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Latitudinal and altitudinal pattern in species richness and mortality factors of the galling sawflies on willows in Japan

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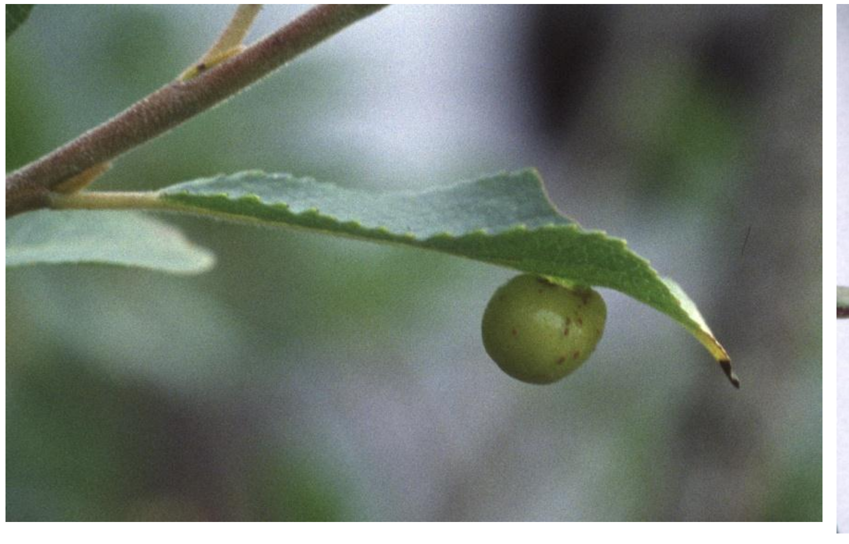


Collaborative research between Finland and Japan

- Long lasting collaboration (started 1996 as comparative studies on willows (Salix spp.) and sawfly gallers on northern hemisphere)
- ***Prof. Takayuki Ohgushi group's*** *in the Center for Ecological Research, Kyoto University*, ***Dr. Masahiro Nakamura (****The Institute of Low Temperature Science, Hokkaido University),* ***Dr. Shunsuke Utsumi*** *(Tokyo University)*

Content of Presentation

- Some background of willows (*Salix* sp.) and their sawfly gallers in Eurasian
- What collaborative studies are done?
- Some suggestions for the future research

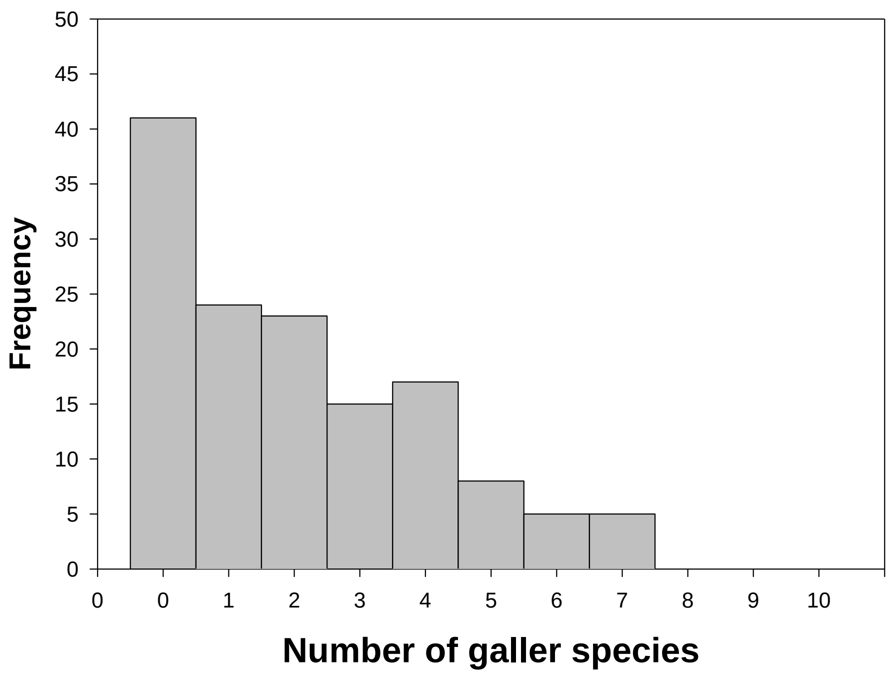
Why willows (Salicaceae; *Salix* spp.) and sawfly gallers (Hymenoptera; Tenthredidae) are important and interesting study objects?

- Gallers and willows are northern species groups
- Both groups have adapted in northern areas
- Their species richness increases towards north (there are very few other groups of organisms which demonstrate that relationship)
- Willows have important role in boreal and arctic ecosystems

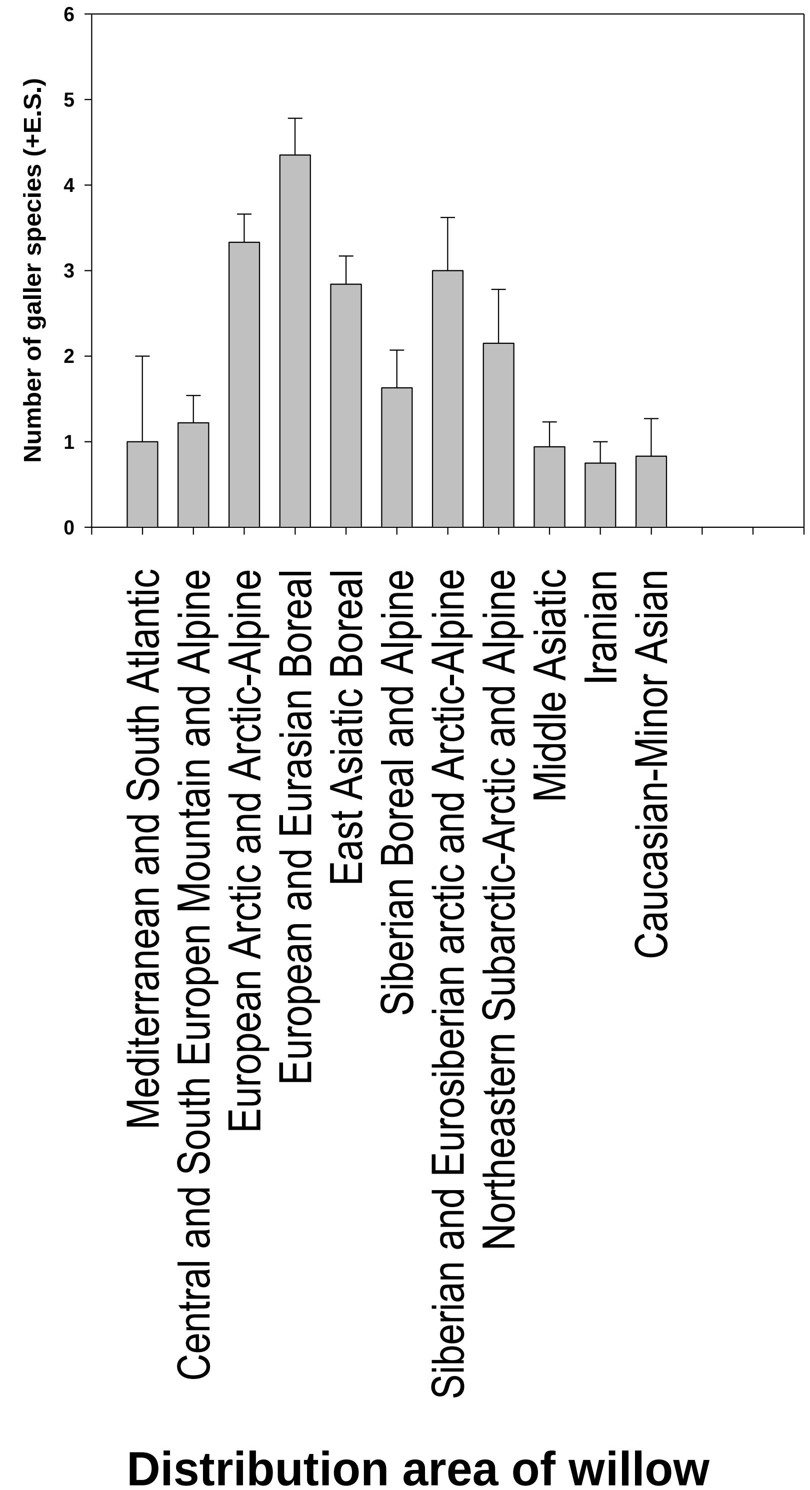
- Willows and their gallers might be vulnerable for climate change?
  - There are a lot of variation in the tolerance of environmental factors among willow species and sawfly gallers (e.g. small arctic willows and almost cosmopolitan temperate willows)
  - Phylogenetic studies on sawfly gallers show that species have been able to effectively colonize circumpolar boreal and arctic areas (e.g. after ice ages)
  - BUT the extinction rate in the past is unknown.
  - CLEARLY the number species of sawfly gallers are not saturated on willow species(i.e. Willows have a lot of empty niches)

