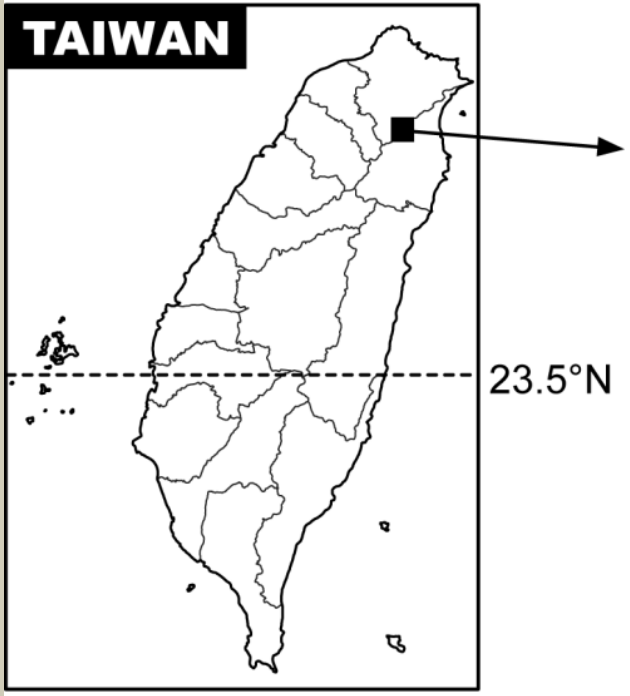
Short-term stand dynamics and tree species characteristics of a subtropical forest at Fushan

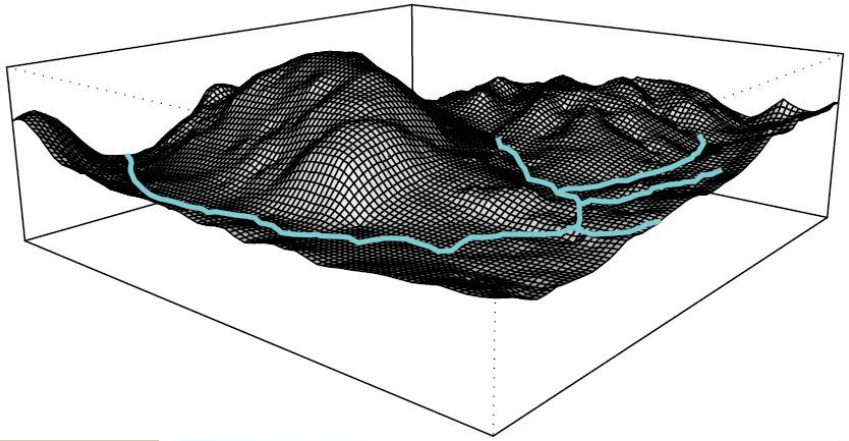
福山亞熱帶森林之短期林分動態與樹種特性

S. H. Su
B. Guan
H. H. Wang
C. F. Hsieh

蘇聲欣
關秉宗
王相華
謝長富

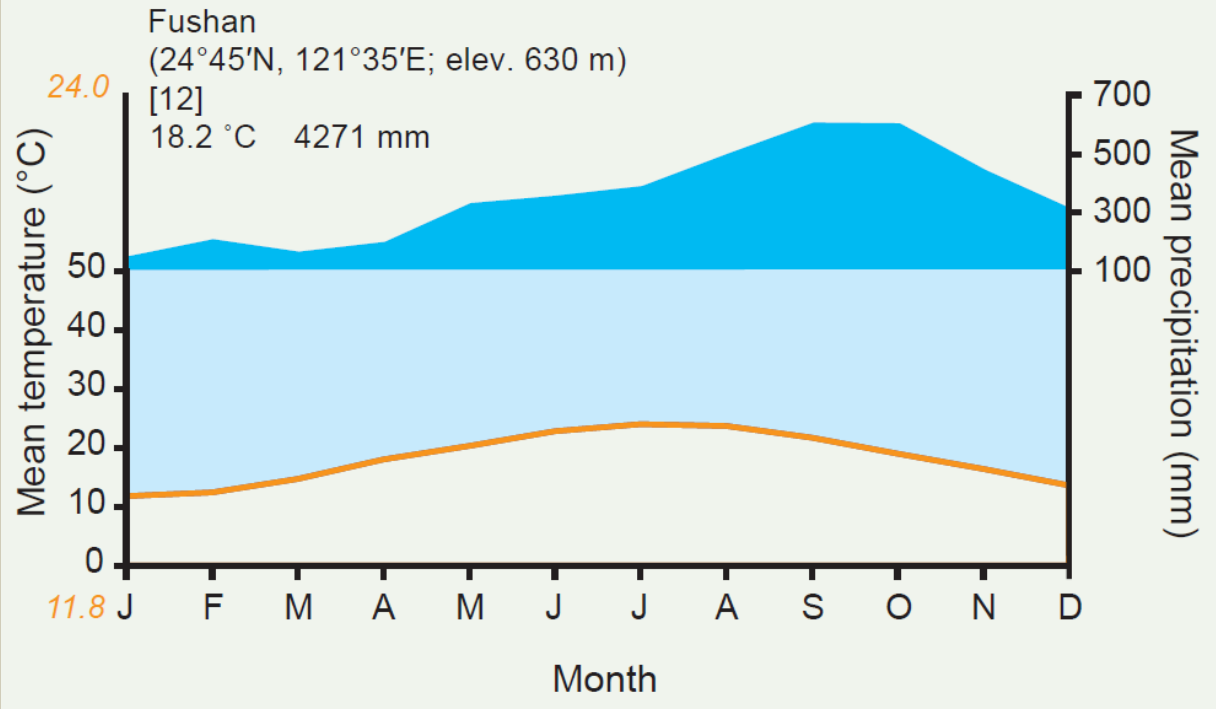
Fushan Forest Dynamics Plot (FFDP)





