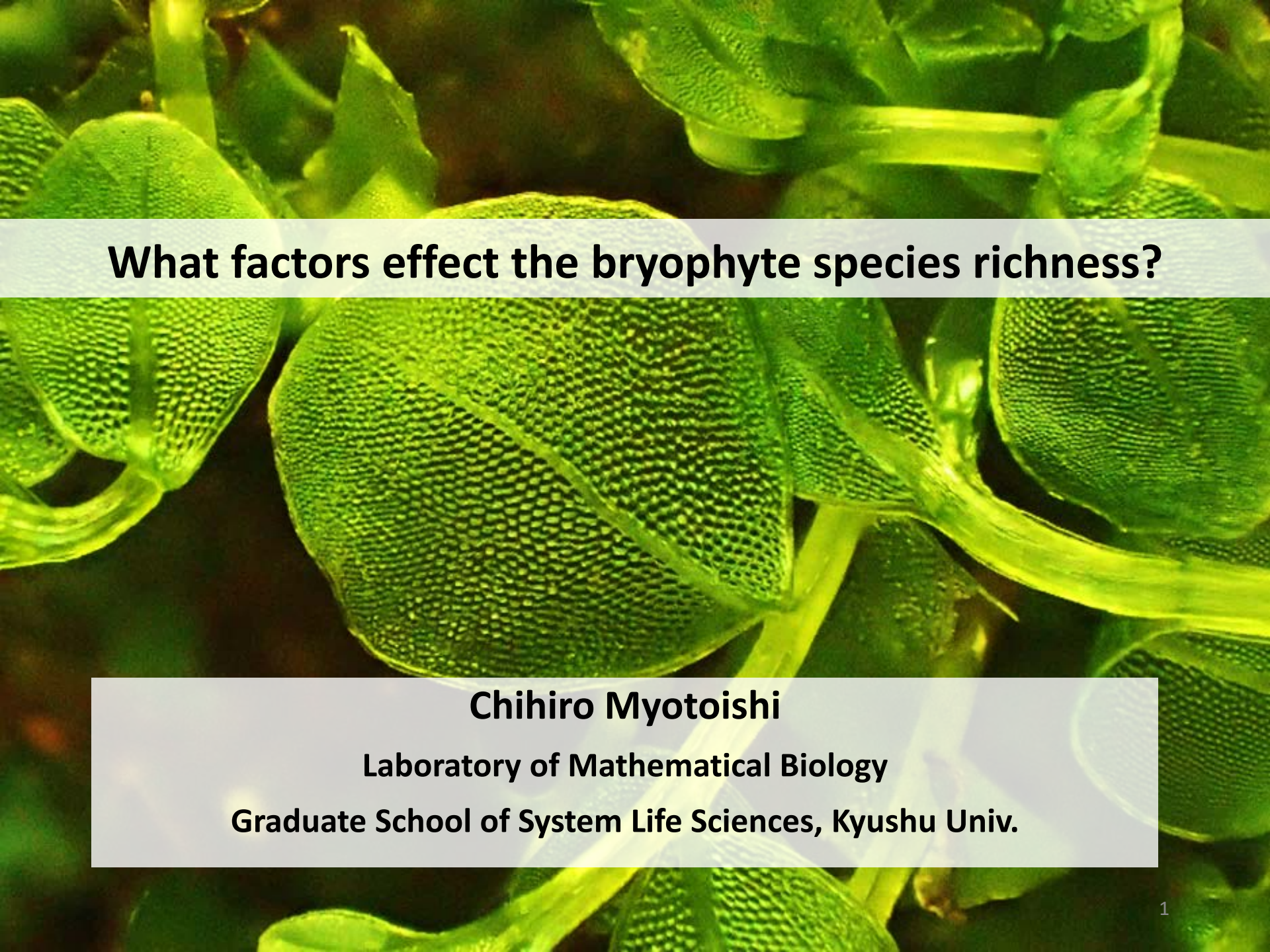

What factors effect the bryophyte species richness?

