Lantana camara invasion in India threatens Tiger habitat

Cane toad invasion of Tropical Australia

- Cane toad (*Bufo marinus*) native to neotropics and introduced to Puerto Rico & Hawaii where it successfully controlled cane beetles devastating sugar cane crops

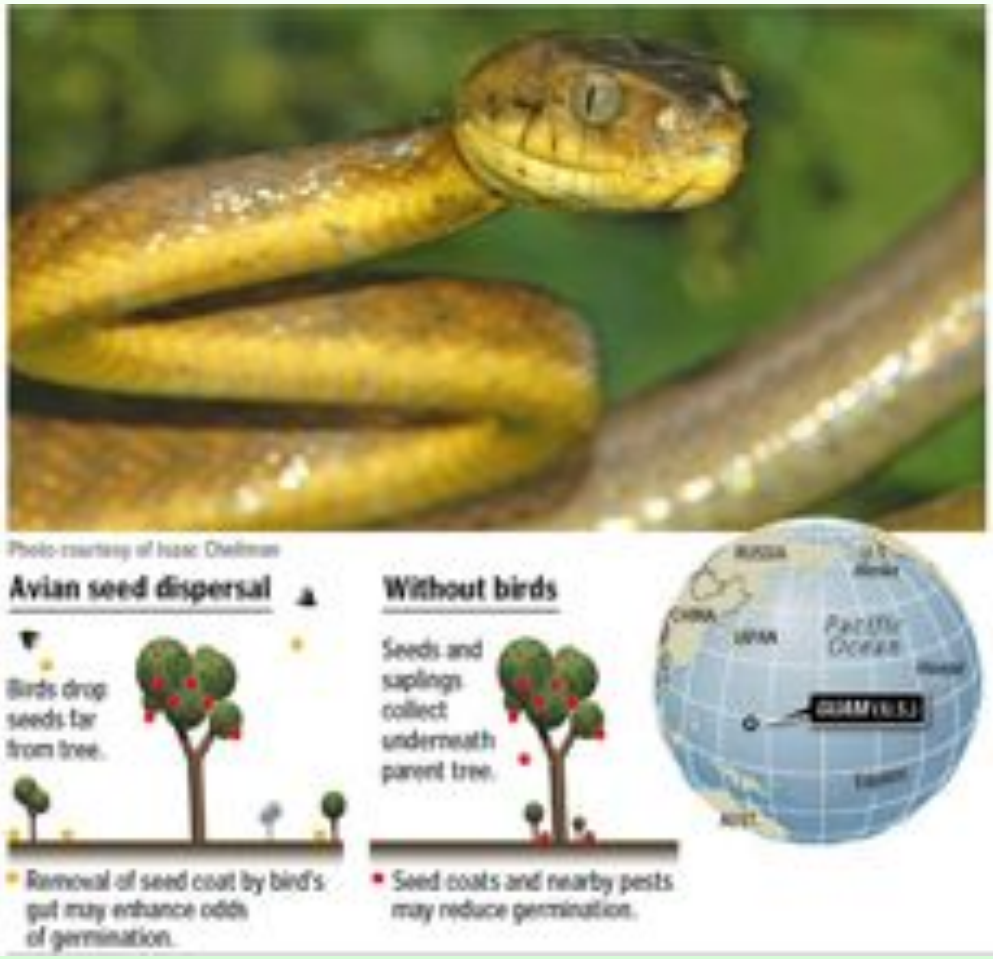
- Later introduced to Australia but not successful in reducing beetles and multiplied prolifically reducing biodiversity, especially reptiles

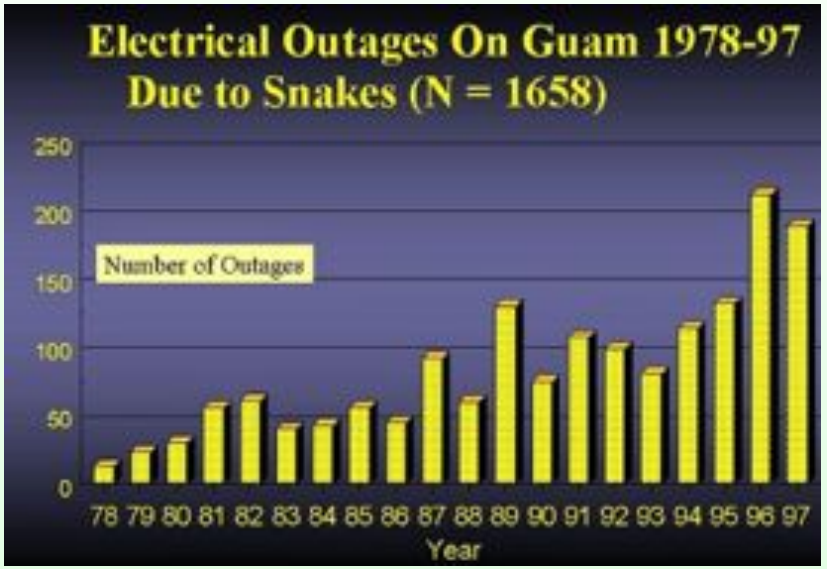
Introduction of the Nile Perch to African Lakes has resulted in the extinction of endemic cichlid fish species

The battle to prevent 'Asian Carp' invading the Great Lakes

Estimated that $30 million will be spent in 2010 to prevent the invasion

Brown tree snake invasion on Guam





- probably introduced as a ship stowaway in 1940's from South Pacific

- Has devastated forests and eliminated most native vertebrates; has also caused much human trauma because of home invasions

