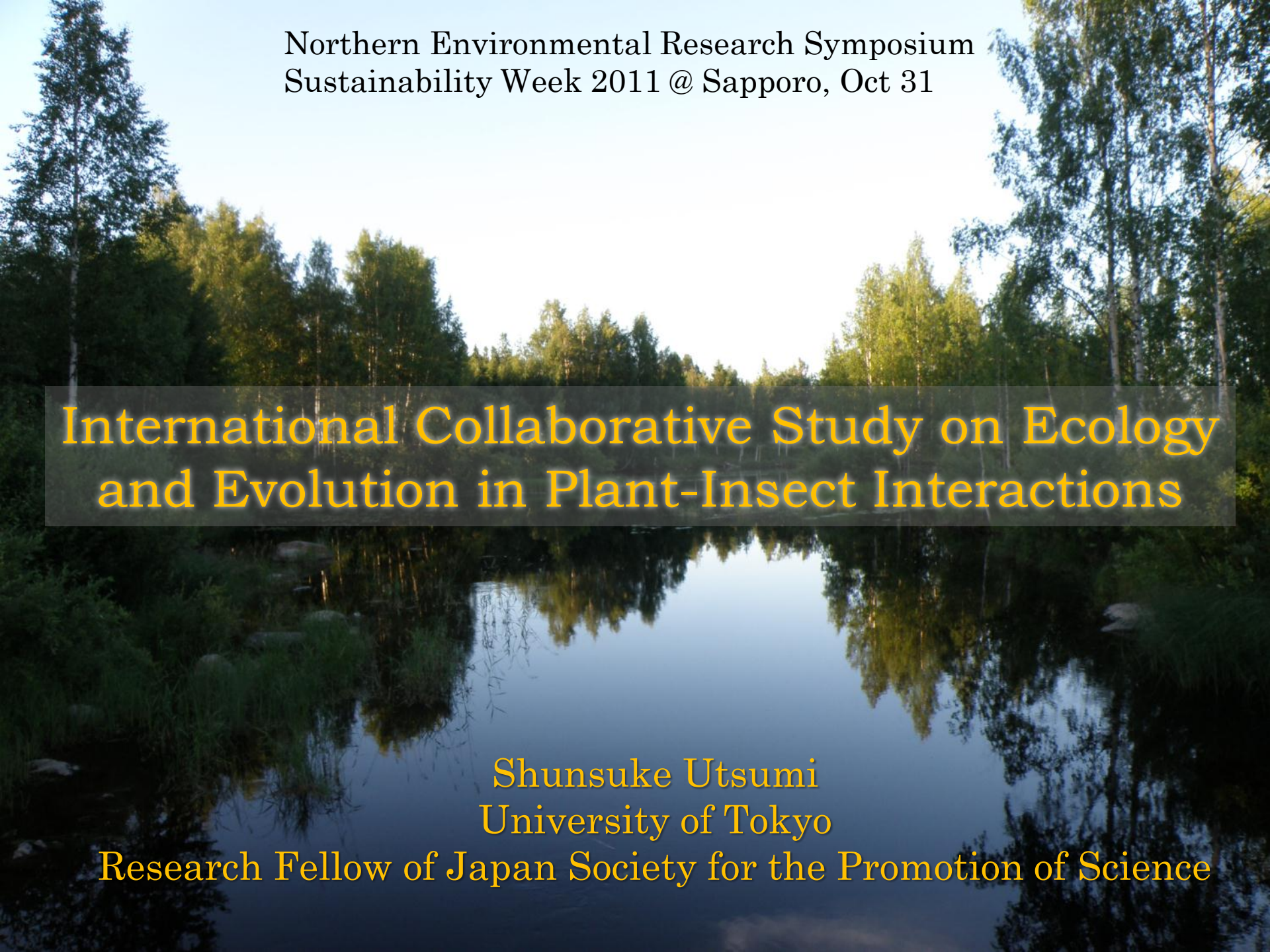


Northern Environmental Research Symposium
Sustainability Week 2011 @ Sapporo, Oct 31

International Collaborative Study on Ecology and Evolution in Plant-Insect Interactions

Shunsuke Utsumi
University of Tokyo
Research Fellow of Japan Society for the Promotion of Science

International collaboration in ecological and evolutionary research

Ecosystems have

- Complexity
- Variety
- Generality

Across boarder problems

- Biodiversity loss
- Species invasion
- Climate change

International collaboration offers many opportunities and advantages

Topics

- 1. Explore general patterns in novel findings about biodiversity and evolution. Japan – Finland Collaboration
- 2. Address biological invasion. Japan – US Collaboration

Collaboration between Japan and Finland to explore general patterns

Prof Heikki Roininen
(University of Eastern Finland)

Funded by Finnish Government Scholarship, Grant-in-Aid for Scientific Research for JSPS fellowship

Research Question

How multiple species influences evolutionary trajectories of a community member?

