Comparing clearance rates between native (*Lampsilis fasciola*) and invasive (*Corbicula fluminea*) bivalves under high and low food conditions

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Research questions:

1. How much do algal clearance rates differ between *C. fluminea* and juvenile *L. fasciola*?
2. Does food concentration affect clearance rate?

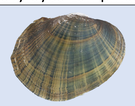
Background:

- Freshwater mussels (Bivalvia: Unionidae) are highly imperiled
- *Corbicula fluminea* are an invasive bivalve that co-occur and may compete with native mussels (Fig. 1, Fig. 2)
- Clearance rate measures the filtration of particles (Riisgård, 2001)
- Clearance rates can be used to compare the filtration potential of bivalves (Atkinson et al, 2011, van Ee et al, 2022)

Fig. 1 Benthic habitat along the Cahaba River in Bibb County, AL

Study Species

Lampsilis fasciola
Wavyrayed Lampmussel



Corbicula fluminea
Asian Clam

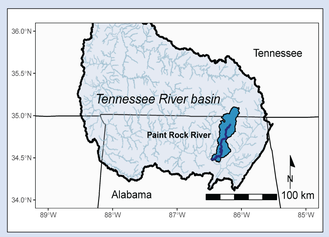


Fig. 2 Map of the Paint Rock River in the Tennessee River basin. *L. fasciola* and *C. fluminea* co-occur here

Experimental Design

- 1 L plastic chambers *(N* = 60*)* were filled with 500 mL of recirculating water at 23°C (Fig. 3)
- Two-way factorial design:
  - Mussel treatment (*L. Fasciola*, *C. fluminea*, control)
  - Food concentration treatment (High, Low)
- Individual *C. fluminea* (*n* = 20) and *L. fasciola* (*n* = 20) were measured and placed in all chambers except controls (*n* = 20)
- High (*n* = 30) and Low (*n* = 30) food treatments were added to chambers to achieve concentrations of 110,700 cells mL^{-1} and 11,070 cells mL^{-1} respectively
- Chambers were left undisturbed for 2 h to allow bivalves to filter
- After 2 h, we filtered chamber water for suspended organic matter dry mass (DM) and ash-free dry mass (AFDM) and chlorophyll-*a* (chl-*a*) using glass fiber filters (0.7 µm pore size)
- Mussels were collected for dissection and dry mass calculation

Clearance rates:

Mass-specific clearance rates were determined based on the difference chlorophyll-*a* concentration between each test chamber ($conc_f$) and the mean concentration of the corresponding control treatment ($conc_i$) (Spooner and Vaughn, 2008)

$$CR = V \ln(conc_i/conc_f) (M\ t)^{-1}$$

- V = volume (L)
- $conc_i$ = estimated initial concentration
- $conc_f$ = final concentration
- M = mussel soft tissue dry mass (g)
- t = filtration time (h)

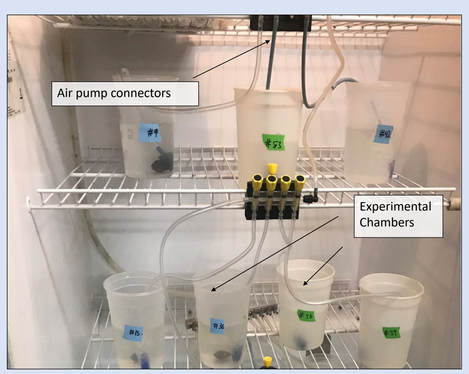


Fig. 3 Experimental incubator setup with labeled experimental chambers. Large air pump connects to individual fittings that bring air to each chamber

Results:

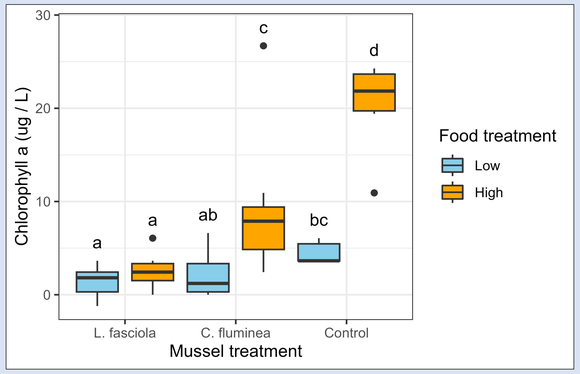


Fig. 4 Chlorophyll-*a* concentrations across mussel and food treatments at the end of the experiment. Different letters represent statistically significant differences ($P < .05$) between treatment groups (pairwise comparisons using Wilcoxon rank sum test with Holm-corrected *P*-values)

