Litterfall Dynamics in a Subtropical Rainforest, Fushan, Northern Taiwan

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Outline

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- Study aims
- Methods
  - Study site
  - Sample collection & treatment
  - Data analyses
- Results & Discussion
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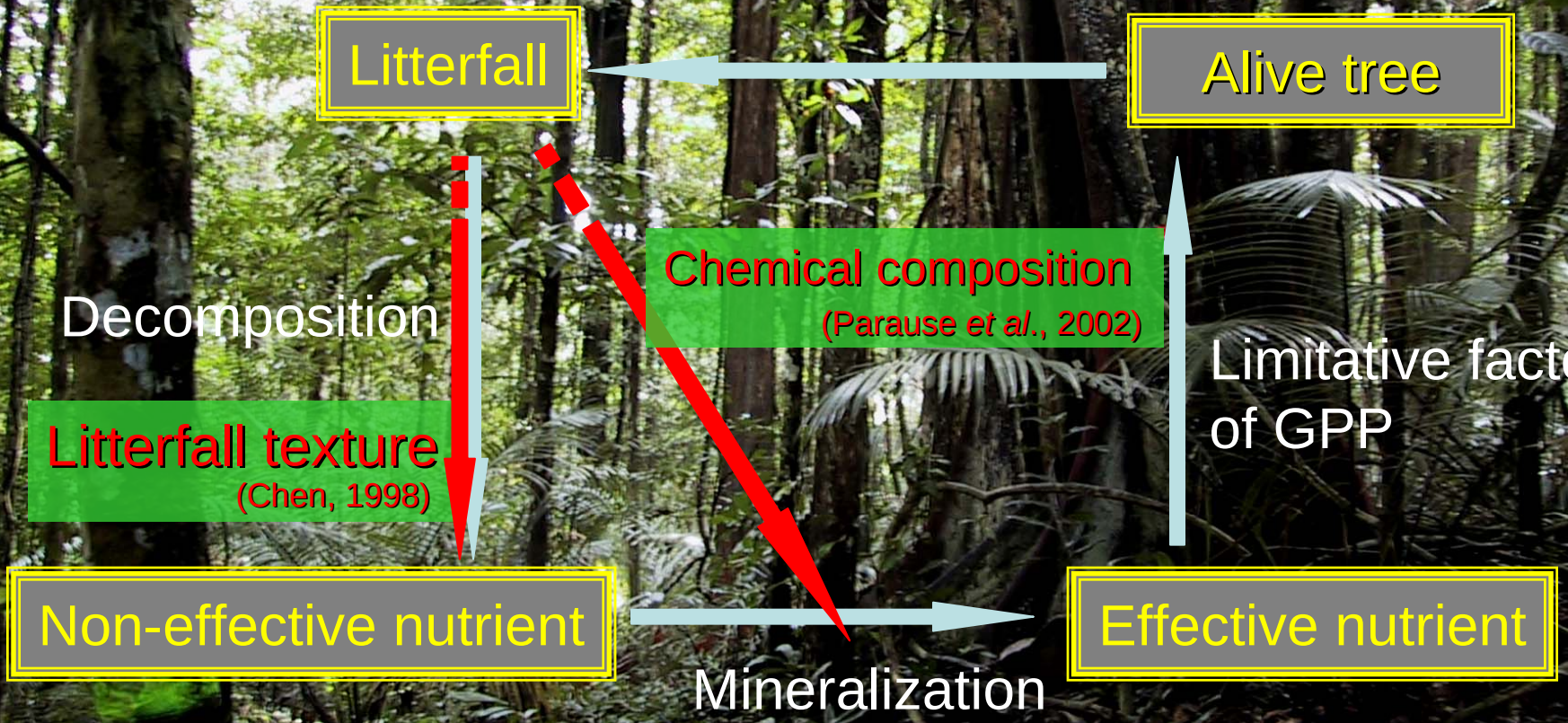
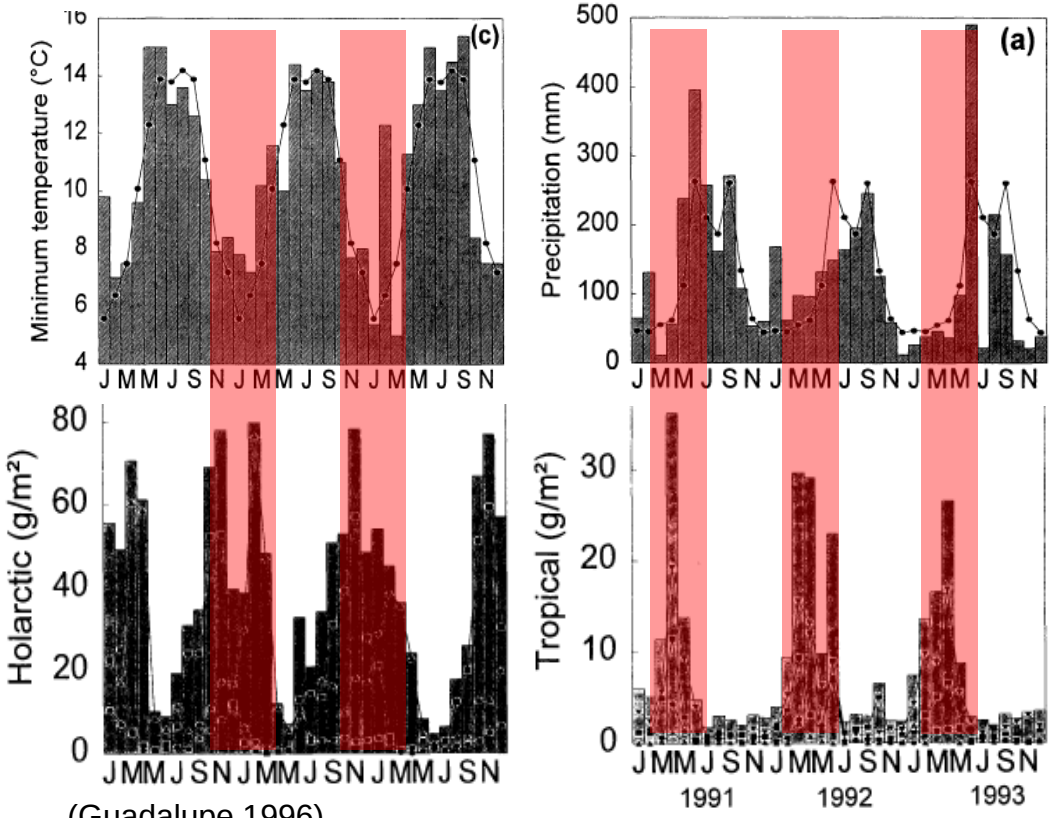
Introduction

