Global change and aquatic ecosystems: An opportunity to combine fundamental and applied researches

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cnrs
dépasser les frontières






AS MOST ECOSYSTEMS,
FRESHWATERS ARE IMPACTED BY MULTIPLE STRESSES

GLOBAL CHANGE

↓

IMPACTS ON BIODIVERSITY
(negative or positive)

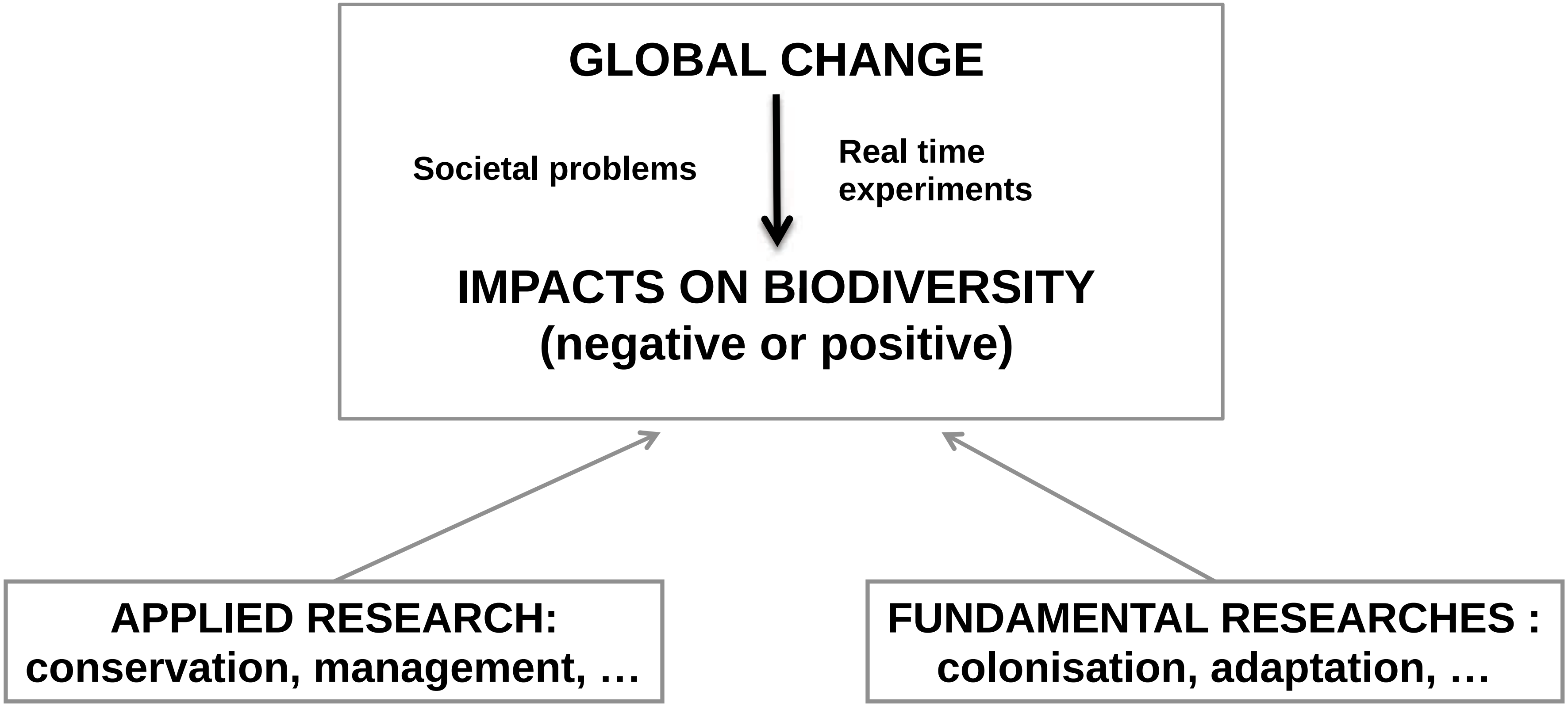
GLOBAL CHANGE

Societal problems

IMPACTS ON BIODIVERSITY
(negative or positive)

APPLIED RESEARCH:
conservation, management, …

GLOBAL CHANGE AND AQUATIC ECOSYSTEMS



GLOBAL CHANGE

Societal problems

Real time experiments

IMPACTS ON BIODIVERSITY (negative or positive)

APPLIED RESEARCH: conservation, management, …

FUNDAMENTAL RESEARCHES : colonisation, adaptation, …

A UNIQUE FRAMEWORK TO COMBINE APPLIED AND FUNDAMENTAL RESEARCHES

Two research axes

Ecology and evolution of host-parasite interactions
Biological invasions

Intraspecific diversity in river networks
Conservation and habitat fragmentation

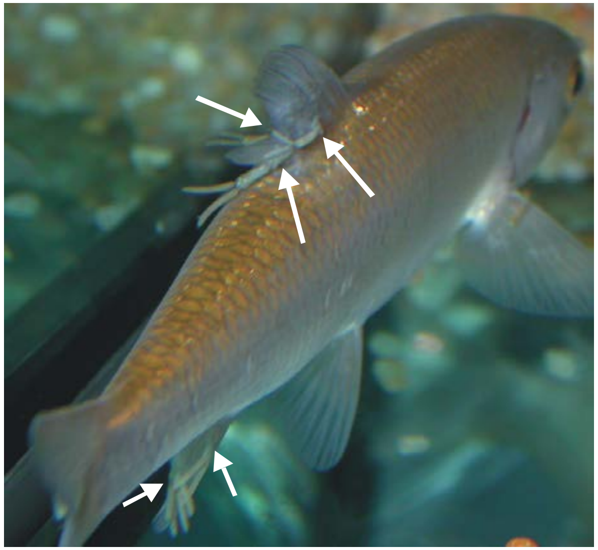
Both applied and fundamental questions
Molecular tools, empirical surveys, simulations, experiments

1) PATHWAYS OF INVASION FOR A NEGLECTED PARASITE

2) ENVIRONMENTAL AND GENETIC BASES OF HOST DEFENSES

3) GENOMIC BASES OF HOST DEFENSES

THE TRACHELIASTES-DACE INTERACTIONS:

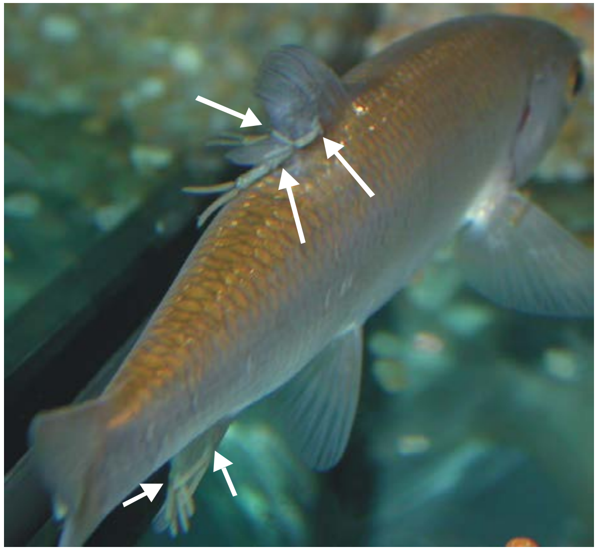


Dace (***Leuciscus sp***)

Copepod (***Tracheliastes polycolpus***)

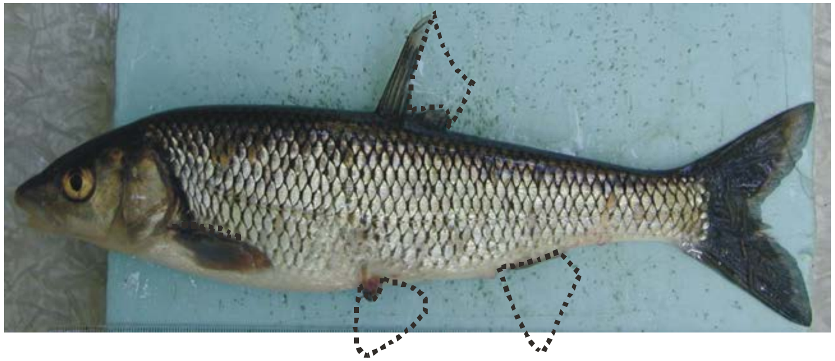
Loot et al. Parasitol. Res., 2004

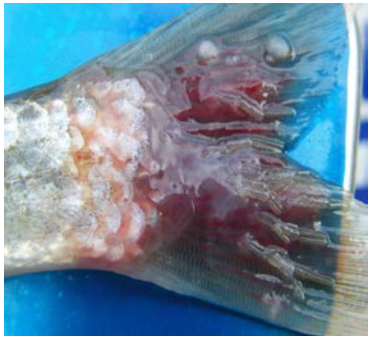
THE TRACHELIASTES-DACE INTERACTIONS:



Dace (***Leuciscus sp***)

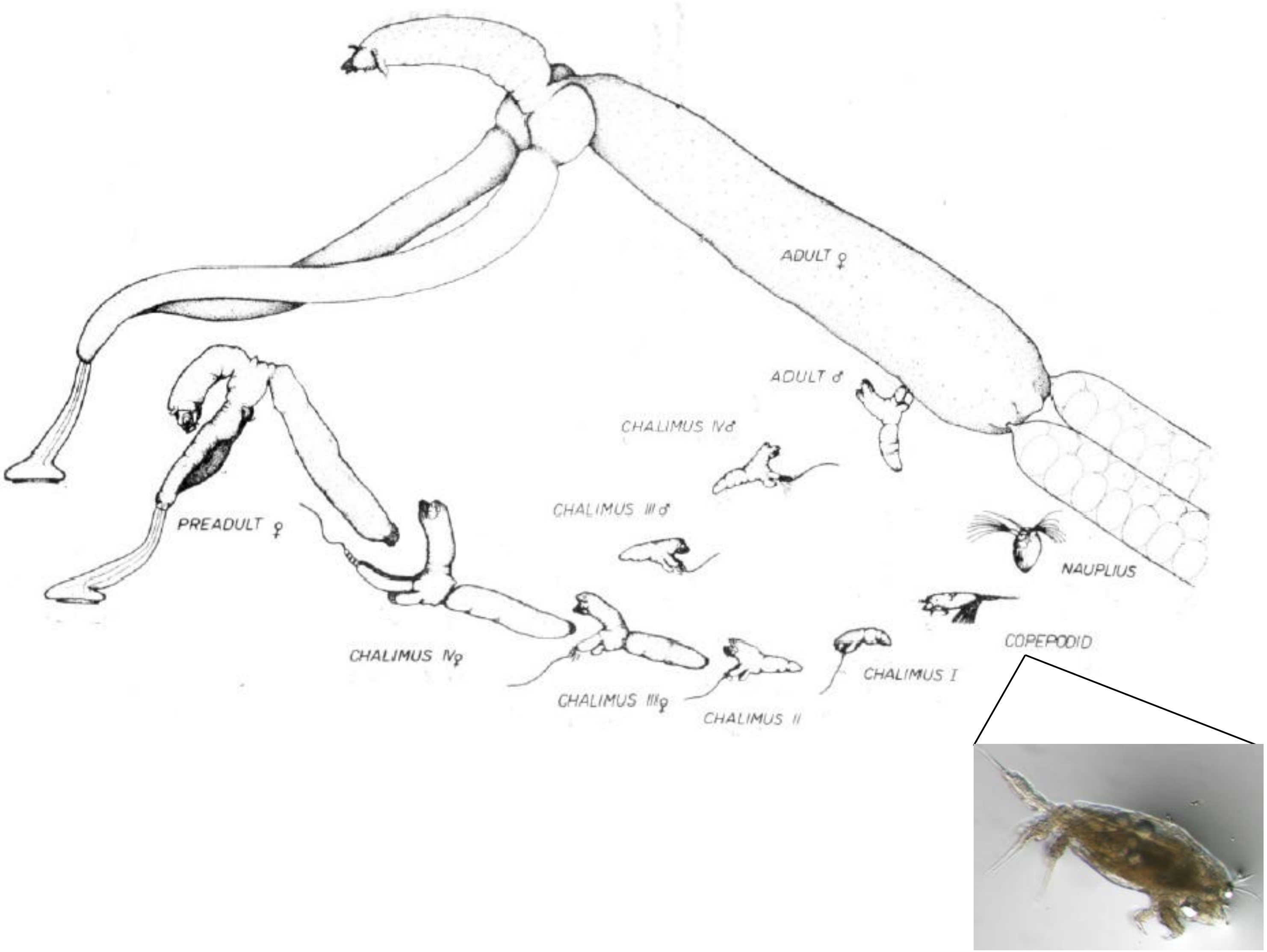
Copepoe (***Tracheliastes polycolpus***)





Loot et al. Parasitol. Res., 2004

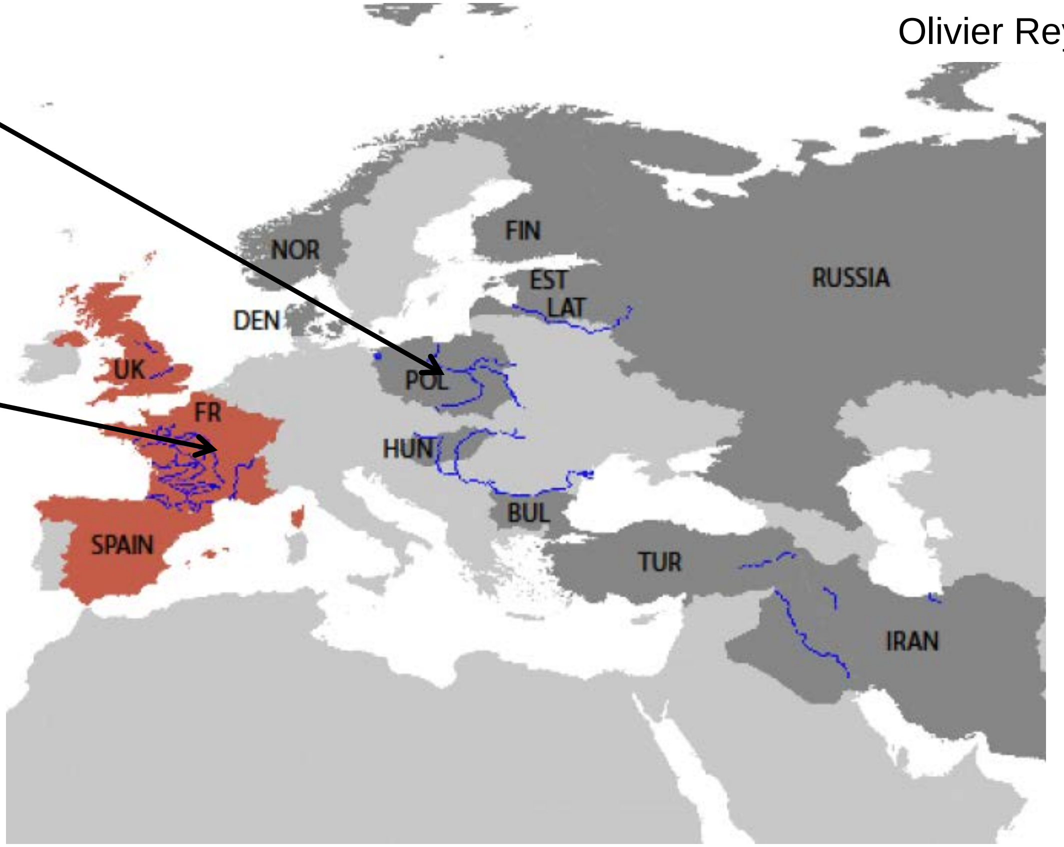
LIFE CYCLE (DIRECT CYCLE, A SINGLE HOST SPECIES):



- **Widespread in the North-Eastern part of the Paelarctic**
- **Detected since the 1930' in the UK, the 1960' in France**

Olivier Rey

Lisa Fourtune

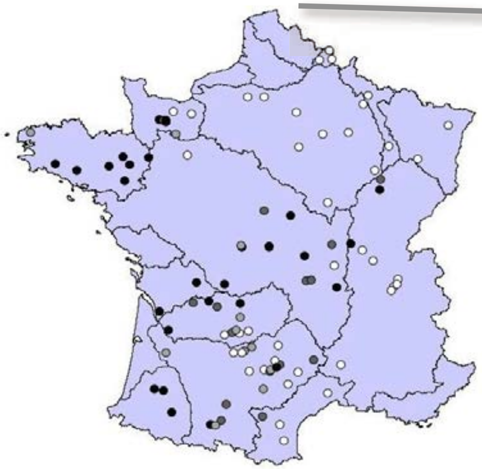


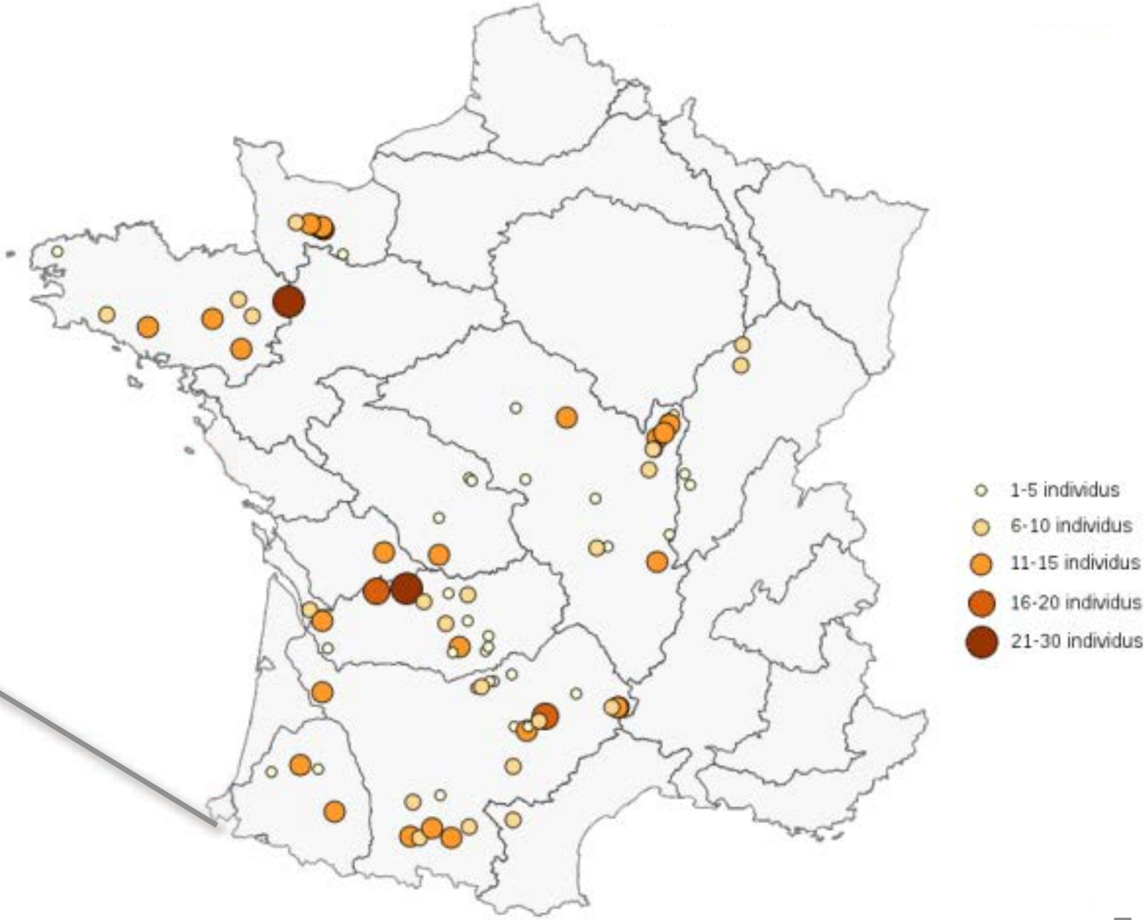
Is *T. polycolpus* a non-native species *in* France?
What is its invasion history? (potential sources are unknown)

Rey et al. Mol Ecol. 2015

(I) PATHWAYS OF INVASION

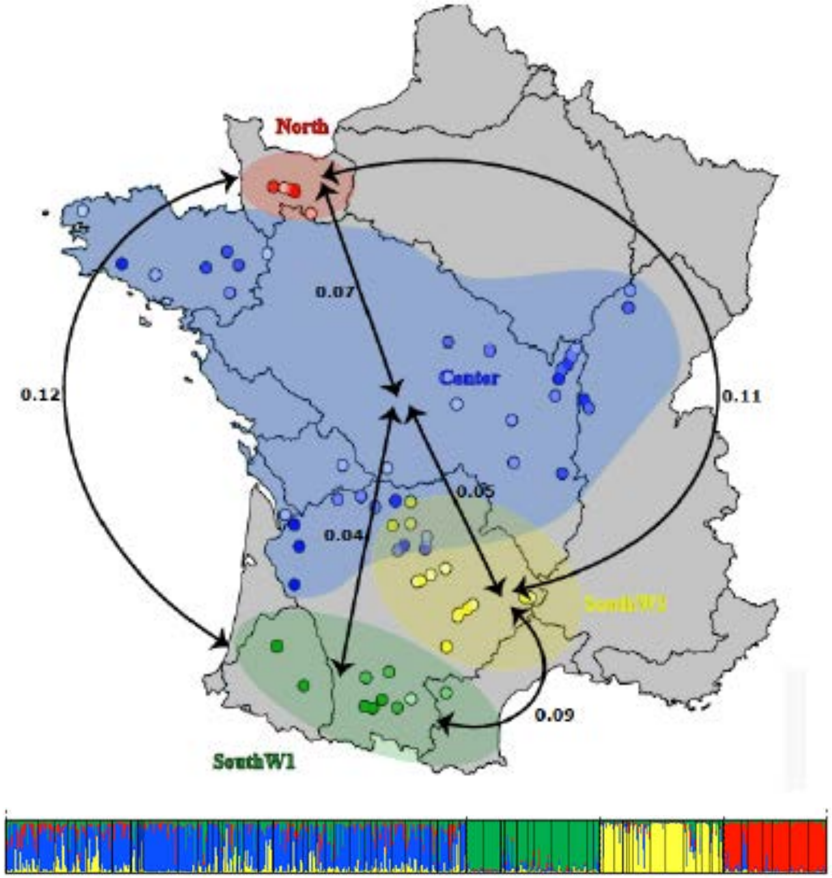
SAMPLING ACROSS FRANCE:
673 individuals, 86 sites, 61 rivers, 16 microsatellite loci





Rey et al. Mol Ecol. 2015

FOUR MAIN GENETIC CLUSTERS *(Structure, Pritchard et al. 2000)*



<u>Two possible types of scenarios</u>:

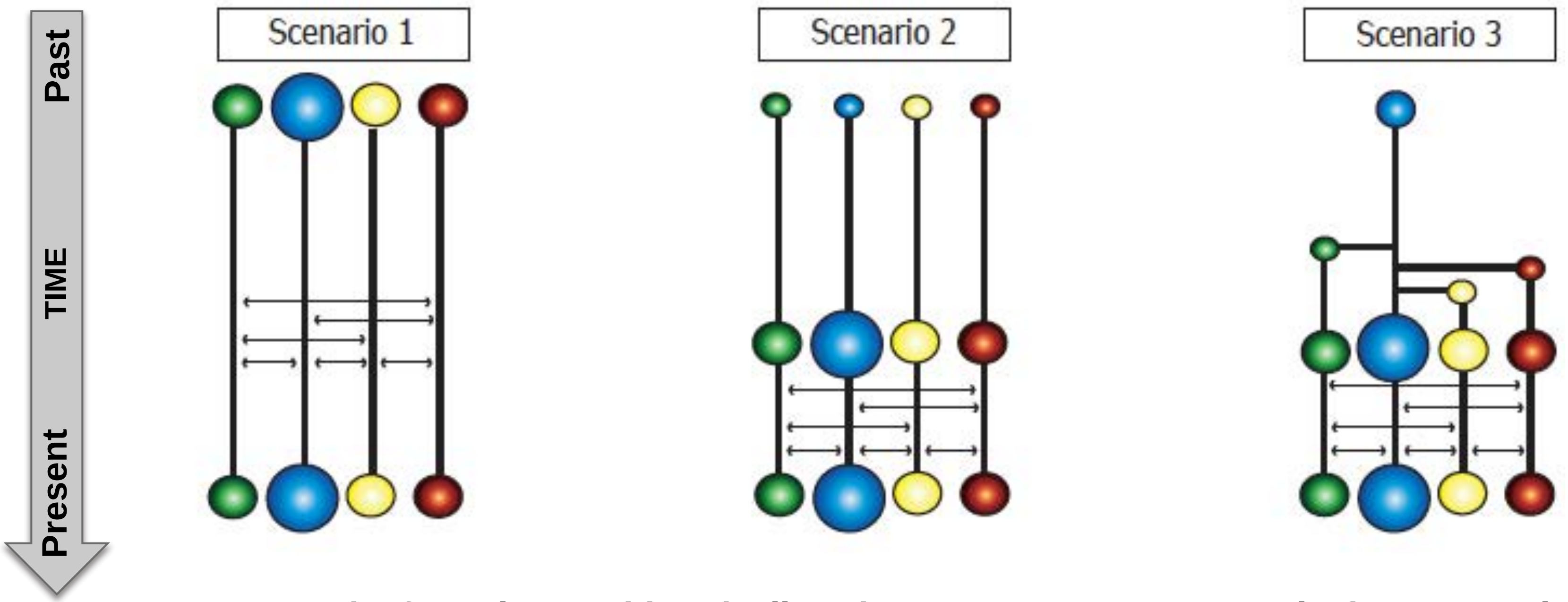
« Native» : historical presence in france, recent expansion

« Non-native » : introduction and recent expansion

Rey et al. Mol Ecol. 2015

(I) PATHWAYS OF INVASION

Native scenarios: 3 models

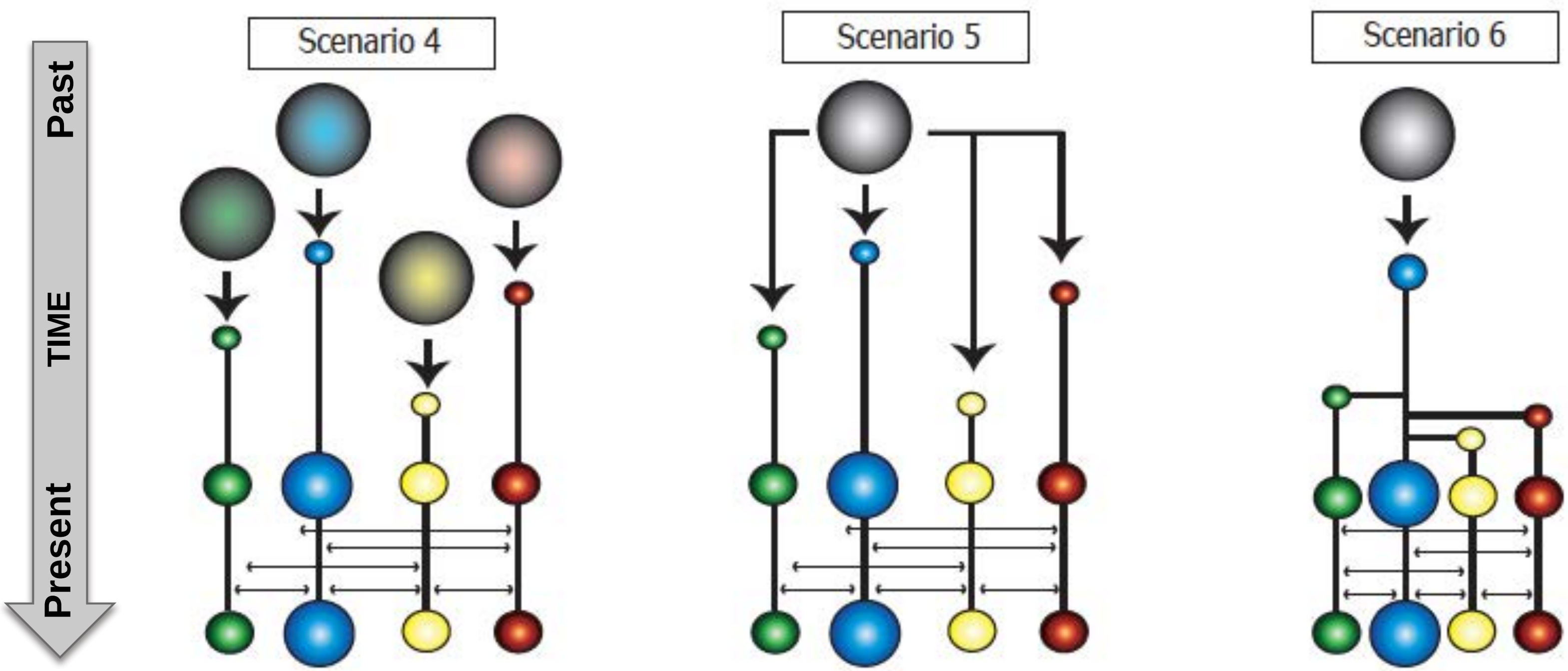


The four clusters historically exist
***Tracheliastes* discovered only recently**
Stabilité (S1) vs. exponential growth (S2)

Only the Center cluster historically exists
Recent colonisation of new basins

Rey et al. Mol Ecol. 2015

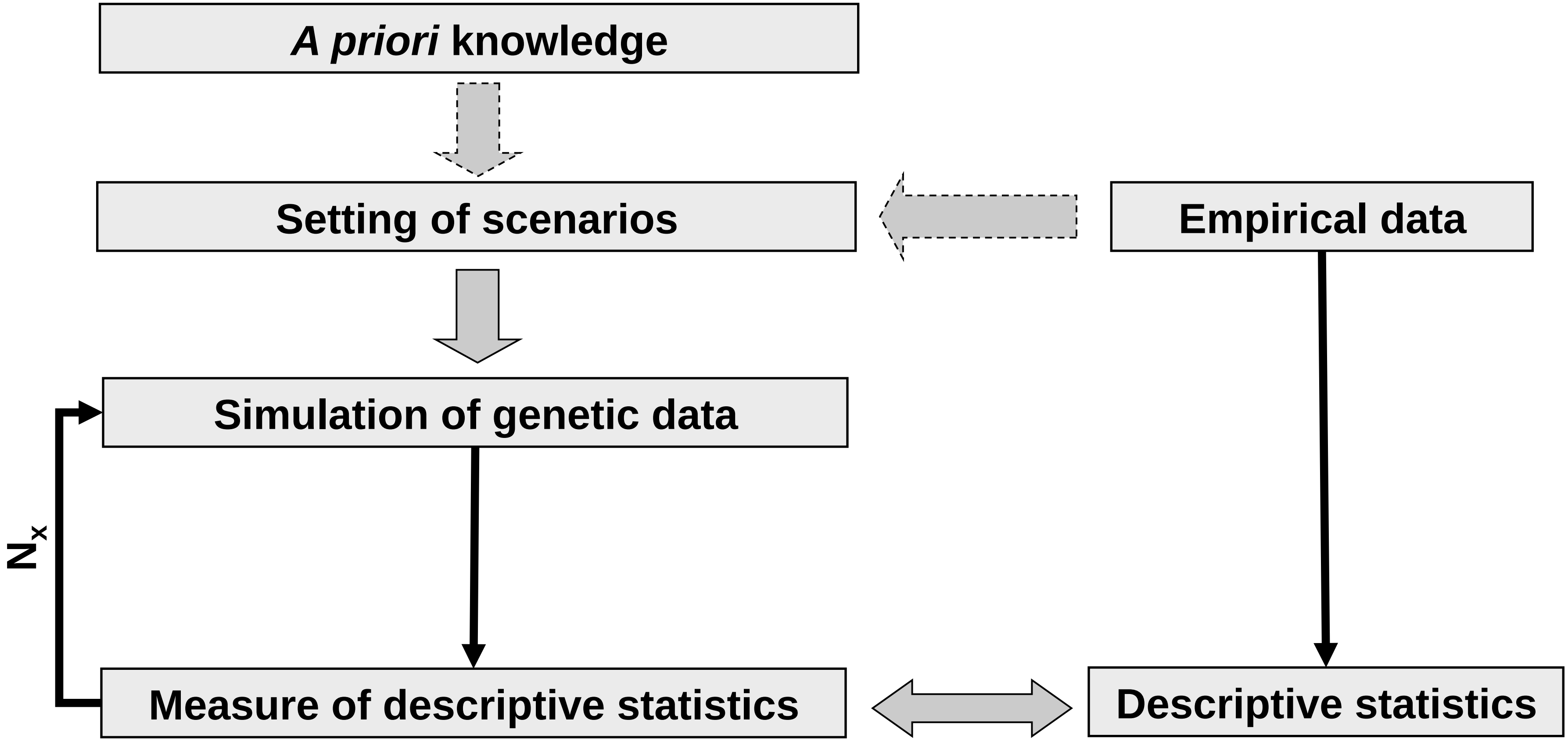
Non-native scenarios: 3 models



Four sources Asynchronous colonisation	A single source Multiple colonisation	A single source Center first invaded