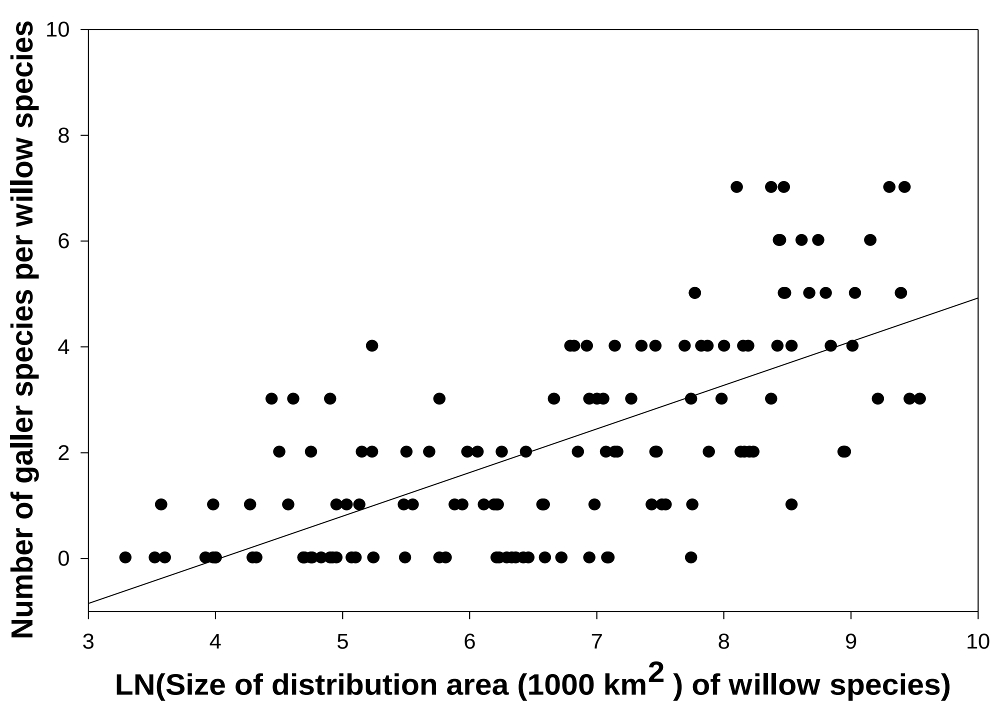
Number of galler species on willows and the size of distribution area of hosts (willows) is important for sawfly gallers

Distribution of galler species on willow species



Numbers of galler species on willows with different type of distribution





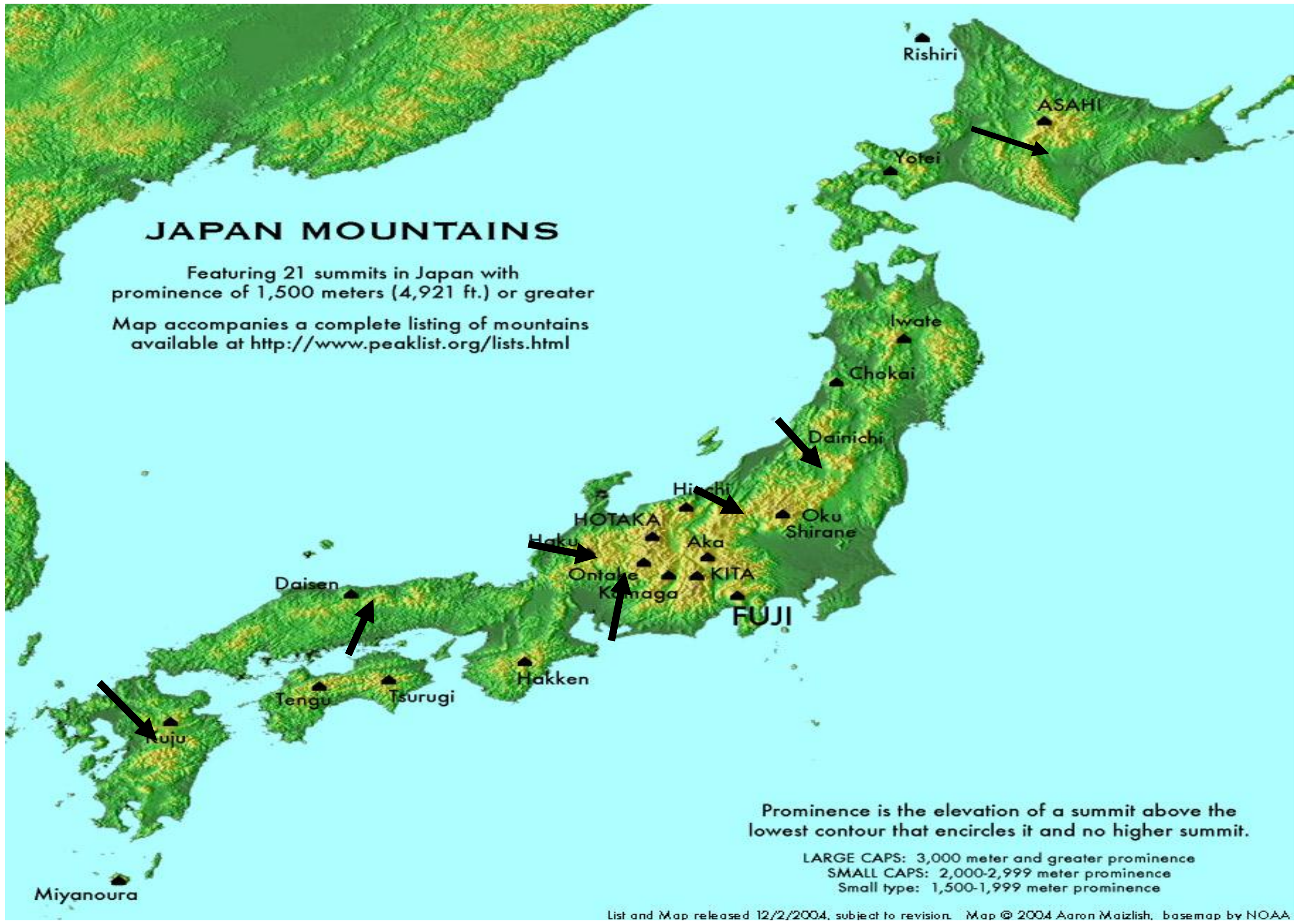
Latitudinal and altitudinal pattern in species richness and mortality factors of the galling sawflies on willows in Japan