[Background]

Organisms are embedded in complex interactions in multiple species community

However, researchers have overwhelmingly focused on coevolution between 2 species

(e.g., arms race: plant's defense – insect's counterdefense)

Study organism

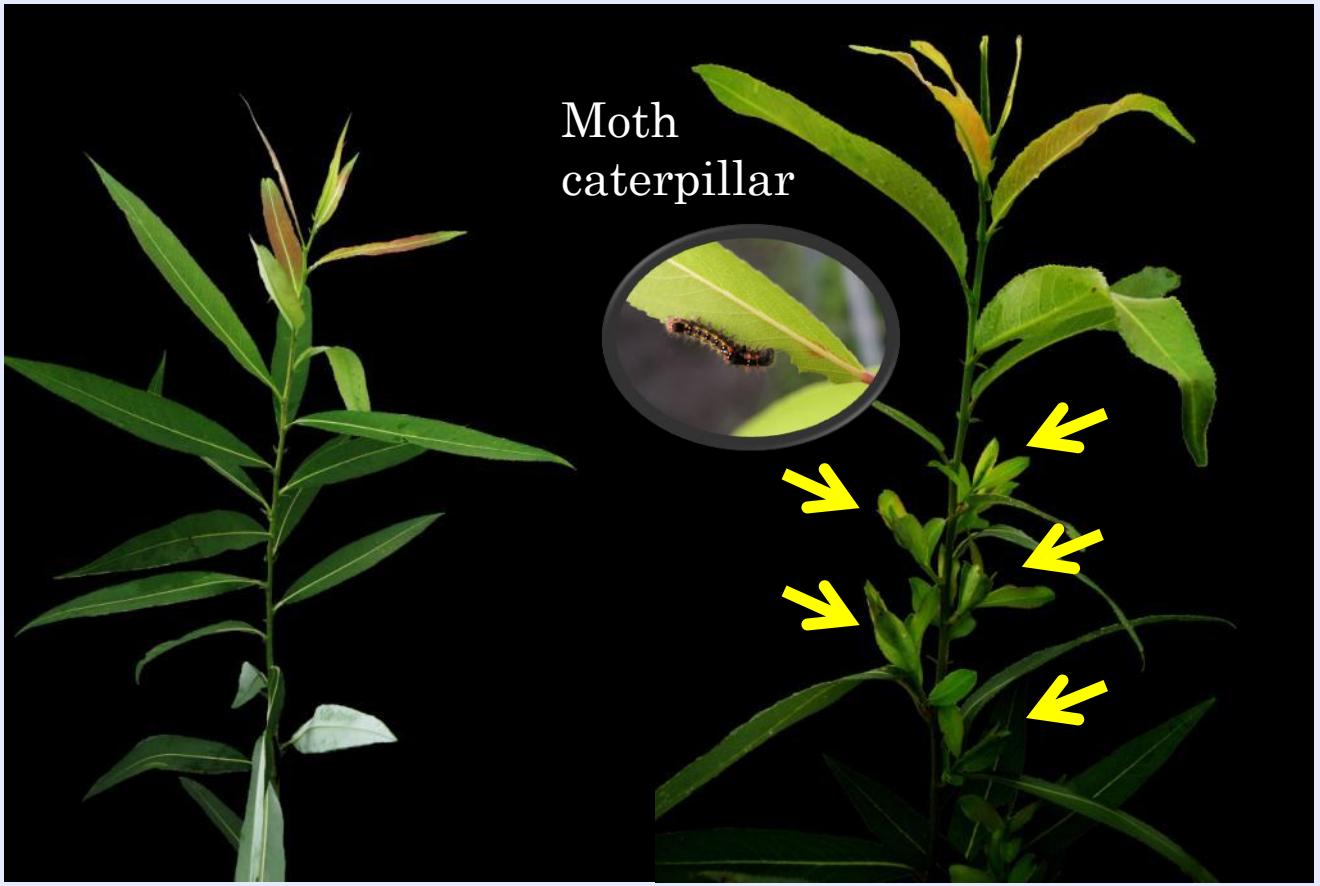
Willow leaf beetle
Plagiodera versicolora (Chrysomelidae)