Rey et al. Mol Ecol. 2015

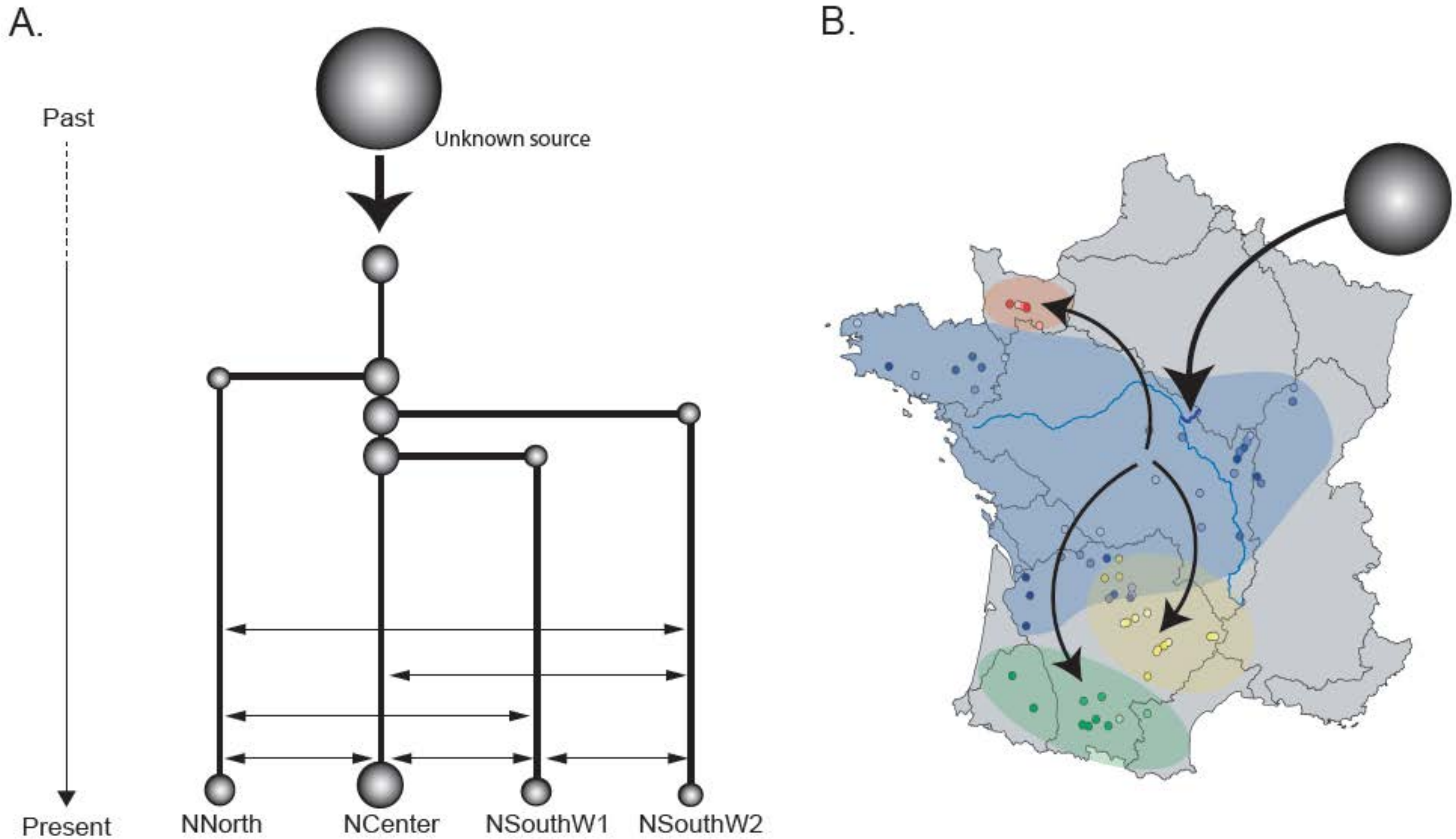
SIMULATION AND MODEL COMPARISON: « ABC » APPROACH



D
distance between the sets of statistics:
the lower is the better

Rey et al. Mol Ecol. 2015

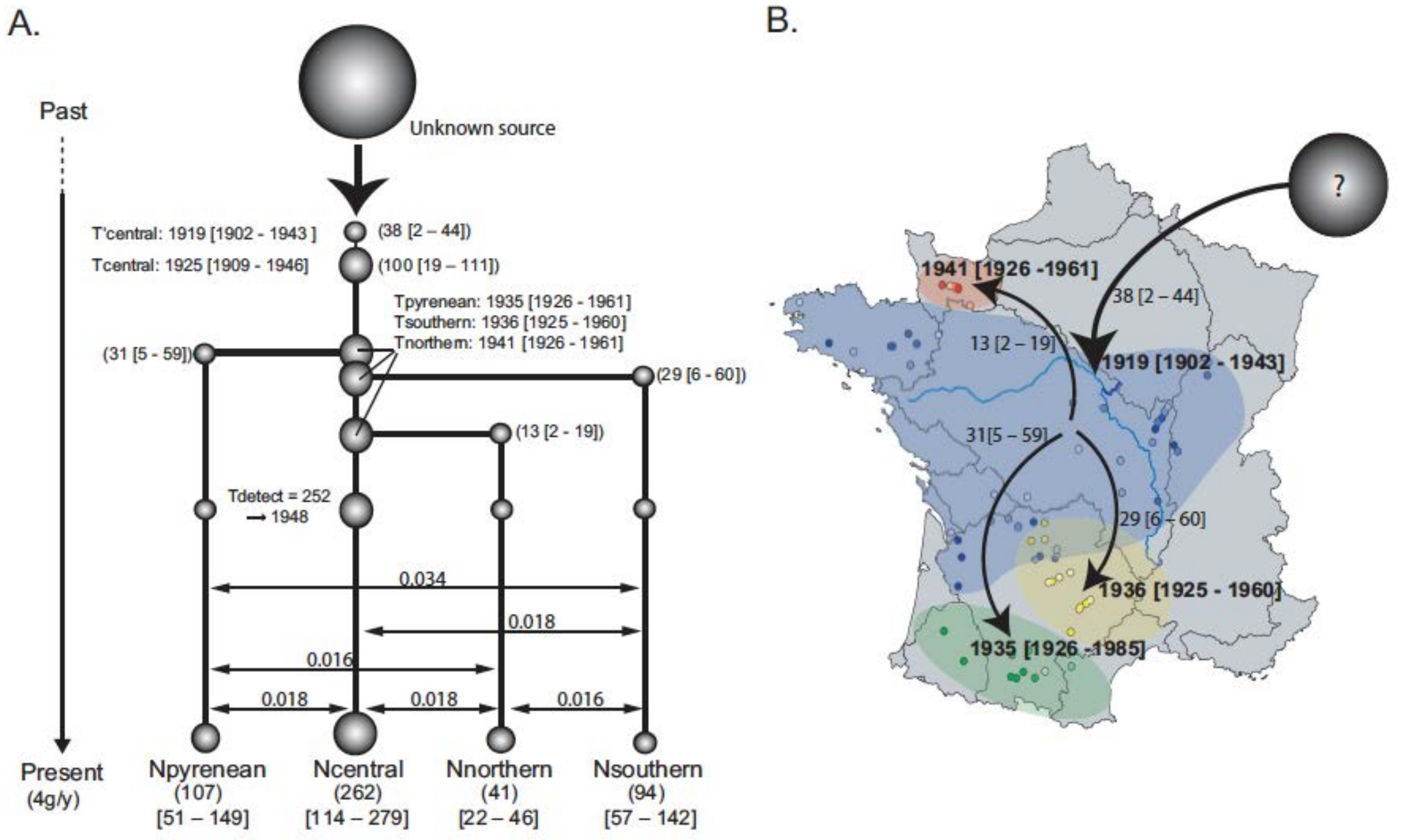
→ One of the « non-native » scenario is most likely:



Tracheliastes has been introduced in Center France in the Loire river from a single unknown source, then spread to other river basins

Rey et al. Mol Ecol. 2015

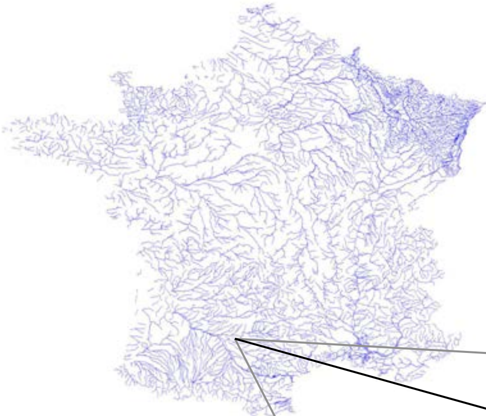
→ Further simulations are ran to infer key parameter values:

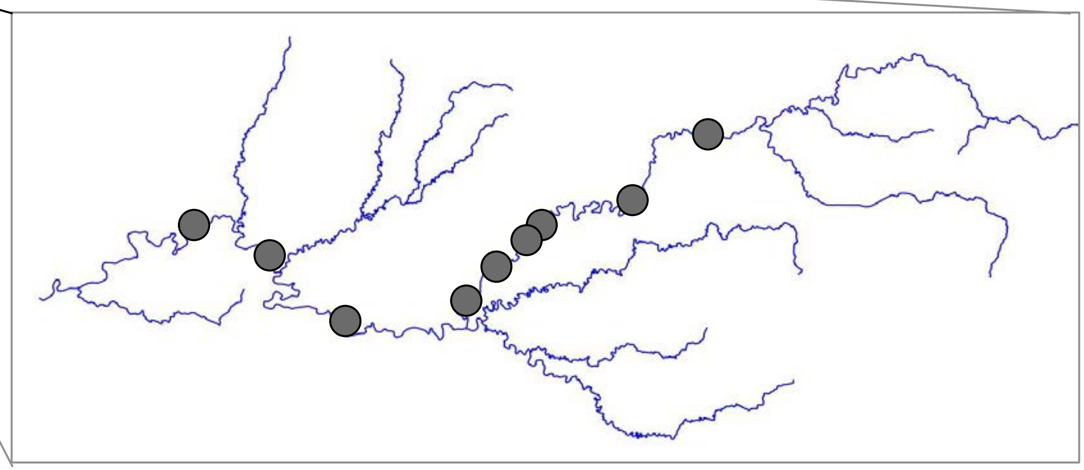


Tracheliastes first arrived in the 1920's (observed in the UK in 1930) from a few numbers of founders (20). It quickly colonised other river basins, i.e. 15 years later.

Rey et al. Mol Ecol. 2015

LONG-TERM SURVEY ON NATURAL POPULATIONS: VIAUR AND CÉLÉ RIVERS

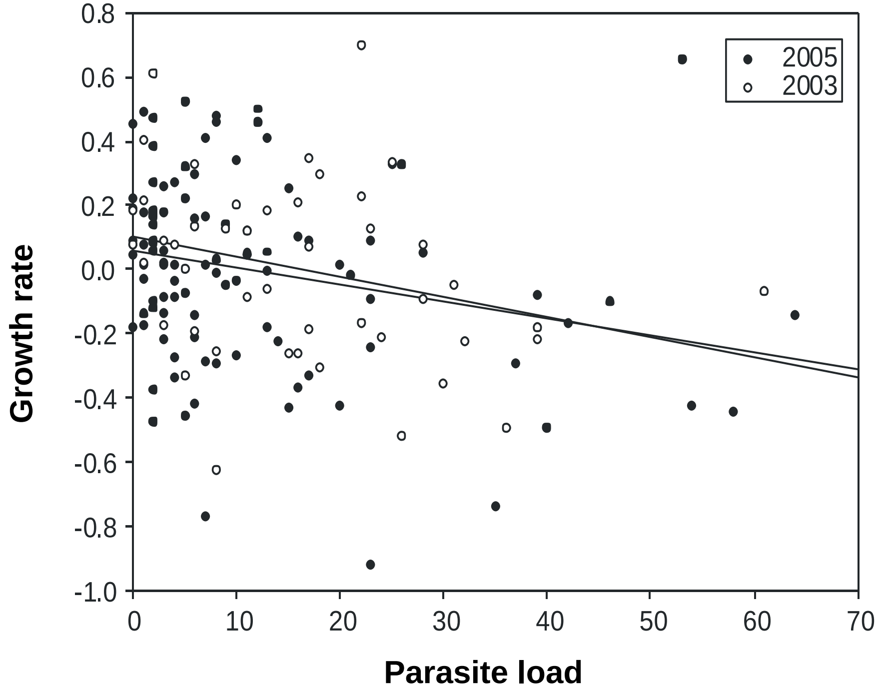




8 sampling sites from 2003 to 2018 x 2 rivers:
Tissue samples– biometry – parasitic indices

Blanchet et al. Oecologia, 2009; Trends Parasitol, 2009

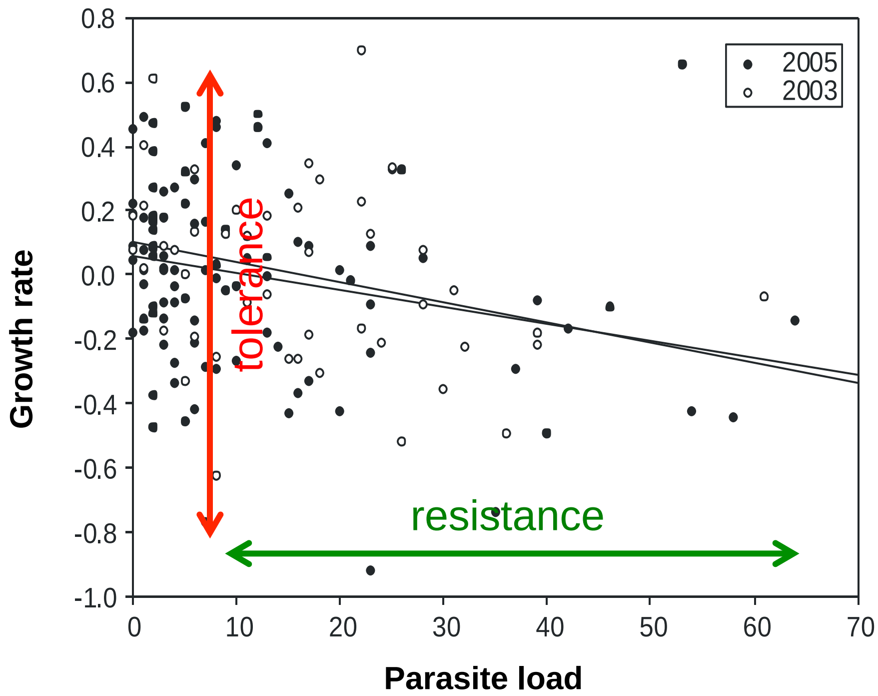
LONG-TERM SURVEY ON NATURAL POPULATIONS: VIAUR AND CÉLÉ RIVERS



- **The parasite affects the dace individual fitness (evidences for population effects – selective mortality)**

Blanchet et al. Oecologia, 2009; Trends Parasitol, 2009

LONG-TERM SURVEY ON NATURAL POPULATIONS: VIAUR AND CÉLÉ RIVERS



- The parasite affects the dace individual fitness (evidences for population effects – selective mortality)

- Large inter-individual variance in terms of resistance and tolerance to the parasite

Blanchet et al. Oecologia, 2009; Trends Parasitol, 2009

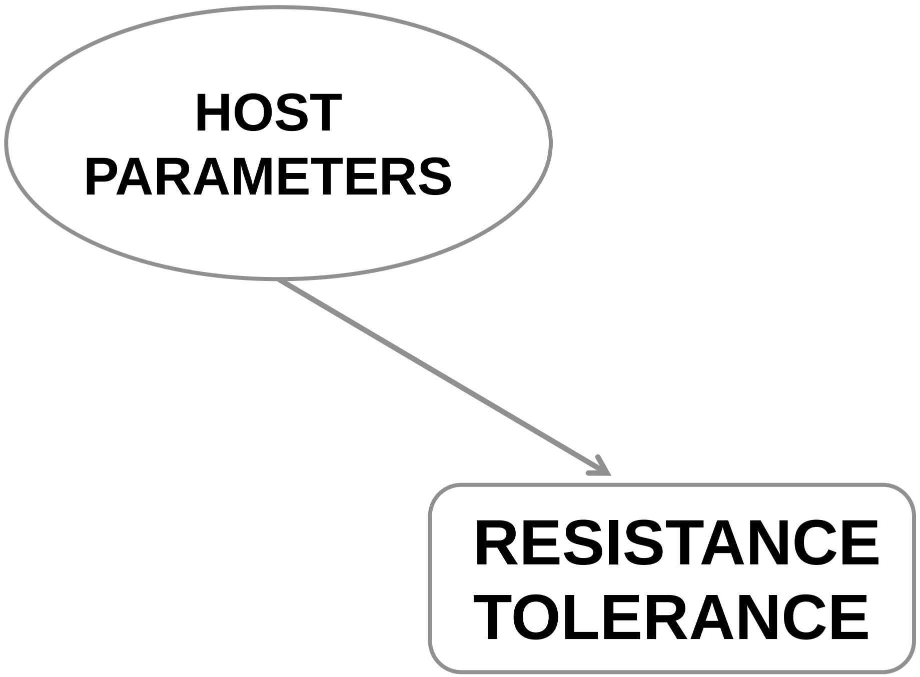
GENETIC AND ENVIRONMENTAL BASES

Maxime Cardon

Cardon et al. J Anim Ecol, 2011

(III) RESISTANCE AND TOLERANCE

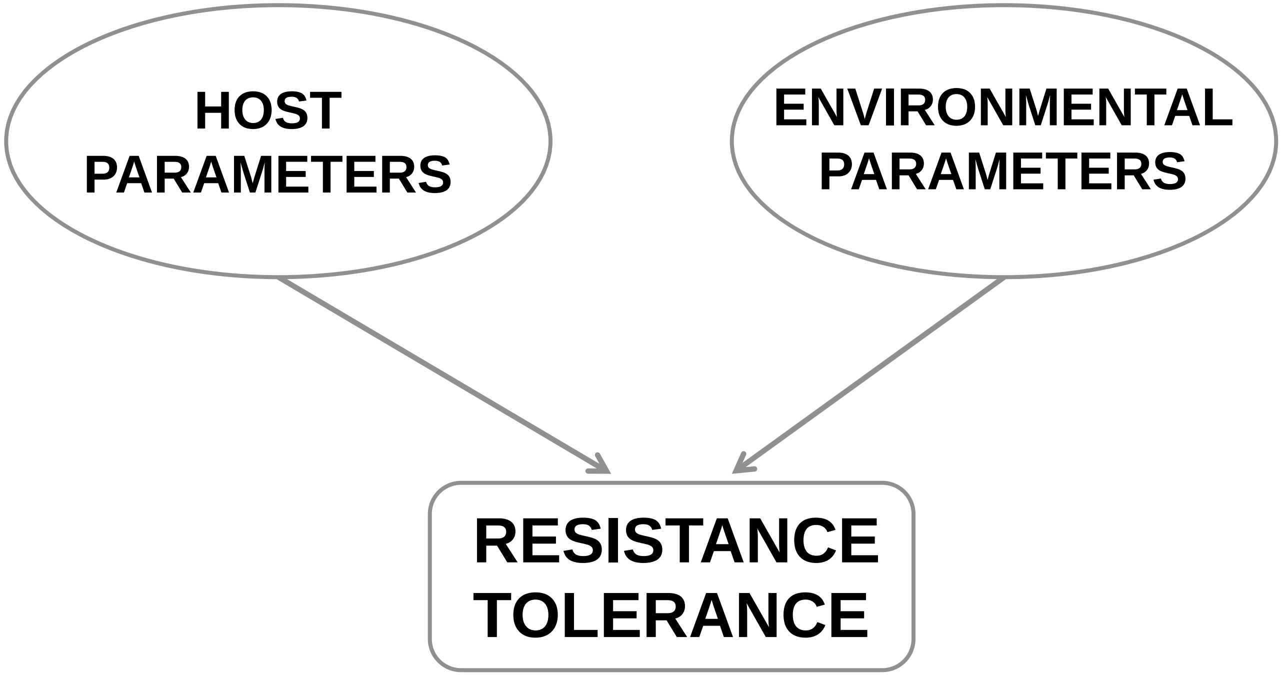
GENETIC AND ENVIRONMENTAL BASES



1) “HOST” MODEL

Cardon et al. J Anim Ecol, 2011

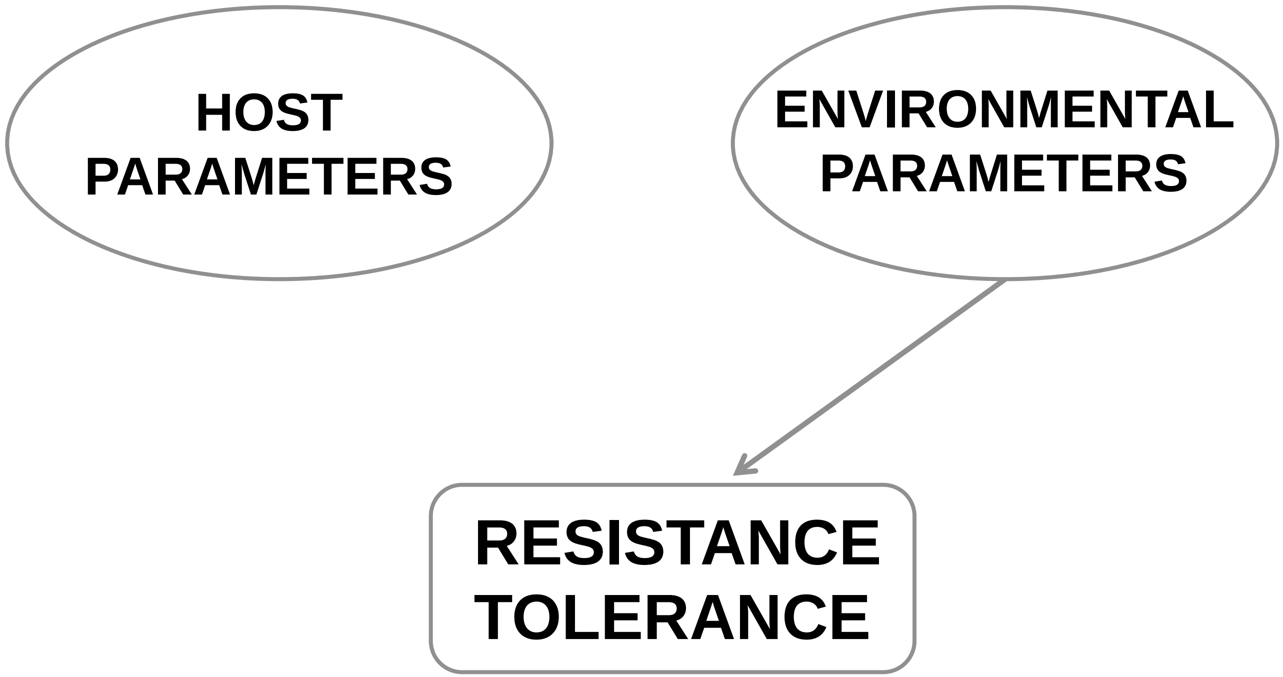
GENETIC AND ENVIRONMENTAL BASES



1) “HOST” MODEL
2) “HOST – ENVIRONMENT” MODEL

Cardon et al. J Anim Ecol, 2011

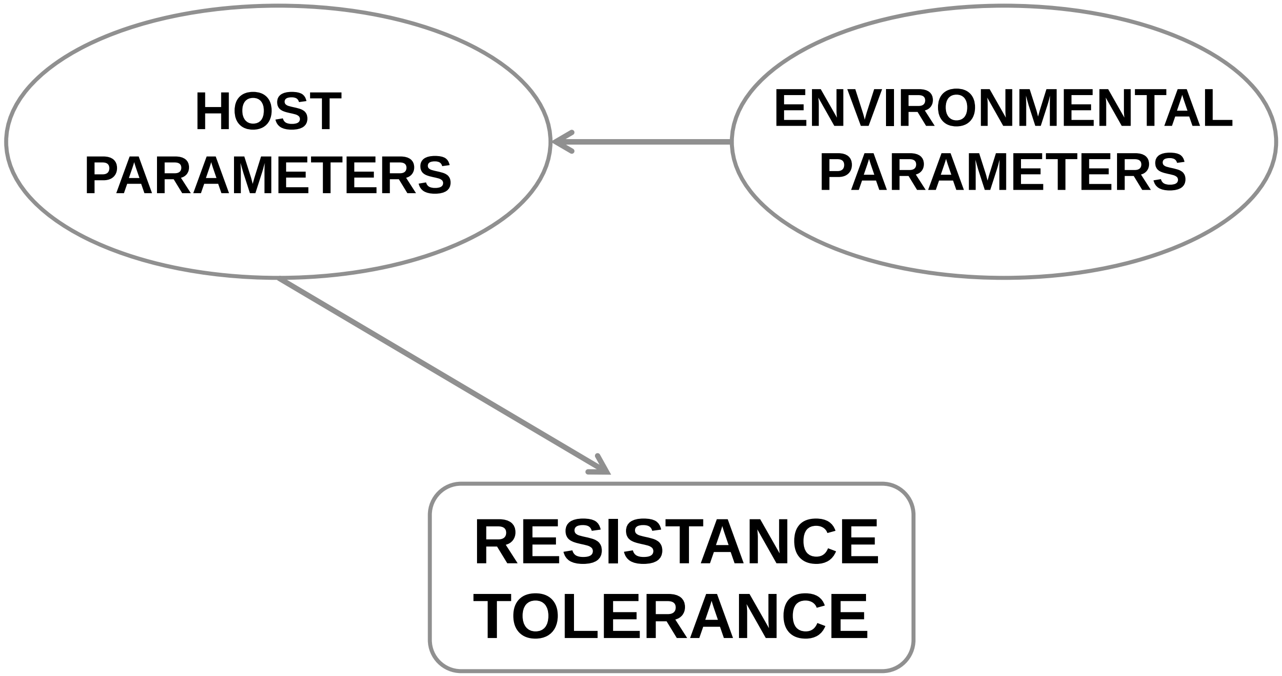
GENETIC AND ENVIRONMENTAL BASES



1) “HOST” MODEL
2) “HOST – ENVIRONMENT” MODEL
3) “DIRECT ENVIRONMENT” MODEL

Cardon et al. J Anim Ecol, 2011

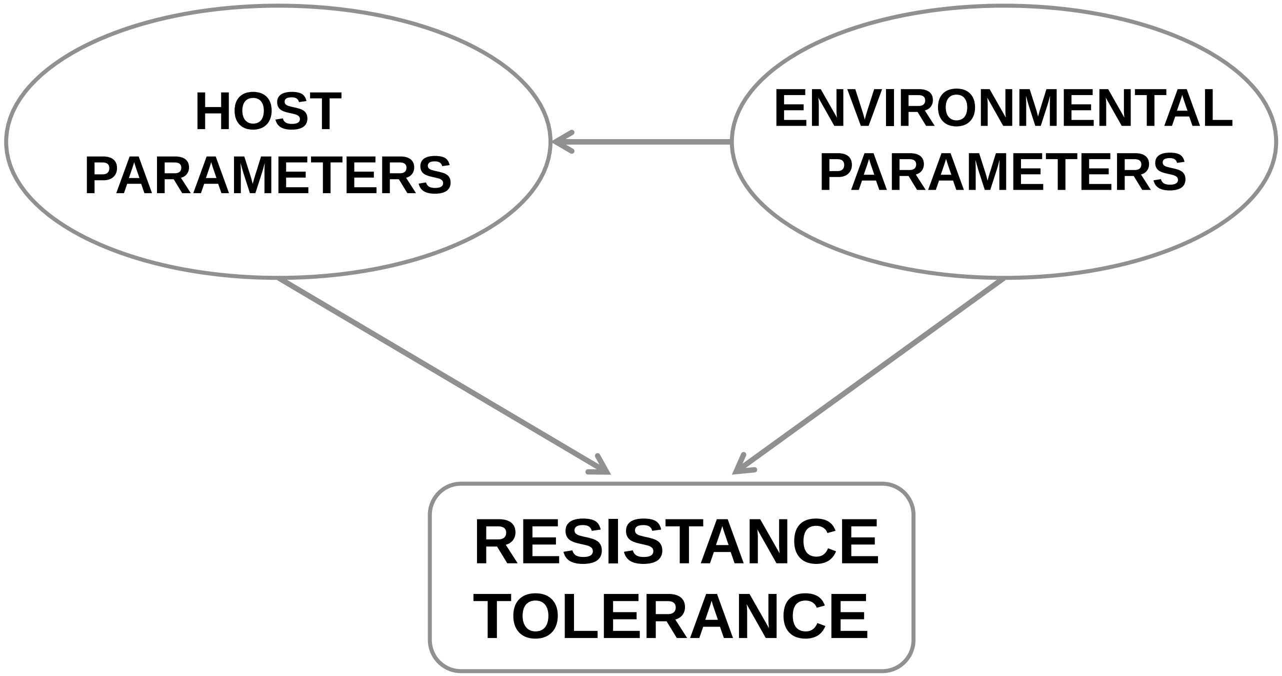
GENETIC AND ENVIRONMENTAL BASES



1) "HOST" MODEL
2) "HOST – ENVIRONMENT" MODEL
3) "DIRECT ENVIRONMENT" MODEL
4) "INDIRECT ENVIRONMENT" MODEL

Cardon et al. J Anim Ecol, 2011

GENETIC AND ENVIRONMENTAL BASES



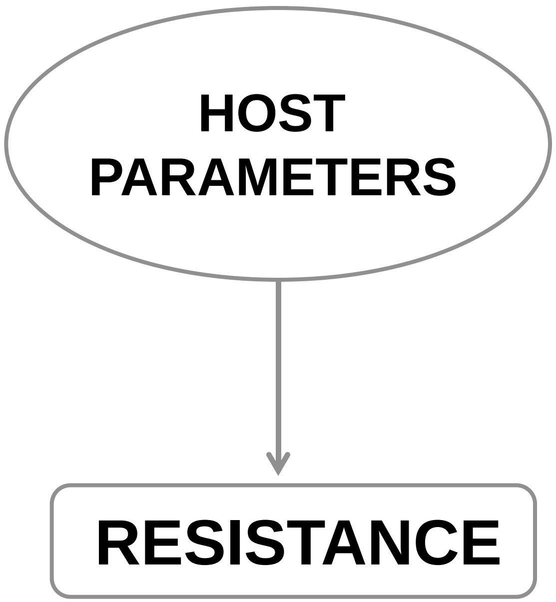
1) "HOST" MODEL
2) "HOST – ENVIRONMENT" MODEL
3) "DIRECT ENVIRONMENT" MODEL
4) "INDIRECT ENVIRONMENT" MODEL
5) "HOST – DIRECT + INDIRECT ENVIRONMENT" MODEL

SEM + AIC

Cardon et al. J Anim Ecol, 2011

GENETIC AND ENVIRONMENTAL BASES

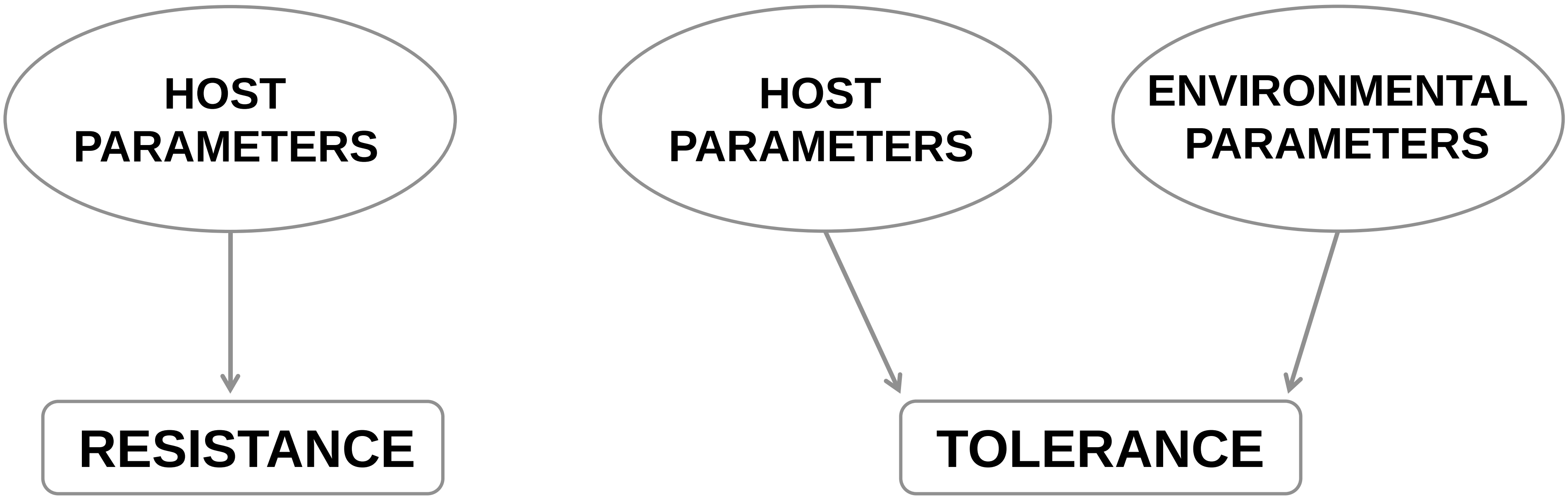
“HOST” MODELS



Cardon et al. J Anim Ecol, 2011

GENETIC AND ENVIRONMENTAL BASES

"HOST" MODELS "HOST + ENVIRONMENT" MODELS



- ENVIRONMENTAL BASES FOR TOLERANCE (thermal regime)
- GENETIC BASES FOR BOTH RESISTANCE AND TOLERANCE?

