Does the invasional meltdown exist? The case of the Ponto-Caspian community

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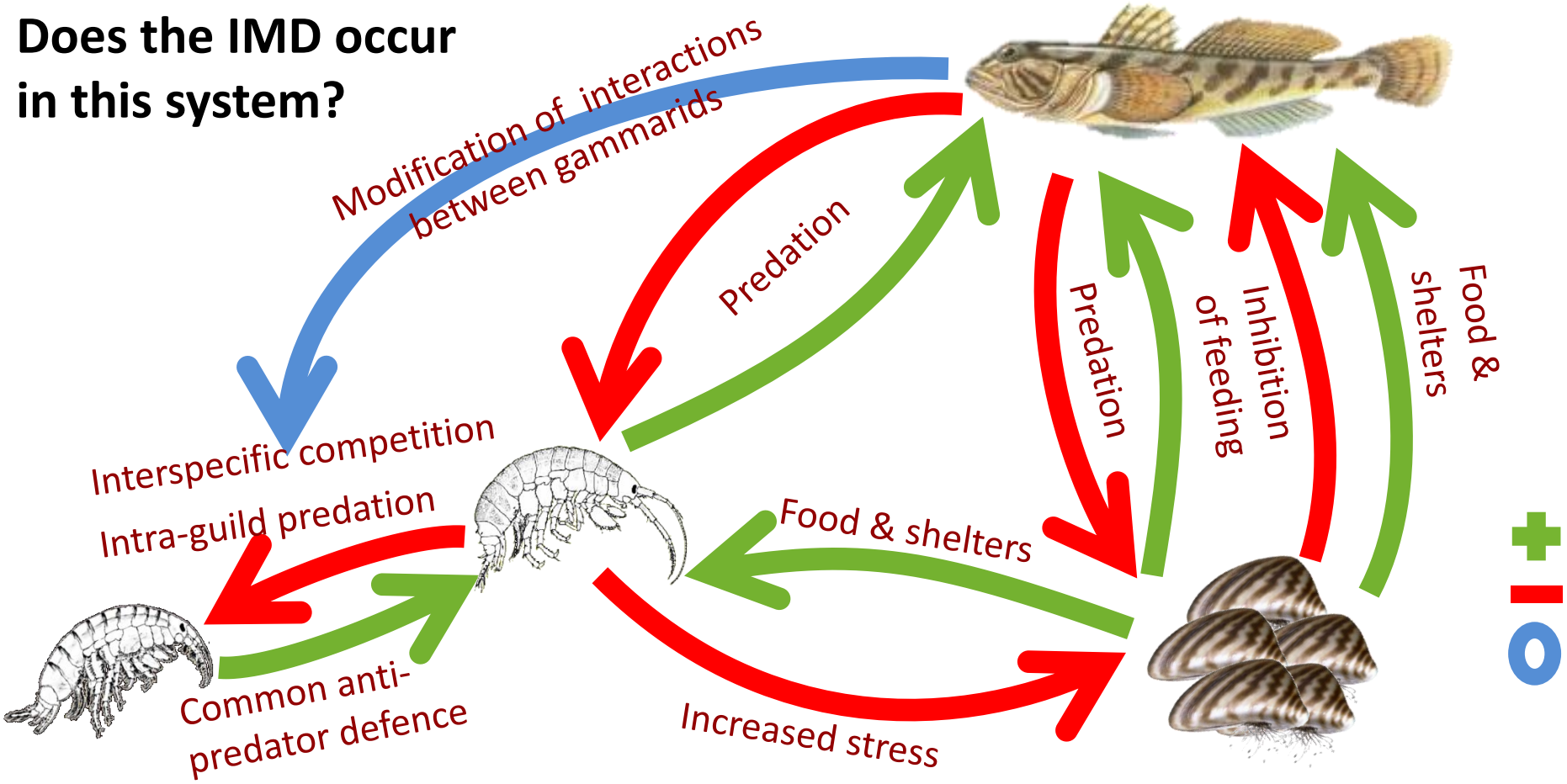
Invasional Meltdown phenomenon

- One of the major concepts in invasion biology
- Invasive species facilitate the introduction of other invaders and increase their impact on local communities
- A community-level phenomenon
- Alien species do not need to originate from the same region, but the common origin may help

Simberloff D, Von Holle B 1999. Positive interactions of nonindigenous species: invasional meltdown? Biol. Inv. 1: 21–32
Ricciardi A 2001. Facilitative interactions among aquatic invaders: is an ‘‘invasional meltdown’’ occurring in the Great Lakes? Can. J. Fish. Aquat. Sci. 58: 2513–2525

The Ponto-Caspian community in Polish fresh waters

Does the IMD occur in this system?



1. Do Ponto-Caspian gammarids facilitate sympatric gobies?

- Gammarids are often found in the guts of gobies in invaded ranges
- Their presence is postulated to facilitate the goby spread
- Valuable food source the fish know from their home range

- But is it really their choice or just the lack of alternatives?
- What if native gammarids were present in the area instead of the aliens?

