Evidence for Density-Dependent Transmission of an Environmentally-Borne Parasite

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For many infectious diseases, determining whether transmission is frequency- or density- dependent (i.e. whether the contact rate between susceptible hosts and the parasite change with host population density) is of crucial importance to understanding epidemic spread and dynamics. For environmentally-borne parasites, especially those with a long free-living stage, the picture is particularly unclear. Here, we monitor transmissibility of an environmentally-borne bacterial parasite, *Pasteuria ramosa* in its host *Daphnia magna* over the course of a seasonal epidemic in a natural pond in Switzerland. Parasite transmission stages (spores) are released into the sediment when an infected individual dies and decomposes. Spores may survive for several years, thus it is assumed that the "spore bank" in the sediment is essentially limitless, and that most transmission in nature occurs from the sediment during grazing (i.e. should be frequency dependent). We here find that spores are present in the water column at infectious levels, and that their concentration in the water column fluctuates over the course of an epidemic, alongside the density of the host population and other invertebrates. As this parasite is not directly transmitted from host to host, we postulate that increasing "activity" in the pond as invertebrate populations grow stirs up spores from the sediment into the water column. We demonstrate experimentally that spores may remain suspended in the water column for long periods of time, thus increased disturbance to the sediment as populations grow may lead to high accumulations of spores in the water column, explaining the density-dependence we observed.