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# Fast and slow depurators of amnesic shellfish toxin: a bioenergetic modelling approach to compare two pectinid species



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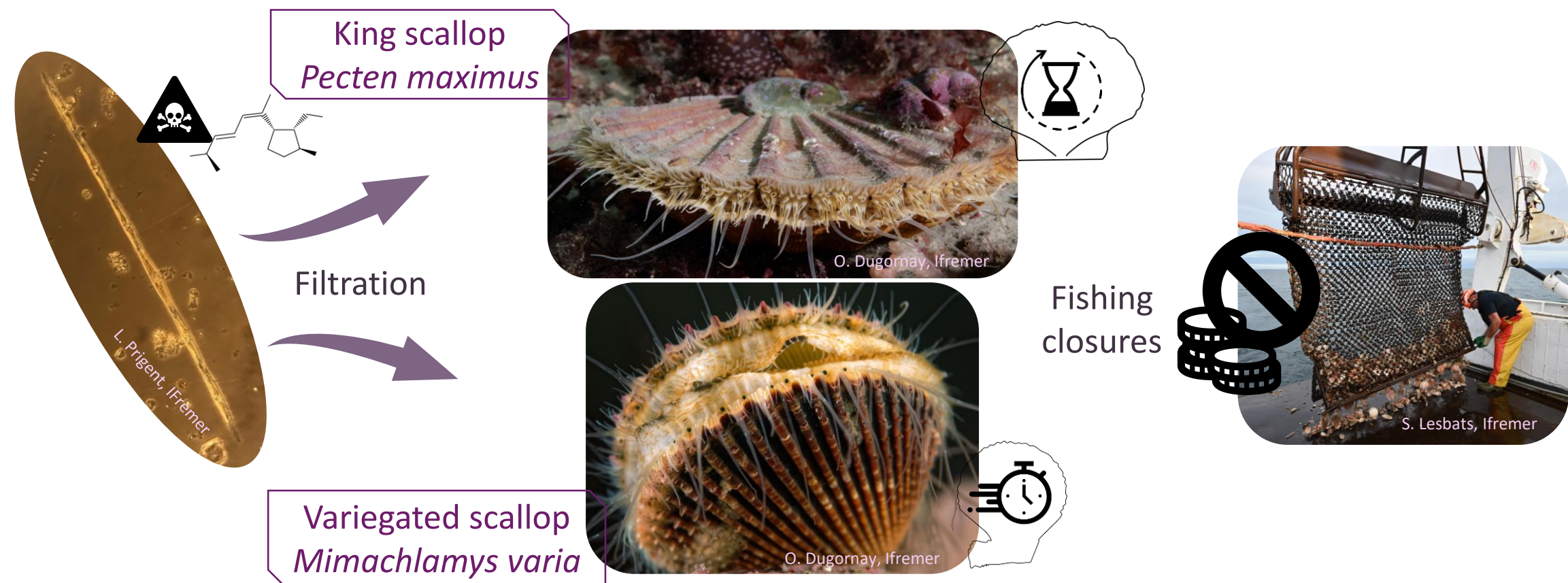
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## Introduction

- Microalgae *Pseudo-nitzschia sp.* (*Psn*) produce domoic acid (DA) and are responsible for amnesic shellfish poisoning (ASP)
- Bivalves as filter-feeders can accumulate the toxin
  - DA concentration in their tissues is monitored
  - If DA concentrations overpass sanitary threshold, fishing activities are closed
- The king scallop *Pecten maximus* and the variegated scallop *Mimachlamys varia* are economically important species in France
- Closures, due to DA presence, implicate socio-economic loss



**MaSCOET project:** better understanding the development of *Psn* and the difference in accumulation and decontamination processes between pectinid species