Plant invasions – more than just a nuisance

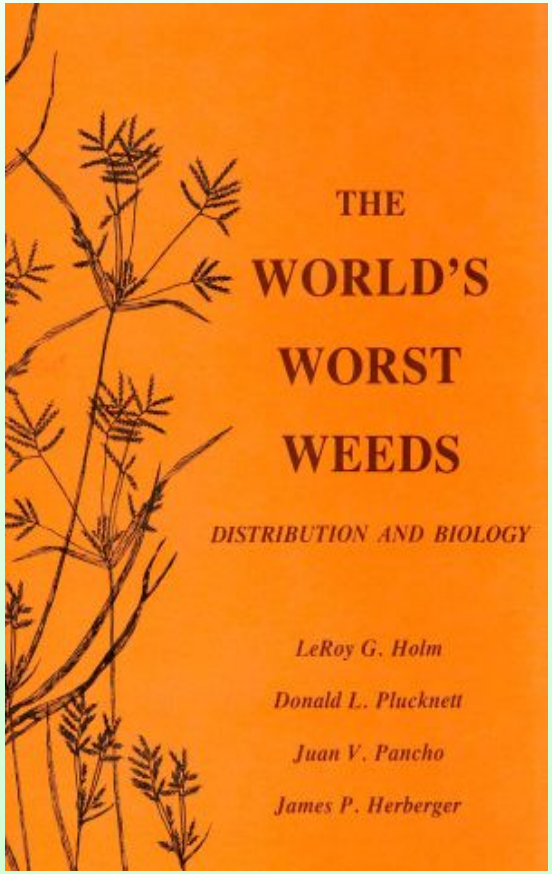
1. What are biological invasions?
2. Traits commonly associated with invasion success
3. Phenotypic plasticity vs. local adaptation in invaders
4. How can we control invaders?

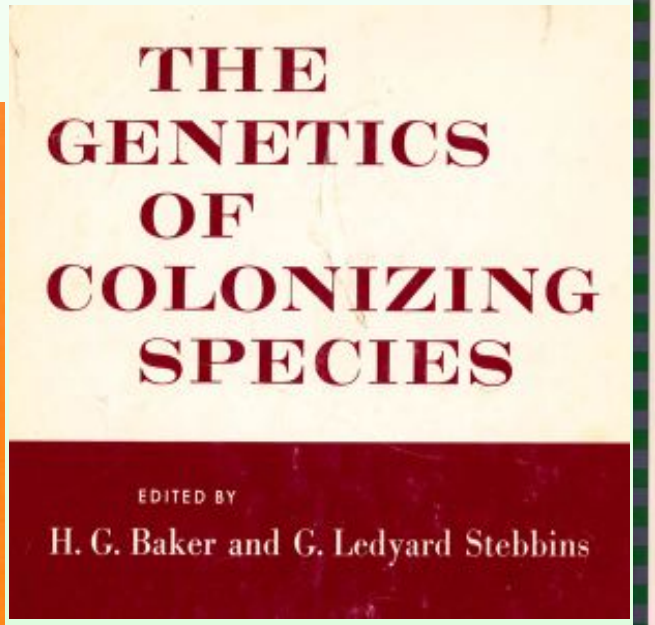
Biological invasions

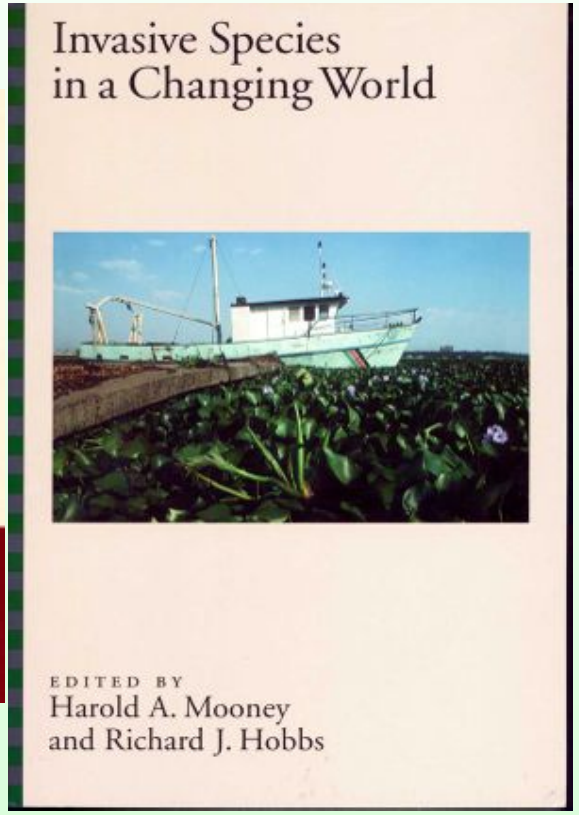
The successful establishment of a species in a region not previously occupied followed by rapid range expansion

Biological invasions do not always involve harmful species but most do

Changing Perspectives on Invaders







Terms Used to Describe the Origins of Species

Native

- An indigenous species that occurs wild in a given region

Alien

- A species that has been introduced to a part of the world to which it is not native
- Also referred to as **adventive**, **exotic** or simply **introduced** species

□

Negative environmental consequences of biological Invasions

- Disrupt ecological processes in natural plant & animal communities
- Displace native species leading to their extinction
- Adverse effects on human health
- Serious economic & social impacts through reduction of yields in agriculture & fisheries

□

Invasive species in the USA

- Economic cost = $120 billion per year
- 50,000 introduced species, number rising
- ~ 42% of threatened & endangered species at risk primarily due to alien invasives

Pimentel et al. *Ecological Economics* (2005)

Questions on invading species

- Why are invading species usually only aggressive in their **introduced** not their **native** ranges?

