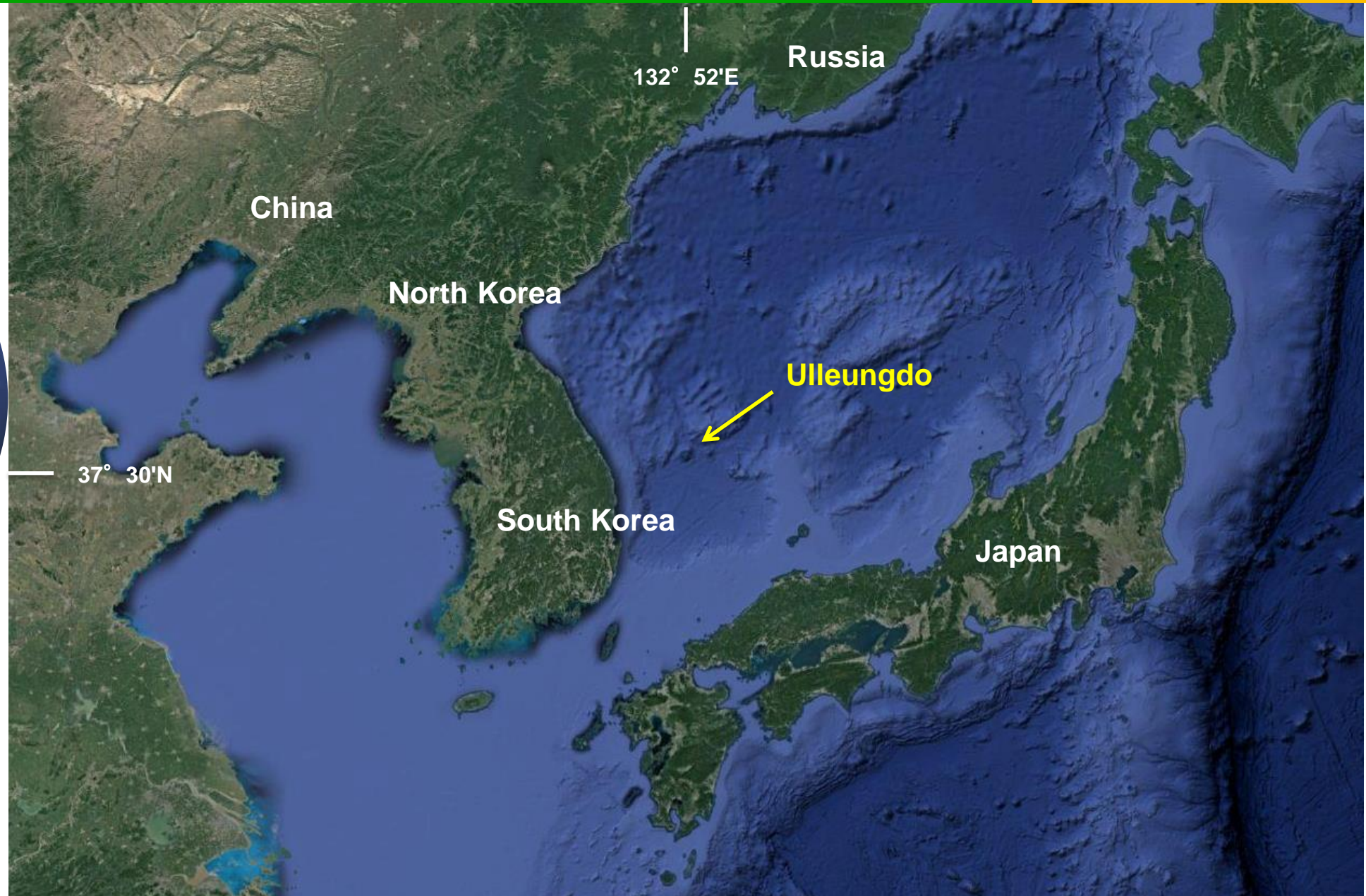


# Biodiversity analysis from soil eDNA on Ulleungdo Island, an oceanic island in Korea

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# Ulleungdo Island, a volcanic island



# Flora of Ulleungdo Island



- The island is very small (73 km<sup>2</sup>) and geologically young (1.8 MYBP).
- About **500 species** of vascular plants are distributed.
- Biodiversity hotspot: ca. **40 species** are **endemic** to the island.
- Endemic species are phylogenetically diverse:  
**36 genera** in 26 families

# Endemic species of Ulleungdo Island



*Anemone maxima*



*Berberis amurensis* var. *latifolia*



*Fagus multinervis*



*Saxifraga fortunei* var. *pilosissima*



*Phytolacca insularis*



*Tilia insularis*



*Viola woosanensis*



*Acer takesimense*



*Salix ishidoyana*



*Arabis takesimana*



*Phedimus takesimensis*



*Acer okamotoanum*

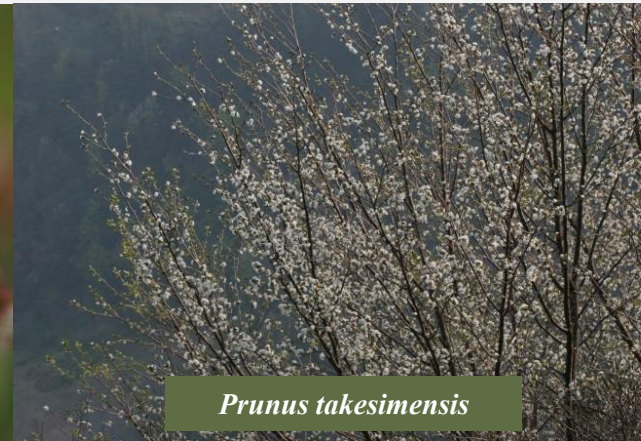
# Endemic species of Ulleungdo Island



*Spiraea insularis*



*Cotoneaster wilsonii*



*Prunus takesimensis*



*Rubus takesimensis*



*Bupleurum latissimum*



*Dystaenia takesimana*



*Lamium takesimense*



*Thymus magnus*



*Ligustrum foliosum*



*Syringa venosa*



*Pseudolysimachion insulare*



*Scrophularia takesimensis*

# Endemic species of Ulleungdo Island



*Adenophora erecta*



*Campanula takesimana*



*Lonicera insularis*



*Sambucus sieboldiana* var. *pendula*



*Valeriana dageletiana*



*Aster chusanensis*



*Aster pseudoglehnii*



*Dendranthema zawadskii*  
var. *lucidum*



*Arisaema takesimense*



*Carex blepharicarpa* var. *stenocarpa*



*Poa takeshimana*



*Allium ulleungense*

# Questions

- To understand the **historical changes** of plant distribution on Ulleungdo
- Has the **vegetation** (ecosystem) remained unchanged since its origin at 1.8 MYBP?
- **When** did the current vegetation form?
- Do **soil eDNA** tools recover the flora in the temperate region?