→ The king scallop accumulates more DA and retains it for a longer time



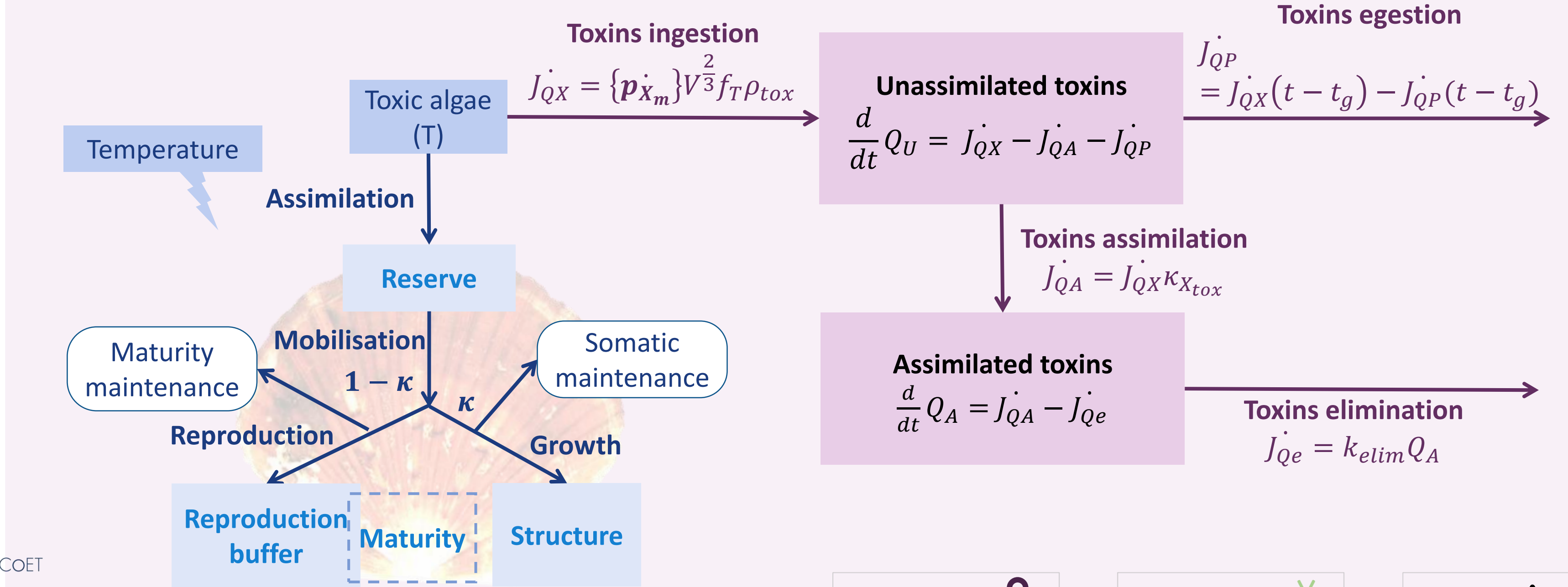
**Aims:** to determine processes for the king scallop's slow decontamination

- Bioenergetic modelling approach to investigate physiological processes and their links to environmental conditions
  - Importance of the size of the individual?
- Comparing pectinid species to understand the differences
  - How to model different toxin kinetics?

## Materials & Methods

- **Abj DEB model** for king scallop (Lavaud *et al.*, 2014) and for the variegated scallop (Regnier-Brisson *et al.*, poster)
  - Parameters: • from AmP for the king scallop • from a new estimation for the variegated scallop
- **Toxin kinetic module** based on Pousse *et al.*, 2019; contamination of *Crassostrea gigas* by *Alexandrium minutum*, producer of Paralytic Shellfish Toxin (PST)
  - **2-compartments model:** fast (egestion, unassimilated toxins) and slow depuration (elimination, assimilated toxins)
  - **Gut retention time:** dependent on the organism length and the functional response
  - First order kinetic for elimination of assimilated toxins
- **No effect on metabolism** (Liu *et al.*, 2007)