Cardon et al. J Anim Ecol, 2011

GENETIC BASES (HERITABLE)

Elise Mazé

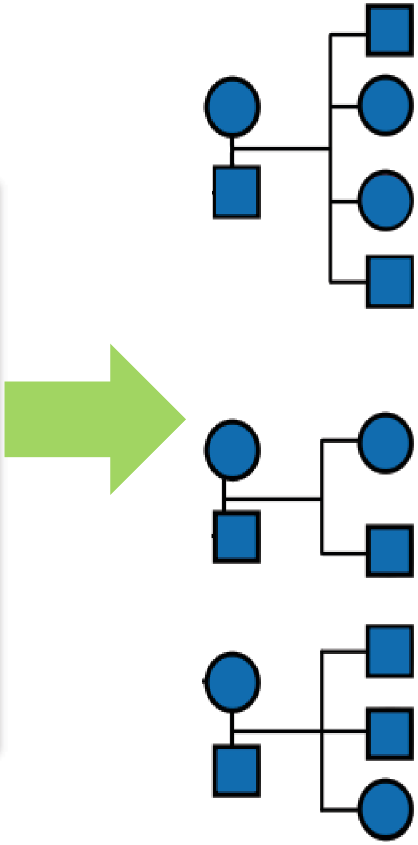
Molecular data => inferring the parental links (pedigrees)

PEDIGREE - JOBS

(Cnrs - Maze)

Please note: your jobs will be held for 365 days. Past this delay, they will be erased. Learn how you can save jobs for later replay.

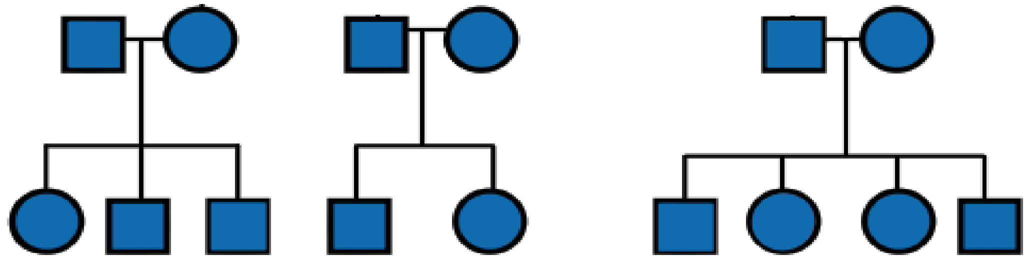
Job Name	Date	Status	Commands
2012-2-14_11_15_4720locus	Thu May 31 15:26:30 2012	100.0% done in 168. mn	View details Delete
2012-2-17_15_15_0813marqueurs	Thu May 31 15:26:31 2012	100.0% done in 162. mn	View details Delete
2012-2-24_16_23_15globalbis	Thu May 31 15:26:32 2012	100.0% done in 5085. mn	View details Delete
2012-2-24_16_26_110markeur	Thu May 31 15:26:48 2012	100.0% done in 989. mn	View details Delete
2012-2-28_12_36_25global12loc	Thu May 31 15:26:50 2012	100.0% done in 329. mn	View details Delete
2012-2-28_12_37_43	Thu May 31 15:26:54 2012	100.0% done in 327. mn	View details Delete
2012-2-28_18_06_49globalrebis	Thu May 31 15:26:58 2012	100.0% done in 838. mn	View details Delete
2012-2-8_12_52_54	Thu May 31 15:27:07 2012	100.0% done in 195. mn	View details Delete
2012-3-14_10_12_23noFSC-W5	Thu May 31 15:27:09 2012	100.0% done (now in run 10, 0. mn to go)	View details Delete
2012-3-15_13_00_44	Thu May 31 15:27:13 2012	100.0% done (now in run 10, 0. mn to go)	View details Delete
2012-3-15_13_02_12restart-FSC vers noFSC	Thu May 31 15:27:17 2012	100.0% done (now in run 10, 0. mn to go)	View details Delete
2012-3-1_10_32_56globalFSC	Thu May 31 15:27:22 2012	100.0% done in 1018. mn	View details Delete
2012-3-1_10_37_01global-noFSC	Thu May 31 15:27:30 2012	100.0% done in 753. mn	View details Delete
2012-3-1_17_58_39weigth	Thu May 31 15:27:35 2012	100.0% done in 1021. mn	View details Delete
2012-3-2_16_09_58W5-FSC-restart-temp	Thu May 31 15:28:01 2012	100.0% done (now in run 10, 0. mn to go)	View details Delete
2012-3-2_16_11_55W10-FSC-restart-temp	Thu May 31 15:28:09 2012	100.0% done (now in run 10, 0. mn to go)	View details Delete



~ 250 FULL-SIB FAMILIES (2-4 INDIV / FAM)

Maze-Guilmo et al. PRSLB 2014

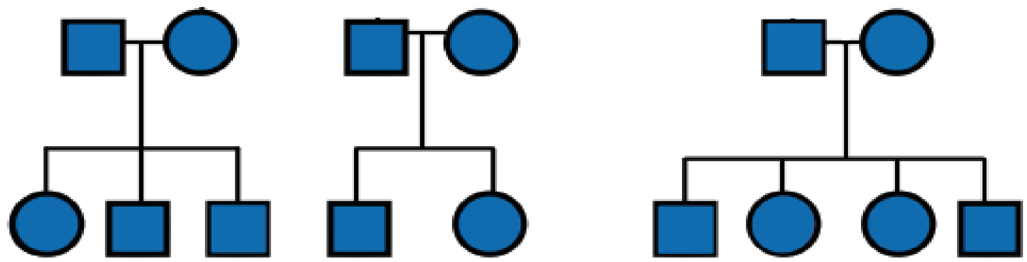
GENETIC BASES (HERITABLE)



RESISTANCE	1	2	1	10	14	7	5	3	6
TOLERANCE	9	6	7	3	5	2	6	6	9

Maze-Guilmo et al. PRSLB 2014

GENETIC BASES (HERITABLE)



RESISTANCE	1	2	1	10	14	7	5	3	6
TOLERANCE	9	6	7	3	5	2	6	6	9

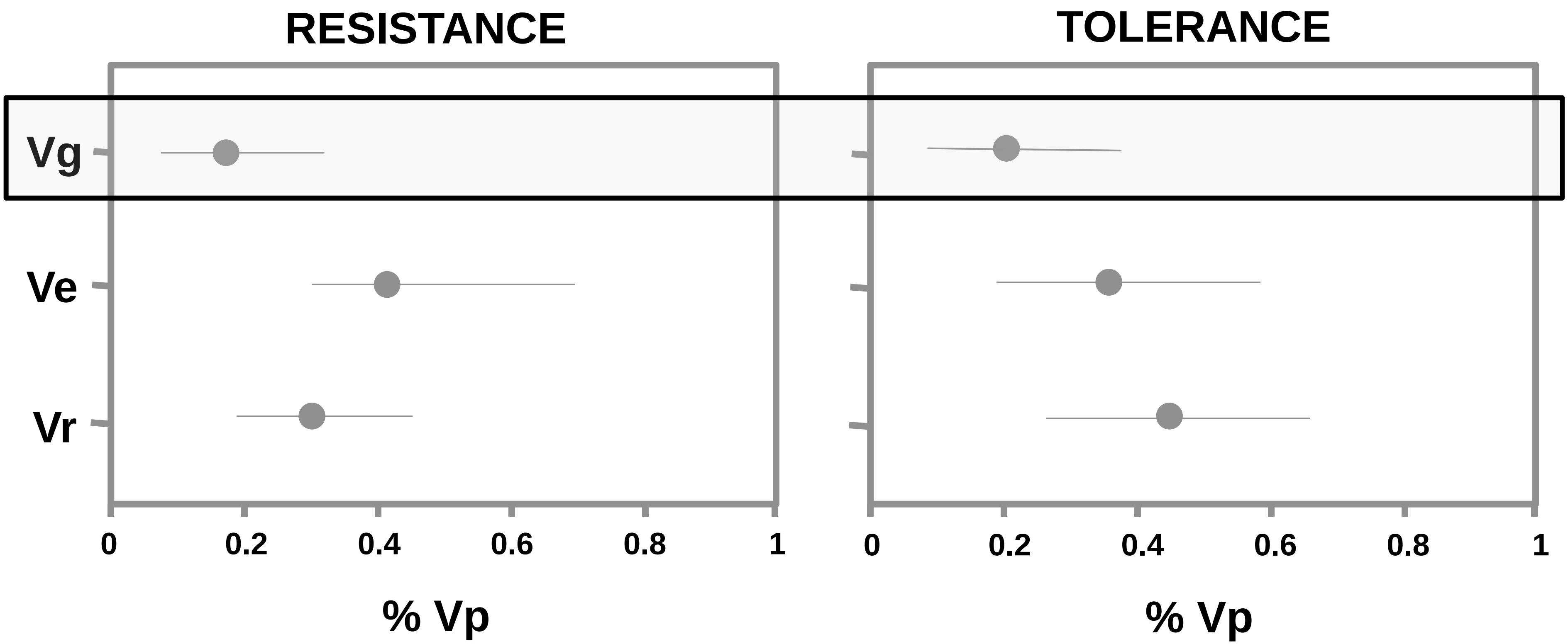
"ANIMAL MODELS" :

$$Vp = Vg + Ve + Vr$$

$$\Rightarrow H^2 = Vg / Vp$$

Maze-Guilmo et al. PRSLB 2014

(III) RESISTANCE AND TOLERANCE



- SIGNIFICANT HERITABILITY VALUES FOR BOTH TRAITS
- GENETIC BASES FOR BOTH DEFENSIVE TRAITS
- BASES FOR HOST ADAPTATION TO THIS NEW SELECTIVE PRESSURE

Maze-Guilmo et al. PRSLB 2014

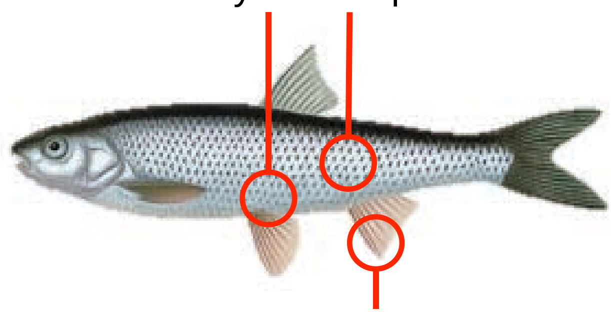
GOING INTO THE PHYSIOLOGICAL PATHWAYS OF RESISTANCE

Eglantine
Mathieu-Bégné

GOING INTO THE PHYSIOLOGICAL PATHWAYS OF RESISTANCE

4 healthy *vs.*
4 parasitized

kidney spleen



fin

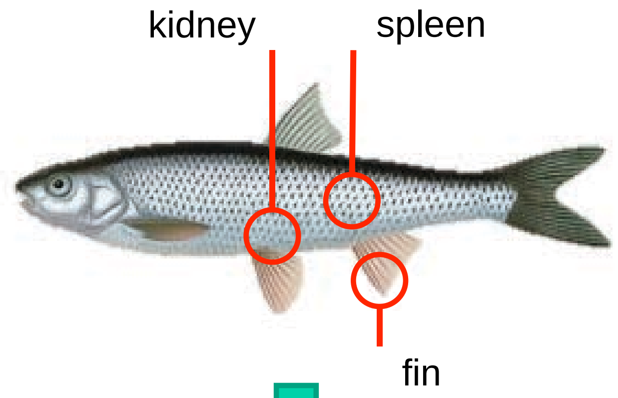
RNA-seq

Gene expression profile
Biological functions

Eglantine
Mathieu-Bégné

GOING INTO THE PHYSIOLOGICAL PATHWAYS OF RESISTANCE

4 healthy *vs.*
4 parasitized



RNA-seq

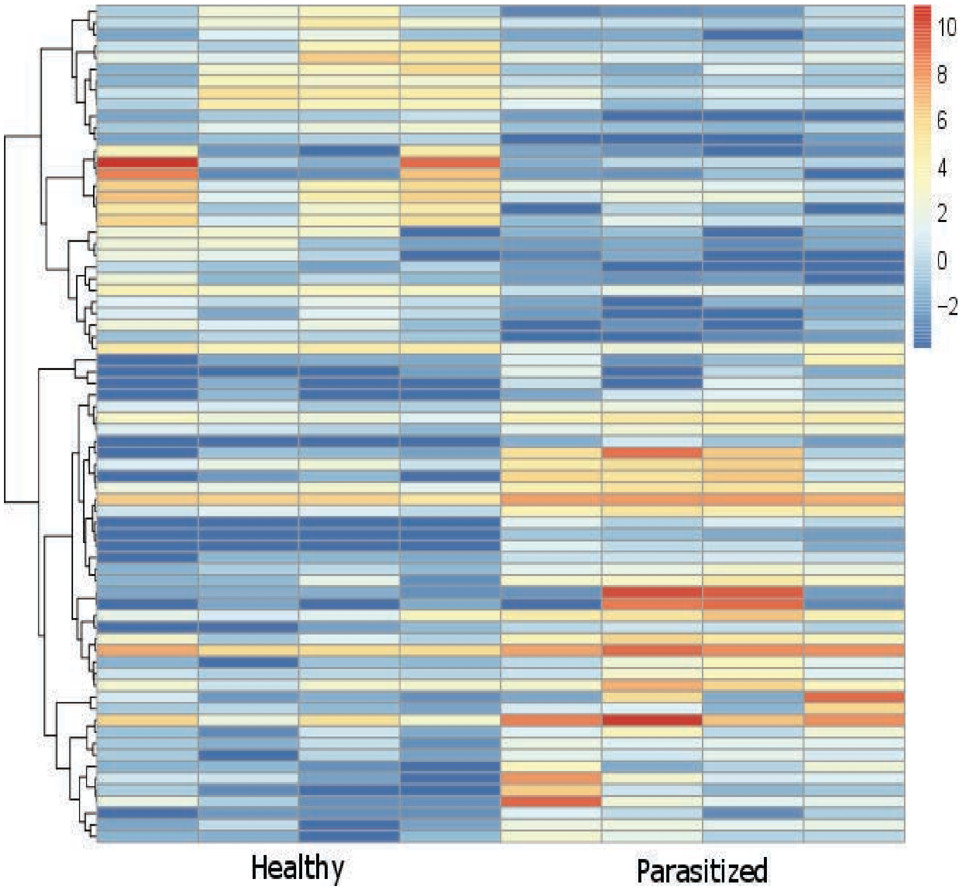
Gene expression profile
Biological functions

Eglantine
Mathieu-Bégné

Understanding the physiological responses to an ectoparasite:

- **local (fin) response or general response?**
- **If general, is the response tissue-specific?**

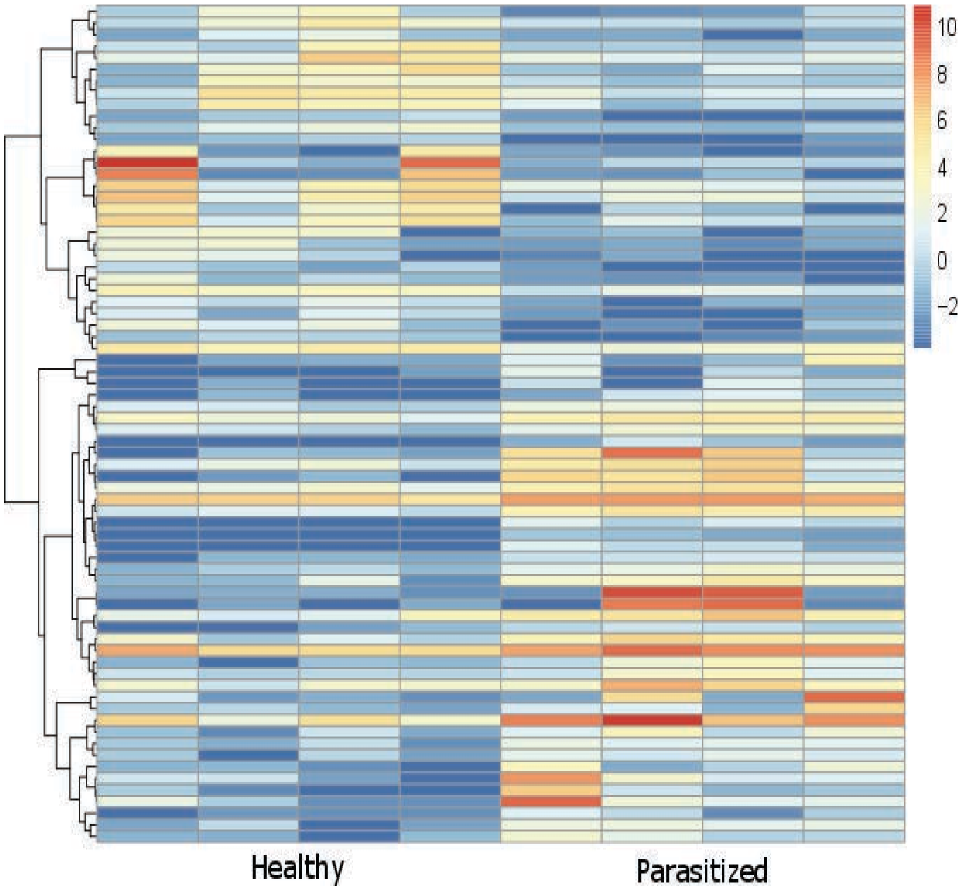
Genes expression profile



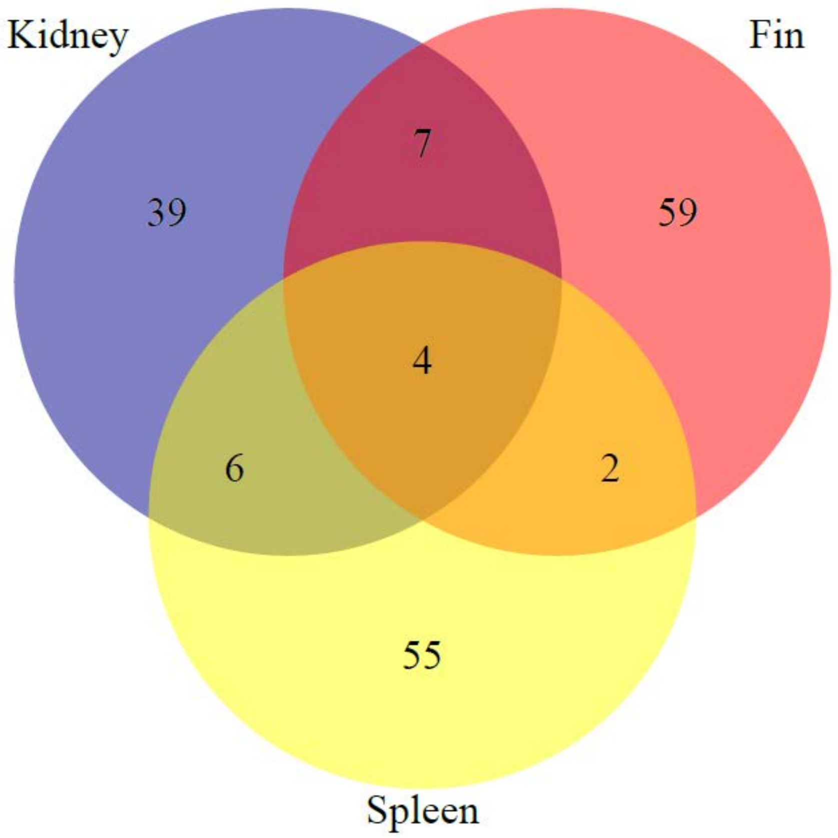
Heat map of genes expression profile:
example of the fin tissue

➔ Some genes are differentially expressed depending on the health status

Genes expression profile



Heat map of genes expression profile: example of the fin tissue

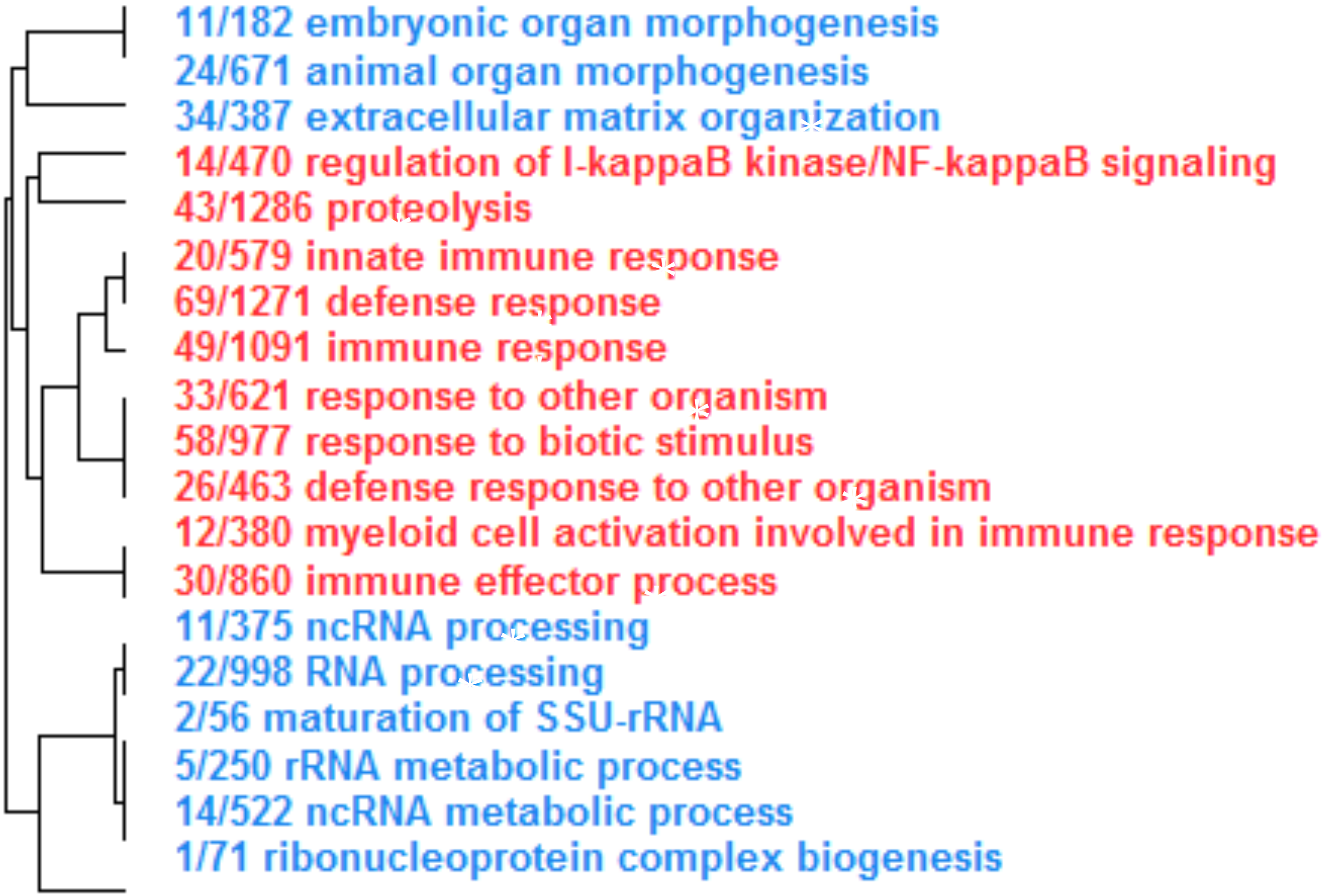


➔ Some genes are differentially expressed depending on the health status

➔ Host response is tissue specific

Biological functions involved

Fins



➔ Generalized immune response in parasitized fishes

➔ Metabolism/Immunity trade-offs

(V) SYNTHESIS

⇒ A NEWLY INTRODUCED SPECIES (< 200 generations)

⇒ SIGNIFICANT PATHOGENIC EFFECTS

⇒ POTENTIAL FOR HOST ADAPTATION

PARASITES = NEW SELECTIVE PRESSURE

= REAL-TIME ADAPTATION

1) RIVER NETWORKS AND PATTERNS OF INTRASPECIFIC DIVERSITY

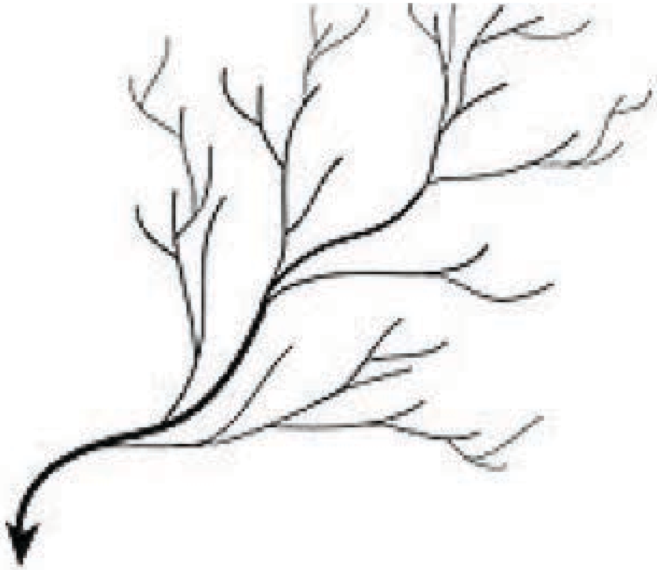
2) ECOLOGICAL CONSEQUENCES OF INTRASPECIFIC DIVERSITY

3) QUANTIFYING THE INFLUENCE OF HABITAT FRAGMENTATION

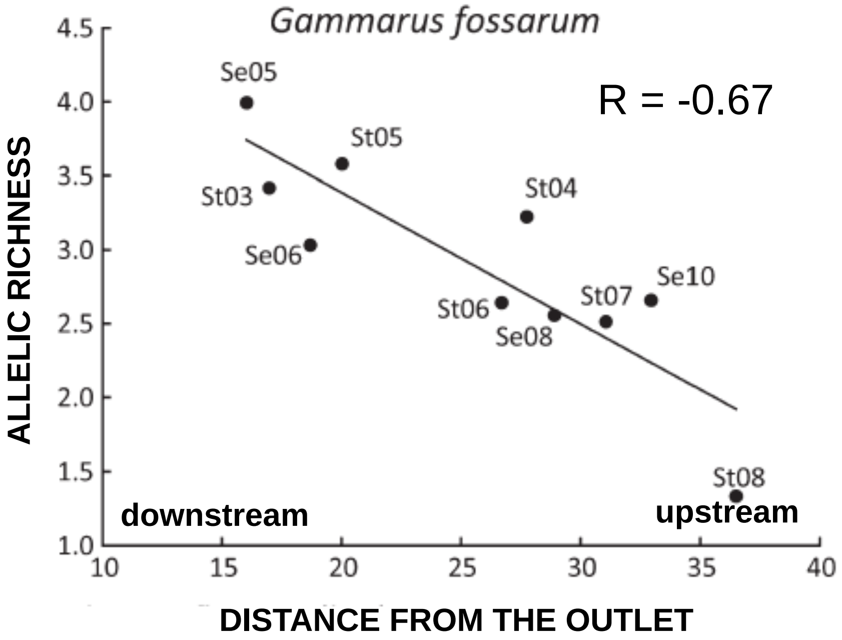
INCREASE IN GENETIC DIVERSITY DOWNSTREAM (IGDD)

Ivan Paz-Vinas

Upstream



Downstream



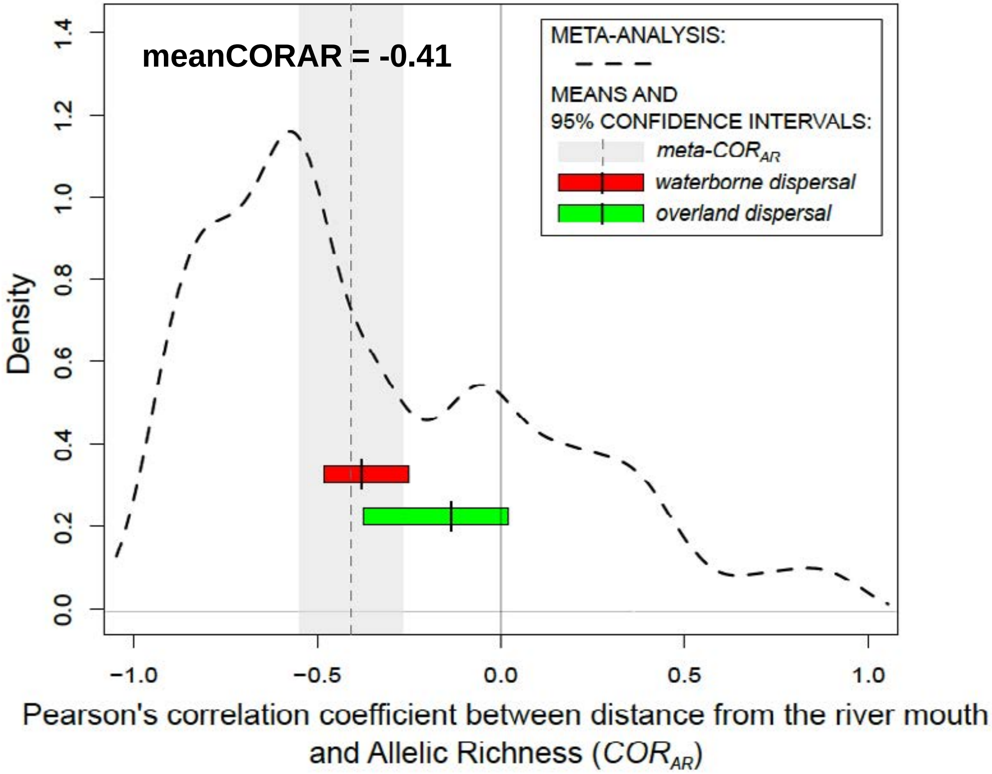
IS THAT A GENERAL PATTERN (RULE) FOUND ACROSS TAXA?