Nutrient cycle

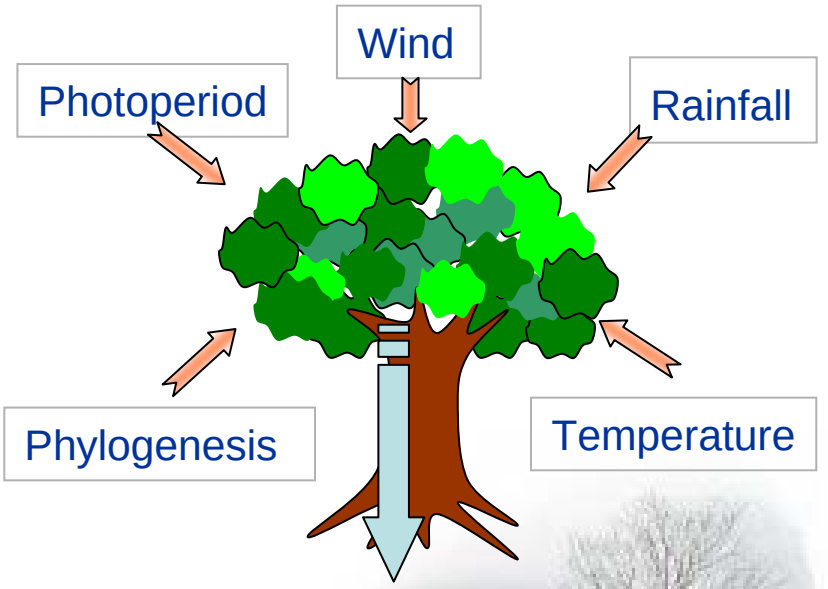


- **Leaflitter (about 70%) is more important than any other categories in nutrient cycle.** (Meentemeyer *et al*, 1982)

- **Leaffall patterns were correlated mainly with solar radiation, PPFD, day length, and temperature in a subtropical wet forest in Puerto Rico.** (Marcela 2008)



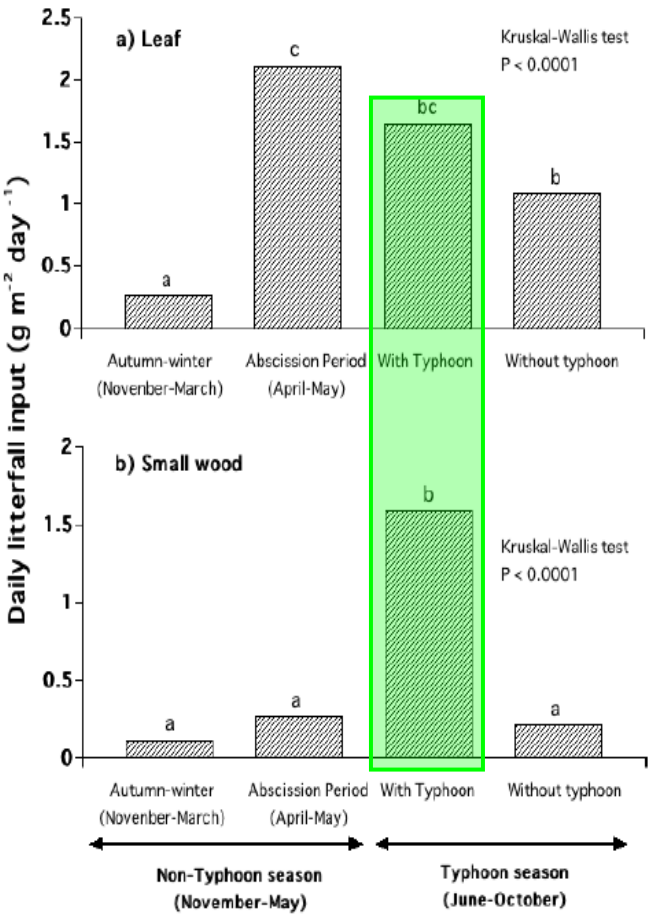
(Guadalupe,1996)