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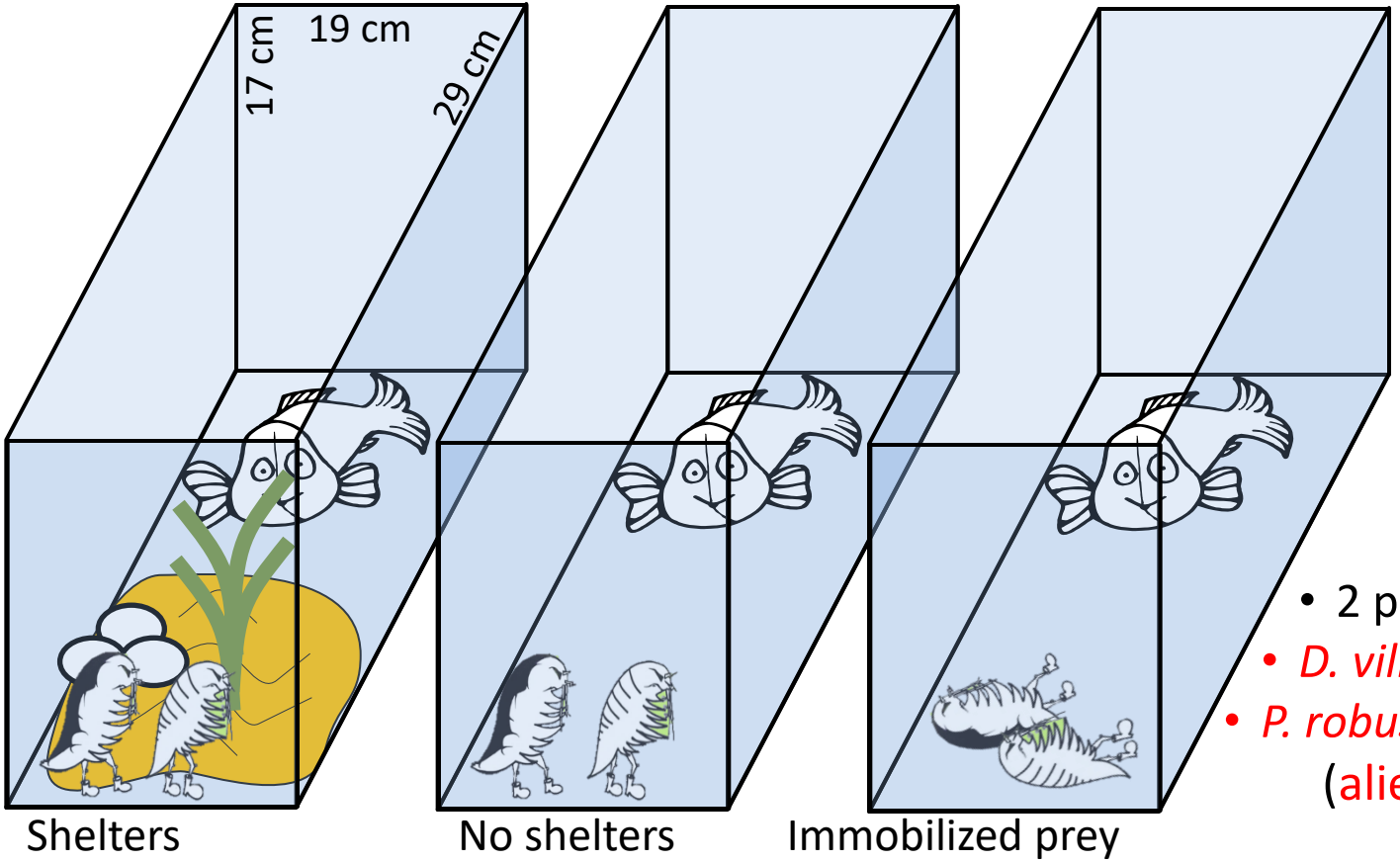

- Predator: the racer goby *Babka gymnotrachelus*
- Duration: 3h
- Number of prey items: 10+10

- 2 prey species:
- *D. villosus* vs. *G. fossarum*
- *P. robustoides* vs. *G. fossarum*

(aliens) (native)

Błońska D, Grabowska J, Kobak J, Jermacz Ł, Bącela-Spychalska K 2015. Feeding preferences of an invasive Ponto-Caspian goby for native and non-native gammarid prey. Freshw. Biol. 60: 2187-2195

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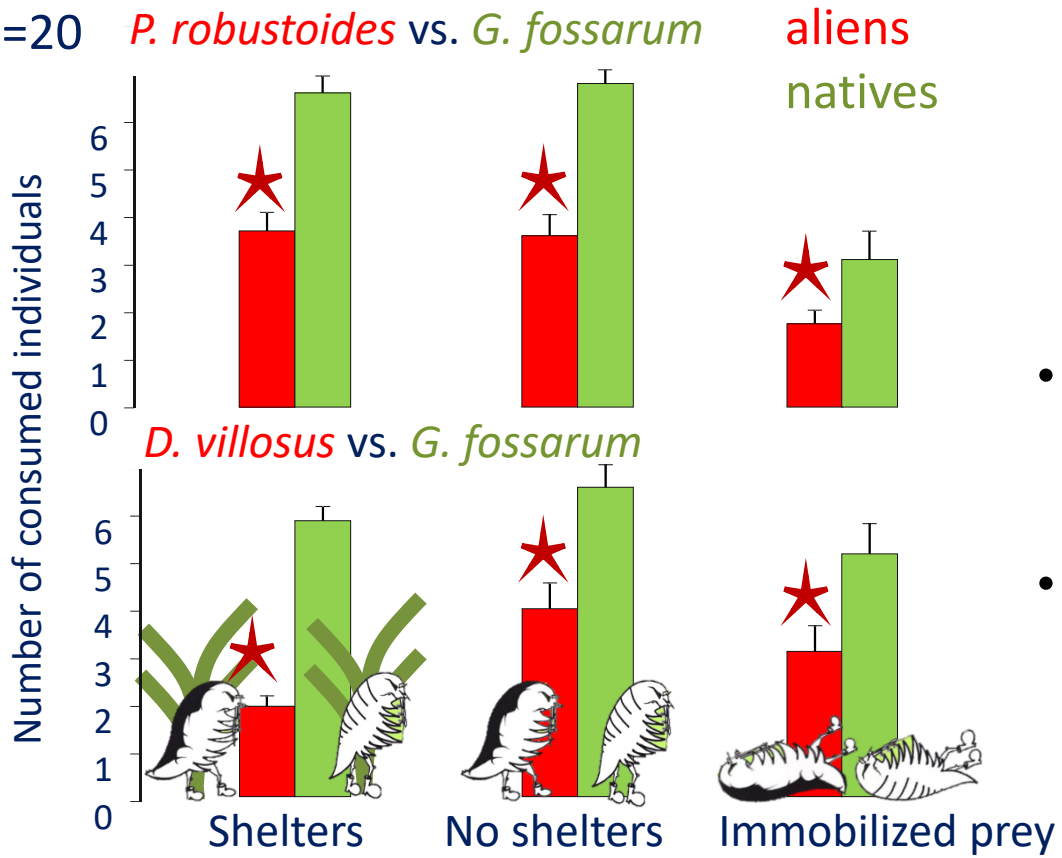

Predator

The racer goby
Babka gymnotrachelus

- The native species were always preferred by fish, regardless of prey behaviour
- Effect of prey structure: hardness?