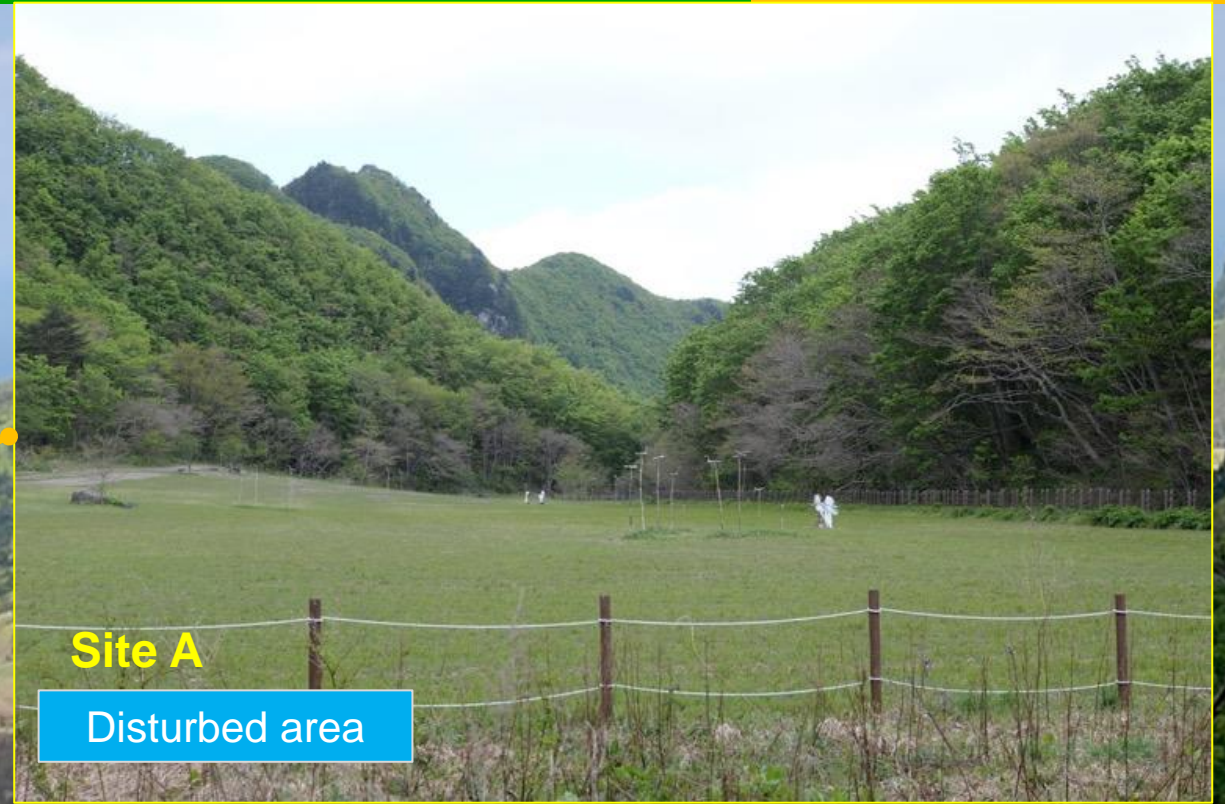
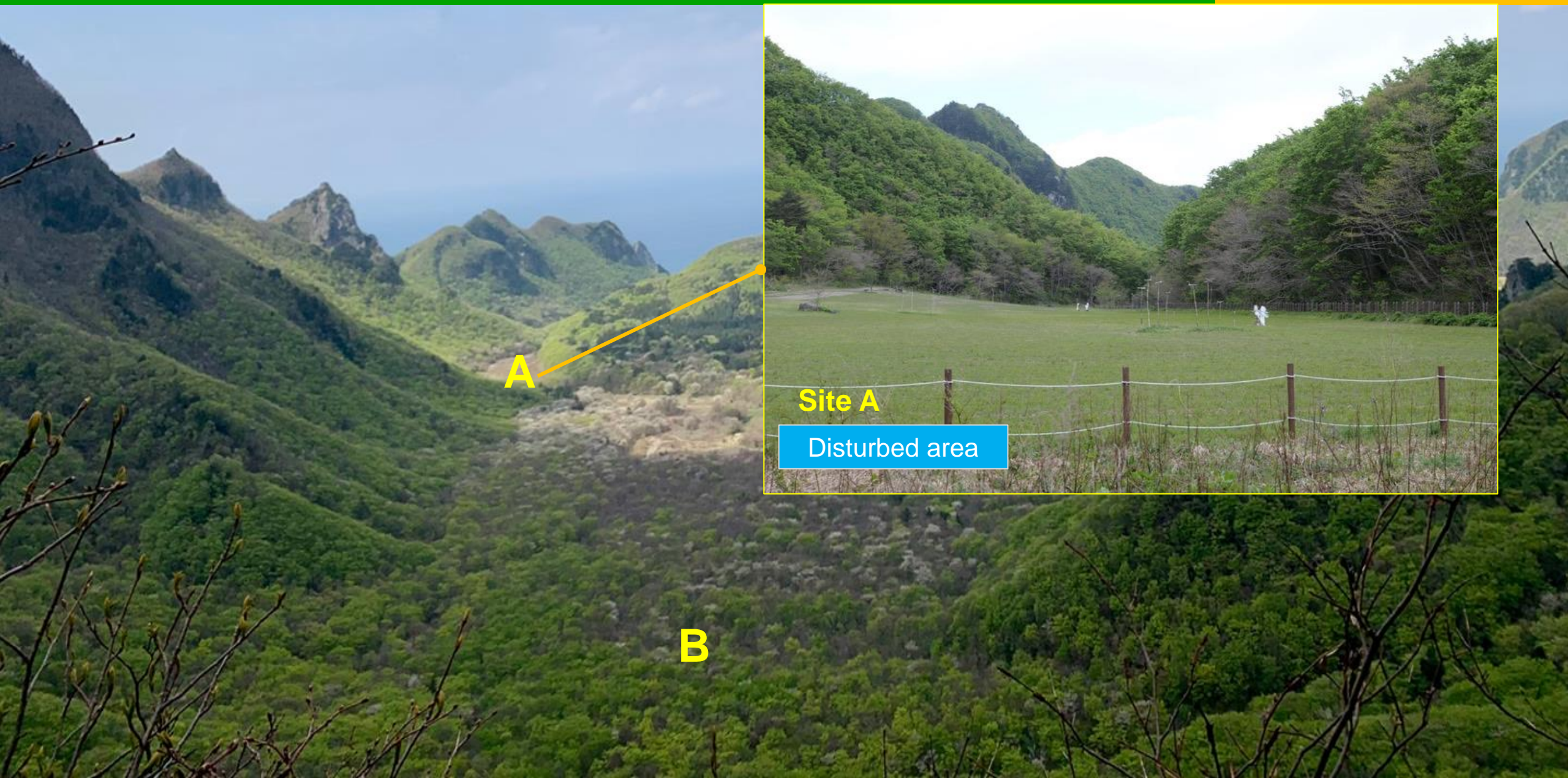
# Why Ulleungdo Island?

