

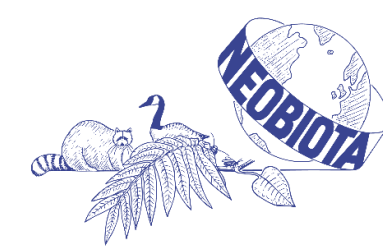
Size matters: predation of fish eggs and larvae by native and invasive amphipods



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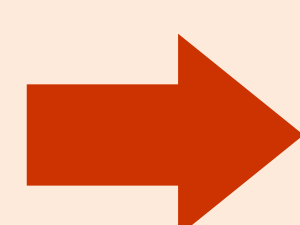


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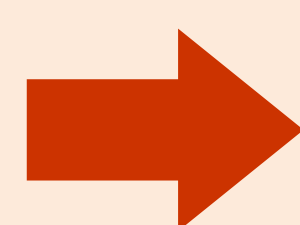
Introduction

The **killer shrimp** *Dikerogammarus villosus* is an invasive amphipod Crustacean in western Europe. Its native range is in south eastern Europe.

- *D. villosus* is a **voracious predator**, consuming a range of macroinvertebrates in the lab¹ and field².
- *D. villosus* has also been observed to prey upon fish eggs^{1,5}.



This predation is thought to contribute to changes in macroinvertebrate community structure^{2,3} and function⁴ following *Dikerogammarus* invasion. Abundance of resident macroinvertebrates declines – especially amphipods, isopods and worms^{2,3}.



Concerns over **declines in fish populations** following *Dikerogammarus* invasion, analogous to macroinvertebrate declines – **but these were poorly quantified**.

Aim:

Quantify predatory impact of *Dikerogammarus villosus* on fish eggs and larvae

PREDATORS

- Compare impact of invader to native analogue. Is *D. villosus* worse than shrimp it may replace?
- Use size-matched amphipods (to compare intrinsic differences in impact) and larger *D. villosus* (to reflect natural size differences).

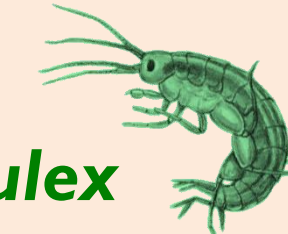
Large
D. villosus



Intermediate
D. villosus



Native
Gammarus pulex



PREY

Ghost carp *Cyprinus carpio*
small eggs and larvae, warmer water

OR brown trout *Salmo trutta*
large eggs and larvae, cooler water



Experiment 1: Functional Response (FR)

Consumption of prey across a range of prey densities

METHODS

Food = eggs **or** larvae at a set density
1, 2, 3, 5, 8, 10/12, 15/16, 25, 35, 50 or 80 prey supplied

Analysis: determine FR type using logistic regression, then fit FR curves (Rogers' random predator equation)

