



Title	Loss of species diversity impacts on genetic variation in an ecological community member
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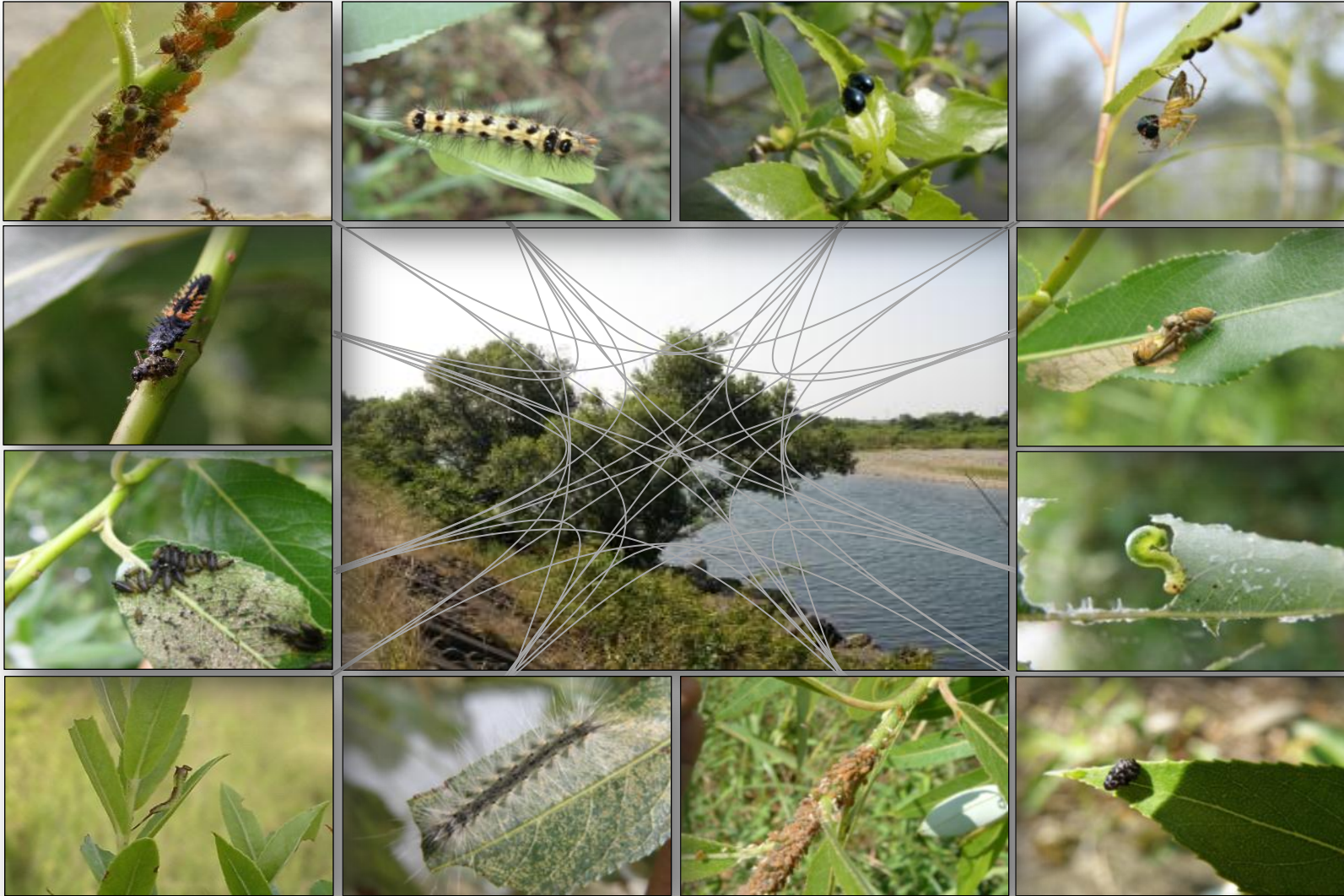
# Loss of species diversity impacts on genetic variation in an ecological community member

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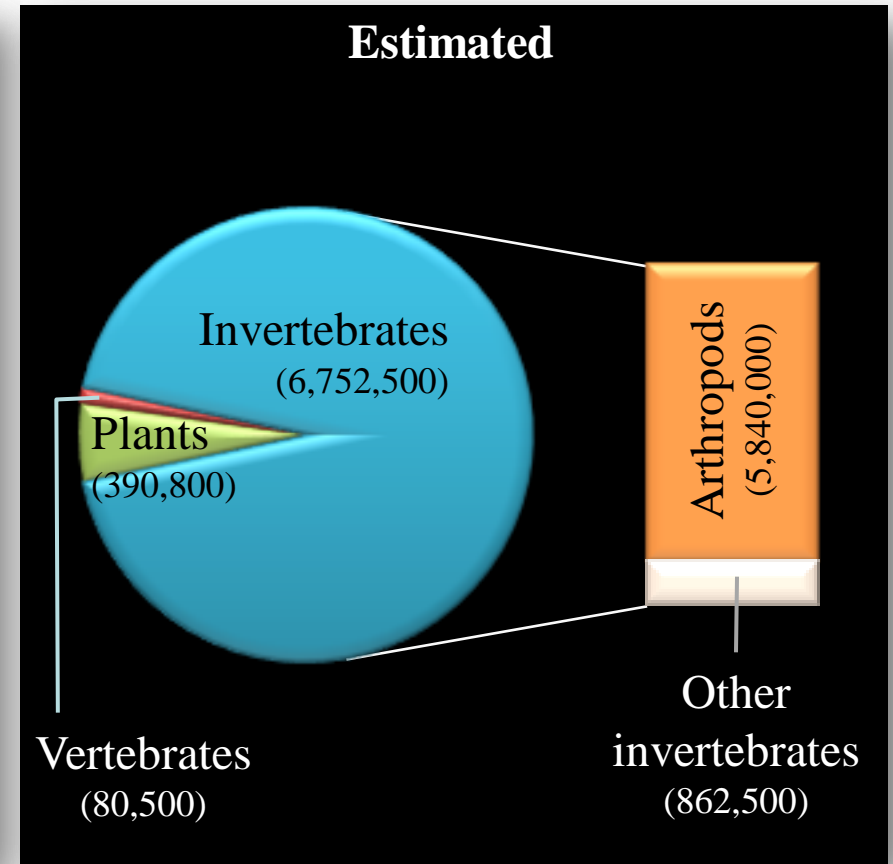
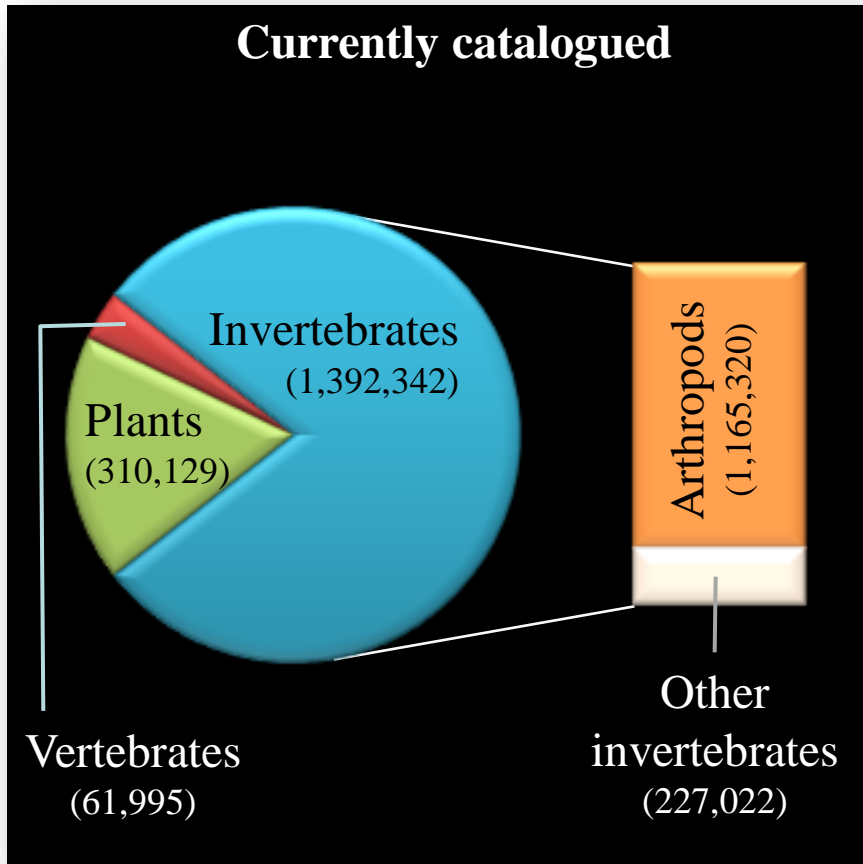
Shunsuke Utsumi