*Distribution: Europe, America, Asia
*Specialist on willow species

Larva

Adult

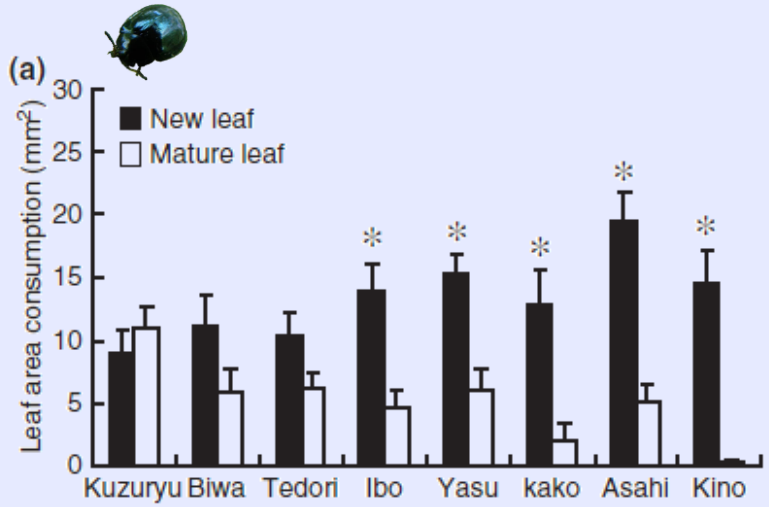
Regrowth response in Willows

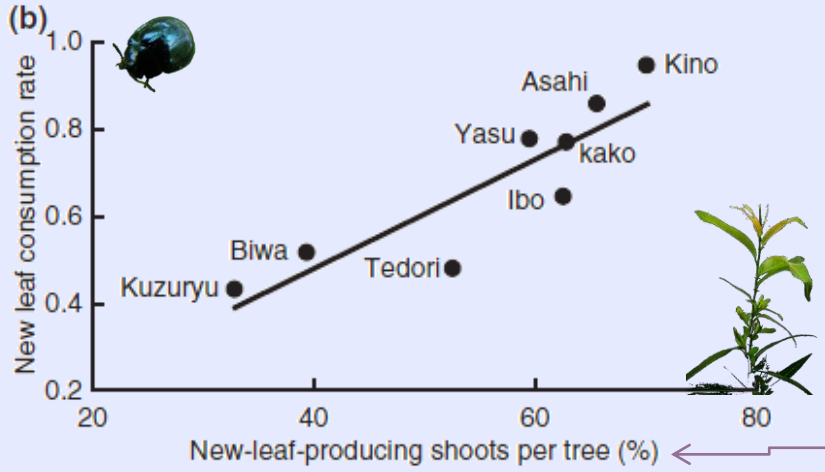


[Regrowth Response to Herbivory]

Willows produce new lateral shoots in response to attack by some herbivore species. As a result, a period of new leaf production is drastically extended.

Evolution of Preference between leaf-age types in Japan

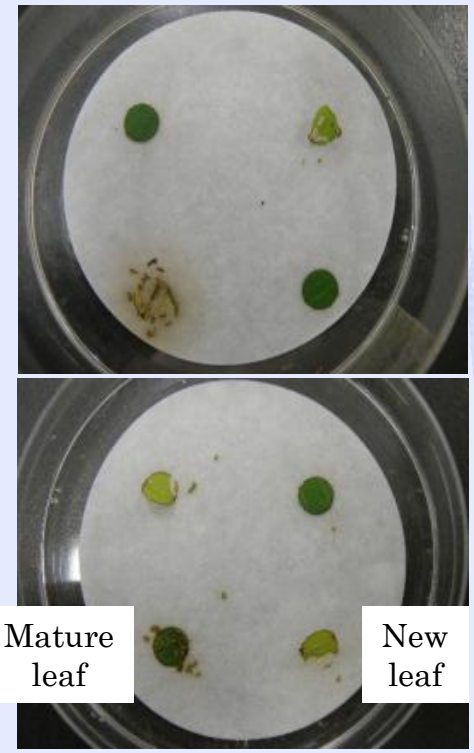




Exclusive preference for new leaves

No preference

(midsummer)



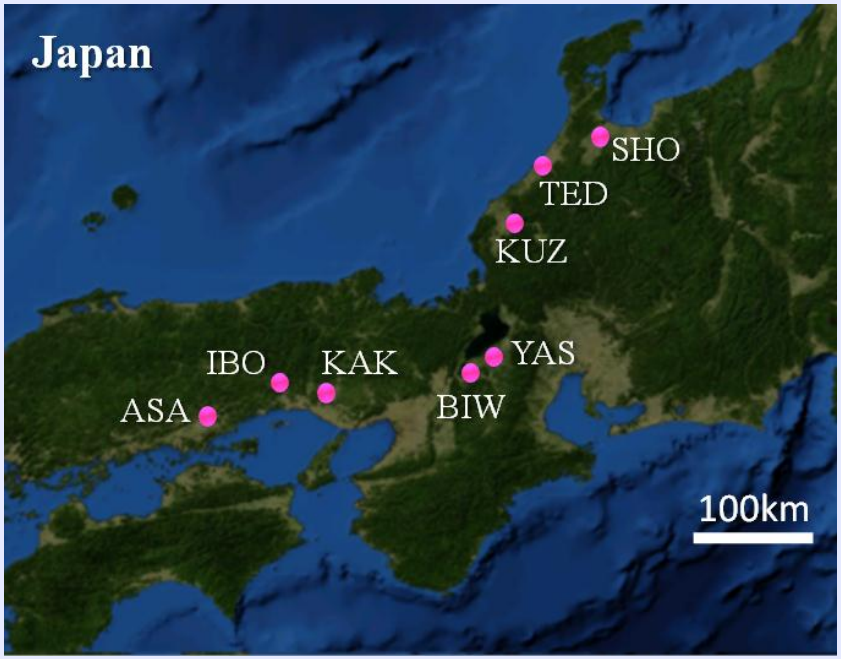
Local regrowth intensity

The leaf beetle populations evolutionarily develop diverse preference according to local regrowth intensity of willows