- 121˚33’E, 24 ˚45’N
- 600-733 m above sea level
- 500 m x 500 m (25 ha)

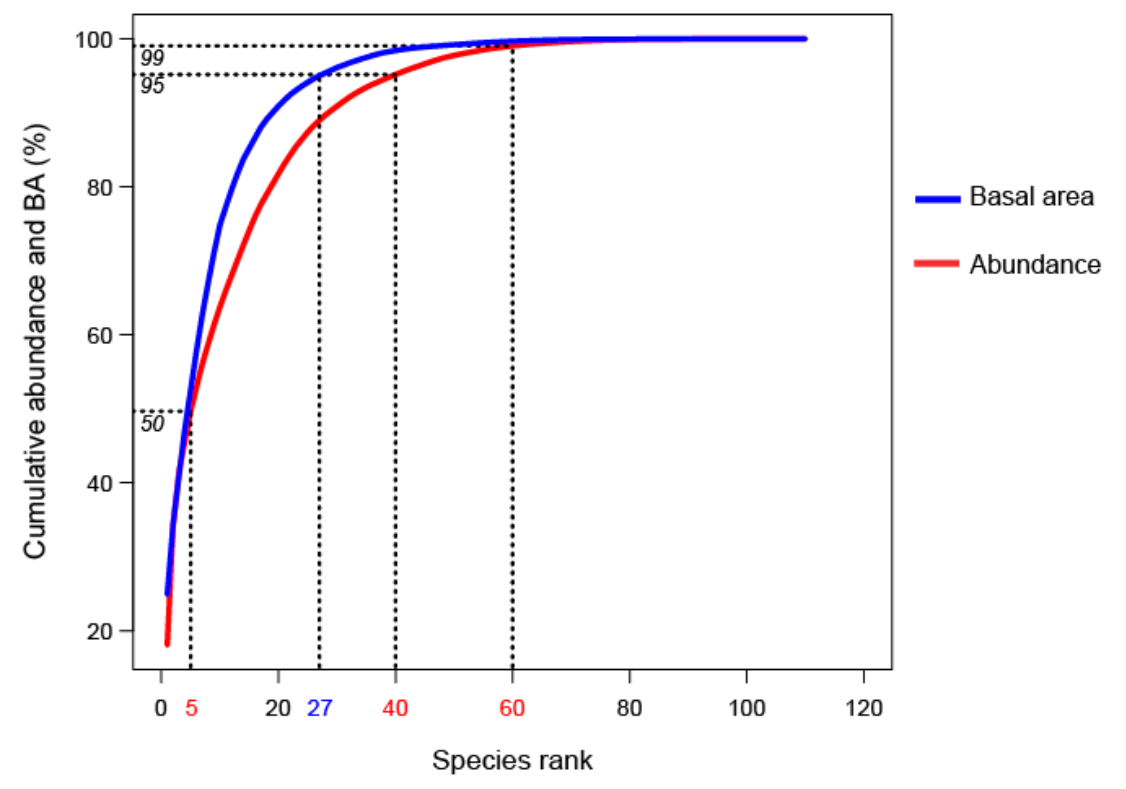
Climate



- Warm and humid
- Typhoon disturbances (June to Sep.)
- Monsoon effects in summer and winter

Forest Composition

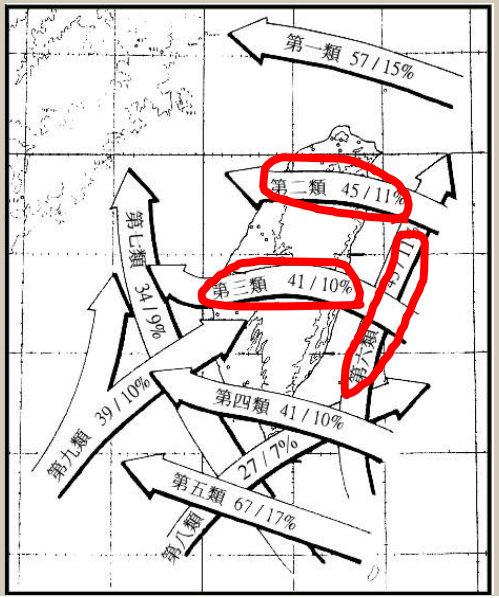
- 114,354 individuals (4574 trees/ha)
- 110 species
- Strong dominance concentration



Tree Census

- First census in 2003-2004
- Second census in 2008-2009

- Typhoon events
  - 1 event during the first census
  - 10 events during inter-census period
  - 4 events during the second census



Main Questions

- What is the feature of community dynamics at this typhoon-disturbed forest? Is it rapid or unstable?
- How is the differentiation of life history characteristics of tree species?

