

Invaxen: invasive biology of *X. laevis* in Europe



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- Solveig Vogt: MSc student (Bonn)
- Ricardo Rodrigues: MSc student (Lisbon)
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Background and context:

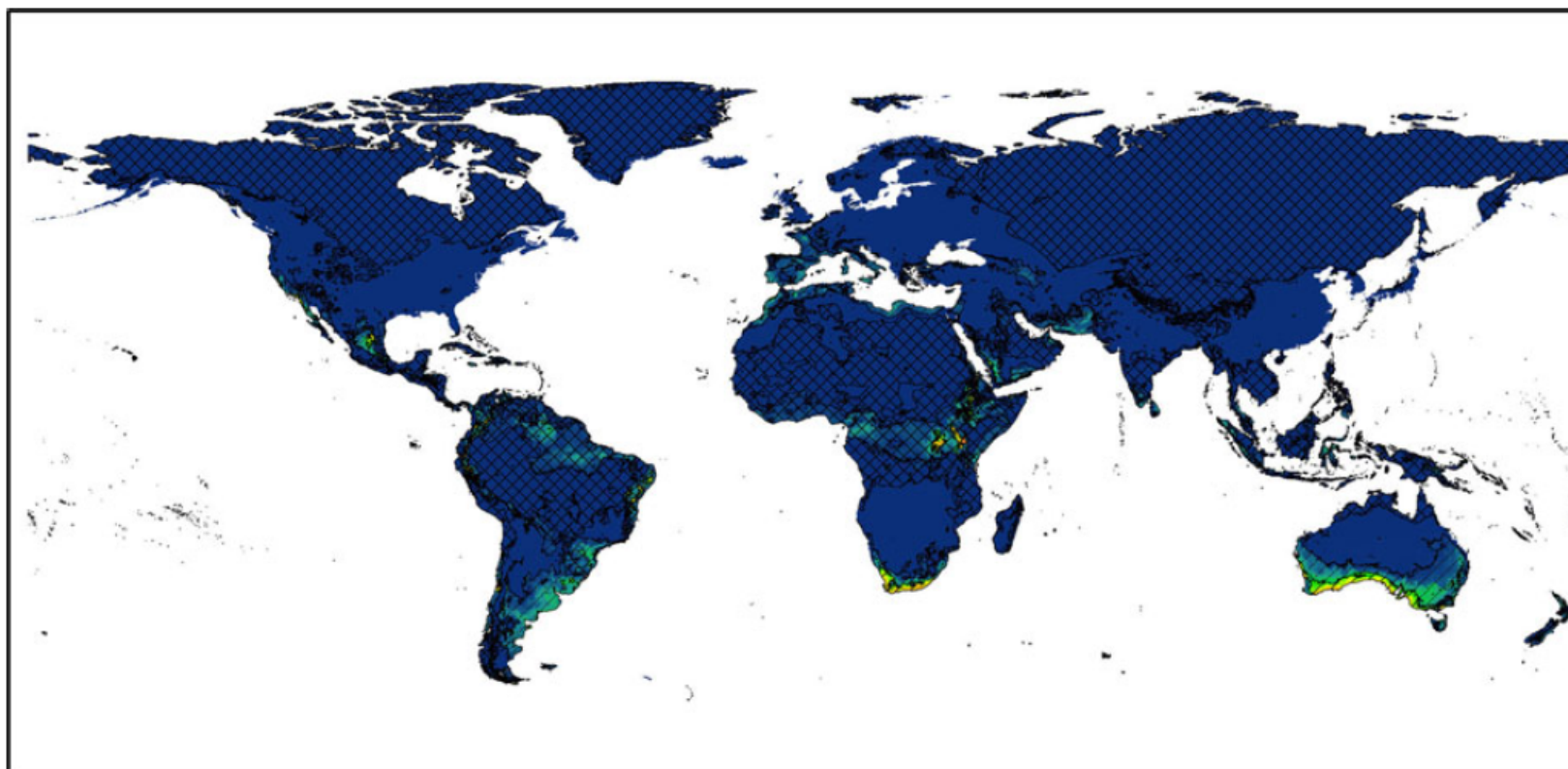
Biol Invasions

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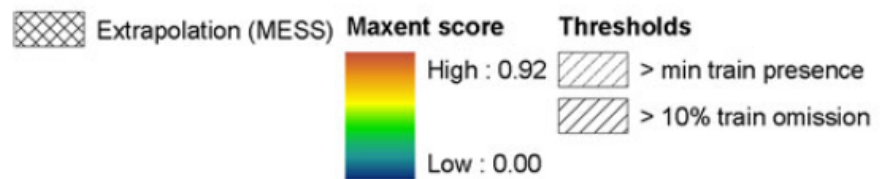