- **The flora of Ulleungdo is well-studied.**
- **It has many unique plant species.**
- **The island is volcanic and isolated since its origin.**
- **Most plant genera on Ulleungdo have one species.**

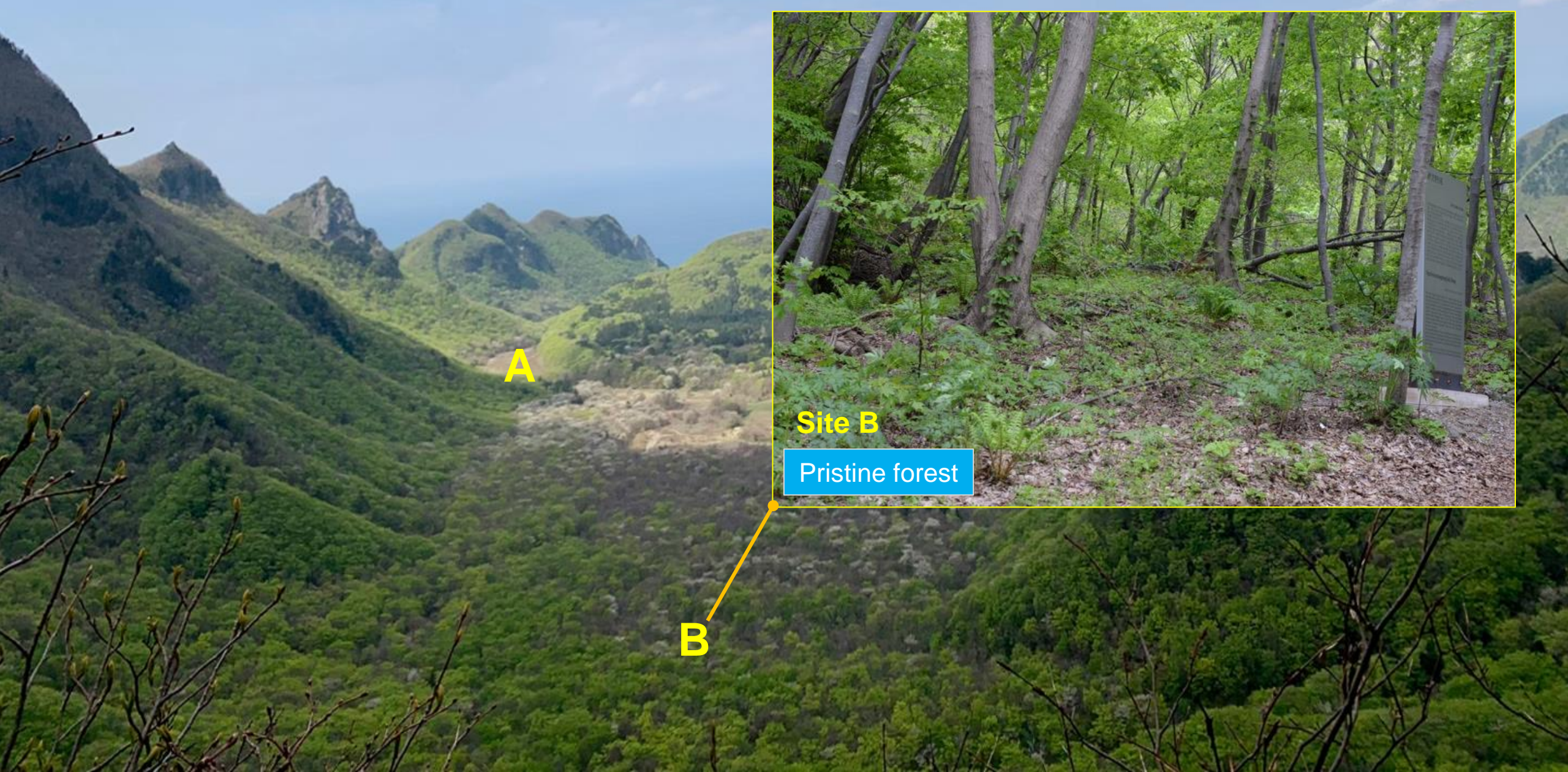
# Study sites: “Nari Basin”, caldera, 350 m in elev.



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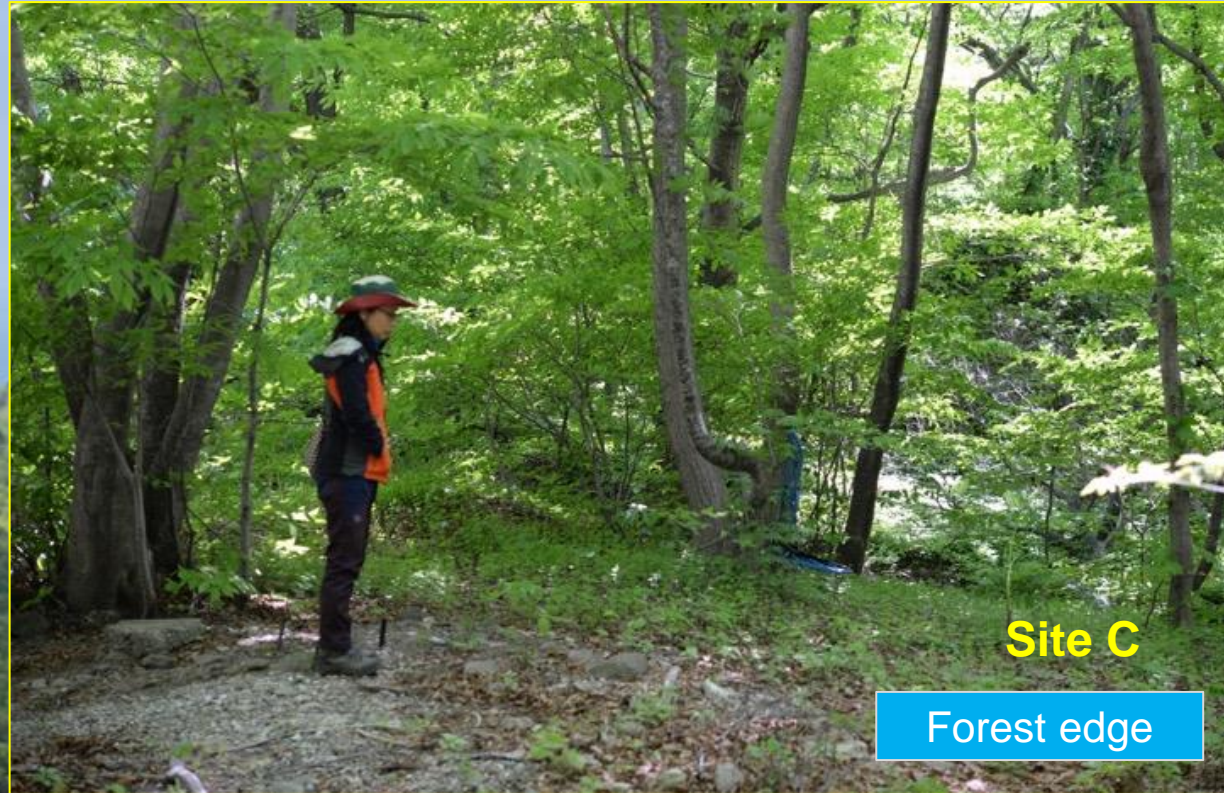
A