$$t_g = \frac{V^{1/3} [M_{gm}]}{f [J_{x_{Am}}]}$$

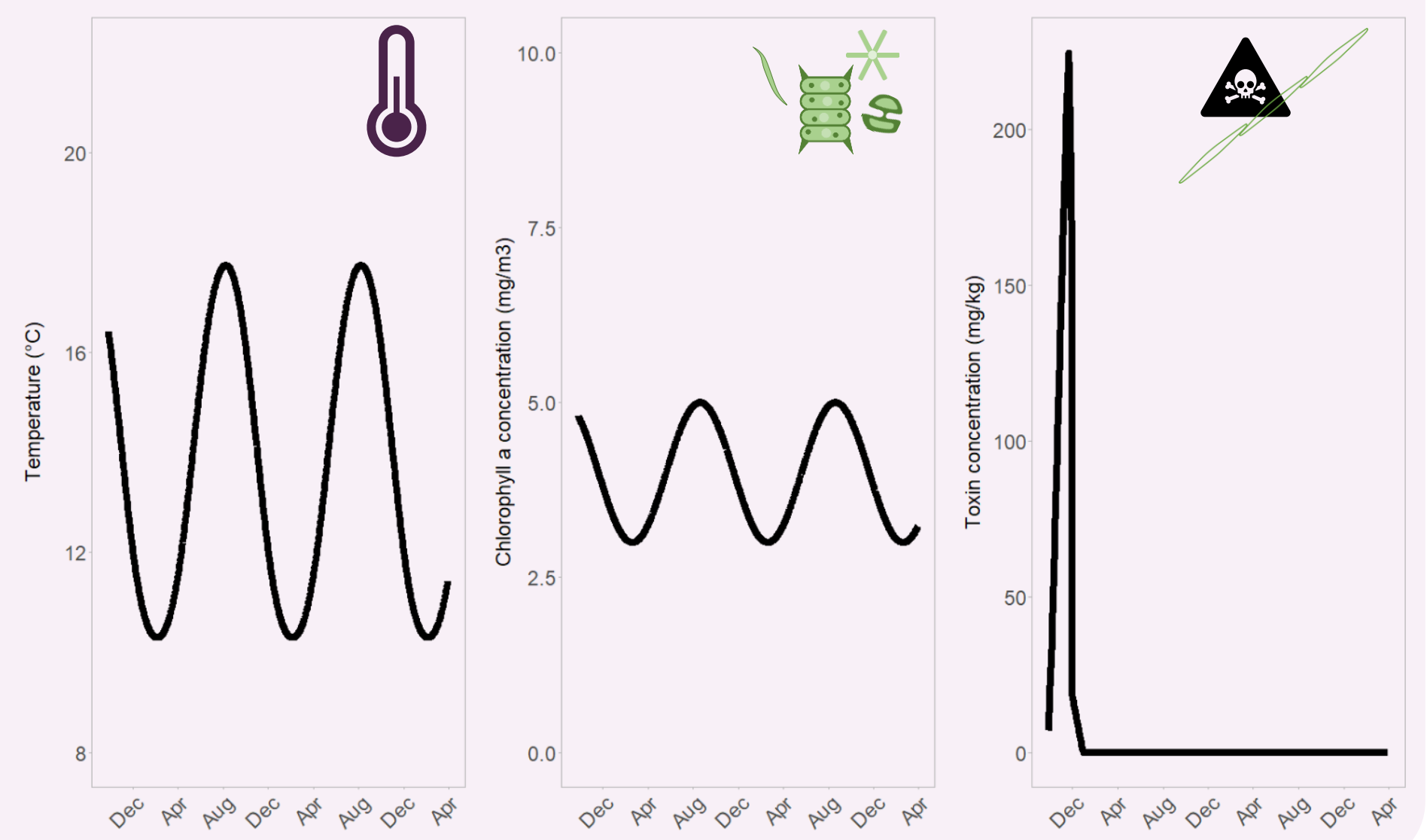


### Environment

- **Temperature and food conditions:** *in situ* monitoring in the Bay of Brest (Regnier-Brisson *et al.* poster)
- **Toxic food conditions:** from REPHYTOX monitoring, average of several years and locations
- Representation of 3 years, from Fourier parameters

### Sensitivity analysis

$$SI(\%) = \frac{1}{n_{days}} \sum \frac{|[DA]_{new param} - [DA]_{standard}|}{[DA]_{standard}} 100$$