ORIGINAL PAPER

Ongoing invasions of the African clawed frog, *Xenopus laevis*: a global review

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R. Kobayashi • F. Lillo • G. Lobos • R. Rebelo •
J.-M. Thirion



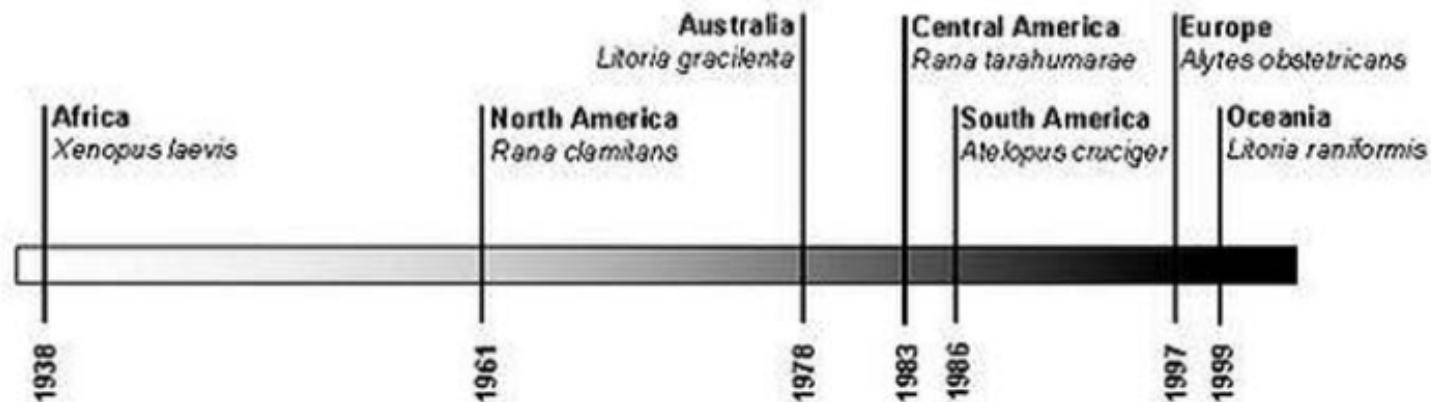
Legend





Origin of the Amphibian Chytrid Fungus

Ché Weldon,* Louis H. du Preez,* Alex D. Hyatt,† Reinhold Muller,‡ and Rick Speare‡

