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THE PUZZLE OF PARTIAL MIGRATION: ADAPTIVE DYNAMICS AND EVOLUTIONARY GAME THEORY PERSPECTIVES

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Abstract. We consider the phenomenon of partial migration which is exhibited by populations in which some individuals migrate between habitats during their lifetime, but others do not. First, using an adaptive dynamics approach, we show that partial migration can be explained on the basis of negative density dependence in the per capita fertilities alone, provided that this density dependence is attenuated for increasing abundances of the subtypes that make up the population. We present an exact formula for the optimal proportion of migrants which is expressed in terms of the vital rates of migrant and non-migrant subtypes only. We show that this allocation strategy is both an evolutionary stable strategy (ESS) as well as a convergence stable strategy (CSS). To establish the former, we generalize the classical notion of an ESS because it is based on invasion exponents obtained from linearization arguments, which fail to capture the stabilizing effects of the nonlinear density dependence. These results clarify precisely when the notion of a "weak ESS", as proposed in [24] for a related model, is a genuine ESS. Secondly, we use an evolutionary game theory approach, and confirm, once again, that partial migration can be attributed to negative density dependence alone. In this context, the result holds even when density dependence is not attenuated. In this case, the optimal allocation strategy towards migrants is the same as the ESS stemming from the analysis based on the adaptive dynamics.

The key feature of the population models considered here is that they are monotone dynamical systems, which enables a a rather comprehensive mathematical analysis.

Contents

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