B

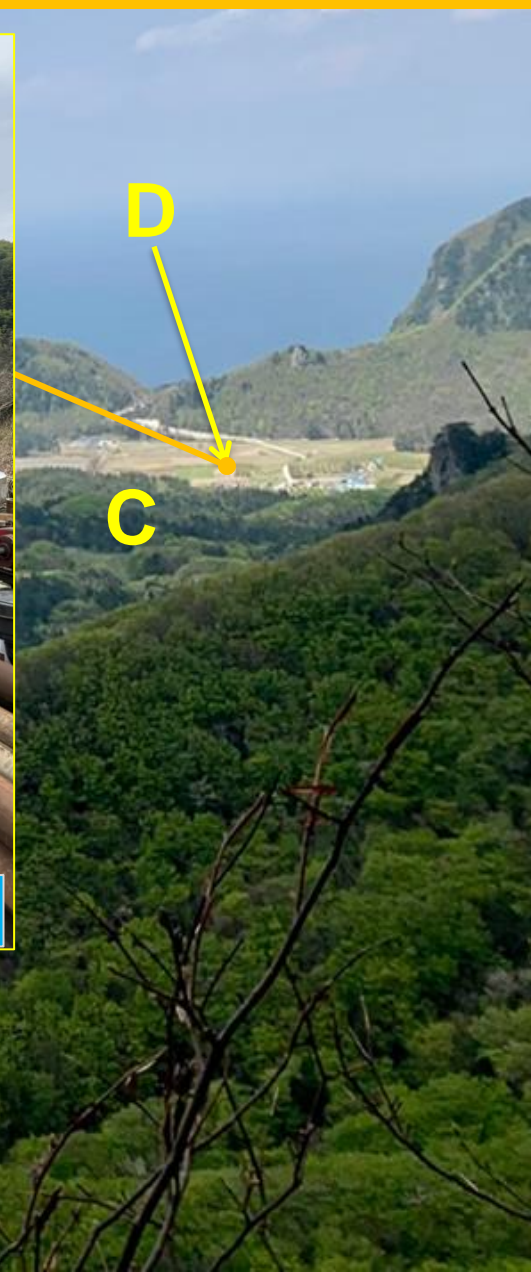
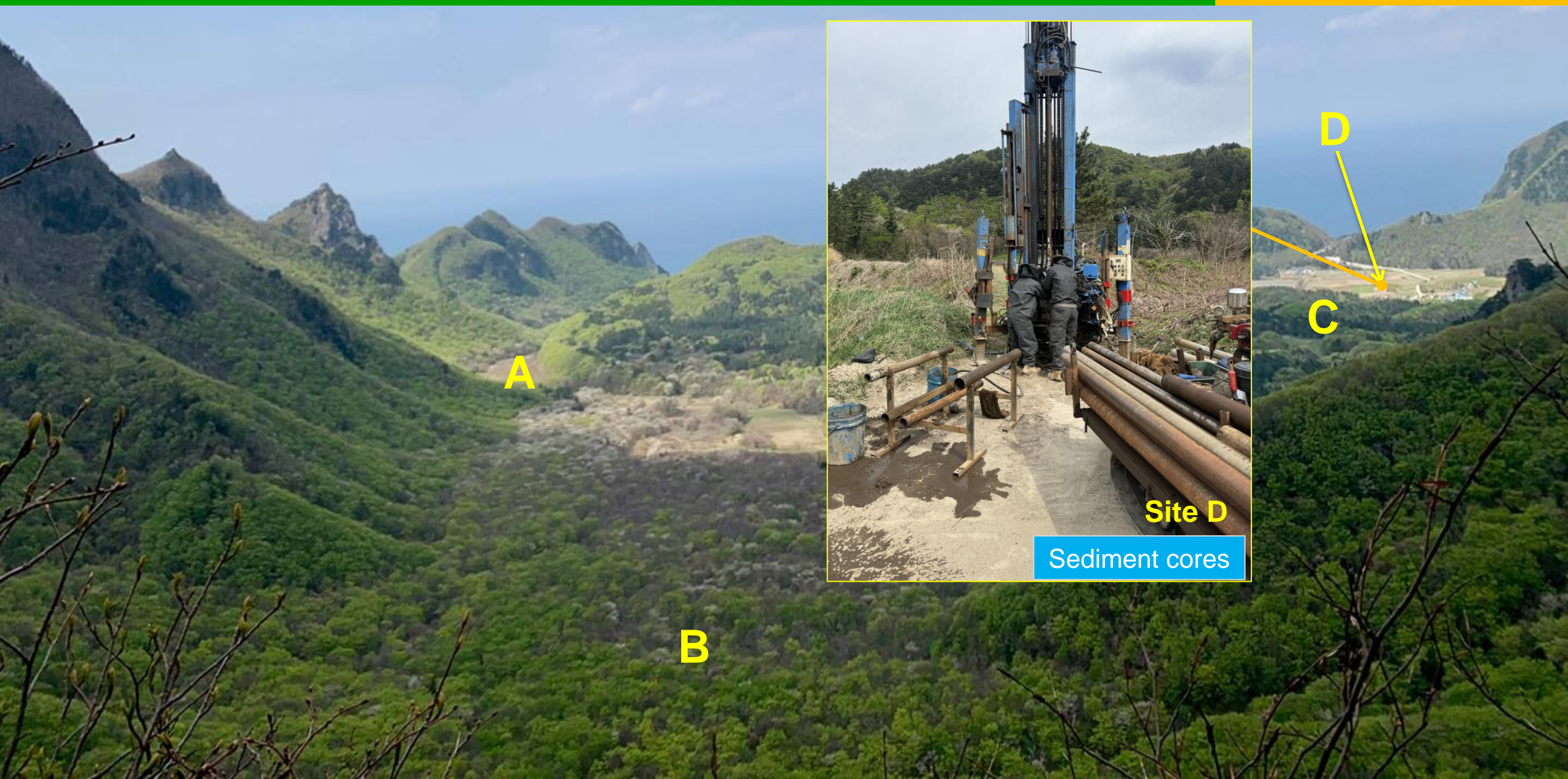
Site B

Pristine forest

# Study site: Nari Basin, caldera, 350 m in elev.



# Study site: Nari Basin, caldera, 350 m in elev.



# Materials & Methods



Soil samples

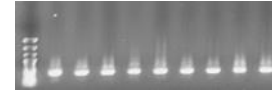
Site A, B, C:  
top soil



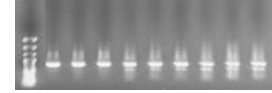
DNA isolation



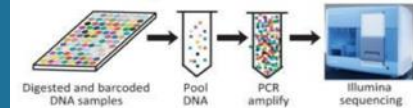
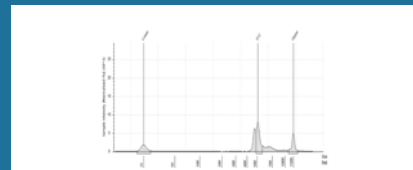
ITS2