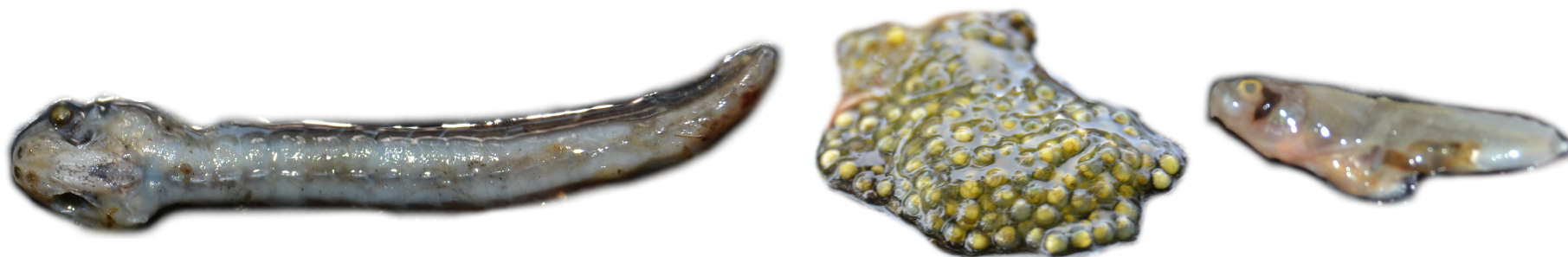




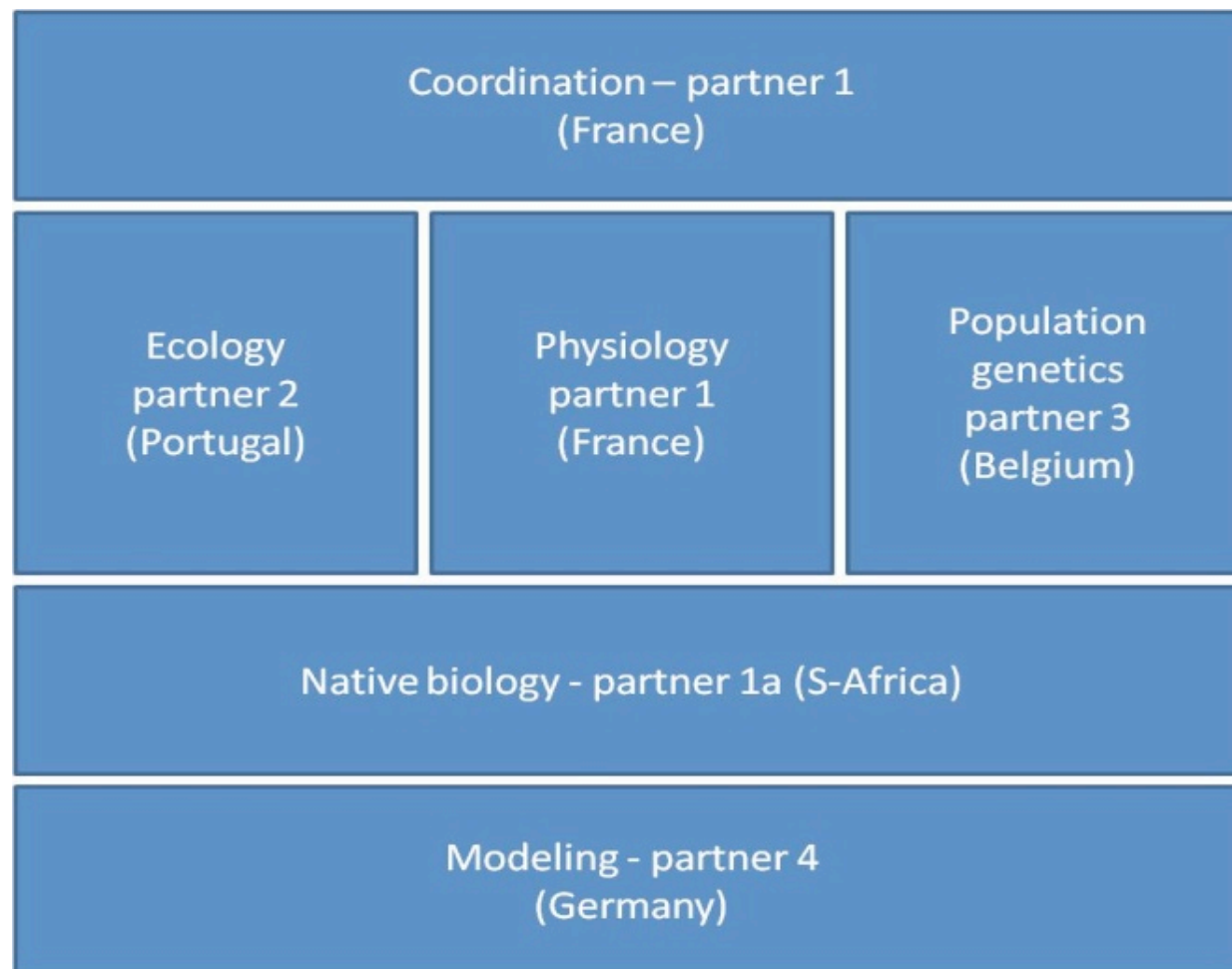
Copeia, 1997(3), pp. 589–592

Predation on the Endangered Tidewater Goby, *Eucyclogobius newberryi*, by
the Introduced African Clawed Frog, *Xenopus laevis*, with Notes on the
Frog's Parasites

KEVIN D. LAFFERTY AND CARL J. PAGE



Newt, frog eggs & fish recovered from the stomach of *X. laevis* in France





WP1 - Biology and Ecology of the invasive populations & impacts on the local fauna

1. document **life history plasticity** in the invasive populations of *X. laevis* (France, Portugal), by **comparing** these traits with those of the populations living in the **native range** (S-Africa; see WP4).
2. assess the role of *X. laevis* as a **carrier of amphibian blood and intestinal parasites**, as well as of the **amphibian pathogenic *B. dendrobatidis***, in the areas where it is invasive (France & Portugal).
3. evaluate **the impacts** on the pond/stream communities (**vertebrate** and **invertebrate**), either by direct consumption or by indirect effects, such as the bioturbation caused the activity of *X. laevis*.
4. use the ongoing **eradication** program of this species in Portugal as a case study to apply the knowledge gained during the project and propose eradication programs for France. Monitor the **recovery of native communities** after the removal of the invasive populations.



Rui Rebelo (CBA-FCUL), Richard Tinsley; Ricardo Rodrigues (CBA-FCUL), Nicolau Ser & Ângela Maurício (Oeiras Municipality)





WP2 - Physiology and mobility