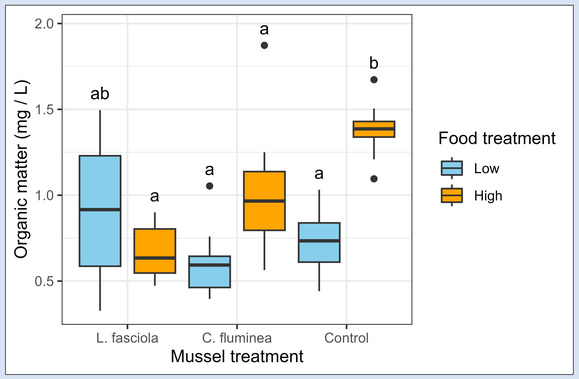


Fig. 5 Organic matter mass across mussel and food treatments at the end of the experiment. Different letters represent statistically significant differences ($P < .05$) between treatment groups (pairwise comparisons using Wilcoxon rank sum test with Holm-corrected *P*-values)

- *Lampsilis fasciola* high food ($P = 0.002$) and low food ($P = 0.007$) treatments were lower in chl-*a* than respective controls
- *Corbicula fluminea* high food treatment ($P = 0.021$) had lower chl-*a* than the control, but the low food treatment did not ($P = 0.092$). *L. fasciola* reduced chl-*a* more than *C. fluminea* in high food treatments ($P = 0.014$) (Fig. 4)
- *Lampsilis fasciola* ($P < 0.001$) and *C. fluminea* ($P = 0.047$) high food treatments both had lower suspended organic matter than the high food control. Organic matter was not reduced in low food treatments ($P > 0.05$) (Fig. 5)

- Clearance rates did not differ significantly between species ($P > 0.05$) (Fig. 6)
- *Lamsilis fasciola* high food treatment had a higher clearance rate than the *L. fasciola* low food treatment ($P = 0.004$)
- Both bivalves' dry masses scaled according to power law relationships with shell length (Atkinson et al, 2020). This relationship can be used to estimate dry mass from mussel length

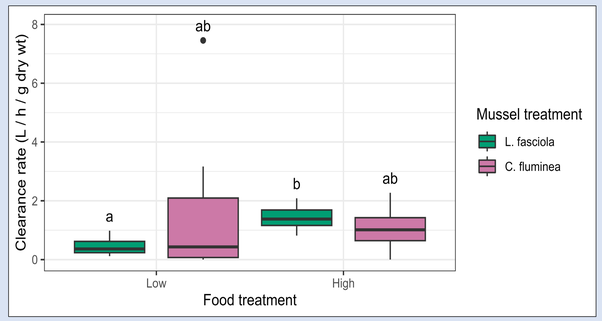


Fig. 6 Estimated clearance rates across food treatments between each mussel treatment group. Different letters represent statistically significant differences ($P < .05$) between treatment groups (pairwise comparisons using Wilcoxon rank sum test with Holm-corrected *P*-values)

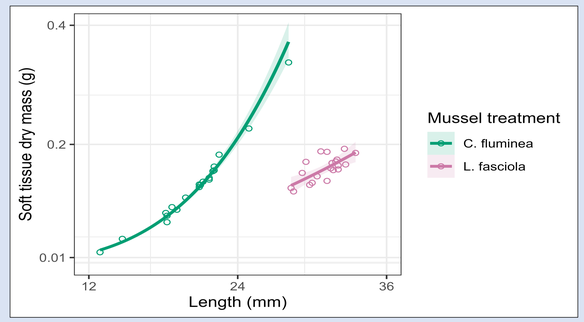


Fig. 7 Length-mass regression lines for non-lethal estimation of individual bivalve mass. Length-mass regression equations are (*C. fluminea:* $M = 2.28 * 10^{-6} * L^{3.60}$, $R^2 = 0.98$; *L. Fasciola:* $M = 1.21 * 10^{-4} * L^{2.09}$, $R^2 = 0.48$)

Discussion:

- Results suggest that clearance rates do not significantly differ between juvenile *L. fasciola* and *C. fluminea,* implying similar filtration potential at this life stage
- Both *L. fasciola* and *C. fluminea* appeared to fully deplete chl-*a* within the low food treatments. This may have lead to underestimations of clearance rate within the low food treatments. Using a shorter experiment duration or higher food concentrations would likely improve clearance rate estimates
- *Lampsilis fasciola* will achieve greater filtration potential as they grow larger. Under natural conditions, the filtration potential of these two species will depend on species abundance, biomass, and life stage

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