Interloper’s legacy: invasive, hybrid-derived California wild radish (*Raphanus sativus*) evolves to outperform its immigrant parents.

Caroline E. Ridley¹ and Norman C. Ellstrand¹,²

¹Department of Botany and Plant Sciences, University of California, Riverside, CA
²Center for Conservation Biology, University of California, Riverside, CA.
Invasions and evolution

- Native Elsewhere
- Survival in Transport
- Establish in New Areas
- Lag Period
- Spread
- Ecological Impact
- Human Impact

Sakai et al. 2001
Invasions and evolution

- How does a species transition from established to spreading?

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• Evidence in many systems says …

• How? By what mechanisms?

Sakai et al. 2001
Invasions and hybridization

Hybridization as a stimulus for the evolution of invasiveness in plants?

Norman C. Ellstrand and Kristina A. Schierenbeck

Invasive species are of great interest to evolutionary biologists and ecologists because they represent historical examples of dramatic evolutionary and ecological change. Likewise, they are increasingly important economically and environmentally as pests. Obtaining generalizations about the tiny fraction of immigrant taxa that become successful invaders has been frustrated by two enigmatic phenomena. Many of those species that become successful only do so after hybridization. Genetic correlates of invasive success have been sought to predict which introduced species might become successful (for example, see refs. 7-11). Less frequently, possible genetic correlates have been sought (for example, see ref. 12). Very little attention has been given to the possibility of the evolution of invasiveness after colonization.
Invasions and hybridization

- Increase reproductive output
  - Purging deleterious alleles
  - Fixed heterosis
  - Transfer of adaptations
- Enhance ability to respond to selection
  - Increasing genetic variation

Ellstrand and Schierenbeck 2000 PNAS
Raphanus in California
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R. raphanistrum

Cultivated R. sativus
Raphanus in California

California wild R. sativus

R. raphanistrum

Cultivated R. sativus
Raphanus in California

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Raphanus in California

California wild *R. sativus*

*R. raphanistrum*

Cultivated *R. sativus*
Question and approach

• Question
  – Has hybridization between *Raphanus* species created a new, more invasive lineage of plants in California?
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  – Compare the reproductive output of hybrid-derived California wild radish to that of its progenitor parents.
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  – Compare the reproductive output of hybrid-derived California wild radish to that of its progenitor parents.
    • Common garden design
    • Multiple years
    • Multiple, contrasting environments
Design and analysis

• Two sites and two years
  – Riverside 2005 and 2006
  – Irvine 2006
Design and analysis

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  – Riverside 2005 and 2006
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• Complete randomized blocks
  – 5 populations of California wild radish (x50 indivs each)
    • San Luis Obispo Co., San Mateo Co., Riverside Co. 1, Riverside Co. 2, Tulare Co.
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  – 3 populations of *R. raphanistrum* (x50 indivs)
    • Denmark, Rhode Island, Mexico
  – 4 cultivars (x50 indivs)
    • Black Spanish, Cherry Belle, French Breakfast, White Icicle
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• Traits measured
  – Proportion surviving to reproduce, total number of seeds produced

• Analysis of variance
Results

Average number seeds per plant

R. raph. | CA wild | Cultiv. | R. raph. | CA wild | Cultiv. | R. raph. | CA wild | Cultiv. | Riverside 2005 | Riverside 2006 | Irvine 2006
Results

CA wild radish

Average number seeds per plant

Riverside 2005  Riverside 2006  Irvine 2006

San Luis Obispo Co.
San Mateo Co.
Riverside Co. I
Riverside Co. II
Tulare Co.
Results

CA wild radish

Cultivated radish

Average number seeds per plant

R. raphanistrum

Denmark
Mexico
Rhode Island

Black Spanish
Cherry Belle
French Breakfast
White Icicle

Riverside 2005
Riverside 2006
Irvine 2006
Conclusions

- Hybrid-derived California wild radish generally survives and reproduces better than either of its progenitor parents.
  - Implication: Invasiveness can evolve via hybridization.
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• Hybrid-derived California wild radish generally survives and reproduces better than either of its progenitor parents.
  – Implication: Invasiveness can evolve via hybridization.

• The reproductive output of California wild radish populations interacts significantly with the environment.
  – Implication: Hybrid-derived populations are diverse and distinct from one another, which could help explain their invasion into the myriad varied environments in California.
Thank yous

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• Staff at Agricultural Experiment Station (Riverside, CA) and South Coast Research and Extension Center (Irvine, CA)
• EPA STAR Fellowship, USDA and Department of Botany and Plant Sciences at UC Riverside

Come see more radish research in the poster session!
Results

Average number pods per plant

- R. raph.
- CA wild
- Cultivar

Riverside 2005
Riverside 2006
Irvine 2006
Results

Average number seeds per pod

R. raph. Cultivar CA wild

Riverside 2005

Riverside 2006

Irvine 2006