Effect of environmental filtering on intraspecific variation in leaf functional traits along an elevation gradient in Fushan Forest Dynamics Plot, Taiwan

by

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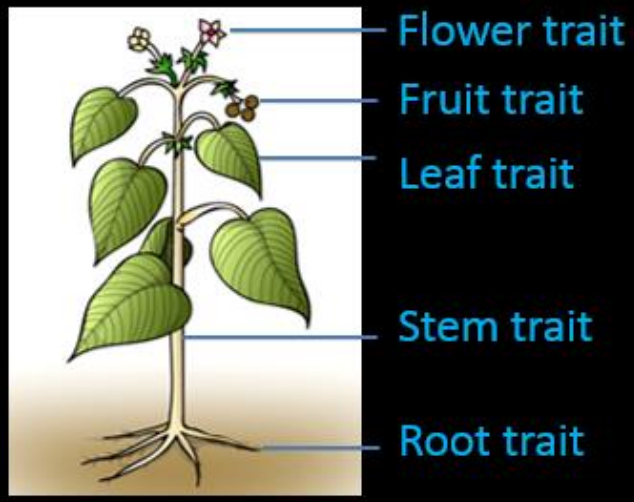
Introduction

What is plant functional traits?

- Functional traits are features which influence on plant performance and express through reproduction, growth and survival (Violle et al. 2007).

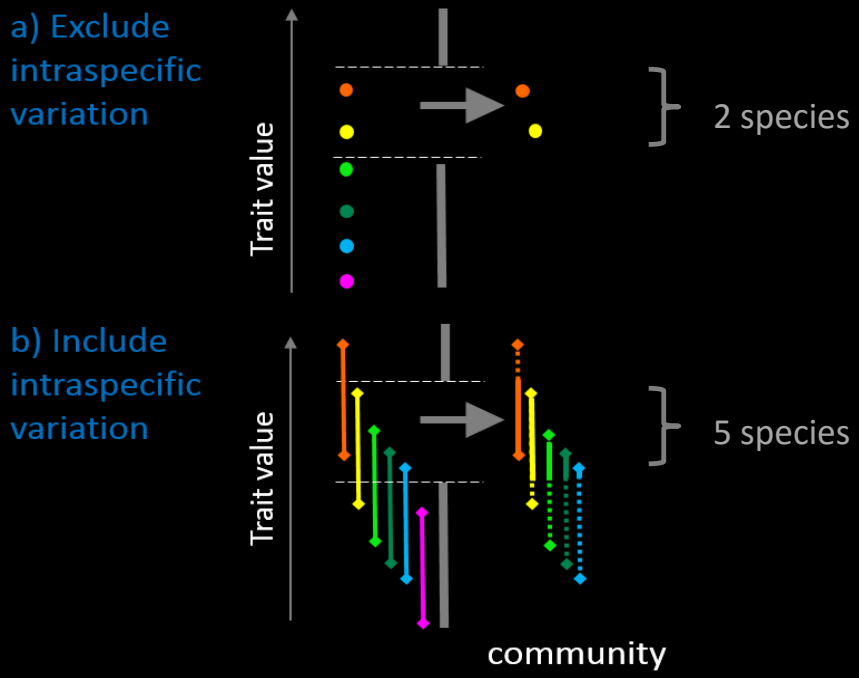


- Functional traits are basis to lead to the understanding of plant strategies and can refer to environment as explaining how plants respond to environmental factors.
- Functional traits are crucial tool to reveal how species coexistence and form community.

