Population dynamics under temperature fluctuations

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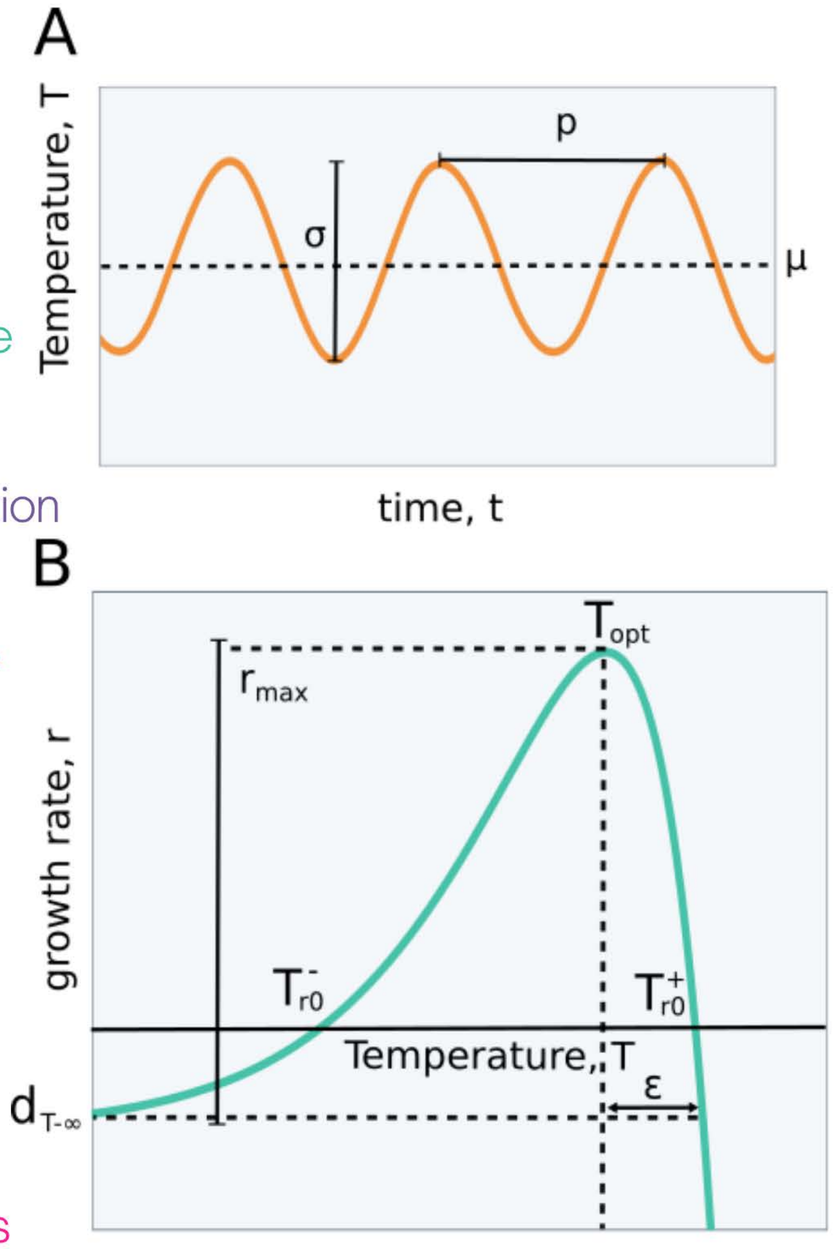
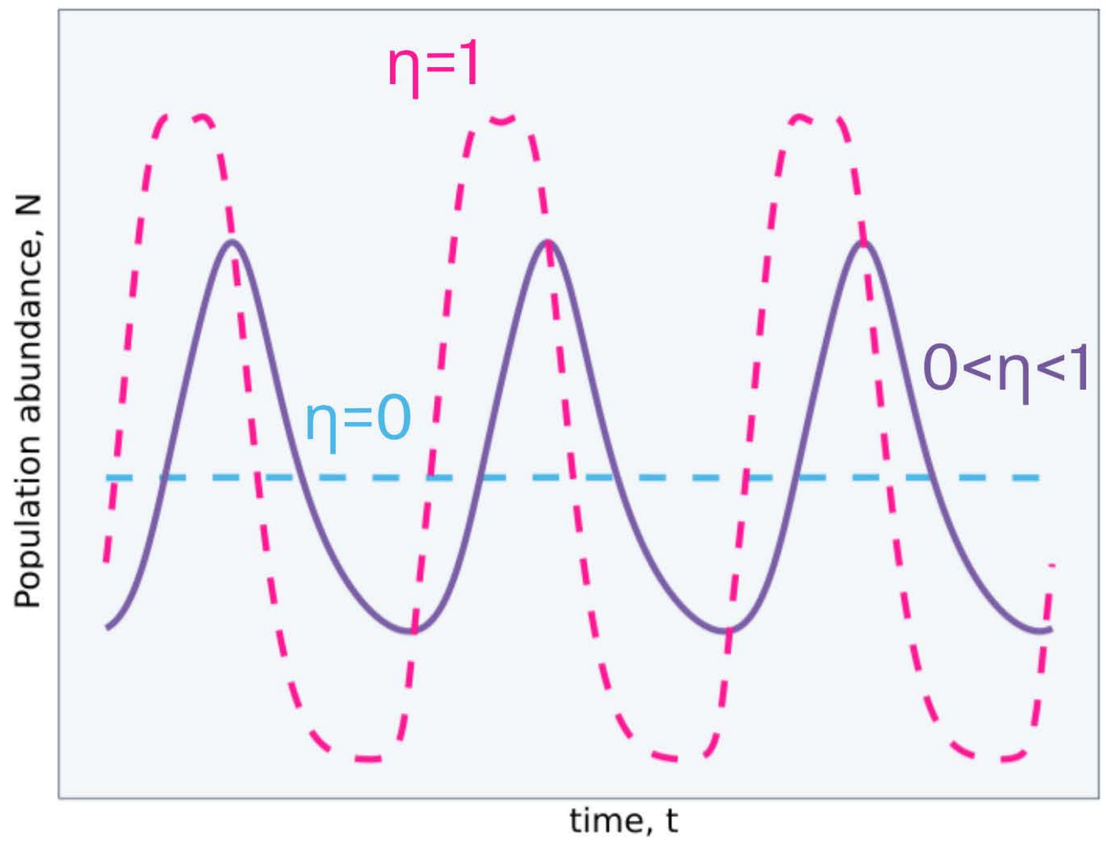
No mechanistic model currently explicits how fluctuations in temperature might affect population dynamics : we develop this elementary building block

