Linear mixed models: a case study in behavioral ecology

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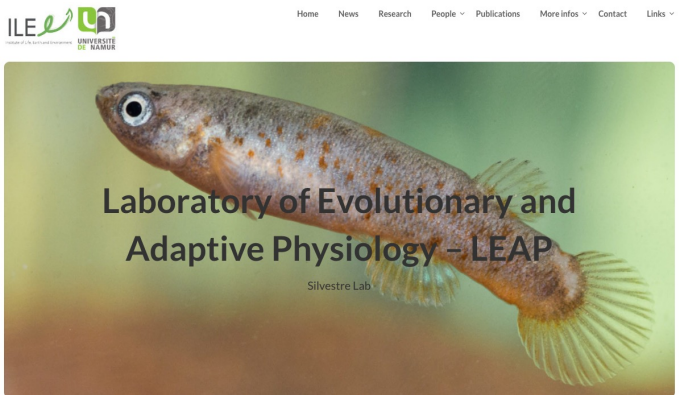

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LEAP

Laboratory of Evolutionary and Adaptive Physiology

https://github.com/fredsilvestre/LMM-case-study-master-BOE

- Context: « README.md »
- ppt « LMM introduction case study… »
- R script to be fulfilled « CDIS » (copy/paste in Rstudio)
- Dataset « Dataset CDIS.csv »
- Dataset for the assignment « Dataset TDM.csv »
- Assignment for the exam « Assignment »
- Example of a study « Bierbach et al 2017 »

The mangrove rivulus: surviving in the mangroves

Kryptolebias marmoratus

The mangrove rivulus: surviving in the mangroves

Rivulus microhabitat and sampling

The mangrove rivulus: surviving in the mangroves

https://www.youtube.com/watch?v=FsDtWwm-XoI&t=929s

The mangrove rivulus: surviving in the mangroves

Simultaneous Hermaphrodites

Males (1-25%)
(Primary and secondary males)

K. marmoratus = Only known self-fertilizing vertebrate

= androdioecy
(≠ parthenogenesis)

The mangrove rivulus: surviving in the mangroves

Simultaneous Hermaphrodites

Outcrossing

Males (1-25%)
(Primary and secondary males)

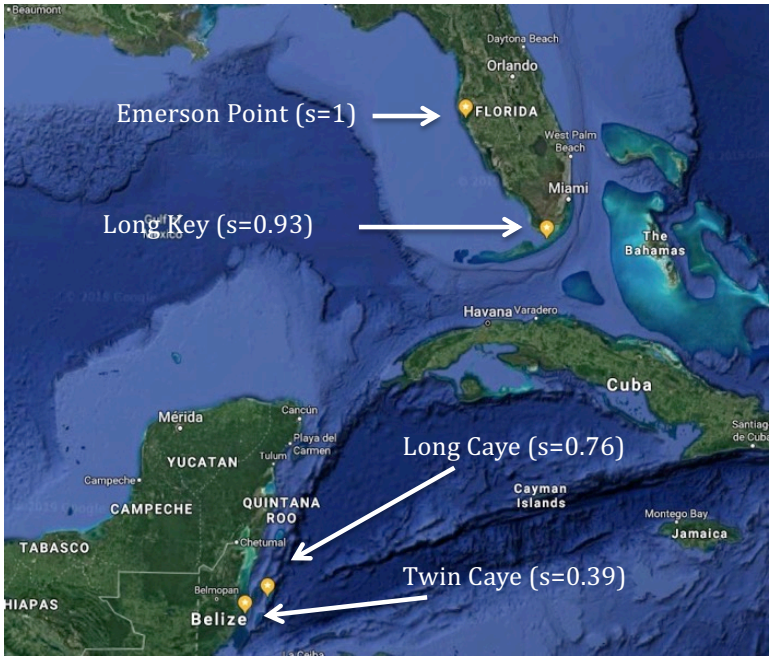
Variable OC (low OC in Florida ; higher in Belize)

Self-fertilization

The mangrove rivulus: surviving in the mangroves

Scientific field missions 2019: Belize and Florida

Valentine Chapelle thesis : "*The epigenetic origin of behavioral traits variability in a self-fertilizing fish : the mangrove rivulus*"