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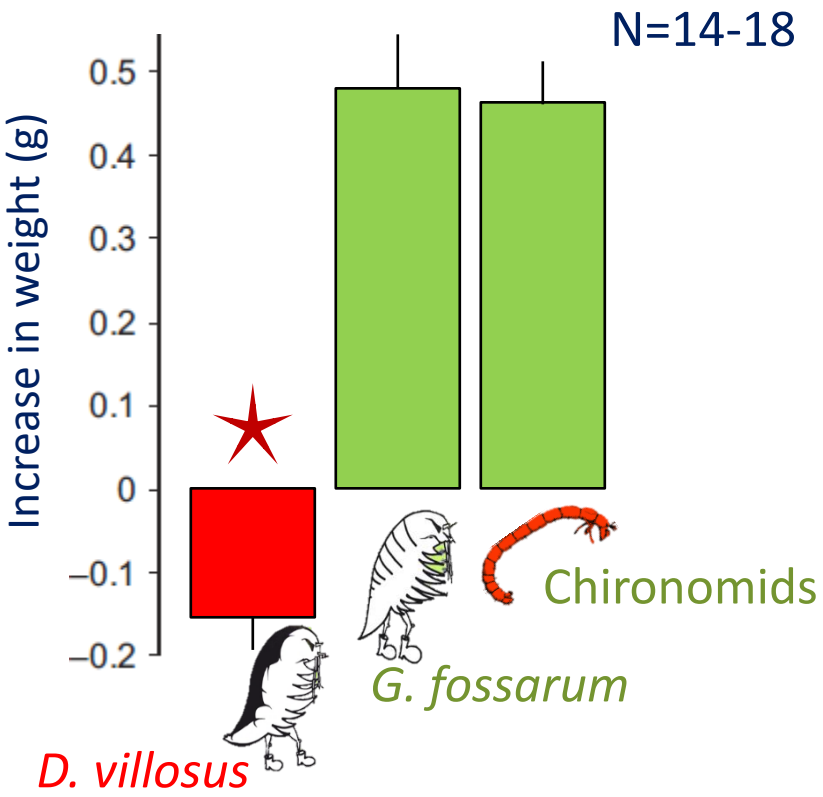
A long-term (4 weeks) exposure of the racer goby to various food types:

- alien gammarid *D. villosus*
- native gammarid *G. fossarum*
- chironomid larvae

! Negative growth on the diet consisting of the alien species



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- Alien gammarids are not such a good diet for Ponto-Caspian gobies
- It is likely that their native counterparts would facilitate the fish much better if they had not been displaced by the invaders

Błońska D, Grabowska J, Kobak J, Jermacz Ł, Bącela-Spychalska K 2015. Feeding preferences of an invasive Ponto-Caspian goby for native and non-native gammarid prey. Freshw. Biol. 60: 2187-2195

2. Does the zebra mussel facilitate or inhibit gobies?

- Zebra mussel colony increases zoobenthos density, but decreases its availability to benthivorous fish
- What is the outcome?
    - a good feeding ground for fish

    or
    - a good shelter for their prey?
- What increase of zoobenthos density makes a mussel colony a good feeding ground for fish?
- Is this increase realistic in the field?

Kobak J, Poznańska M, Jermacz Ł, Kakareko T, Prądzyński D, Łodygowska M, Montowska K, Bącela-Spychalska K 2016. Zebra mussel beds: an effective feeding ground for Ponto-Caspian gobies or suitable shelter for their prey? PeerJ 4:e2672

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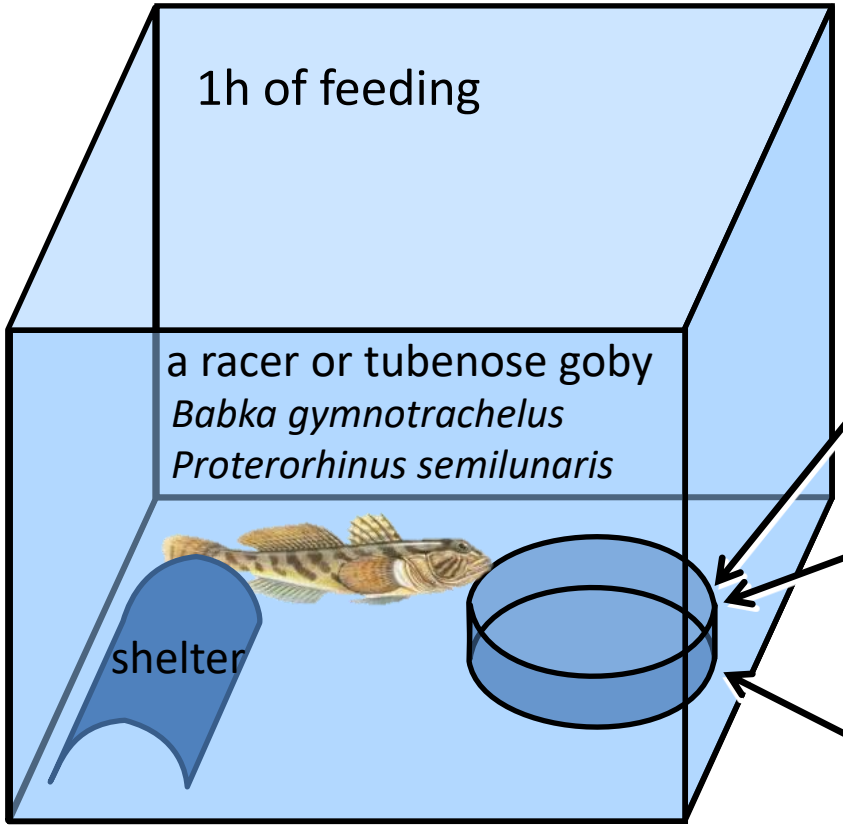
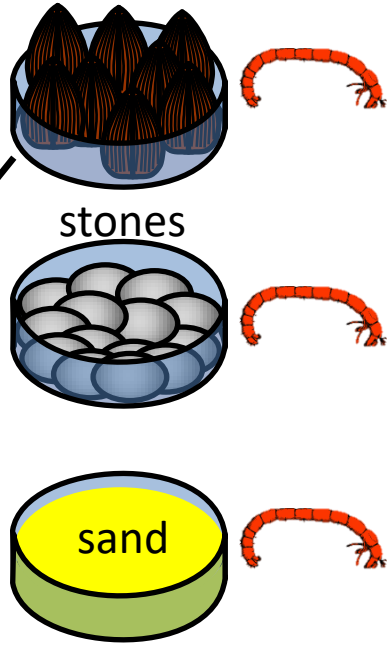