Introduction

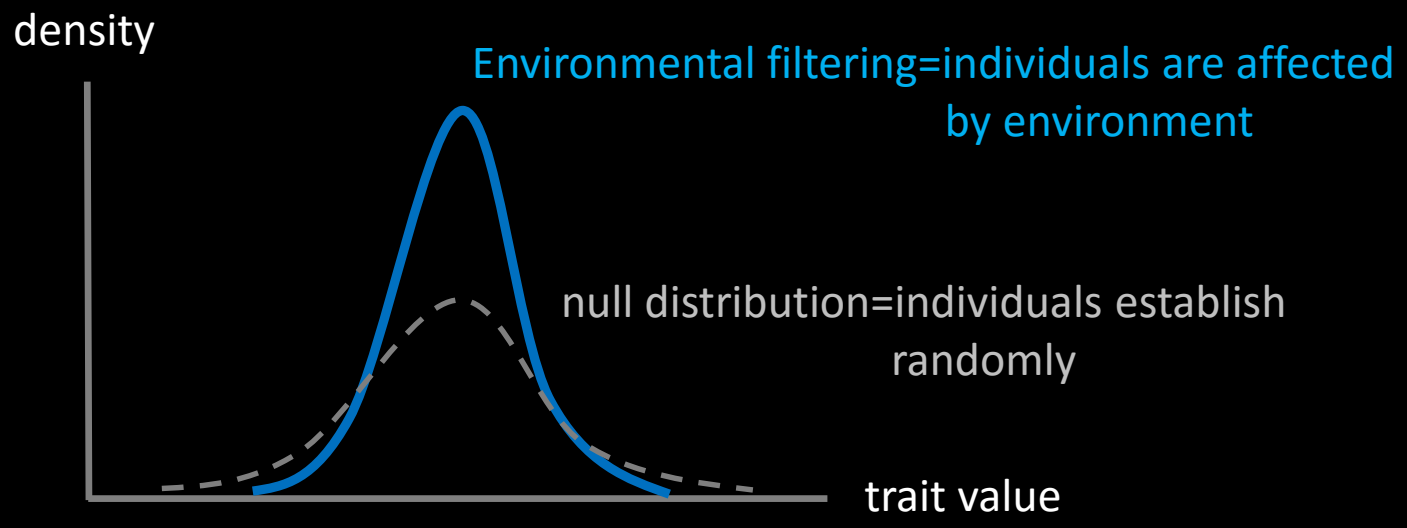
Why using intraspecific variation?

- It provides more accurate detail for understanding community assembly, i.e. environmental filtering process
- For example, using only interspecific variation (mean of species) lead to incorrect conclusion (Jung et al. 2010).



Introduction

Identification environmental filtering using intraspecific variation



Trait metrics to investigate

1. Lower variance
2. Smaller range
3. Higher kurtosis
4. Higher standard deviation of neighbor distance divided by range (SDNDr)