AIMS OF THE STUDY

Species richness of willow species and galling sawflies living on them were examined in **latitudinal and altitudinal gradients**.

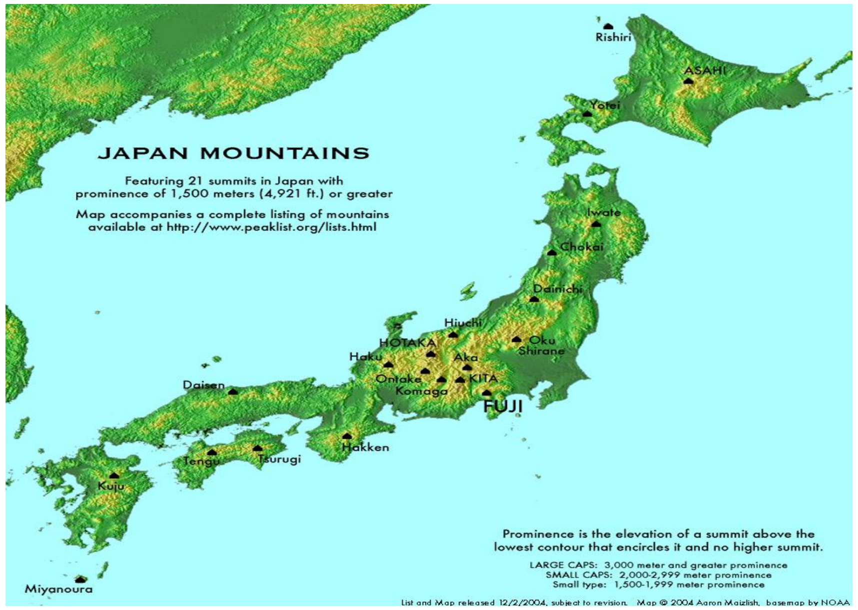
Mortality factors of gallers including plant based mortality, parasitoids and inquilines during larval development were studied.

Study areas (river systems) in Japan



LOCATION

Japan, from Hokkaido
to southern Honshu
(sporadic observations
from Kyushu;Fukuoka)



METHODS

We sampled the galling sawflies along latitudinal and altitudinal gradients in six river systems in Japan. The total number of dissected galls were 4258. Sampled galls were dissected under the microscope and survival and mortality factors were recorded.


The arctic willow (*S. polaris*)


Full grown larva emerge from gall

Pontania pustulator on *Salix phylicifolia*


Heikki Roininen

RESULTS

Table 1. The species of galling sawflies or their morphotypes and host plants included into the study. We used Kimura's (1989) taxonomy used in Japanese literature and give Skvortsov (1999) suggested names in parenthesis. If there is no name in parenthesis classification is identical.

Galler	Willow species
Phyllocolpa "folder" sp.1	*S. reinii*
Phyllocolpa "folder" sp.2	*S. rorida*
Phyllocolpa "folder" sp.3	*S. sachalinensis* (*S. udensis**)
Phyllocolpa "roller" sp.4	*S. pet-susu* (*S. schwerinii**)
Phyllocolpa "folder" sp.5	*Toisusu urbaniana* (*S. cardiophylla**)
Phyllocolpa "folder" sp.6	*S. jessoensis* (*S. pierotii*)
Phyllocolpa "folder" sp.7	*S. miyabeana*
Phyllocolpa "folder or roller" sp.8	*S. gracilistyla*
Phyllocolpa "folder" sp.9	*S. futura*
Phyllocolpa "folder" sp.10	*S. gilgiana*#
Eupontania "viminalis" sp.1	*S. reinii*
Eupontania "viminalis" sp.2[1]	*S. sachalinensis* (*S. udensis**)
Eupontania "viminalis" sp.3	*S. rorida*
Eupontania "viminalis" sp.4[2]	*S. gracilistyla*
Eupontania "viminalis" sp.5	*S. miyabeana*
Eupontania "viminalis" sp.6	*S. pet-susu* (*S. schwerinii**)
Eupontania "viminalis" sp.7	*S. gilgiana*
Pontania mirabilis	*Toisusu urbaniana (S. cardiophylla** **)**
Eupontania "vesicator" sp. close to *P. lapponica*	*S. pet-susu* (*S. schwerinii**)
Eupontania mandshurica	*S. jessoensis (S. pierotii)*
Eupontania amurensis	*S. miyabeana*
Eupontania "vesicator" sp.1[4]	*S. integra*
Eupontania "vesicator" sp.2[5]	*S. chaenomeloides*
Pontania "proxima" sp.1	*S. pet-susu* (*S. schwerinii**)
Pontania "proxima" sp.2[3]	*S. sachalinensis* (*S. udensis**)
Pontania "proxima" sp.3	*S. yezoalpina* (*S. nakamurana**)
Euura mucronata	*S. reinii*
Euura mucronata	*S. sachalinensis* (*S. udensis**)

Salix species with no galls in any sites

S. pauciflora (*S. nummularia**)

S. subfragilis (*S. triandra**)

S. hultenii (*S. caprea**)

S. bakko (*S. caprea**)

*Superscript numbers show the classification by Yukawa (1996); 1 Pontania sp. I, 2 Pontania sp. K, 3 Pontania sp. H, 4 Pontania sp. J, and 5 Pontania sp. A. # Ohashi (2000) combined with S. miyabeana, * Enumerated also by Ohashi (2000).*