Feeding from different substrata

Food: chironomid larvae:



x 8, 12, 16, 24, 32

x 8

x 8

8 larvae = 520 ind./m^2

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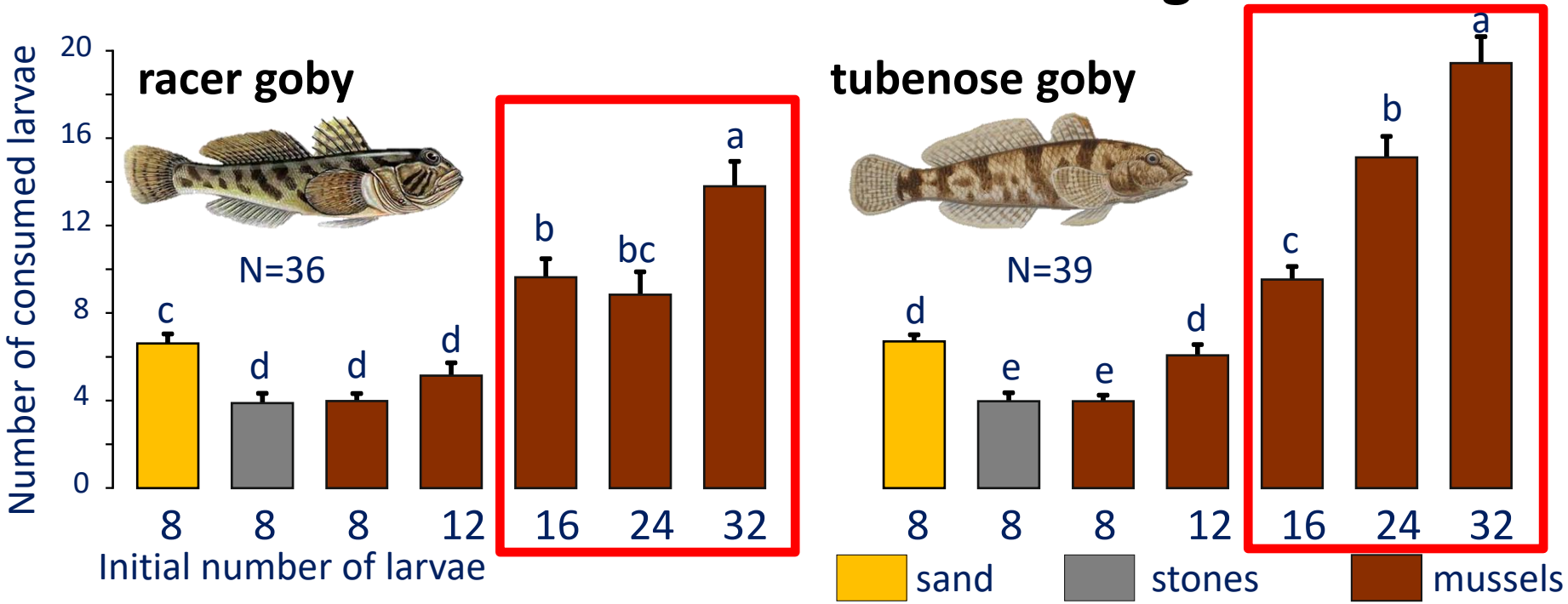

- Mussels are better than sand when contain 2x more food
- Mussels are better than stones when contain 2x (racer) or 1.5x (tubenose) more food

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2. Does the zebra mussel facilitate or inhibit gobies?

The increases in zoobenthos densities in mussel colonies needed to show the positive effect on fish (ca. 2x) are often observed in the field

The positive effect of zebra mussel colonies on the goby fish is likely and may contribute to the invasional meltdown

Kobak J, Poznańska M, Jermacz Ł, Kakareko T, Prądzyński D, Łodygowska M, Montowska K, Bącela-Spychalska K 2016. Zebra mussel beds: an effective feeding ground for Ponto-Caspian gobies or suitable shelter for their prey? PeerJ 4:e2672

3. Does the zebra mussel facilitate alien gammarids?

- A zebra mussel colony provides shelters and food for gammarids
- Several species (*D. villosus*, *D. haemobaphes*, *E. ischnus*) are known to reach high densities in mussel beds

- What is the quality of a mussel bed as a shelter for gammarids?