# Diverse arthropods on a tree

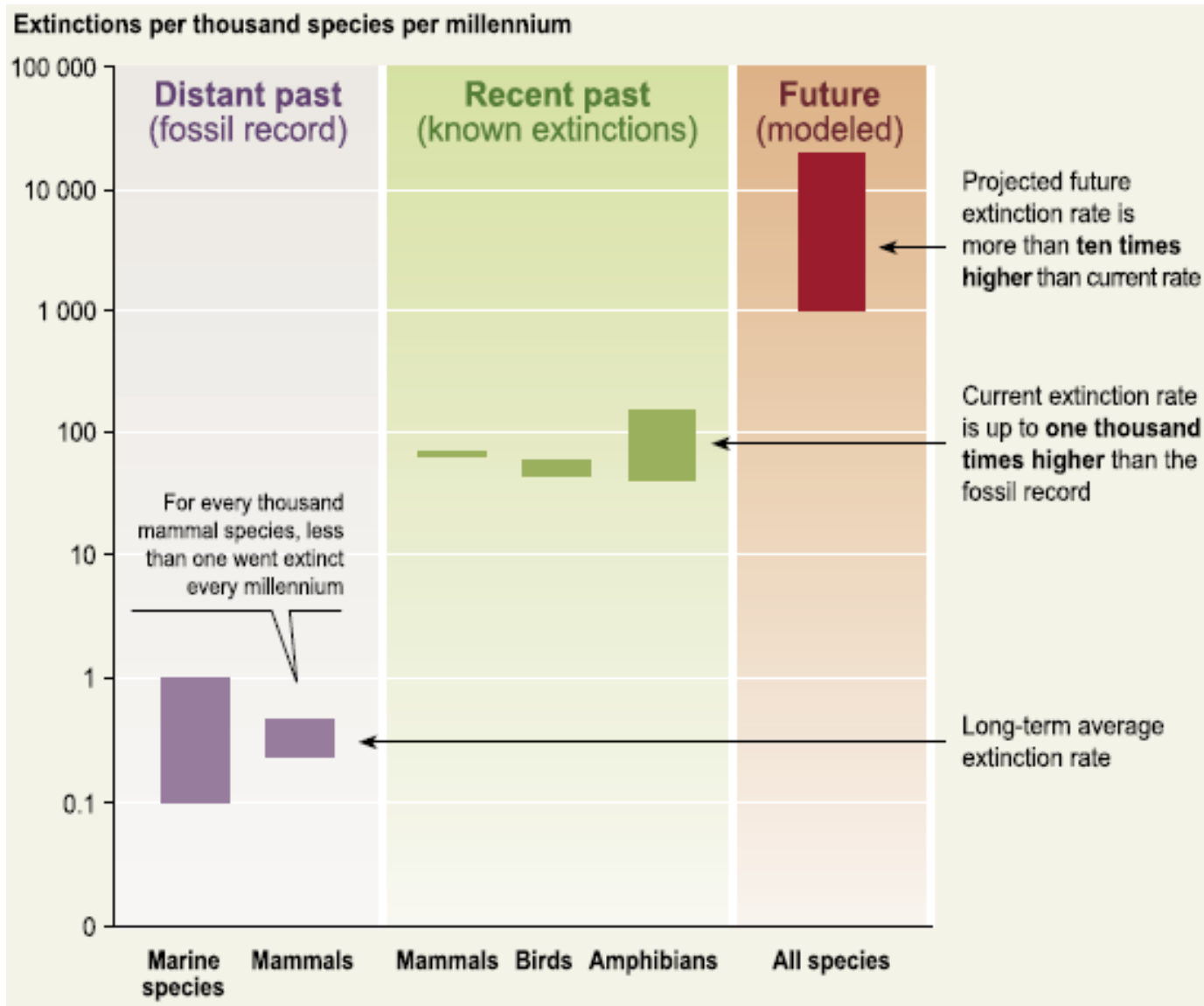


# Number of species on Earth



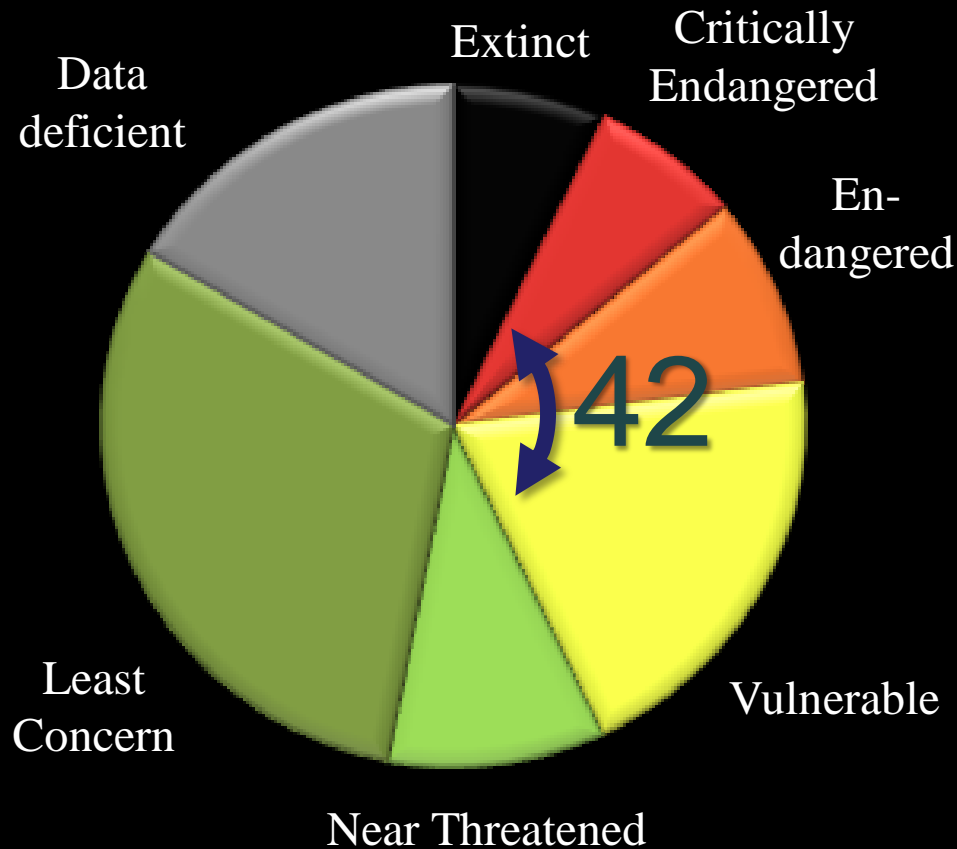
**Insects > 85% of Arthropods**

# Loss of species diversity accelerating



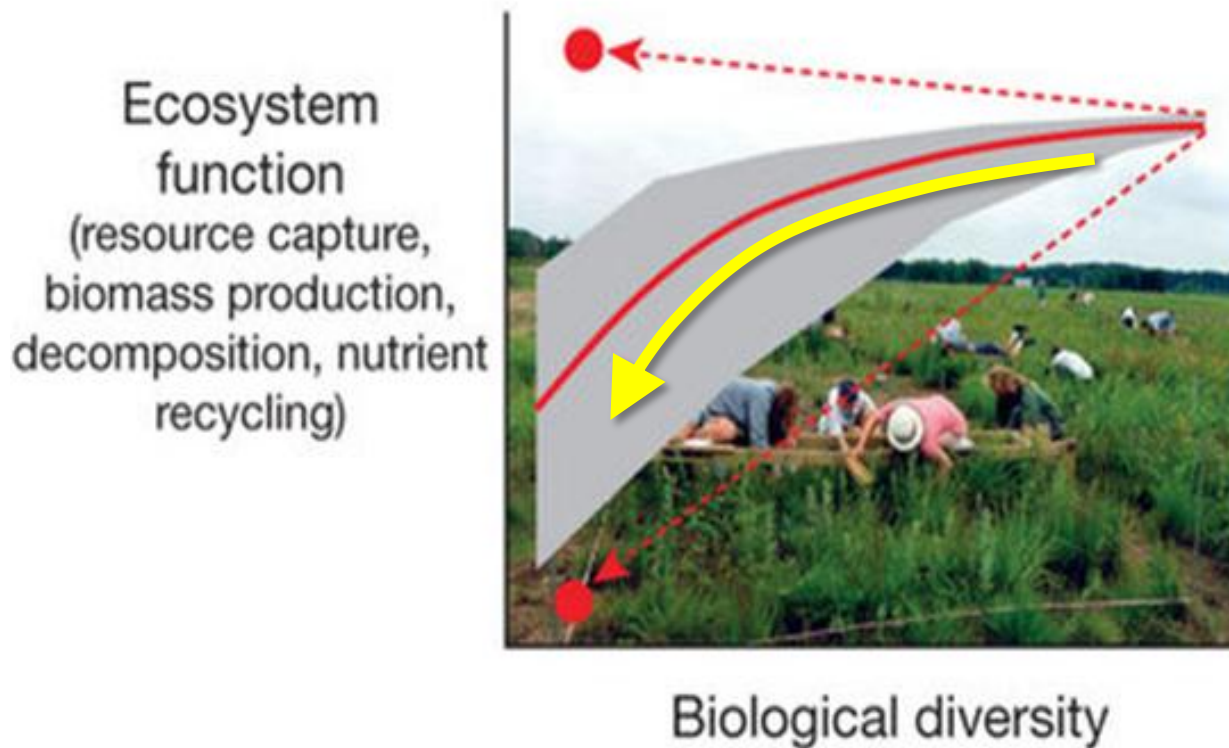
# Loss of worldwide species diversity in invertebrates

