Factors of invasions' success or failure: estimation in frameworks of optimization mathematical model

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Histories of insect invasions into new areas (in particular, the history of the gypsy moth invasion in North America) are mainly success stories. But it is difficult to trace the unsuccessful attempts of invasions and analyze the reasons for failure. However, it's necessary to determine population characteristics and environmental factors which will contribute to (or, conversely, hinder) insects invasion into new territories. Knowledge of these factors is needed for monitoring and preventing invasion of potentially dangerous insect species.

An approach stemming from mathematical modeling of forest insects' invasive processes is presented in this paper. We suggest that this approach is used as a tool for estimations of invasion risk.

The set of models that comprise the approach includes:

- models that describe features of forest insects population dynamics, phase portraits structure of potentially invasive species in natural habitats and characteristics of population density fluctuations at low density level (Isaev et al., 2001; Soukhovolsky et al, 2004; Isaev et al., 2009);
- models of spatial population structure and migration activity of the studied forest insect species;
- models of interaction of invasive individuals with their host plants. A model of optimal food consumption is used for description of these interactions. The ecological prices of food consumption are determined and insects' probability of survival is estimated, depending on the characteristics of food resources across this territory (Soukhovolsky et al, 2009);
- models that characterize pheromone communication of insects. These models allow to assess the effectiveness and reliability of sex partner search in different species of Lepidoptera, the influence of environmental factors on the stability of pheromone molecules. They also help to detect causes of noise in the pheromone communication channel. Quantum chemistry methods are used for evaluation of pheromone molecules stability (Tomilin et al., 2011);
- models of invasive species outbreaks within a new territory. A one-dimensional phase portrait (potential well) and the model of an outbreak as a second order phase transition are considered for these purposes. It is possible to estimate influence of weather on population dynamics of invasive species using these models (Soukhovolsky et al, 2005; Soukhovolsky et al., 2009).

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The work supported by Russian Foundation for Basic Research (grant #11-04-00173).

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