Alp et al. Freshw Biol 2013

IGDD: A META-ANALYTIC TEST (79 case studies)

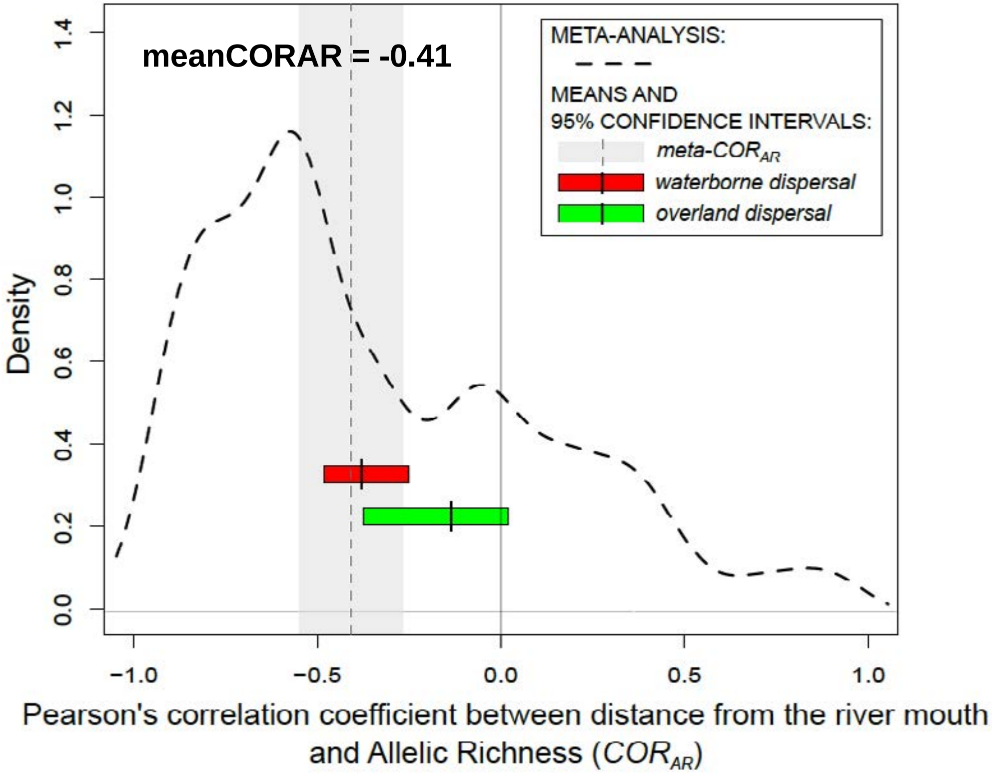
Paz et al. Mol Ecol. 2015

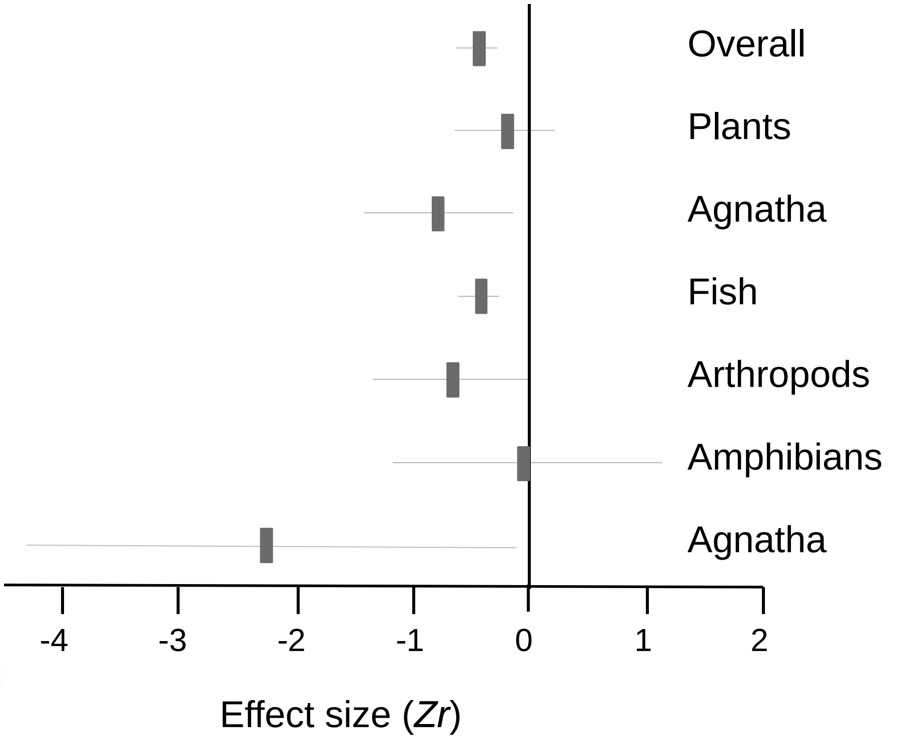
IGDD: A META-ANALYTIC TEST (79 case studies)



Paz et al. Mol Ecol. 2015

IGDD: A META-ANALYTIC TEST (79 case studies)



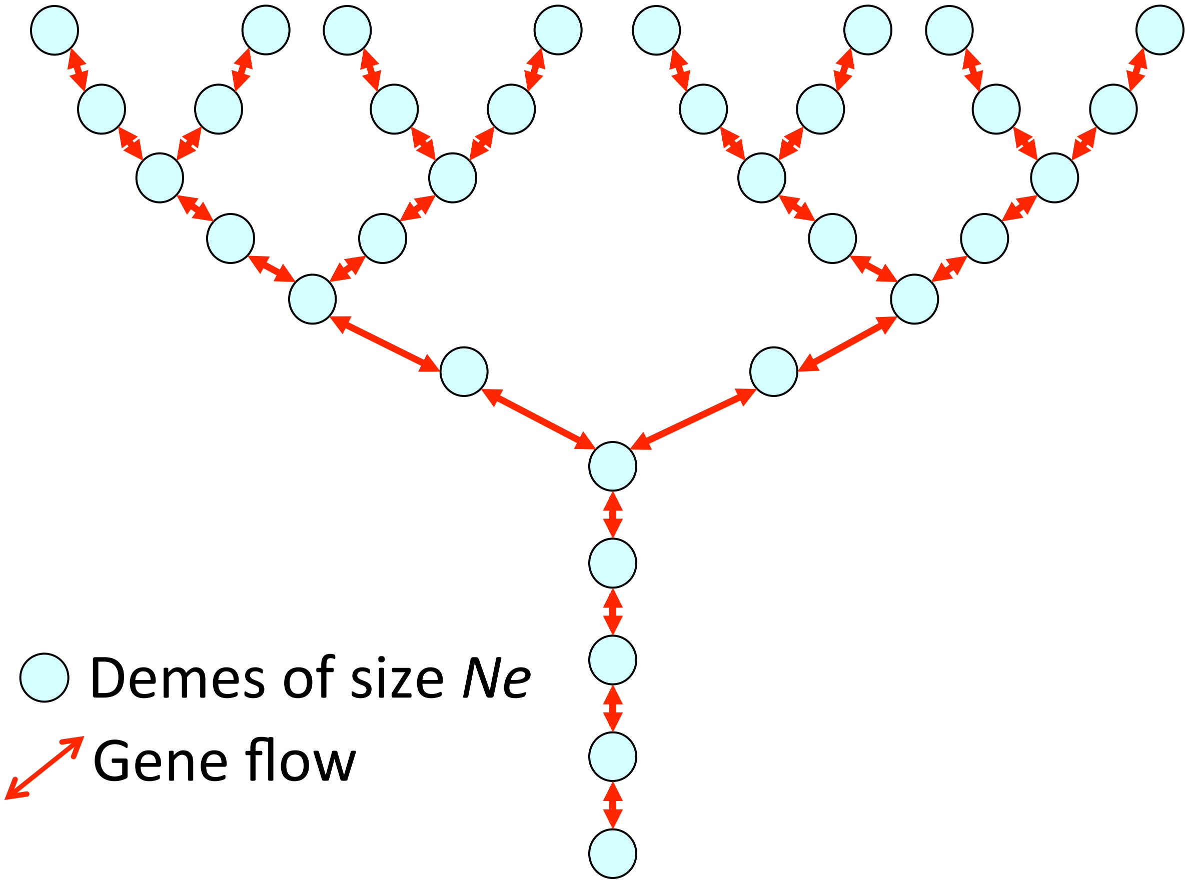


THE PATTERN HOLDS TRUE FOR SEVERAL TAXA

WHAT ARE THE PROCESSES BEHIND THIS GENERAL PATTERN?

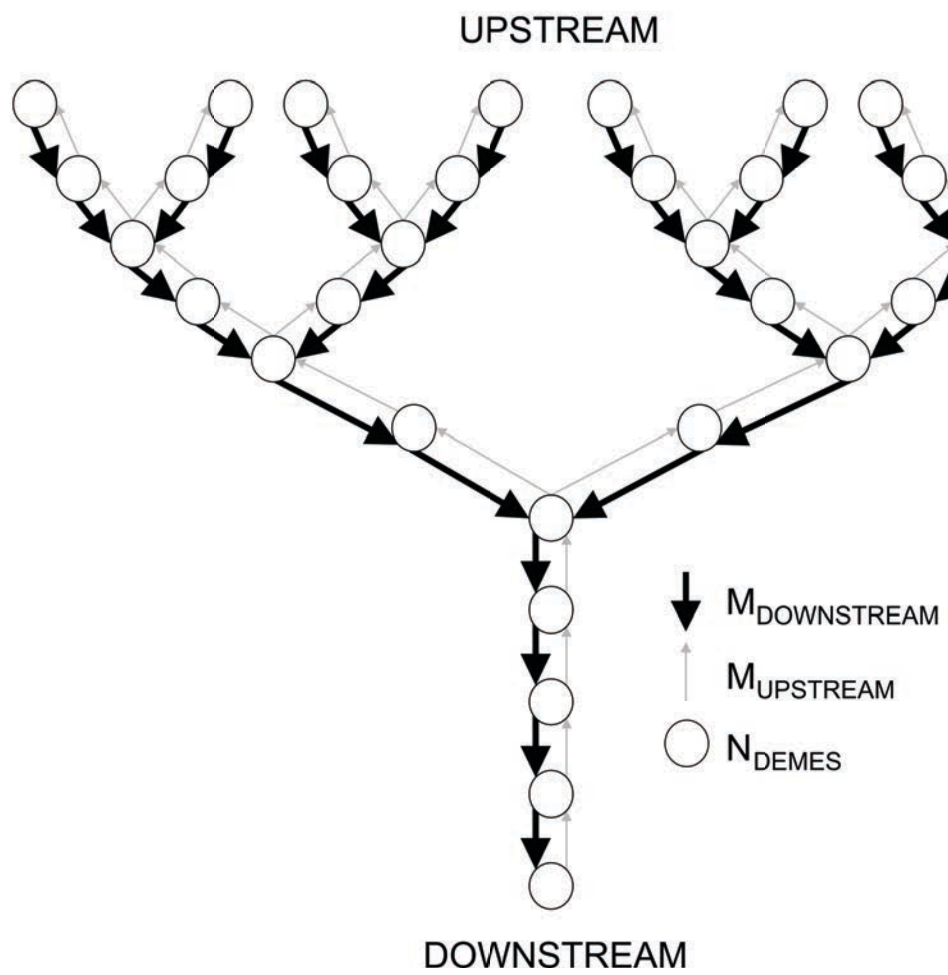
Paz et al. Mol Ecol. 2015

SIMULATIONS OF NEUTRAL GENETIC DIVERSITY IN RIVER NETWORKS



Paz et al. Mol Ecol. 2015

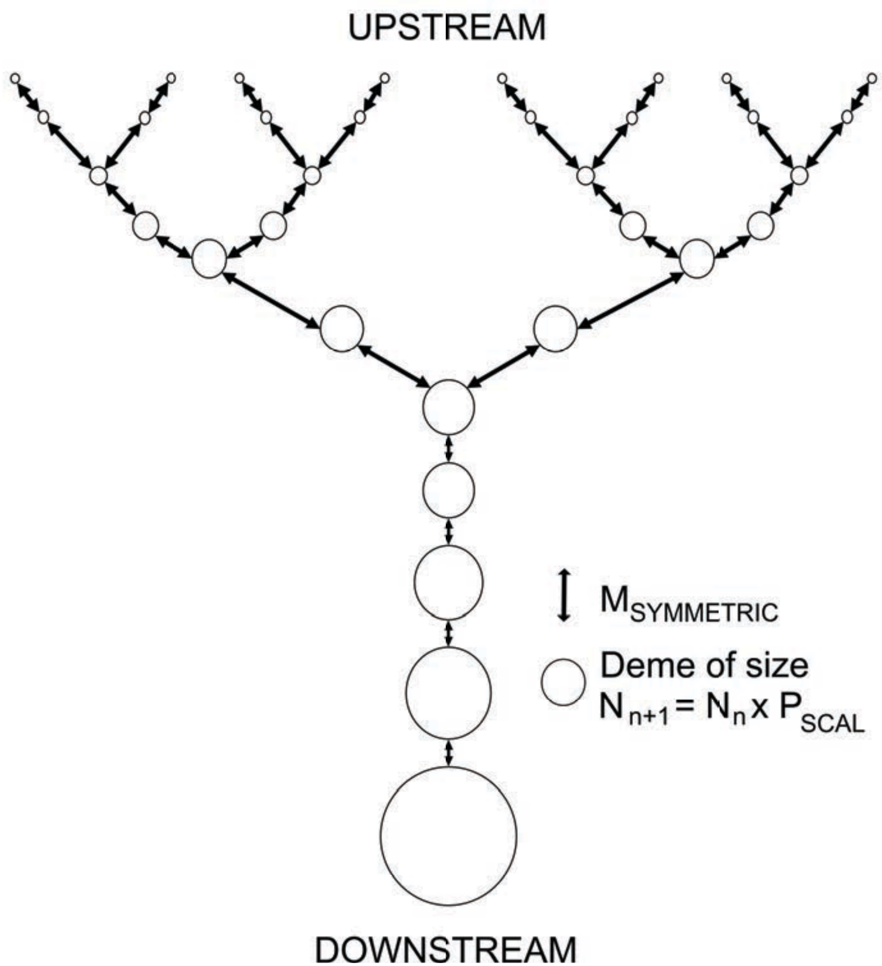
(A) ASYMMETRIC GENE FLOW MODEL



ACCUMULATION OF ALLELES DOWNSTREAM DUE TO ASYMMETRIC GENE FLOW (ASYMM MODEL)

Paz et al. Mol Ecol. 2015

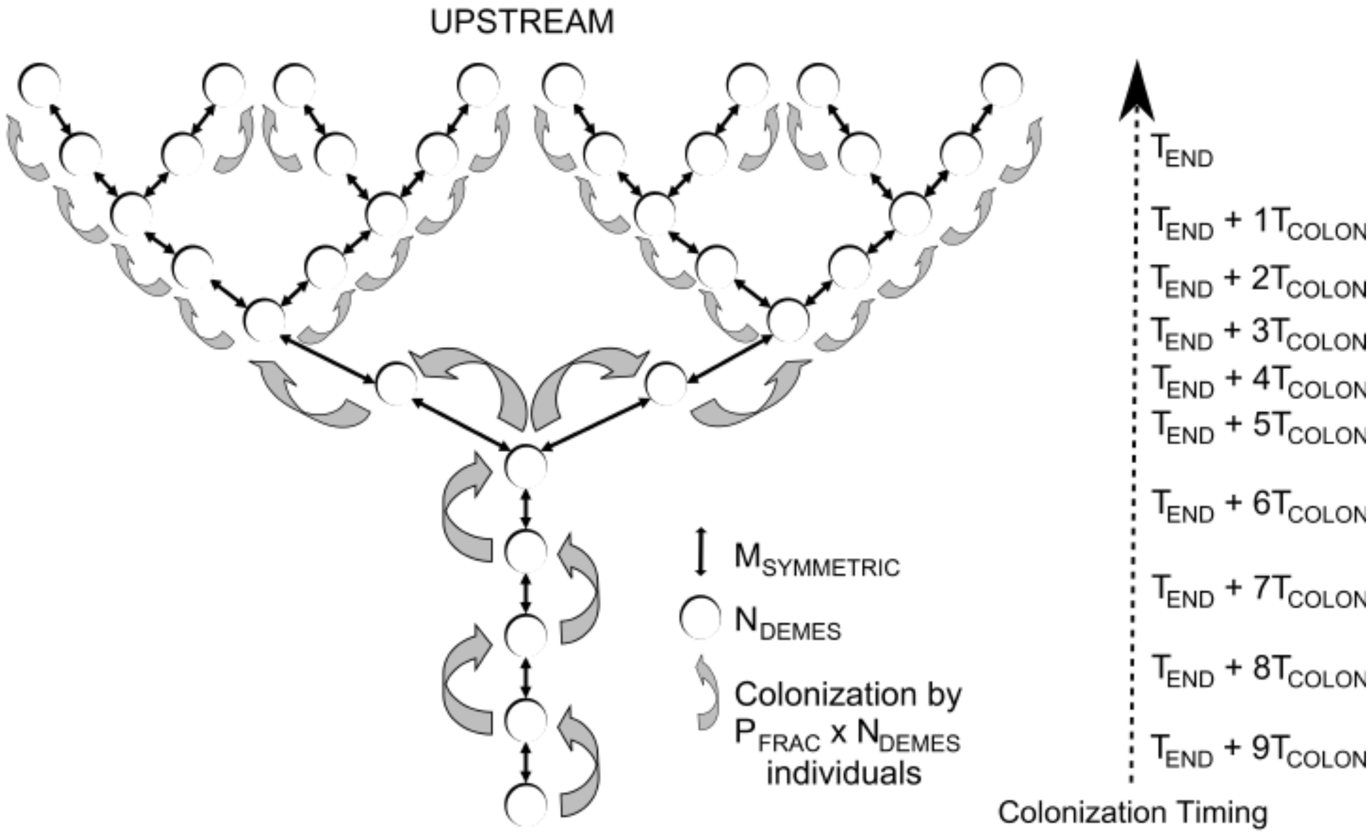
(C) DIFFERENTIAL IN Ne MODEL



HIGHER NE DOWNSTREAM FAVOUR INCREASE GENETIC DIVERSITY DOWNSTREAM (DIFFNE MODEL)

Paz et al. Mol Ecol. 2015

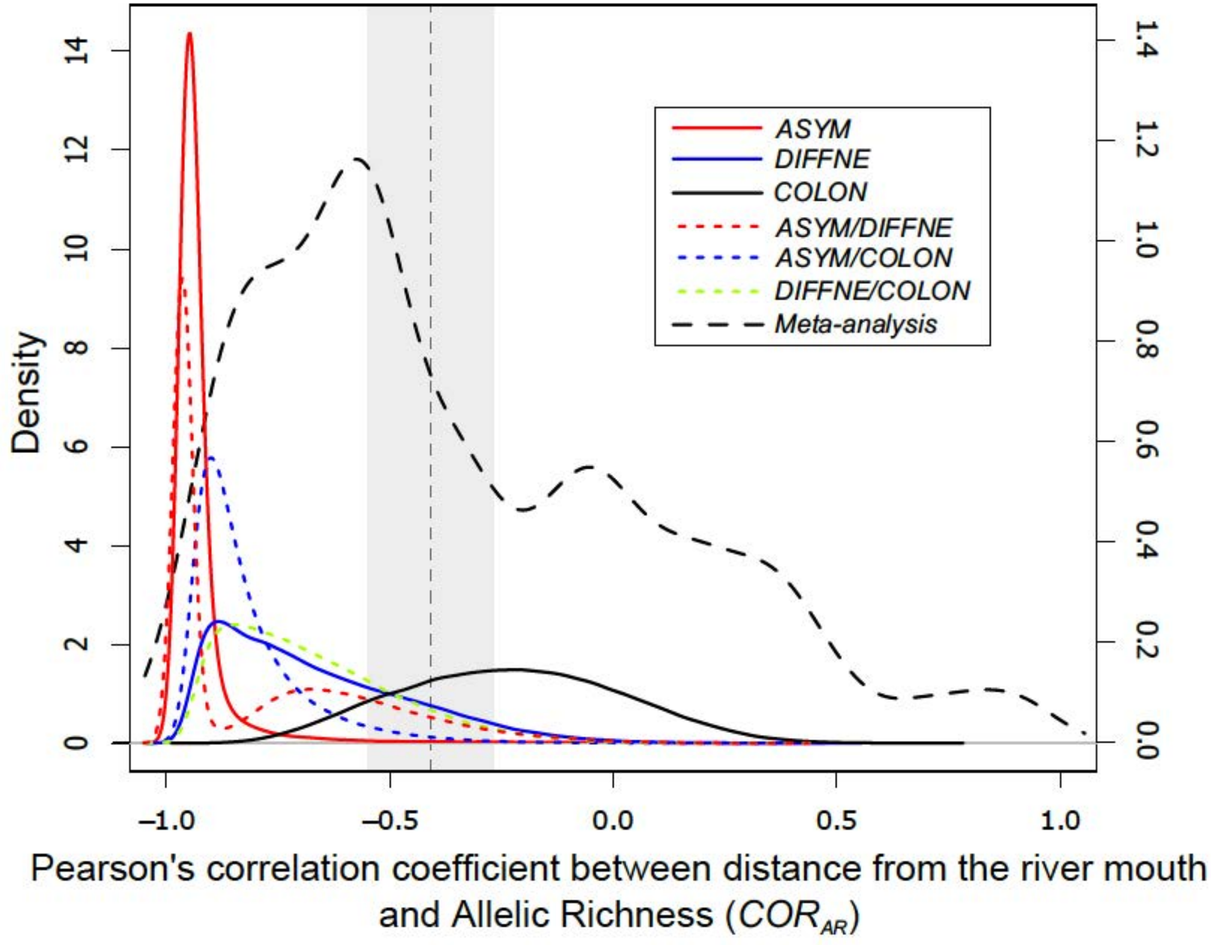
(B) COLONISATION MODEL



COLONISATION PROCESS BEGINNING DOWNSTREAM: LOSS OF ALLELES ALONG THE PROCESS (COLON MODEL)

Paz et al. Mol Ecol. 2015

SIMULATIONS UNDER ALL THESE POSSIBLE MODELS



ALL PROCESSES CAN GENERATE IGDD (IN THEORY), EITHER INDIVIDUALLY OR IN INTERACTION

Paz et al. Mol Ecol. 2015

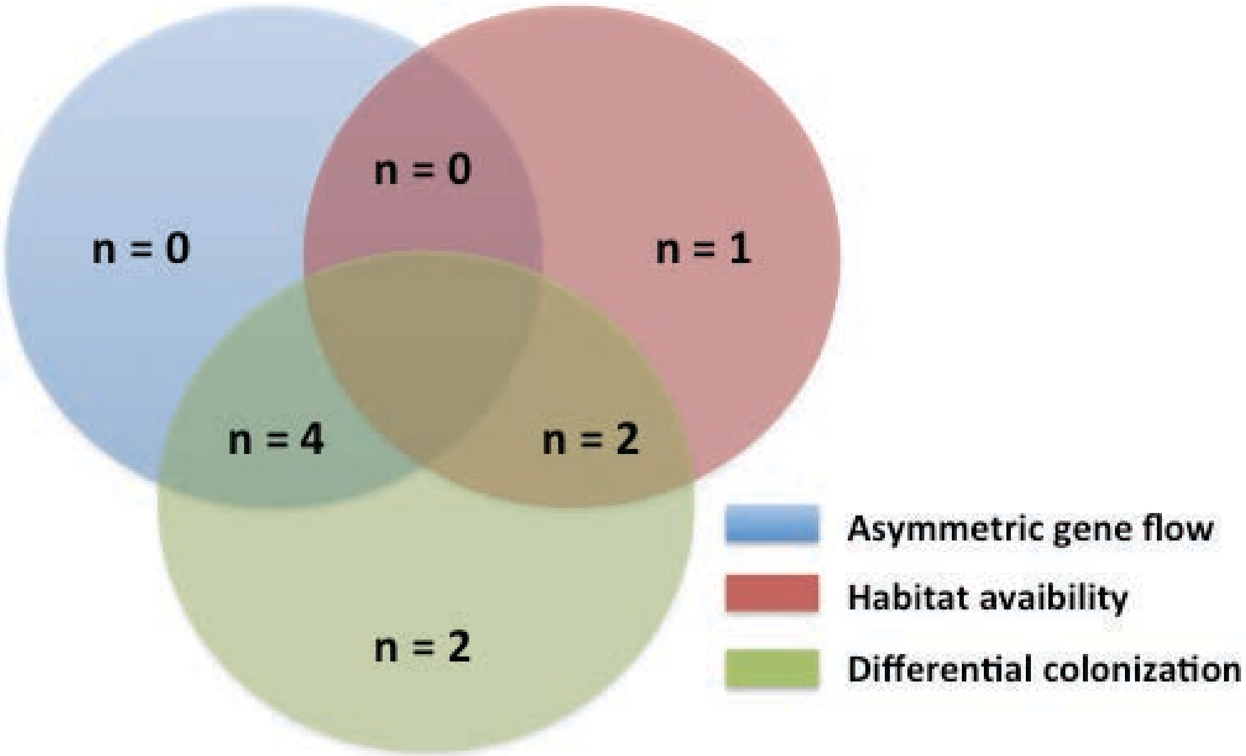
ABC APPROACH TO INFER PROCESSES IN THE WILD:

12 EMPIRICAL CASE STUDIES (fish, invertebrates…)

Paz et al. Mol Ecol. 2015

ABC APPROACH TO INFER PROCESSES IN THE WILD:

12 EMPIRICAL CASE STUDIES (fish, invertebrates…)



COLONISATION LEGACY AS AN IMPORTANT PROCESS GENERATING PATTERNS OF GENETIC DIVERSITY IN THE WILD

Paz et al. Mol Ecol. 2015

INTRASPECIFIC DIVERSITY VARIES SPATIALLY. DOES IT MATTER FOR ECOLOGICAL PROCESSES?

Allan Raffard

Raffard et al. BioRxiv 2018

INTRASPECIFIC DIVERSITY VARIES SPATIALLY. DOES IT MATTER FOR ECOLOGICAL PROCESSES?

Allan Raffard

- do diverging populations have similar effects on ecosystem functioning?
- Are these effects of similar magnitude than climatic variation?

Raffard et al. BioRxiv 2018

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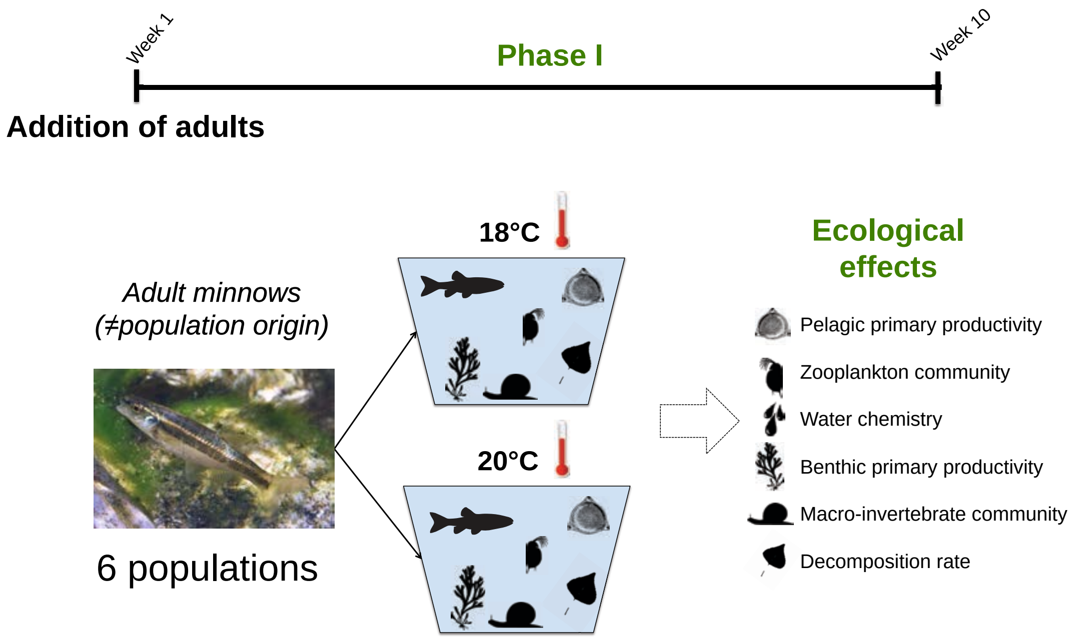
Allan Raffard



Effect sizes on all these parameters

Raffard et al. BioRxiv 2018

INTRASPECIFIC DIVERSITY VARIES SPATIALLY. DOES IT MATTER FOR ECOLOGICAL PROCESSES?