## Results

### Dilution by growth

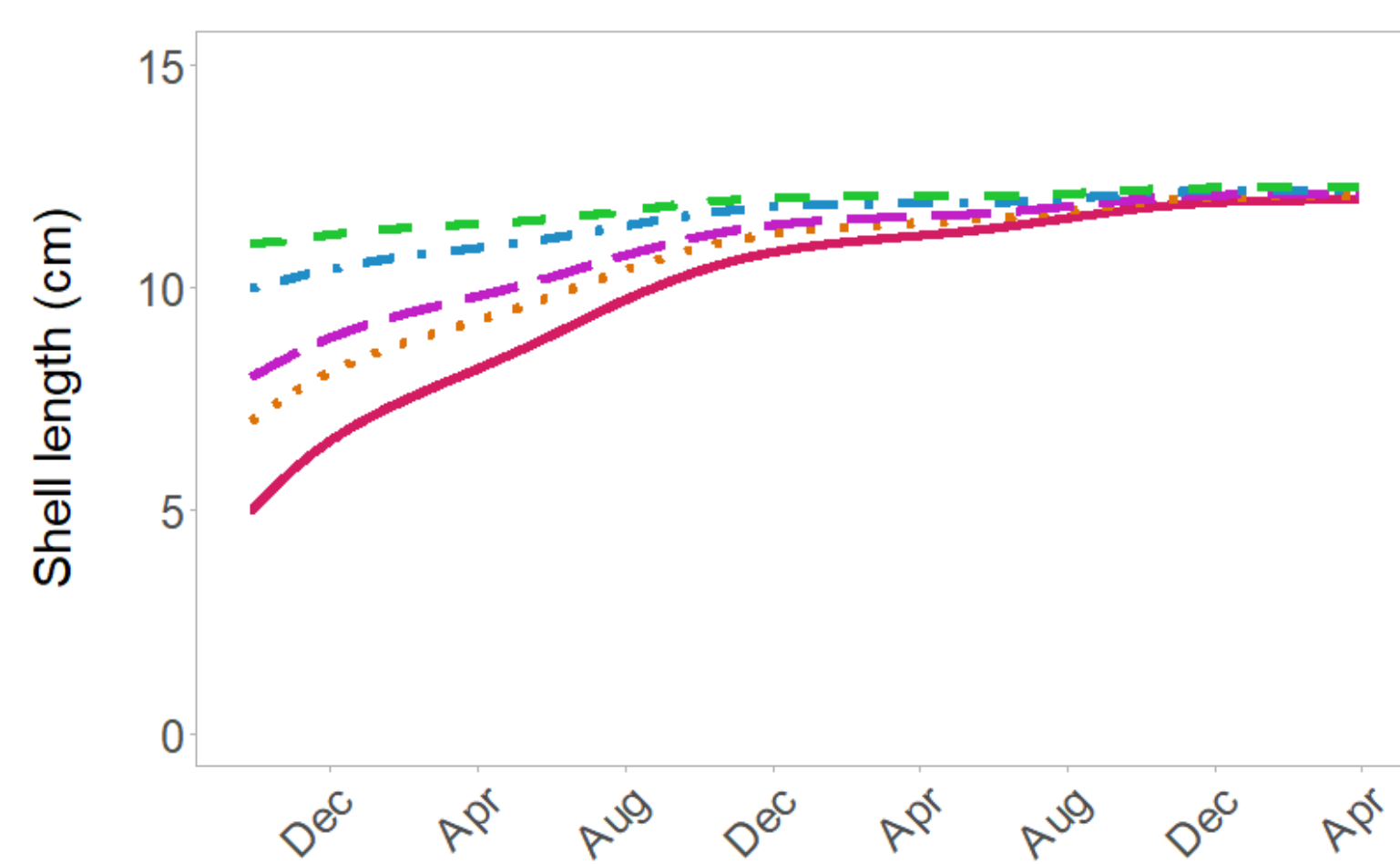
#### Simulations

- 5 adults with different initial shell heights and flesh dry weights
- Same environment, simulations for 3 years