Chihiro Myotoishi

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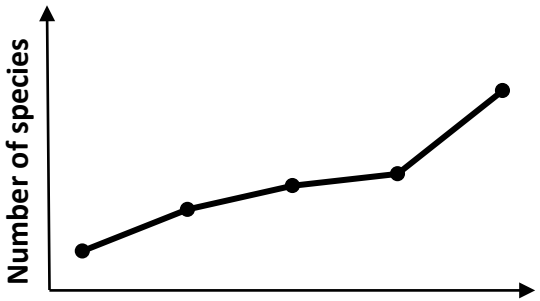
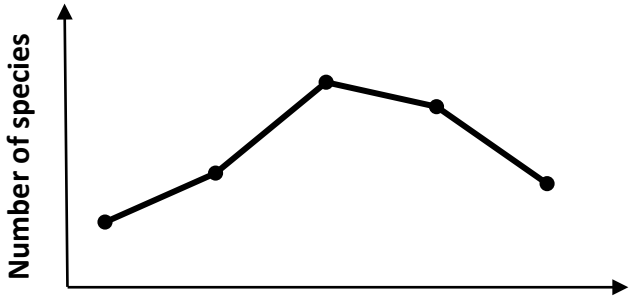
The factors determining bryophyte species richness

Elevation



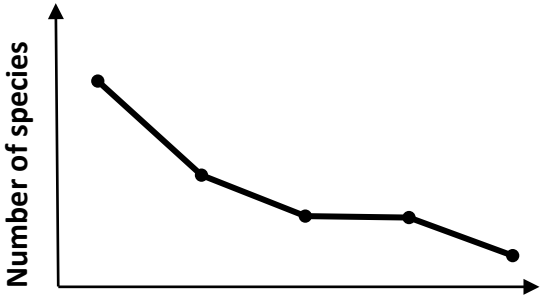
increases with elevation

(Ah-Peng et al. 2007, Song et al. 2015)



maximum at intermediate elevations

(Coelho et al. 2021)



decreases with elevation

(Gradstein & Culmsee 2010)

Substrate

A greater number of substrate types was associated with a higher species richness of bryophytes

(Pharo et al. 2004; Lohmas et al. 2007)

Rock

Living tree

Decayed tree

Soil

leaf

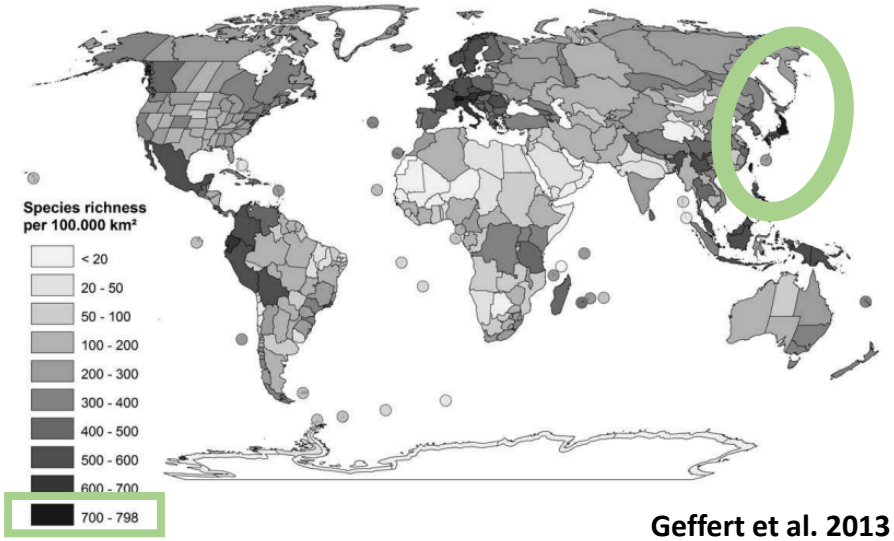
Water availability

habitats along streams are known to be rich in bryophyte

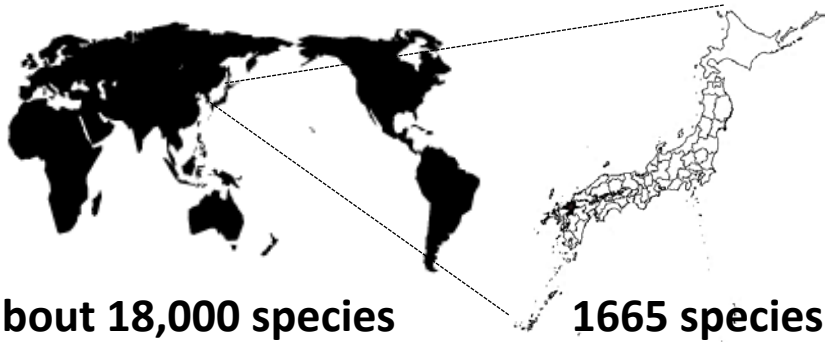
(Hylander & Dynesius 2006; Belland & Schofield 1994; Heinlen & Vitt 2003)