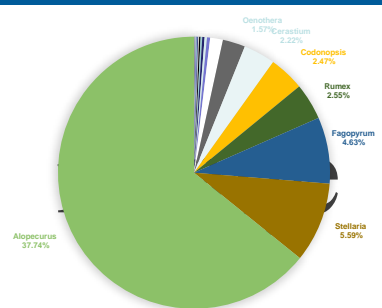
*rbcL*



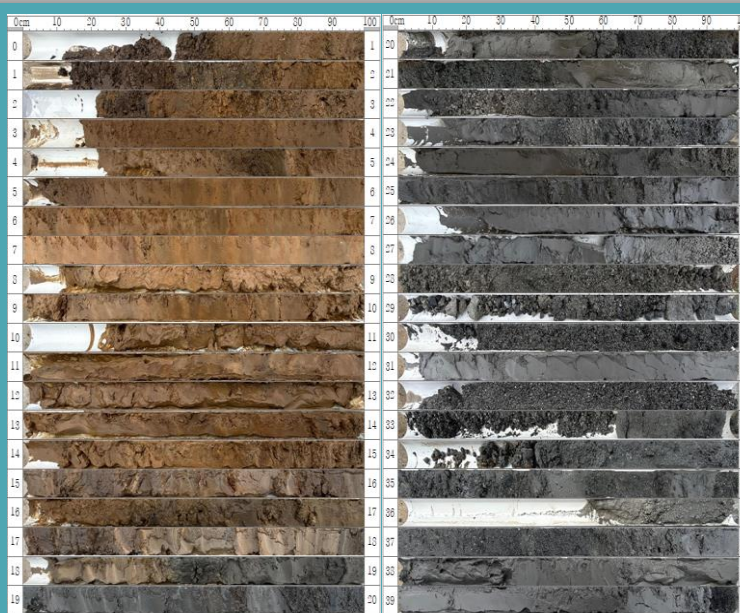
PCR



Illumina Mi-seq



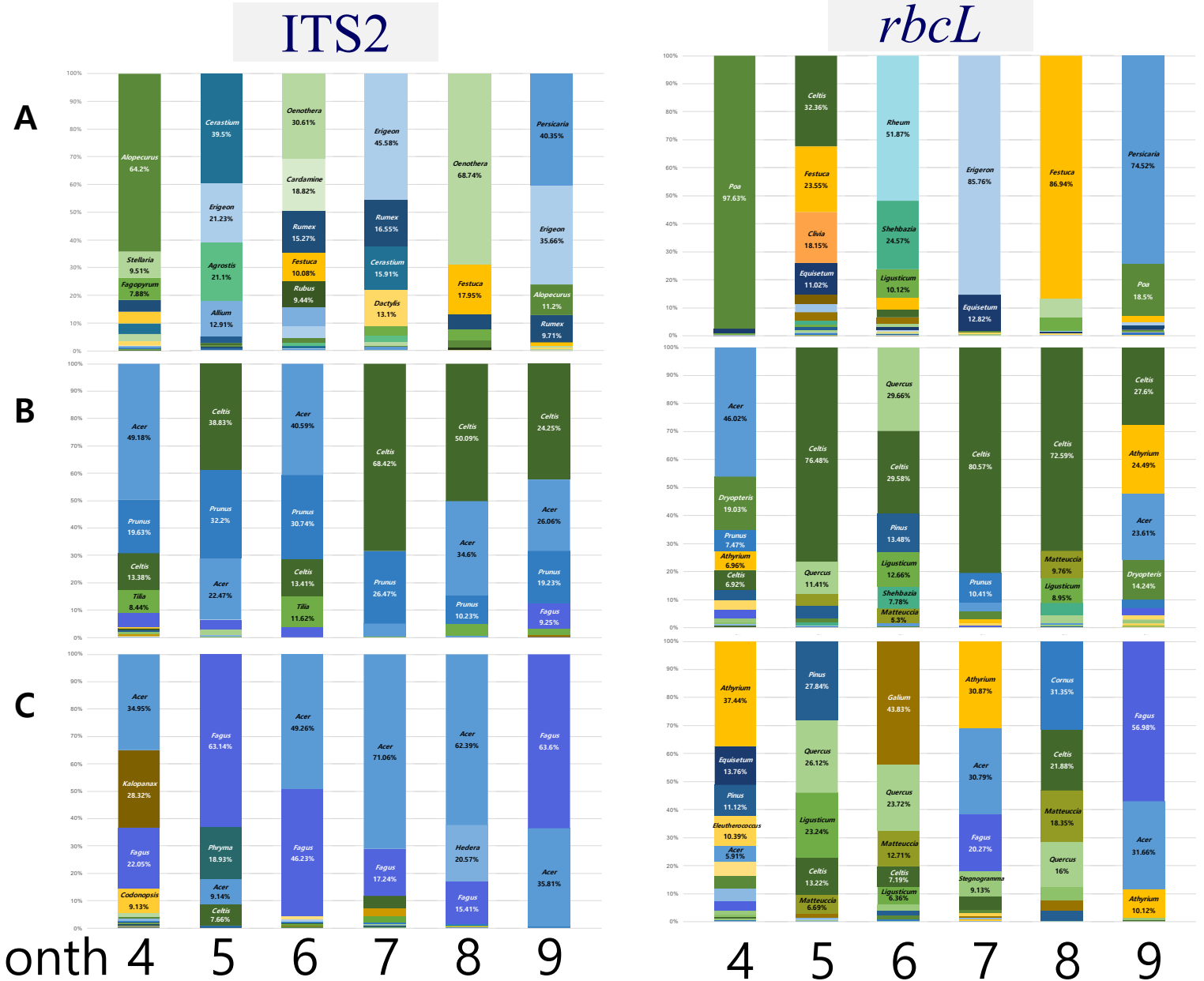
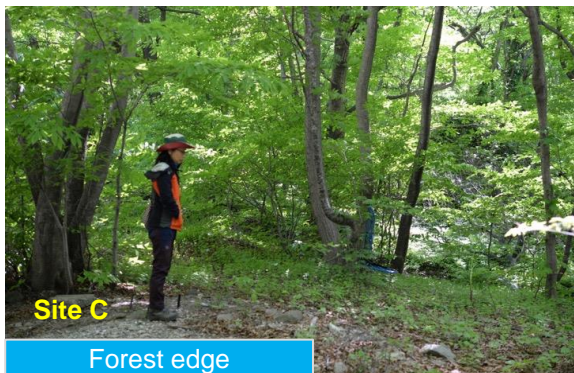
Amplicon Sequence  
Variants (ASV) analysis



Soil samples

Site D: soil core

# Results of top soil eDNA



# Results of top soil eDNA



Disturbed  
area



*Alopecurus*



*Conyza*



*Dactylis*



*Rumex*



Pristine  
forest



*Fagus*



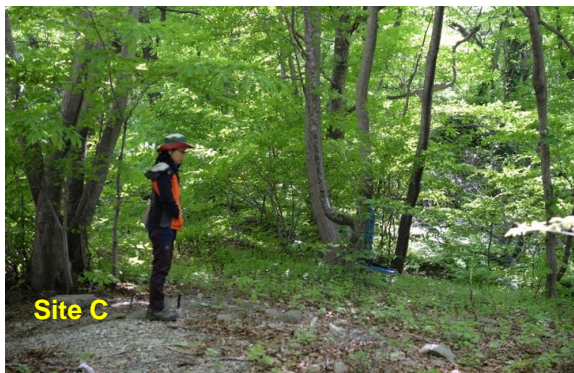
*Celtis*



*Prunus*



*Acer*



Forest  
edge



*Equisetum*



*Athyrium*



*Asperula*



*Acer*

# Summary of top soil eDNA analysis

## ITS (nuclear gene) & *rbcL* (chloroplast gene)

- ITS: recover dominant species of angiosperms
- *rbcL*: additionally detect various species with herbs and ferns.