cm	g dw
5	0.8
7	2.3
8	3.4
10	6.7
11	8.9

#### Growth in shell height

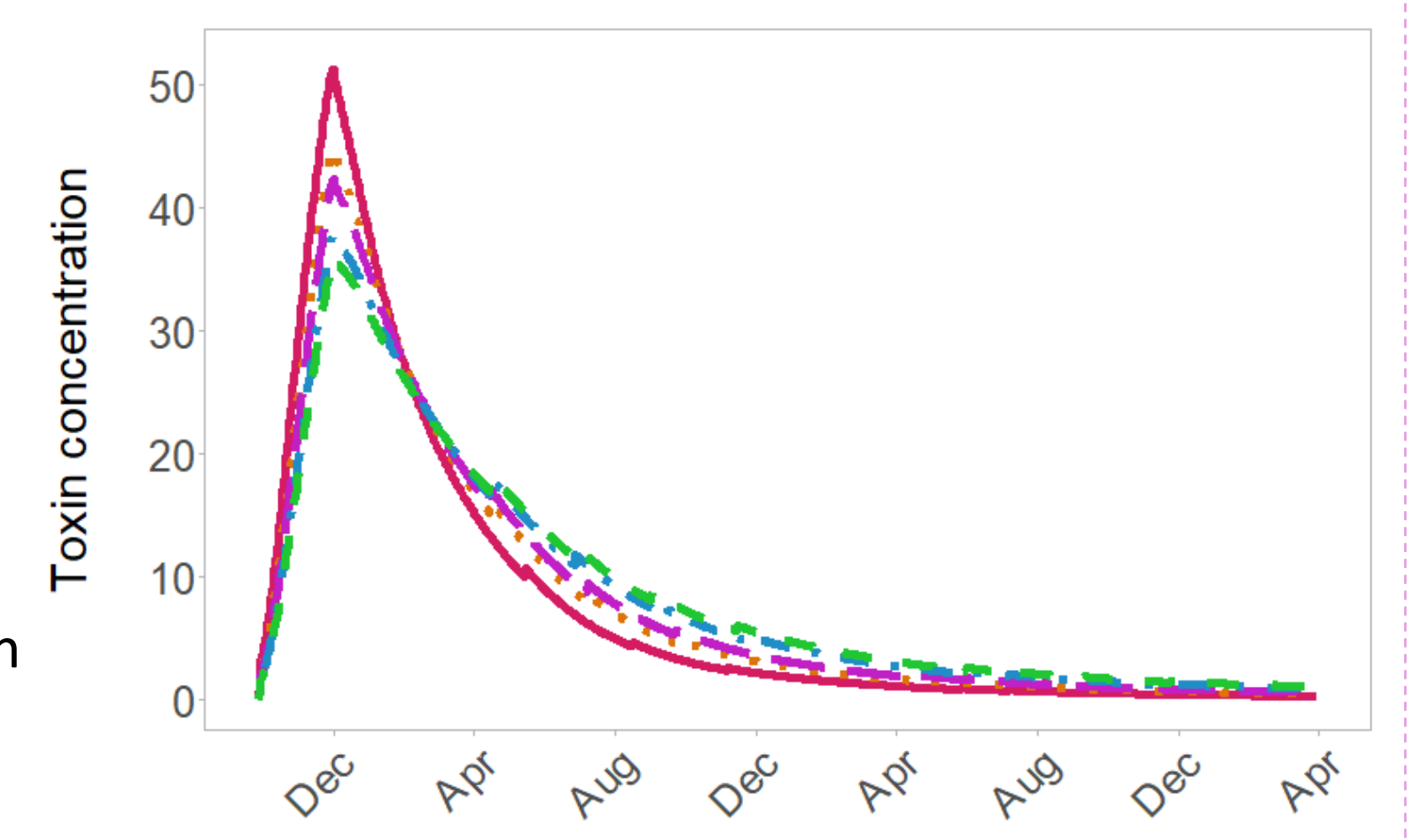
- Higher and longer length growth for small individuals
- Ultimate length around 12.5 cm



#### Toxin concentration

- At the peak: higher toxin concentration for smaller individuals
- Smaller scallops
  - Faster contamination
  - Faster decontamination
- Bigger scallops
  - Toxin remains for a longer time

Remark: little increase of the concentration at spawning events (loss of weight)