1. Measure **temperature dependence** of performance traits (swim speed & acceleration; terrestrial endurance, jump forces); **temperature preference** as well as **critical limits** (Ctmin, Ctmax) , temperatures for adults and tadpoles. Effect of **temperature** on mobility (**behavior**: tendency to move, directionality of movement) in both life-history stages.
2. Measure **hydric dependence** of performance traits (terrestrial endurance, jump forces) in adults. We will also quantify the effects of **hydric state on dispersal behavior**.
3. We will quantify **resting and active metabolism** for tadpoles and adult frogs from invasive (France, Portugal) and native (WP4) populations under different **temperature and hydric regimes** to assess how changes in environmental variables affect metabolism and the cost of locomotion.
4. We will perform **mark-recapture studies** to quantify **mobility** and movement patterns in the field for invasive (France, Portugal) and native (S-Africa; see WP4) populations.








WP3 – Population genetics and gene flow

1. Assess **genetic diversity** and **population structuring** in native and introduced populations in order to infer the basic population genetic characteristics of invading populations.
2. Estimate **gene flow** among native and introduced populations for incorporation in the species distribution models developed in WP5, and for measuring the **connectivity** among populations, as well as for testing patterns of isolation by distance.
3. Implement a **landscape** based interpretation of the **population genetic** data to identify invasion pathways in conjunction with WP4, and insofar the data provided by WP1, WP2 and WP4 allow it, to estimate the impact of gene flow on the distribution of ecologically relevant variation.

