Exotic plants in Japan set stage for reconciling Darwin's naturalization conundrum

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Video Abstract

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Abstract

Exotic species are a big problem worldwide. While the mechanisms of invasion vary from one exotic species to the next, researchers can tease out patterns that are useful for understanding and ultimately managing invasion. A new study published in the *Journal of Biogeography* reveals how one team has applied an emerging method known as the phylogenetic field approach to do just that for exotic plants in Japan. The results offer critical insight into how ecology and evolution influence the dynamics of invasion. Darwin's *On the Origin of Species* marked the first time biological invasion had been addressed using the principles of evolutionary ecology. But followed to their logical end, these principles yielded two contradictory hypotheses. The pre-adaptation hypothesis states that exotic species successfully colonize assemblages with native species that are ecologically similar because both require the same set of environmental conditions to thrive. The naturalization hypothesis, on the other hand, states that ecologically distinct exotic species successfully colonize native assemblages because they avoid inter-species competition. Reconciling these two hypotheses remains an important challenge in the fields of biogeography and invasion biology. The researchers addressed this challenge using as their model exotic plants found in Japan. Here, geological processes dating to the Pliocene and Pleistocene divided the islands or periodically connected them through land-bridge corridors. The result was endemic flora specific to each region. As trade with Japan has flourished over the past 150 years, invasion by exotic species has become a growing concern. The team looked at two facets of invasion: how invasive exotic plants are in their new surroundings and how susceptible native plants are to invasion. Specifically, they mapped the evolutionary relatedness of native plants colonized by each exotic species as a function of how similar, evolutionarily speaking, those exotic species are to the natives they're colonizing. This so-called phylogenetic field approach yields four possible scenarios: exotic plants colonize areas where native plants that are either close or distant relatives thrive, with those exotic plants themselves being closely or distantly related to the native plants they colonize. The researchers' data reflected each scenario. Some species colonized native plants that were ecologically similar; others colonized plants that were diversified. The upshot is that these patterns are associated with different properties of exotic species, such as their place of origin and climatic requirements; importantly, they also depend on the spatial scale being observed. Further refinements are needed to understand all the mechanisms of invasion at play. But as they stand, the findings provide a useful starting point for comprehending, managing, and perhaps even preventing the spread of invasive species.