42% of terrestrial invertebrates assessed by IUCN *RL* are threatened with extinction



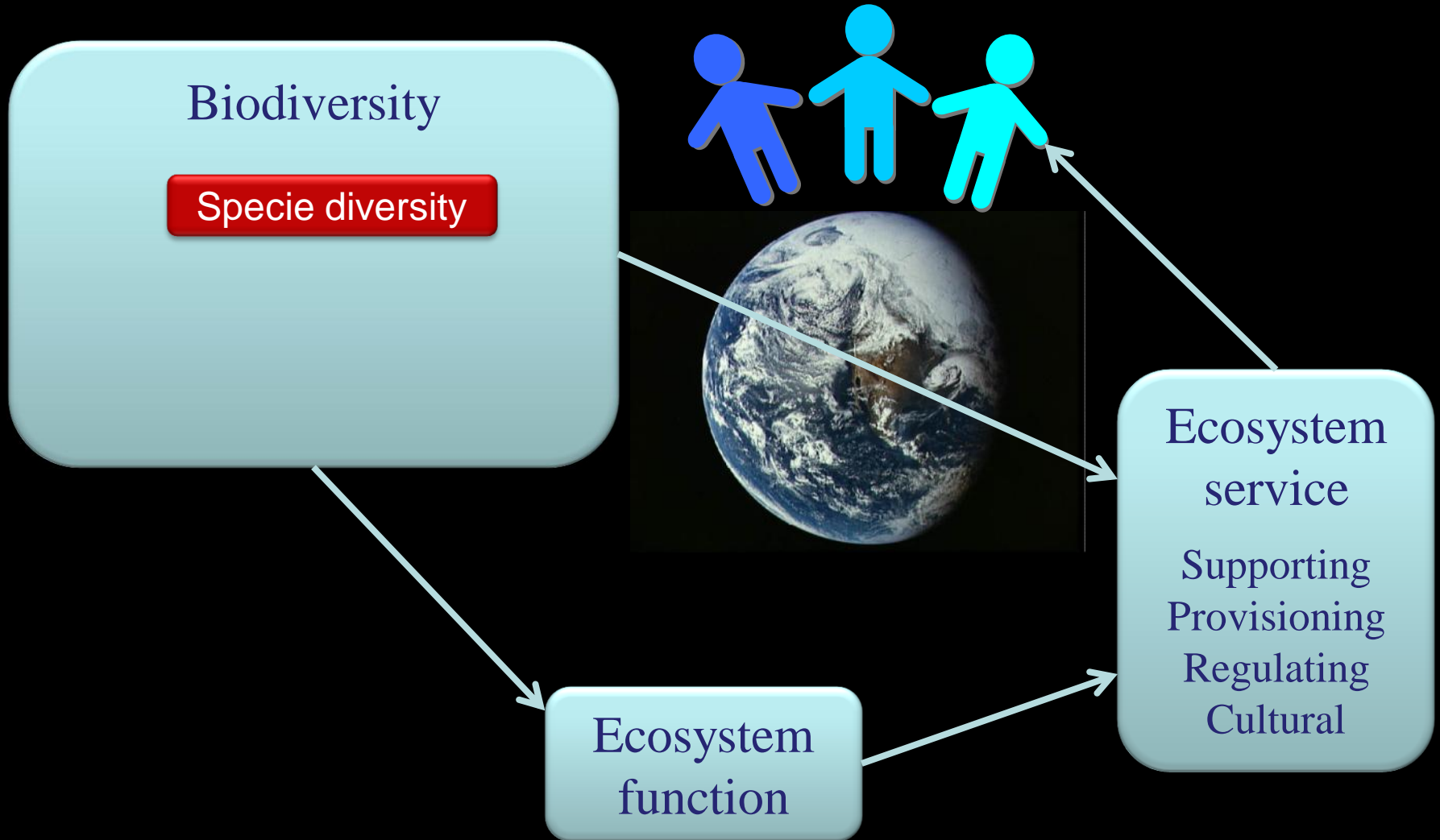
# Why biodiversity is important?