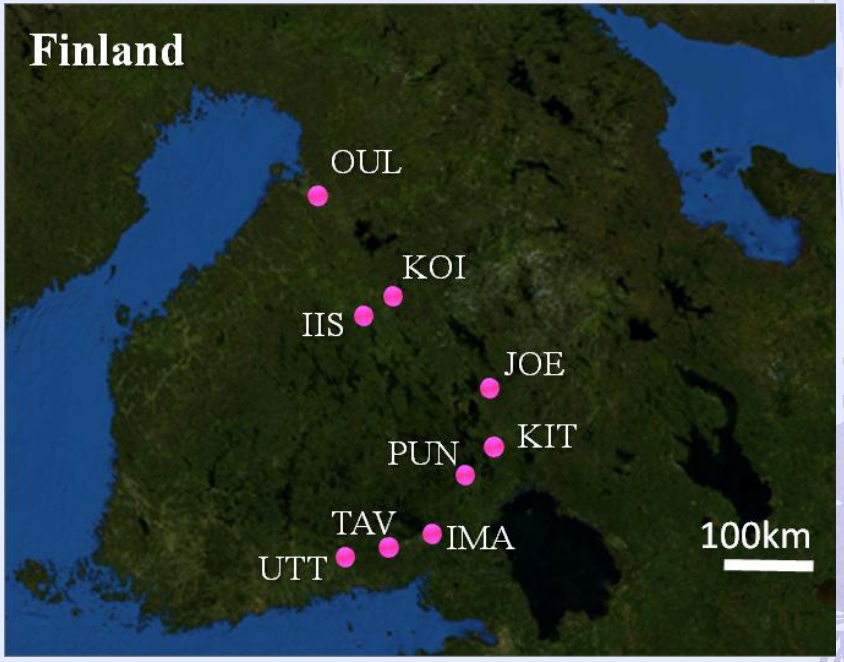
Utsumi *et al.* (2009) *Ecol Lett* **12**: 920-929

Hypothesis

1. Herbivore community structure affects plant regrowth response
2. The leaf beetle populations develop diverse preference according to local regrowth intensity.
3. There is a similar pattern between Japan and Finland even when host plant species are different.



Host plant: *Salix eriocarpa*

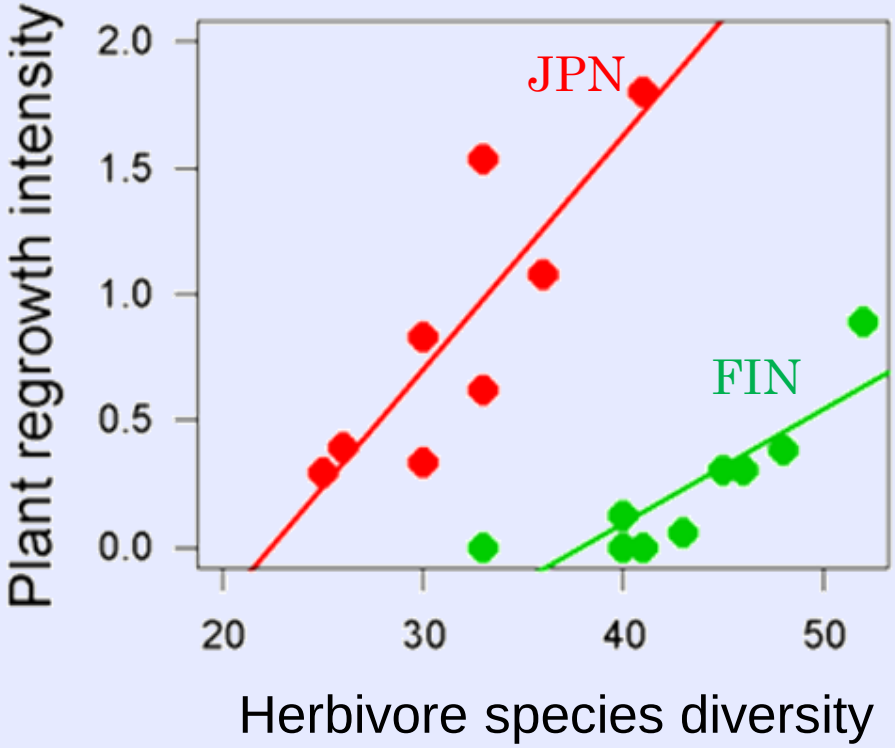


Host plant: *Salix caprea*

Why Finland?

- Willows are very common throughout Finland.
- Willows are widely distributed in the north hemisphere.
- The north limit of *Plagiodera versicolora* distribution.
- Long history of ecological research for insect-willow interactions.