Kobak J, Jermacz Ł, Płąchocki D 2014. Effectiveness of zebra mussels to act as shelters from fish predators differs between native and invasive amphipod prey. Aquat. Ecol. 48: 397-408

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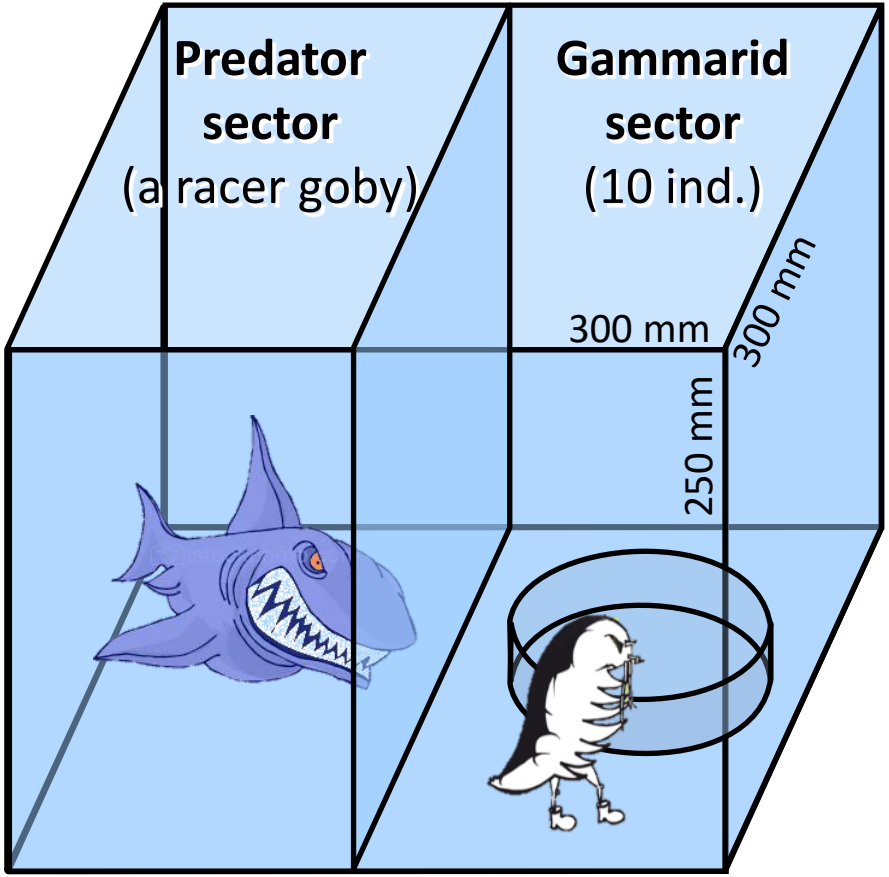
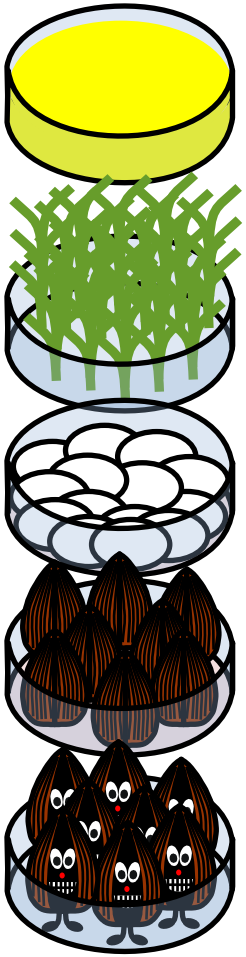