- Are certain **ecosystems** more susceptible to invasions than others?

- What are the **ecological** & **genetic** characteristics of **successful** invaders?

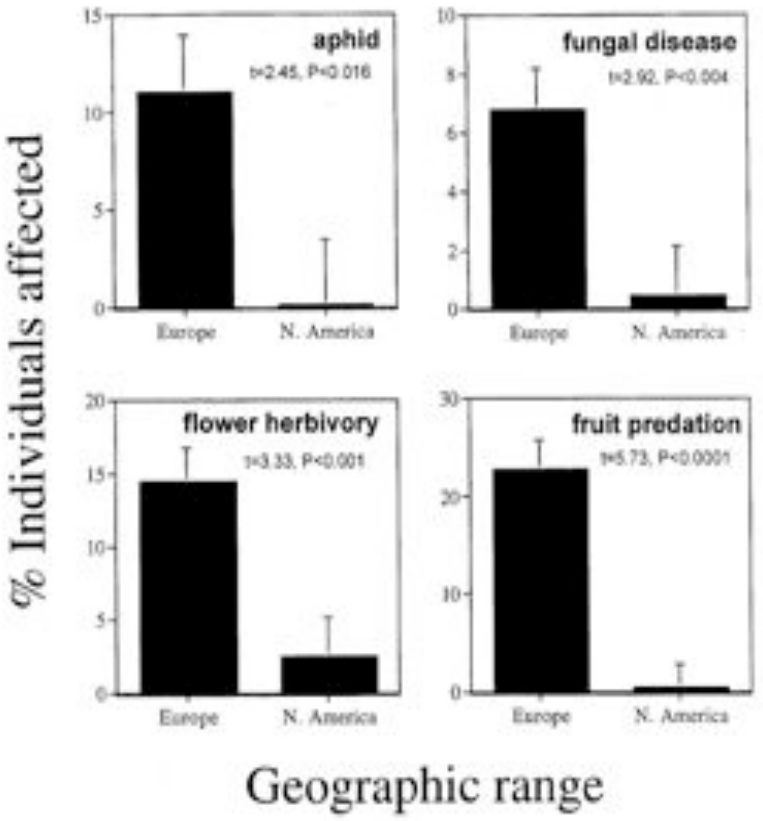
- Is their evidence for the **contemporary evolution** of **local adaptation** in invaders?

- How can invaders be **controlled**?

□

Differences in enemy attack in populations of white campion (Silene latifolia) from Europe and North America: an example of the enemy release hypothesis

Lorne Wolfe



Sterilizing anther smut fungus

Seed and fruit predation

aphids

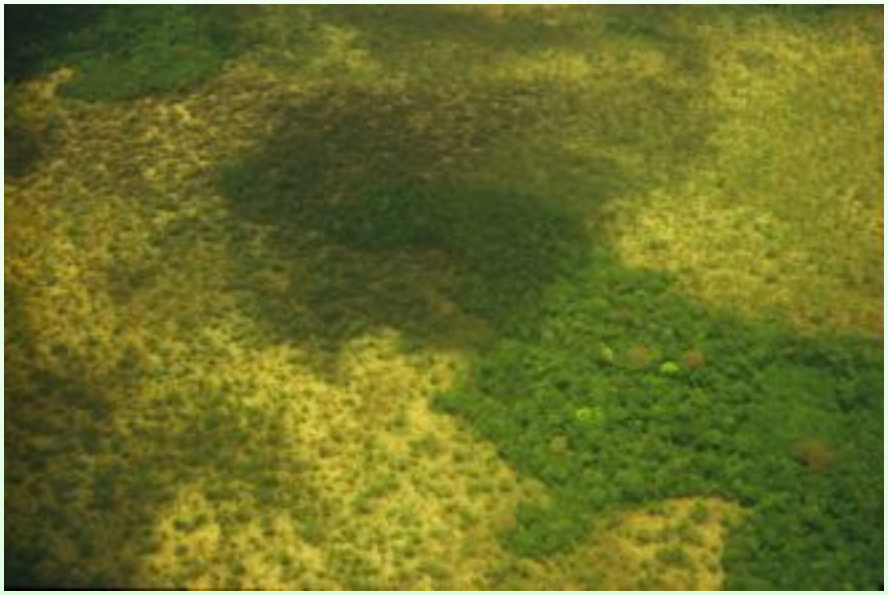
snails

florivory

American Naturalist (2002)

• pest and disease pressure was x17 times higher in the native range compared to the alien range and involved both specialist and generalists

Invasive species thrive in disturbed sites: the more disturbance the more vulnerable to invasion



Caused by humans
(Amazon forest)

Natural
(volcanic eruption)

Forms of Disturbance

□


California
Pampas grass invasion
along abandoned fire trail

Common attributes of successful invasive species

- Rapid development to reproduction
- High reproductive output
- Well-developed dispersal mechanisms
- Broad ecological tolerance
- High phenotypic plasticity*

* The ability of a genotype to alter its phenotype in response to environmental change – important trait in unpredictable environments

Evolution in invasive species of agriculture

- Selection of barnyard grass plants that mimic cultivated rice (SE Asia)
- Selection of herbicide resistant weed species (worldwide)