Japan is one of the greatest bryophyte's hotspots in the world

(Geffert et al. 2013; Patino & Vanderpoorten 2018; Iwatsuki 2004; Yamada &Iwatsuki 2006)



Geffert et al. 2013



about 18,000 species
(Fujii & Akiyama 2017)

1665 species
(Iwatsuki 2001)

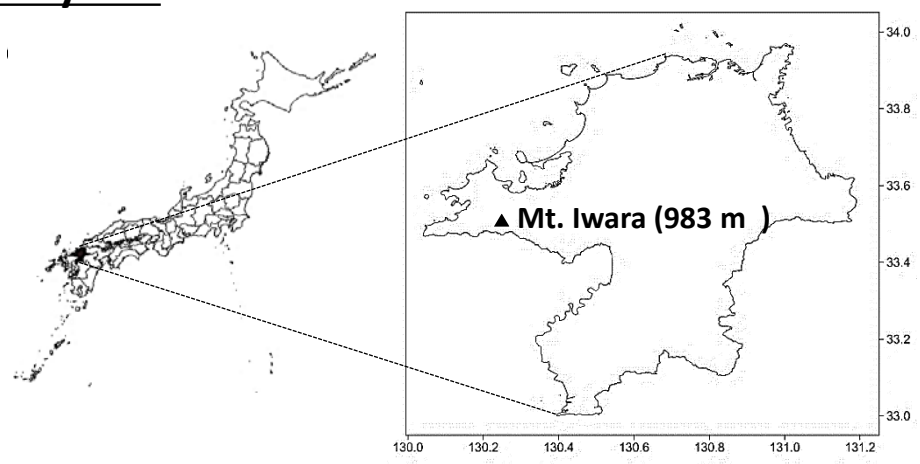
There is little study in Japan about the relationship between species richness and elevation, substrates, water availability, and other environmental factors

Question of this study

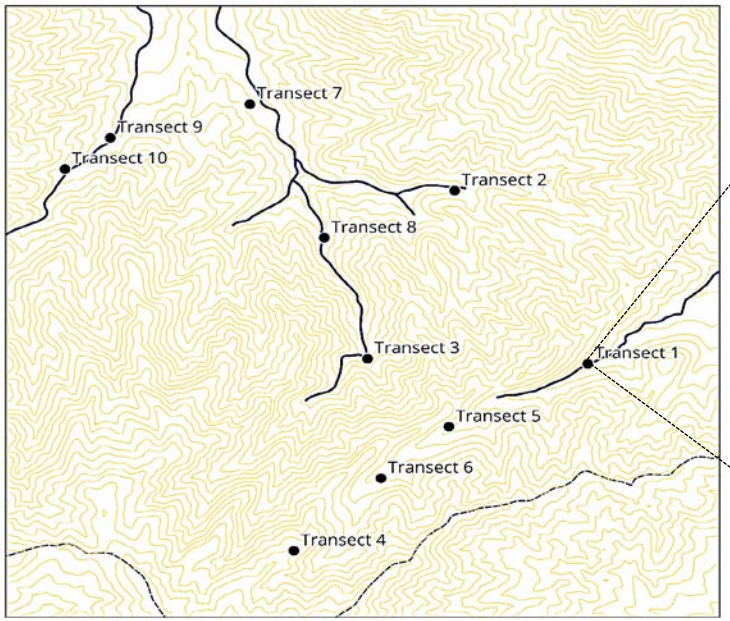
How bryophyte species richness changes with elevation, substrate, and water availability In Japan ?