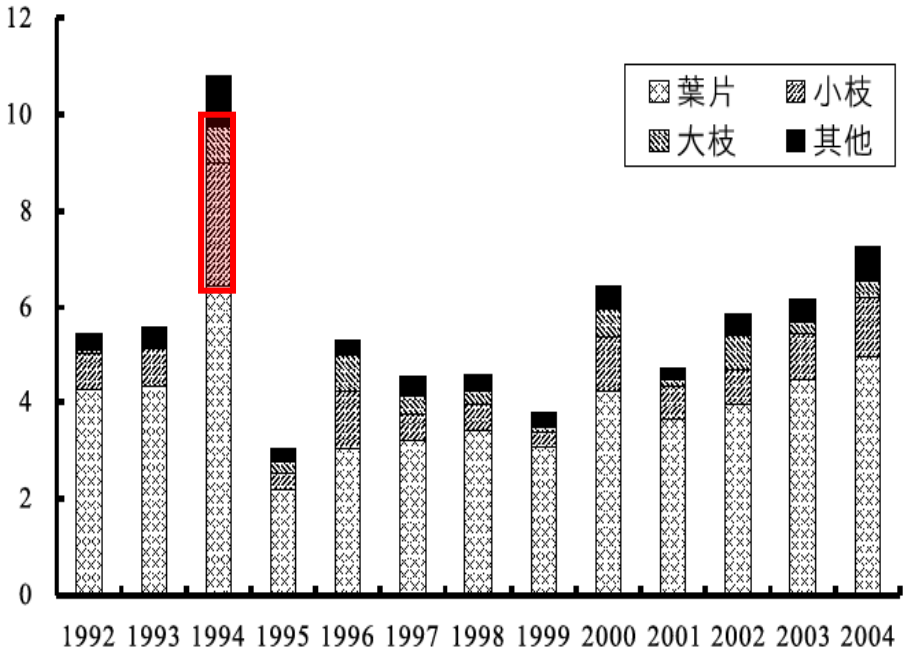
Different patterns

Typhoon is a instable disturbance.

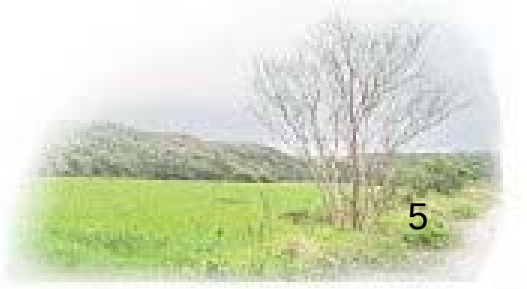
Severe wind disturbance have a significant impact in changing the timing of litterfall input. (Tamotsu,2003)



(Tamotsu,2003)



(Lin, 2006)



What kind of situation it is in a typhoon-driven subtropical rainforest ?

Fushan FDP is a suitable study site!

- **A weakly seasonal forest**
- **No significant dry-season**
- **Be disturbed by typhoons frequently**