Five-year Demography

- 4 species of single individual emigrated
- Whole community increased 2,894 individuals (15,869 recruits - 12,975 deaths)
- Total basal area increased 2.04 m^2ha^{-1}

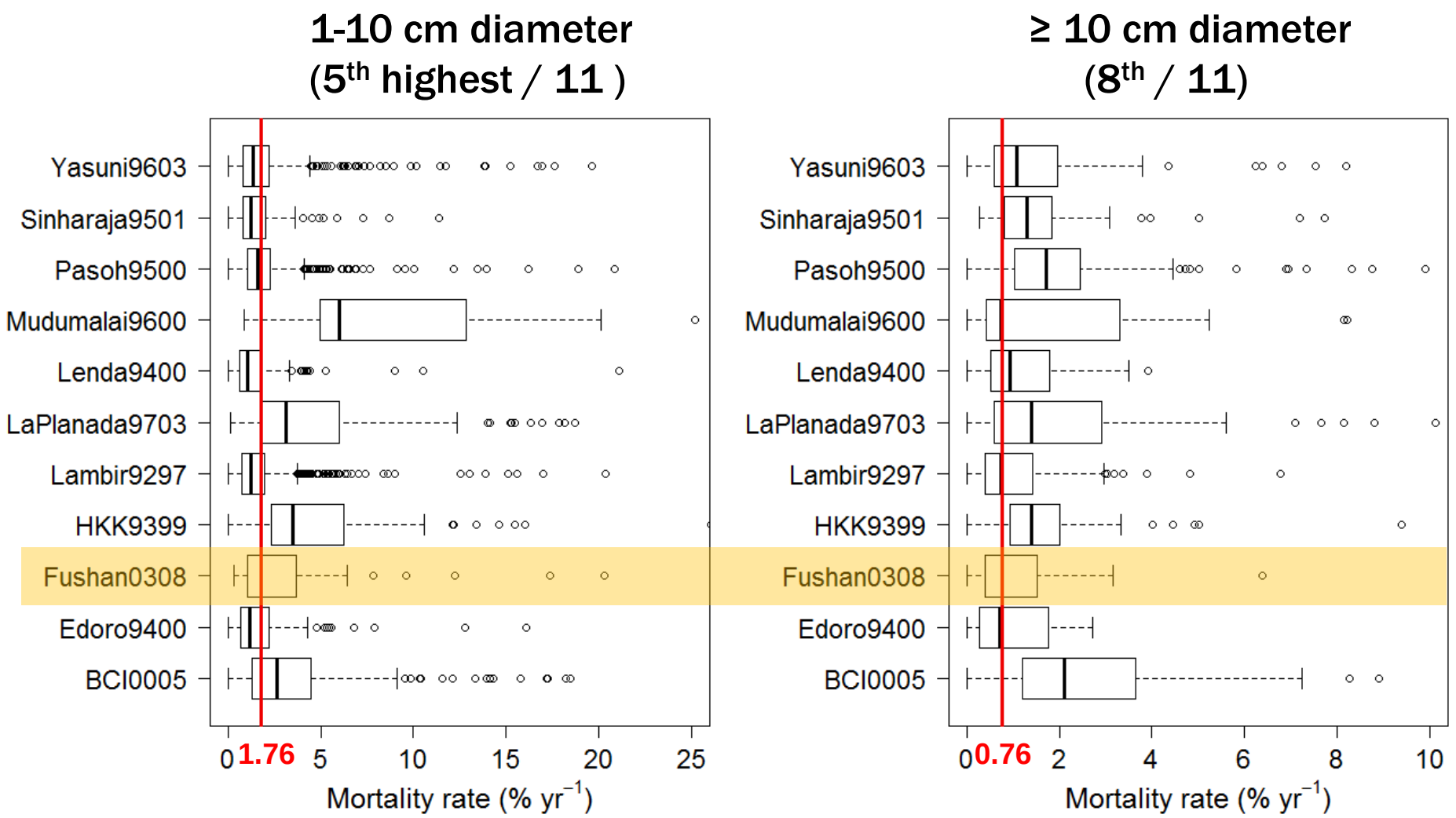
- Demographic rates
  - Mortality = 2.61 $\%yr^{-1}$
  - Recruitment = 3.05 $\%yr^{-1}$
  - RGR= 2.78 $\%yr^{-1}$

$$mortality\ rate = \frac{\ln(N_0) - \ln(survivors)}{time}$$

$$recruitment\ rate = \frac{\ln(N_1) - \ln(survivors)}{time}$$

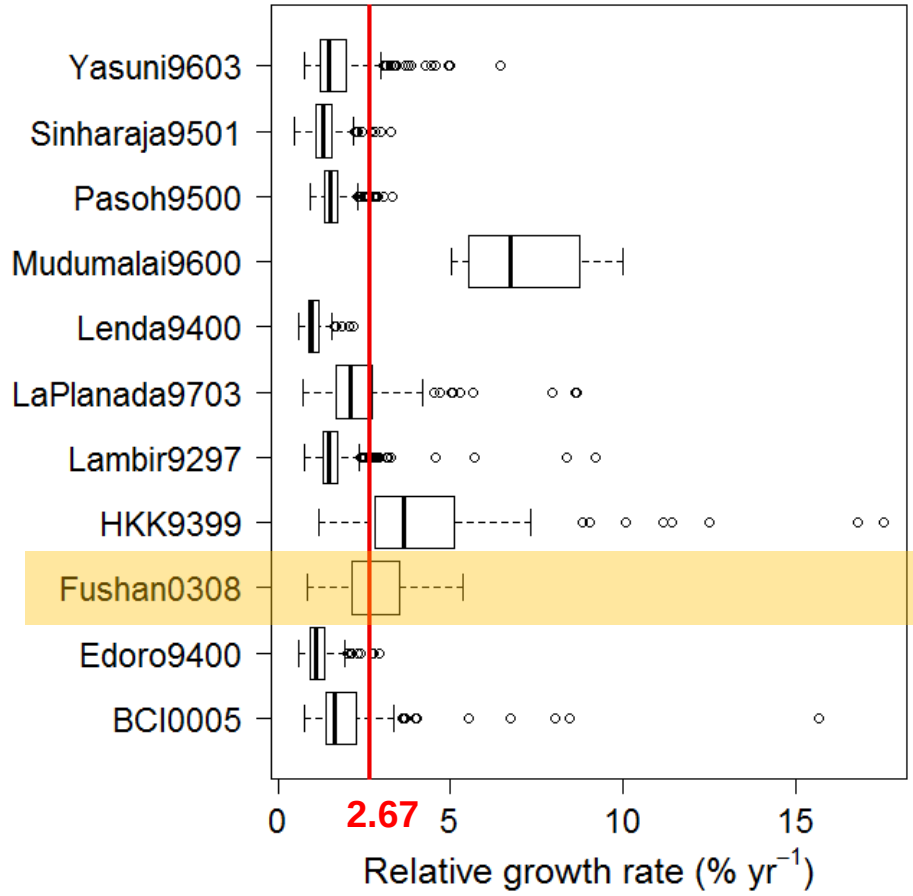
$$relative\ growth\ rate\ (RGR) = \frac{\ln(DBH_1) - \ln(DBH_0)}{time}$$