- do diverging populations have similar effects on ecosystem functioning?
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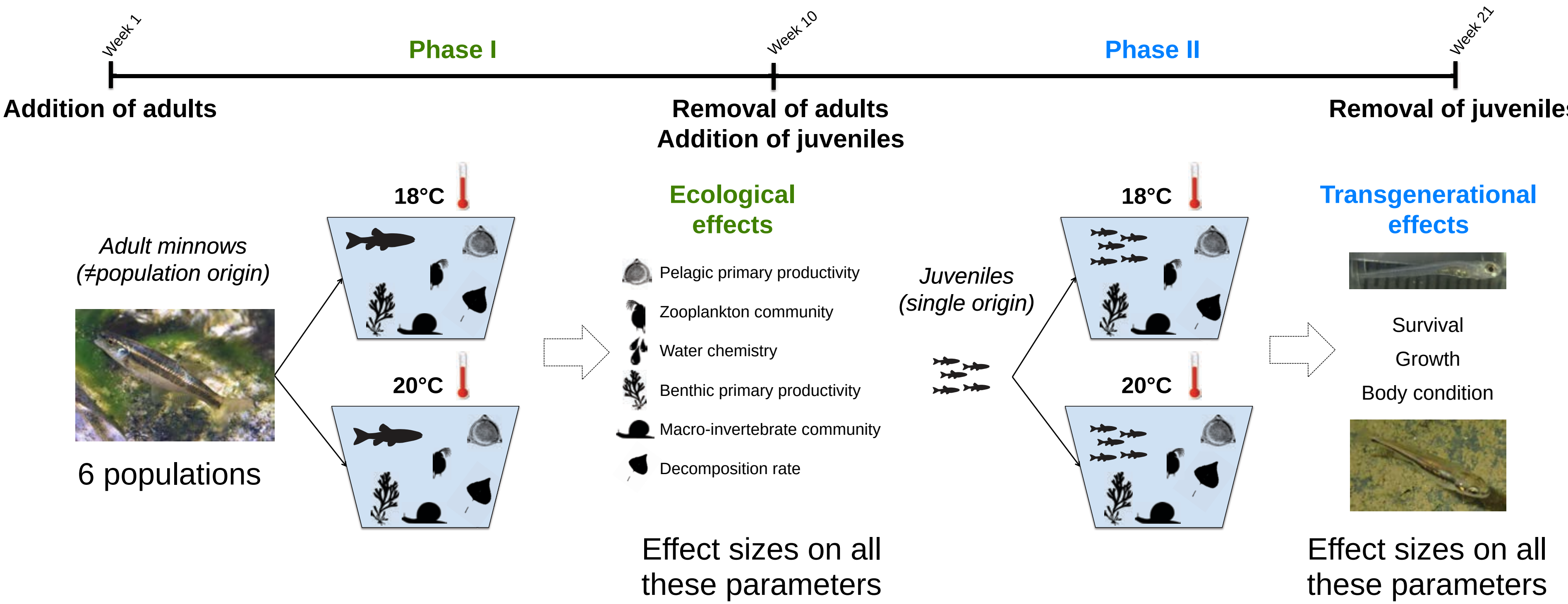
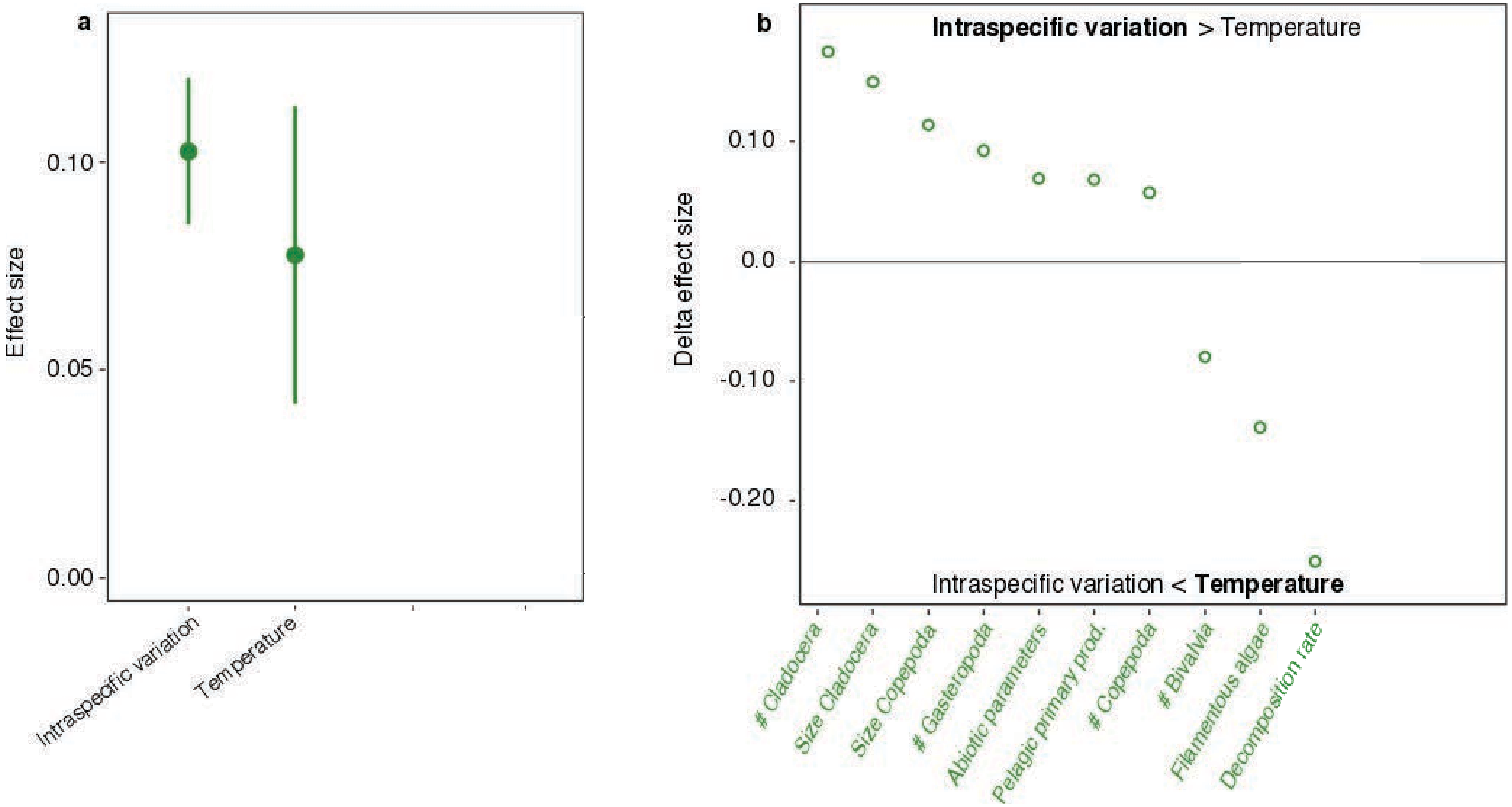
Allan Raffard



Raffard et al. BioRxiv 2018

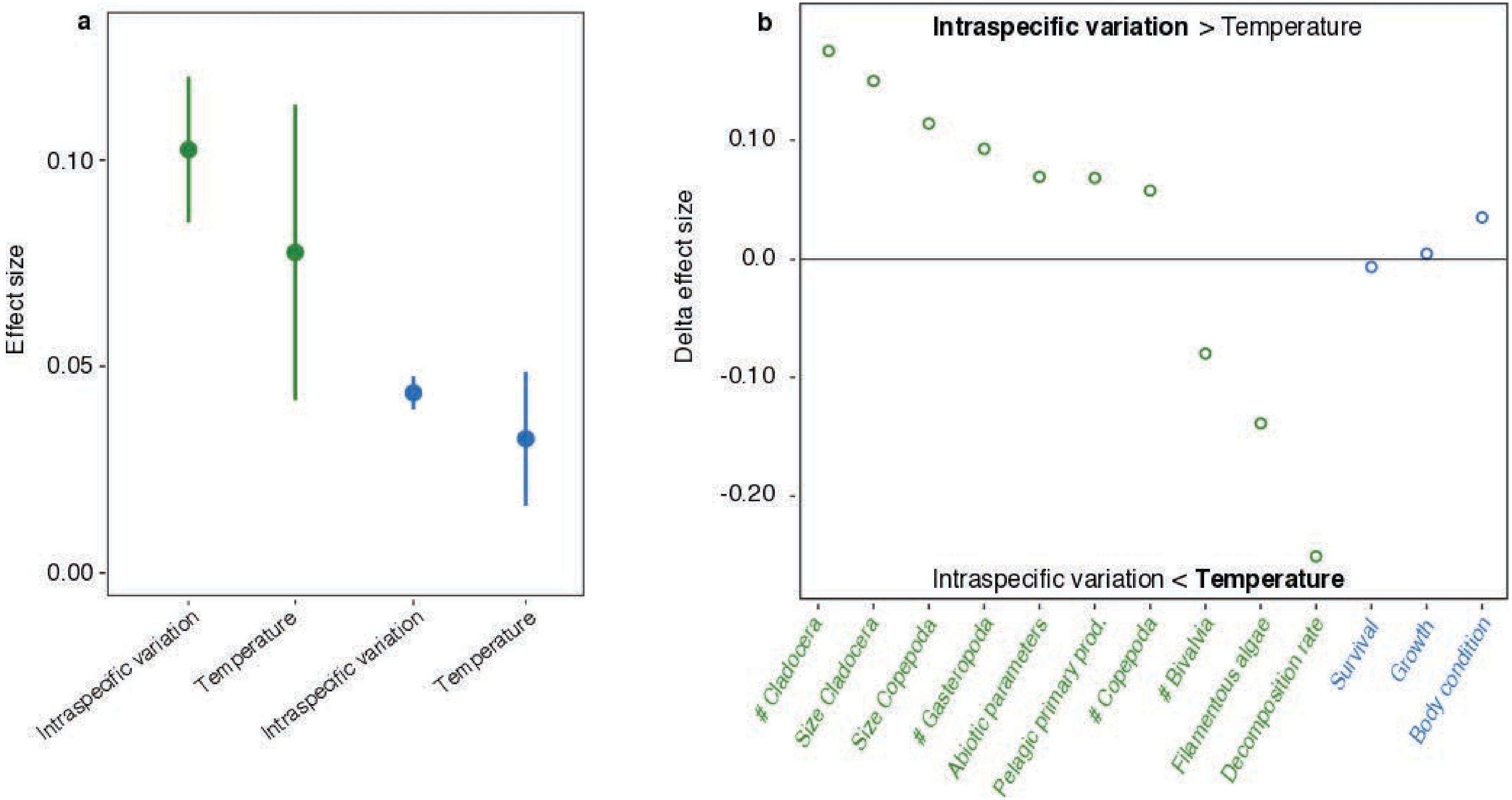
INTRASPECIFIC DIVERSITY STRONGLY IMPACTS ECOLOGY



ID HAS ECOLOGICAL EFFECTS OF SIMILAR STRENGTH THAN WARMING

Raffard et al. BioRxiv 2018

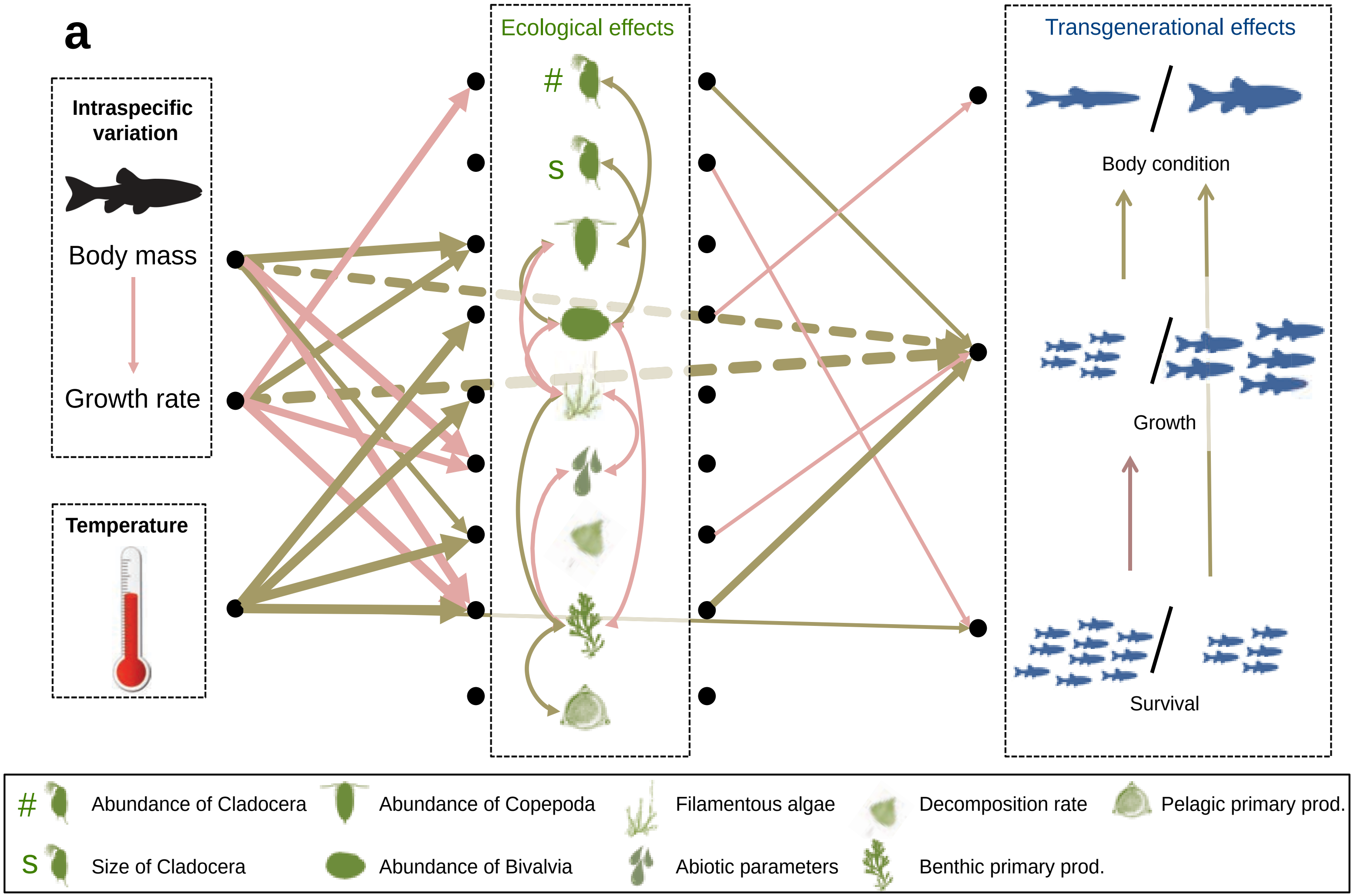
INTRASPECIFIC DIVERSITY STRONGLY IMPACTS ECOLOGY…AND "EVOLUTION".



ID HAS ECOLOGICAL EFFECTS OF SIMILAR STRENGTH THAN WARMING LEADING TO ECO-EVO FEEDBACKS

Raffard et al. BioRxiv 2018

(II) ECOLOGICAL CONSEQUENCES OF INTRASPECIFIC DIVERSITY



ID IS NOT DISTRIBUTED HOMOGENEOUSLY, AND THIS CAN HAVE CONSEQUENCES FOR ECOSYSTEM FUNCTIONING (AND EVOLUTION)

Raffard et al. BioRxiv 2018

MANY OBSTACLES ALONG RIVERS: MAINLY WEIRS

Restoring connectivity by erasing or managing (fishpass) weirs and dams: costly. Hierarchizing actions is needed.


5 m high, 1960


1.2 m high, 1640

Prunier, Dubut et al. In prep.

MANY OBSTACLES ALONG RIVERS: MAINLY WEIRS

Restoring connectivity by erasing or managing (fishpass) weirs and dams: costly. Hierarchizing actions is needed.

5 m high, 1960

1.2 m high, 1640

Using genetic differentiation (below-to-above design) to identify the most problematic weirs. But!

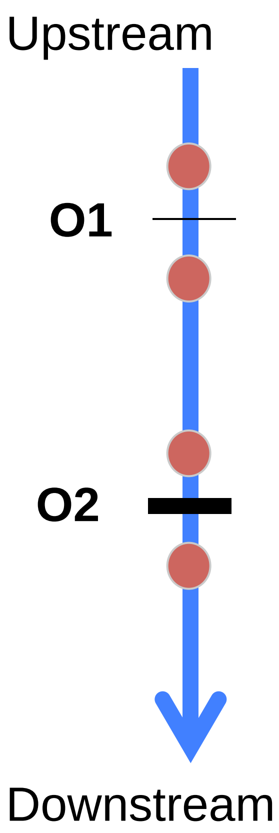
→ How to take into account the age of the obstacle?

→ How to take into account the size of populations?

Prunier, Dubut et al. In prep.

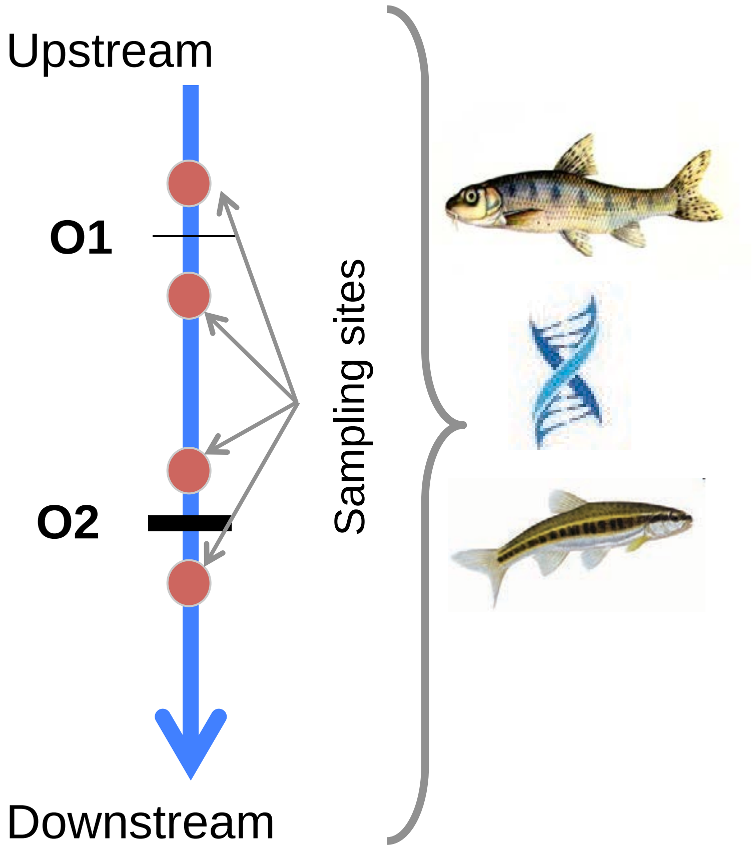
(III) ID AS A INDICATOR OF FRAGMENTATION

A below-to-above design quantifying genetic differentiation :



Prunier, Dubut et al. In prep.

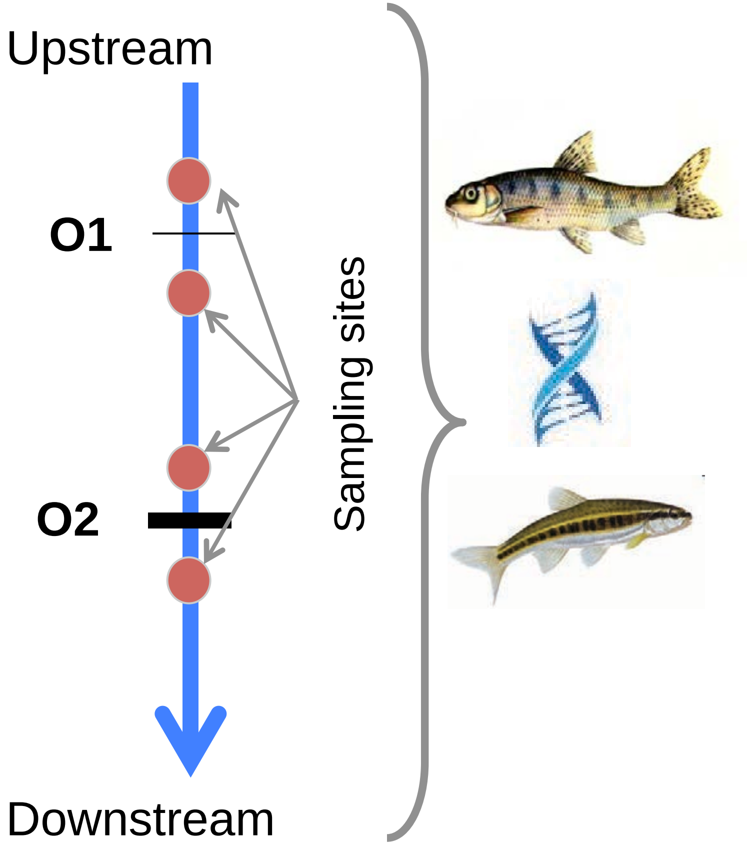
A below-to-above design quantifying genetic differentiation :



$GD_{O1} < GD_{O2}$,

Prunier, Dubut et al. In prep.

A below-to-above design quantifying genetic differentiation :



$GD_{O1} < GD_{O2}$,

if:

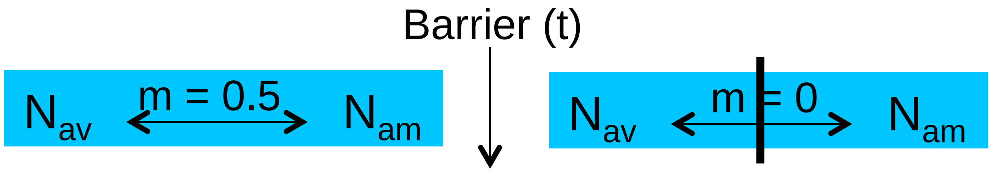
- O1 and O2 of the same age
- Population size in O1 = 02

Designing an index of fragmentation (F) accounting for the age of obstacles and the local population size

Prunier, Dubut et al. In prep.

(III) ID AS A INDICATOR OF FRAGMENTATION

Step 1: Simulations. Calculating expected GD (*eGD*) if the barrier is total (m=0, maximum expected effect) according to Ne and Age (t)



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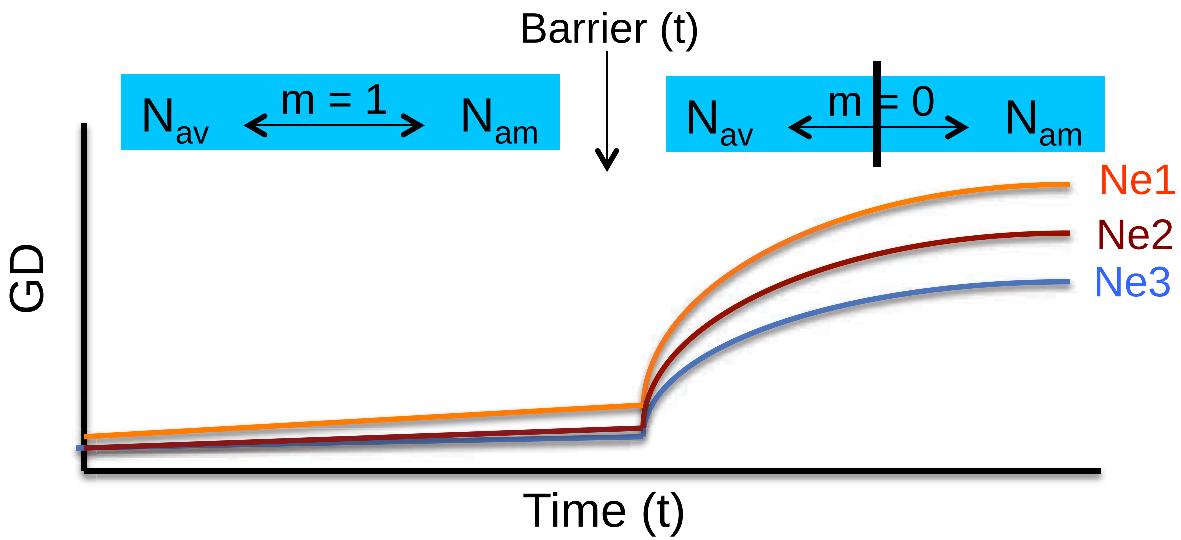

Prunier, Dubut et al. In prep.

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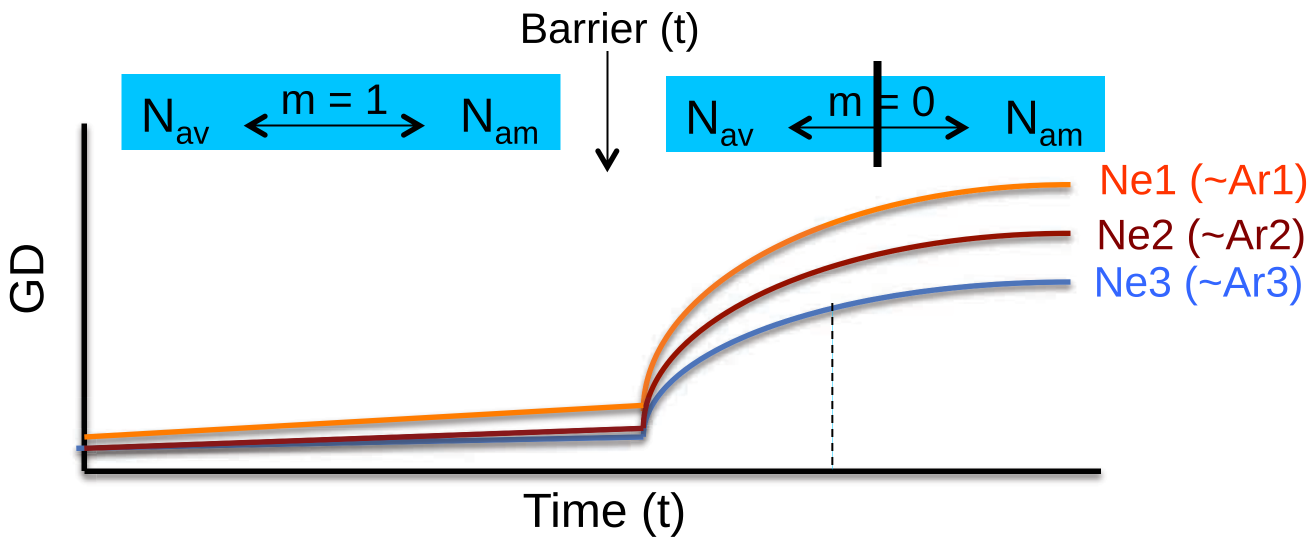

Prunier, Dubut et al. In prep.

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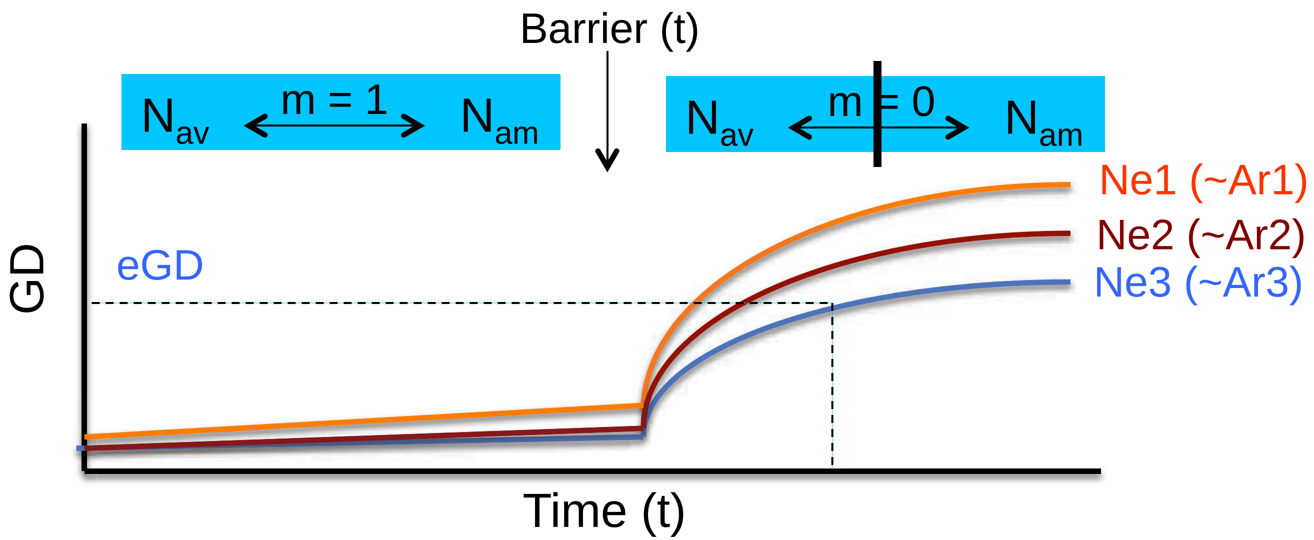

Prunier, Dubut et al. In prep.

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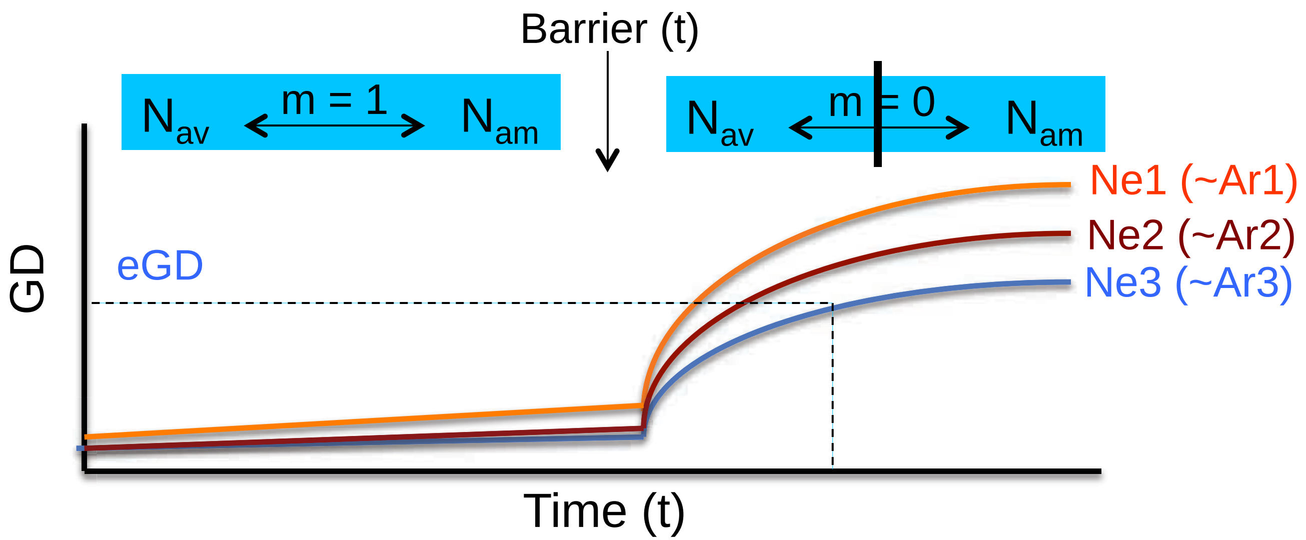
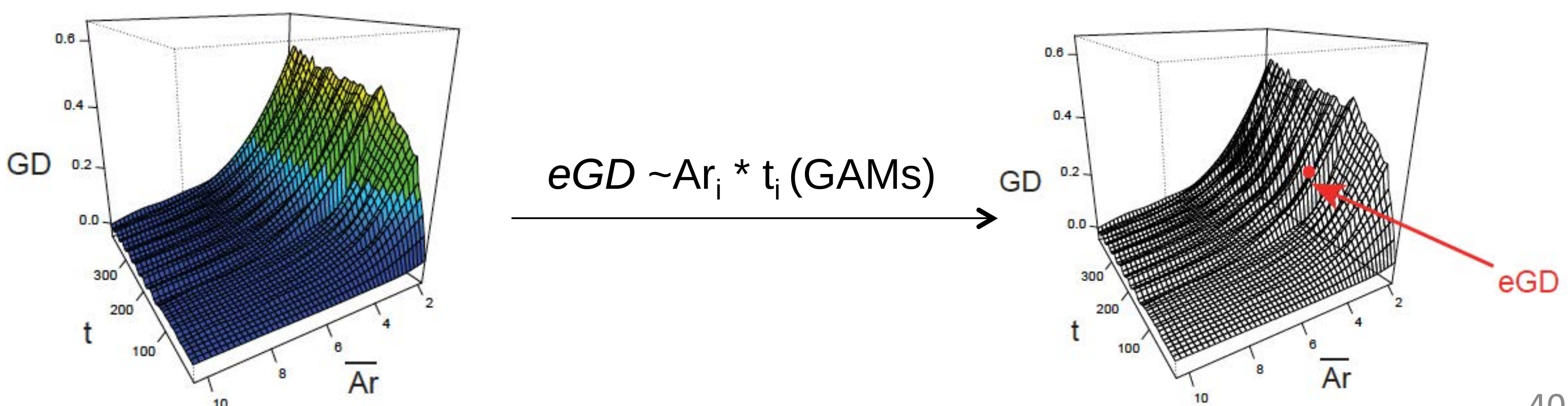


Step 2: Calibrating models (from simulations) to predict *eGD* from any Ne (Ar) and t



Prunier, Dubut et al. In prep.