The mangrove rivulus: surviving in the mangroves

a

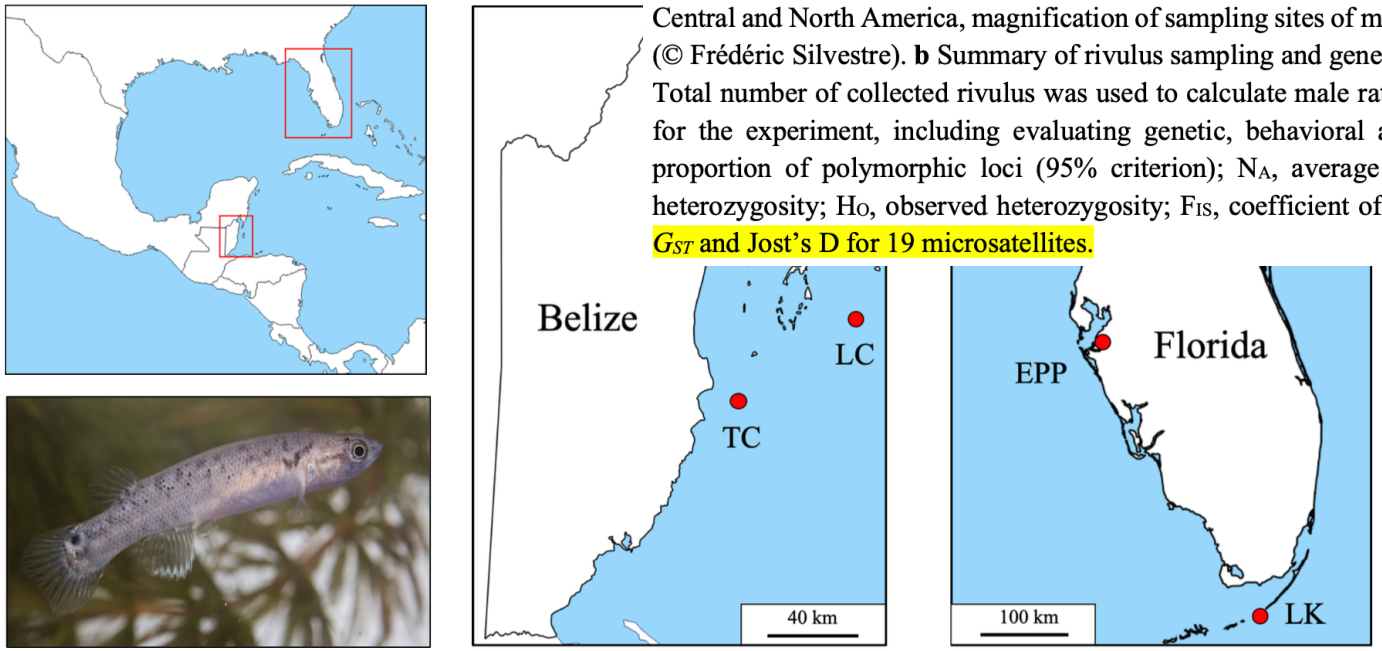


Fig. 1 Sampling and genetic diversity of four populations of mangrove rivulus *Kryptolebias marmoratus*. **a** Map of Central and North America, magnification of sampling sites of mangrove rivulus and photograph of hermaphrodite rivulus (© Frédéric Silvestre). **b** Summary of rivulus sampling and genetic variation in four populations from Belize and Florida. Total number of collected rivulus was used to calculate male ratio in each population. Rivulus where randomly selected for the experiment, including evaluating genetic, behavioral and epigenetic diversity. N, number of individuals; P, proportion of polymorphic loci (95% criterion); N_A, average number of alleles; A_R, allelic richness; H_E, expected heterozygosity; H_O, observed heterozygosity; F_{IS}, coefficient of inbreeding; S, selfing rate. **c** Pairwise estimates of F_{ST}, G_{ST} and Jost's D for 19 microsatellites.

b

Population	Total collected	Male ratio	N	P	N_A	A_R	H_E	H_O	F_{IS}	S
Twin Cayes (TC)	177	0.418	40	0.95	6.10	5.14	0.62	0.43	0.32	0.49
Long Caye (LC)	32	0.125	28	0.90	5.30	4.52	0.57	0.13	0.71	0.85
Long Key (LK)	36	0.028	30	0.65	2.80	2.59	0.35	0.10	0.71	0.83
Emerson Point Preserve (EPP)	540	0.004	42	0.35	1.65	1.33	0.04	0.00	0.94	0.97

The mangrove rivulus: surviving in the mangroves

Behavioral tests for boldness and exploration for 140 fish = 163 hours of video to be analyzed