## Relationship of Biodiversity-Ecosystem Function (BEF) Consensus of 20-year BEF studies



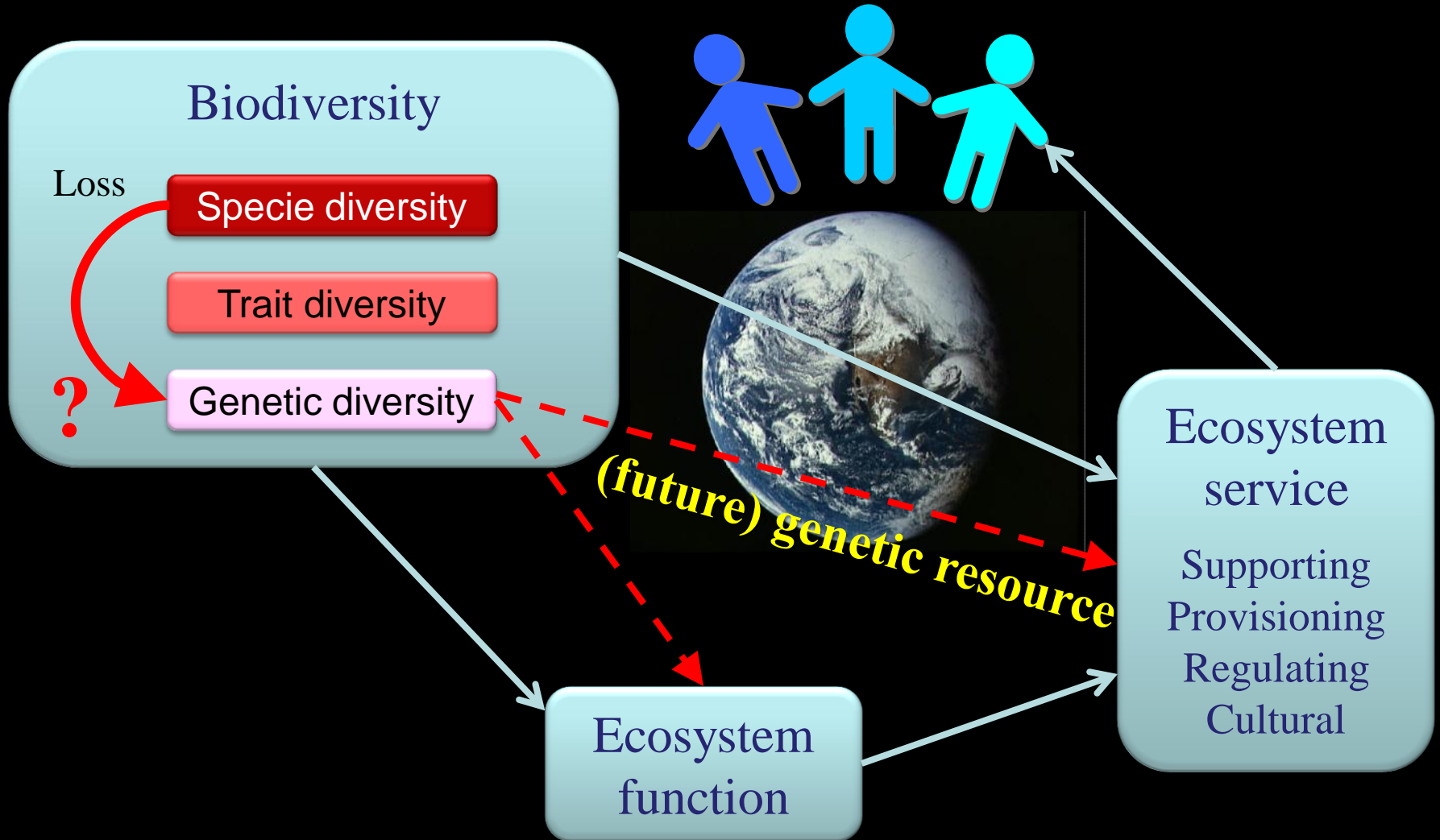
Cardinale *et al.* (2012) *Nature*

# For human well-being



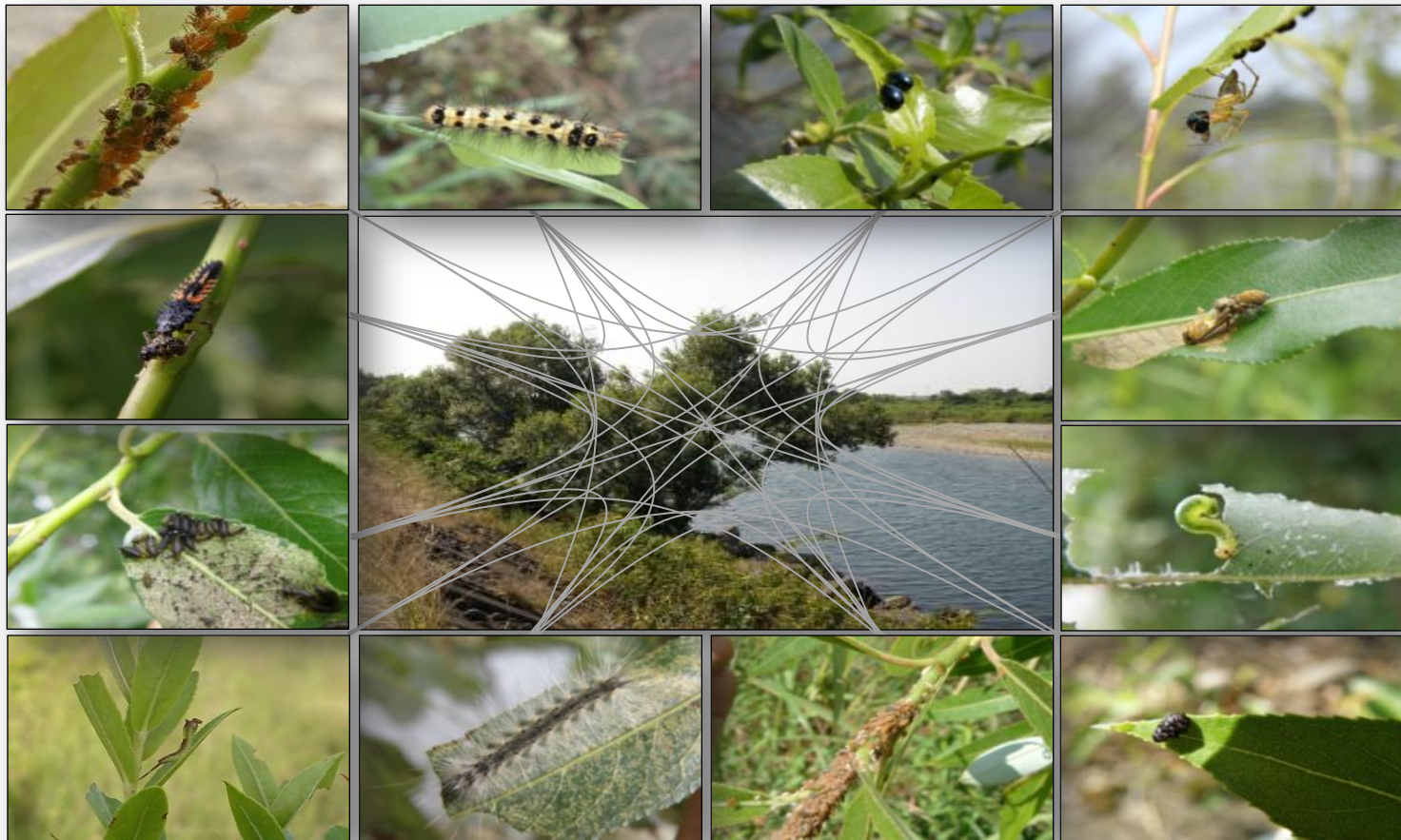


# Hierarchy of Biodiversity



# The main question of our study

How does insect species diversity affect genetic variation in one insect species through **evolutionary** interactions?



# Genus *Salix* (willow) as a model system

## *Nature*

- One of the most dominant and diverse plant group of northern hemisphere (e.g., > 450 species in the whole Holarctic region), growing all northern habitats from tundra to old-growth forests. Common in Finland and Japan.
- Utilized by many, many different insect species (Lepidoptera, Hemiptera, Coleoptera, Hymenoptera, Diptera,...). → **We focused on species diversity and genetic diversity of insects on a willow**



# Genus *Salix* (willow) as a model system

## *Applied use*

- Short Rotation Coppice (SRC) as an energy crop
- Phytoremediation to clean up soil

→ for **Sustainable Development**

- In Hokkaido, SRC trial has been initiated by the government
- **Insect attack** is a critical topic for productivity and success of plantation



# Focal insect species to consider genetic variation

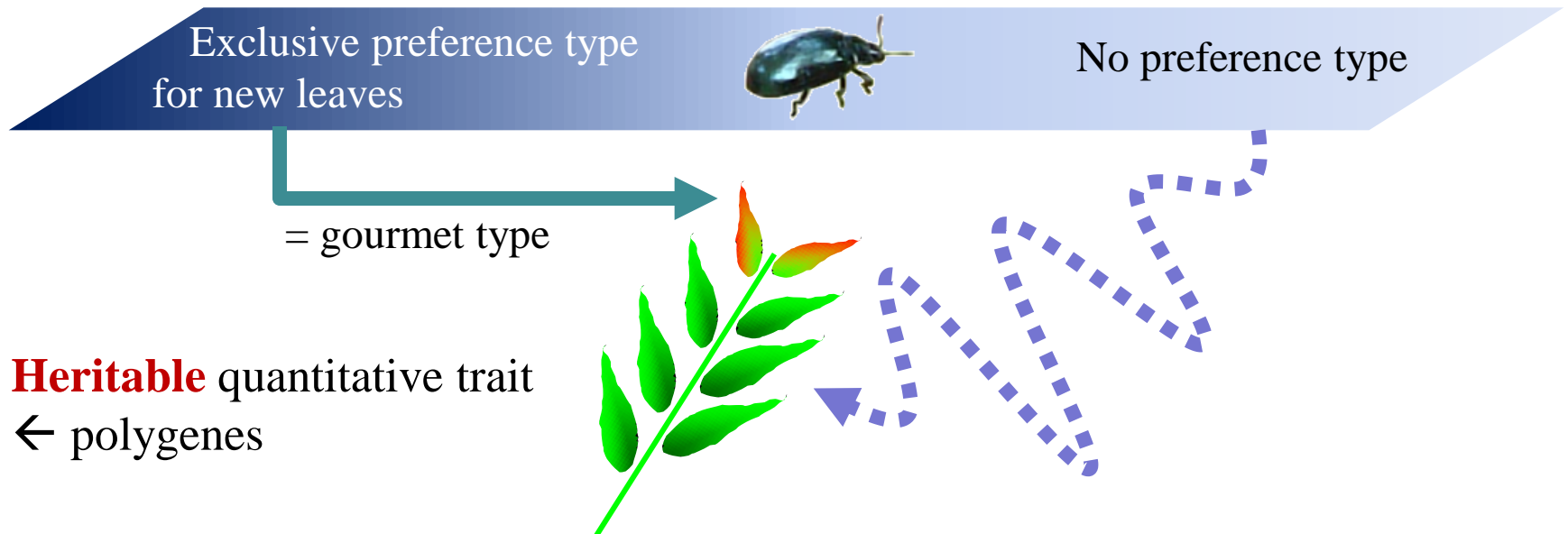


Leaf beetle

*Plagiodera versicolora*

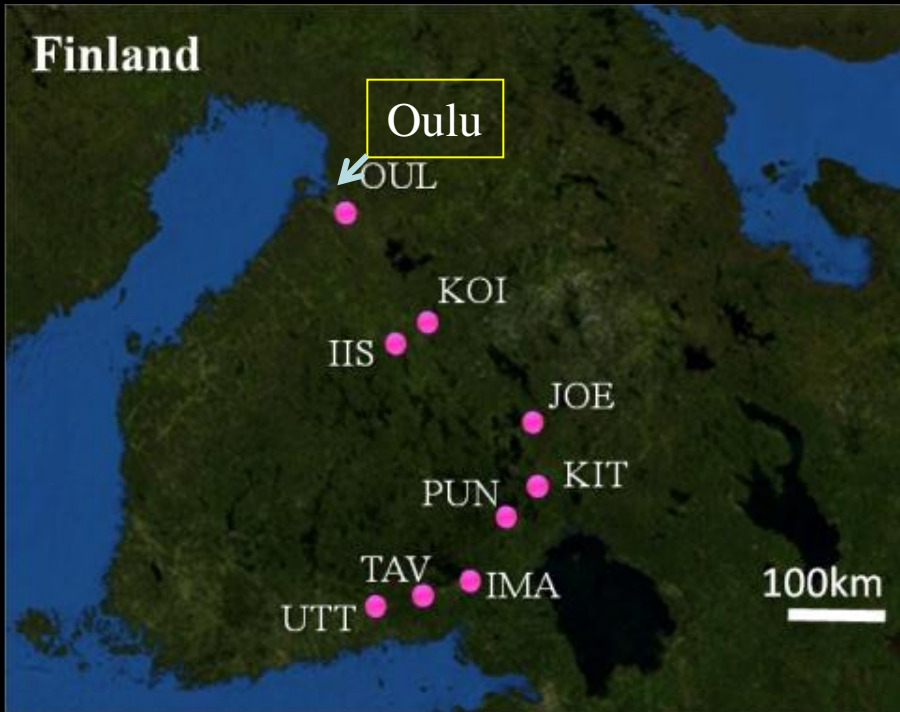
- only feeding on salicaceous trees
- wide distribution in northern hemisphere