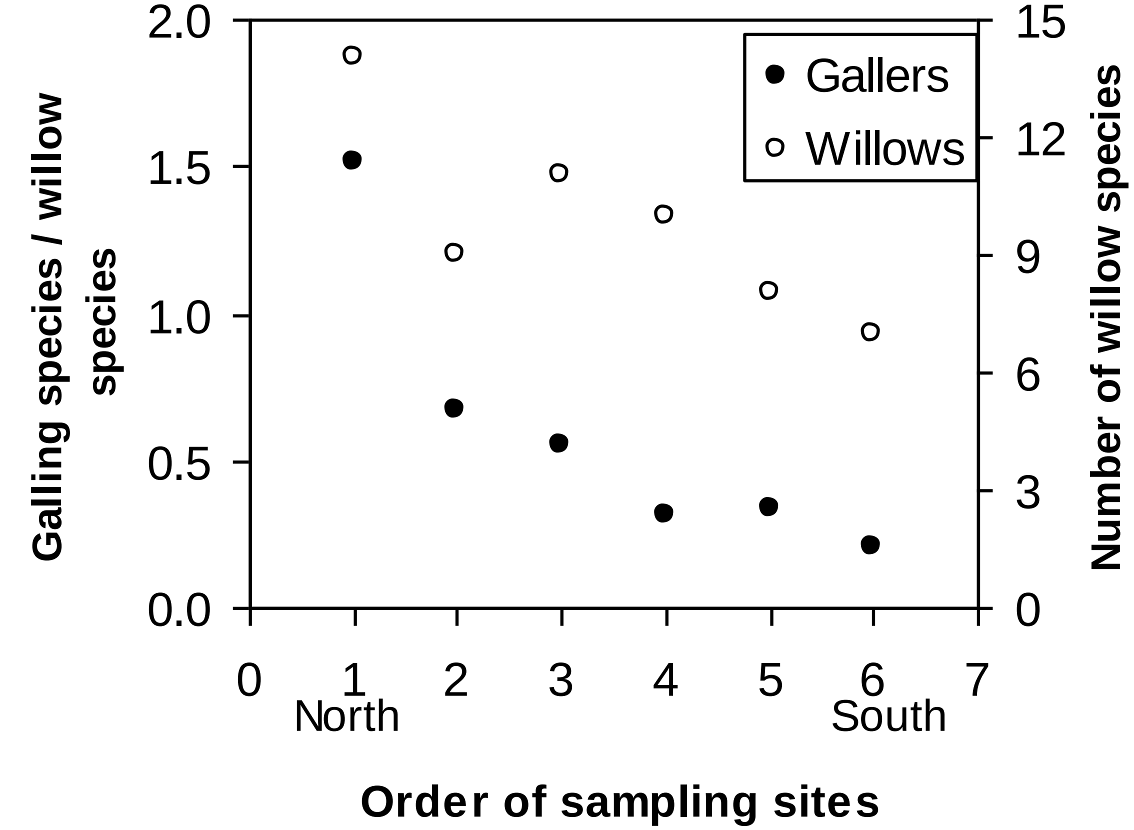
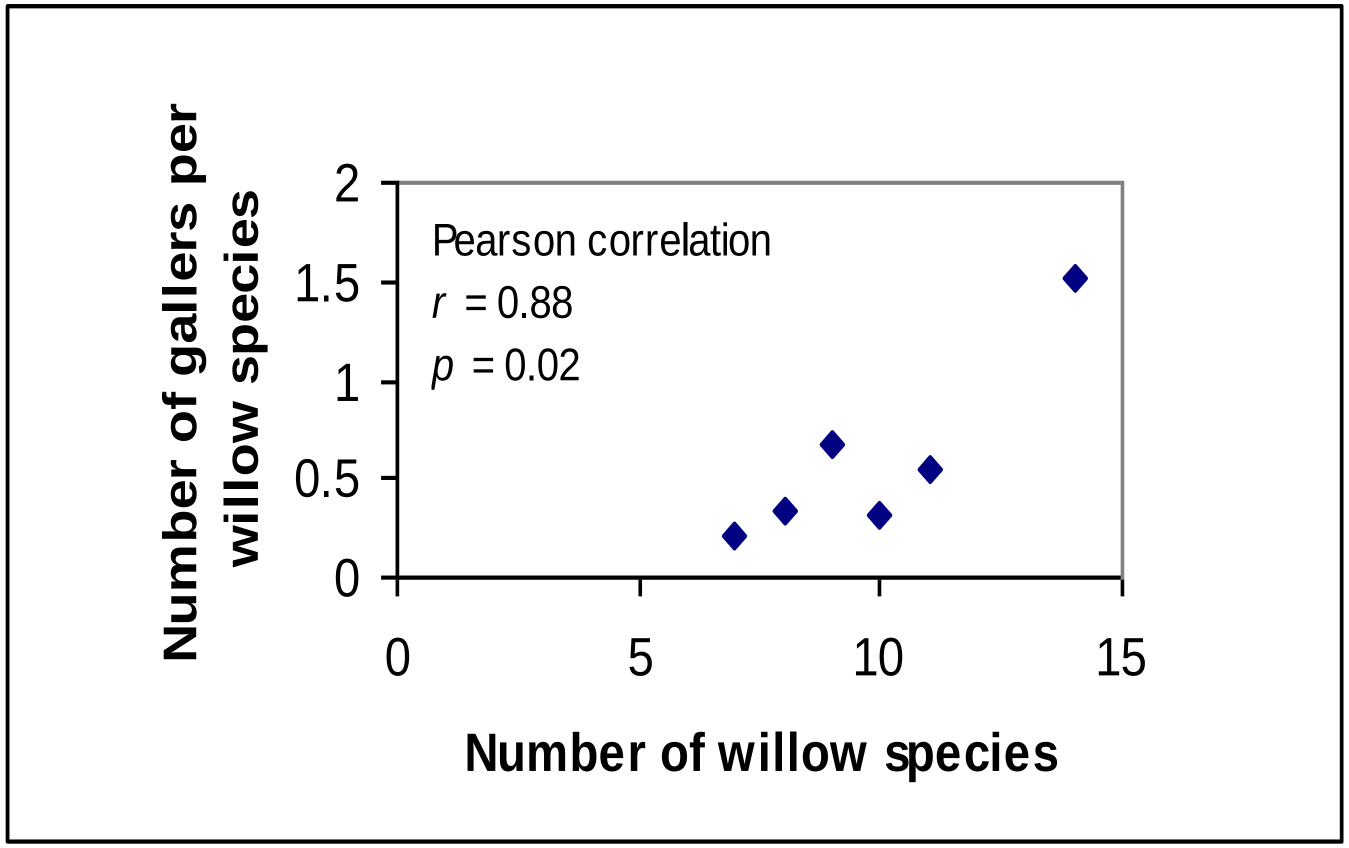
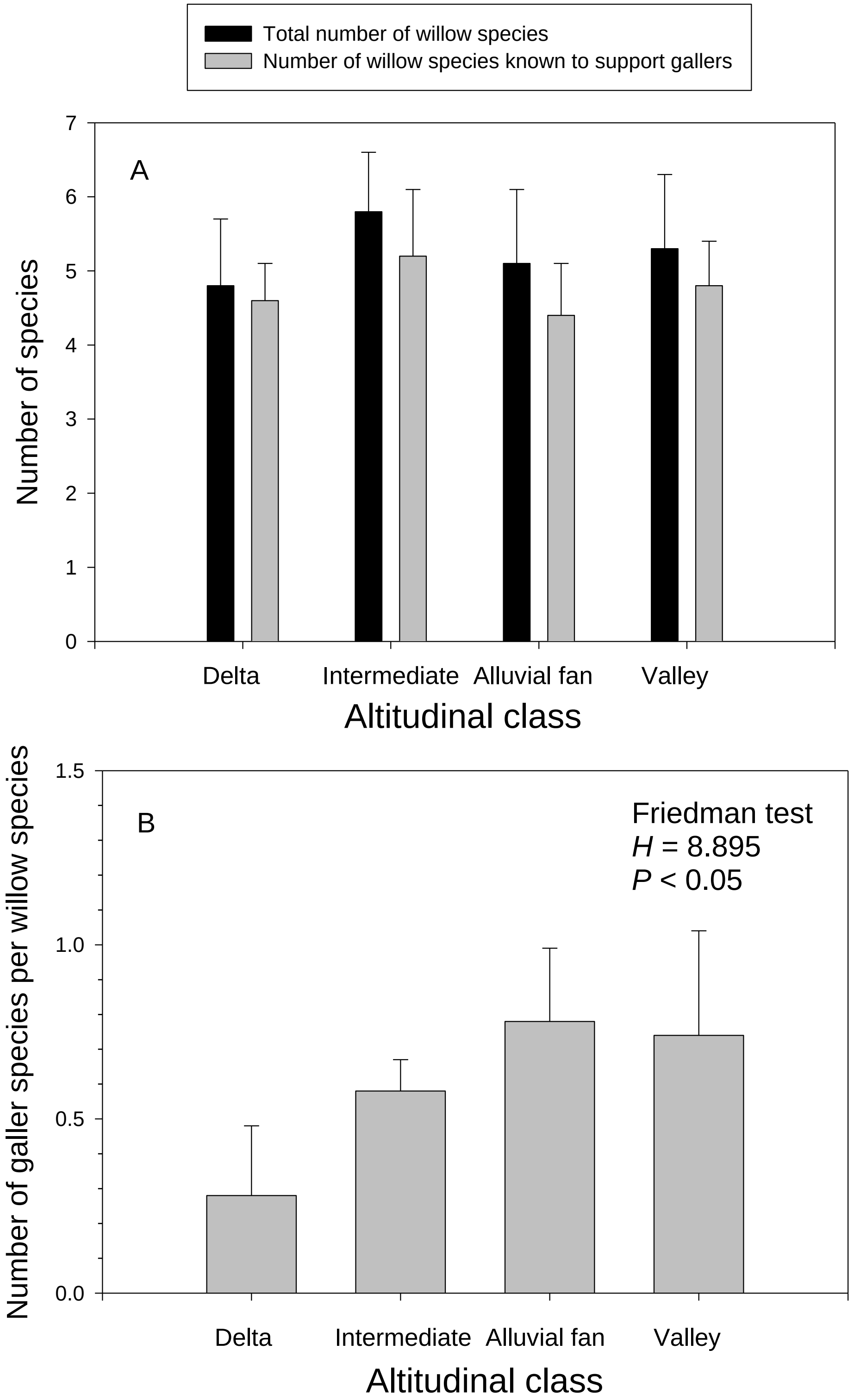


