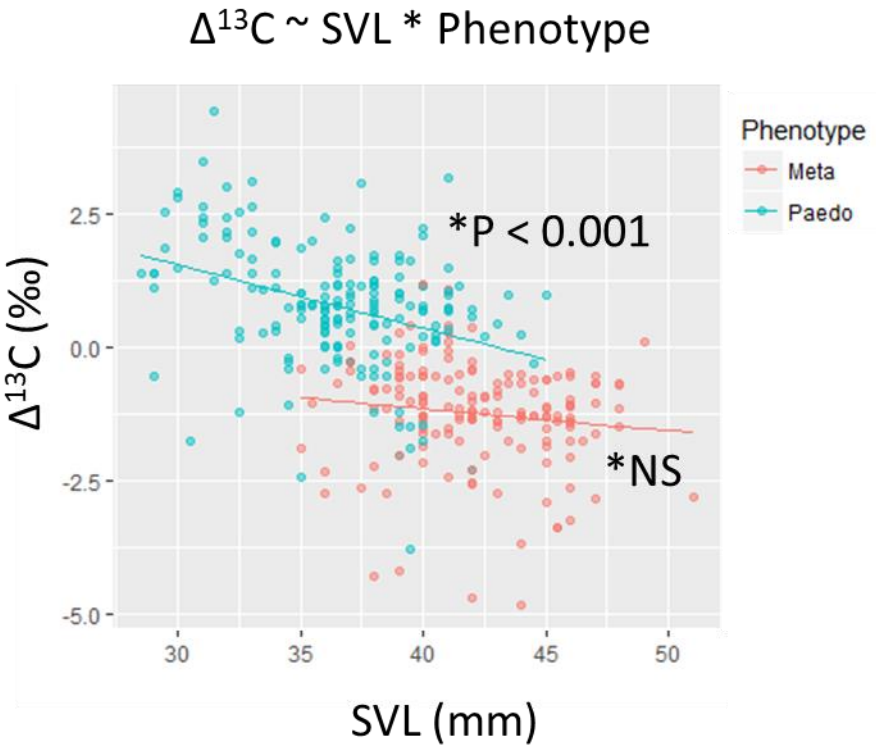


Legend:

Metamorphs, **paedomorphs**

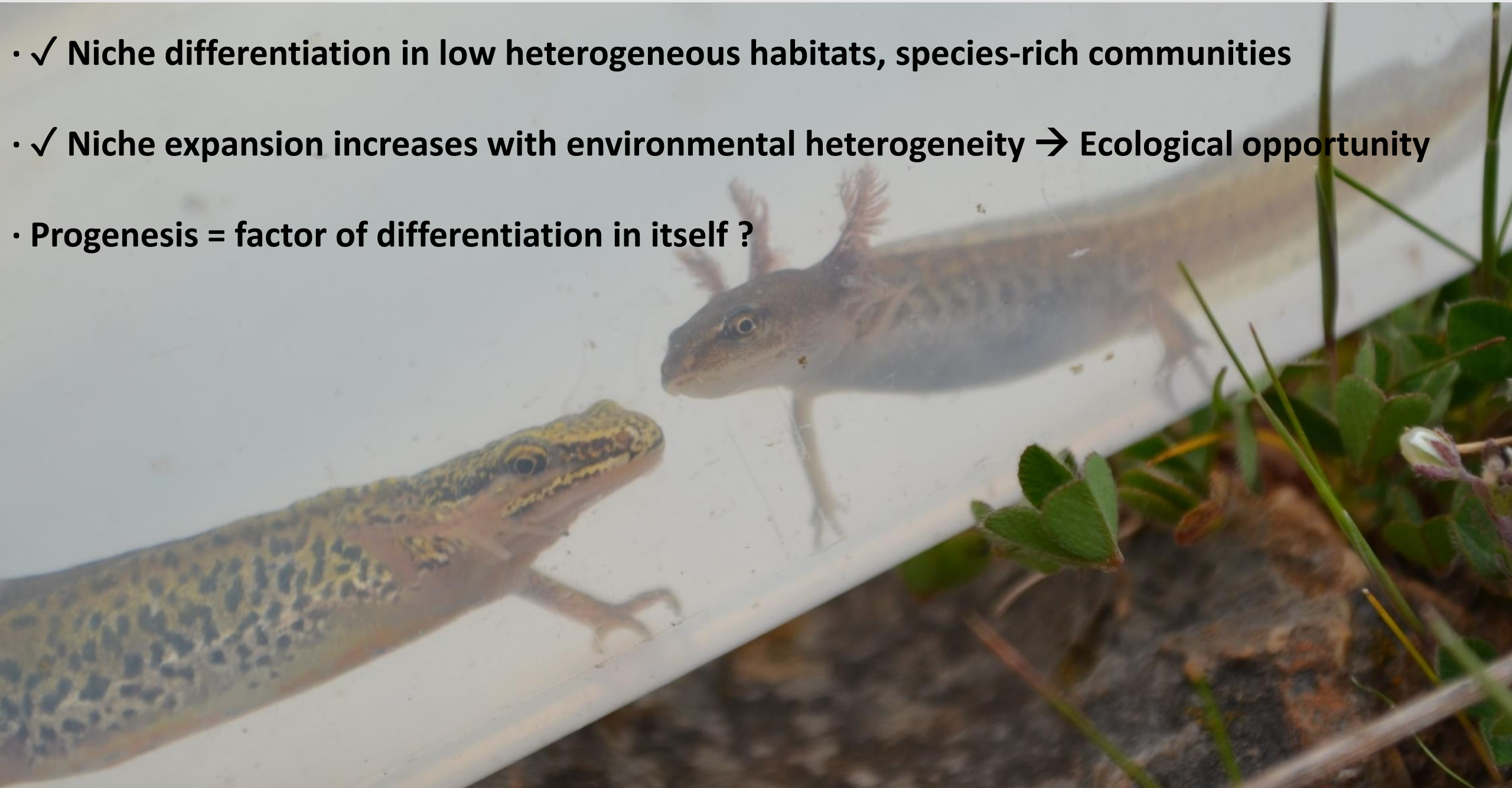
✓ **Environmental heterogeneity**

But there's another factor: **Progenesis**



QUESTION 2 – Conclusion

Lejeune et al. *in prep*



- **✓ Niche differentiation in low heterogeneous habitats, species-rich communities**
- **✓ Niche expansion increases with environmental heterogeneity → Ecological opportunity**
- **Progenesis = factor of differentiation in itself ?**

SYNTHESIS

Facultative paedomorphosis not only response to terrestrial vs aquatic conditions

➔ ✓ Trophic advantage in ≠ species and ≠ contexts

Niche expansion and differentiation to take advantage of ecological opportunity

➔ Environmental heterogeneity vs. Progenesis

FOCUS Research Unit:

Develop a network for future collaborations

Prompt discussions across labs (share knowledge, methods, tips) ~ Facebook page ?

Opportunity for doctoral training: FOCUS Days to improve presentation skills (valued in credits)

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Thank you !

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