Continuative variation among individuals in “preference”



# Research in Finland and Japan

## Finland



- Field Census-
- 1. Herbivorous insect species diversity

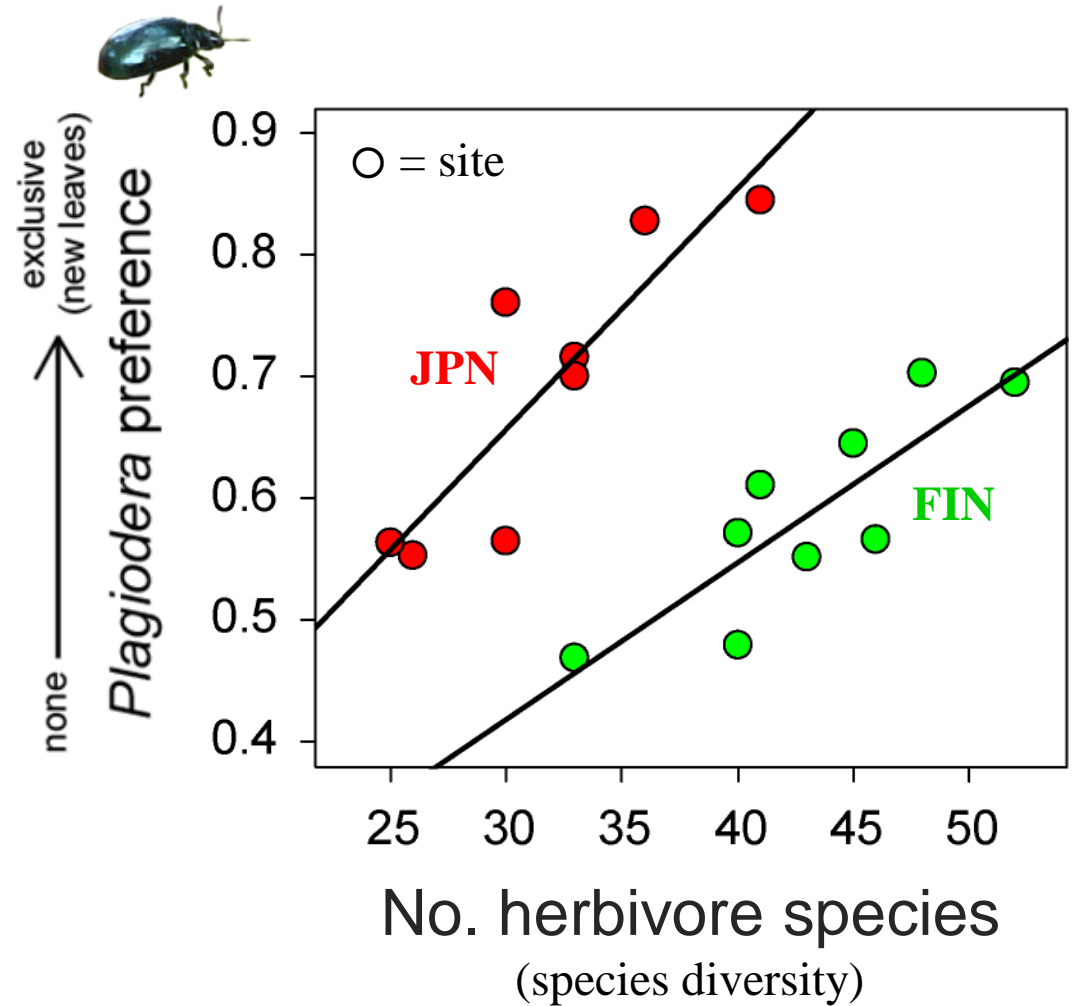
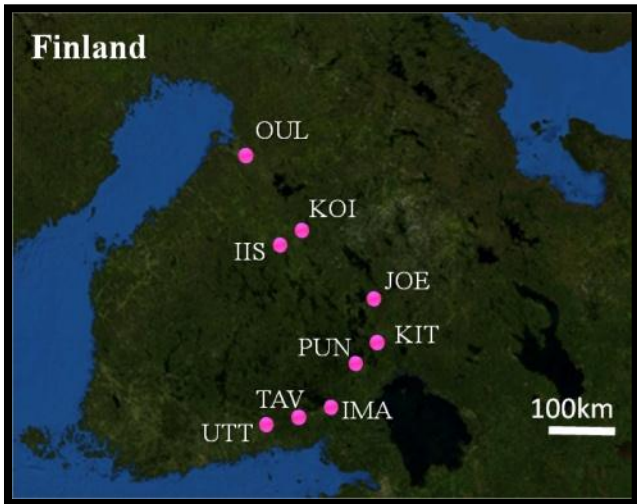
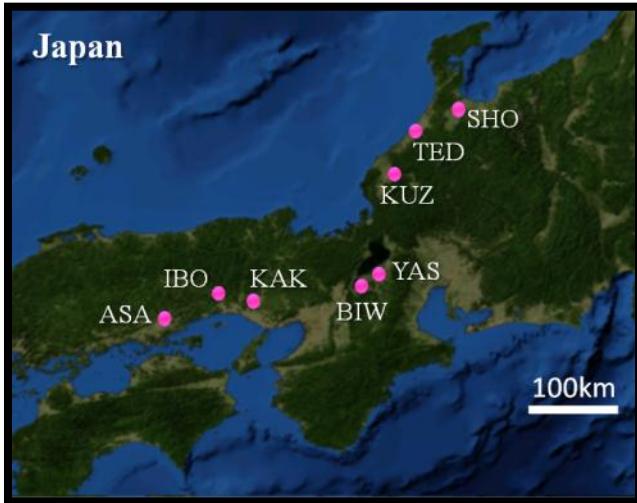


## Japan



- Collecting leaf beetle populations-
- 2. Preference test under laboratory condition
- 3. Genetic structure

# Biodiversity-Trait relationship





Sequence analyses of mitochondrial gene (COI region)

- Significant among-population **genetic differentiation** (within each country)

[AMOVA:  $P < 0.05$ ]

- Non-significant correlation between genetic differentiation ( $F_{ST}$ ) and trait difference (within each country).

[Mantel test: NS]

