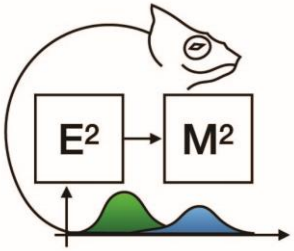
Vector dynamics-1

Hélène Guis



❖ **Background:**

Dynamics of arthropod vectors → dynamics of vector-borne disease.

Dynamics *of Culex antennatus,* a major vector of Rift Valley fever virus, has never been studied in the central highlands of Madagascar.

❖ **Question for the statistical model:**

What are the environmental drivers of *Culex antennatus* dynamics in Andoharanofotsy (Analamanga)?

❖ **Question for the mechanistic model:**

How sensitive are the dynamics of *Culex antennatus* to climate-driven parameters?

Thanks to E²M² team and Liantsoa and Nina

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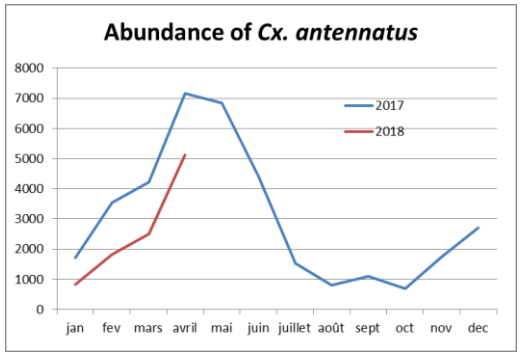
Vector dynamics-2: Statistical model

❖ **Question for the statistical model : What are the environmental drivers of *Culex antennatus* abundance in Andoharanofotsy?**

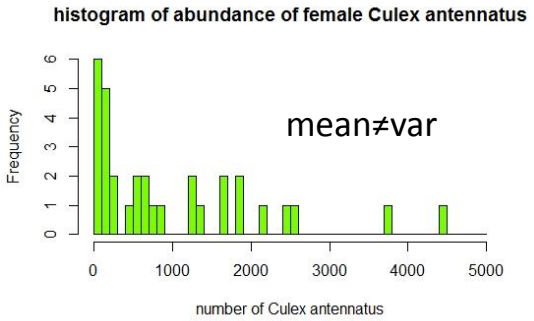
❖ **Generalized linear negative binomial model (glm.nb)**

m1<- glm.nb(Abundance~X1 + X2 +…+ Xn), data=d1)

- **Response variable:** Abundance of *Cx. antennatus* (count data)
- **Predictor variables:** Xi: environmental variables among: temperature, rainfall, humidity, sunshine, lunar phase, different vegetation and water indices (NDVI, EVI, NDWI…)
- Explanatory variables will be lagged
- Glm.nb *vs* mixed model:
  - Repeated measures: but in only one site (no site effect)
  - Temporal correlation: with lagged climate variables
    → start as glm, not a mixed model



- 1 site, 16 months
- Bi-monthly catches



❖ **Outcome**

- Which environmental variables drive the dynamics
- Optimal lag for these variables

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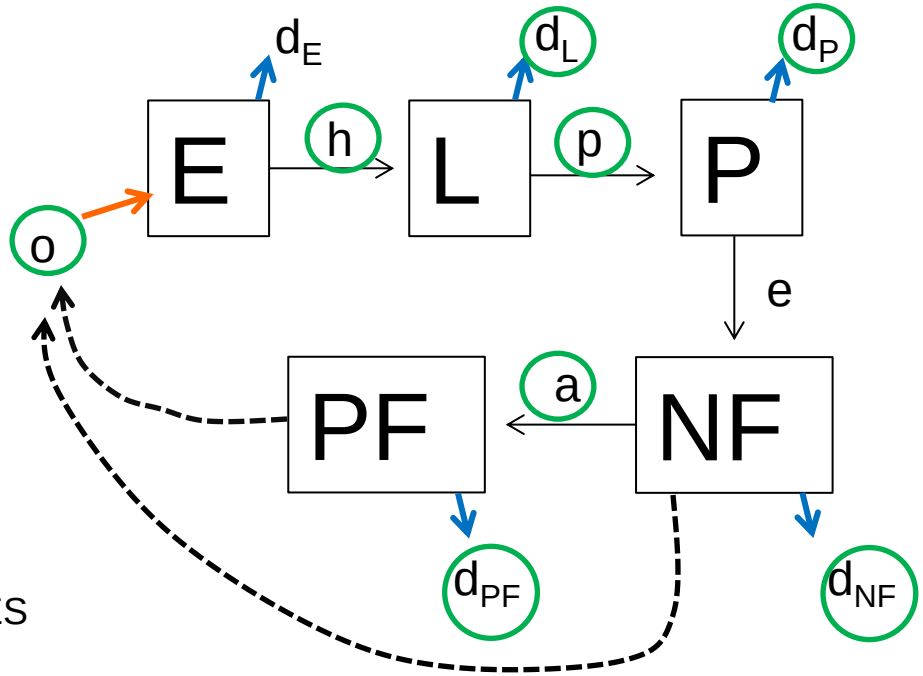
Vector dynamics-3: Mechanistic model

❖ **Question: How sensitive are the dynamics of *Culex antennatus* to different climate-driven parameters?**



$$\frac{dE}{dt} = -hE - d_E + o.PF.NF$$

$$\frac{dL}{dt} = -pL - d_L + hE$$

$$\frac{dP}{dt} = -eP - d_P + pL$$

$$\frac{dNF}{dt} = -a.NF - d_{NF} + eP$$

$$\frac{dPF}{dt} = -d_{PF} + a.NF$$

STATES
E: Egg
L: Larvae
P: Pupae
NF: Nulliparous females
PF: Parous females

PROCESSES
o: oviposition
h: hatching
p: pupation
e: emergence
a: aging
d: death

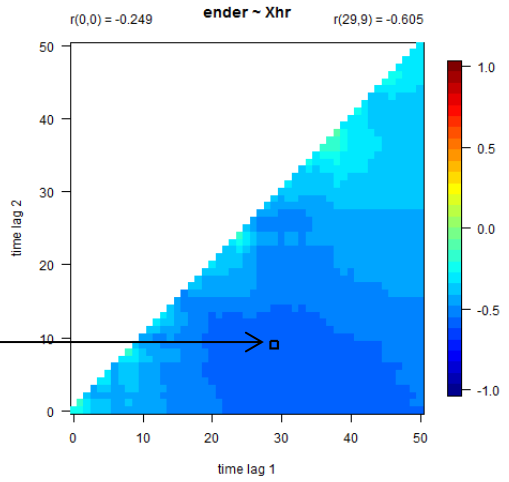
CLIMATE-dependant parameters (temperature and rainfall)

Vector dynamics-4: Further steps

❖ Time-lagged environmental variables (statistical model)

→ Cross correlation maps (Curriero *et al.* VBZD, 2005)

Determines the lagged period for which correlation between abundance and the environmental variable is the strongest: *eg.* humidity of 9 to 29 days before the catch



❖ GLM:

- Check residuals for autocorrelation (*acf* function)
- If temporal autocorrelation, include abundance(t-1) as explanatory variable

❖ Mechanistic model

- Estimate parameters and carrying capacities for *Culex antennatus* (literature review + discussion with entomologists)
- Sensitivity analysis to assess impact of parameters

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