Herbivore species diversity governs the expression of willows' regrowth response

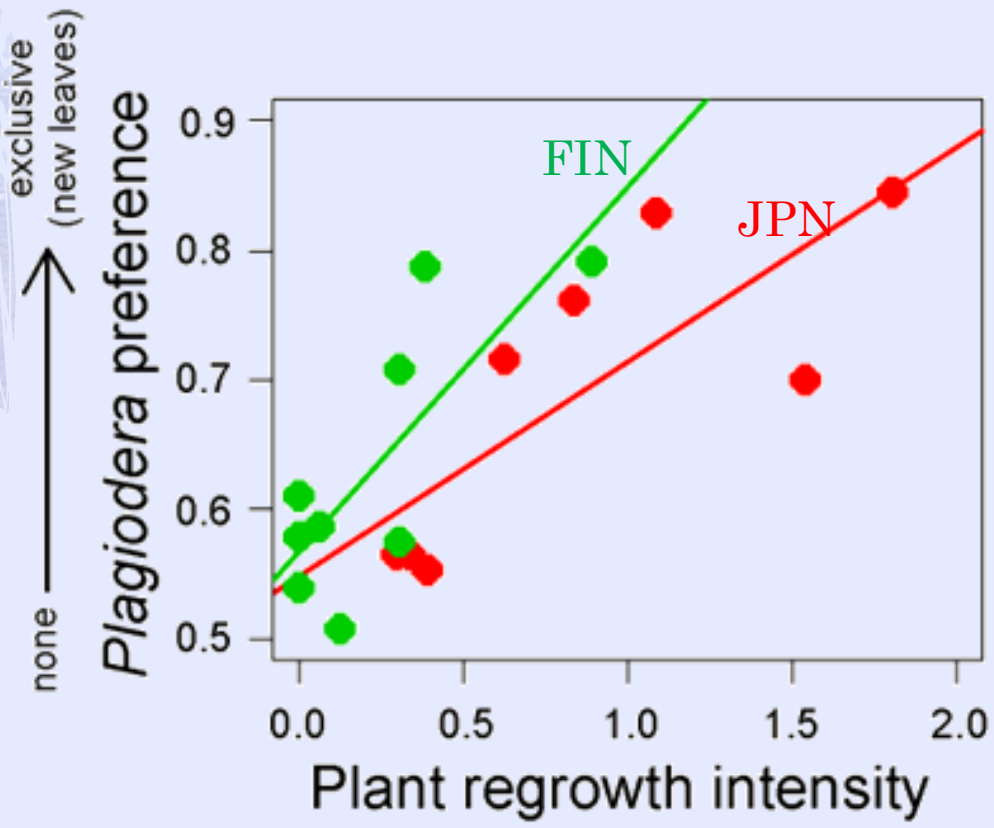


Significant difference
in species composition among sites
[Permutation MANOVA]
JPN: $P < 0.001$, FIN: $P < 0.001$

Higher species diversity
→ Greater plant regrowth intensity

Utsumi *et al.* (in prep)

Leaf beetle populations develop diverse preference according to local regrowth intensity