Comparison with Tropical FDPs (Mortality Rate)

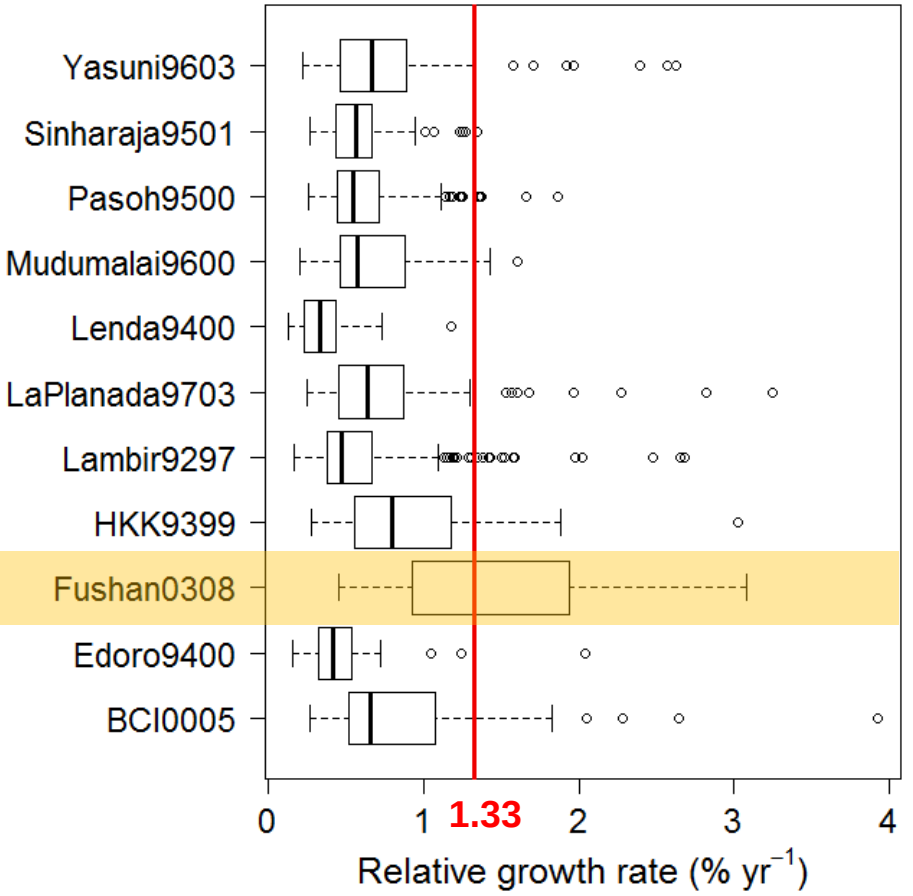


Comparison with Tropical FDPs
(Relative Growth Rate)

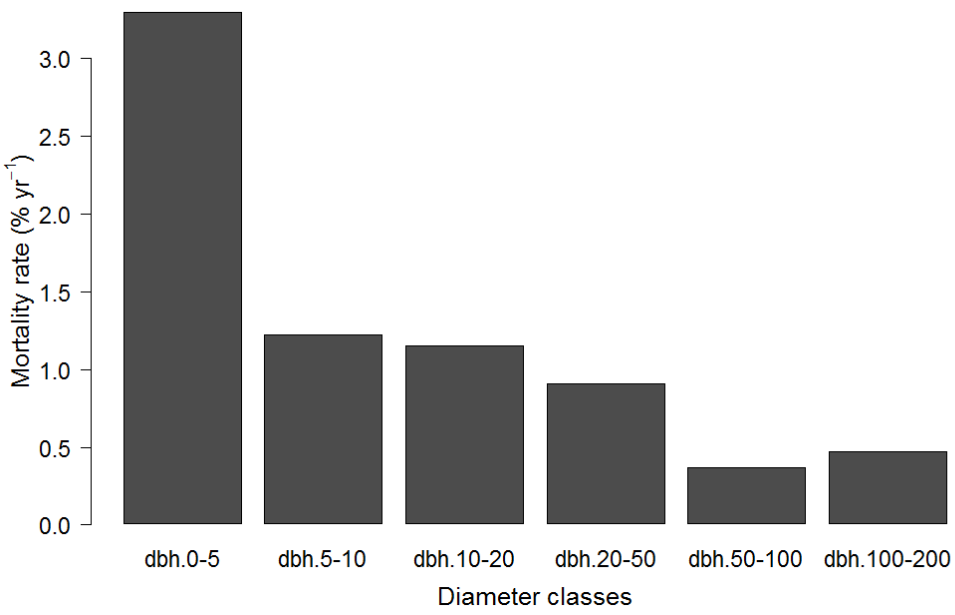
1-10 cm diameter
(3rd highest / 11)