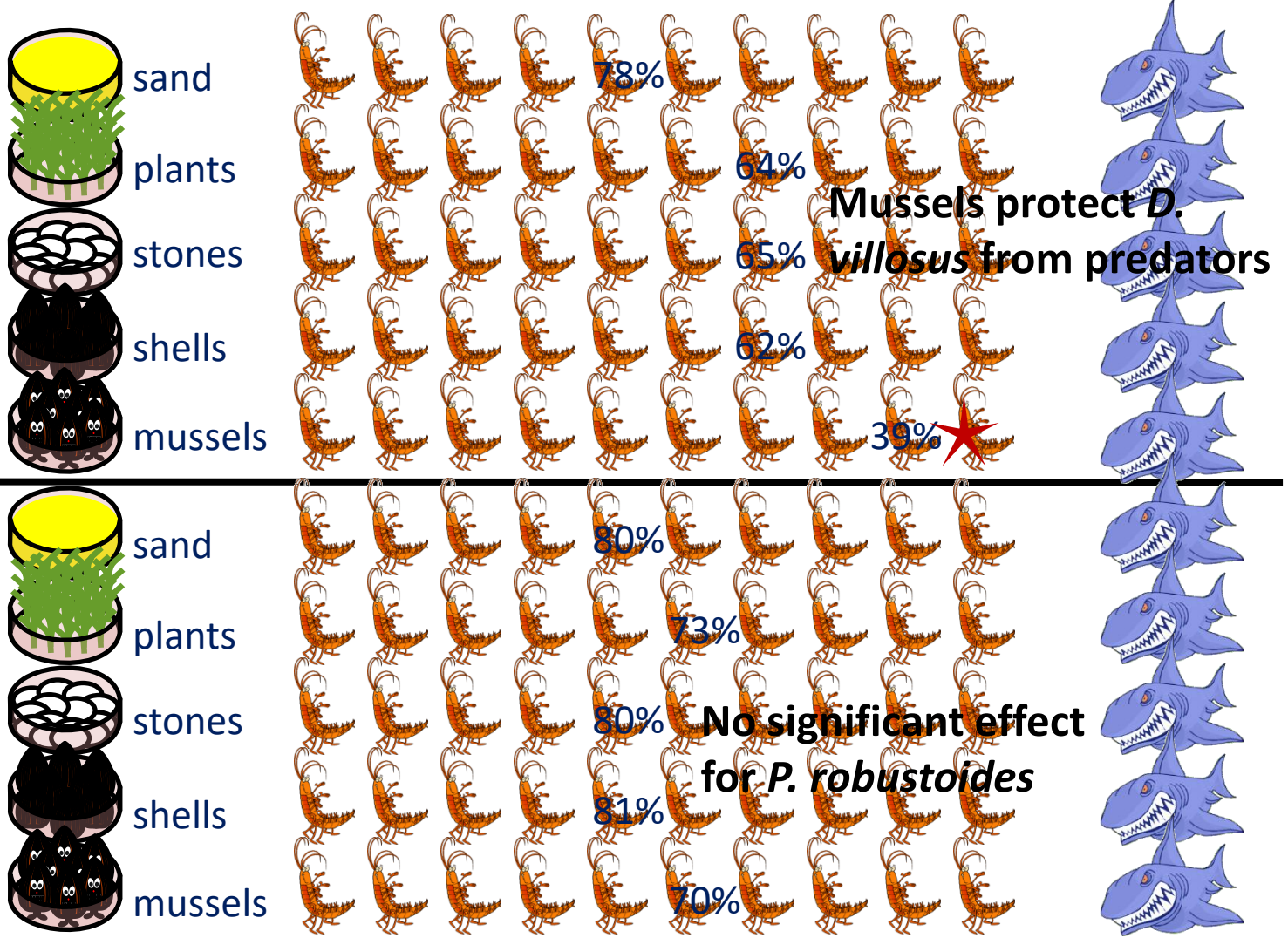
We counted the survivors after 24 h

Kobak J, Jermacz Ł, Płąchocki D 2014. Effectiveness of zebra mussels to act as shelters from fish predators differs between native and invasive amphipod prey. Aquat Ecol 48: 397-408

Gammarid consumption

Dikerogammarus villosus

inhabitant of mussel colonies



not closely associated with mussels

Kobak et al. 2014

4. Do the gammarids facilitate each other?

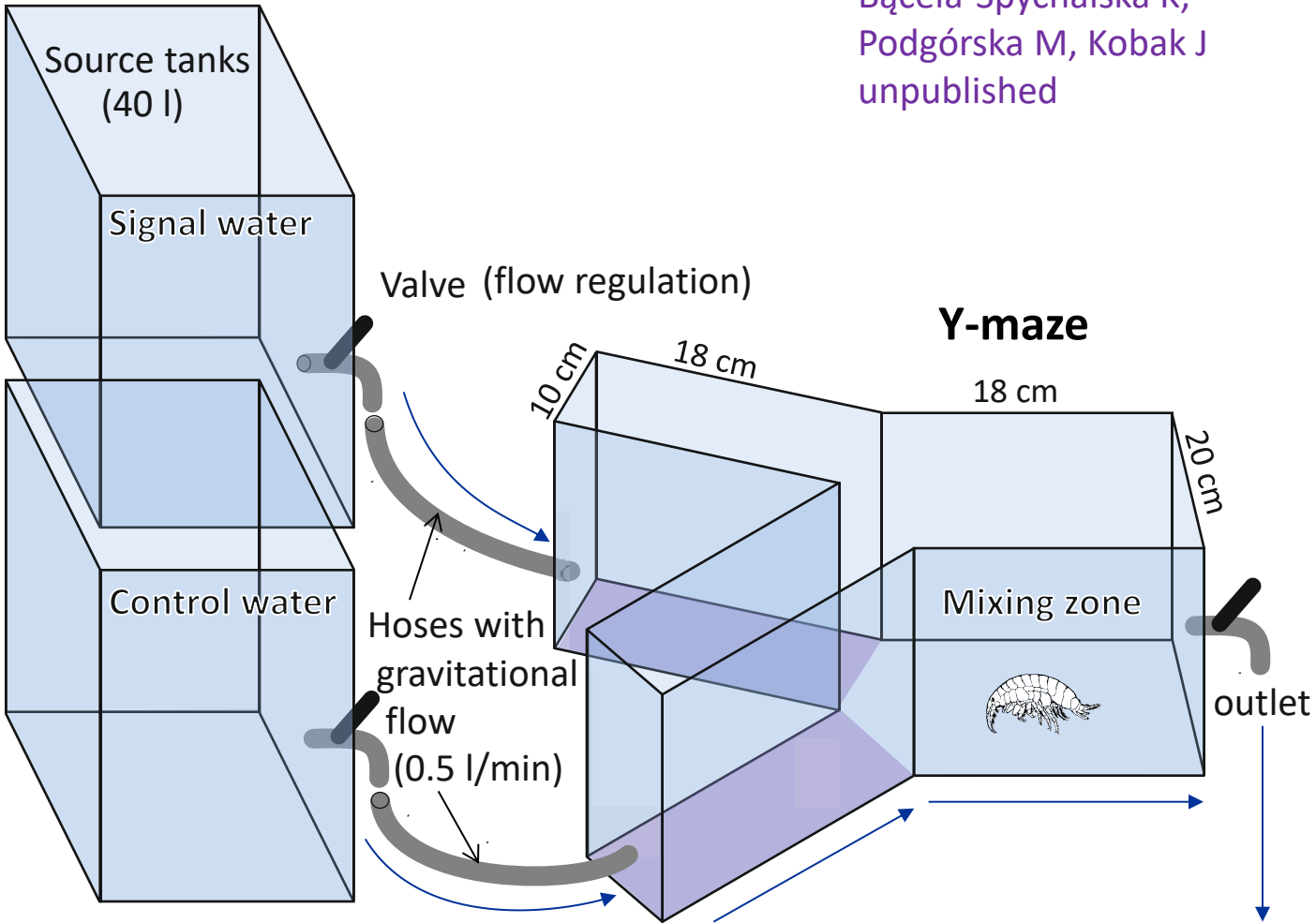
Rachalewski M, Jermacz Ł, Bącela-Spychalska K, Podgórska M, Kobak J unpublished