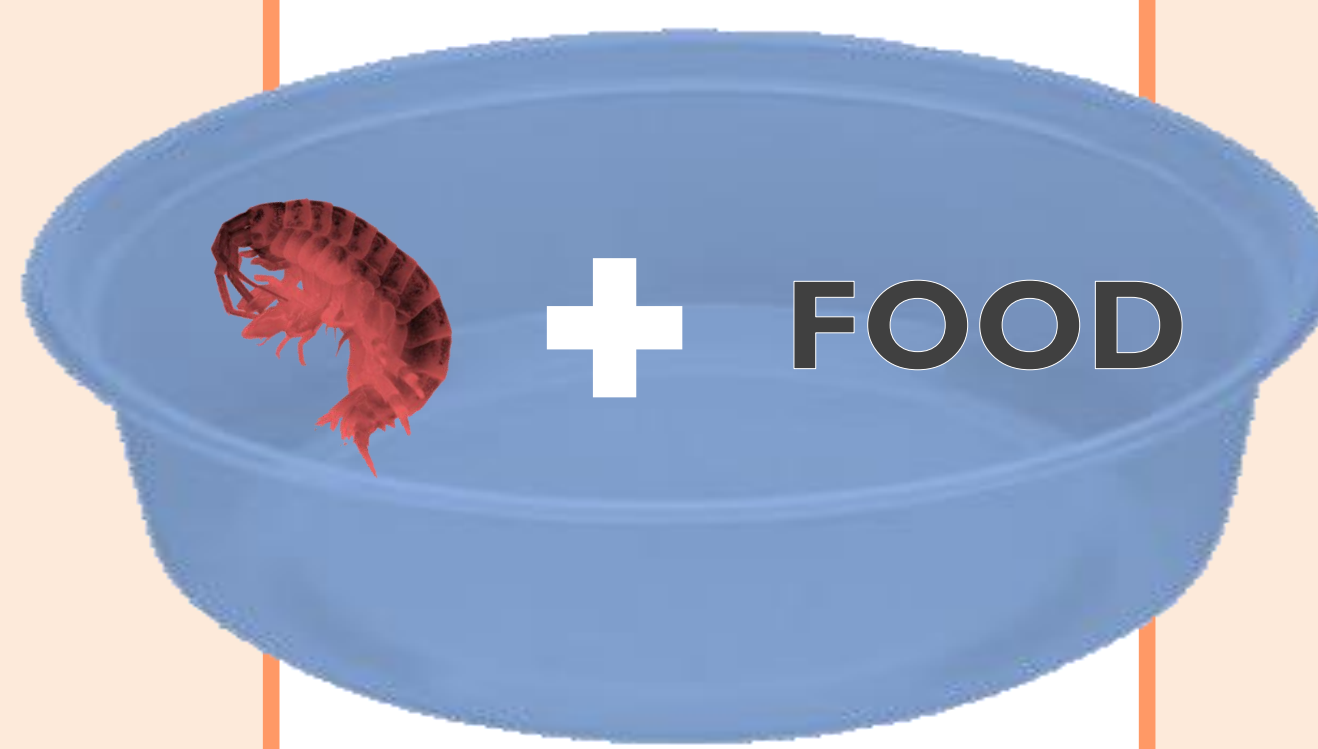
RESULTS

On carp eggs/larvae: large *D. villosus* have higher max. feeding rate than smaller amphipods (Fig. 1)

On trout larvae: Predation low, but *D. villosus* more likely than *G. pulex* to kill larvae

On trout eggs: minimal predation by any amphipod

Each replicate:



24h carp
48h trout



How many prey remaining?

Experiment 2: Electivity

= proportion of different food items in the diet
Are carp eggs/larvae consumed even when other food present?

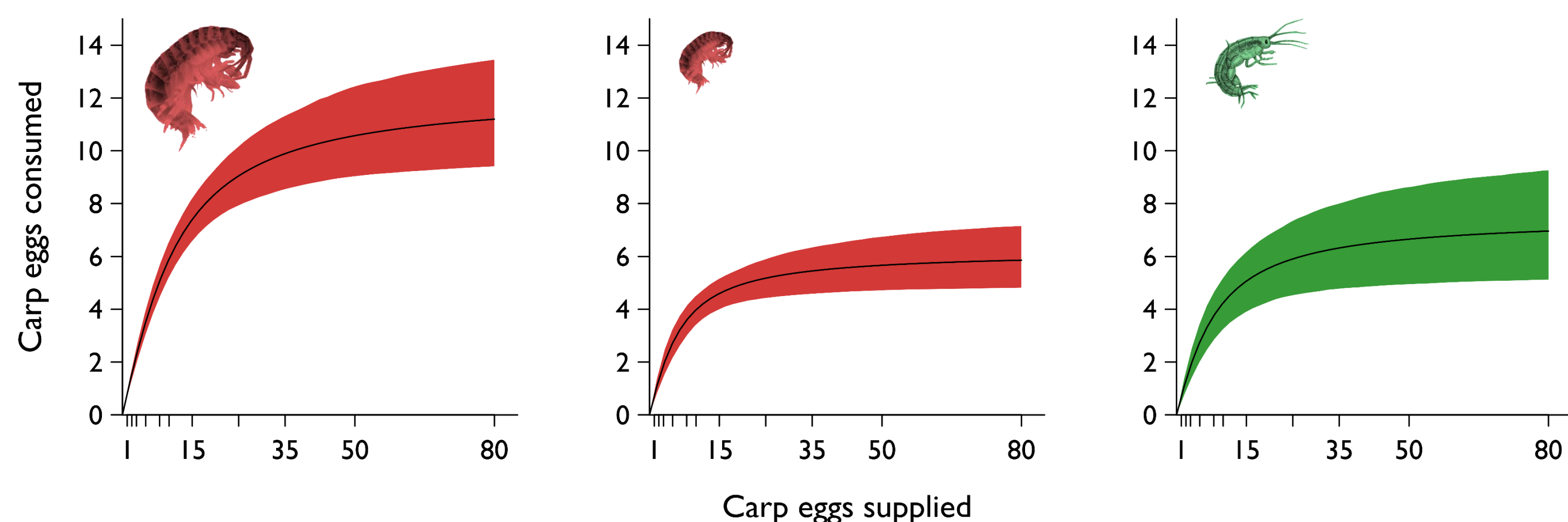
METHODS

Food = 4 types in equal masses
fish eggs/larvae + leaf litter + plant + macroinvertebrates
Analysis: compare mass consumed and diet composition