Step 3: using the models to estimate *eGD from* empirical *Ar* and *t* values

t = 238 *generations*

$Ar_{mean} = 6.3$ → *eGD* = 0.6

Prunier, Dubut et al. In prep.

Step 3: using the models to estimate *eGD from* empirical *Ar* and *t* values

t = 238 generations

$Ar_{mean} = 6.3$

eGD = 0.6

Step 4: calculating o*GD (observed GD)*

oGD = 0.15

Prunier, Dubut et al. In prep.

Step 3: using the models to estimate *eGD from* empirical *Ar* and *t* values

t = 238 generations

$Ar_{mean} = 6.3$ → $eGD = 0.6$

$oGD = 0.15$

$F = 25\%$

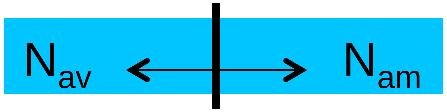
Step 4: calculating o*GD (observed GD)*

Step 5: calculating the fragmentation index: F = [*oGD/eGD*]*100

Percentage of an expected maximal effect, given Ne and t

Prunier, Dubut et al. In prep.

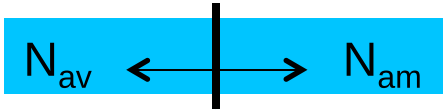
Validation using independent simulations.



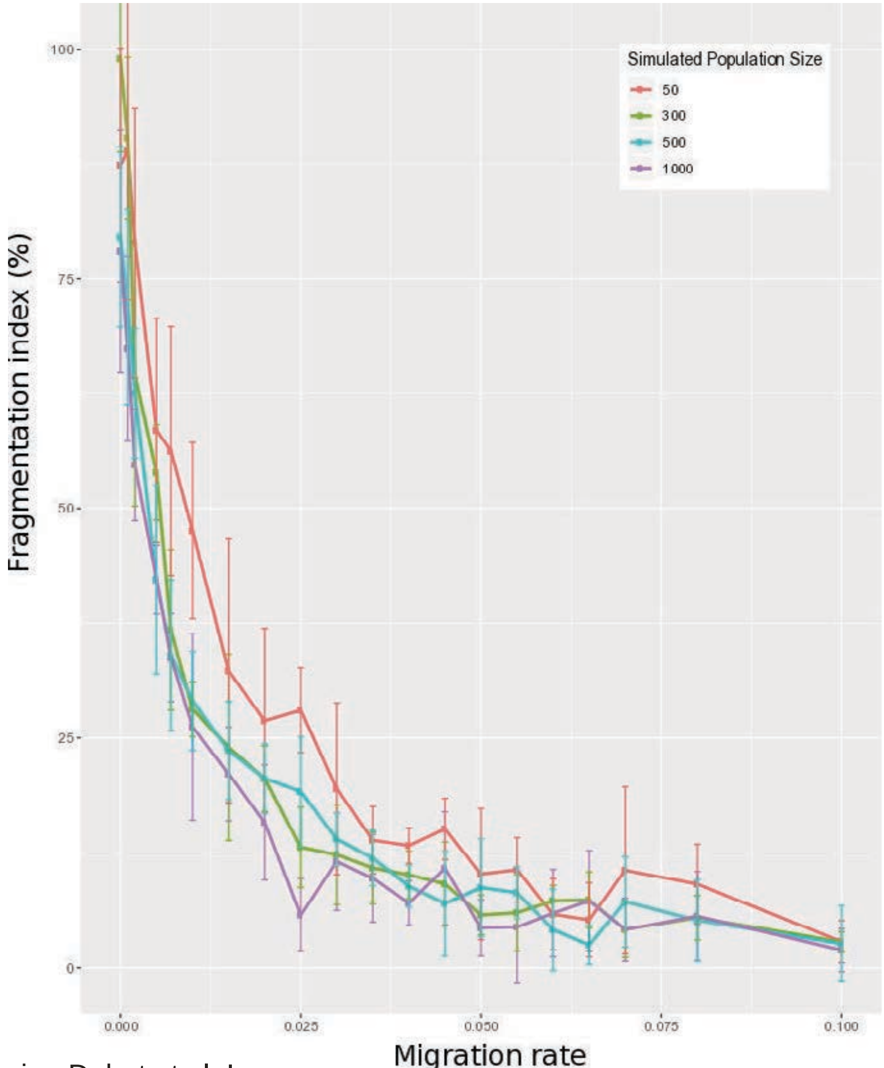
m = 0.2 - 0

Prunier, Dubut et al. In prep.

Validation using independent simulations.



m = 0.2 - 0

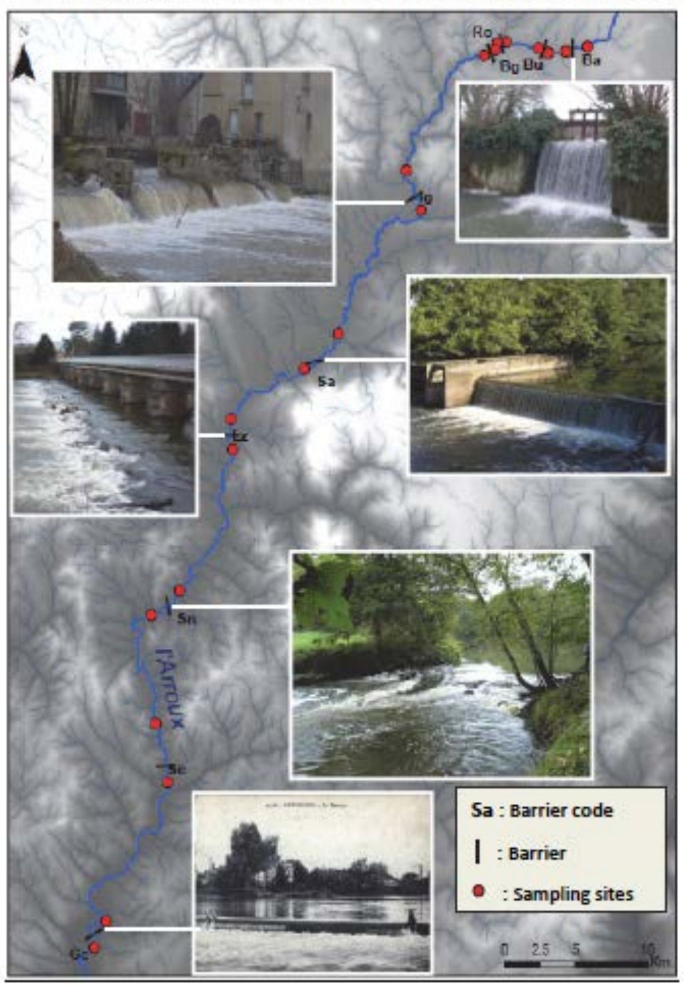


The index is close to 100% when m = 0 (total barrier)

The index decreases very quickly and is rapidly closed to 0% (no barrier effect detected when m > 0.1)

Prunier, Dubut et al. In prep.

An empirical test on 10 obstacle along a river (Arroux)



Prunier, Dubut et al. In prep.

(III) ID AS A INDICATOR OF FRAGMENTATION

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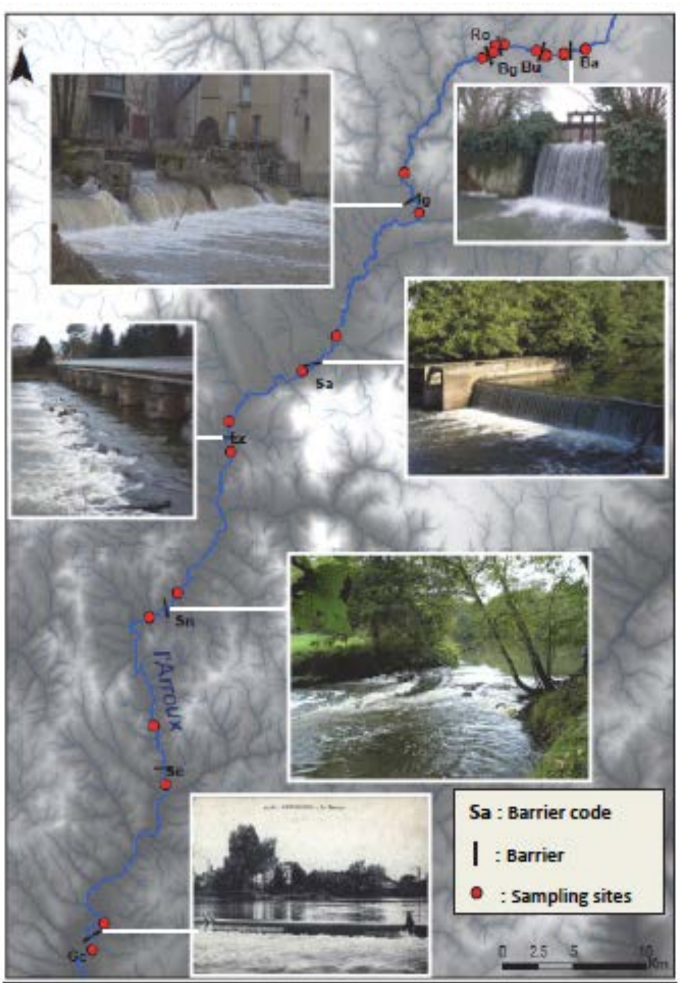
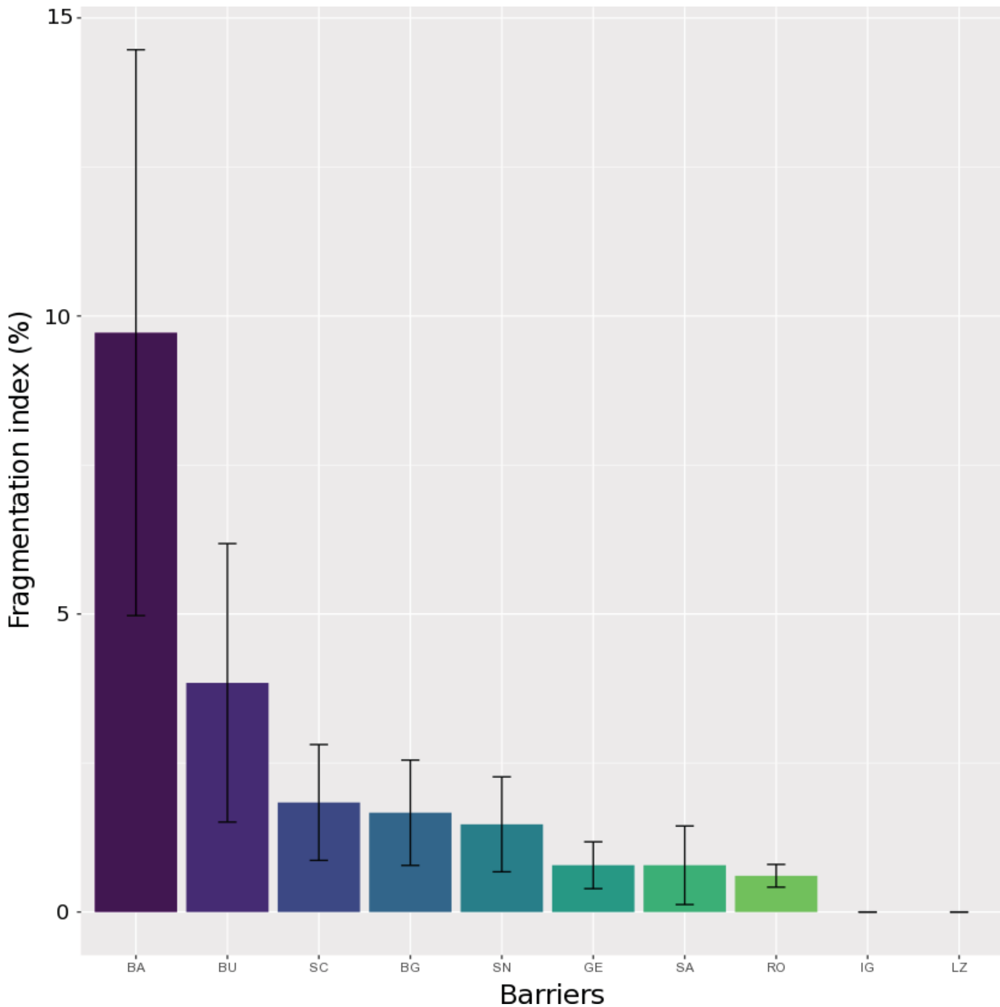




The index has relatively value (weirs are not impassables)

Variability among barriers: hierarchisation

Prunier, Dubut et al. In prep.

SYNTHESIS

⇒ DIVERSITY VARIES ALONG NETWORKS, PATTERNS ARE REPEATABLE

⇒ DECIPHERING THESE PROCESSES IS POSSIBLE

⇒ DIVERSITY IS NOT ECOLOGICALLY TRIVIAL. IT HAS STRONG IMPACTS ON ECOLOGICAL DYNAMICS

⇒ CONSERVATION OF THESE EVOLUTIONARY AND ECOLOGICAL SIGNIFICANT UNITS IS REQUIRED

⇒ IT IS ALSO A USEFUL INDICATOR FOR SOME HUMAN PRESSURES

ACKNOWLEDGMENTS

LES FINANCEURS

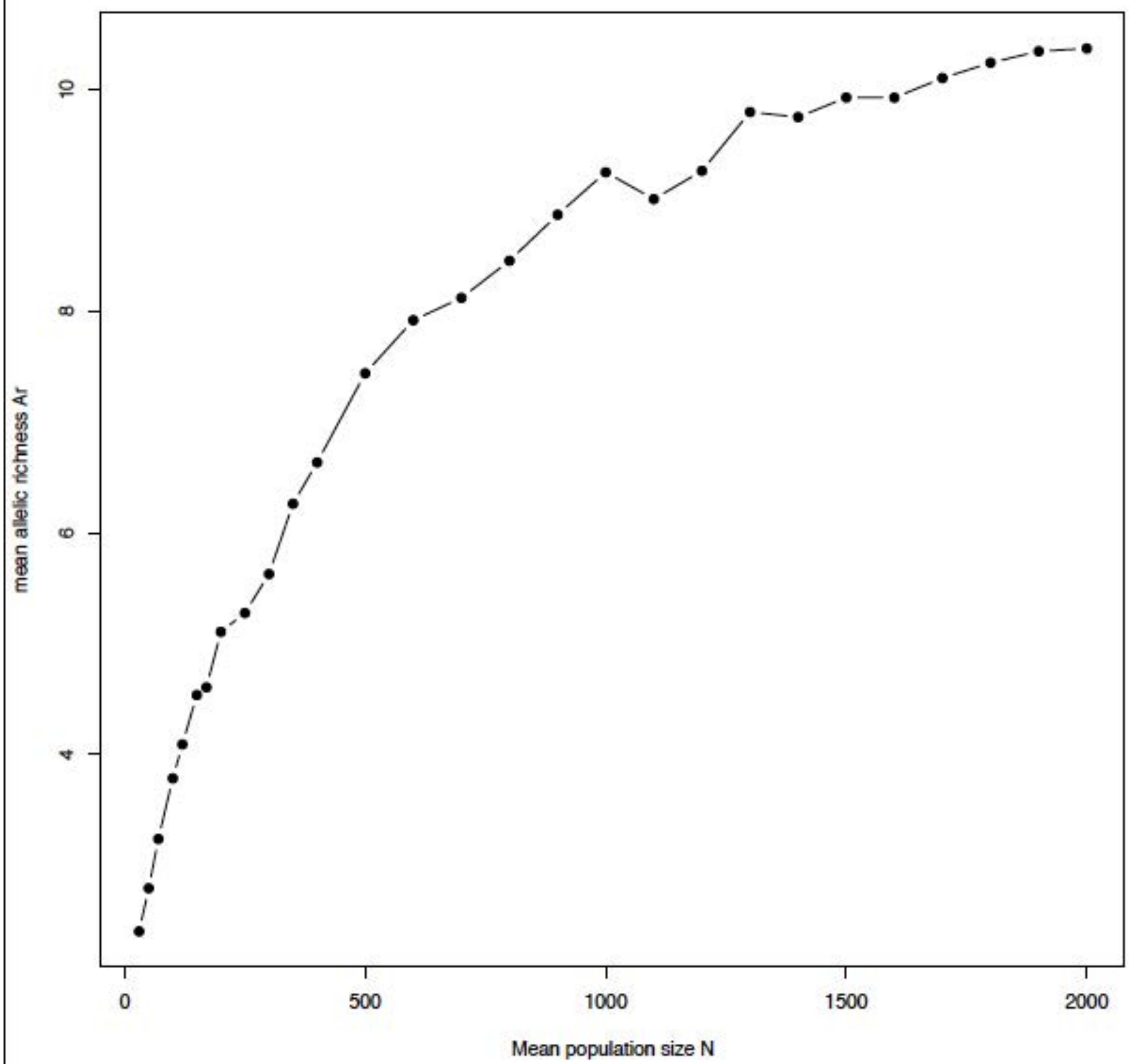
cnrs

AGENCE NATIONALE DE LA RECHERCHE
ANR

ONEMA
Office national de l'eau
et des milieux aquatiques

ET VOUS.

(III) INTRASPECIFIC DIVERSITY AND CONSERVATION PLANNING



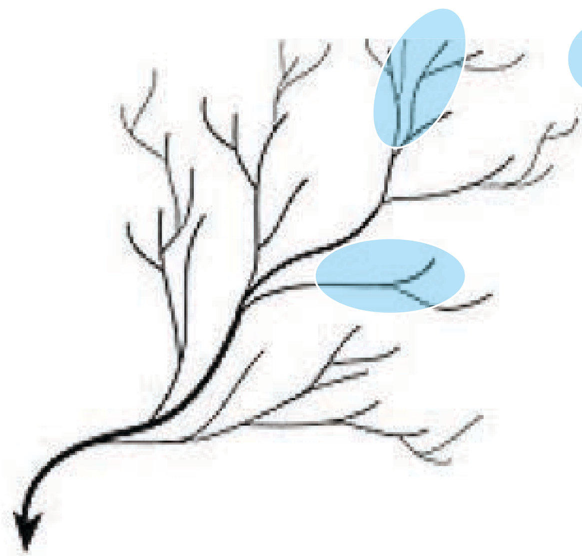
Paz et al. PRSLB 2018.

INTRASPECIFIC DIVERSITY VARIES SPATIALLY AND IT MATTERS FOR ECOLOGICAL PROCESSES.
HOW TO PRIORITIZE CONSERVATION AREAS FOR ID?

Paz et al. PRSLB 2018.

Ivan Paz-Vinas

INTRASPECIFIC DIVERSITY VARIES SPATIALLY AND IT MATTERS FOR ECOLOGICAL PROCESSES.
HOW TO PRIORITIZE CONSERVATION AREAS FOR ID?



WHICH PARTS OF THE NETWORK SHOULD WE TARGERT TO CONSERVE INTRASPECIFIC DIVERSITY?

Paz et al. PRSLB 2018.

INTRASPECIFIC DIVERSITY VARIES SPATIALLY AND IT MATTERS FOR ECOLOGICAL PROCESSES.
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Paz et al. PRSLB 2018.

INTRASPECIFIC DIVERSITY VARIES SPATIALLY AND IT MATTERS FOR ECOLOGICAL PROCESSES.
HOW TO PRIORITIZE CONSERVATION AREAS FOR ID?

Ivan Paz-Vinas

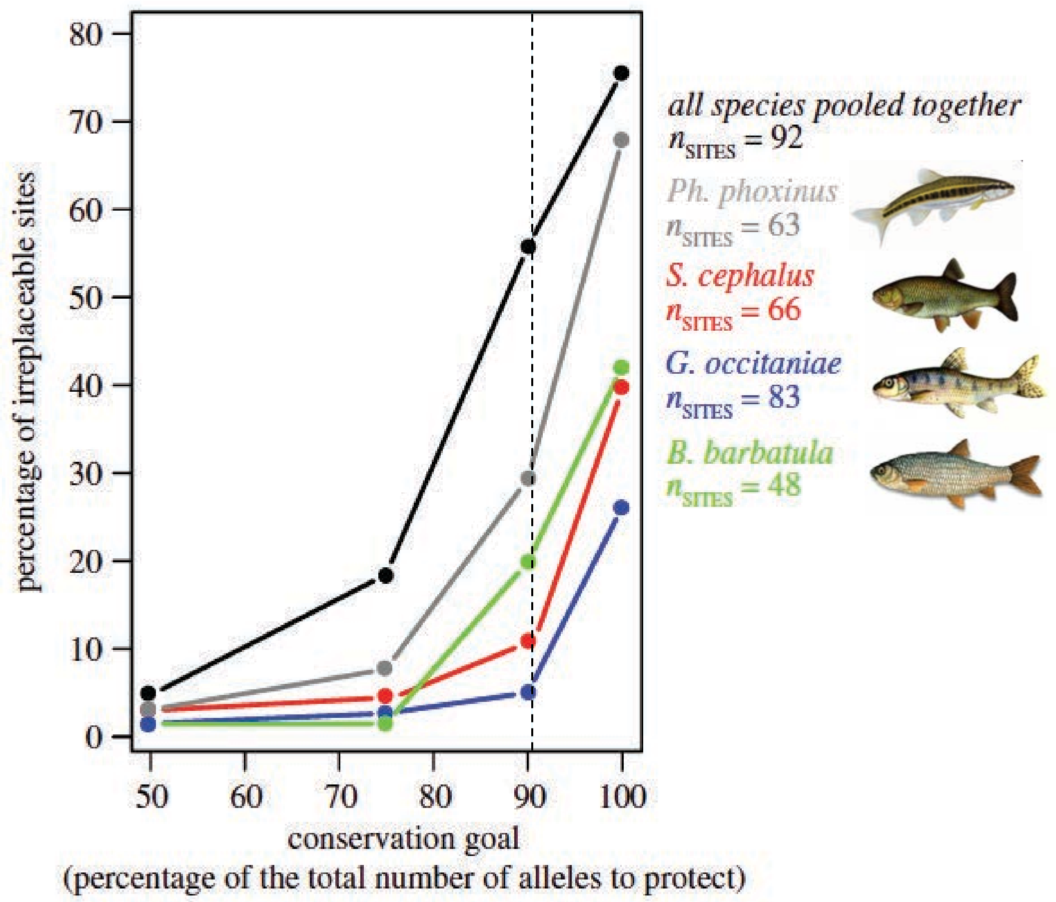
A multispecies conservation planning approach:

- 6 species sampled in 92 sites and typed for microsatellites
- Identifying the sites (*irreplaceable sites*) required to cover a certain amount of genetic diversity (*conservation target*)
- Mapping these sites and testing for congruencies among species

WHICH PARTS OF THE NETWORK SHOULD WE TARGERT TO CONSERVE INTRASPECIFIC DIVERSITY?

Paz et al. PRSLB 2018.

CONSERVATION PLANNING: IDENTIFYING PRIORITY ZONES FOR ID

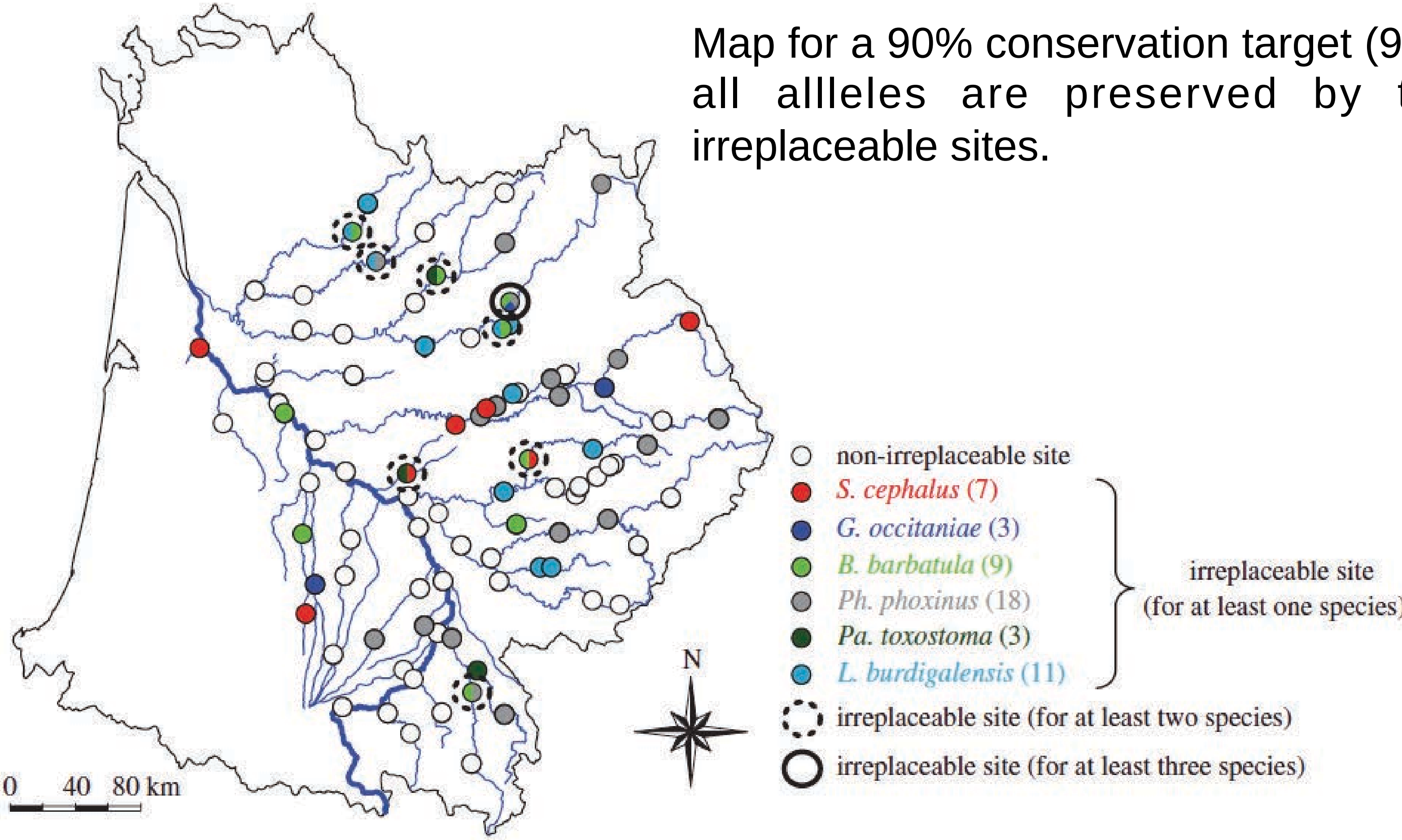


THE NUMBER OF IRREPLACEABLE SITES VARY ACCORDING TO THE CONSERVATION TARGET AND THE SPECIES

Paz et al. PRSLB 2018.

CONSERVATION PLANNING: IDENTIFYING PRIORITY ZONES FOR ID

Map for a 90% conservation target (90% of all allleles are preserved by these irreplaceable sites.



MOST IRREPLACEABLE SITES ARE SPECIES-SPECIFIC. HARD TO CONSERVE ID FOR A POOL OF SPECIES

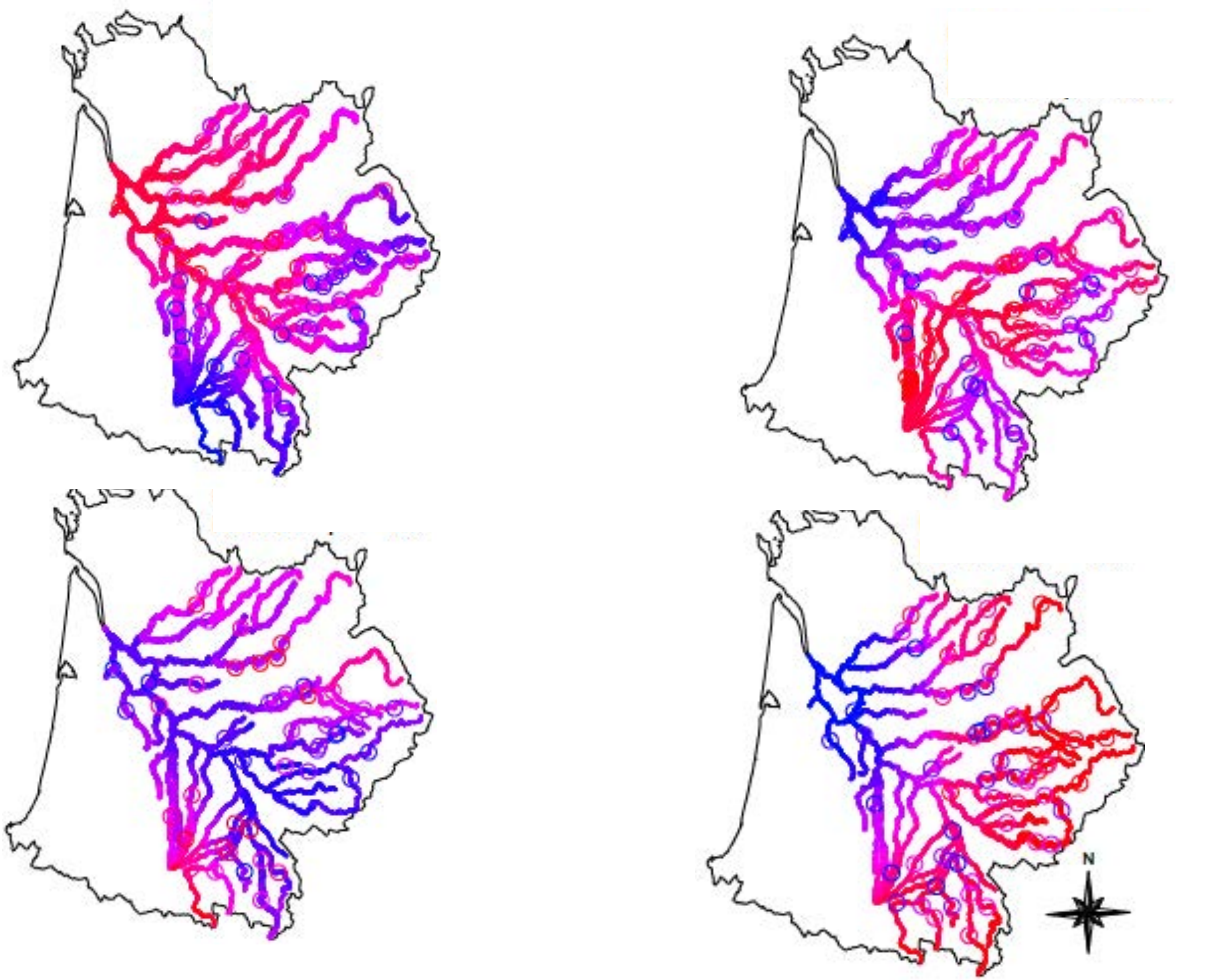
Paz et al. PRSLB 2018.