- Gammarids originating from the same region can sense one another's chemical signals and
  - better respond to predation danger
  - find suitable habitats

4. Do the gammarids facilitate each other?

Rachalewski M, Jermacz Ł, Bącela-Spychalska K, Podgórska M, Kobak J
unpublished

- 10 gammarids in the maze
- Duration: 5 + 35 min
- Video recording and analysis of time spent in the zones (Noldus Ethovision XT 10.1)



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Response variable: time in the signal zone

Responding species	Signal source: Living individuals			Signal source: Crushed individuals		
	Dv	*Dh*	*Pr*	*Dv*	*Dh*	*Pr*
D. villosus		0	+		0	+
D. haemobaphes	−		−	−		0
P. robustoides	−	0		0	0	

- *D. villosus* is attracted by signals from *P. robustoides*
- Other species respond only negatively to heterospecific signals
- **No facilitation except *D. villosus***

5. Do the gammarids hurt zebra mussels?

- Zebra mussels help gammarids by providing them shelters and food
- That is why gammarids are commonly found in mussel colonies
- Is there any reverse impact: of gammarids on mussels?
    - They can irritate soft parts of mussel body by crawling among them

Kobak J, Poznańska M, Kakareko T 2012. Behavioural changes of zebra mussel *D. polymorpha* induced by Ponto-Caspian gammarids. Biol. Inv. 14: 1851-1863

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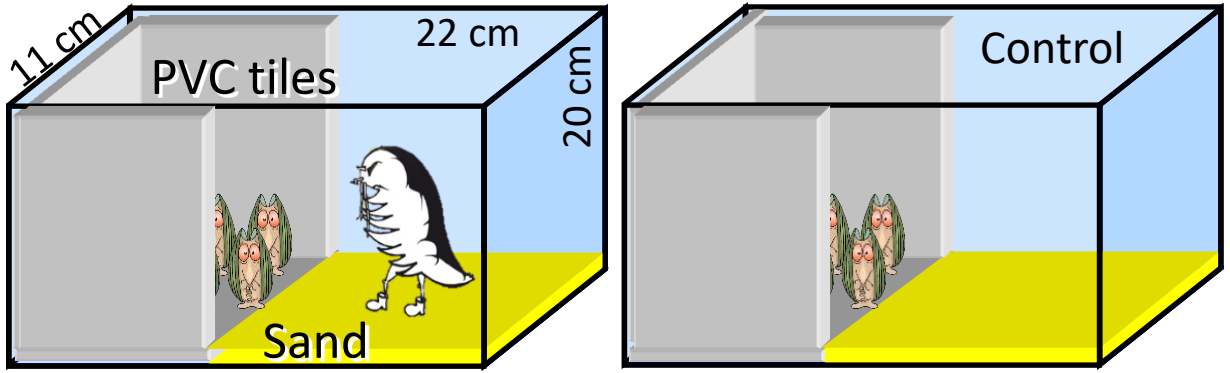


Kobak J, Poznańska M, Kakareko T 2012 Behavioural changes of zebra mussel induced by Ponto-Caspian gammarids. Biol. Inv. 14: 1851-1863

- 10 gammarids
- 24 h

- Mussels exposed to gammarids attached more strongly (by 40%) and stayed at the bottom more often (by 40%)

These responses resemble those induced by predators

Kobak J, Poznańska M, Kakareko T 2012. Behavioural changes of zebra mussel *D. polymorpha* induced by Ponto-Caspian gammarids. Biol. Inv. 14: 1851-1863

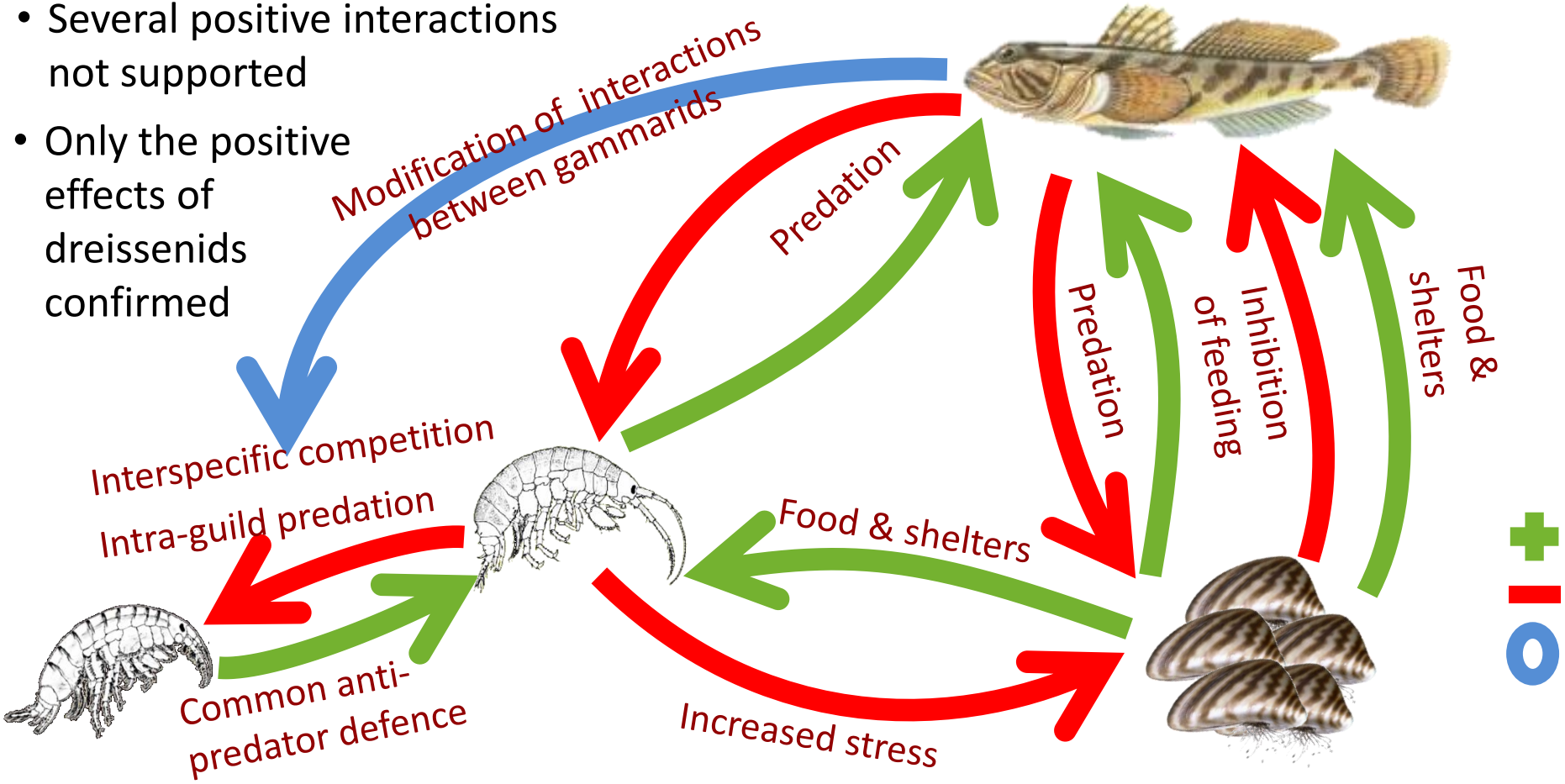
Also, mussels reduce their valve opening (time and %) in the presence of gammarids