Epigenome to be analyzed in brain, liver and gonads

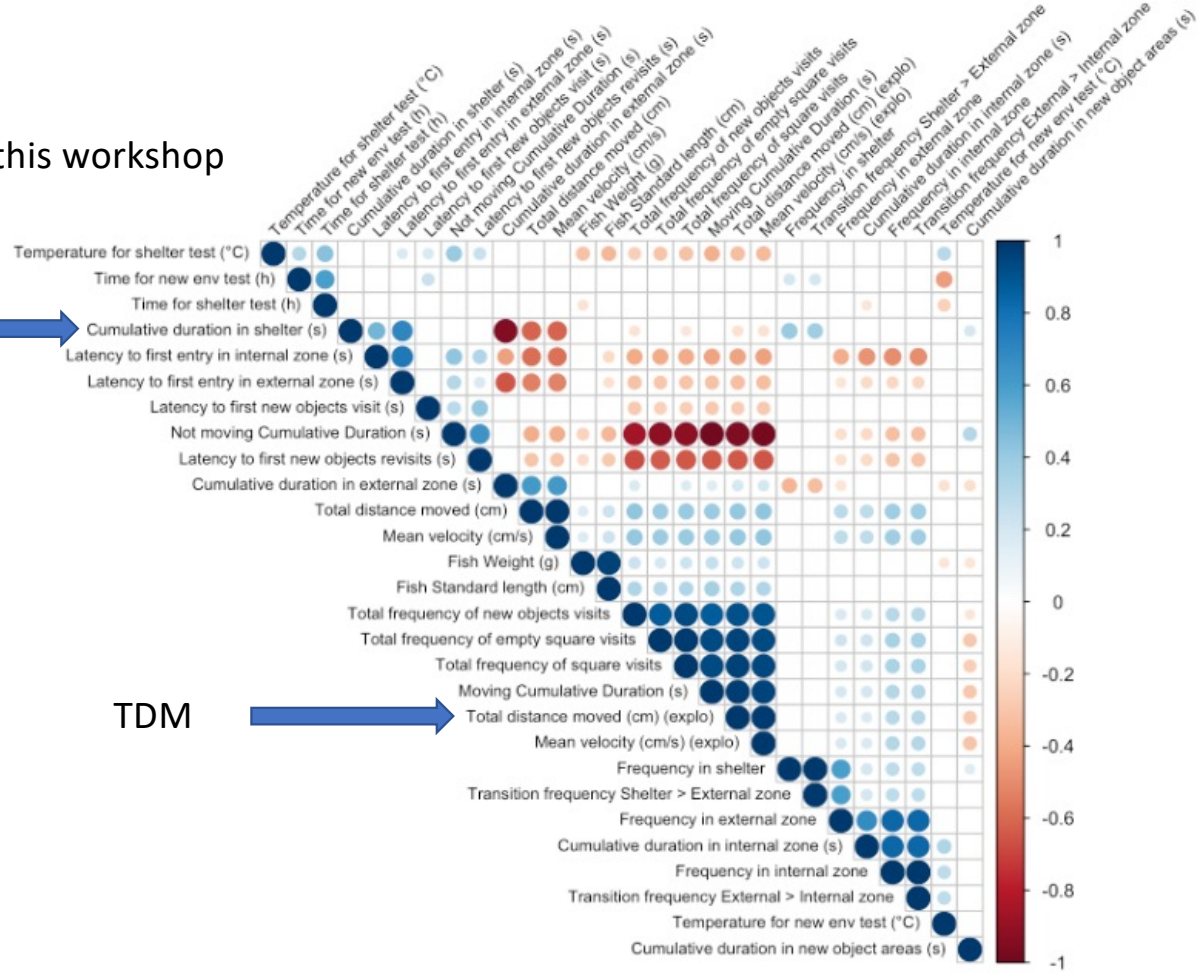
2 tests in duplicate !!:
- Shelter test
- Open Field test