### Comparison between species

#### Simulations

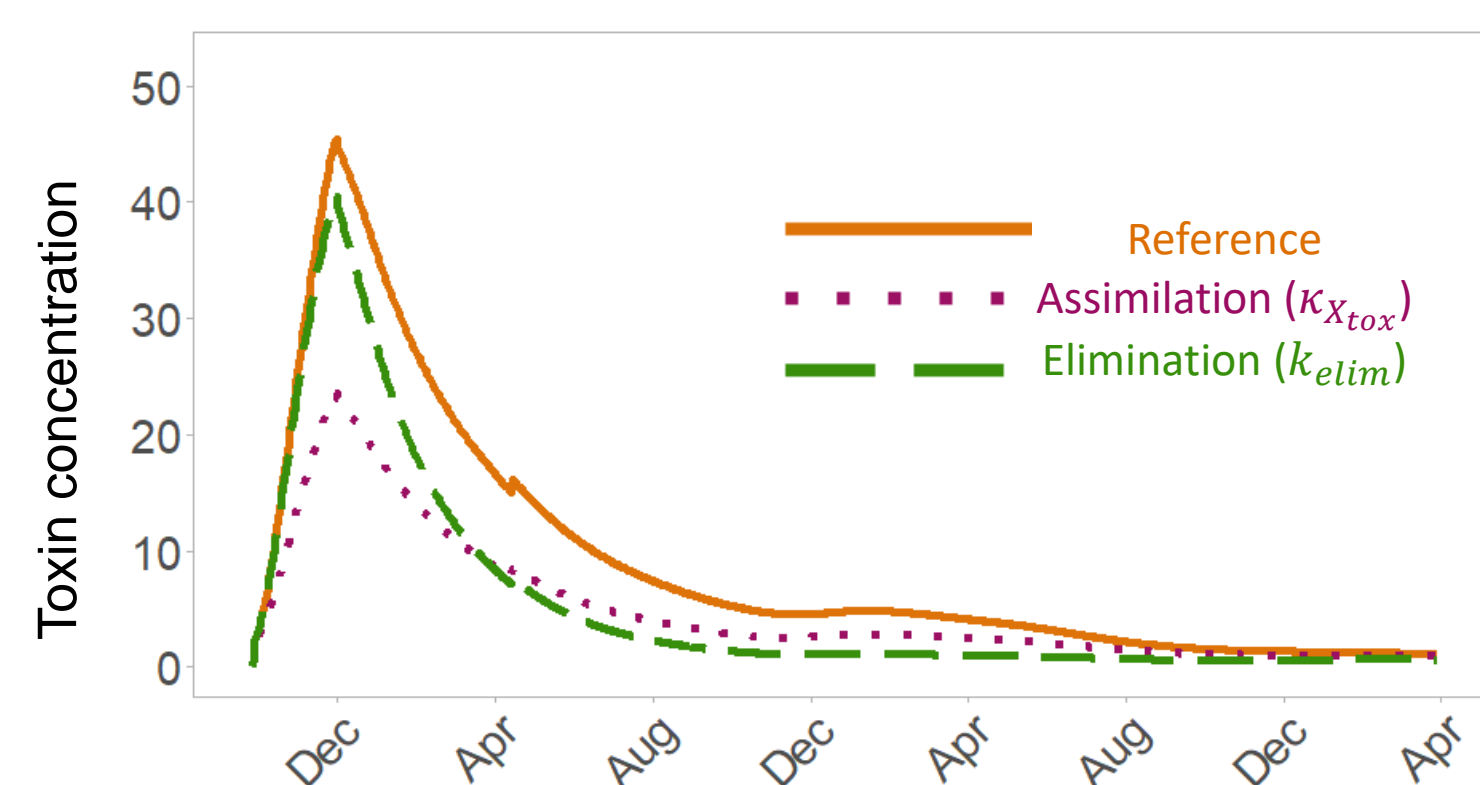
- DEB parameters for the king scallop, same environment, simulations for 3 years
- 2 individuals – 1 "fast" (variegated scallop-like), 1 "slow" (king scallop-like) depurator



- 2 hypothesis for faster depuration

- **Hypothesis 1: Lower toxin uptake**
  - 50% reduction of the  $\kappa_{x_{tox}}$  value
- **Hypothesis 2: Greater toxin elimination**
  - 50% increase of the  $k_{elim}$  value

- Sensitivity analysis (SI) on the toxin concentration for parameters variation of 50%



#### Toxin concentration

- Lower toxin concentration with lower assimilation but similar dynamic
- Faster decrease with higher elimination

#### Sensitivity analysis

- The elimination parameter is more sensitive ( $SI = 56\%$ ) than the assimilation parameter ( $38\%$ )

## Discussion

### Environment

- Need to better define the availability of toxic algae

### Dilution by growth

- Representation of the contamination and decontamination of the toxin as expected
  - The contamination is quick and punctual
  - The decontamination is quick for the first days, then it is very slow, as observed
- Smaller animals accumulate the toxin more rapidly. Thus, they reach a higher toxin concentration
  - They depurate faster than the bigger individuals

### Comparison between species

- The model will permit to test hypotheses on differences between species for toxin concentration

### Perspectives

- Coupling approaches between modelling, experimentation and *in situ* observations
- Contamination of *P. maximus* by *Pseudo-nitzschia sp.* with a large interval of shell heights

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