Dzierżyńska-Białończyk et al. unpublished

Negative effect of gammarids on mussels

The Ponto-Caspian community in Polish fresh waters

- Several positive interactions not supported
- Only the positive effects of dreissenids confirmed



IMD in the Ponto-Caspian community in Polish fresh waters

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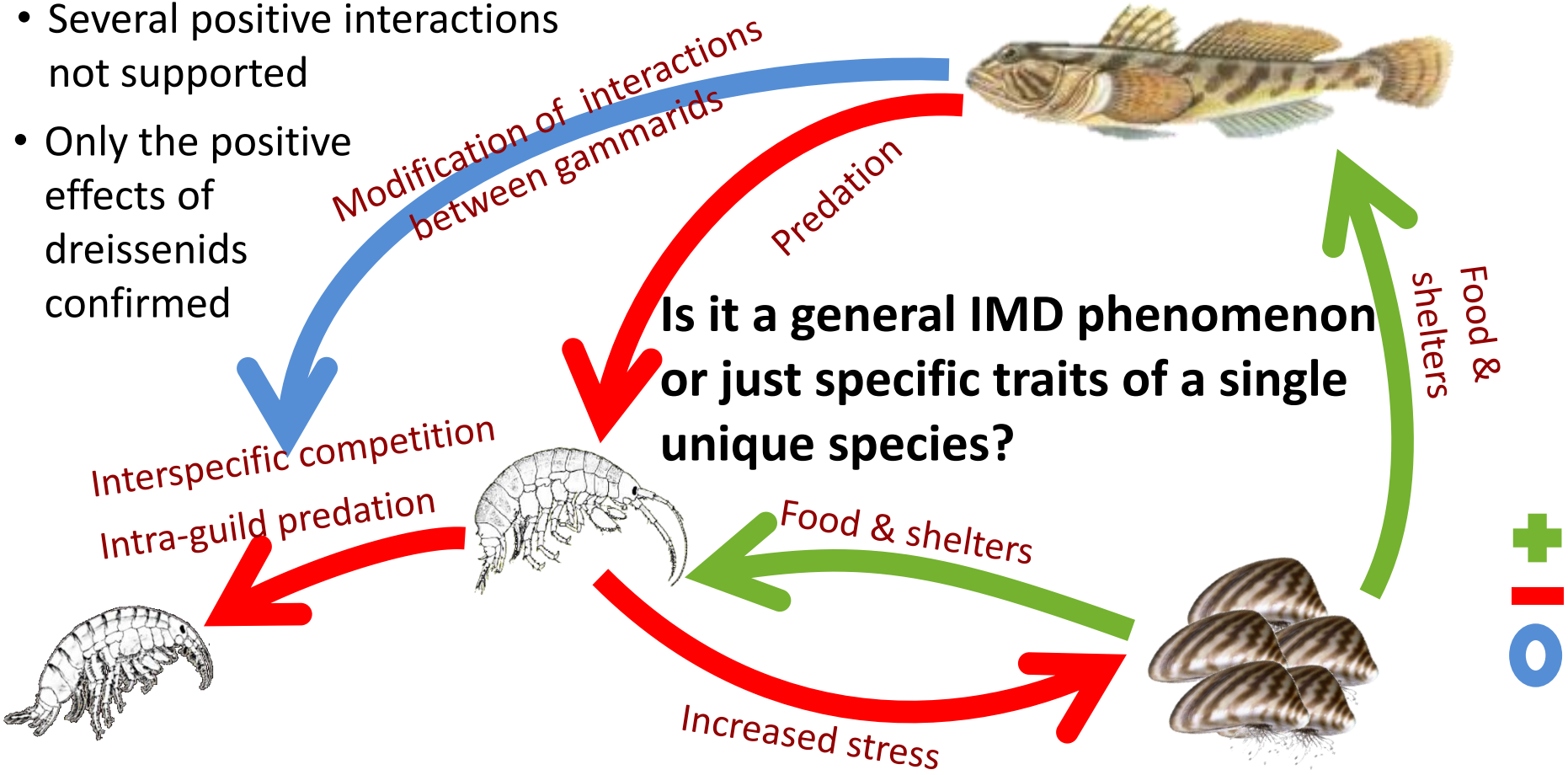

Is it a general IMD phenomenon or just specific traits of a single unique species?

Thank you for your attention

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to Jarosław Kobak

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