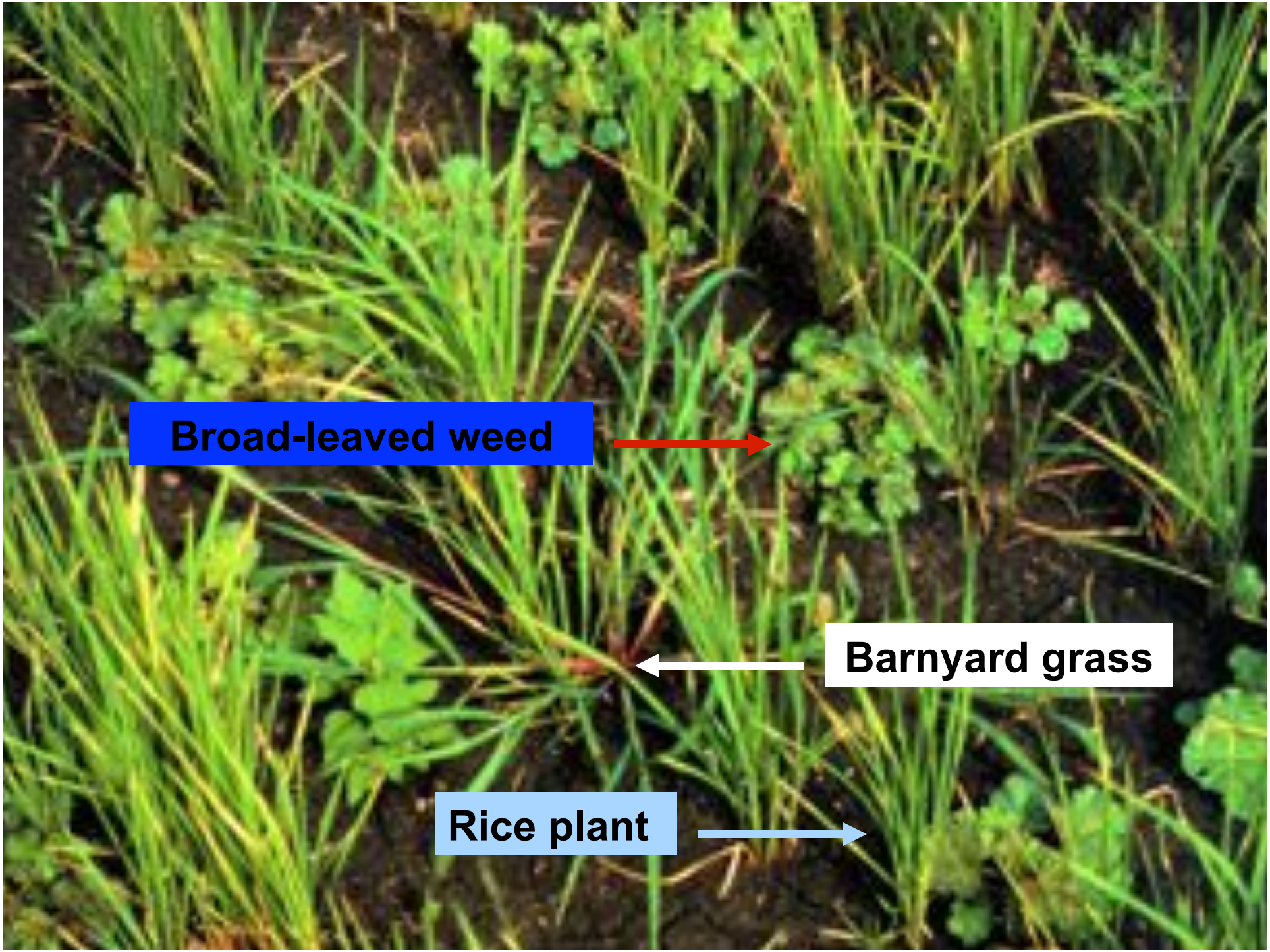
Weeding practices in rice

Latin America

- weed removal involves the ability to distinguish visually between crop and weed

