Contrasting abilities of metal bioaccumulation in Gammarus populations with different exposure histories

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Contrasting abilities of metal bioaccumulation in *Gammarus* populations with different exposure histories

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INTRODUCTION

- Kinetic models are used to link metal exposure to metal contamination in aquatic organisms and enable also the prediction of metal bioaccumulation.
- Kinetic models are characterised by kinetic parameters (uptake and elimination rate constants) which can be determined in controlled conditions.
- "Global" kinetic parameters for Cd, Pb and Ni have been established in five naïve populations of gammarids.
➔ BUT gammarids can live in rivers exhibiting metal contamination to which organisms may adapt physiologically.
- Adaptation can result in the modulation of bioaccumulation abilities i.e. kinetic parameters.
➔ This may limit the environmental relevance of kinetic models and the reliability of bioaccumulation predictions.

OBJECTIVES

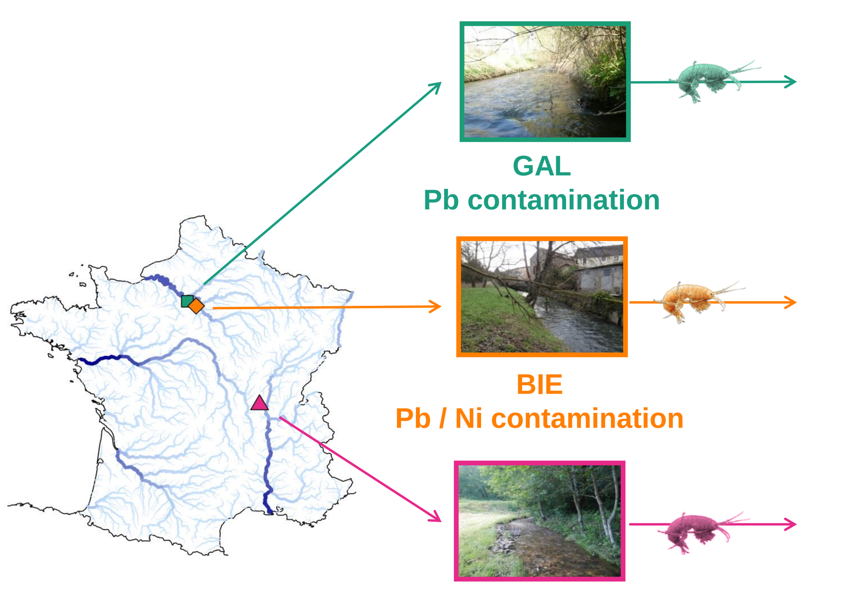
Assess the bioaccumulation abilities of metals in gammarids chronically exposed to metals *in situ*.

1. Determine the kinetic parameters describing Cd, Pb and Ni bioaccumulation in populations of gammarids chronically exposed to metals *in situ*.

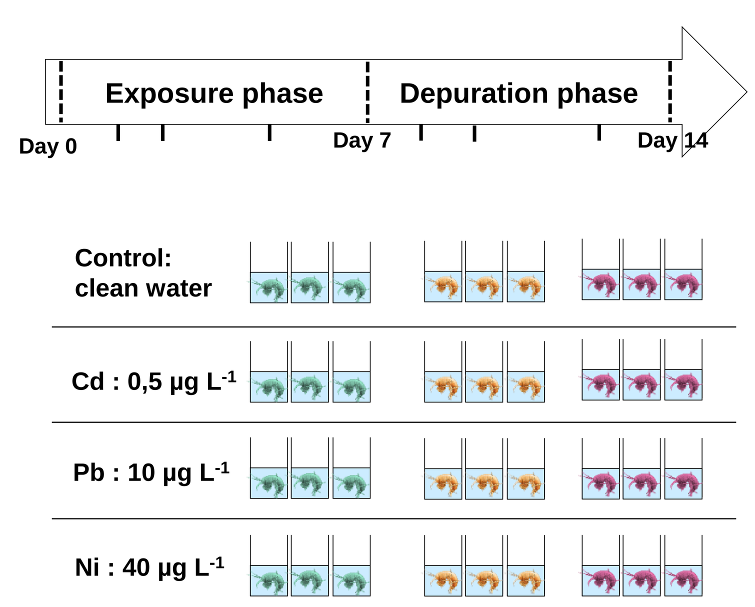
2. Compare the kinetic parameters with "global" kinetic parameters already determined in five naïve populations of gammarids.