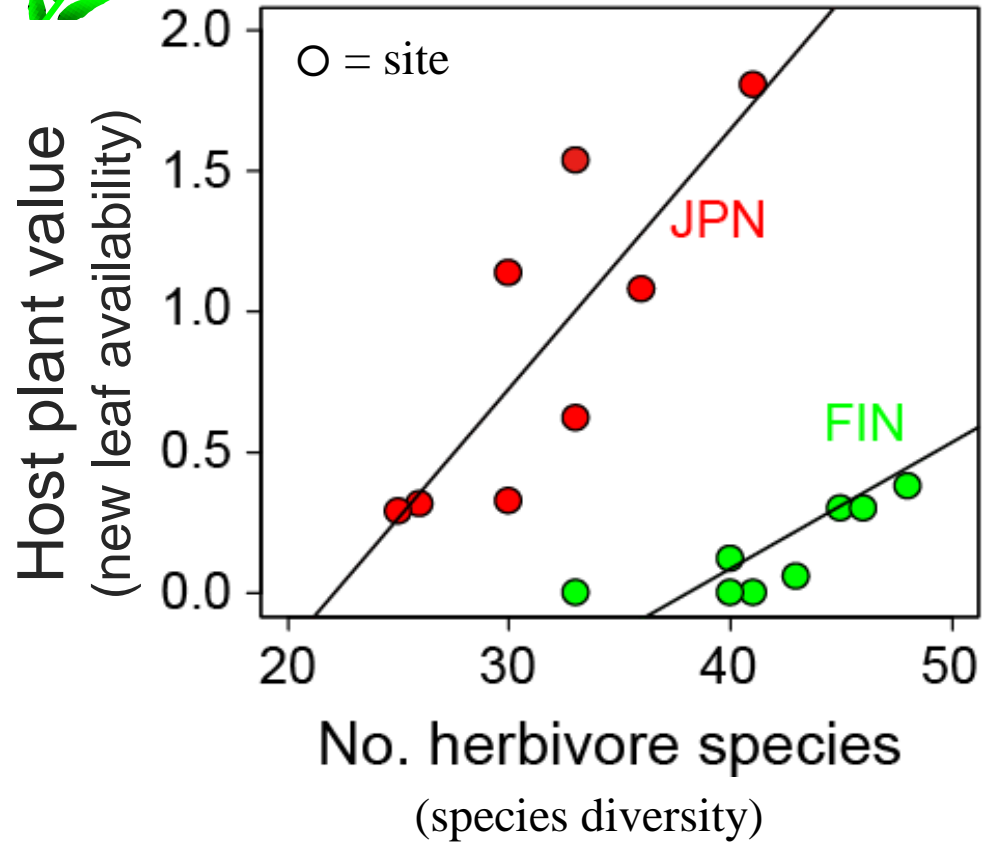
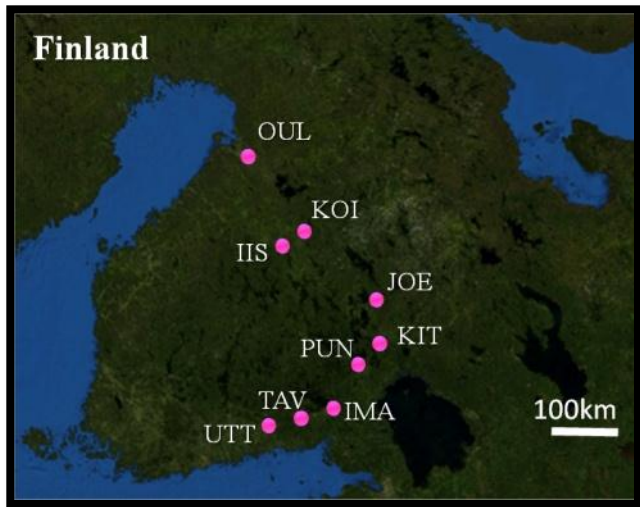
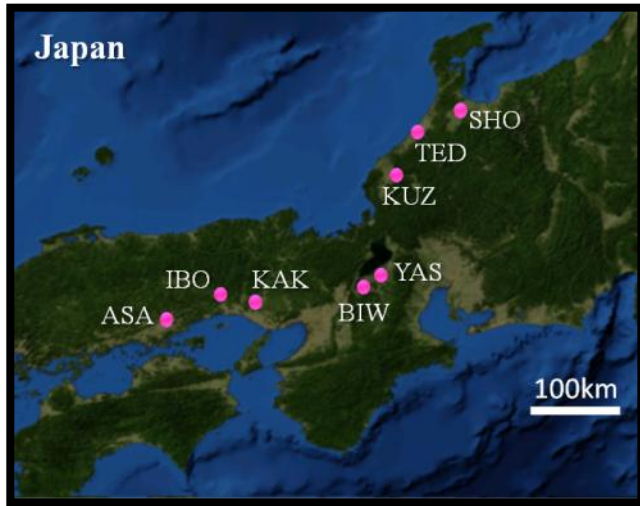
**Preference variation among sites is due to evolutionary change in each site rather than individual migration**



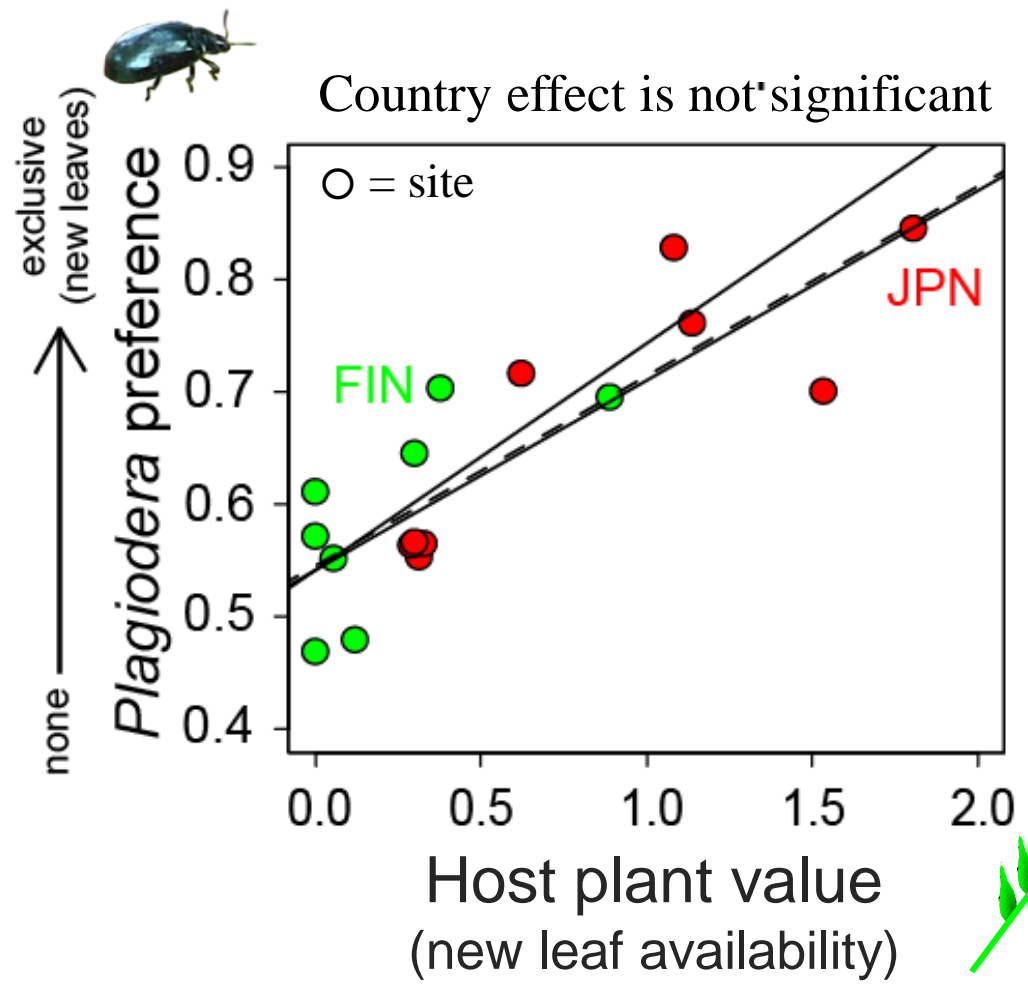
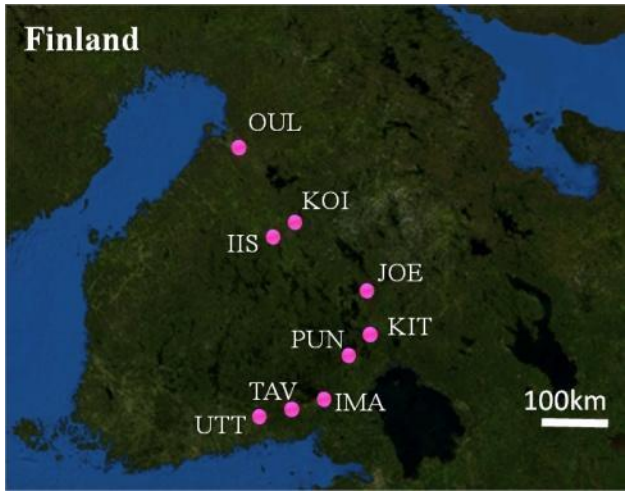
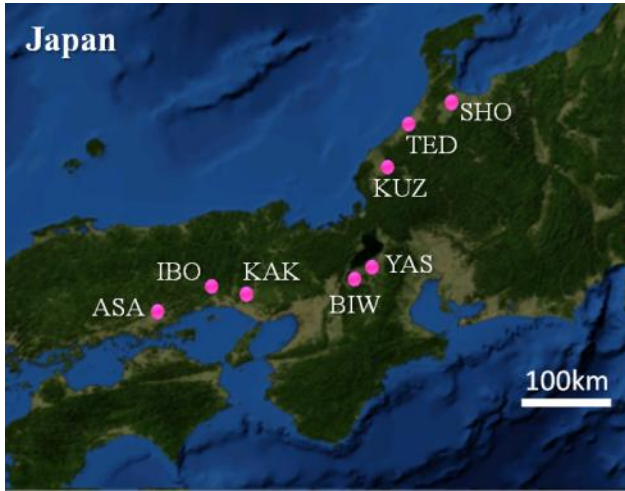