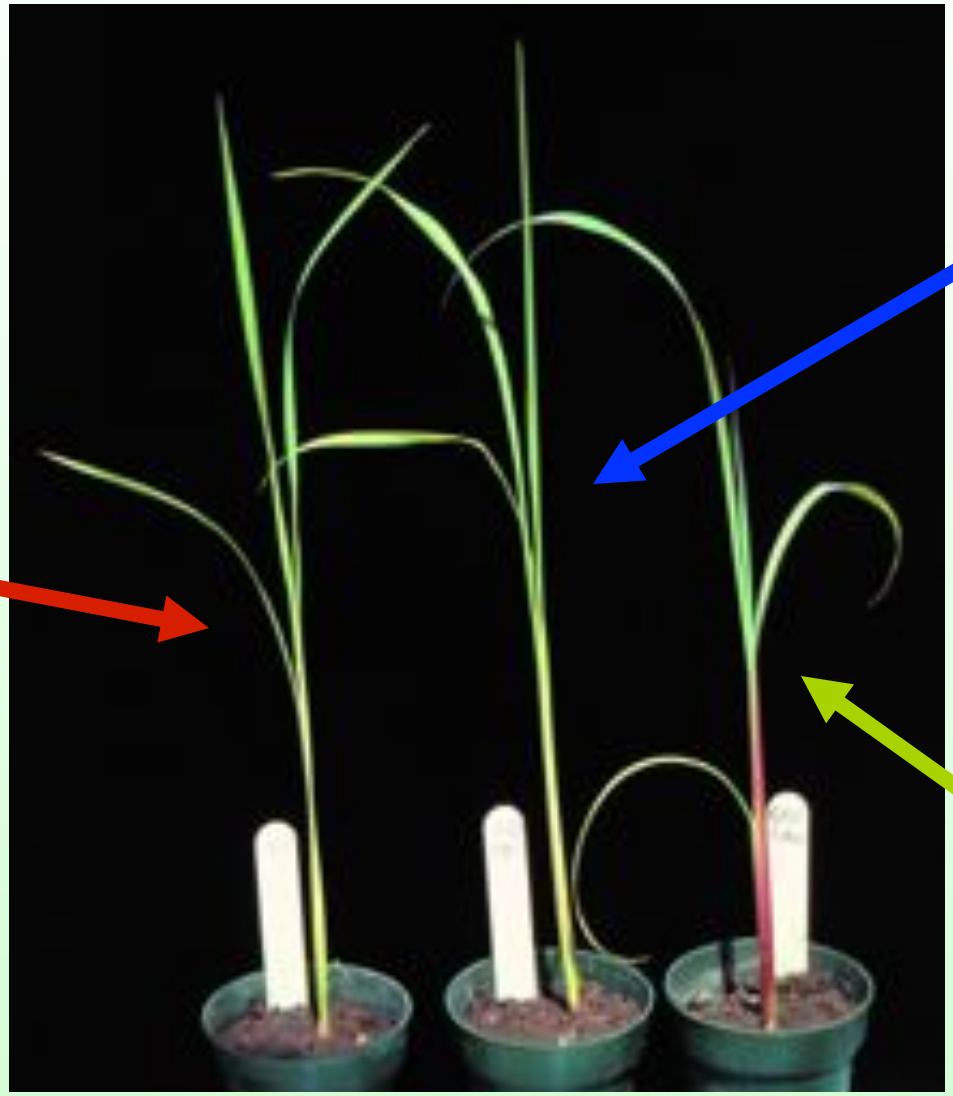
- weeds that look more like the crop escape detection inadvertently selecting for mimicry

Africa


Broad-leaved weed
Barnyard grass
Rice plant

Find the rice mimic?

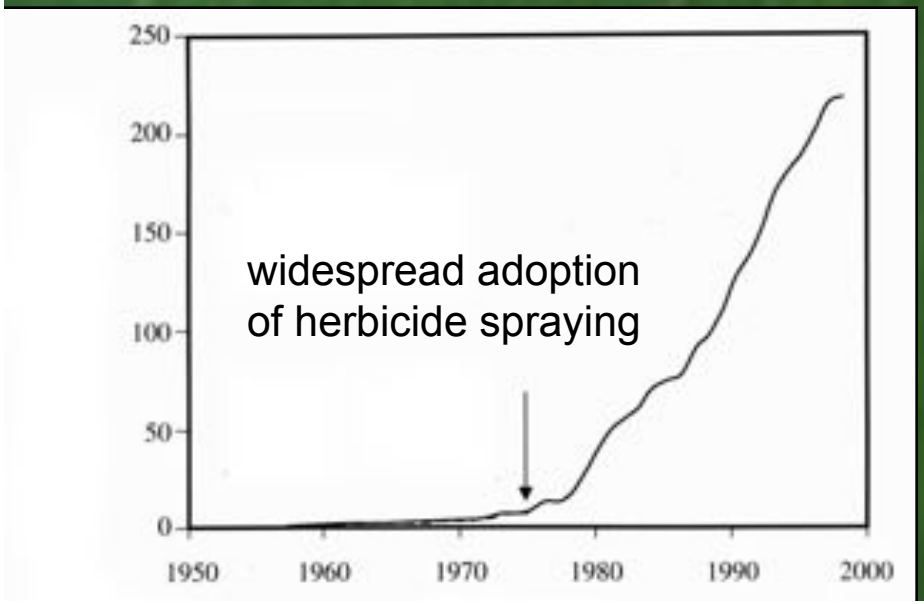
Rice mimicry in barnyard grass



Scientific American (1987)