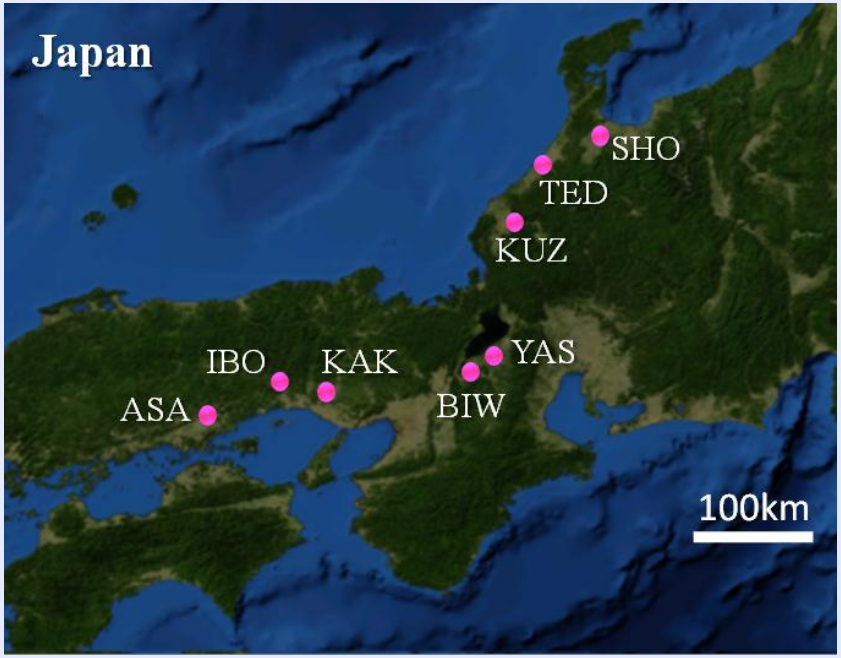


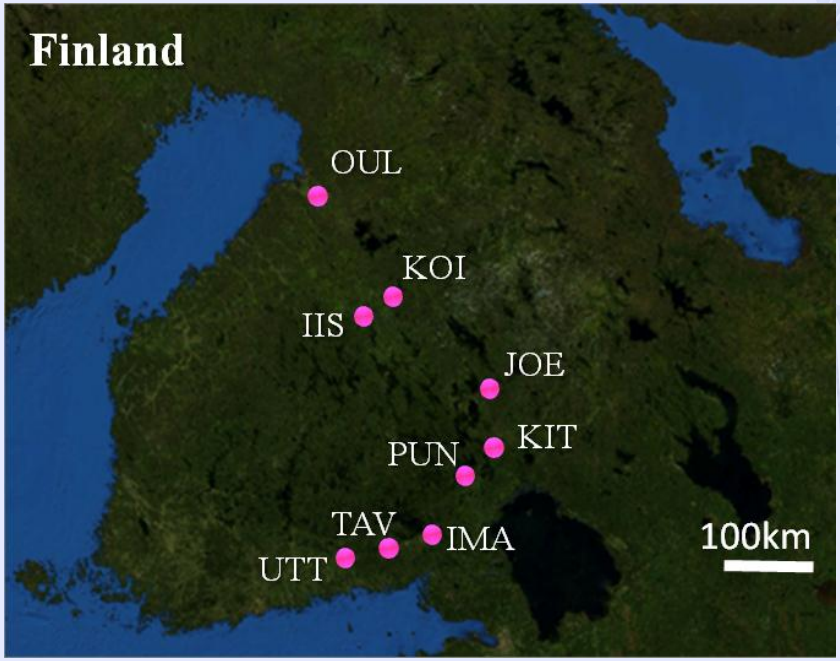
Greater plant regrowth intensity
→ Stronger preference for new leaves

Significant difference
in preference among populations
[ANOVA]
JPN: $P < 0.01$, FIN: $P < 0.05$

Utsumi *et al.* (in prep)

Population Genetics in Japan and Finland

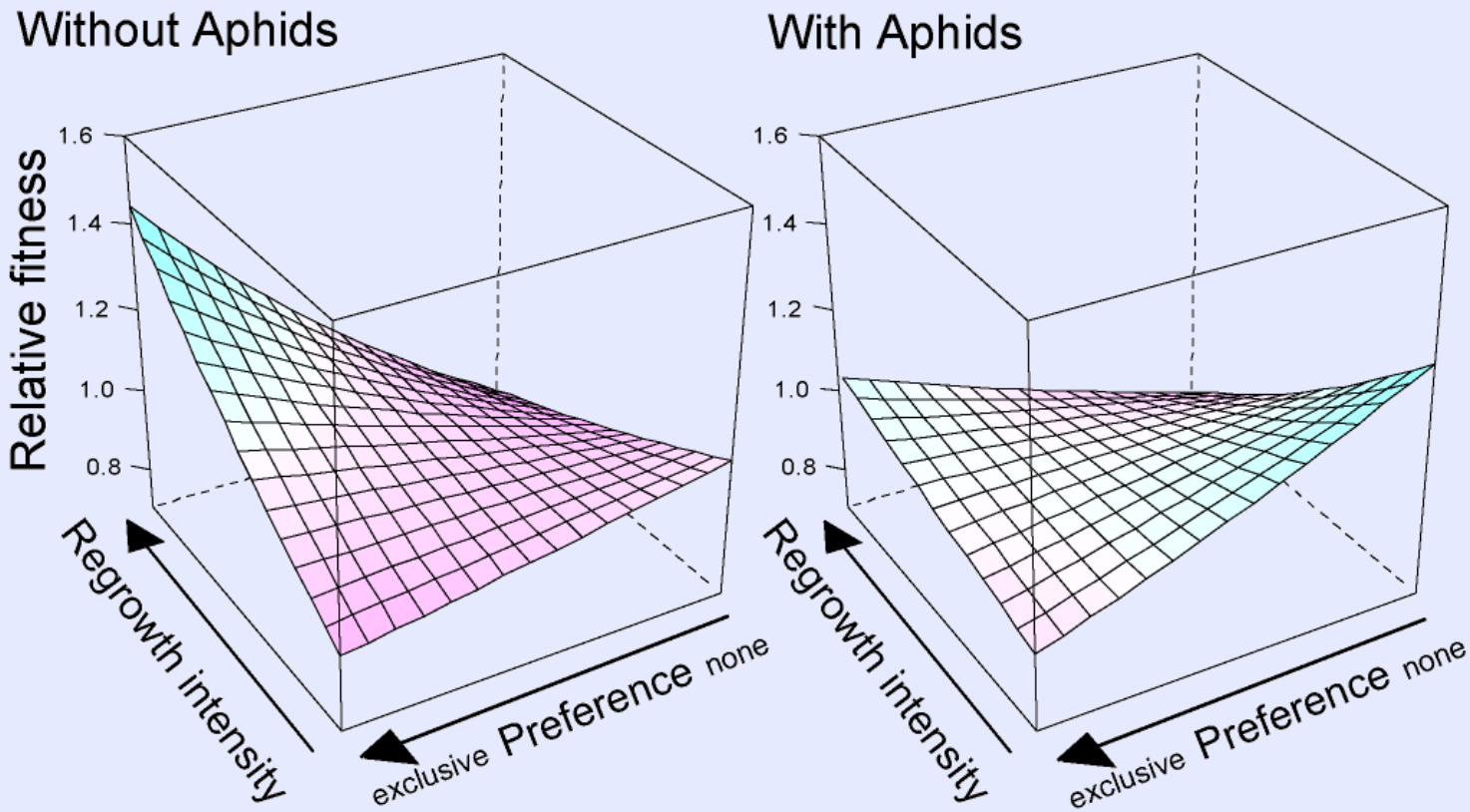




Genetic differentiation was detected among populations within a country (mtDNA COI)

