A Biological Basis of Plant Invasions: Can Seedling Relative Growth Rate Predict Invasive Woody Species?

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Predicting Invasive Exotic Species

Our goal is to find robust generalizations about invasive woody species and to develop and apply risk assessment tools on species for which little or nothing is known. We have previously shown that seedling relative growth rate (RGR) is positively correlated with invasiveness for woody species. We will compare the seedling RGR of known invasive woody species with less invasive, phylogenetically-related species to confirm the usefulness of RGR for risk assessment of introduced species. We will produce a list of potentially invasive, horticulturally desirable species as well as a list of safer related species as alternatives for the nursery trade.

Are RGR & SLA useful for prediction?

RGR is an integration of a plant's physiology, growth pattern, leaf architecture, and allocation patterns, and is reflective of a species' resource acquisition patterns and life-history. Quantitatively, RGR is the amount of new biomass produced per total biomass per day. RGR is a product of photosynthetic efficiency (NAR: net assimilation rate) and the investment into leaf area (LAR: leaf area ratio). LAR itself is a product of leaf mass ratio (LMR) and specific leaf area (SLA). LMR is the biomass allocation to leaves, while SLA represents the architecture of a leaf, its density (cell wall thickness, amounts of fibers and sclerenchyma) and thickness.

In a previous study we analyzed 22 species within 10 phylogenetically-independent contrasts and showed that seedling RGR and SLA are significantly higher for invasive species (one-tailed paired t-test).

Growth variable	p-value
RGR (mg/g/day)	**0.026**
NAR (g/cm^2/d)	0.300
LAR (cm^2/g)	0.069
SLA (cm^2/g$_{leaf}$)	**0.024**
LMR (g$_{leaf}$/g)	0.853

Seedling RGR & SLA Study

We performed a comparative seedling growth study with 42 species (see list at right) in order to determine the importance of RGR in predicting invasiveness. All species chosen are commonly cultivated in California. The invasive species included some already invasive in California, as well as some invasive in other mediterranean climates but not invasive in California. These were paired with related non-invasive (or much less invasive) species.

All species were grown in the greenhouse as sets of phylogenetically-related species contrasting in invasiveness. Seedlings (30/species) were grown in the greenhouse and harvested at 10, 20, and 30 days after seedling emergence. Leaf areas were recorded with digital photography. Roots, stems, leaves, and cotyledons were oven-dried and will be weighed to calculate RGR, NAR, LAR, SLA, and LMR.

Seed Germination Experiment

Seeds of all species were surface sterilized, placed in Petri dishes with filter paper and distilled water, and placed in a growth chamber with temperature conditions typical for a California spring. Germination response and timing were observed in 45 species under varying light (light or dark) and stratification (none or 30-day cold/moist) regimes to see if germination characteristics are good indicators of invasiveness.

Nitrogen and Drought Experiment

Future conditions in California are predicted to have longer drought periods coupled with atmospheric nitrogen deposition. We tested a subset of the phylogenetically-independent contrasts (19 species, see list at right) for potential invasiveness under two nitrogen levels (low N representing wildland conditions and elevated N representing anthropogenic input) and under three levels of drought (no drought, medium drought, and high drought). Plants were grown under no drought conditions (for both low and high nitrogen levels) for 2 months to mimic California's wet winter/early spring and then subjected to a drought/nitrogen treatment for an additional month. Initial and final biomass, mortality, and drought tolerance (chlorophyll and carotenoid concentrations assayed every 10 days) were measured.

Acknowledgments

This study (Project # 05XN027) is funded by the USDA's UC IPM Exotic/Invasive Pests and Diseases Research Program. We also thank Clare Aslan, Tim Metcalf, Cheryl Phillips, Annie Pierpoint, Pamela Riley, and Doug Walker for all their hard work to make this project feasible.