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Biotic and Abiotic Controls of Argentine Ant Invasion Success at Local and Landscape Scales

Predicting where introduced species will occur requires an understanding of what factors limit invasion success and how they change in importance with spatial scale. It is also important to assess the extent to which the factors that determine occurrence of introduced species are the same as those that influence native diversity. Although the ecological success of introduced species hinges on species interactions and physical conditions, few experimental studies have simultaneously investigated the relative importance of both types of factors. The lack of such research may stem from the common assumption that native and introduced species exhibit similar environmental tolerances. A study in the December 2007 issue of *Ecology* by USGS scientist Robert Fisher and colleagues at the University of California at San Diego demonstrates a case where an ecologically and economically destructive invasive species, the Argentine ant *(Linepithema humile),* responds to the environment differently compared to native ant species. Their results illustrate surprising complexities with respect to how environmental factors limiting invasion can change with spatial scale.

Management Implications:

- Fine-scale differences in the physical environment can eclipse biotic resistance from native competitors in determining community susceptibility to invasion.
- Factors explaining occurrence at the community scale, such as soil moisture, appeared largely independent of factors operating at the landscape scale, such as temperature and precipitation.
- Efforts to model ranges of native and introduced species that rely on coarse environmental data may often exclude factors that determine occurrence at the community scale.
- Scale-dependent factors limiting the occurrence of invasive species also relate to the potential distribution and persistence of native species.

The researchers used a combination of experimental and analytical approaches to test the relative importance of biotic and abiotic factors in determining the local and regional occurrence of Argentine ants in southern California. They conducted field manipulations to gauge the relative importance of interspecific competition from native ants and the abiotic environment in determining invasions success, and to determine if native ants and Argentine ants respond similarly to key physical conditions. In these experiments, Argentine ants failed to invade any dry plots (even in the absence of native ants) but invaded all moist plots. Native ants slowed the spread of Argentine ants into irrigated plots but did not prevent their invasion. In areas without Argentine ants, native ant species showed variable responses to irrigation.

To complement these community-level experiments, the researchers used GIS-based approaches to examine patterns of occurrence at the landscape scale to test if the environmental variables that determine invader occurrence at the community scale are also important at the landscape scale, and to test if the environmental correlates of native species diversity are the same as those that determine introduced species occurrence. At the landscape scale, Argentine ants and native ants responded differently to environmental variables known to determine ant activity and occurrence. Argentine ant occurrence was strongly predicted by proximity to urban areas. The most important environmental determinant of Argentine ant presence at the landscape scale

was minimum winter temperature. Argentine ants were less likely to occur in lower winter temperatures. High temperatures also decreased the likelihood of their occurrence, but like precipitation, maximum summer temperature was a relatively poor predictor. Compared to environmental correlates of Argentine occurrence, the number of native ant species exhibited a nearly opposite pattern. Native ants increased in species number with increasing precipitation and less strongly with increasing NDVI (normalized difference vegetation index), a measure of the greenness of vegetation. High maximum summer temperatures significantly depressed the number of native ant species. Areas with higher minimum winter temperatures had fewer native ant species, but at the lowest winter temperatures, native ants exhibited their highest diversity.

Menke, S. B., R. N. Fisher, W. Jetz, and D. A. Holway. 2007. Biotic and abiotic controls of Argentine ant invasion success at local and landscape scales. Ecology 88:3164–3173.