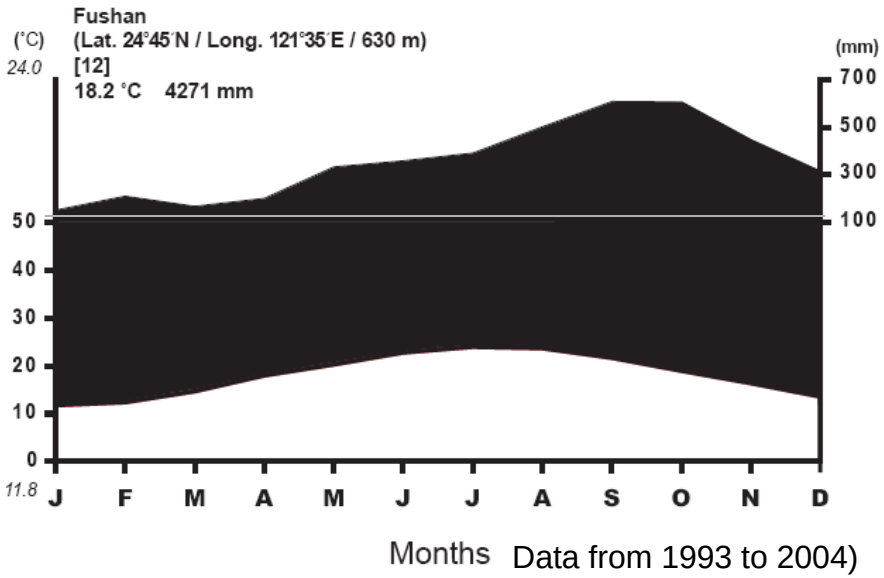
Study aims

1. To get the data of litterfall contributors, annual litterfall pattern, and leaffall patterns of different taxa
2. To discuss the effects of typhoon disturbance

Methods

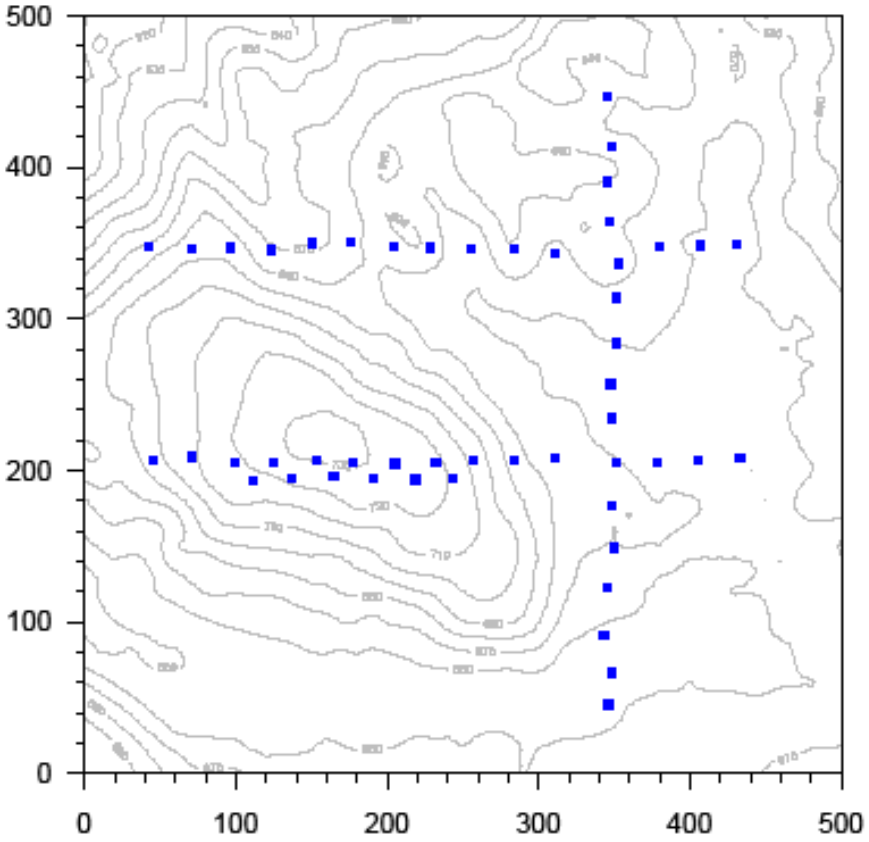
◆ Study site

- **Temperature: 18.2℃**
- **Precipitation: 4271 mm/yr**
- **Elevation: 600 – 730 m**
- **Subtropical evergreen rainforest**
- **110 woody species (67 genera and 39 families)**
- **Abundant families: Fagaceae and Lauraceae**
- **Be disturbed by typhoons frequently in summer**



Data from 1993 to 2004)