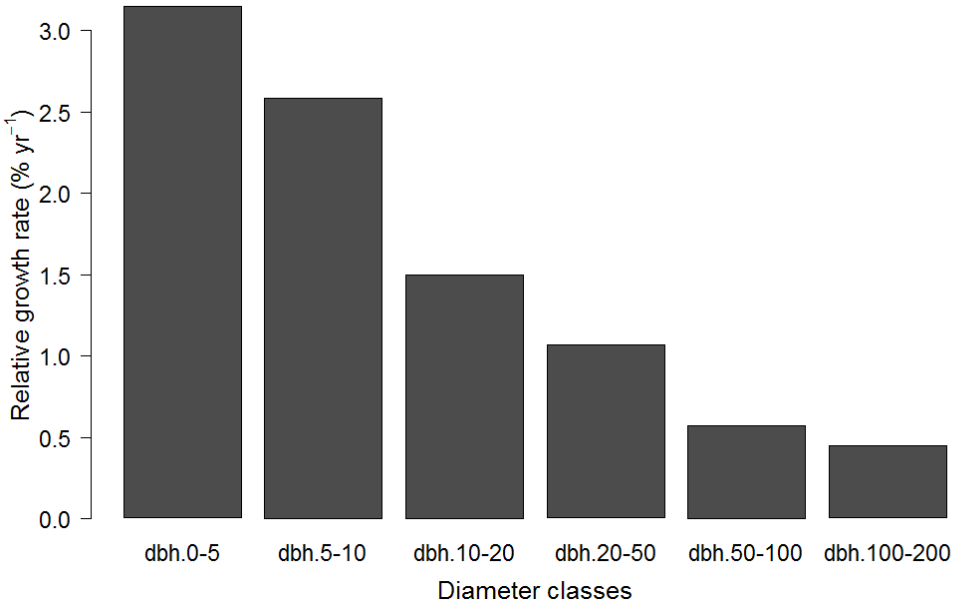
≥ 10 cm diameter
(1st / 11)