(III) INTRASPECIFIC DIVERSITY AND CONSERVATION PLANNING

ALLELIC RICHNESS | **GENETIC UNIQUENESS (Djost)**

CHUB

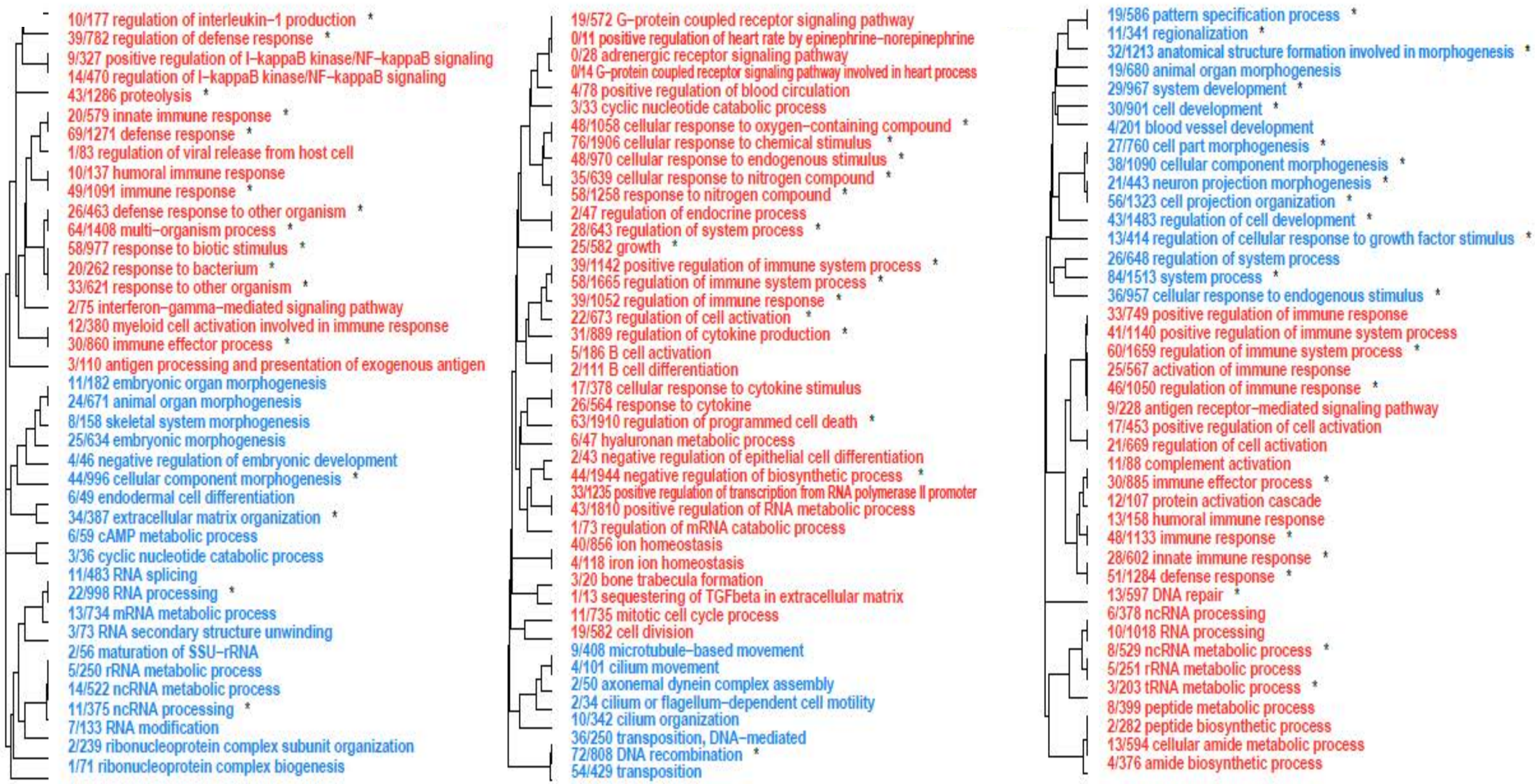
LOACH



SPATIAL PATTERNS OF GENETIC DIVERSITY ARE NOT CONGRUENT AMONG SPECIES

Paz et al. PRSLB 2018.

Molecular level: Gene expression profile & biological functions involved

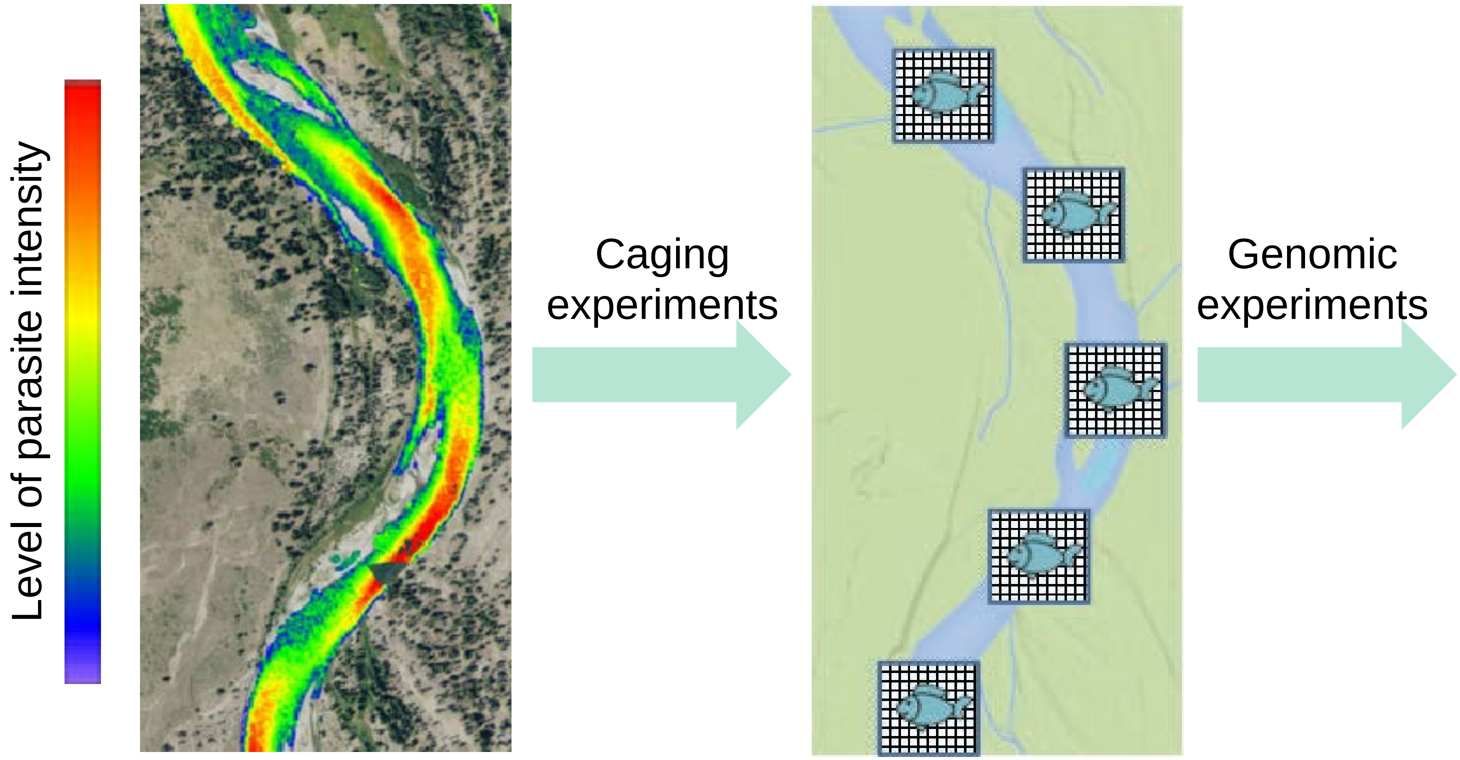


➔

Eglantine Mathieu-Bégné

THE ENVIRONMENTAL AND GENOMIC BASES OF RESISTANCE

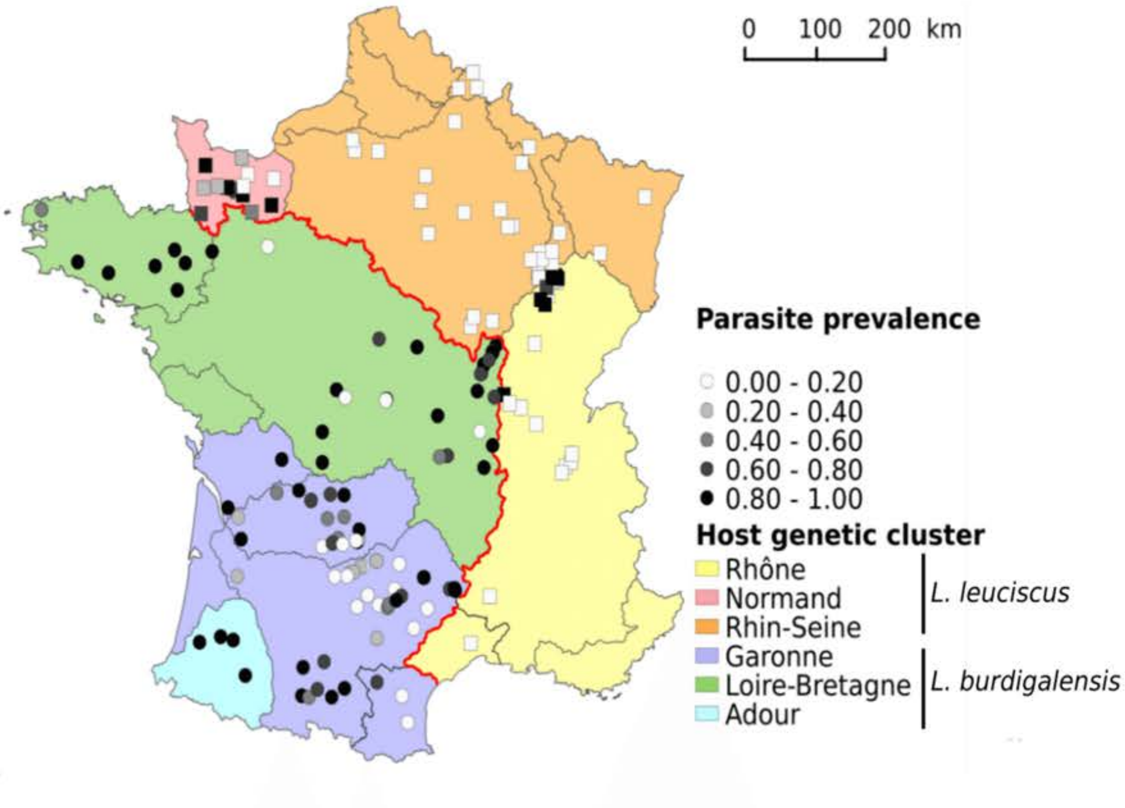
Meetic: How can an ugly larvae meet a lovely host in a desert?



RESOLVING THE "NEEDLE IN A HAYSTACK" PARADOX

THE ENVIRONMENTAL AND GENOMIC BASES OF RESISTANCE

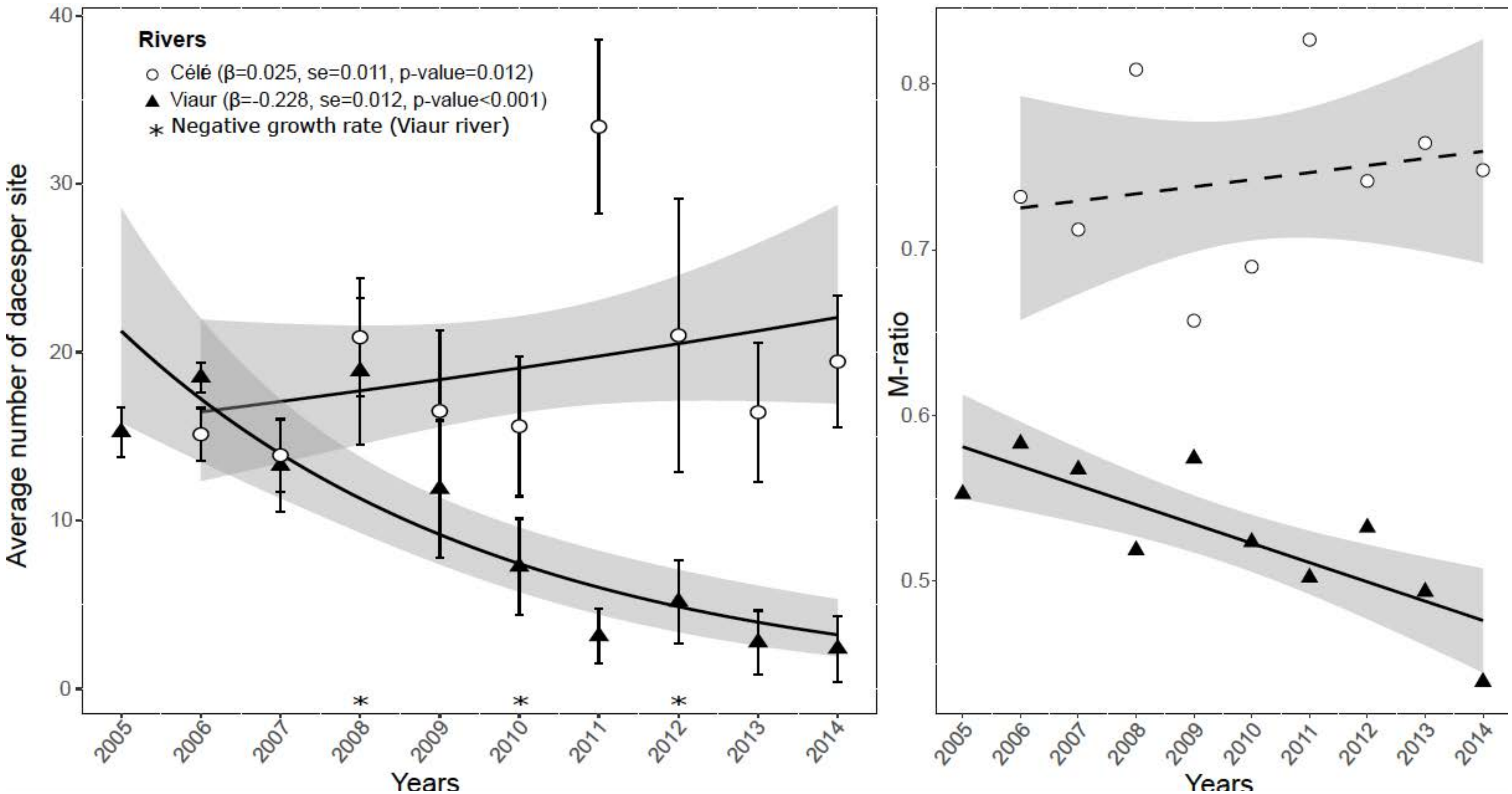
Eglantine Mathieu-Bégné



Environmental niche limitations *vs*. host resistance in uninfected areas?
→ Combining niche modeling and genomic analyses

UNDERSTANDING THE DRIVERS OF RESISTANCE AT LARGE SPATIAL SCALE

LONG-TERM CONSEQUENCES



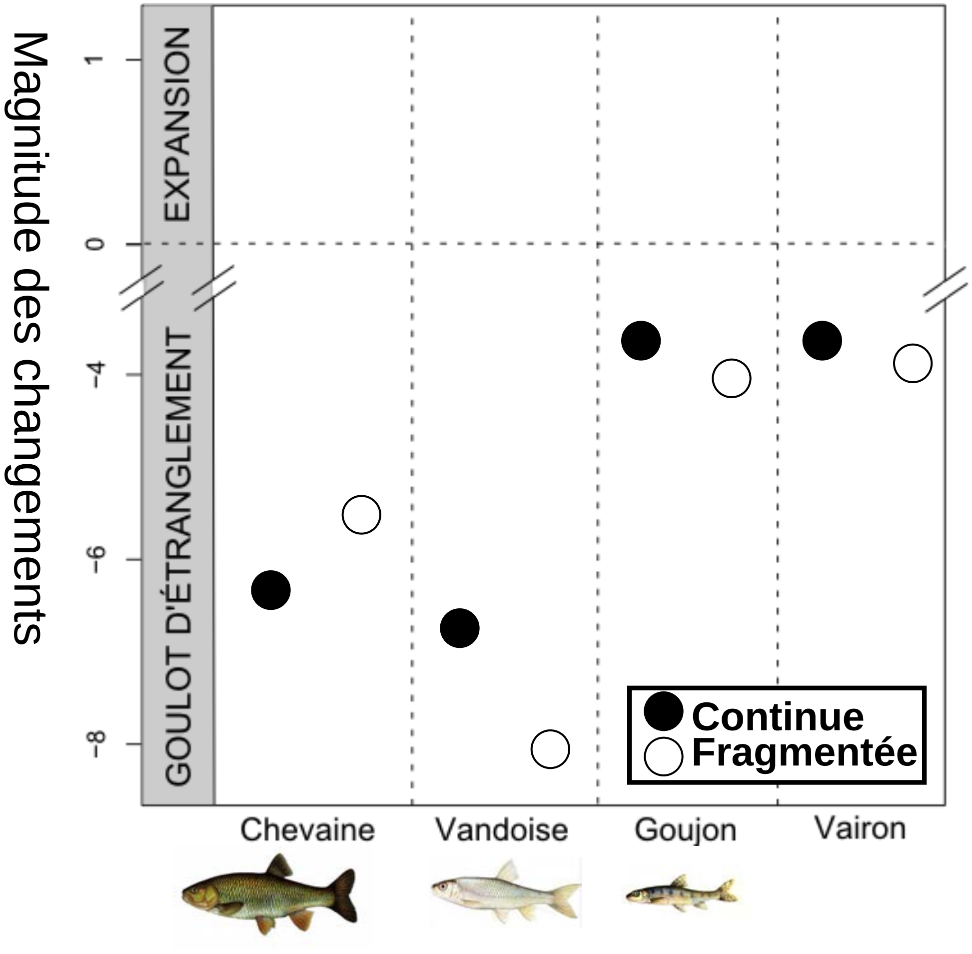
Eglantine Mathieu-Bégné

TEMPORAL DYNAMICS OF NEUTRAL AND NON-NEUTRAL GENETIC DIVERSITY IN HOST POPULATIONS

DYNAMIQUE DÉMOGRAPHIQUE DES POPULATIONS :

=> Restriction (goulot d'étranglement) attendue en cas de perte d'habitat

Deux rivières (Viaur et Célé) - Dix stations / rivière

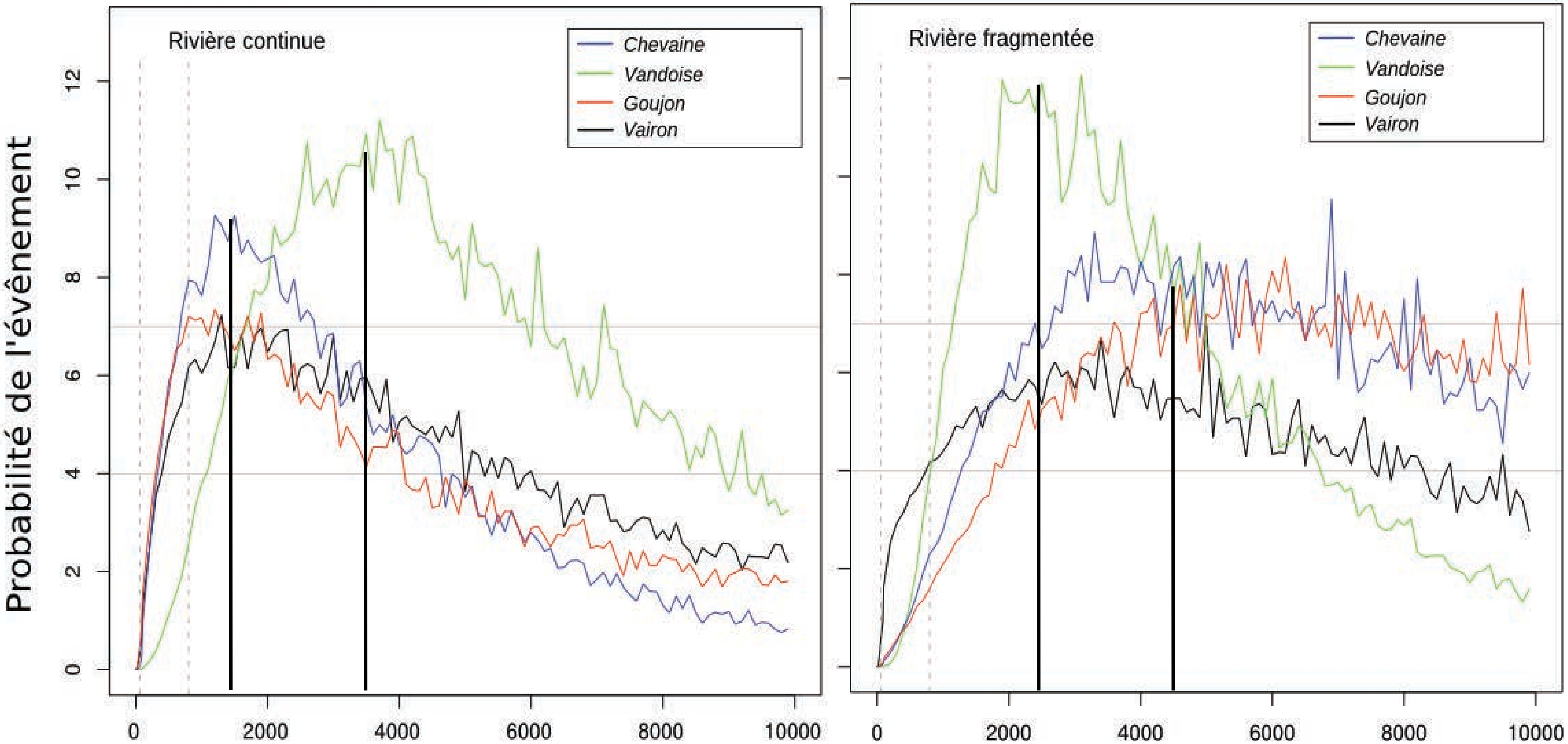


DIFFÉRENCE ENTRE TAILLE DE LA POP ANCESTRALE ET TAILLE DE LA POP ACTUELLE

FORTS GOULOTS D'ÉTRANGLEMENT POUR TOUTES LES ESPÈCES DANS LES DEUX RIVIÈRES

Paz et al. Soumis, 2012

DYNAMIQUE DÉMOGRAPHIQUE DES POPULATIONS :

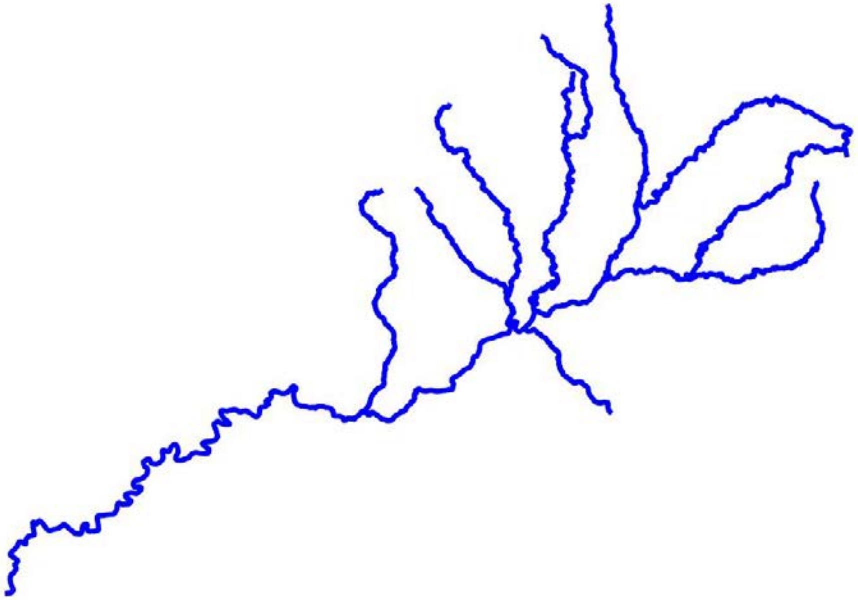


LA FRAGMENTATION NE SEMBLE PAS ÊTRE À L'ORIGINE DES GOULOTS D'ÉTRANGLEMENT DANS LE VIAUR ET LE CÉLÉ

Paz et al. Soumis, 2012

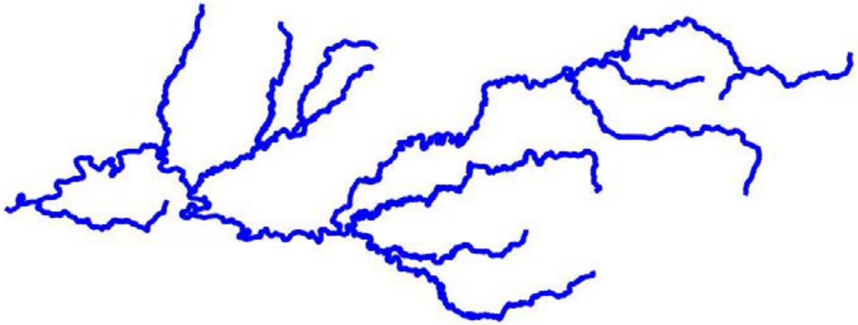
DEUX RÉSEAUX HYDROGRAPHIQUES :

LE CÉLÉ



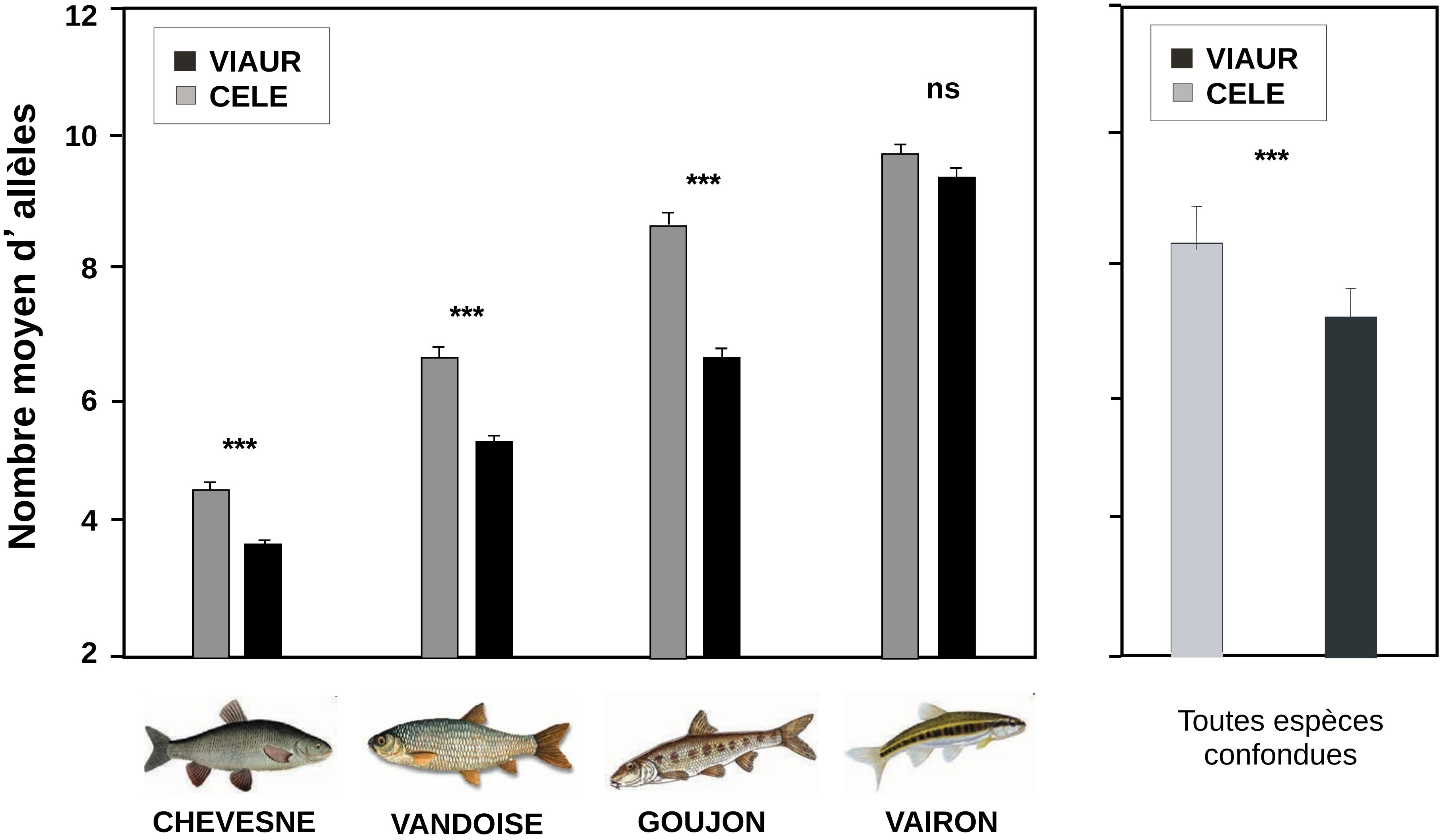
“Faiblement fragmentée”
(~15 chaussées, passes à poissons)

LE VIAUR



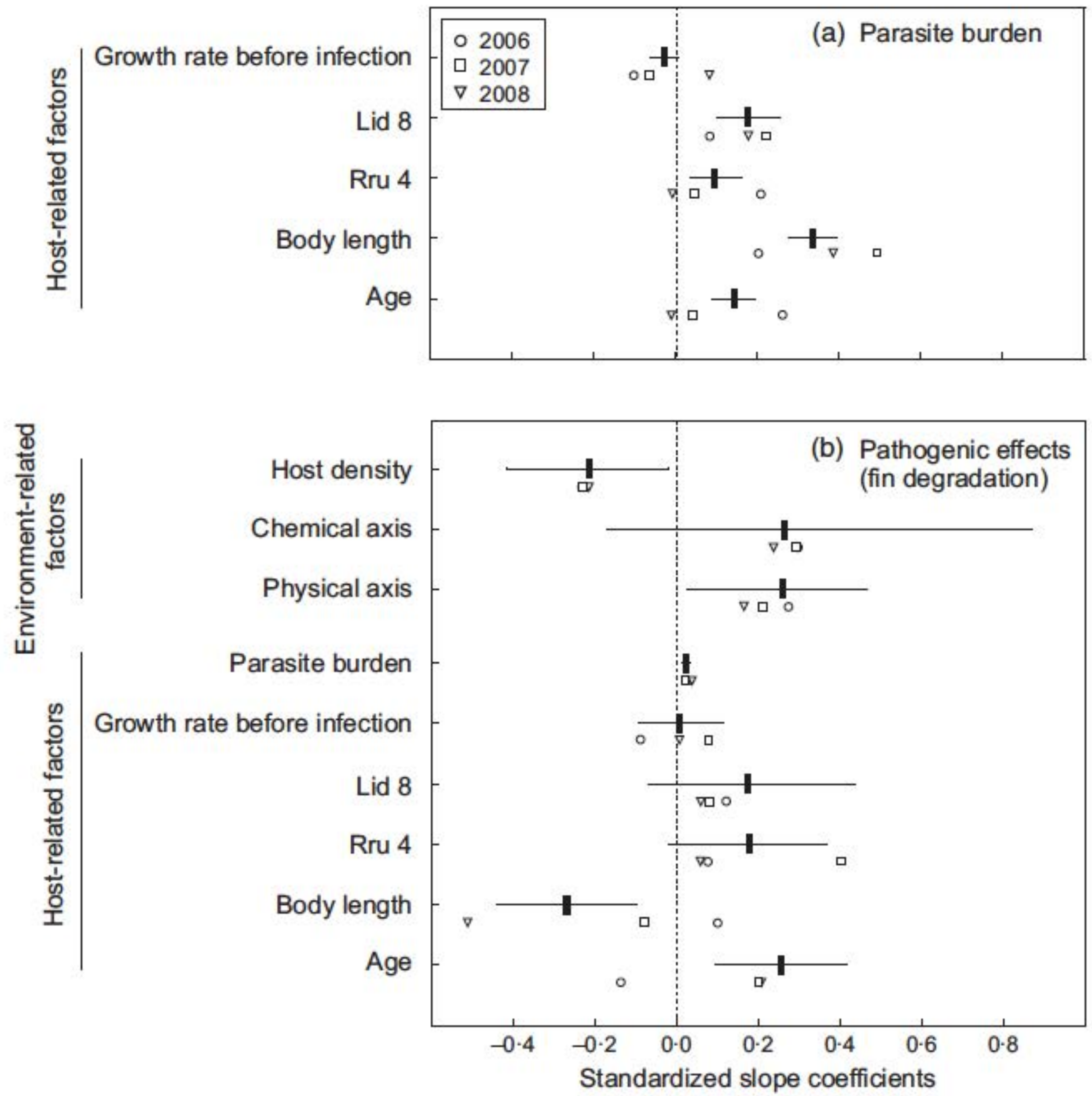
“Fortement fragmentée”
(~50 chaussées, 2 barrages hydro)

