Positive and negative density-dependent infection found in an emerging disease of stream insects

Stable species coexistence allows species-rich communities to form and persist. Density-dependent population regulation, and specifically density-dependence concentrated within species, is a key requirement for coexistence. However, field tests of whether and how density-dependence can permit coexistence are almost completely lacking due to logistical barriers. We tested whether the oomycetes *Saprolegnia*, which infects and kills the eggs of hydrobiosid caddisflies, acts in a density-dependent way and may therefore aid coexistence of species. We achieved this test by manipulating the densities of oviposition habitat that was suitable for hydrobiosids (emergent rocks in different water velocities) over multiple sites in the Taggerty River, south-eastern Australia. Following our manipulation, sites varied from near-zero emergent rocks to high densities (exceeding background levels). Our experiment succeeded in creating a gradient in the densities of hydrobiosid egg masses among sites. We documented the percentage of egg masses that were infected over different scales (whole sites, individual rocks, and clusters of egg masses on the same rock). We found density-dependent infection, with the strength and direction of density-dependence varying among species and dependent on the scale at which density was measured. We attribute this complexity to species-specific oviposition traits and behaviours, which influence the timing and transmission mechanisms of infection. Although the mechanisms driving infection processes are complex, the positive density-dependence observed in the most abundant species and the negative density-dependence observed in three rarer species have potentially important outcomes for species coexistence.

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