MATERIALS & METHODS

❶ Collection of 3 gammarids populations from metal-contaminated sites

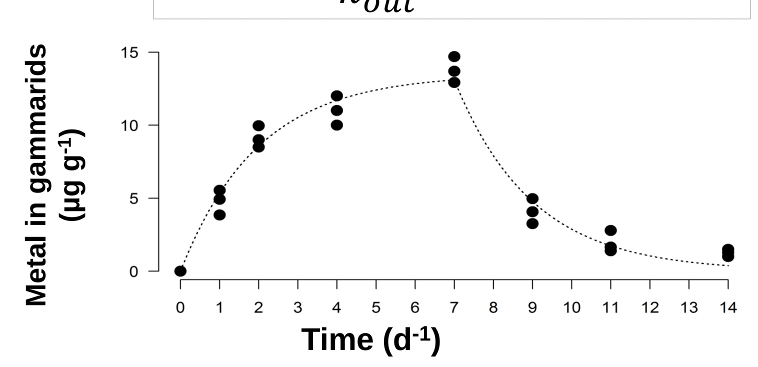


❷ Exposure of gammarids to metals in controlled conditions



❸ Fitting of the kinetic model to the bioaccumulation data

$$C_a = \frac{k_{in} \cdot C_{water}}{k_{out}}(1 - e^{-k_{out} \cdot t})$$



C_a: Metal concentration in gammarids (µg g^{-1})
k_{in} : Uptake rate constant (L g^{-1} d^{-1})
k_{out}: Elimination rate constant (d^{-1}) / t: time (d)
C_{water}: Dissolved metal concentration (µg L^{-1})

❹ Determination of kinetic parameters for each contaminated population

➡ k_{in} and k_{out}

❺ Comparison with the "global" kinetic parameters already established in five naive populations living in pristine sites but exhibiting contrasted geochemical parameters

(See Plateform: «Between-population variability of waterborne metal bioaccumulation in *Gammarus sp.* from uncontaminated freshwaters», at 2:30 PM,ID 149, room 131/132)