The measured variables and their correlations

2 Response variables to be analysed in this workshop

CDIS

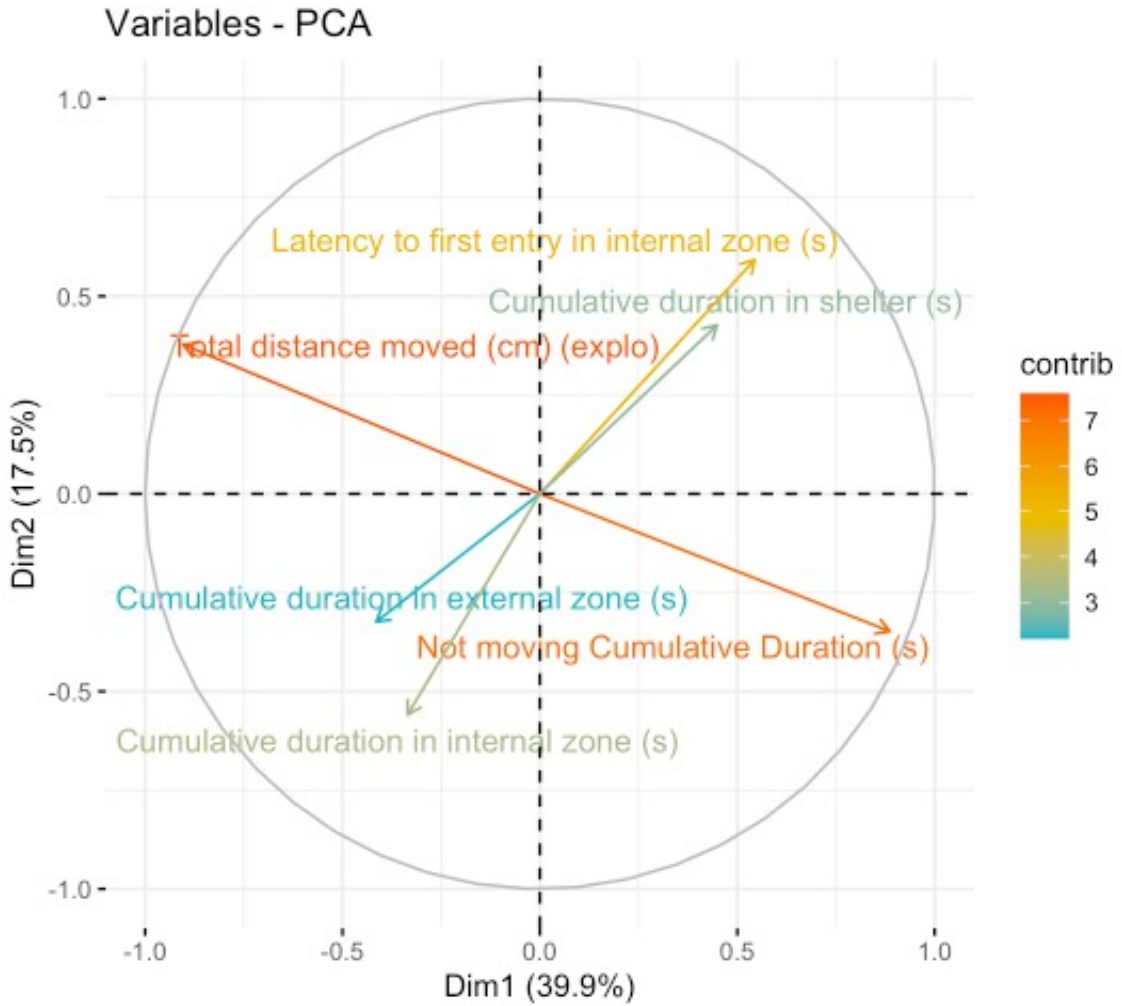
TDM



Explanatory variables:

- Population
- Replicate
- Fish length
- Fish weight
- Fish ID
- Temperature (for each test)
- Time (for each test)

PCA of the 6 selected response variables



Rstudio

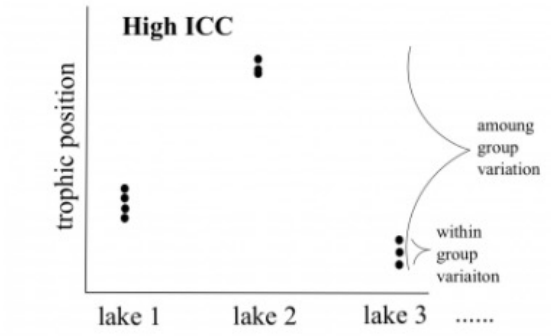
- Prepare the working environment
- Install and load the packages
- Load the data

1° Preparation of the data
2° Exploration of the data
3° Search for colinearity
4° Search for extreme values
5° Variables transformation
6° Model building
7° Model validation
8° Model visualization
9° Repeatability calculation

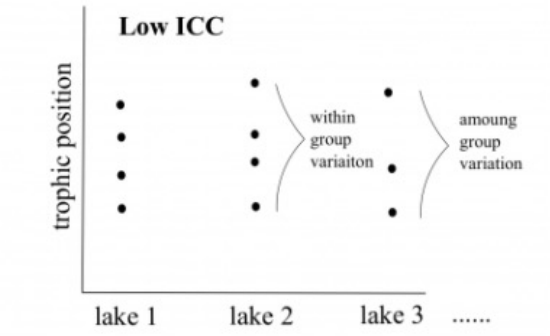
Questions scientifiques ?

ICC (Intraclass correlation coefficient)

High ICC



Low ICC



Conditional repeatability $R = \frac{\mathrm{VAR}_{across}}{\mathrm{VAR}_{across} + \mathrm{VAR}_{resid}}$