◆ Litterfall collection



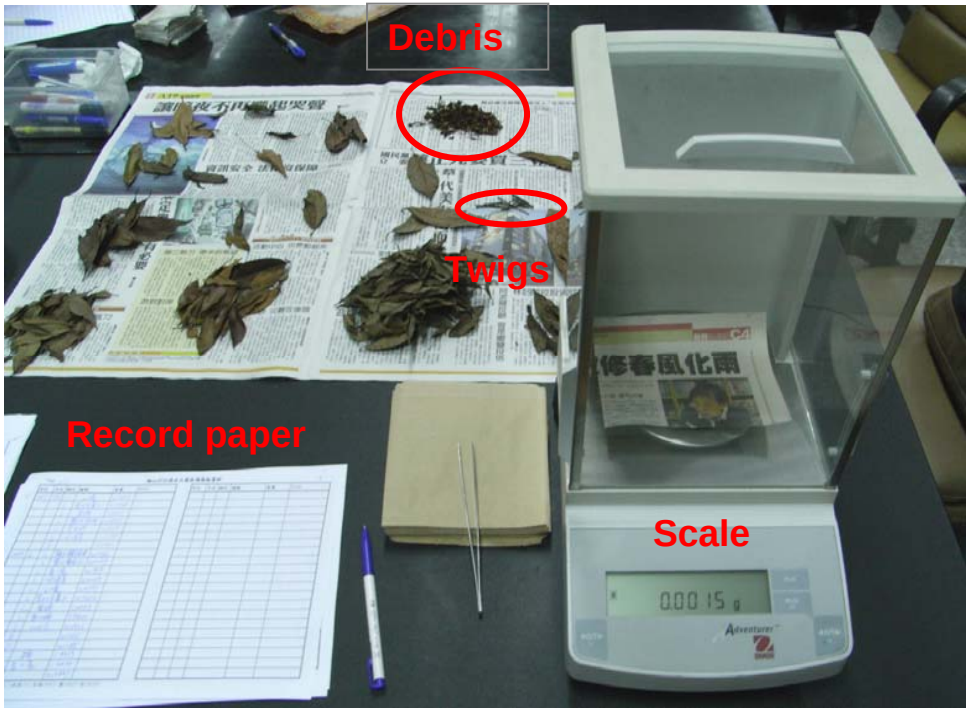
- Standard of trap:
  - Surface area: 0.5 m^2
  - Mesh: 1.6 mm
- Trap number: 50
- Collecting weekly:
  - 2002/09-2003/08 & 2004/03-2004/09
  - Twig (< 2 cm in diameter)
  - No reproductive bodies

◆ Litterfall treatment

Separately weighed (constant weight at 80℃)

Litterfall

- **leaf** → Separated by species
- **twig**
- **debris** → Organism no belong to leaf or twig



Limlia uraiana

Castanopsis carlesii

↓

One taxon: 烏來柯+長尾栲

Marchilus thunbergii

Marchilus japonica

Marchilus zuihoensis

Marchilus zuihoensis var. *mushaensis*

↓

One taxon: 楨楠屬

◆ Data analyses

1. Composition & litterfall pattern:

   (Data from 2002/09 to 2003/08)

2. Patterns of taxa: Cluster analysis (Pcord 4.0)
   (Data from 2002/09 to 2003/08)

3. Litterfall pattern during typhoon period:

   (Data from 2004/03/05 to 2004/09/04)