Study site

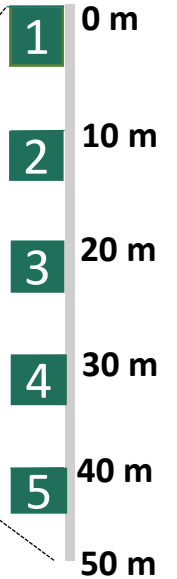
Study site



10 transects with different elevation (268 – 869 m)



1 transect
5 quadrats



quadrat size : 2m x 2m

Filed survey

Date : March 20th - November 16th, 2020

recording data in each quadrat

- elevation
- bryophyte species' name
- substrate (what's bryophyte growing on)
- taking picture of each quadrat

5 substrates

rock

living tree

decayed tree

soil

leaf

the number of living tree

the height of rock

relative area of water surface and rock (Water availability)

2 pattern multiple regression analysis

1. Which factors effects on bryophyte species richness?

Objective variable 1

the number of bryophyte species

$$y = b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

- X_1: elevation
- X_2: the number of living tree
- X_3: the relative water surface area
- X_4: the relative rock area
- X_5: height of rock

Explanatory variables

2. Which factors effects on bryophyte species richness of each substrate type species?

Objective variable 2

the number of species growing on rock, living tree, decayed tree, soil, leaves

$$y = b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

- X_1: elevation
- X_2: the number of living tree
- X_3: the relative water surface area
- X_4: the relative rock area
- X_5: height of rock

The number of living tree effects on bryophyte species richness

10-transect dataset (50 m scale)

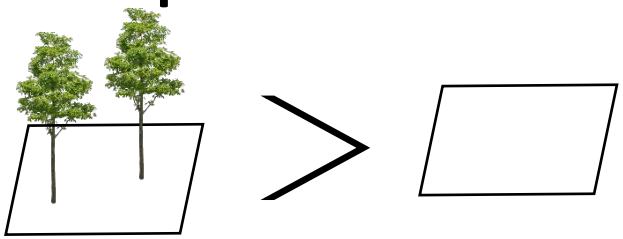
Objective variable	Explanatory variables	P value
The number of bryophyte species (n = 174)	The relative area of rock	0.22
	The relative area of water	**0.02** *
	The number of living tree	**0.03** *
	The height of rock (cm)	0.15
	Elevation(m)	0.89

50-quadrat dataset (2 m scale)

Objective variable	Explanatory variables	P value
The number of bryophyte species (n = 174)	The relative area of rock	0.51
	The relative area of water	0.26
	The number of living tree	**0.02** *
	The height of rock (cm)	0.54
	Elevation(m)	0.9

Why does the number of living tree effect on species richness?

