Qu'est ce qui détermine la diversité génétique des animaux ?

Jonathan Romiguier
the PopPhyl project

374 transcriptomes in 76 non-model species

What are the determinants of genetic diversity?

J. Romiguier et al., 2014, Nature
What determines genetic diversity?

\[ \pi_s = Ne \times 4\mu \]

Neutral nucleotidic diversity

Effective population size

Mutation rate
What determines genetic diversity?

πᵔ = Ne x 4μ

Neutral nucleotidic diversity

Effective population size

Mutation rate

Species biology

Ambundance

Body Size

Fecundity

Generation time

Longevity
What determines genetic diversity? 

Neutral nucleotidic diversity

\[ \pi_s = \text{Ne} \times 4\mu \]

Effective population size

Mutation rate

Can we predict genetic diversity from species biology?

→ No empirical data have shown this link (Leffler et al. 2012)
→ Many confounding factors are expected to prevent \( \pi_s \) prediction
What determines genetic diversity?

\[ \pi_s = Ne \times 4\mu \]

- Neutral nucleotidic diversity
  - Effective population size
  - Mutation rate

### Species biology
- Ambundance
- Body Size
- Fecundity
- Generation time
- Longevity

### Environmental disturbances
- Demographic history
  - Distribution area
  - Population bottlenecks
  - Population structure
- Adaptative history
  - Local adaptation
  - Selective draft
What determines genetic diversity?

Neutral nucleotidic diversity

\[ \pi_s = N_e \times 4\mu \]

Effective population size
Mutation rate

Ambundance
Body Size
Fecundity
Generation time
Longevity

Species biology

Environmental disturbances

Demographic history
Distribution area
Population bottlenecks
Population structure

Adaptative history
Local adaptation
Selective draft

Species history

Can we predict genetic diversity from species biology?

Too much noise from recent demographic or adaptative history to predict anything?
Overview of the species sampling

- 9 Phyla
- 31 Families
- 1 focal species (7-11 individuals)
- 0-3 taxonomic replicate (2-4 individuals)
- 76 species
- 374 individuals

Transcriptome sequencing (Illumina)
De novo assembly (Cahais et al. 2012)
SNP calling (Tsagkogeorga et al. 2012)

2.58 millions SNPs
Genome-wide nucleotidic diversity $\pi$
Results: Genetic diversity distribution across the Metazoan tree of life
Low genetic diversity levels are not restricted to large Vertebrate but are found repeatedly in the metazoan tree of life.
Results: Genetic diversity distribution across the Metazoan tree of life

1st observation
Low genetic diversity levels are not restricted to large Vertebrate but are found repeatedly in the metazoan tree of life

2nd observation
Species from the same family have similar genetic diversity levels (ANOVA, p-value<0.0001)

Non-stochastic evolution of $\pi_s$

Species biology > Species history
Effect of body size
(classical abundance/Ne proxy)

Species biology

Significant (p-value < 0.0001) but low explained variance ($R^2 = 0.19$)

$\Pi_s (\%)$

Adult size (cm)
Can we predict genetic diversity from species biology?

The key to understand what determines $\pi_s$ is probably contained in the difference between these two groups.
Can we predict genetic diversity from species biology?

Parental investment index

Low parental investment

High parental investment

Size of the stage leaving its parents to disperse

Propagule size

Adult size

\( \pi_s (\%) \)
Parental investment and propagule size key parameters

\[ \Pi_s (\%) \]

Adult size
\[ R^2 = 0.19 \]

Propagule size
\[ R^2 = 0.58 \]
Propagule size explains $\pi_s$ disparities

$R^2 = 0.57$
Averaged values per families

Species with Low $\pi_s$ are K-strategists (favour quality)

Species with High $\pi_s$ are r-strategists (favour quantity)

$R^2 = 0.72$
Take-home messages

→ Genetic diversity can be predicted from species biology

→ Invertebrate species with high parental investment can have genetic diversity as low as large vertebrates

→ Propagule size is the key parameter to explain genetic diversity disparities across species

At this scale, demographic history seems to have a secondary influence on genetic diversity. Life-history strategies is what determines most of the genetic diversity disparities in animal species.
Thanks to:

Nicolas Galtier

- the PopPhyl team:
  - P. Gayral
  - V. Cahais
  - Y. Chiari
  - N. Faivre
  - E. Loire
  - J. Lourenço
  - M. Ballenghien
  - G. Tsagkogeorga
  - L. Weinert
  - A. Bernard
  - C. Roux
  - J. Romiguier

- collaborators:
  - S. Glémin
  - N. Bierne
  - F. Delsuc
  - J. Melo-Fereira
  - M. Carneiro
  - V. Ranwez

- dozens of sample providers

http://kimura.univ-montp2.fr/PopPhyl
http://mbb.univ-montp2.fr/MBB/