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Origin of turbidity mediating the cascade-effect of piscivores on invertebrate survival: shoal and individual perspectives

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Environmental changes such as eutrophication and increasing inputs of humic matter may have strong effects on predator–prey interactions in lakes, because many aquatic species rely primarily on visual cues to capture prey and avoid potential threats. Here, we hypothesized that the origin of turbidity and piscivore presence (*Hoplias malabaricus*) affect (i) the total consumption of invertebrates by a small characid fish (*Moenkhausia forestii*) and (ii) the partition of resources among individuals in the same shoal. We also investigated possible differences in selectivity of different prey by *M. forestii* under different turbidity conditions and predator presence. We conducted an experiment with two levels of piscivore presence (present and absent), three levels of turbidity (clear water, organic and inorganic turbidity), with eight replicates (48 experimental units). Each aquarium received 5 characid fish individuals, 15 Chironomidae larva and 15 *Daphnia* as prey. We calculated the Chesson index of prey selectivity for each shoal using *Daphnia* consumption, and we used the Pielou equitability index to compare prey consumption among individual fishes in the same shoal. From the shoal perspective, prey consumption was lower in both turbid treatments in the presence of piscivore, while in the absence of it, consumption was not statistically different. *Daphnia* was strongly preferred over Chironomidae in inorganic turbidity in the presence of piscivore. This indicates that the hunting-mode of piscivore indirectly influences prey selectivity by *M. forestii* depending on prey habitat (benthonic x planktonic). From the individual perspective, fish partitioned resources better in the absence of the piscivore. Few individuals consumed Chironomidae prey in the presence of the piscivore and in inorganic turbidity, which may indicate a difference in foraging behaviors (e.g., boldness) among individuals in the same shoal. Therefore, cascade effects generated by piscivorous fish on invertebrate preys may be stronger if the vision through water is deteriorated.

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