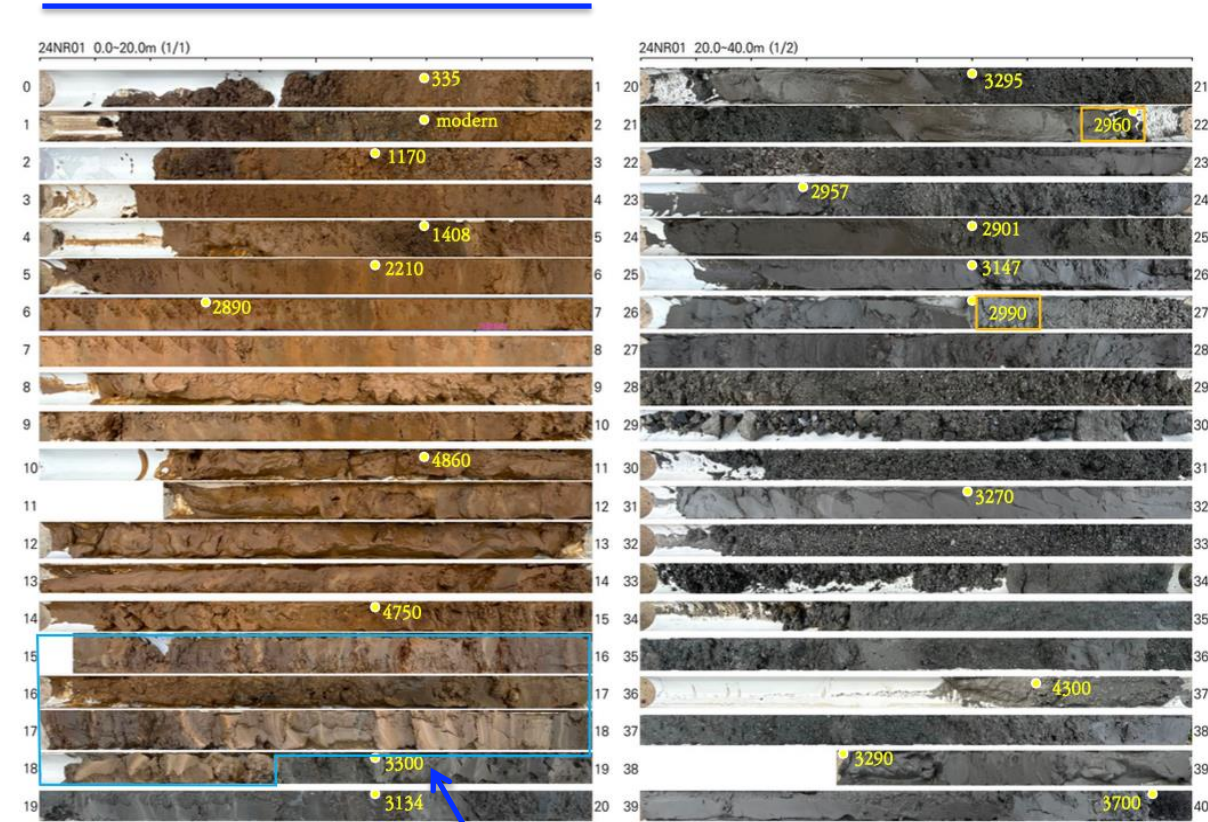
## Sites A, B, C

- Results of ASV from soil eDNA reflect the vegetation types.
- ASVs are consistent with local flora on Ulleungdo.
- Combination of ITS and *rbcL* is a powerful tool for uncovering plant biodiversity.