Fig. 1. Correlations between latitudinal order of sampling site and total number of galler species and number of willow species known to have galling sawflies in Japan (**Spearman's rank correlation: for gallers; r = -0.87, P < 0.019, and for willows r = -0.83, P < 0.05**).



Number of gallers per willow species
Number of willow species
Pearson correlation
r = 0.88
p = 0.02
0
0.5
1
1.5
2
0
5
10
15

No differences on larvae survival in north-south gradient!



Main Results:

1. Species richness of sawfly gallers and their host plants decreased toward south.

2. Species richness of gallers was lower in the delta areas at lower altitudes than at higher altitudes.

3. Number of willow species and numbers of galling sawflies per willow species decreased towards south.

4. Different mortality factors, plant based mortality, parasitoids or inquilines, showed no significant trends with latitude or altitude.

MAIN CONCLUSIONS :

The **diversity** of galling sawflies **increased toward north** as well as their willow hosts. This pattern is opposite to that in the most other animals and plants. It is unlikely explained by larval survival or different mortality factors since they showed no difference in latitudinal or altitudinal gradient.

A possible hypothetical explanation of the pattern may be:

1. the decreasing host plant species richness with other host related factors, like increased habitat fragmentation and decreased abundance of host plants towards south. In addition,

2. leaf flush of host plants and egg laying of galling sawflies might be better synchronised in north with highly seasonal but predictable resource availability.

