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Species interactions modify the spread of vector-borne pathogens independent of transmission mode

Many pathogens are transmitted by vectors, and transmission studies traditionally focus on vector-host-pathogen interactions. However, vectors are animals that forage in complex food webs, where they interact with individuals of many species across multiple trophic levels. These interactions might indirectly affect pathogens by altering vector fitness, movement, or feeding duration, although these effects might differ for pathogens with different transmission modes. Interactions that affect vector-host encounter rates, for example, might most strongly affect non-persistent pathogens, which attach to vector mouthparts and are transmitted quickly; interactions that affect vector feeding duration might most strongly affect persistent pathogens that require long feeding bouts for transmission. Here we addressed these knowledge gaps by developing a model to explore the impacts of interactions such as competition, predation, and mutualism on the spread of pathogens with either non-persistent or persistent transmission modes. Interactions that affected aspects of vector movement and feeding behaviour (feeding duration, vector-host encounter rates) substantially altered rates of pathogen spread, whereas interactions affecting vector fitness (births, deaths) had relatively small effects. These effects of species interactions were largely independent of transmission mode, except when interactions affected vector-host encounter rates, where effects were strongest for non-persistent pathogens. Our results suggest that including species interactions and food web structure in pathogen transmission models could greatly enhance our understanding of disease ecology.

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