Mortality rate



Relative growth rate

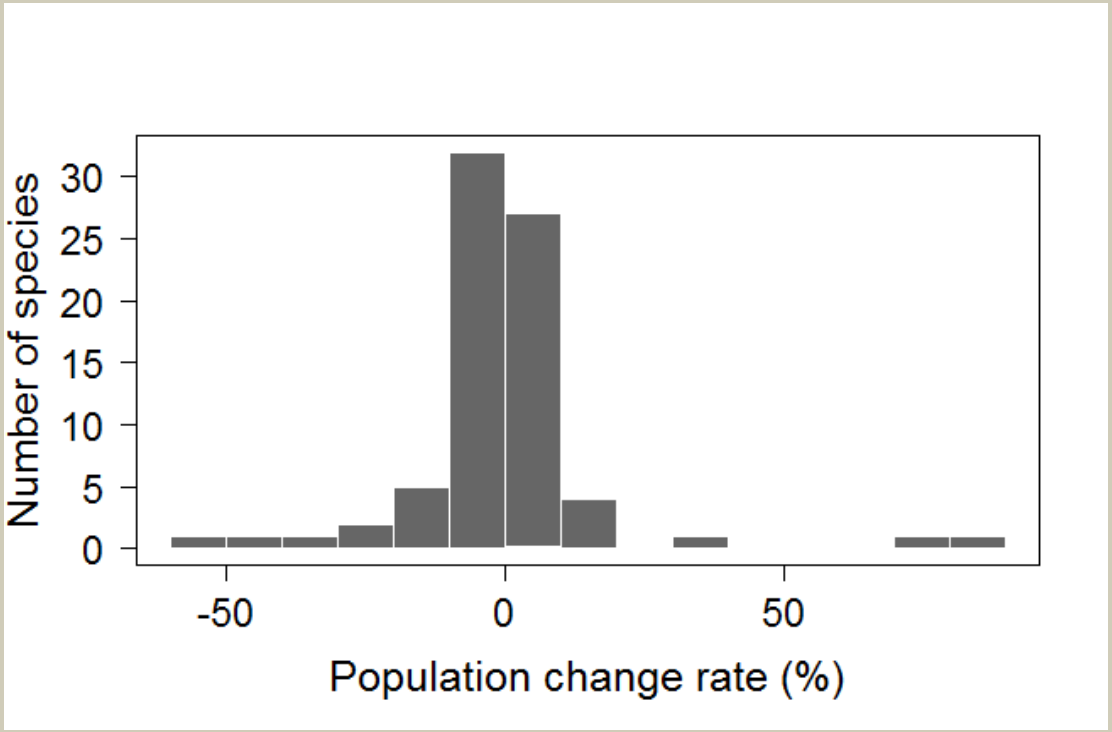


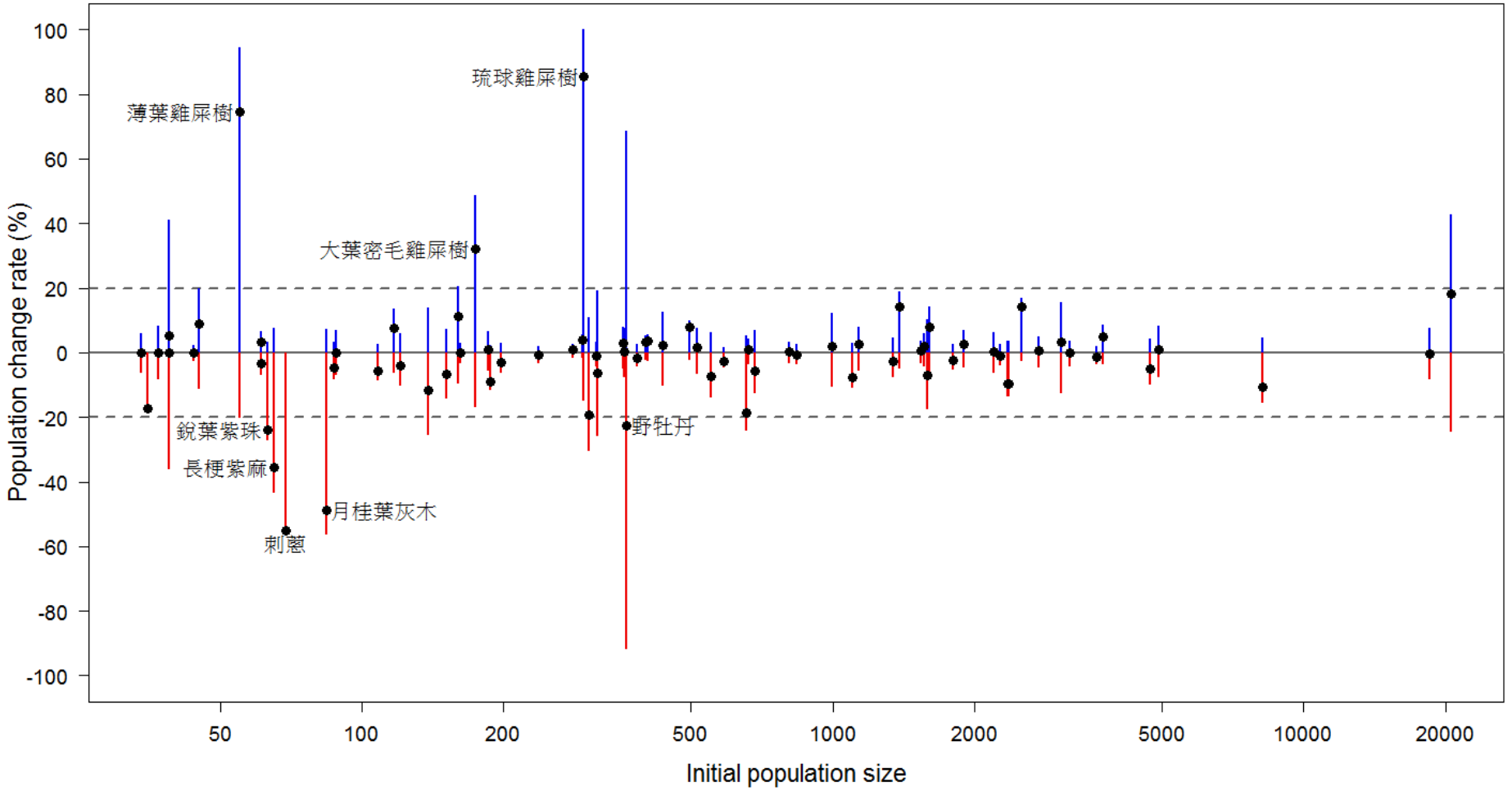
Population Changes in FFDP

34 spp. increased

36 spp. decreased

6 spp. remained the same




100
80
60
40
20
0
-20
-40
-60
-80
-100
Population change rate (%)
薄葉雞屎樹
琉球雞屎樹
大葉密毛雞屎樹
鋭葉紫珠
長梗紫麻
刺蔥
月桂葉灰木
野牡丹
50
100
200
500
1000
2000
5000
10000
20000
Initial population size

Species Life History Characteristics

- Principal component analysis (PCA)
  - Demographic variables + population structural variables