ACKNOWLEDGMENTS

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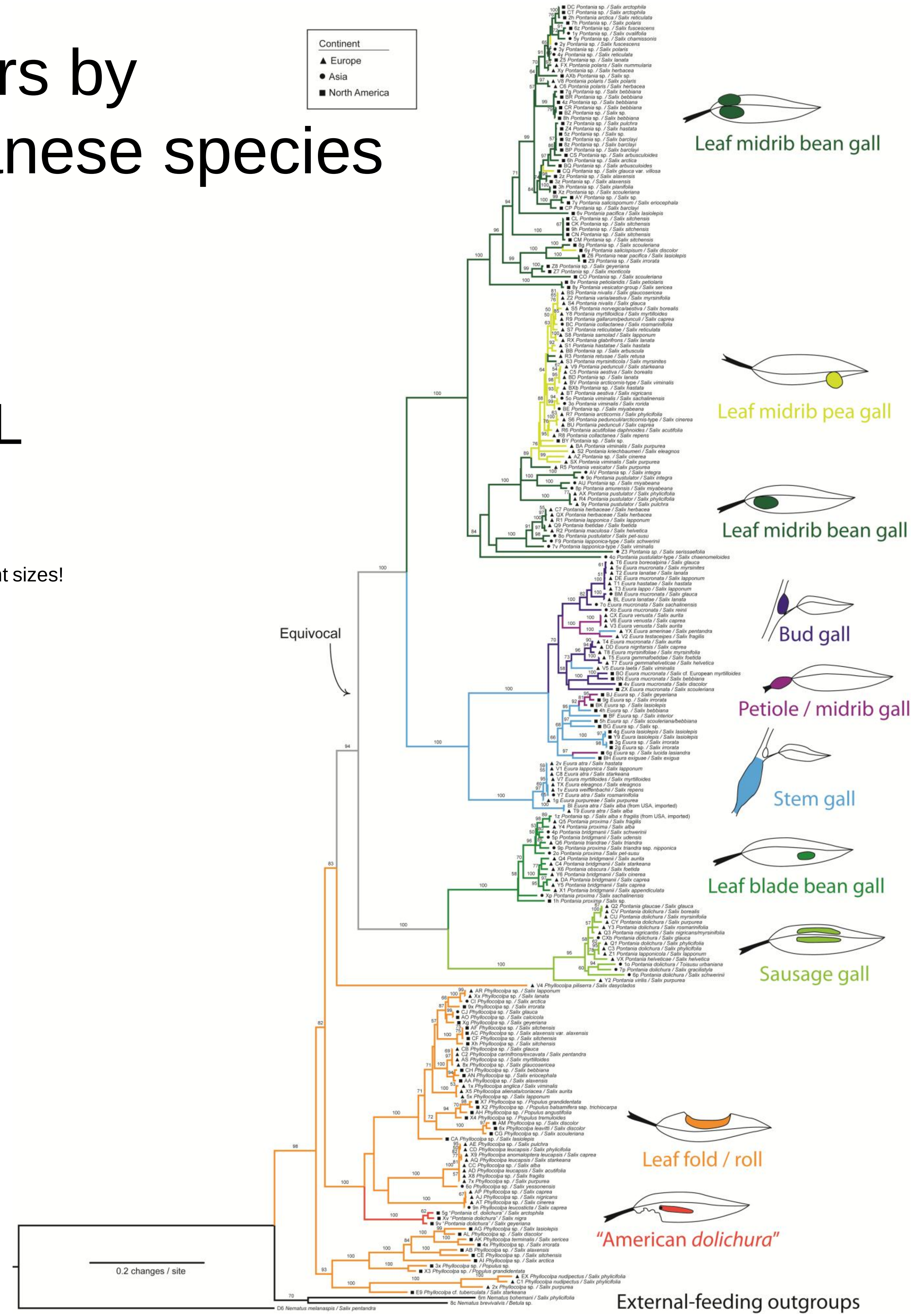
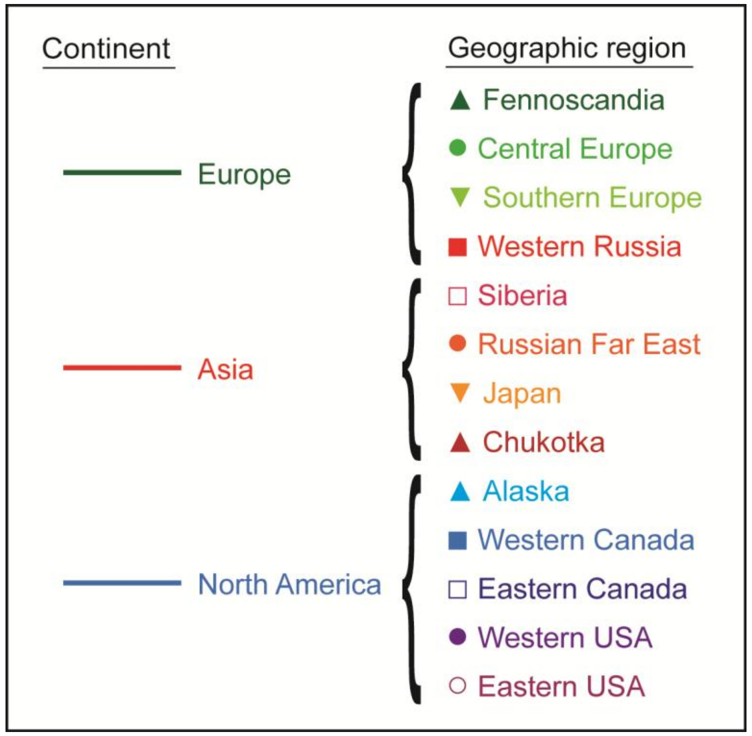
Phylogeny of sawfly gallers by **Dr. Tommi Nyman** (Japanese species included)

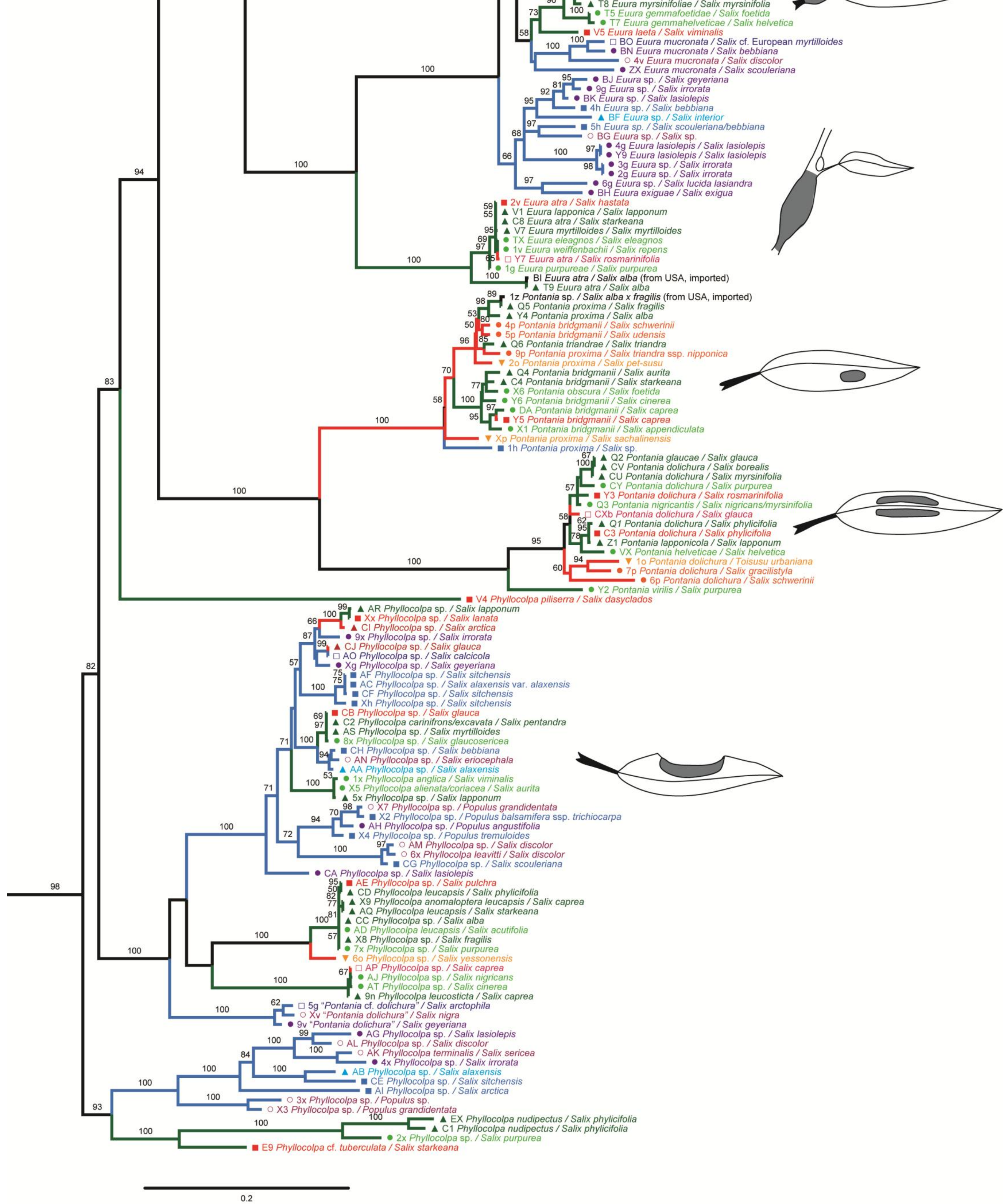
- Well-supported mtDNA ML phylogeny
- 247 specimens → beware of small font sizes!





Geographic distribution is labile!

