A problem of population dynamic

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We study the dynamics of a prey-predator system, with the particularity that the species are spread out over N sites, each site possessing its own characteristics (birth/death rates, predation pressure, etc.). The evolution is governed by two phenomena. On the one hand populations tend to migrate from one site to another, on a fast time scale, and we assume that the migration rates themselves oscillate on the same time scale (so as to reproduce migrations on a daily scale, say). On the other hand, the predator-prey dynamics itself takes place, yet on a much longer time-scale. We model this situation through a Lotka-Volterra-like system, modified by a fast oscillating, periodic, migration term, whose typical dimensionless time-scale is a small parameter epsilon.

We completely describe the asymptotic model that is relevant as epsilon goes to zero, and analyse the qualitative properties of the limiting model. Our approach provides approximations at any order of the original equations.

Our strategy relies on an original combination of a central manifold approach (so as to smooth out the rapid trend to equilibrium involved during the migration process), and of an averaging procedure (so as average out the fast oscillating coefficients involved in the migration rates themselves). Technically, we make use of a Floquet-Magnus approach, combined with a specific version of the central manifold in the case when the central manifold has oscillating coefficients, our last tool being the use of a high order version of periodic averaging for evolution equations.

Références

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