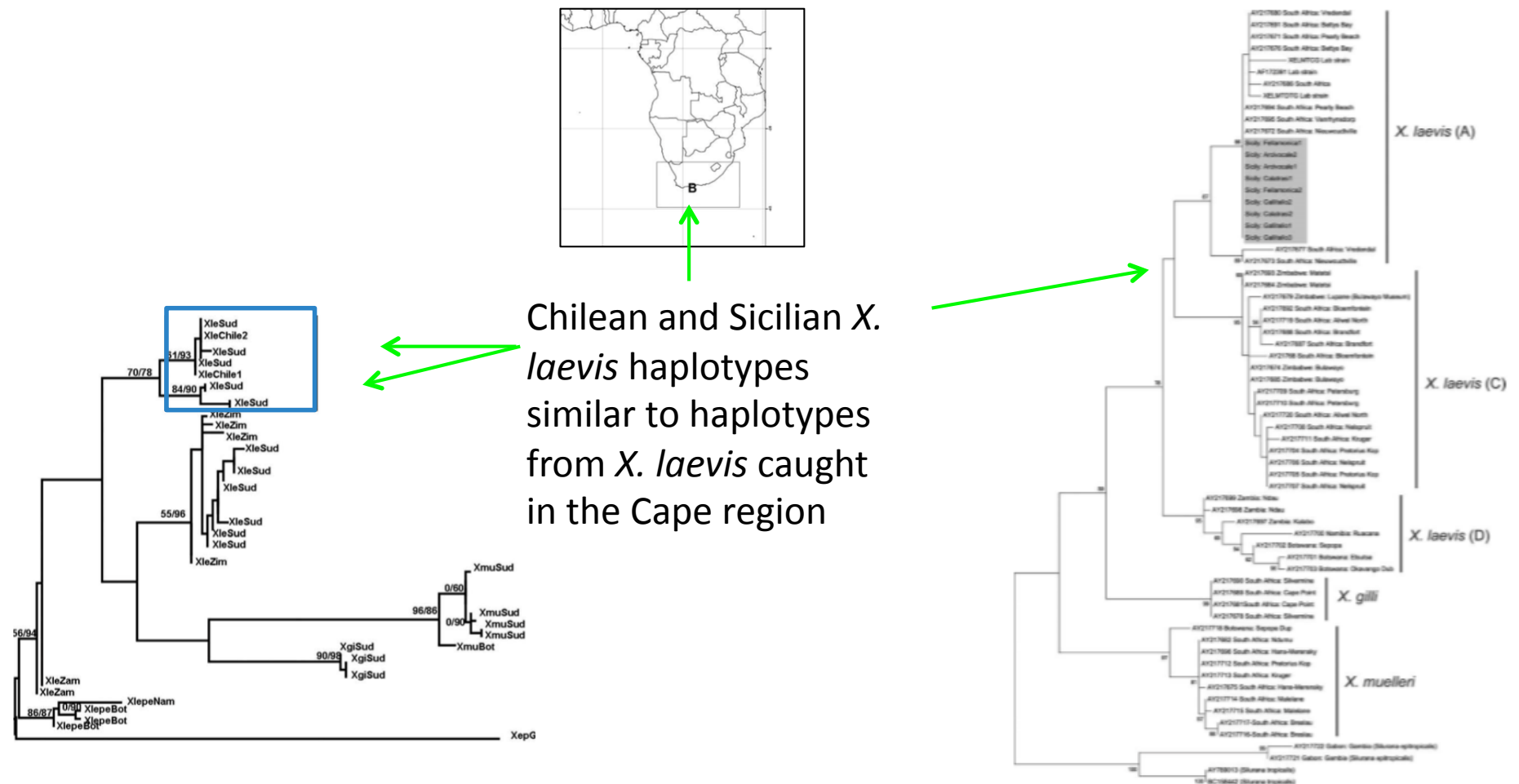


Workflow

-  Identification of putative origin populations
-  Assessing genetic relationships among European invasive and native populations
-> **mtDNA and nDNA**
-  Assessing genetic diversity and gene flow within European invasive populations
-> **Detection of SNP's with RadSeq (Baird *et al.* 2008)**