**How does different preference type evolve?**

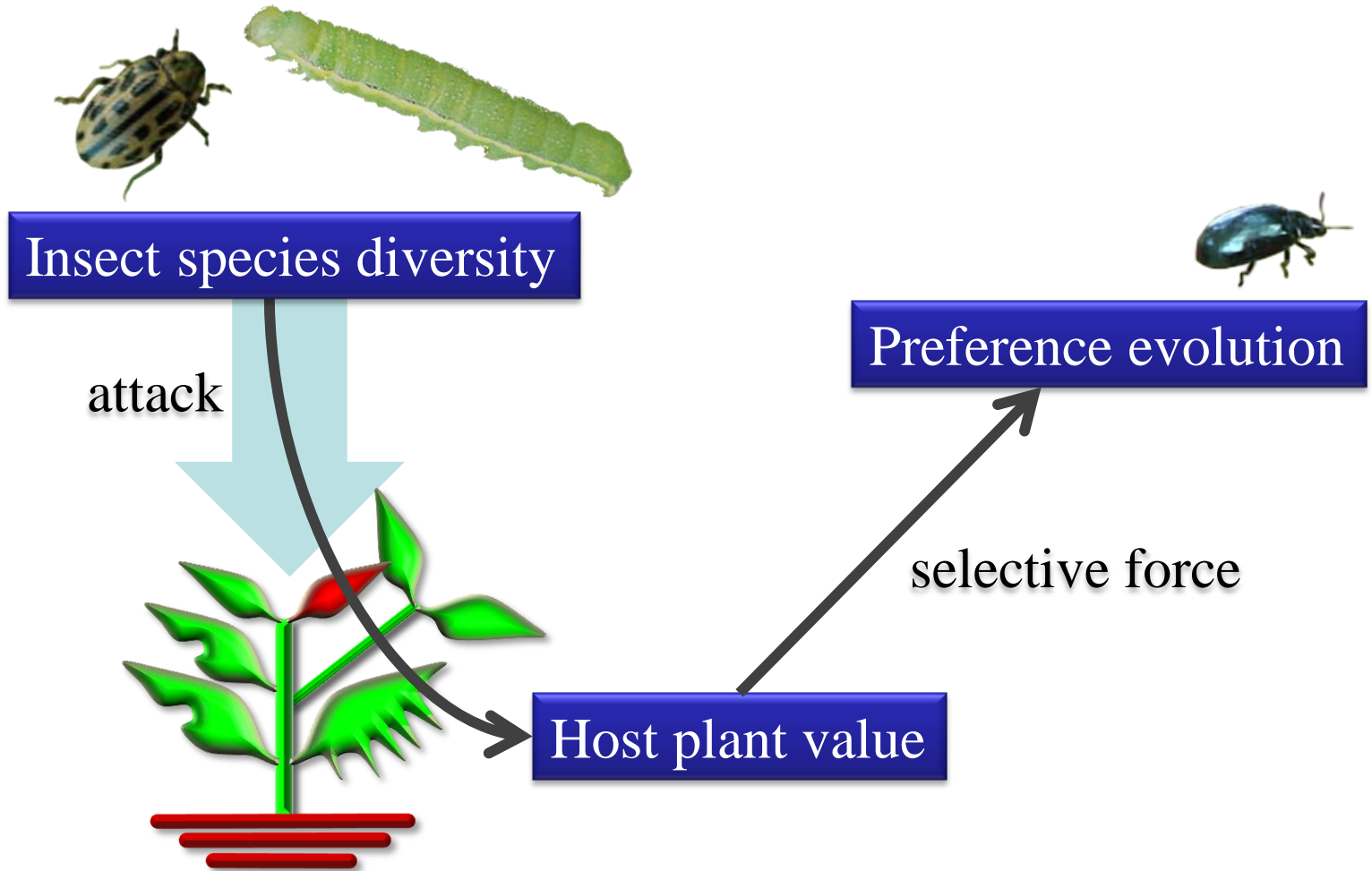
# Herbivore diversity → host plant value



# Host plant value → leaf beetle preference



# Scenario



# Community-manipulation experiment

Experimentally demonstrated  
trait evolution scenario of the leaf beetle



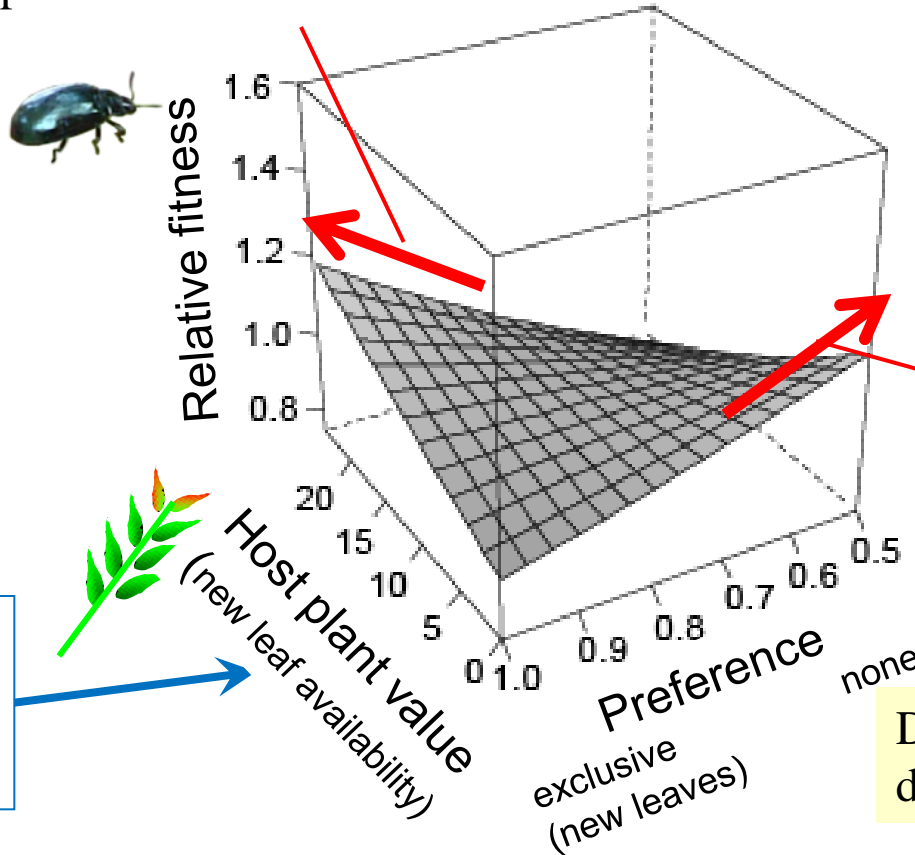
mesocosm

3 species community

+

the leaf beetle

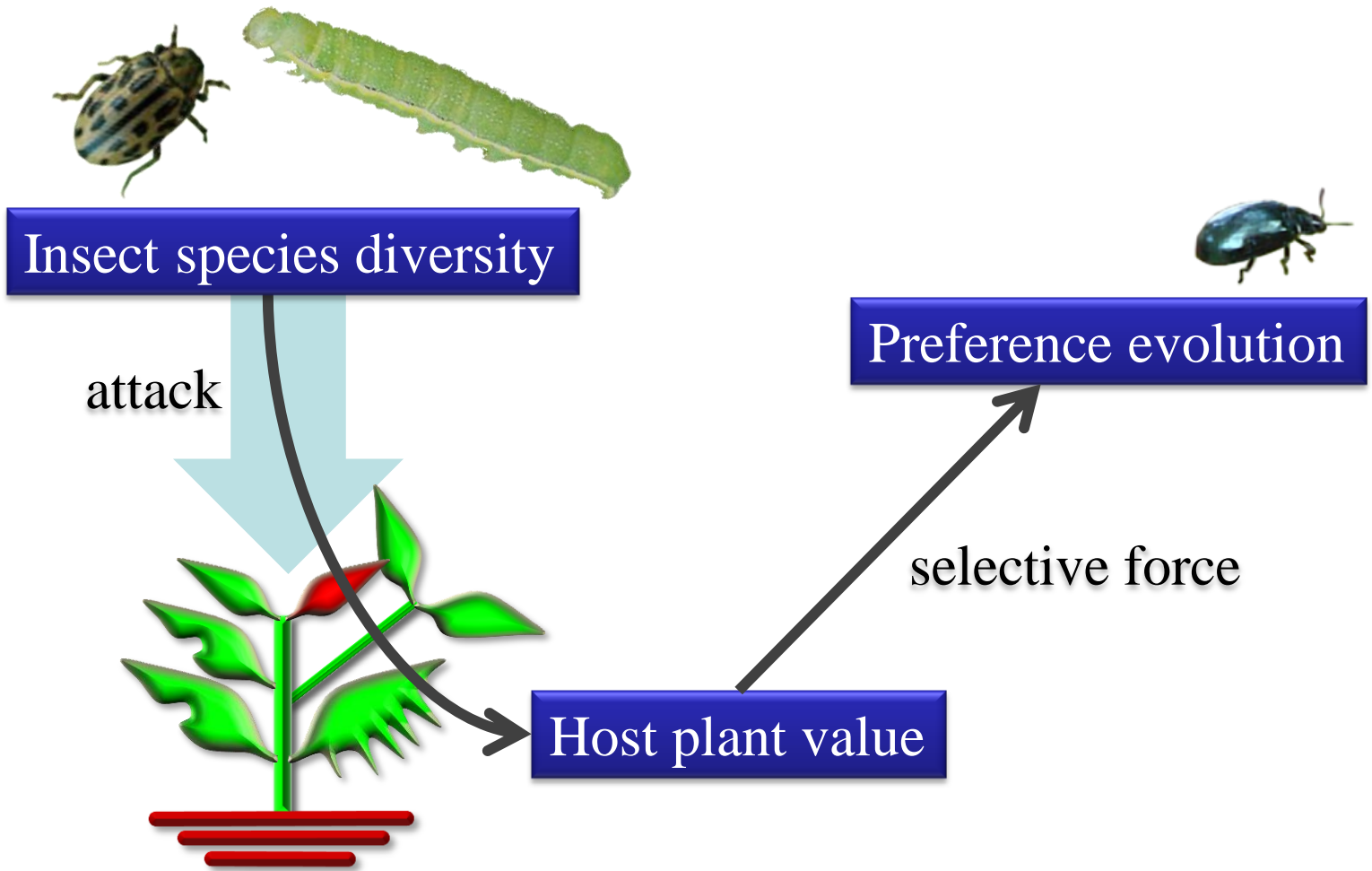
Natural Selection toward  
exclusive preference for new leaves