# Results of soil cores: site D

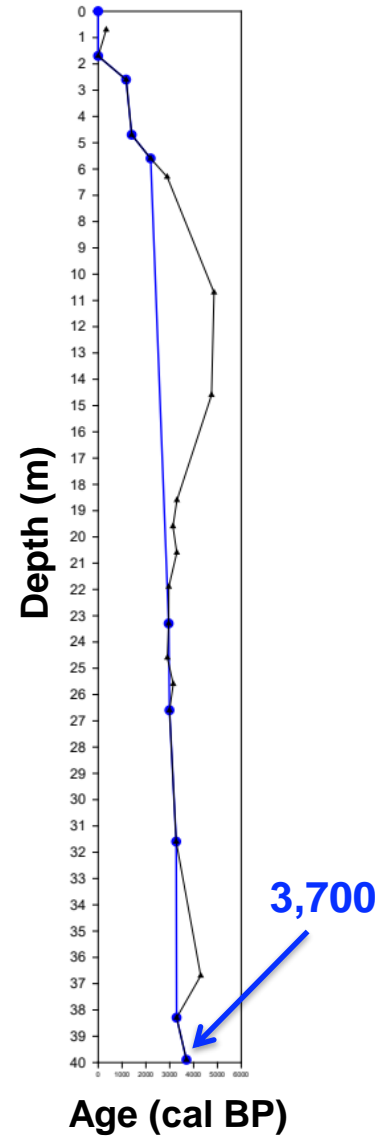
40 sediment cores, 3 samples/core

1 m

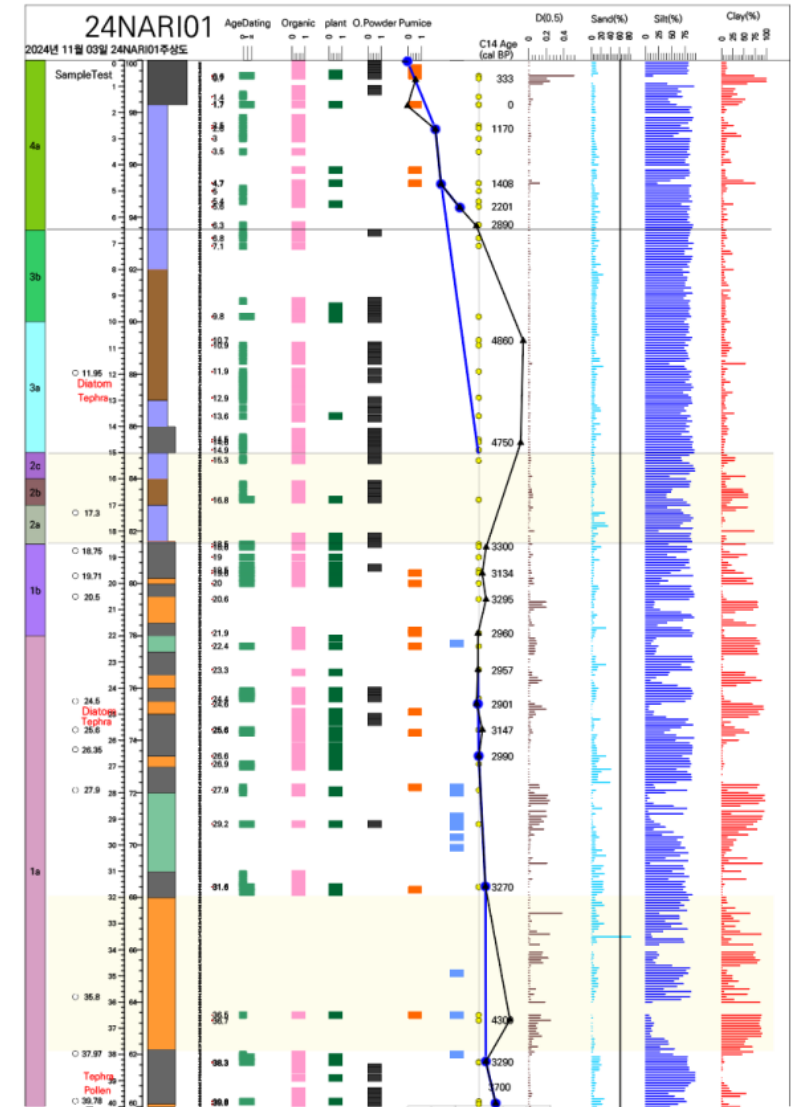


Samples for dating

$^{14}\text{C}$  dating

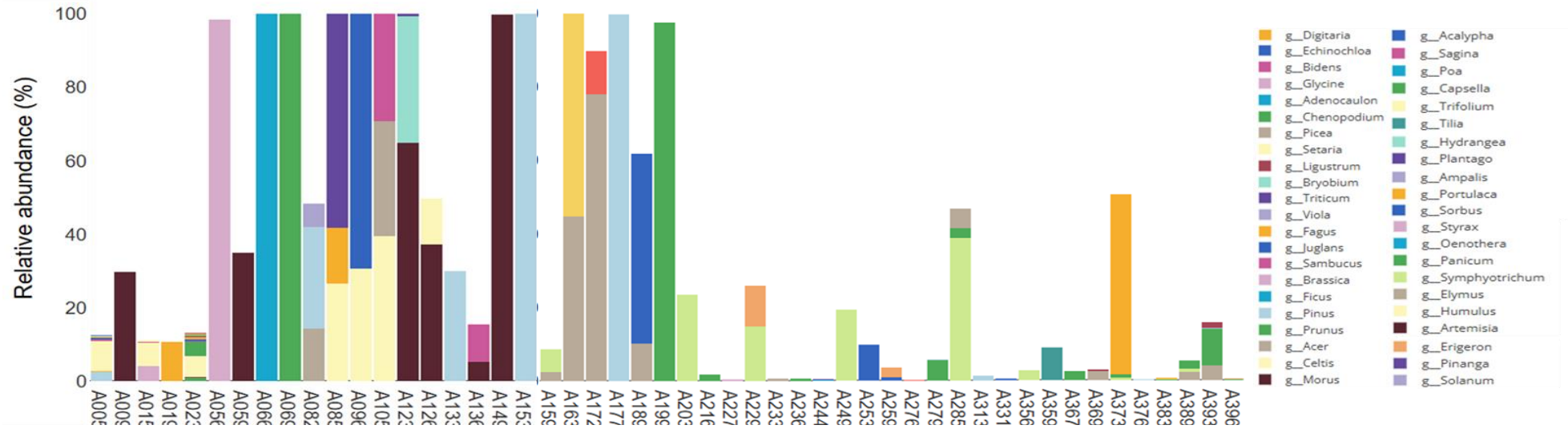


Geologic profile

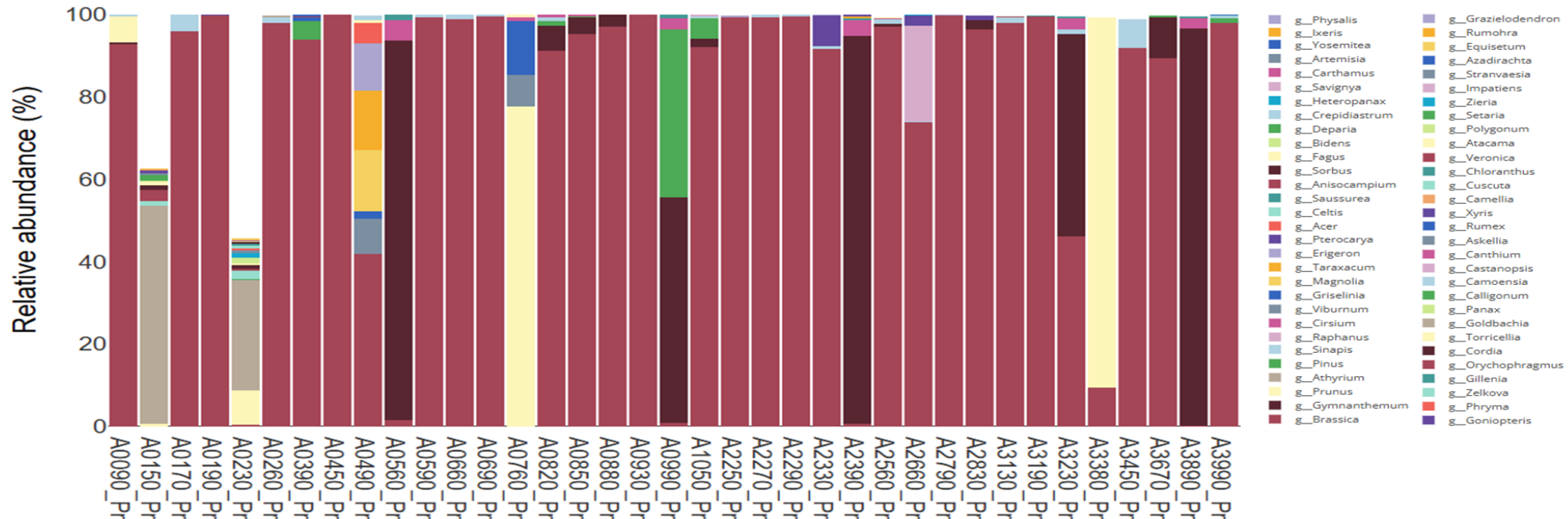


# Results of the sediment eDNA: site D

ITS



rbcl



# Pollen and spores of sediments soil core

PLATE 11

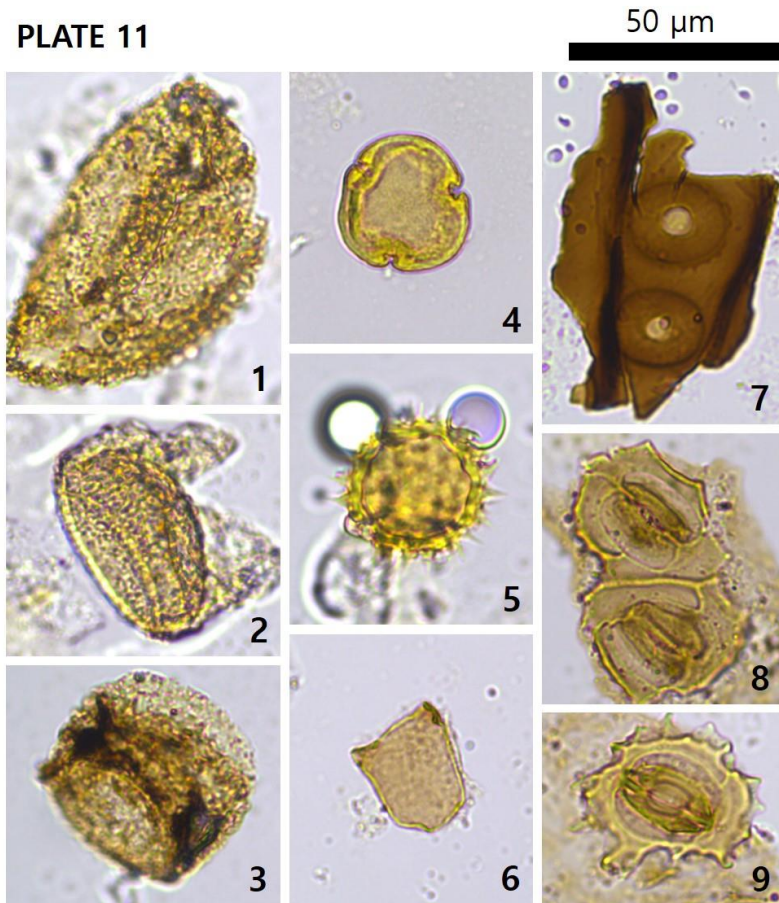


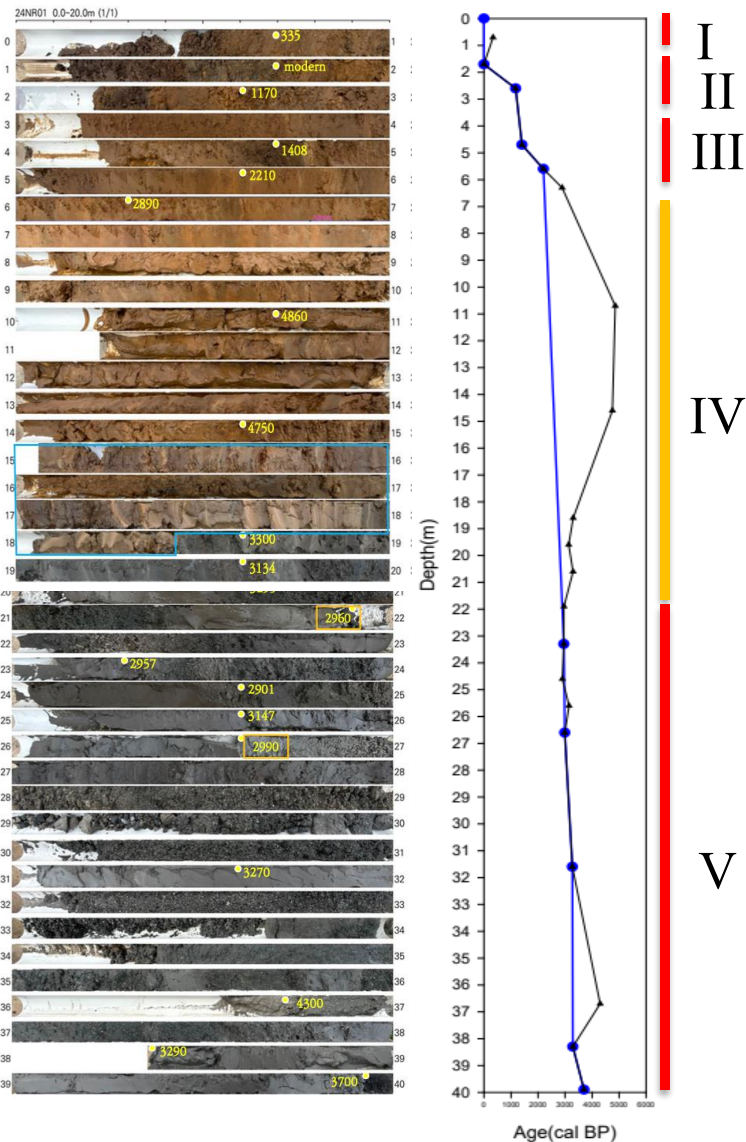
PLATE 1



PLATE 3

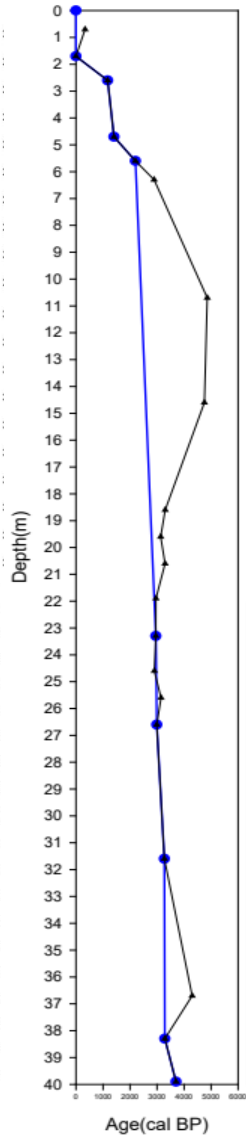
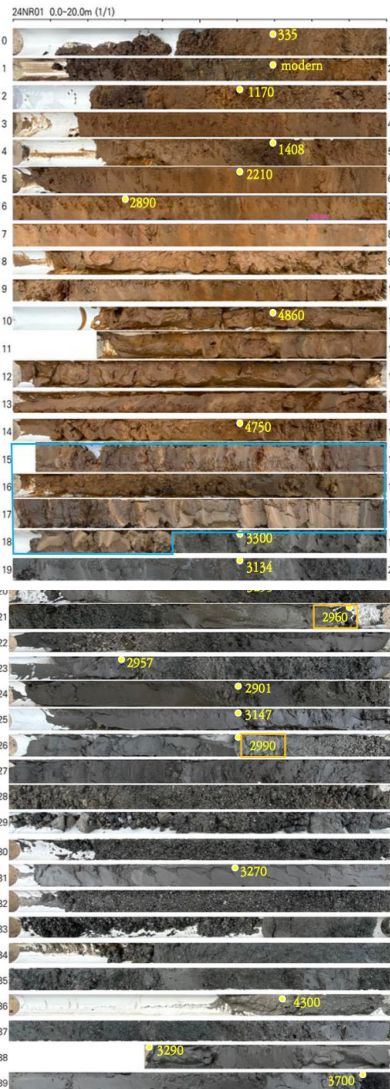


# Ecosystem and human activities in Nari Basin



Stage	Age (yrs BP)	Major plant species	Ecosystem
I	modern	<i>Pinus, Fagus, Prunus, Morus, Bidens, Chenopodium, Erigeron</i>	Natural forest & farmland
II	0-1170	<i>Pinus, Fagus, Prunus, Sorbus, Elymus, Artemisia, Bidens</i>	Increase of farmland & opportunist species
III	1300-2200	<i>Pinus, Fagus, Prunus, Morus, Viburnum, Cirsium, Rumex, Taraxacum</i>	Mixed forest & open grassland
IV	2900-4860	<i>Pinus, Fagus, Prunus, Morus, Solanum, algal spores</i>	Abruptly accumulated unusual layer
V	2950-3700	<i>Pinus, Fagus, Prunus, Morus, Avena, Glycine, Triticum</i>	Forest & early cultivation

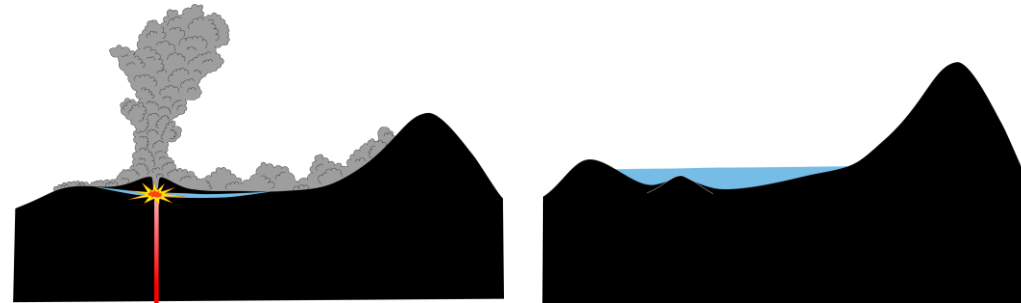
# Geological changes in Nari Basin



I  
II  
III



IV



V



# Ecosystem and human activities in Nari Basin

## Mulberry (*Morus*)

Planted near houses for food