Putative origins of invasive clawed frogs





WP4 - biology of the invasive in its native range

1. Use monitoring, trapping and **mark-recapture** to document the **ability** of this domestic exotic species to **colonize novel water bodies**. Moreover we will quantify the **effects** of the arrival of *X. laevis* **on macro-invertebrates, other amphibians and fish**.
2. Using **landscape genetics** to determine **gene-flow** pathways and barriers across from the Mediterranean southwestern Cape, across the Cape Fold Mountains and into the Karoo desert. Distinct genetic lineages have already been uncovered in the Cape Fold Mountains, together with the suggestion that the spread of these is being facilitated by new **irrigation systems** for viticulture.
3. **Physiological and performance** traits of 5 populations of *X. laevis* will be measured incorporating those animals in recently expanding populations. CTmin and CTmax will be measured for adults, while CTmin, CTmax and LT50 will be determined for tadpoles. Desiccation tolerance will be measured. Aquatic burst speed and terrestrial exertion capacity will be measured at different temperatures and hydric states.



- 2 sites near Cape Town: 1441 *X. laevis* pit tagged; 388 + 432 *X. gilli* pit tagged
- Sundays river valley: 385 *X. laevis* tagged



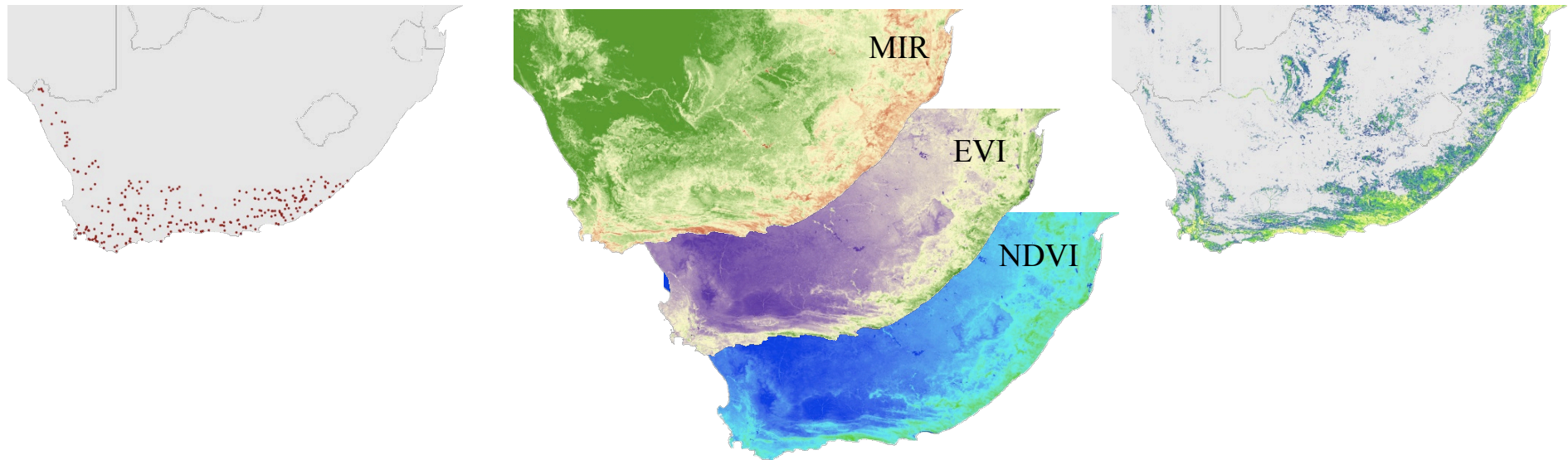
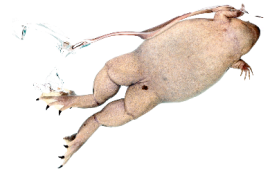