Rapid evolution of herbicide resistant weeds in agriculture

crop duster

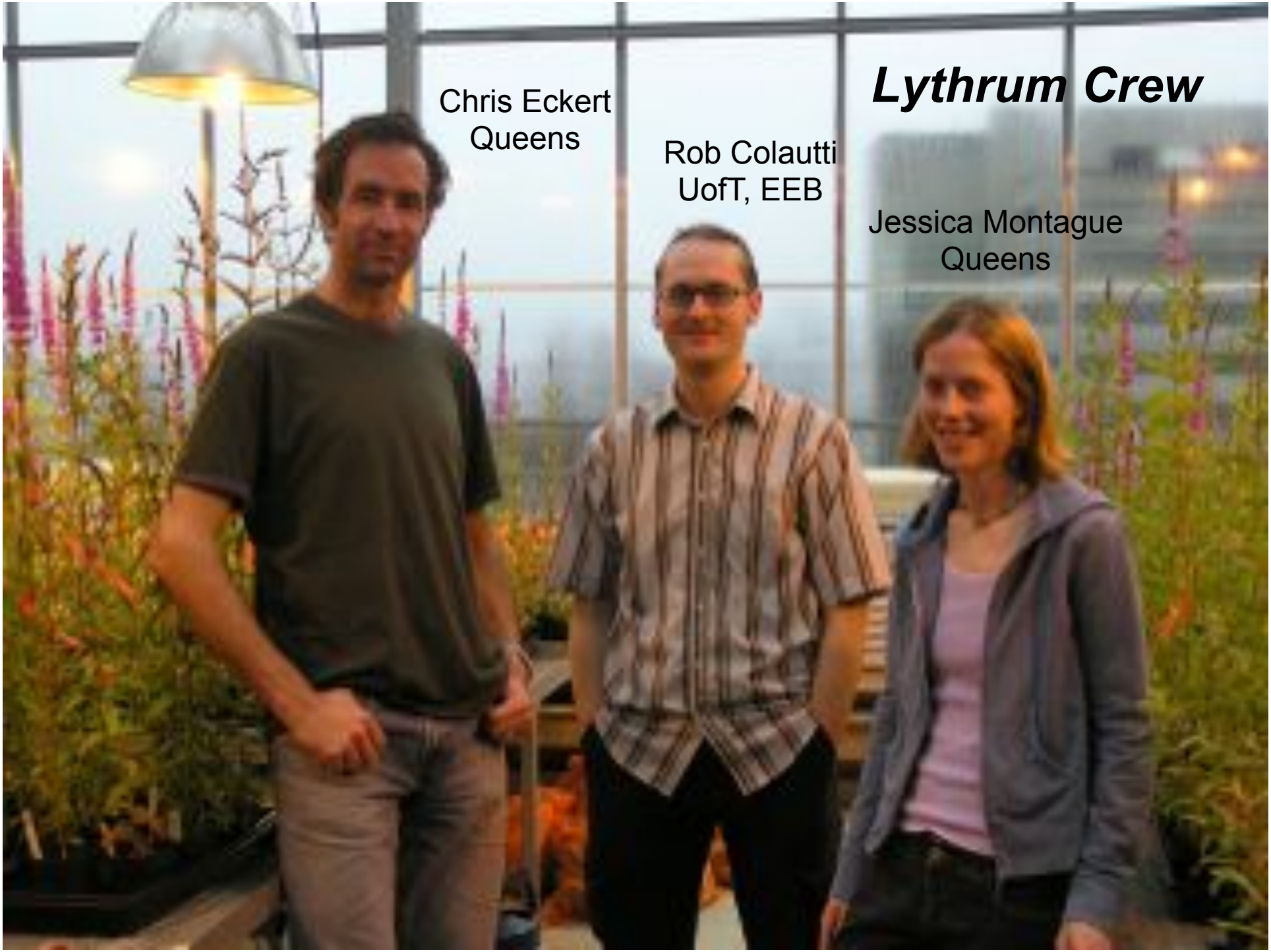


Wetland invasions

Purple loosestrife (*Lythrum salicaria*)

- Aquatic perennial with showy purple flowers native to Europe; used as an ornamental.
- Multiple introductions to eastern North America during past century followed by invasion of wetlands.

□


Lythrum Crew
Chris Eckert
Queens
Rob Colautti
UofT, EEB
Jessica Montague
Queens


Early colonization by purple loosestrife
on the Leslie Street Spit, Toronto
Lythrum salicaria
Lythraceae