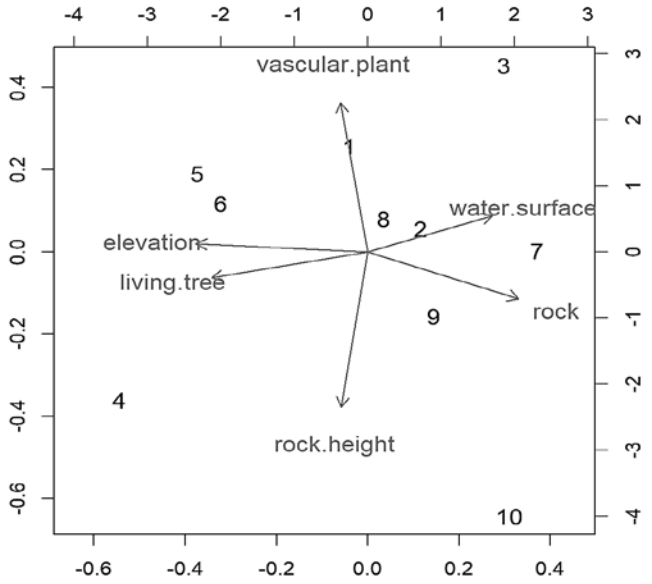
the area bryophytes can grow increases



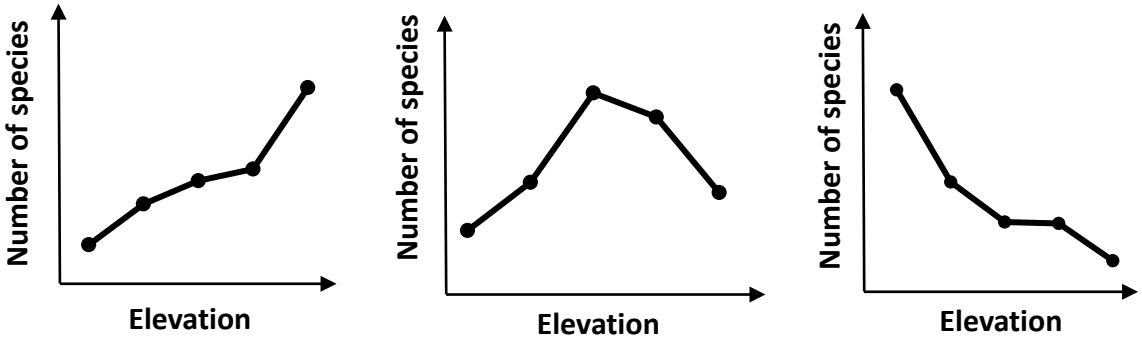
A previous study also found that forest density influences bryophyte species richness, but there was little association between elevation (Evans et al. 2012)

Why was there no significant relationship between elevation and species richness?

Elevation seemed to be related to other 3 environmental factors



inconsistent results about elevation



Elevation alone may not be sufficient to fully understand the factors that influence bryophyte species richness.

At least within 268m to 869m,
the number of living trees significantly influenced the bryophyte species richness.

Among different species with varying substrate preferences, factors affecting the species richness may also vary

10-transect dataset (50 m scale)

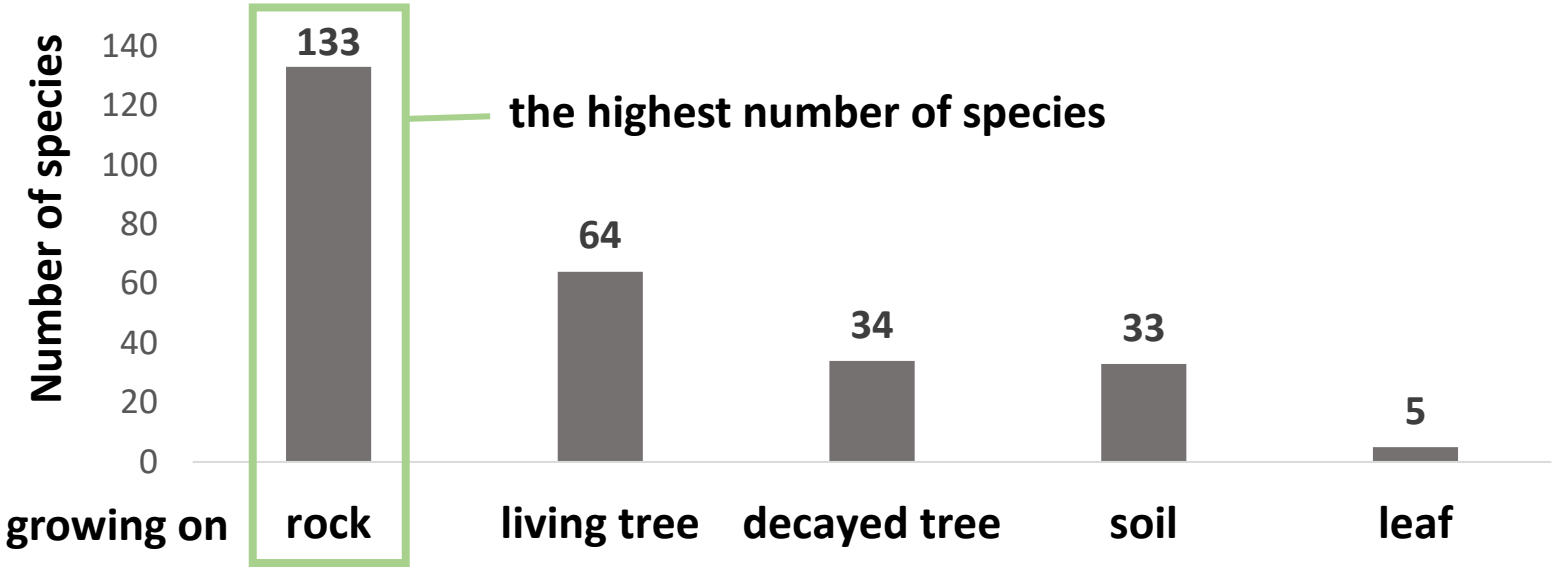
Objective variable	Explanatory variables	p value
growing on **Rock** (n=133)	The relative area of rock	**0** *
	The relative area of water	**0.03** *
growing on **Living tree** (n = 64)	The number of living tree	**0** *
growing on **Decayed tree** (n=34)	-	-
growing on **Soil** (n=33)	The relative area of rock	**0.02** *