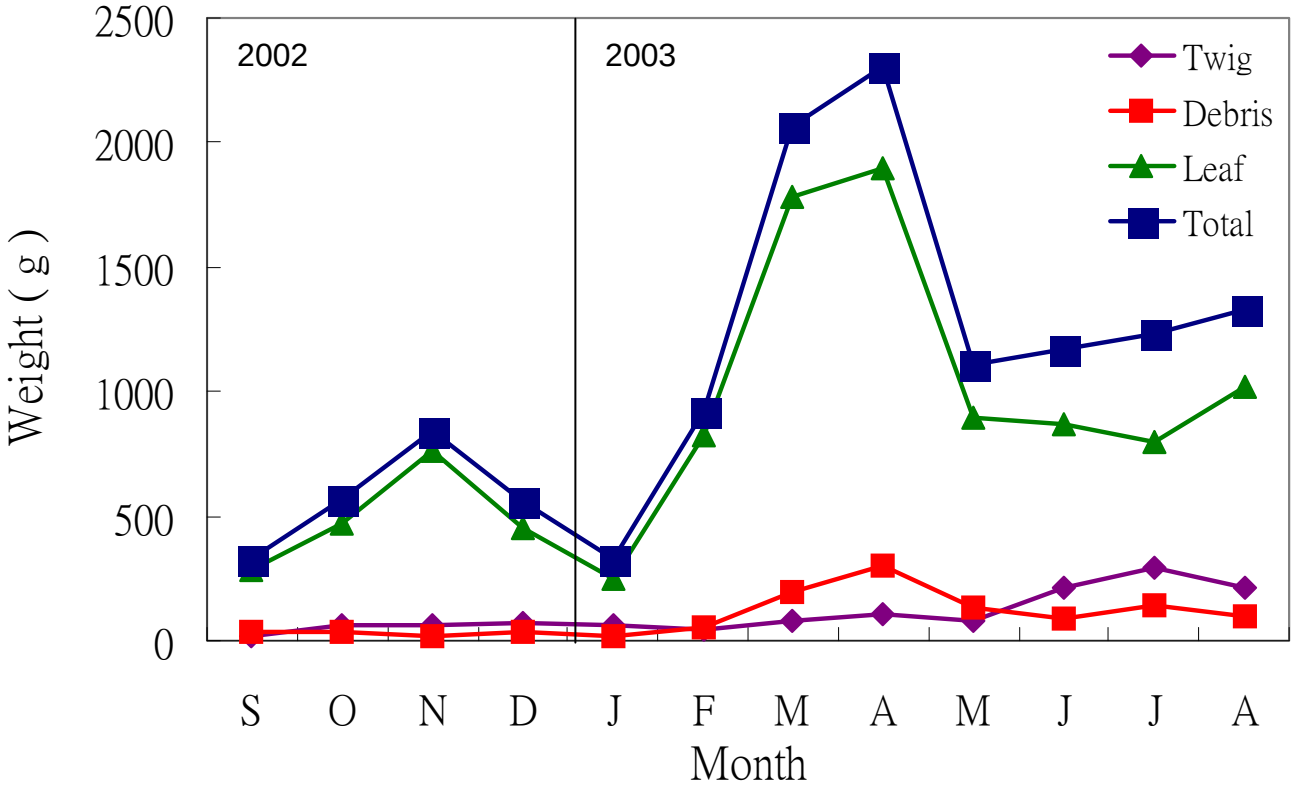
Results & Discussions

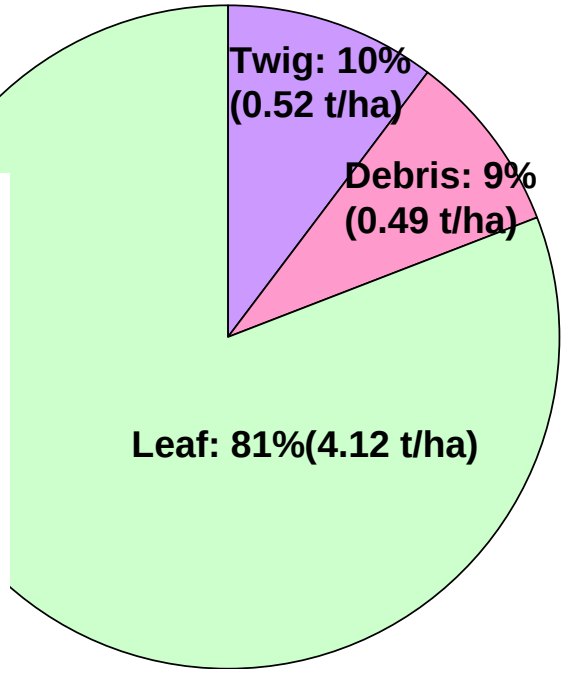
- To get the data of litterfall contributors, annual litterfall pattern, and leaffall patterns of different taxa
- To discuss the effects of typhoon disturbance

The litterfall contributors and patterns

- **Main peak in growth period; secondary peak in late autumn.**
- **Leaffall pattern almost responses to the total pattern.**

(Meentemeyer *et al*, 1982)