[Exact test]: JPN: $P < 0.0001$, FIN: $P < 0.0001$

Experimentally estimated fitness landscape of the leaf beetle



1. Herbivore species diversity modifies evolutionary trajectory of a community member

2. There is a similar pattern between Japan and Finland even when host plant species are different.

International Collaborative Study

↓

Novelty and Generality

(→…toward sharing concerns for biodiversity loss)

Collaboration between Japan and US to address biological invasion

Prof Tim Craig
(University of Minnesota, Duluth)

Funded by JSPS Core-to-Core program, Grant-in-Aid for Scientific Research for JSPS fellowship

Study organisms

Solidago altissima (Asteraceae)
Uroleucon nigrotuberculatum
(Hemiptera: Aphidae)

Invasive species from US to Japan

Motivation

- Studying exotic species in both their introduced and native is important.
- Biological and ecological knowledge of exotic species are often accumulated in the native range institute.

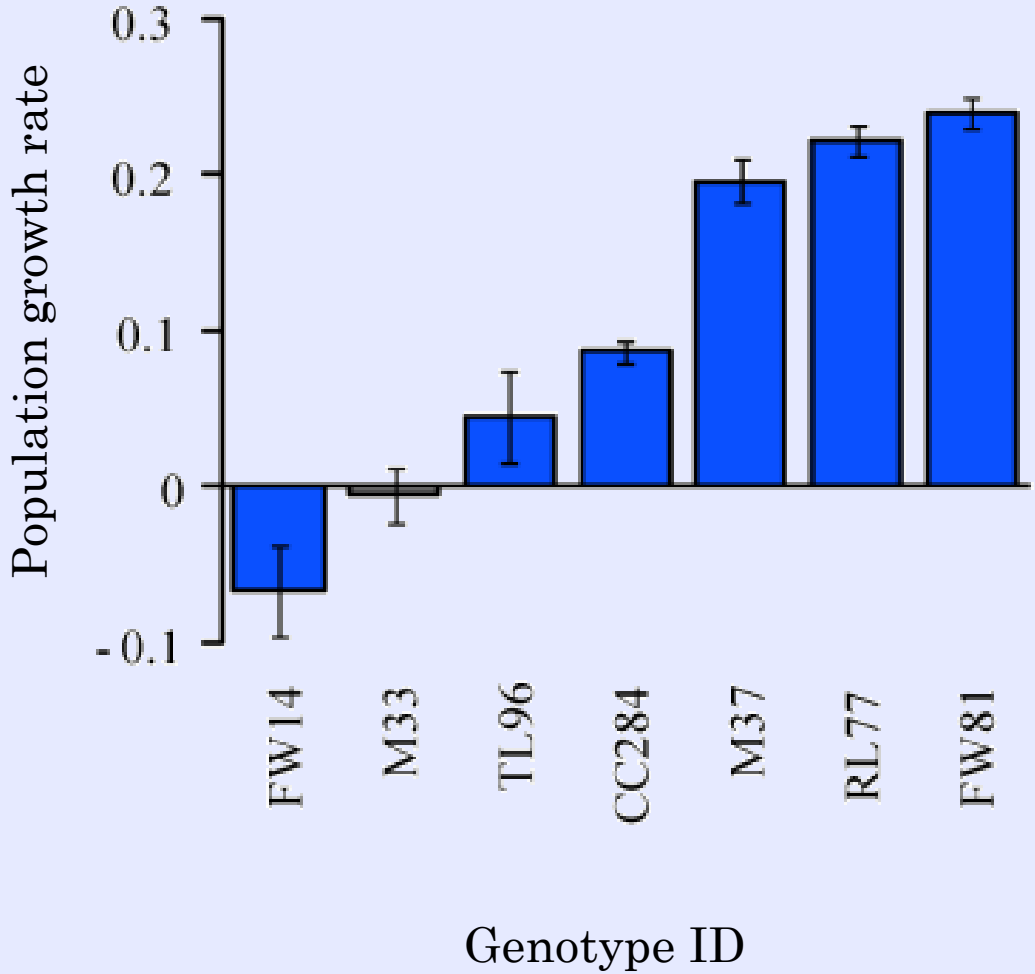
Research Question

- How exotic plant genotypic diversity contributes to population size of exotic herbivores?
- How exotic plant genotypic diversity contributes to spatial dynamics of exotic herbivores?

First we examined these questions in a native habitat because the US collaborator maintains a variety of *Solidago* genotypes in a common garden)

