

### Is the "killer shrimp" resistant to non-consumptive effects of predators?

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### Duality of predator effects

1. Direct predation on single prey individuals (Consumptive effects – CEs)





- 2. Induction of costly defence mechanisms (Non-Consumptive effects NCEs)
  - Behavioural response activity reduction resulting in the shorter time of food acquisition.
  - Physiological response metabolism acceleration inducing oxidative stress.

### Differences between tested gammarid species





*Pontogammarus robustoides* 

Predator identification system

Jermacz et all. 2017. Predator diet, origin or both? Factors determining responses of omnivorous amphipods to predation cues. Hydrobiologia, 785: 173-184.

Effectivity of defence response Kobak et all. 2014. Effectiveness of zebra mussels to act as shelters from fish predators differs between native and invasive amphipod prey. Aquatic Ecology 48: 397-408.

#### Hardness of shell

Błońska et all. 2015. Feeding preferences of an invasive Ponto-Caspian goby for native and non-native gammarid prey. Freshwater Biology 60: 2187-2195.

Avoidance by predators in the presence of alternative food Błońska et all. 2015. Feeding preferences of an invasive Ponto-Caspian goby for native and non-native gammarid prey. Freshwater Biology 60: 2187-2195.

Dikerogammarus villosus



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### Working hypothesis

*D. villosus,* as a species avoided by predators, would exhibit less pronounced responses to predation cues, which would allow it to sustain higher feeding and growth rates under

predation pressure, than P. robustoides.

### Experiment I – Impact of the predator presence and food availability on gammarid feeding



food close to the shelter

- Experiment duration: 4 hours
- Number of gammarids: 5 of single species
- Number of replicates: 12 for each variant
- Number of chironomids: one per gammarid

B 200 min 

food distant from the shelter prey

- Measured variables: number of eaten chironomids and time spend outside the shelter
- Experiment was recorded by an IP camera placed above the tanks

## Experiment I – Impact of the predator presence and food availability on gammarids feeding

- Gammarids significantly reduced consumption in the presence of the predator, but only in situation when food was close,
- At the same conditions *D. villosus* exhibited a stronger response to the predator presence than *P. robustoides*,
- Under the control conditions, *D. villosus* consumed significantly less distant food compared to the close food resources.



## Experiment I – Impact of the predator presence and food availability on gammarids feeding

- In the presence of fish, when food close both gammarids significantly reduced time spent in the open space, though the response of *P. robustoides* was clearly stronger than that of *D. villosus*
- When food was distant *D. villosus* compare to *P. robustoides* spent significantly less time outside the shelter



# Experiment II – impact of a predator on consumption behaviour



Capacity: 100 ml

- Experiment duration: 2h
- Prey: 2 chironomids
- Experiment recorded by an IP camera placed above the tanks
- Tested variables: % of consumed chironomids and consumption rate
- Control tap water
- Test tap water with predator kairomones



## Experiment II – impact of a predator on consumption behaviour

- •The amount of consumed chironomids was not affected by predator presence or by gammarid
- •Gammarid feeding rate was also independent of the predator presence and gammarid species



# Experiment III – Impact of predators on the gammarid growth



- Experiment duration: 14 days
- Gammarid number: 12 of single species (one species per tank)
- Gammarid feeding: once a week (detritus and chironomids – not limited)
- Goby feeding: three times a week, with gammarids

# Experiment III – Impact of predators on gammarid growth

- Under control conditions, *P. robustoides* exhibited faster growth than *D. villosus* but in the presence of fish the growth of P. robustoides was significantly reduced.
- The growth of *D. villosus* was not affected by the predators



### Conclusions

- *D. villosus* compared to *P. robustoides* did not reduce its growth in the predator presence, which indicates it higher resistance to indirect predator effects.
  - Resistance of *D. villosus* could result from the higher efficiency of its antioxidant systems and/or lower level of its physiological response.
- Despite its higher resistance to predator pressure, *D. villosus* exhibits similar behavioural responses to the predator presence as the other gammarid species
  - In the predator presence, *D. villosus* reduces its activity and food searching, but not consumption (if prey is close).
  - Therefore, the correct choice of habitat, which guarantees safety and food resources could reduce the cost of predator NCEs.
- Our results showed that the resistance to predator NCEs may be one of the factors contributing to the great invasion success of *D. villosus*, currently taking place in European fresh waters.



Project title: Ecology of fear of invasive organisms. Are Ponto-Caspian gammarids (Crustacea, Amhipoda) less susceptible to predator-induced stress? OPUS-11

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RESEARCH ARTICLE

\*lukasjermacz@gmail.com Abstract

Keep calm and don't stop growing: Nonconsumptive effects of a sympatric predator on two invasive Ponto-Caspian gammarids *Dikerogammarus villosus* and *Pontogammarus robustoides* 

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ons by elimination of individuals (consumptive effects) and by pehaviour, physiology or morphology (NCE-non-consumpe allocation to defence, decreased feeding and higher CEs can be considerable. Therefore, the resistance to NCEs owth and interspecific competition. We tested the resistance Dikerogammarus villosus and Pontogammarus robustoides ator, the racer goby Babka gymnotrachelus. As D. villosus is he presence of alternative food, we hypothesised that it would siological costs of anti-predator responses. We tested gam eriments (2-4 h) with food (chironomid larvae) located at var helter (to enforce food searching, Experiment I) or in the earching needed. Experiment II). Moreover, we checked the owth in a 2-week Experiment III. Both gammarids exposed fficiency outside the shelter (Experiment I). Contrary to our villosus was stronger. When food was provided in their the feeding of both species was unaffected by predators. d with food can reduce predator NCEs. The growth of P. presence of predators (Experiment III), whereas that of D. oh D villosus has a more effective defence strategy than P. even higher behavioural costs of NCEs. However, it exhibits a-term predator presence, sustaining its growth rate under ne of the factors contributing to the great invasion success of e in European fresh waters

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## Adaptation to stress conditions - catalase activity (preliminary results)