“FORTEMENT FRAGMENTÉ” = DIVERSITÉ PLUS FAIBLE



Blanchet et al. Evol. Appl., 2010

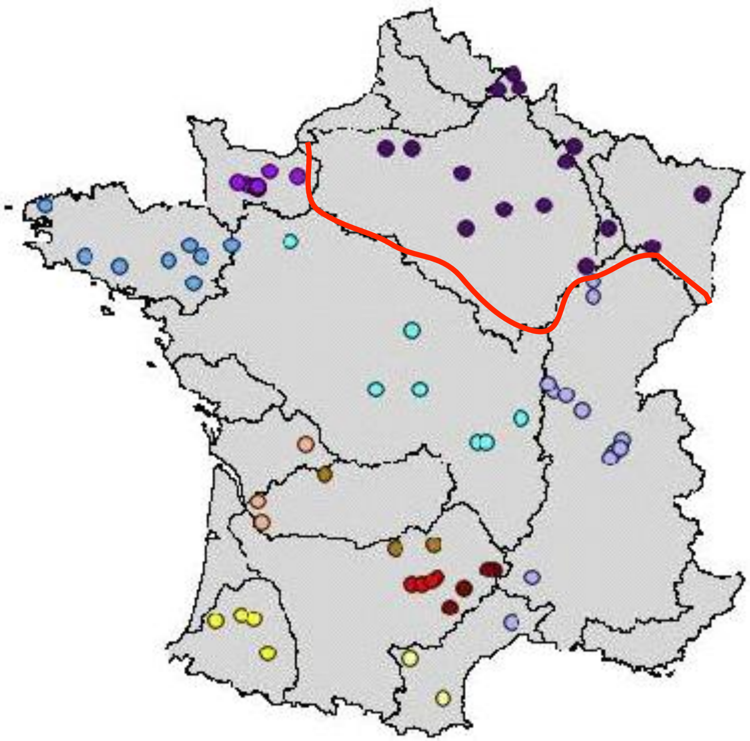
(III) RÉSISTANCE ET TOLÉRANCE



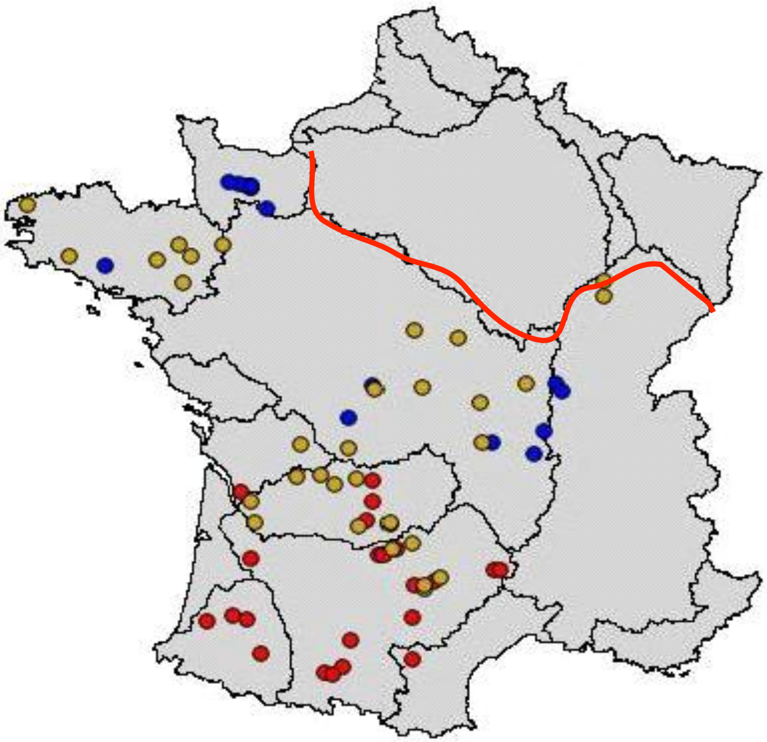
Cardon et al. J Anim Ecol, 2011

STRUCTURE GÉNÉTIQUE HÔTE ET PARASITE
(MICROSATELLITES)

HOST



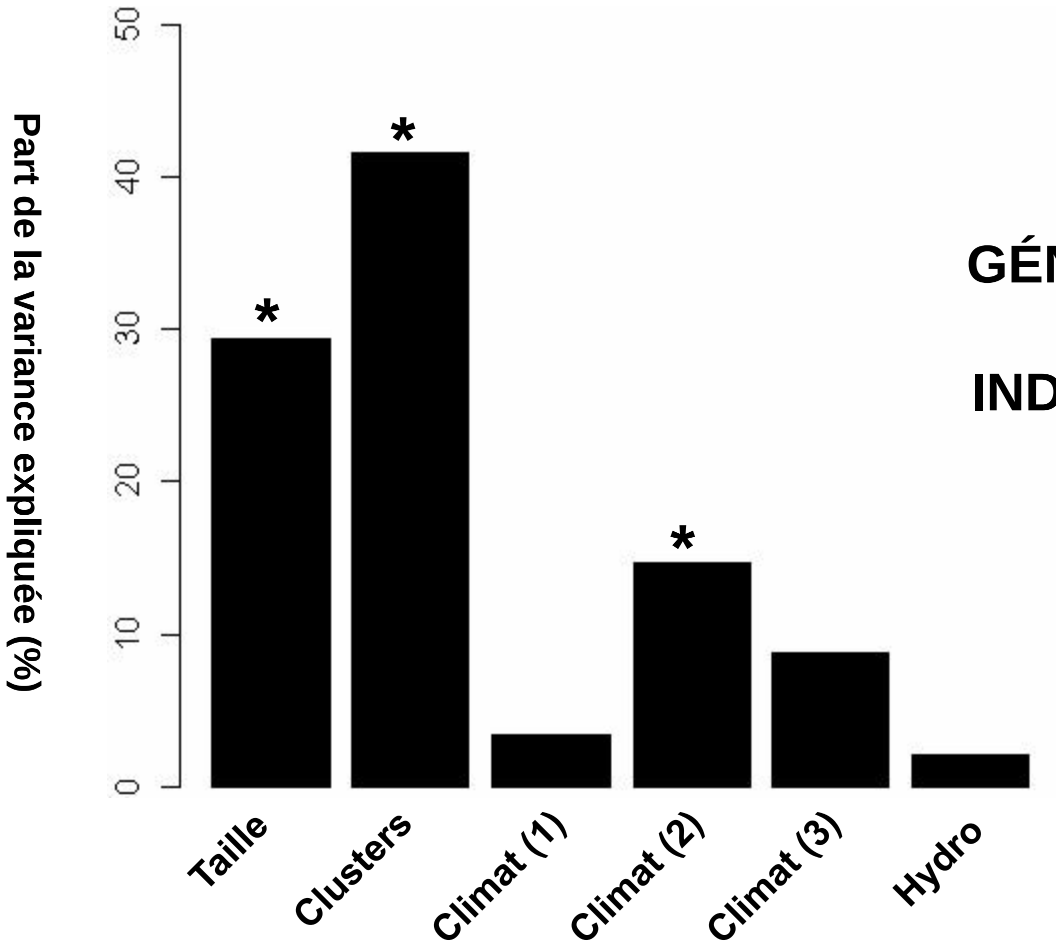
PARASITE



ASSOCIATION GÉNOTYPE – PRÉVALENCE?

PARTITIONEMENT DE LA VARIANCE

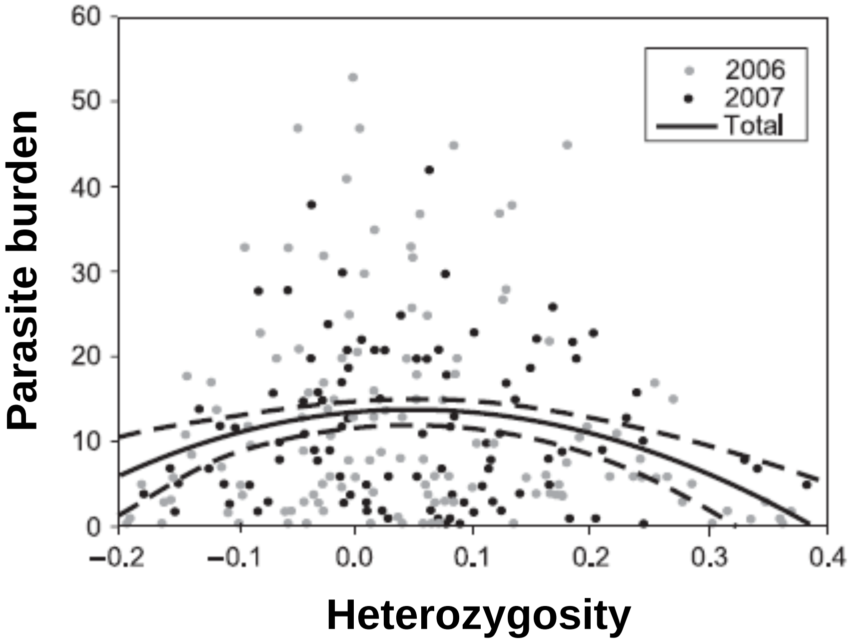
(PRÉVALENCE~TAILLE+CLUSTER GÉNÉTIQUE+HYDROMORPHO+CLIMAT)

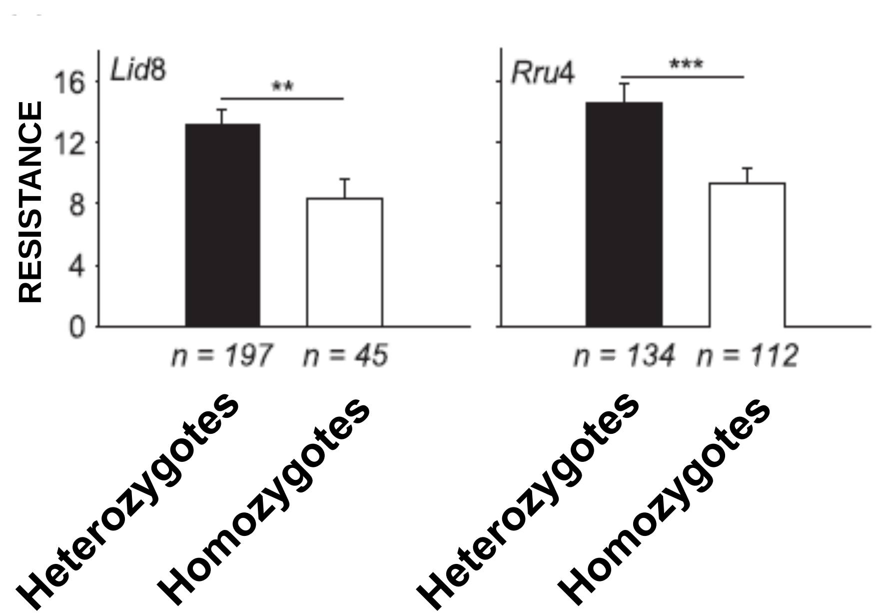


ASSOCIATION GÉNOTYPE – PRÉVALENCE SIGNIFICATIVE ET INDÉPENDANTE D'AUTRES CO-FACTEURS

(II) TOLERANCE - RÉSISTANCE

DÉTERMINISMES ENVIRONNEMENTAUX ET GÉNÉTIQUES





RELATIONS SIGNIFICATIVE ENTRE DIVERSITÉ GÉNÉTIQUE (MICROSAT), TOLÉRANCE ET RÉSISTANCE

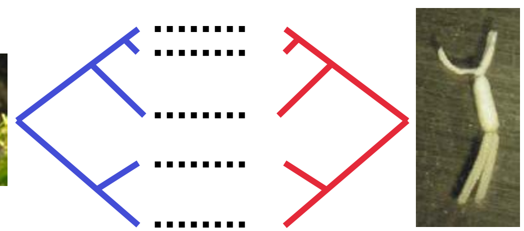
Cardon et al. J Anim Ecol, 2011

ET LA RECHERCHE APPLIQUÉE ?

=> CAPACITÉ DE COLONISATION

(1) Filtre environnemental
- => Facteurs abiotiques (T°C, courant, oxygénation)
- => Facteurs biotiques (densité de l’hôte)

(2) Capacité de dispersion

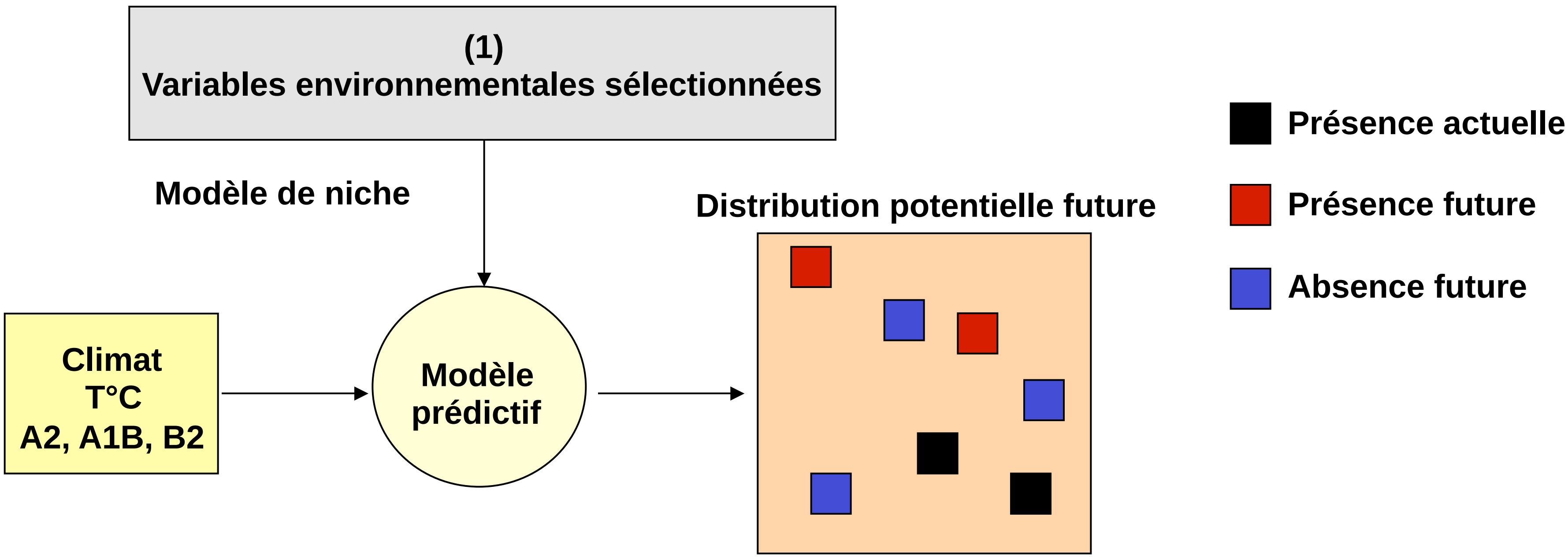


(3) Adaptation locale
- => Expérimentation en mésocosmes

(4) Capacité de transfert d’hôtes
- => Etude descriptive comparative
- => Etude fitness parasite

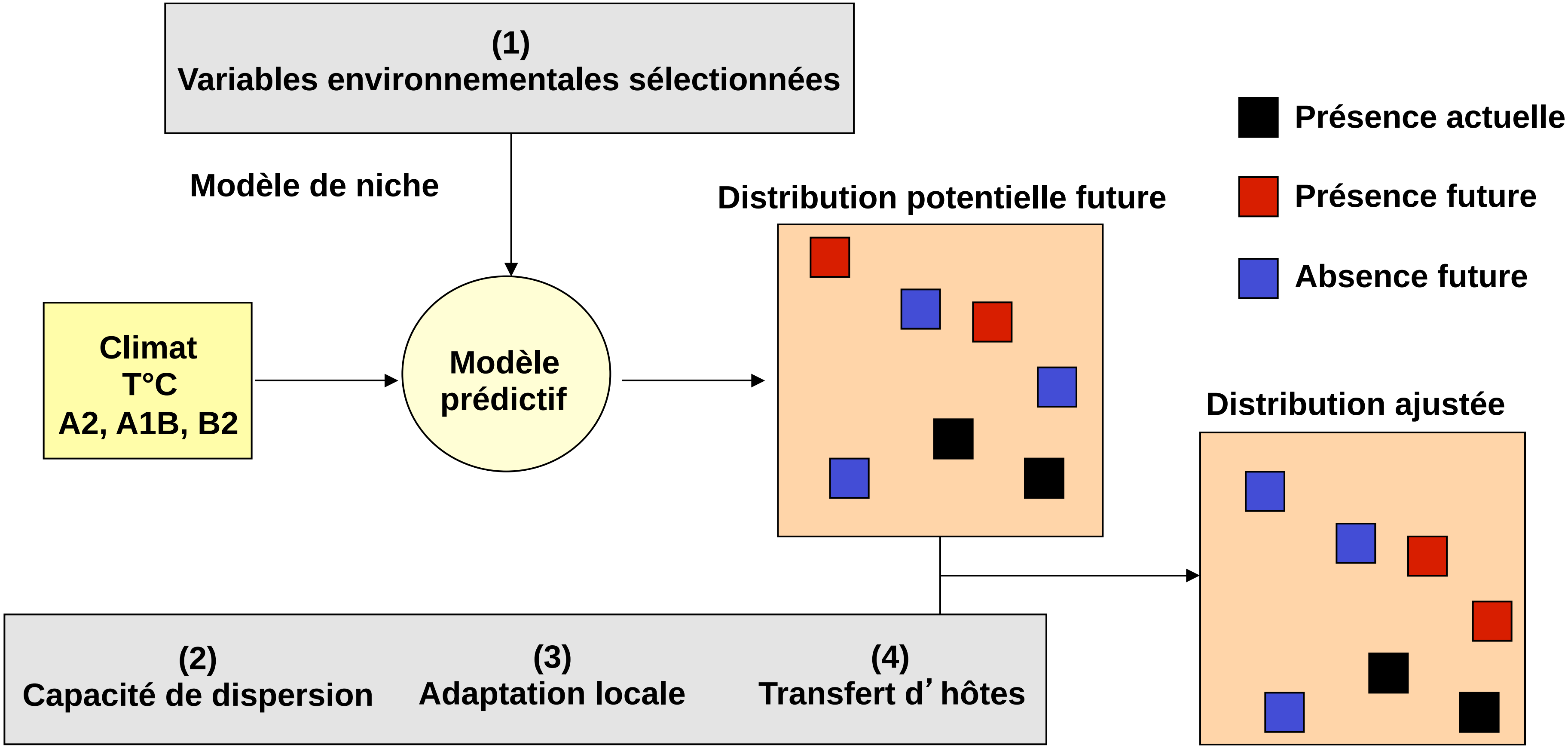
ET LA RECHERCHE APPLIQUÉE ?

=> PRÉDIRE DISTRIBUTION FUTURE



ET LA RECHERCHE APPLIQUÉE ?

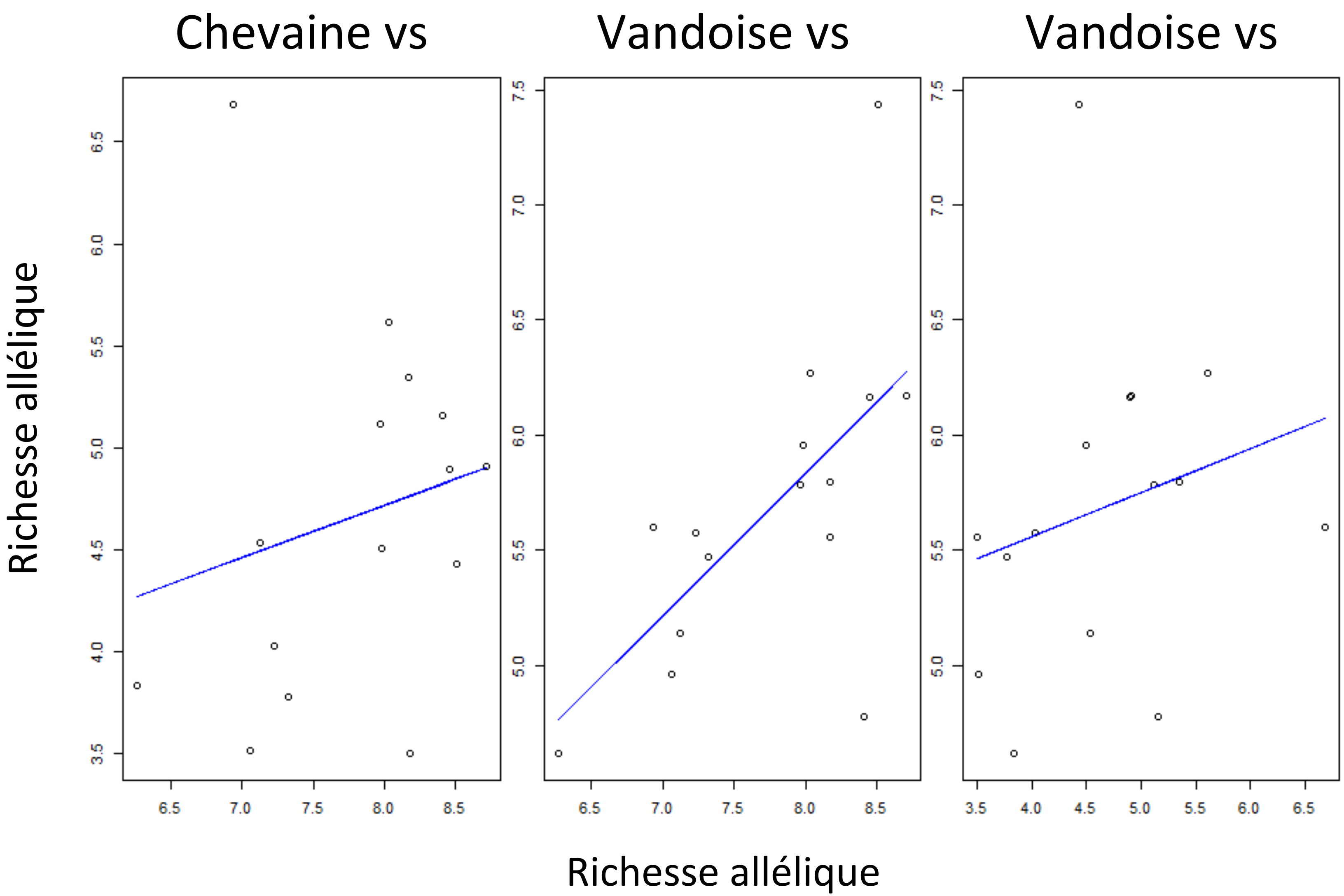
=> PRÉDIRE DISTRIBUTION FUTURE



⇒ Carte de distribution future : outil de gestion

⇒ Modèles prédictifs plus réalistes

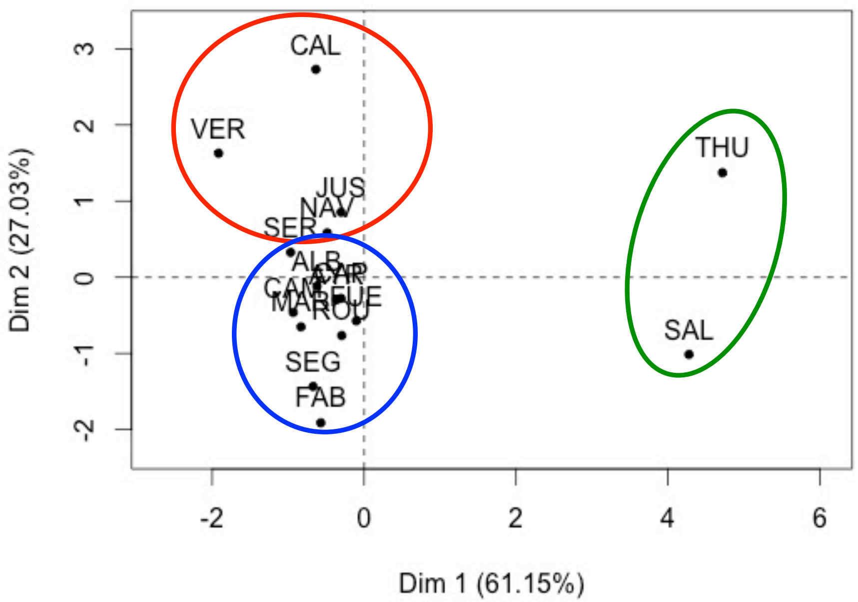
III - PREMIERS RÉSULTATS



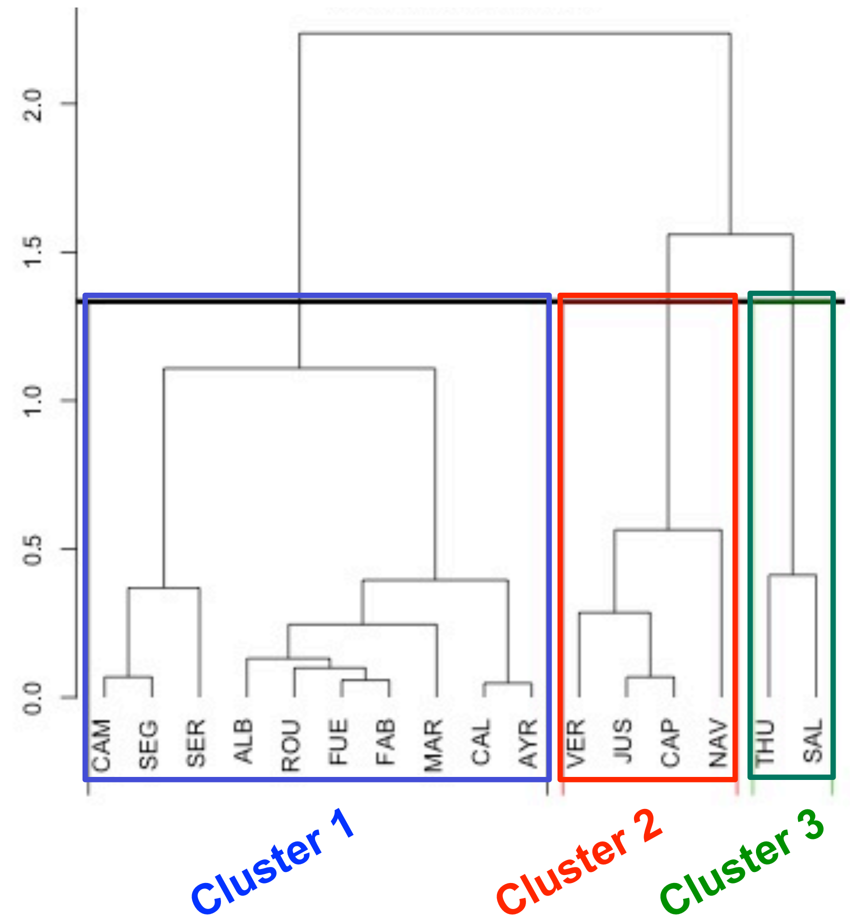
Congruence pour la vandoise et le goujon

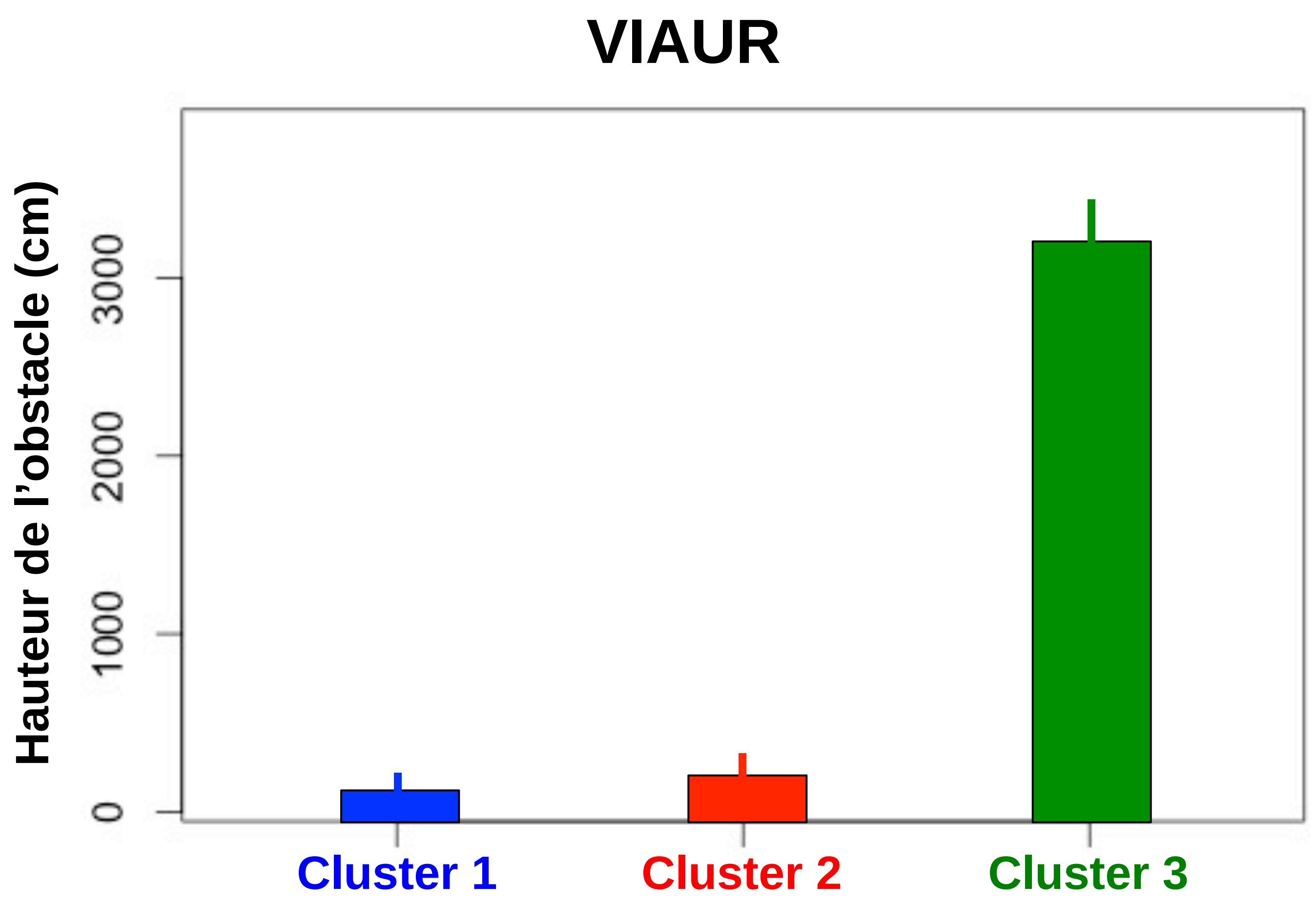
VIAUR

ACP SUR INDICES DE CONNECTIVITÉ



CLUSTERING





⇒ Pas d'effets de distance à la source, pente, tirant d'eau

⇒ Importance de la hauteur de l'obstacle (barrages hydroélectriques)