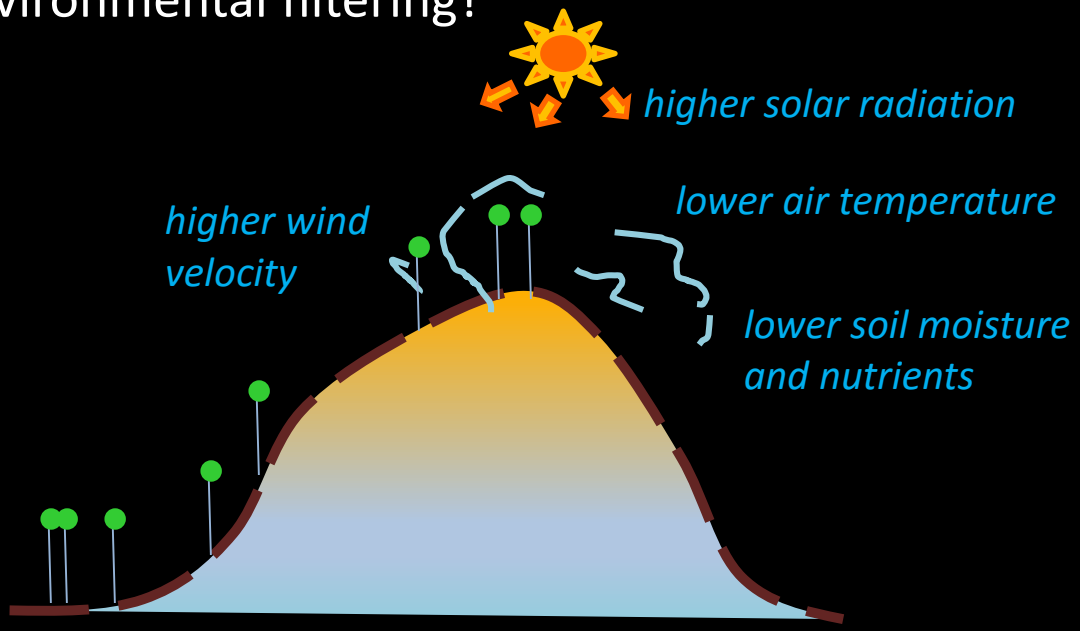
Introduction

Purpose

- To understand environmental stress acting on functional traits of populations which are established in different appropriate environments.

Question and hypothesis

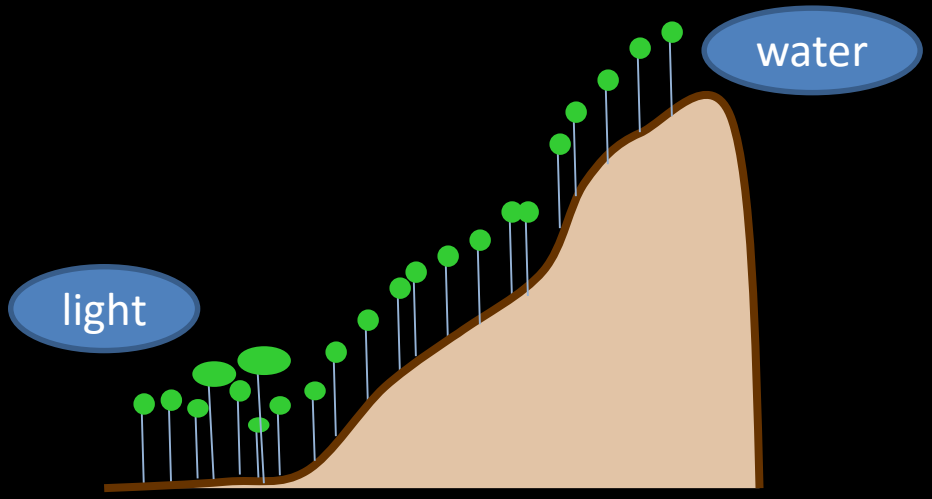
- Do different populations associating with different elevation classes exhibit different extent of environmental filtering?



Introduction

Question and hypothesis

- Hypothesis: in the different environmental conditions, environmental filtering exerts on functional trait values in population with similar functional attribute is selected relate to environmental condition.
- Prediction:



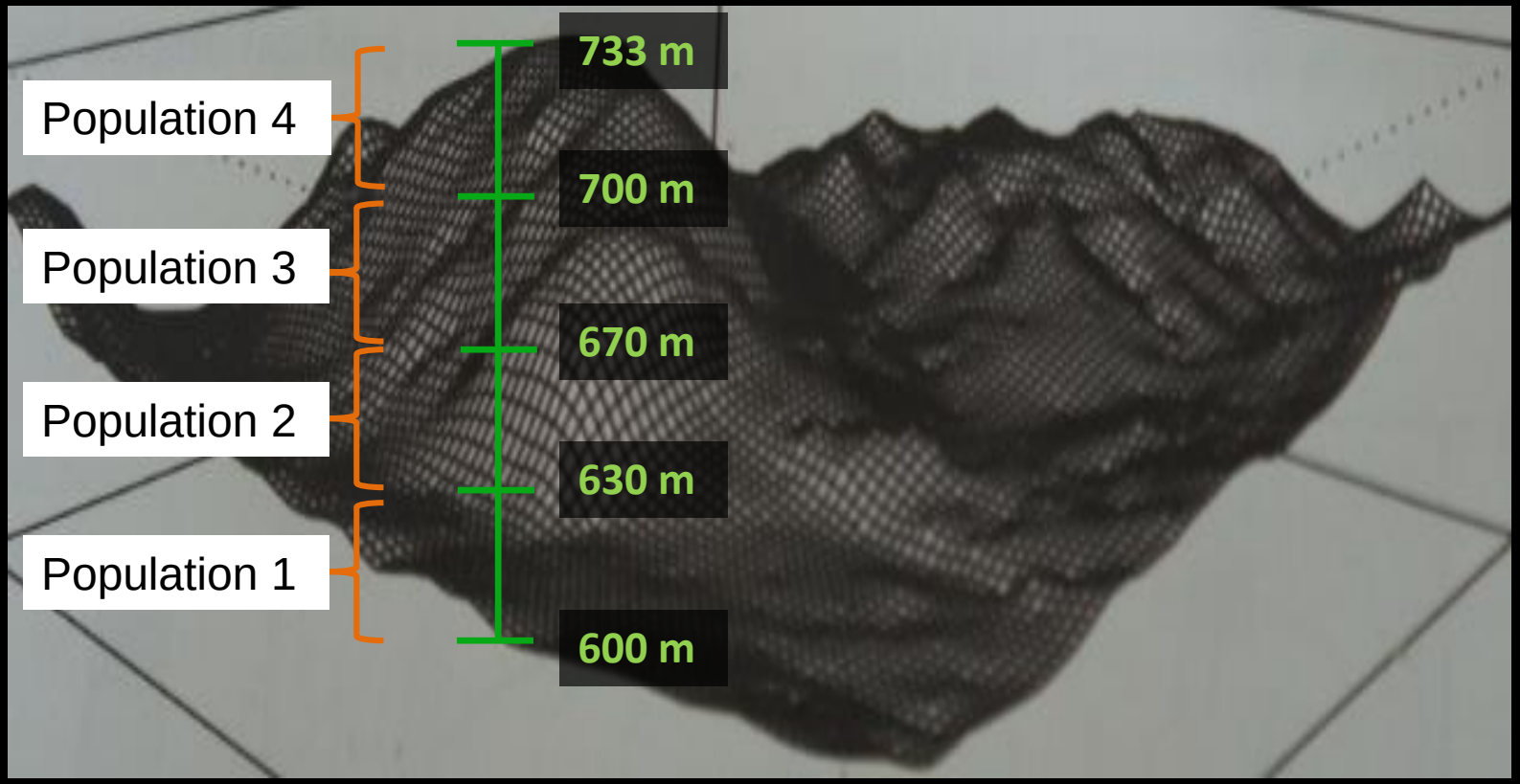
- At higher elevations, functional trait distribution should have:

  1) lower variance 2) smaller range 3) higher kurtosis 4) higher SDNDr

Method

Study site

- 25 ha in a 500 m x 500 m square in Fushan Forest Dynamics Plot (FDP)
- Range of elevation from 600 - 733 m above sea level



Su et al. 2007

Method

Tree species collection

- Specialist in low elevation: *Saurauia tristyla* var. *oldhamii* and *Wendlandia formosana*
- Generalist species: *Symplocos theophrastioilia* and *Diospyros morrisiana*
- Specialist in high elevation: *Myrsine sequinii* and *Pyrenaria shinkoensis*

Functional traits collection and analysis

- I collected eight leaves from each 10 individual of each species in each elevation class.
- As five leaf functional traits are collected: leaf area, specific leaf area (SLA), leaf dry matter content (LDMC), leaf thickness, and leaf vein density.
- Functional traits were measured following the standard protocol described in Cornelissen et al. (2003)

Method

Functional traits collection and analysis

- I used null model approach to distinguish effect of environmental filtering
- Therefore observed data of functional traits are expected to having lower variance or range or having higher kurtosis or SDNDr

Result

Tables represent trait metrics for functional traits of species as specialists in low elevation. Environmental filtering is represented by the numbers in bold type which significant differences compare to null model.