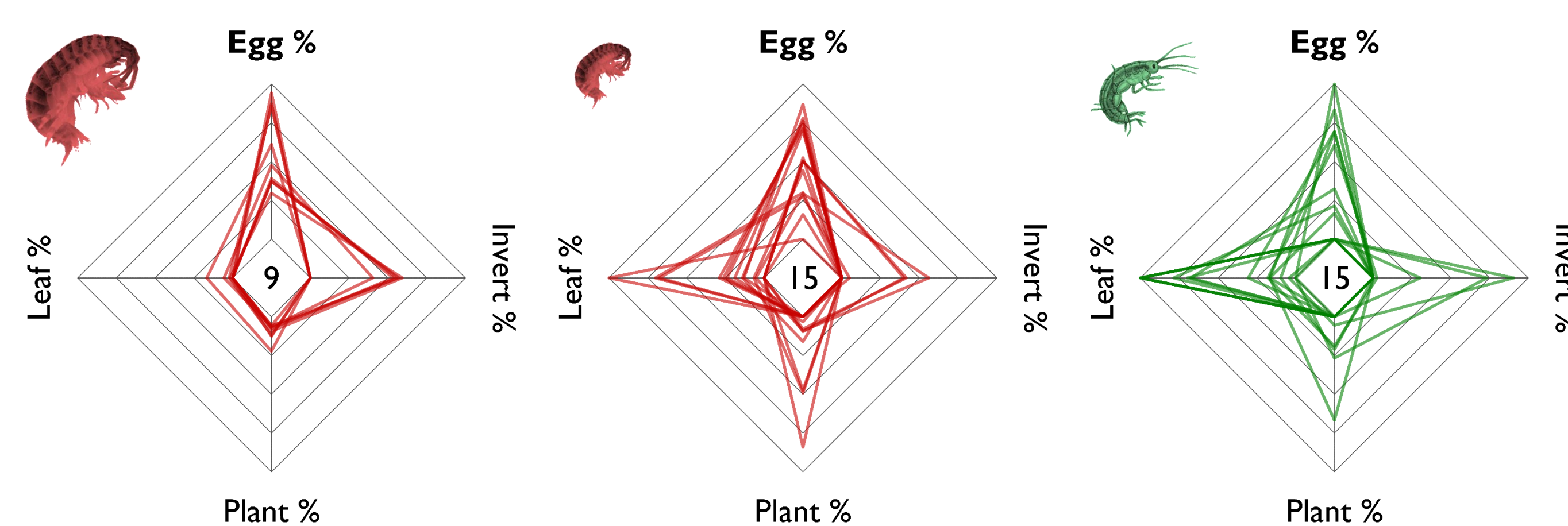
RESULTS

With carp eggs: Large *D. villosus* consume more overall, consume more eggs and are more predatory than smaller amphipods (Fig. 2). Intermediate *D. villosus* consume more eggs than *G. pulex*.

With carp larvae: No difference in larval consumption, but large *D. villosus* more predatory (data not shown)



▲ Fig. 1 Functional responses of amphipods using carp eggs as prey for 24h. Lines are Type II FRs, shaded areas are 95% bootstrapped CIs



▲ Fig. 2 Percentage of each food type in amphipod diet. Each coloured polygon represents one amphipod (n in centre of each plot)

Conclusions

1. Invasive *D. villosus* is a more damaging egg/larval predator than native *G. pulex* – but mainly because it is bigger

Large *D. villosus* most likely to kill trout larvae + has higher FRs on carp + consumes more carp eggs when alternative food present

Intermediate *Dv* rarely consumes > *Gp*; any differences small in magnitude

2. Influence of abundance?

D. villosus may reach higher densities than *G. pulex*⁶ – which would multiply its *per capita* effect

3. Negative effect on fish recruitment?

Increased mortality of juveniles → strong effects later in life⁷