Natural Selection toward  
no preference

Herbivore  
Species  
diversity

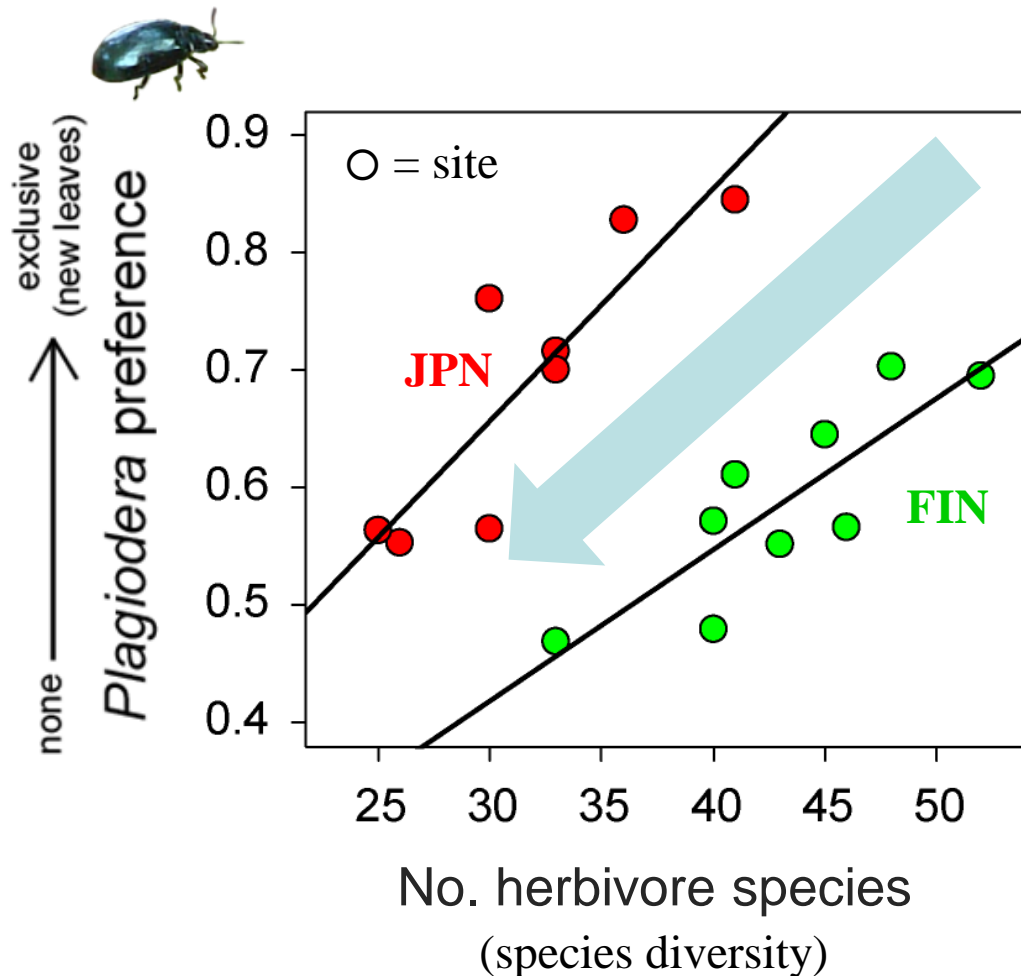
Different trait can evolve,  
depending on species diversity



“ubiquitous” evolutionary process

# Loss of species diversity leading to...

- Evolution toward no preference type
- Extinction of gourmet type populations



All populations are no preference type

All populations are homogenous

Low genetic diversity

Genes contributing to gourmet type may be lost

# Take-home message

Loss of species diversity can result in

- **Homegeneity of selective force** for a community member among localities
- Reduction in trait and genetic diversity among populations
- **Cascade of biodiversity degradation across hierarchies** (i.e., species  $\rightarrow$  trait  $\rightarrow$  genes  $\rightarrow$  ? feedback ?)
- Loss of potential genetic resource loss on Earth

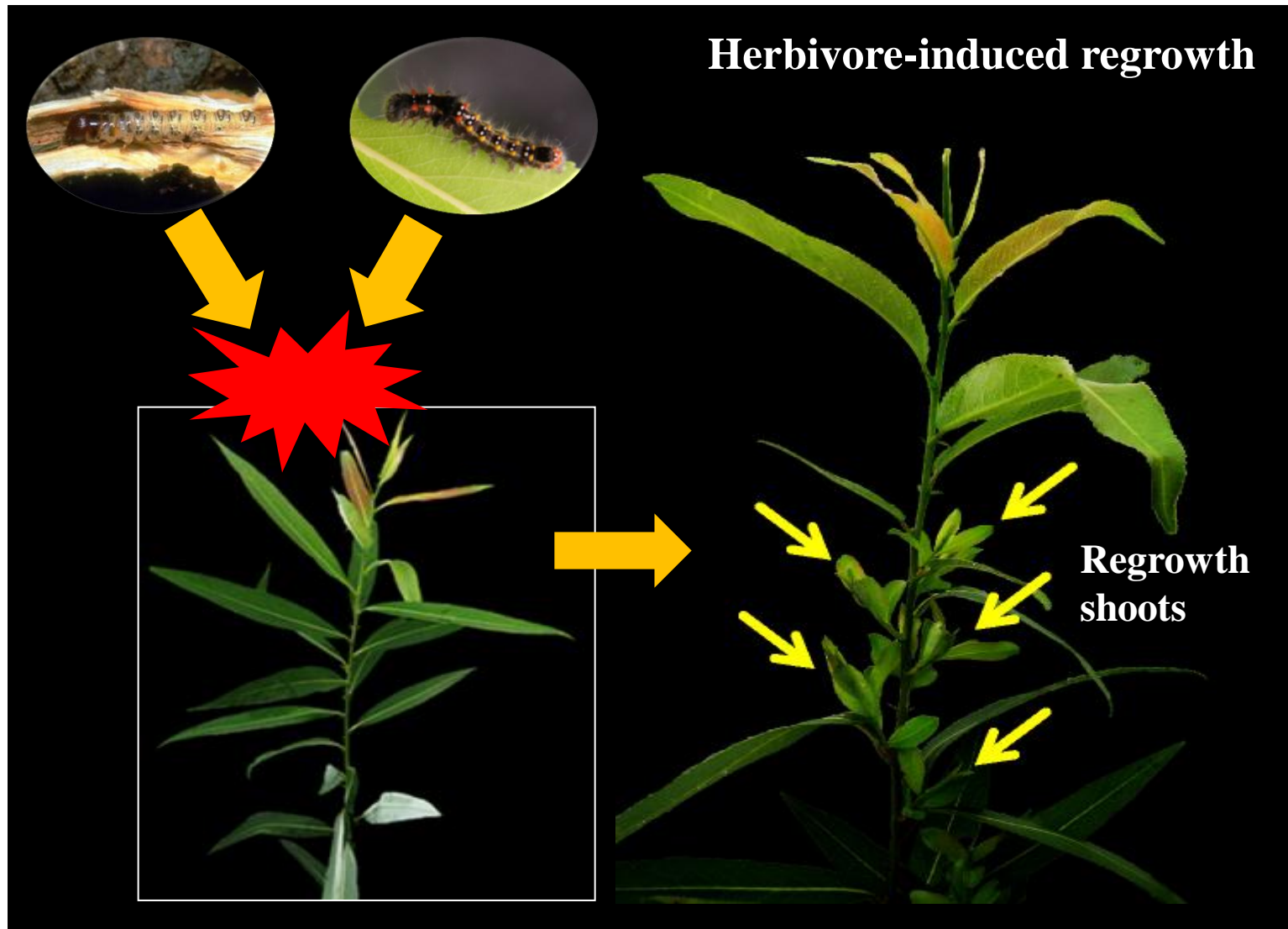
We need a new “Evolutionary Community Ecology” study in various ecosystems



# Kiitos paljon



# Willow – Herbivore System



Strong regrowth drastically increase availability of new leaves