→ multiple shifts among continents (Europe, Asia, North America), but also long-range dispersals within continents



The role of spatial variation in plant traits for herbivore community dynamics

Shunsuke Utsumi

THE UNIVERSITY OF TOKYO

Salix system in Finland

Joensuu, Finland
Common garden experiment

[Host plant]
Salix phylicifolia

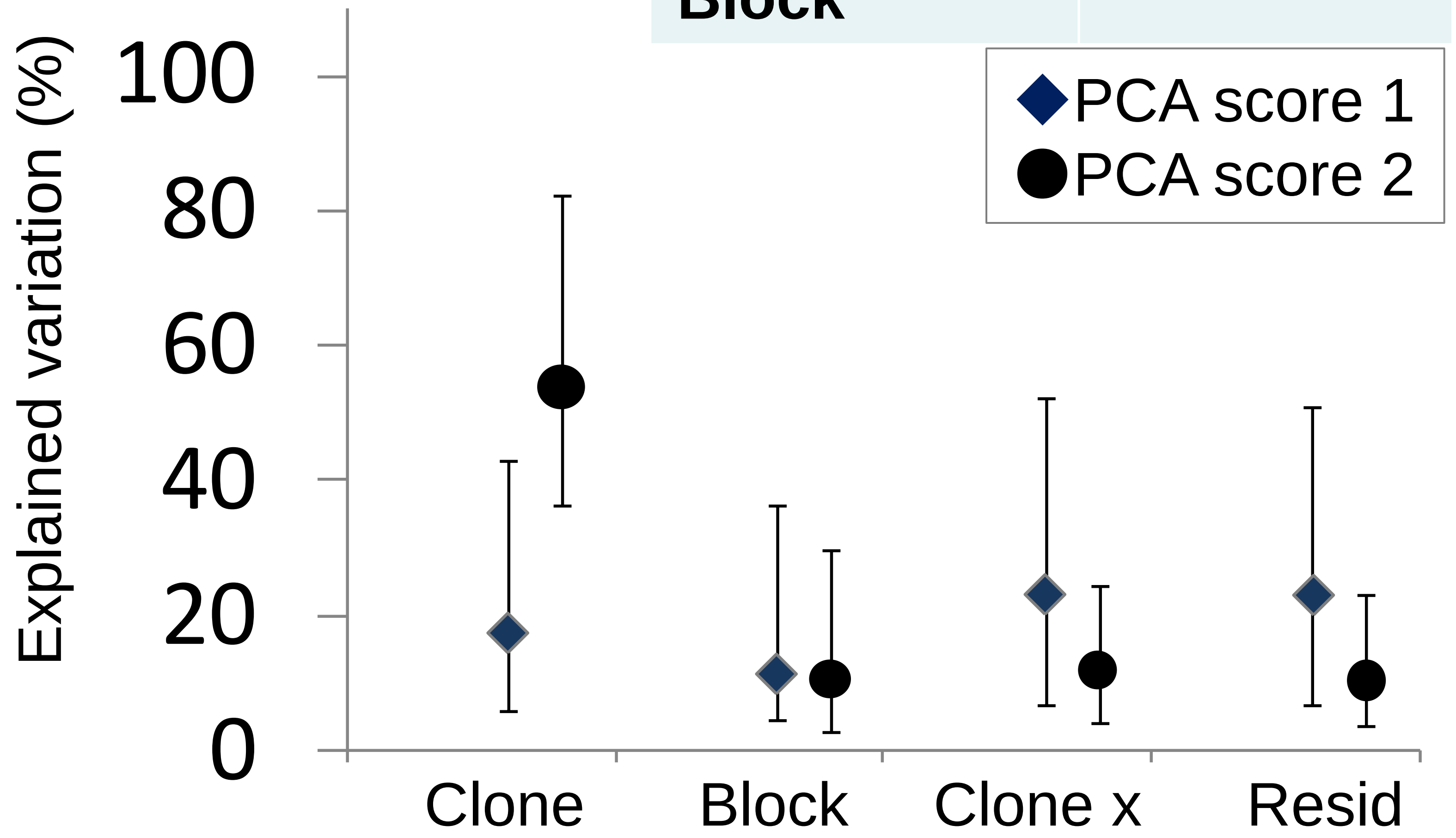
12 clone types from a natural population
Randomized block design

Phenolics compounds composition

Permutation MANOVA

Source	*P*
Clone (CL)	< 0.001
Block (BL)	< 0.001
Clone X Block	< 0.001

Variation partitioning



Error bar = 95% highest posterior density interval

Clone effects dominate phenolics compounds

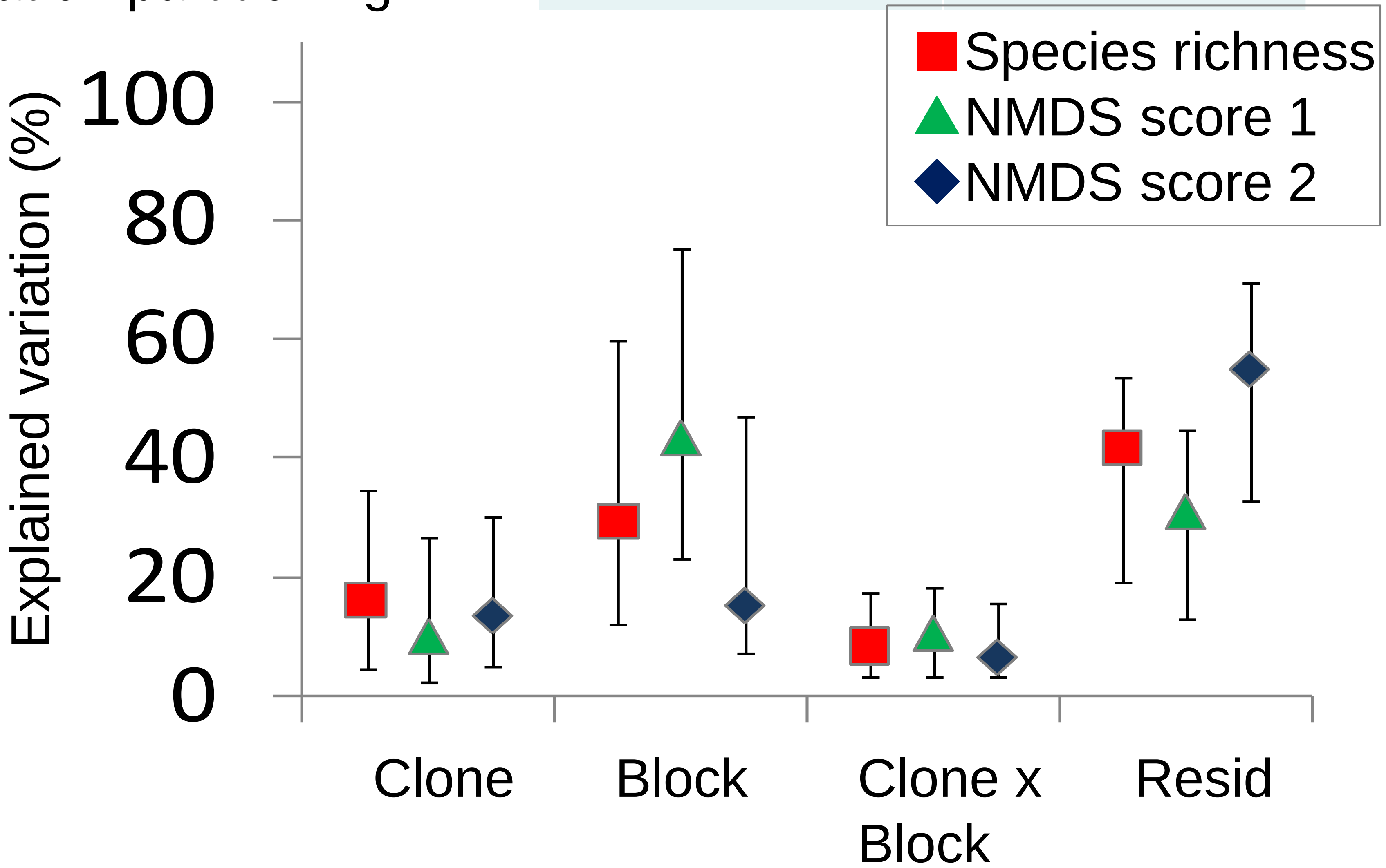
Utsumi *et al*. (in prep)

