Species invasiveness in biological invasions: a modelling approach

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RESUMEN

The study of invasiveness, the traits that enable a species to invade a habitat, and invasibility, the habitat characteristics that determine its susceptibility to the establishment and spread of an invasive species, provide a useful conceptual framework to formulate the biological invasion problem in a modelling context. Another important aspect is the complex interaction emerging among the invader species, the noninvader species already present in the habitat, and the habitat itself. Following a modelling approach to the biological invasion problem, we present a spatially explicit cellular automaton model (Interacting Multiple Cellular Automata (IMCA)). We use field parameters from the invader Gleditsia triacanthos and the native Lithraea ternifolia in montane forests of central Argentina as a case study to compare outputs and performance of different models. We use field parameters from another invader, Ligustrum lucidum, and the native Fagara coco from the same system to run the cellular automaton model. We compare model predictions with invasion values from aerial photographs. We discuss in detail the importance of factors affecting species invasiveness, and give some insights into habitat invasibility and the role of interactions between them. Finally, we discuss the relevance of mathematical modelling for studying and predicting biological invasions. The IMCA model provided a suitable context for integrating invasiveness, invasibility, and the interactions. In the invasion system studied, the presence of an invader's juvenile bank not only accelerated the rate of invasion but was essential to ensure invasion. Using the IMCA model, we were able to determine that not only adult survival but particularly longevity of the native species influenced the spread velocity of the invader, at least when a juvenile bank is present. Other factors determining velocity of invasion detected by the IMCA model were seed dispersal distance and age of reproductive maturity. We derived relationships between species' adult survival, fecundity and longevity of both theoretical and applied relevance for biological invasions. Invasion

velocities calculated from the aerial photographs agreed well with predictions of the IMCA model.

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