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Mechanistic movement models to understand epidemic spread

An overlooked aspect of disease ecology is considering how and why animals come into contact with one and other resulting in disease transmission. Mathematical models of disease spread frequently assume mass-action transmission, justified by stating that susceptible and infectious hosts mix readily, and foregoing any detailed description of host movement. Numerous recent studies have recorded, analysed and modelled animal movement. These movement models describe how animals move with respect to resources, conspecifics and previous movement directions and have been used to understand the conditions for the occurrence and the spread of infectious diseases when hosts perform a type of movement. Here, we summarize the effect of the different types of movement on the threshold conditions for disease spread. We identify gaps in the literature and suggest several promising directions for future research. The mechanistic inclusion of movement in epidemic models may be beneficial for the following two reasons. Firstly, the estimation of the transmission coefficient in an epidemic model is possible because animal movement data can be used to estimate the rate of contacts between conspecifics. Secondly, unsuccessful transmission events, where a susceptible host contacts an infectious host but does not become infected can be quantified. Following an outbreak, this enables disease ecologists to identify 'near misses' and to explore possible alternative epidemic outcomes given shifts in ecological or immunological parameters.