Herbivore community structure

Permutation MANOVA

Source	*P*
Clone	< 0.001
Block	< 0.001
Clone X Block	< 0.05

Variation partitioning

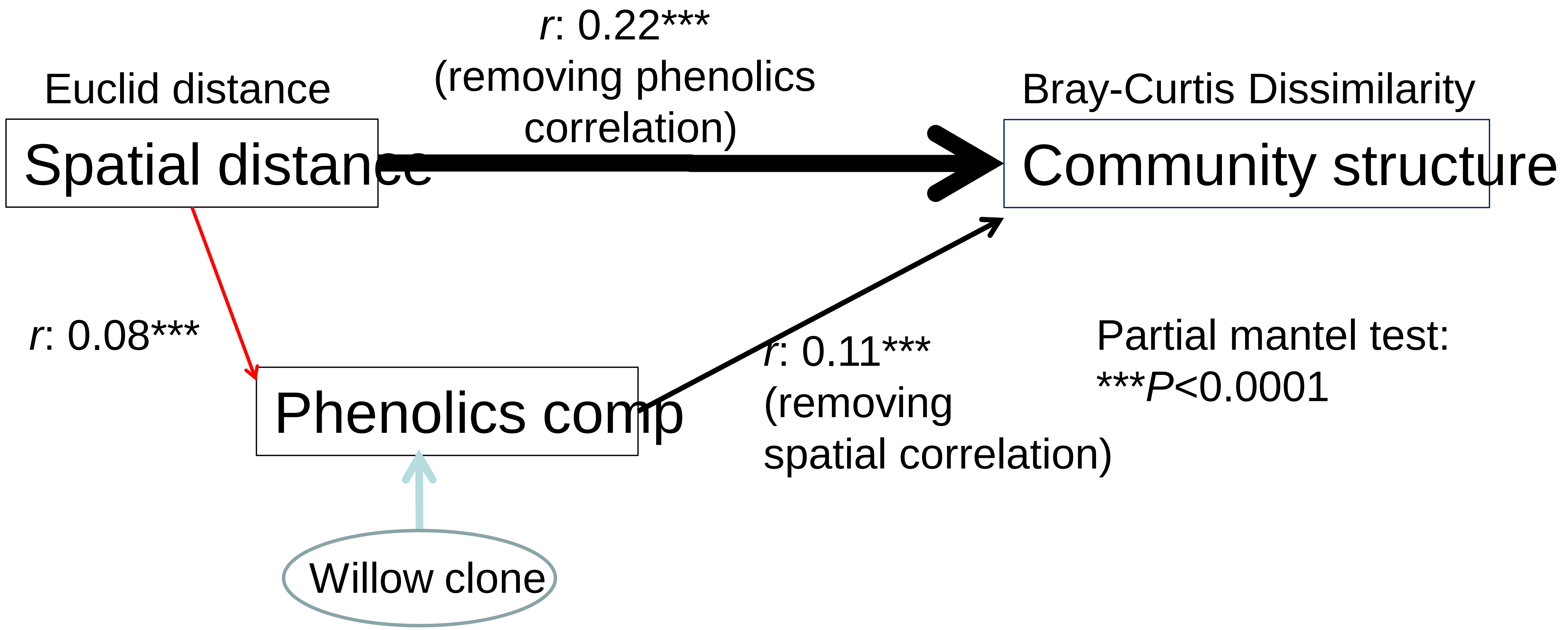


Error bar = 95% highest posterior density interval

Clone effect explained small fraction and large residuals remained.

Utsumi *et al*. (in prep)

Direct spatial effect on community was likely to be stronger than clone effect. Spatial effect on phenolics was very weak.



It means…

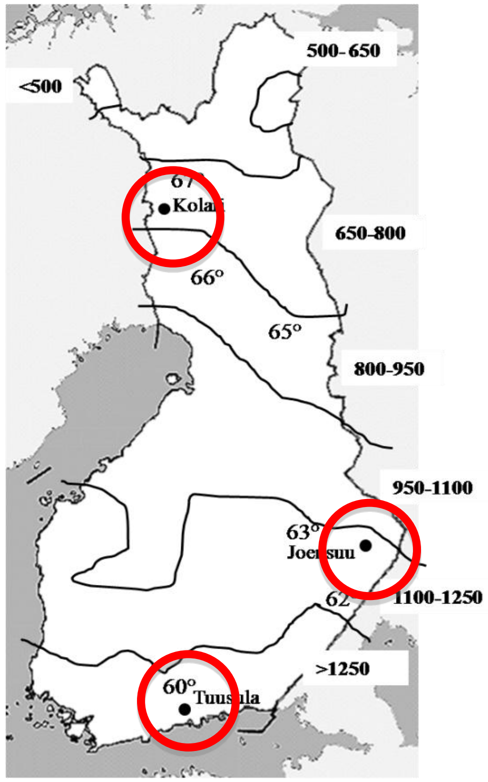
Not only genetic effect of host plant but also dispersal effects (e.g., source-sink dynamics) is important even within a small spatial scale

Utsumi *et al*. (in prep)

Possible future research of “common organisms” in different environmental conditions

- Study questions in the common systems
  - Willows and sawfly gallers
  - Birches (*Betula* sp.) and there leaf feeding herbivores

- Study question: e.g. Climate change
  - 1) latitudinal transplantation experiments
    - done with birches in Finland
  - 2) elevational transplantation experiments
    - There are excellent possibiities for this in Japan



Quantitative food web approach is important

- Host plant density, herbivore density (gallers), and parasitoids and other mortality factors
  - This kind of data is practically impossible to get in other that galler and miner communities (which are living microcosmos)

→→ Observational and/or experimental studies on human induced changes in ecosystems

- How are the food webs changed and how well they work after or under disturbances?
  - E.g. Global warming, forest management, forest fragmentation or side effects of agriculture, etc.