WP5 - invasive modeling

1. study **the adaptive potential** of environmental niches in *X. laevis* by **comparing** its **native** and **invasive realized niches** with the **fundamental niches** of the populations as quantified by **physiological performance** tests (CTmin, CTmax, locomotor performance). Such a comprehensive, multidisciplinary framework has been recently suggested to be best suited to study evolutionary scenarios of environmental adaptation.
2. relate these results with **population genetic information** likely providing novel insights in the genetic architecture of fundamental niche shifts
3. generate **predictive maps** indicating **the invasion potential** of *X. laevis*, which are much more advanced than pure correlative distribution model and incorporate in addition to physiological data also information on the dispersal capacity of the species. These maps can be directly used to guide further **mitigation measurements** for **controlling invasive** populations.



Assessing the potential distribution of *X. laevis*



Locality records + Environmental predictors = Correlative SDM





Year 1

WP1: monitor populations, capture animals, quantify diet and growth; eradication Portugal

WP2: capture animals from France, measure physiology

WP3: develop and test microsatellites

WP4: monitor populations, capture animals measure physiology

WP5: develop standard SDMs

Year 2

WP1: monitor populations, capture animals, quantify diet and growth; eradication Portugal

WP2: capture animals from Portugal, measure physiology

WP3: analyze gene flow for native populations

WP4: monitor populations, capture animals & quantify movement

WP5: run niche models

Year 3

WP1: quantify parasites & presence of chytridiomycosis

WP2: quantify mobility in the field (France & Portugal)

WP3: genetic structure and diversity of native and introduced pops.

WP4: migration potential and gene flow

WP5: run dispersal and gene flow models



Delivrables

D.01 develop microsatellite markers for *Xenopus* - month 12

D.02 correlative species distribution model for *Xenopus* in Europe at the landscape level - month 12

D.03 publish microsatellite data and geneflow estimates in invasive populations - month 18

D.04 publication of realized niche differentiation in native and invasive populations - month 24

D.05 publish on growth and life history in invasive populations - month 24

D.06 publish on ecological impacts of the species - month 30

D.07 publication of the physiological data in three peer-reviewed papers - month 30

D.08 publish fundamental niche models for *Xenopus* - month 30

D.09 publish data on genetic diversity in invasive and native populations - month 30

D.10 dispersal and gene flow models + publications - month 36

D.11 publish on parasites and presence of chytridiomycosis - month 36

D. 12 publish on the assessment of eradication efficacy - month 36 (Portugal, France & S-Africa)



Milestones

M.01 characterization of growth and life history in invasive and native populations - month 24

M.02 characterization of physiology in invasive and native populations - month 24

M.03 genetic diversity analysis of invasive and native populations - month 24

M.04 assessment of the efficacy of the eradication program in Portugal - month 24

M.05 quantification of realized niche differentiation in native and invasive populations - month 24

M.06 mobility and movement patterns in invasive and native populations - month 30

M.07 comparisons of genetic structure, fundamental and realized niches of native and invasive populations - month 30

M.08 quantify presence of parasites and chytridiomycosis in invasive populations - month 36



Outreach & stakeholders:

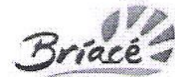
Programme des 5^e rencontres naturalistes des Pays de la Loire

Samedi 23 et dimanche 24 novembre 2013

Lycée Briacé – Le Landreau (44)



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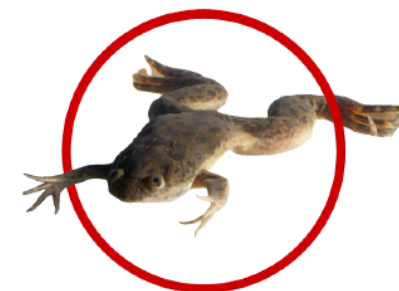


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