50-quadrat dataset (2 m scale)

Objective variable	Explanatory variables	p value
growing on **Rock** (n=133)	The relative area of rock	**0** *
	The relative area of water	**0.01** *
growing on **Living tree** (n = 64)	The relative area of rock	**0.03** *
growing on **Decayed tree** (n=34)	The relative area of water	**0.03** *
growing on **Soil** (n=33)	-	-

(the species growing on leaves had no significant relationship with any environmental factors)

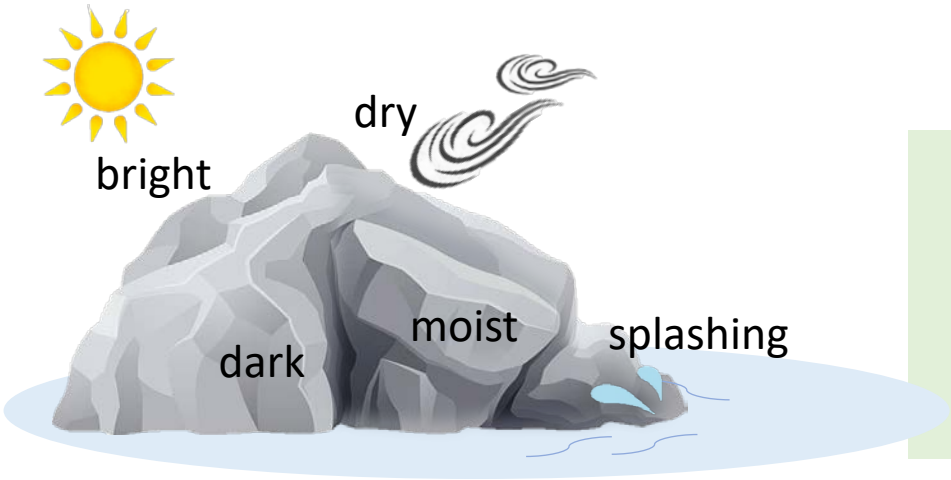
Species growing on rock increase as the relative area of rock and water surface area increase



Point

The morphology of rock surfaces promotes the heterogeneity of bryophyte habitats

(Hespanhol et al. 2011; Hylander & Dynesius 2006)



rock + high water availability

||

the combination of these factors creates more diverse micro-habitat

Summary of this study

- **Bryophyte species richness is more influenced by substrate and water availability than elevation within 268 - 869 m.**

- **The species richness growing on rocks is influenced not only the relative rock area, but also by the relative water surface area.**
  This may be due to the heterogeneity of micro-habitats on the rock surface, which is further increased by the high water availability.

Acknowledgement

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Ai Nagahama (Department of Botany, National Museum of Nature and Science)

Members of Ecological Science Lab., Kyushu University

The type and number of environmental factors affecting species richness varies with scale

50-quadrat dataset (2 m scale)

Objective variable	Explanatory variables
The number of bryophyte species	**The number of living tree**

increase

10-transect dataset (50 m scale)

Objective variable	Explanatory variables
The number of bryophyte species	**The relative area of water**
	The number of living tree

50-quadrat dataset (2 m scale)

Objective variable	Explanatory variables
growing on **Rock** (n=133)	The relative area of rock
	The relative area of water
growing on **Living tree** (n = 64)	The relative area of rock
growing on **Decayed tree** (n=34)	The relative area of water
growing on **Soil** (n=33)	-

change

decrease

increase

10-transect dataset (50 m scale)

Objective variable	Explanatory variables
growing on **Rock** (n=133)	The relative area of rock
	The relative area of water
growing on **Living tree** (n = 64)	The number of living tree
growing on **Decayed tree** (n=34)	-
growing on **Soil** (n=33)	The relative area of rock

it is not possible to determine the optimal combination of scale sizes based on this study alone

Multi-scale study is necessary to identify the environmental factors influencing the species richness of bryophytes.