Model

- Sinusoidal temperature change
- temperature dependance of r via the UTPC
- logistic model of population
- η is a metric which quantifies the distance of N to two extreme scenarios, in order to quantify the mismatch of timescales between the environment and the organism
- All results are derived both from analytical formulas and simulations





- stationary scenario : population averages every change in temperature
- instantaneous scenario : population tracks every change.

Results

Higher fluctuations cause lower mean density

$$\frac{dN}{dt} = \left[r' \left(\frac{\mu - T_{opt}}{\mathcal{E}} + \frac{\sigma}{\mathcal{E}} sin(2\pi t') \right) \right] r_{max} p$$

Relative thermal mismatch

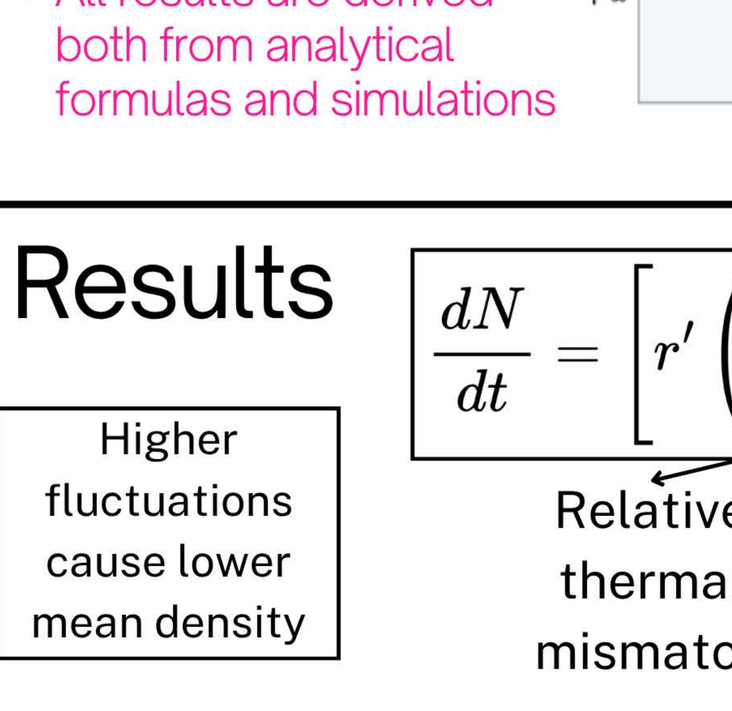
Relative thermal amplitude

Relative speed of demography

Three parameters emerge through nondimensionalisation

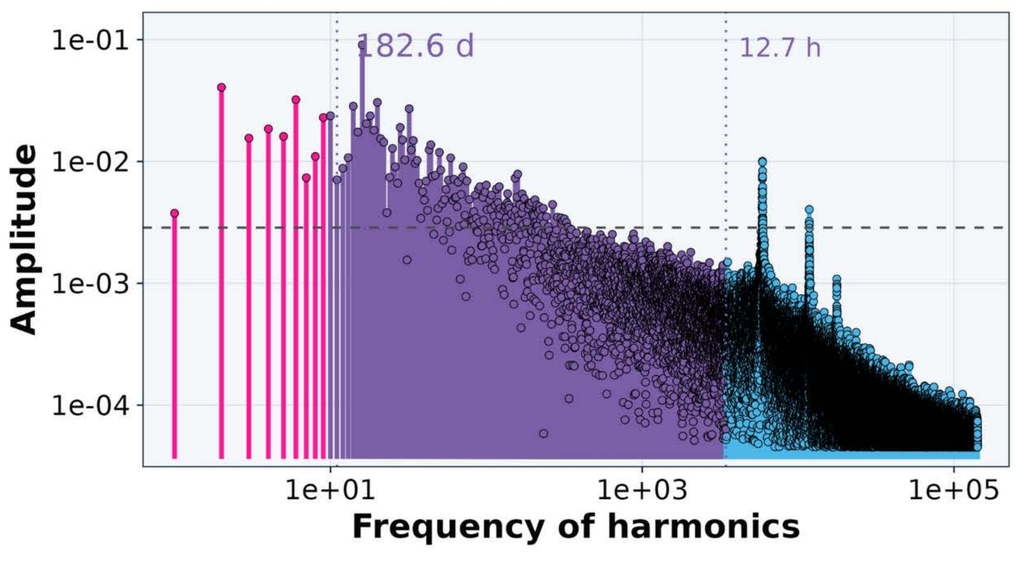
$$\eta = \frac{\bar{r}p}{\bar{r}p + 2\pi}.$$

We find an expression for η, which can be applied to complex real time-series via a Fourier transform



At Higher fluctuations species live under their thermal optimum : a shift in thermal mismatch allows a safety margin from mortal warm temperatures

timescales mismatch η



Further leads

These results would need to be tested in an experimental setting in order for the theory to be validated