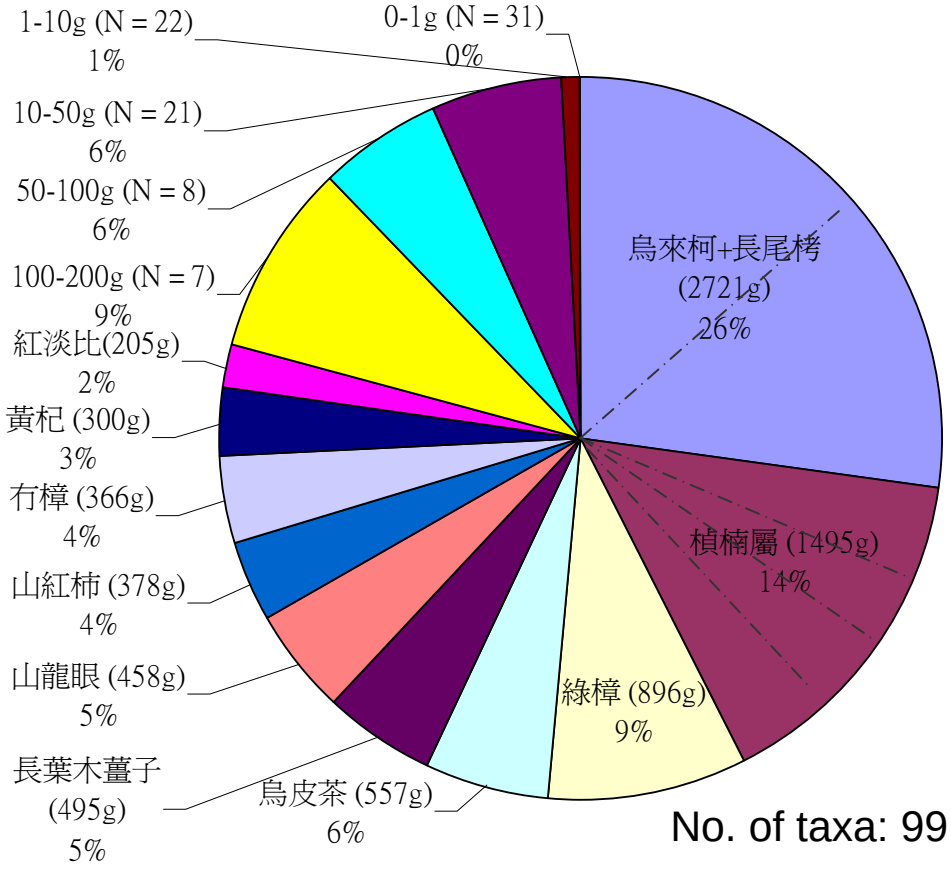


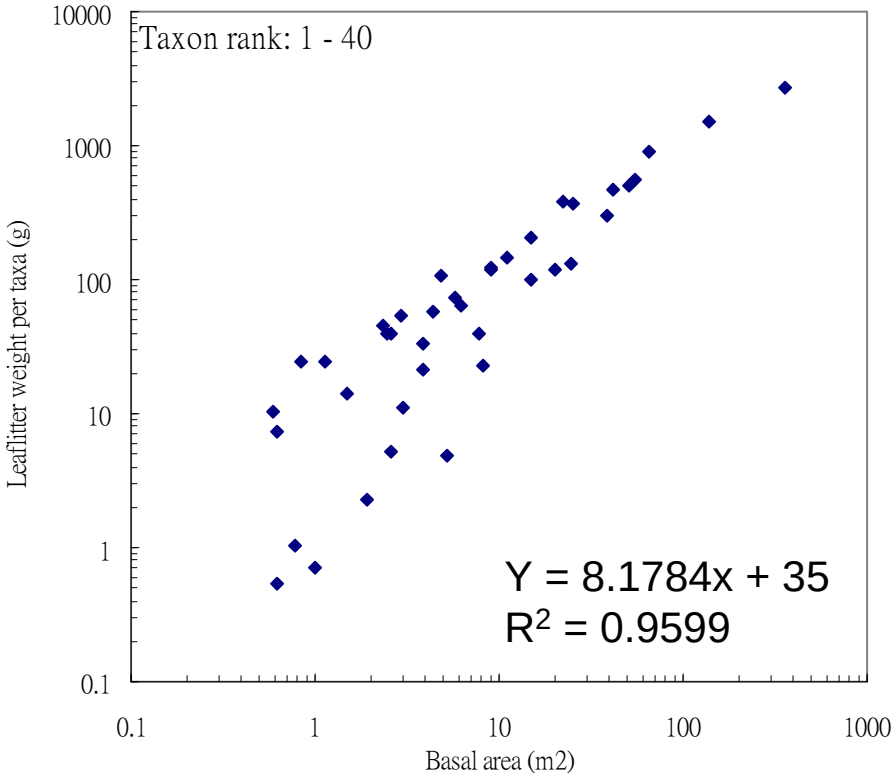
Total litterfall: 5.10 t ha^{-1}

- **More than 78% of total leaflitter was composed by 10 taxa (>14 spp.).**
- **The higher the basal area, the more the total leaf-litter.**

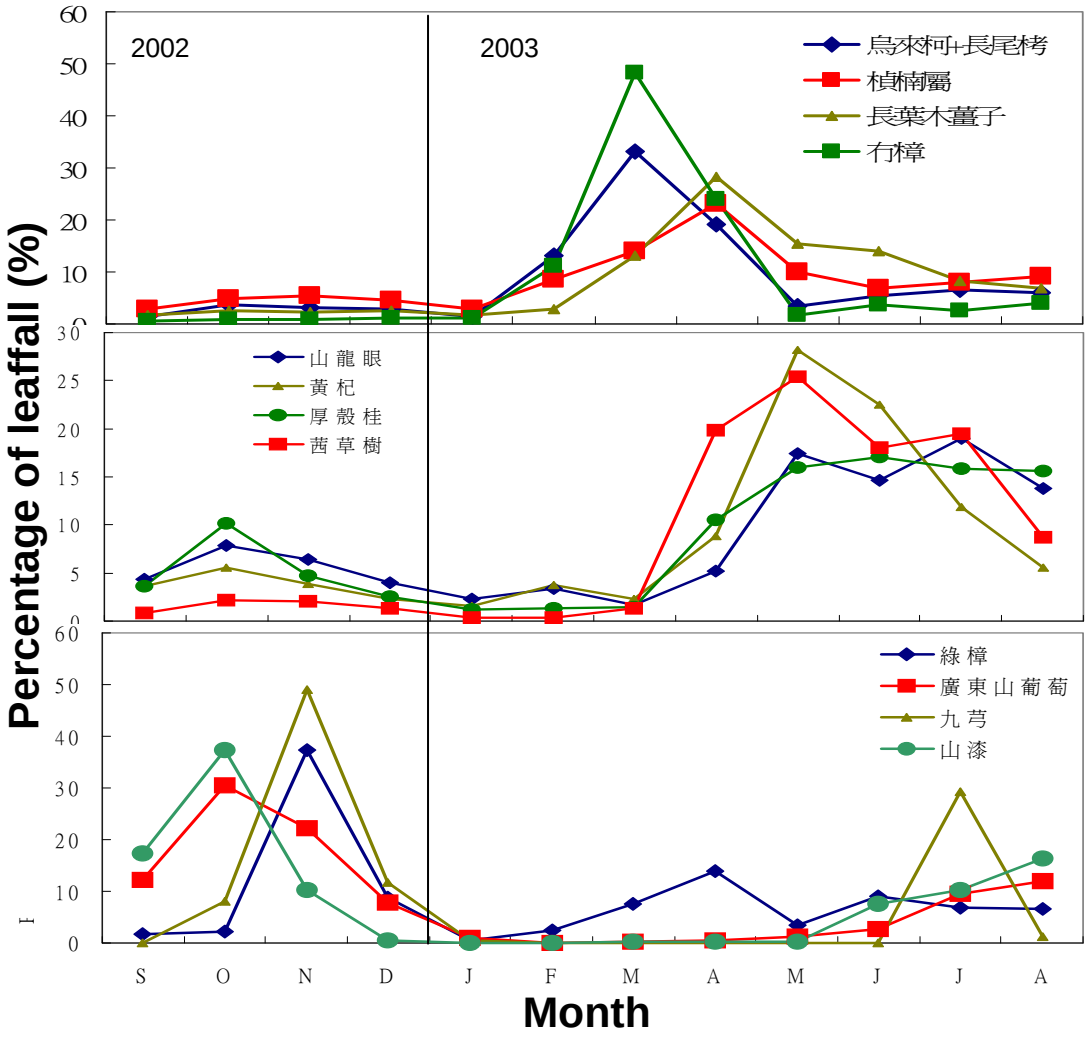
→A similar relationship between the leaf-fall and basal area was also found for evergreen and deciduous trees. (Alhamd, 2003)