Wendlandia formosana

Elevation class	Functional trait	Trait metric			
		range	variance	kurtosis	SDNDr
1	SLA	1.05	0.49	**2.40**	1.36
1	Leaf thickness	1.50	2.21	**1.62**	1.59
1	Leaf vein density	**0.13**	0.01	1.00	0.41

Saurauia tristyla var. *oldhamii*

Elevation class	Functional trait	Trait metric			
		range	variance	kurtosis	SDNDr
1	SLA	**0.68**	**0.47**	0.89	0.82
1	Leaf area	**0.59**	**0.30**	1.02	0.82
1	LDMC	0.87	**0.44**	1.64	1.16
1	Leaf thickness	**0.59**	**0.41**	0.68	0.84
3	LDMC	1.06	0.88	**2.11**	1.26

Result

Tables represent trait metrics for functional traits of species as specialists in high elevation. Environmental filtering is represented by the numbers in bold type which significant differences compare to null model.

Myrsine sequinii

Elevation class	Functional trait	Trait metric			
		range	variance	kurtosis	SDNDr
2	Leaf vein density	1.03	1.06	1.00	**1.75**
3	SLA	**0.60**	**0.59**	0.49	0.70
3	LDMC	**0.37**	0.34	0.22	0.45
4	Leaf area	**0.61**	0.58	0.55	0.90

Pyrenaria shinkoensis

Elevation class	Functional trait	Trait metric			
		range	variance	kurtosis	SDNDr
2	LDMC	1.72	1.03	**3.46**	**1.77**
4	Leaf area	0.81	**0.67**	0.70	0.85

Result

Tables represent trait metrics for functional traits of generalist species.

Symplocos theophrastioilia

Elevation class	Functional trait	Trait metric			
		range	variance	kurtosis	SDNDr
1	Leaf area	1.02	**0.87**	0.41	0.56
2	Leaf area	**0.59**	**0.27**	0.71	0.96
3	Leaf vein density	1.32	1.64	1.00	**1.87**
4	LDMC	0.82	**0.45**	1.86	1.25
4	Leaf area	**0.59**	0.26	0.97	0.95
4	SLA	**0.60**	0.51	0.70	0.64
4	Leaf vein density	1.12	1.08	1.00	**1.46**

Diospyros morrisiana

Elevation class	Functional trait	Trait metric			
		range	Variance	kurtosis	SDNDr
1	Leaf vein density	**0.17**	**0.02**	1.00	**1.17**
2	Leaf area	0.59	**0.27**	0.71	0.96
2	SLA	1.55	1.98	1.74	**1.42**
3	SLA	**0.43**	0.18	0.72	**1.77**
3	LDMC	0.62	**0.20**	**3.82**	**2.19**
4	Leaf area	**0.59**	**0.26**	0.97	0.95

Discussion

- As environmental filtering happens among populations, individuals among populations may be affected by different environmental factors, i.e. light, and water
- Generalist species have environmental filtering in most habitats which more intense functional trait distribution in each habitat. Supporting that functional trait of species dependent on environmental condition for most habitats.
- This could be generalist species have functional traits that are more flexible to success in different habitats.

Discussion

- Specialists in high and low elevation have more concentrated functional trait distribution in their optimal habitats. Therefore, more evident environmental filtering happens in the optimal habitats, which suggests performance is more tightly linked to trait value in a specialist species optimal habitat.

- To confirm which environmental factor at Fushan had the strongest affect, environmental data are needed

Conclusion

- Intraspecific trait variation provides a crucial understanding environmental effect in community and community assembly and it is able to be linked to community structure.
- Under environmental filtering, intraspecific variation determines species performance and maintain distribution of a species
- Data of genetic diversity and tests using actual environmental factors should be considered in future studies
- Study of intraspecific variation should examine how change in population performance relates to environmental change and influence community structure

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