    - Mortality and recruitment rates
    - Relative growth rate(
    - Coefficient of variation of relative growth rate
    - Abundance, basal area

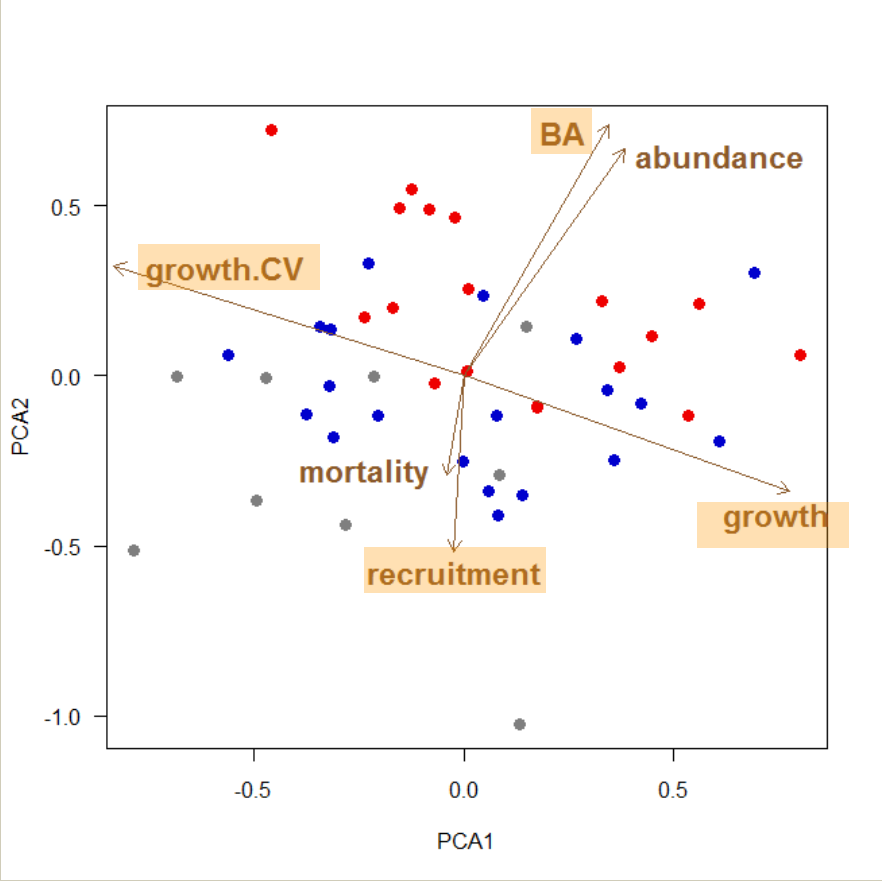
- Correlation of species traits and species performance
- Trait variables
  - Lifeform: canopy trees, sub-canopy trees, shrubs
  - Size: median of diameter
  - Multi-stem status
    - Proportion of multi-stemmed individuals
    - Mean stem number by individual
  - Aggregation: Ripley's *K* statistic (within 10-m-radius area)
  - Wood specific gravity