Purple loosestrife
invasion in eastern
Ontario

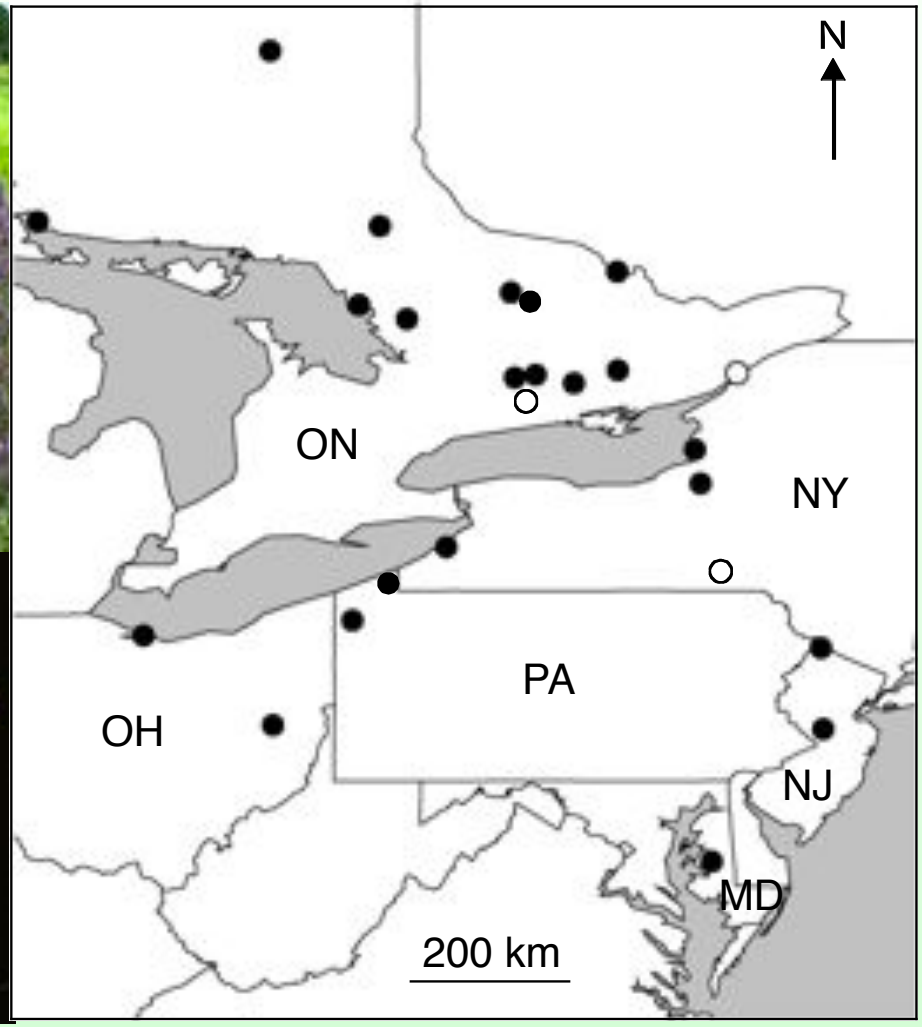

Purple Loosestrife in China

Some attributes of purple loosestrife

- Plants competitive with high phenotypic plasticity, produce millions of small, easily dispersed seeds with high viability
- Populations genetically diverse due to multiple introductions, outbreeding and polyploidy; provides opportunities for evolution of local adaptation

□

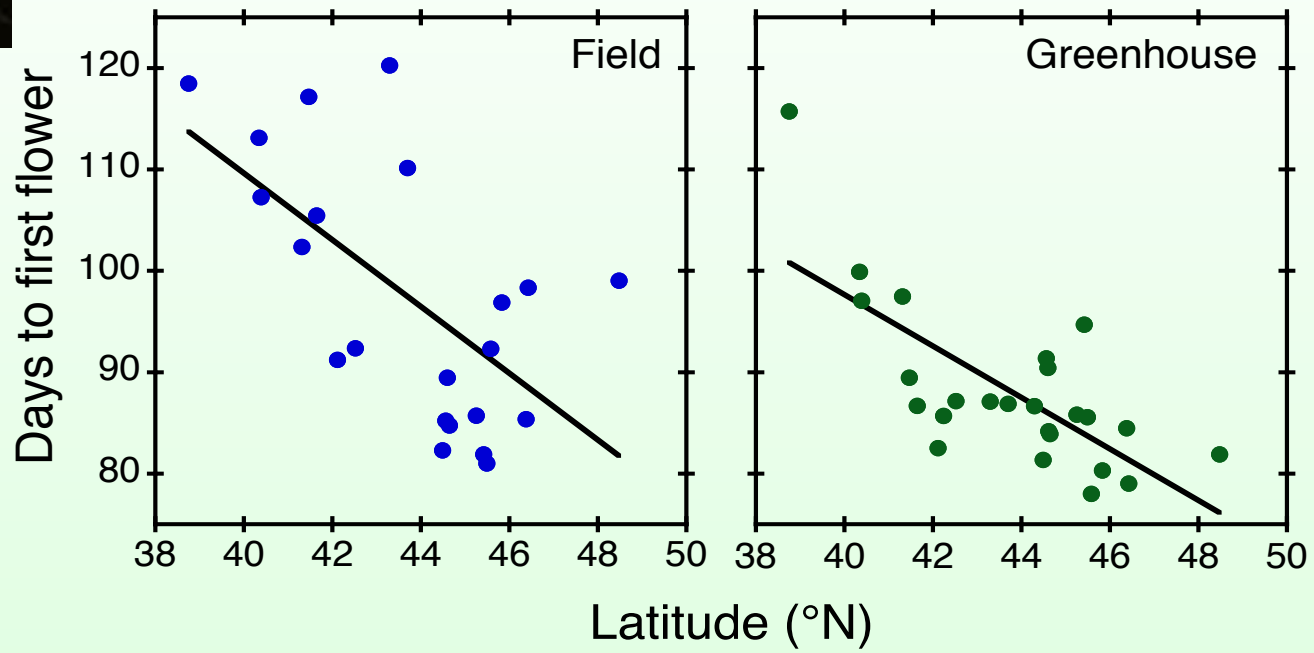
Is there evidence for rapid adaptive evolution in invasive populations of Purple Loosestrife?




Rob Colautti's Common Garden Experiment
At Koffler Scientific Reserve (KSR)


Common garden experiment at KSR -2009

Flowering time correlated with latitudinal gradient of seasonality



- **common garden studies indicate significant genetic differentiation among populations**

- **variation forms a cline* in time to flowering with northern populations flowering faster than southern populations**

- **populations farther north have adapted to shorter growing season**

*** A gradual change in trait means over a geographical transect**

***Proc Roy Soc B* (2010)**

Aquatic plant invasion in the tropics

The world's worst aquatic invaders:

- Water hyacinth (*Eichhornia crassipes*)
- Kariba weed (*Salvinia molesta*)

Features in common:

- Native to South America, introduced by humans to Old World tropics, free-floating with prolific clonal propagation, populations genetically uniform and invasiveness due to high phenotypic plasticity NOT genetic diversity

- Herbicide control causes pollution of aquatic habitats so biological control methods used