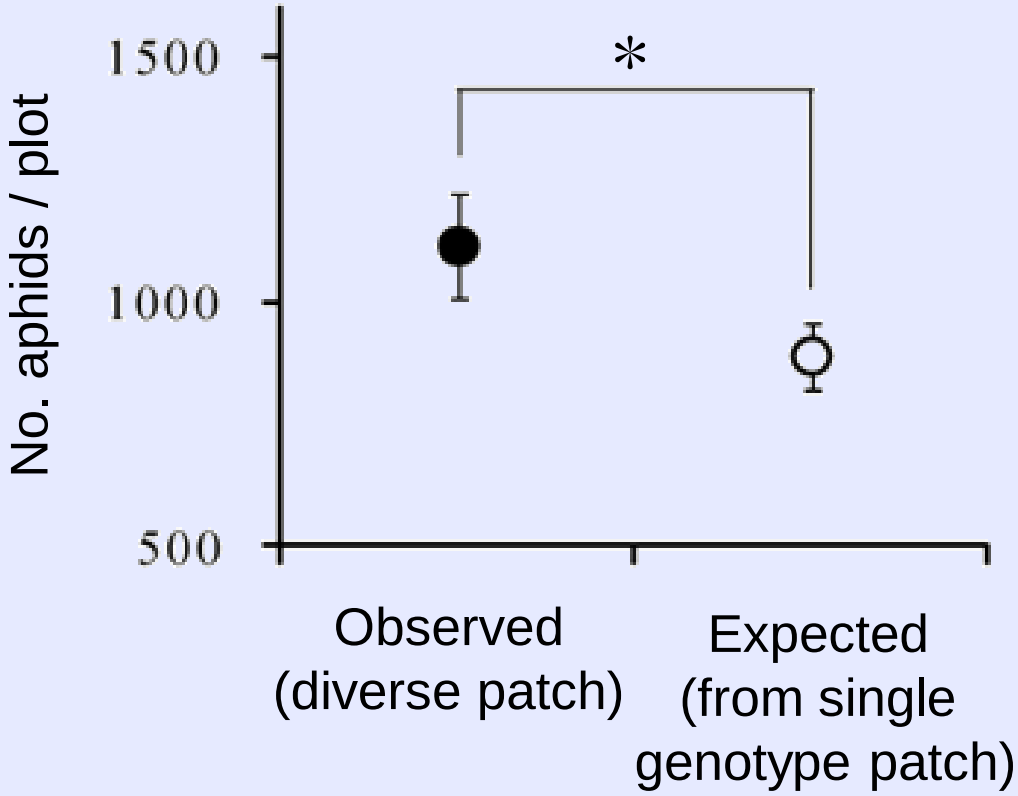
Genetic variation and spatial spreading dynamics of exotic species are important issues in biological invasion…

Genotypic variation in plant resistance to the aphid



Utsumi *et al.* (2011) *Proc R Soc B* **278**: 3108-3115

Plant genotypic diversity increased aphid population size



Greater than a sum of single genotype effects (expected) = non-additive (synergistic) effect of diverse genotypes

Utsumi *et al.* (2011) *Proc R Soc B* **278**: 3108-3115

Mechanism: Source-sink dynamics

Local density-dependent processes determine aphid abundance under isolated condition (monoculture)

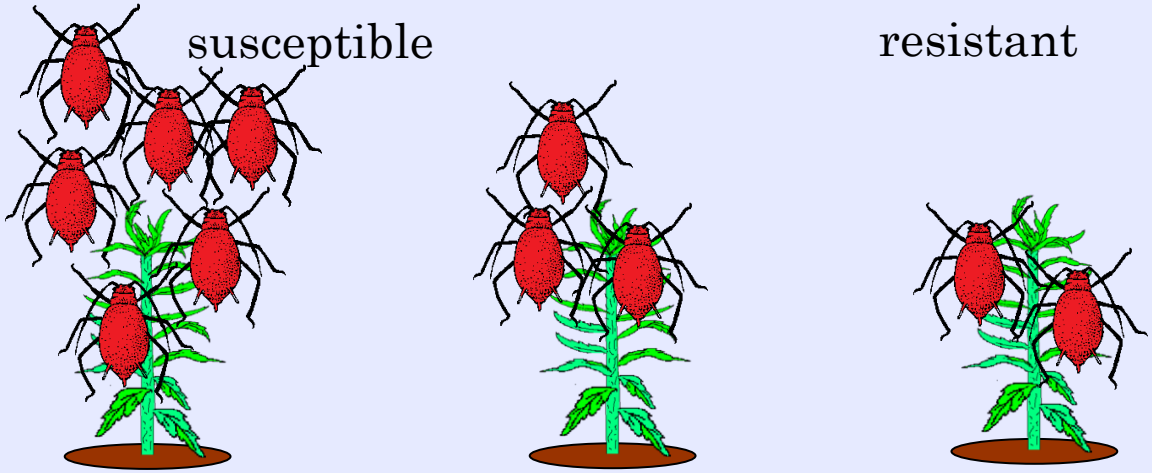
(Diverse genotype plot)
A surplus over carrying capacity on a susceptible genotype (source)

↓

moving to a bad quality genotype (sink) where reproductive success is low (walking by wingless morphs)

↓

Synergistic increase in population size



In Japan?

- Genotypic diversity and composition might be different between native and introduced ranges - undergoing
- Insect movement manner might be different between a native and introduced range due to biotic and abiotic factors - undergoing
- Genetics and spatial spreading dynamics in Japan differ from US?

International Collaborative Study in Invasion Biology

Accumulation of knowledge about differences in genetics, population dynamics, and species interactions between a native and introduced habitat

→ Condition dependence in evolutionary and ecologically dynamics (invasive species often show rapid adaptation in an introduced habitat)

→ Insights for adaptive management

Thanks for your attention
and amazing memories in Finland