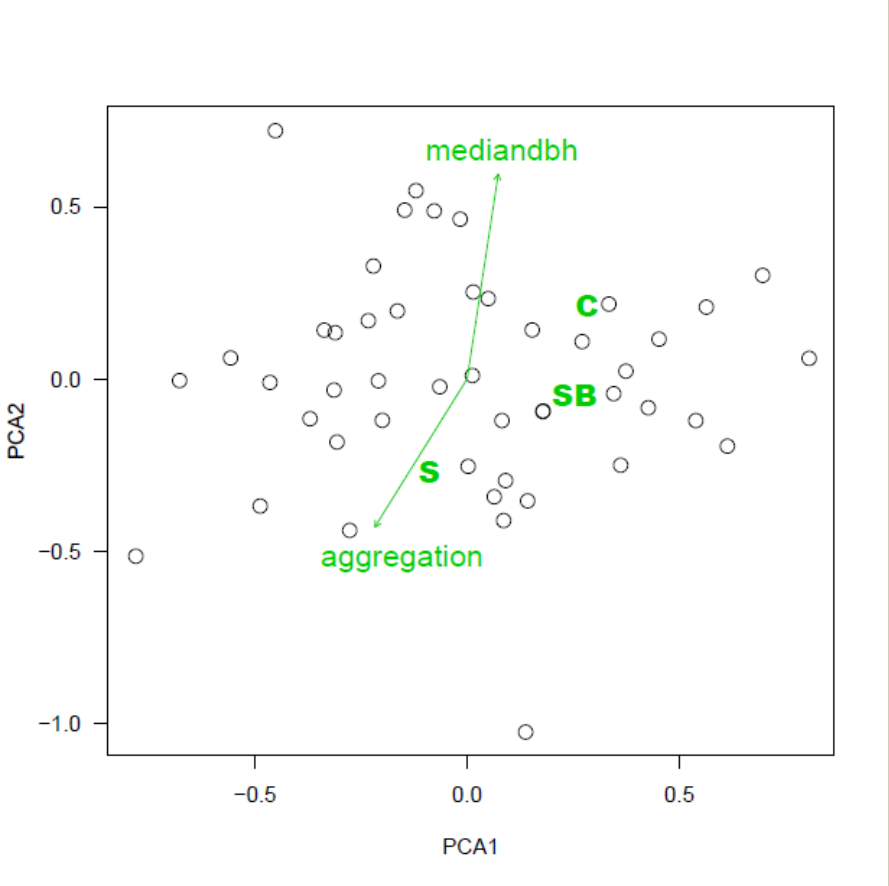
PCA results

PCA axis	% variance	Cumulative % variance
1	41.4	41.4
2	30.4	71.8
3	18.8	90.6

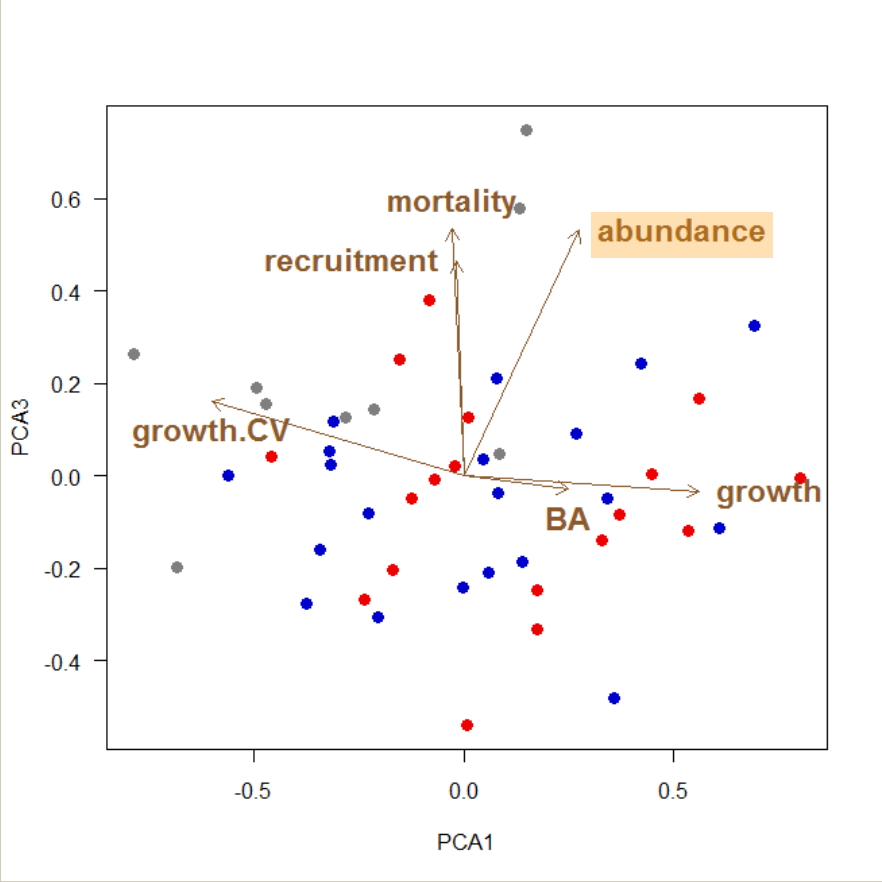
Variables	PCA loadings		
	Axis 1	Axis 2	Axis 3
abudance	0.31	**0.53**	**0.59**
BA	0.28	**0.59**	-0.03
mortality	-0.03	-0.23	**0.59**
growth	**0.62**	-0.27	-0.04
growth.CV	**-0.67**	0.26	0.18
recruitment	-0.02	**-0.41**	**0.52**

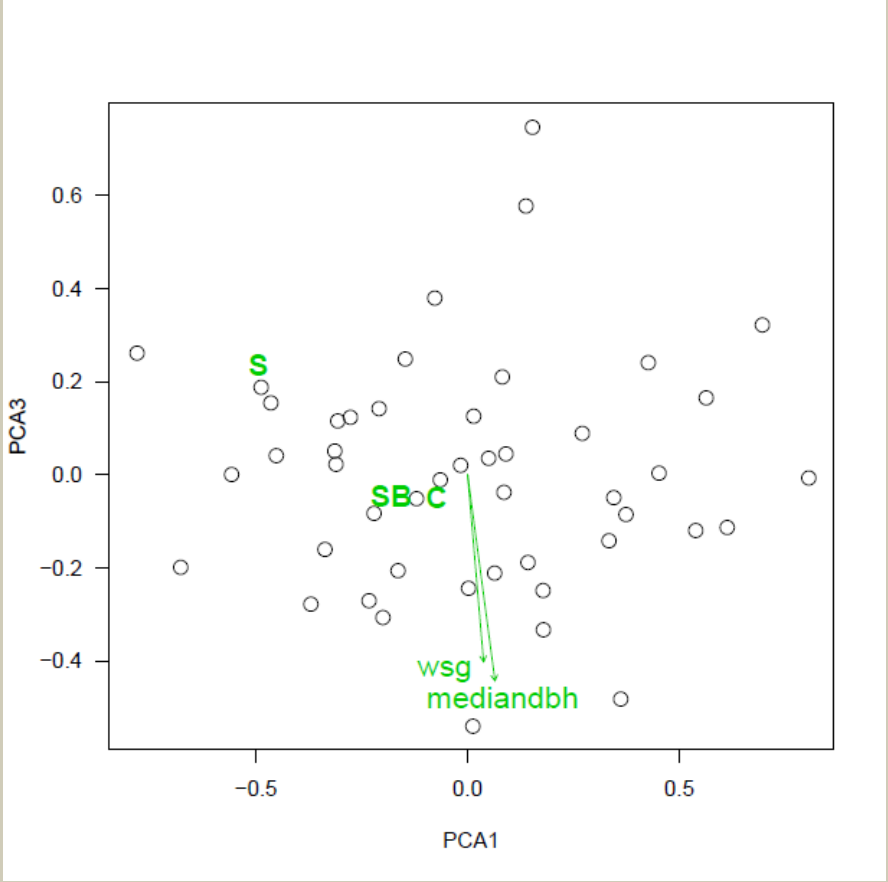
PCA1 vs. PCA2


BA
abundance
growth.CV
mortality
growth
recruitment
0.5
0.0
-0.5
-1.0
PCA2
-0.5
0.0
0.5
PCA1


mediandbh
C
SB
S
aggregation
0.5
0.0
−0.5
−1.0
PCA2
−0.5
0.0
0.5
PCA1

PCA1 vs. PCA3


mortality
abundance
recruitment
growth.CV
BA
growth
PCA3
PCA1
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.5
0.0
0.5


S
SBAC
wsg
mediandbh
PCA3
PCA1
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.5
0.0
0.5

Summary

- Demography of species in FFDP
  - Higher growth efficiency than most tropical FDPs
  - Lower mortality than the expected
  - Small sapling phase (0-5 cm diameter) showed greatest dynamics
  - No obvious directional change on forest composition
- Adaption to typhoon disturbance (persistence)

- Life history differentiation of tree species
  - Species showed the greatest variation on RGR-related variables
  - Species dominance (BA) is negatively correlated to recruitment
  - Mortality is positively correlated to recruitment ("demographic niche")
  - RGR-related variables were not related to mortality and recruitment
  - Size and wood specific gravity traits were negatively related to species demography

Acknowledgement

- Field crews of the two tree census work
- Forest Bureau, Council of Agriculture, National Science Council for generous funding
- Fushan Research Center and Taiwan Academy of Ecology for logistic support
- Drs. W. L. Chiou, I. F. Sun, and H. B. King for the motivation of FFDP project

Thank you
for the attention