□

Water Hyacinth blocks river in Vietnam


River in Louisiana
clogged with water hyacinth

Kariba weed invading a reservoir in Australia

Kariba weed is a floating fern that is genetically sterile

Management of invasives – methods of control

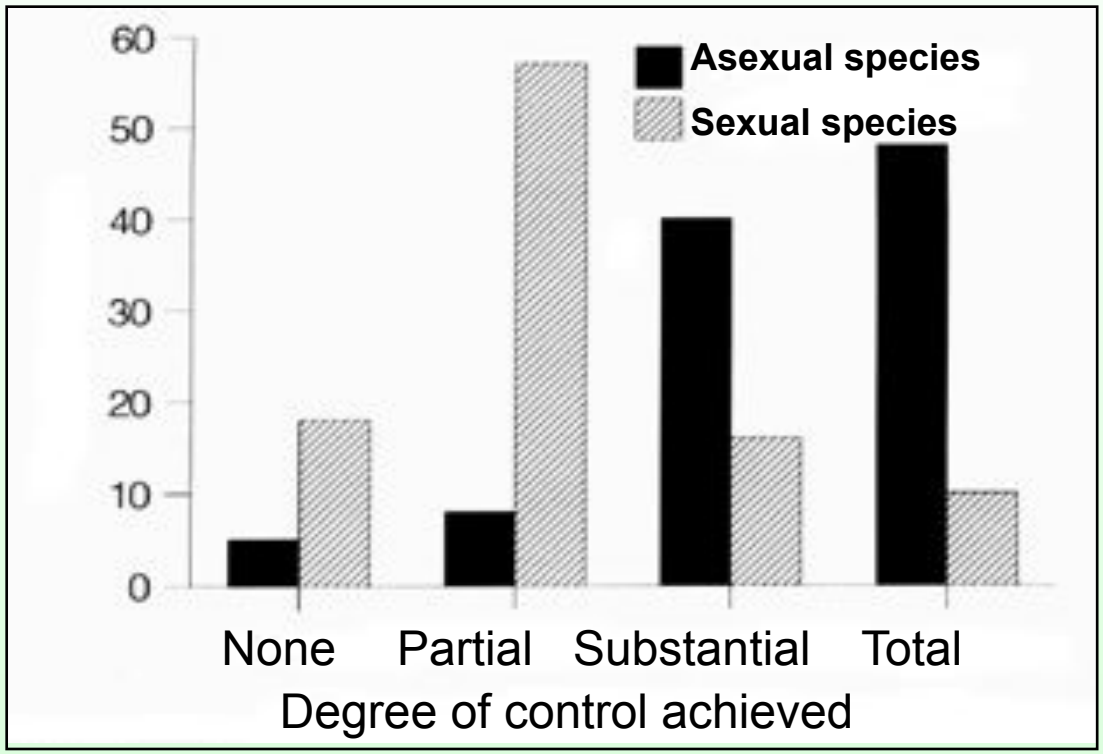
- mechanical e.g. hand weeding, machines
- chemical – herbicides
- ecological e.g. burning, flooding
- biological control

Biological control of invaders

- The planned introduction of natural enemies (e.g. predators, parasites, pathogens) to control unwanted populations of invaders in alien range

□

Mode of reproduction of plant invaders & likelihood of success from biological control



- asexual species easier to control than sexual species
- why?
- answer lies in influence of reproductive systems on genetic diversity
- genetic diversity will determine whether resistance evolves

Burdon & Marshall (1981) *J. Appl. Ecology*

□

Advantages of biological control

- Non-toxic to humans; if conducted carefully no serious environmental impacts
- If successful the effects are permanent
- Economically cheap ($1 for biological control vs. $5 for chemical control)

Danger of biological control

Sloppy science creates new invasion

□

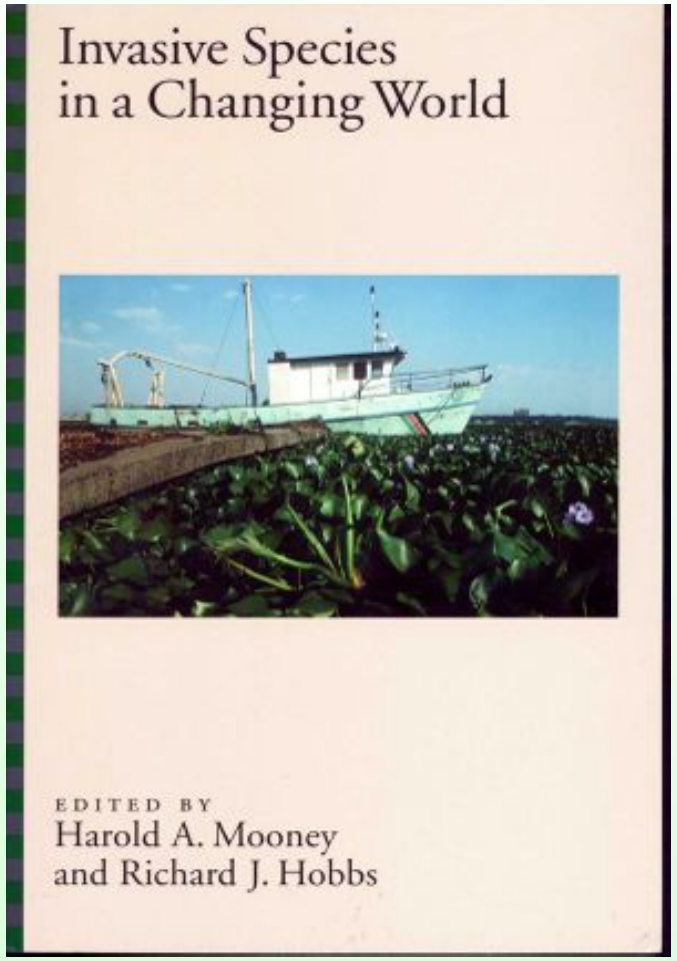
Today's General Messages

- **Biological invasions reduce biodiversity and are a serious financial drain on the global economy**

- **Understanding why some species are invasive is a key biological question**

- **Genetic and ecological studies can provide insights for management of invasives**

Further Reading



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