RESULTS & DISCUSSION

1. Bioaccumulation kinetics

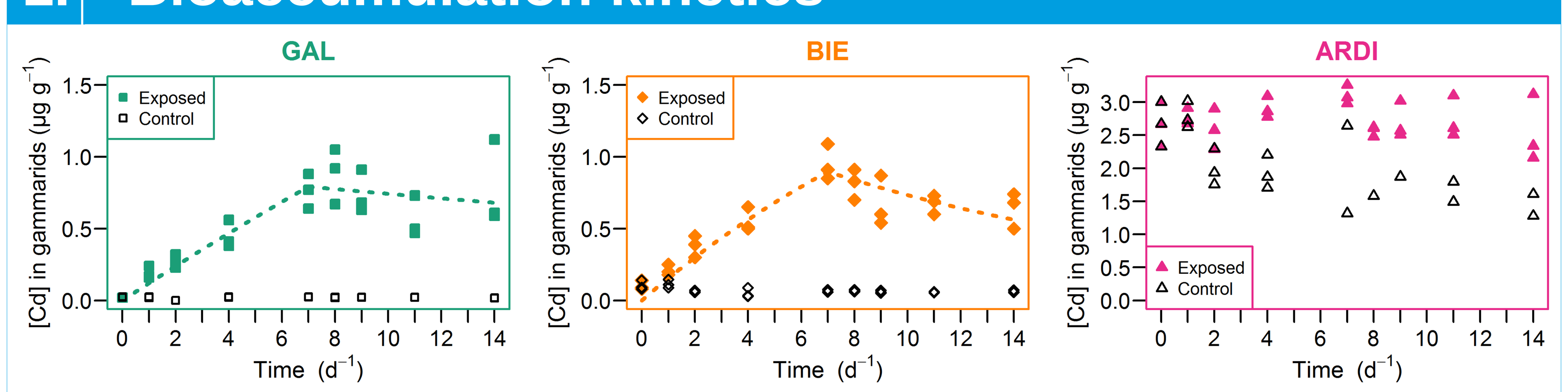


Fig. 1. Accumulation and elimination kinetics of Cd in gammarids from contaminated rivers after exposure to Cd in the laboratory. A point represents a pool of 5 gammarids.

For GAL and BIE:

- **k_{in} was successfully determined for Cd.**
- **k_{out} was not determined because of the high variability between replicates and the inadequate elimination phase length.**

For ARDI:

- **High basal Cd content**
- **No new accumulation**
- **No kinetic parameters**

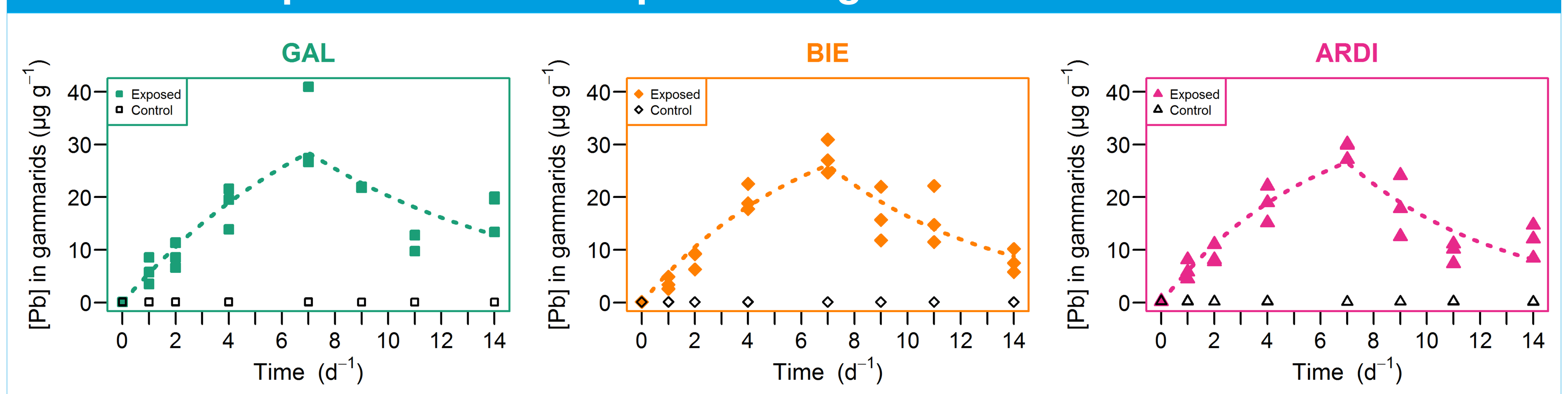


Fig. 2. Accumulation and elimination kinetics of Pb in gammarids from contaminated rivers after exposure to Pb in the laboratory. A point represents a pool of 5 gammarids.

