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Coexistence and competition in macroparasite models

Models for macroparasites are based on the idea of dividing the host population according to the number of parasites a host harbours. Considering two parasite species, one gets a doubly infinite system, which may look prohibitive to analyse. However, it is sometimes possible to compute explicitly the invasion coefficient, that allows to establish whether an equilibrium where a host coexists with one parasite species is stable against introduction of the second parasite species. When both equilibria with only one parasite species can be invaded, coexistence of both parasite species can be inferred. Using this technique, it is possible to find conditions for parasite coexistence when parasites interact only through deaths of a common host, or when there is direct competition affects parasite fertility. In the first case, coexistence is possible but very unlikely, occurring only under a very balanced trade-off between parasite fertility and mortality. In the second case, coexistence is rather widespread as long as inter-specific competition is lower than intra-specific one, similarly to what happens for free-living species. A different approach is to approximate the original system with a low-dimensional one through some kind of moment closure, for instance the normal approximation. With this method, and some further simplifications, it is possible to analyse more cases of parasite competition, obtaining similar trends. An interesting finding is that parasite coexistence is more likely under the joint effect of host heterogeneity in predisposition to infection, and imperfect correlation in the predisposition to infection from the two species.