## Archeological records

The earliest archeological evidence suggests that Ulleungdo Island was inhabited ca. 2,300 years ago.

Stage	Age (yrs BP)	Major plant species	Ecosystem
I	modern	<i>Pinus</i> , <i>Fagus</i> , <i>Prunus</i> , <i>Morus</i> , <i>Bidens</i> , <i>Chenopodium</i> , <i>Erigeron</i>	Natural forest & farmland
II	0-1170	<i>Pinus</i> , <i>Fagus</i> , <i>Prunus</i> , <i>Sorbus</i> , <i>Elymus</i> , <i>Artemisia</i> , <i>Bidens</i>	Increase of farmland & opportunist species
III	1300-2200	<i>Pinus</i> , <i>Fagus</i> , <i>Prunus</i> , <i>Morus</i> , <i>Viburnum</i> , <i>Cirsium</i> , <i>Rumex</i> , <i>Taraxacum</i>	Mixed forest & open grassland
IV	2900-4860	<i>Pinus</i> , <i>Fagus</i> , <i>Prunus</i> , <i>Morus</i> , <i>Solanum</i> , algal spores	Abruptly accumulated unusual layer
V	2950-3700	<i>Pinus</i> , <i>Fagus</i> , <i>Prunus</i> , <i>Morus</i> , <i>Avena</i> , <i>Glycine</i> , <i>Triticum</i>	Forest & early cultivation

# Summary of soil core eDNA analysis

## Recovering the past vegetation in a temperate region

- Vegetation has remained unchanged during the past 3,700 years.
- Early human activities, corresponding to the Bronze Age
- Volcanic activities and/or lake formation in 2,900-4,860 years ago.
- Further studies are needed for deeper sediments.

# Thank you

Soo-Yeon Kim  
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National Research Foundation, Korea