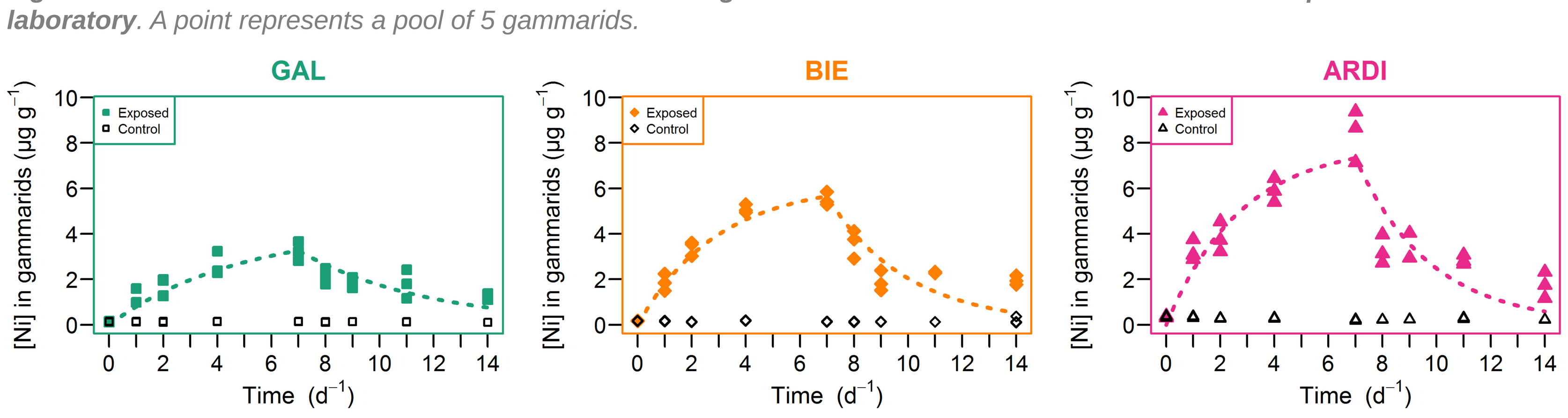


Fig. 3. Accumulation and elimination kinetics of Ni in gammarids from contaminated rivers after exposure to Ni in the laboratory. A point represents a pool of 5 gammarids.

For GAL, BIE and ARDI:

- **k_{in} and k_{out} were successfully determined for Pb and Ni.**

2. Comparison with the "global" kinetic parameters

k_{in} - Uptake rate constant

k_{out} - Elimination rate constante

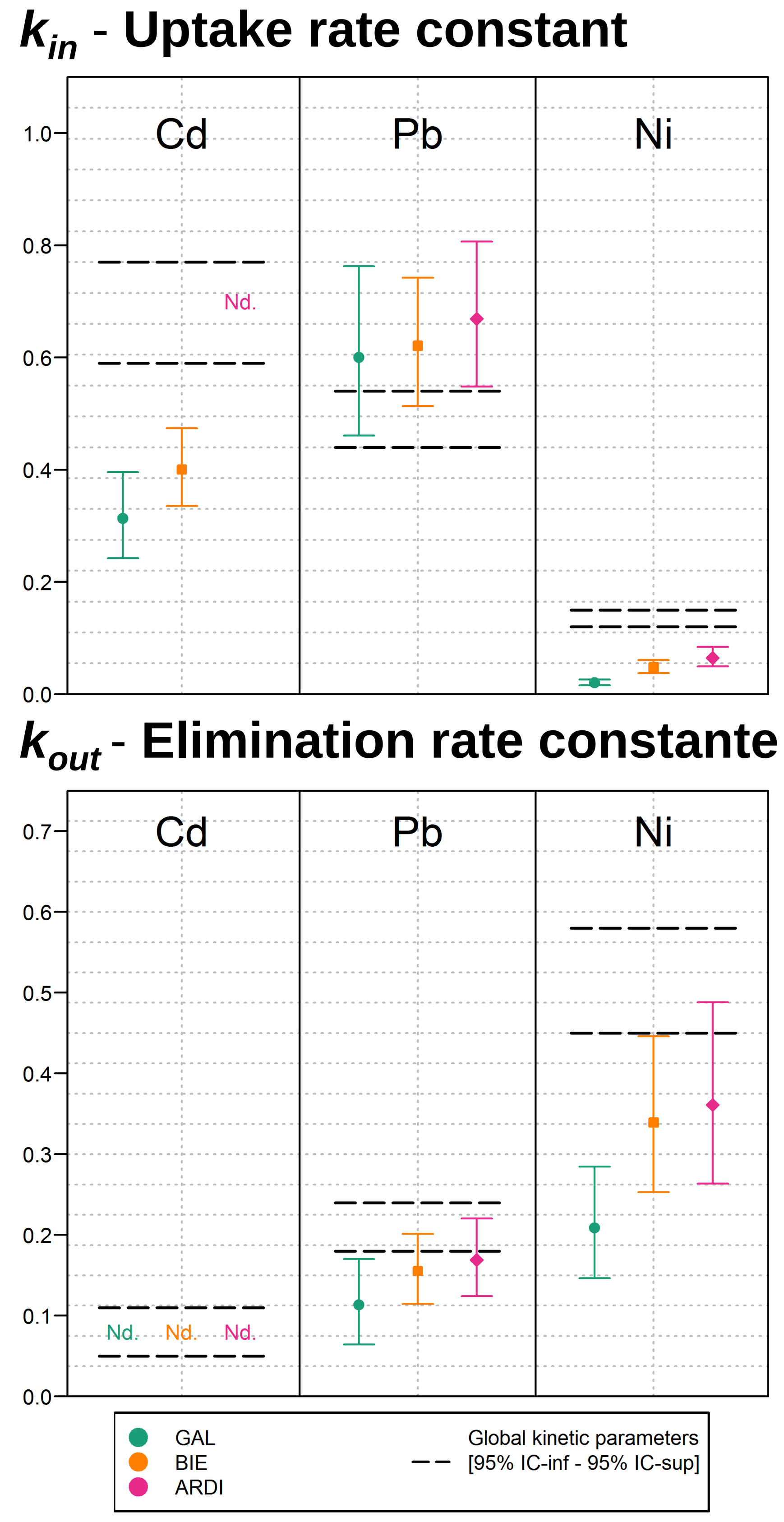


Fig. 4. Kinetic parameters, k_{in} and k_{out} determined for each population of gammarids from contaminated sites (with 95% confidence interval) and comparison with the "global" kinetic parameters determined in 5 naive populations and represented by the upper and lower values of 95 % confidence interval.

Cd:

- k_{in} < k_{in} in naïve populations

GAL and BIE: Populations chronically exposed to metals *in situ* decrease their Cd uptake compared to naive populations.

➔ **Physiological adaptation**

ARDI: High basal Cd content in organisms chronically exposure to Cd *in situ.*

➔ **Storage under detoxified forms**

Pb:

- k_{in} > k_{in} in naive populations
- k_{out} < k_{out} in naive populations

GAL, BIE, ARDI: Population chronically exposed to metals *in situ* tend to accumulate more Pb and to eliminate less Pb compared to naive populations.

➔ **Storage abilities**

Ni:

- k_{in} < k_{in} in naive populations
- k_{out} < k_{out} in naive populations

GAL, BIE, ARDI: Populations chronically exposed to metals *in situ* accumulate and eliminate less Ni compared to naive populations.

➔ **Regulation abilities**

These results suggest that tolerance mechanisms occur in chronically contaminated populations with metals.

CONCLUSION

- Bioaccumulation strategies are specific to the metal considered.
- Populations chronically exposed to metals *in situ* modulate their metal bioaccumulation abilities compared to naïve populations.
- The modulation of metal bioaccumulation does not seem to be specific to the type of metal encountered *in situ* but to a global metallic pressure.
- Predictive models require to well defined the population used to determined k_{in} and k_{out} and, thus, to calibrate models.
- Further studies are needed to assess the physiological mechanisms involved in the modulation of metal bioaccumulation.

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