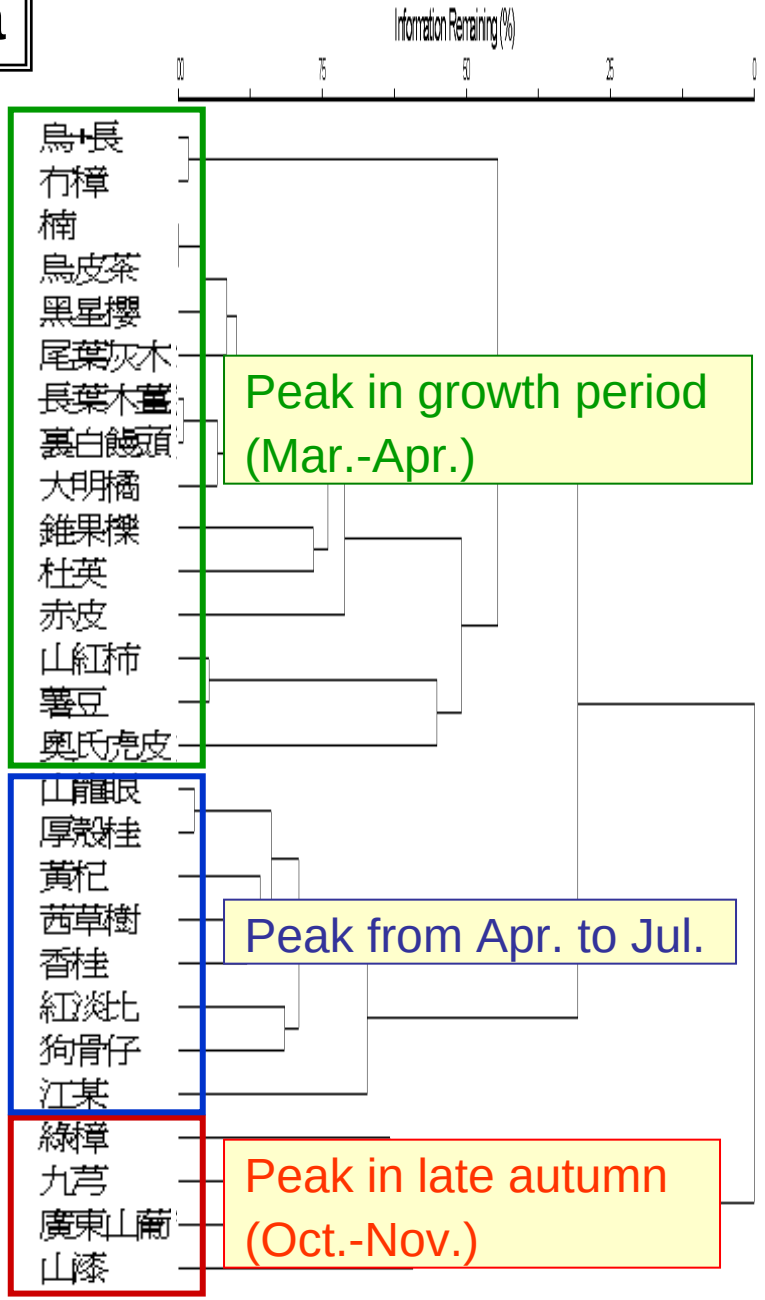
→Percentage of total leaf litter and basal area are significantly related in most cases so that one could be an index of the other. (John, J. R., 1974)





The leaffall patterns of different taxa

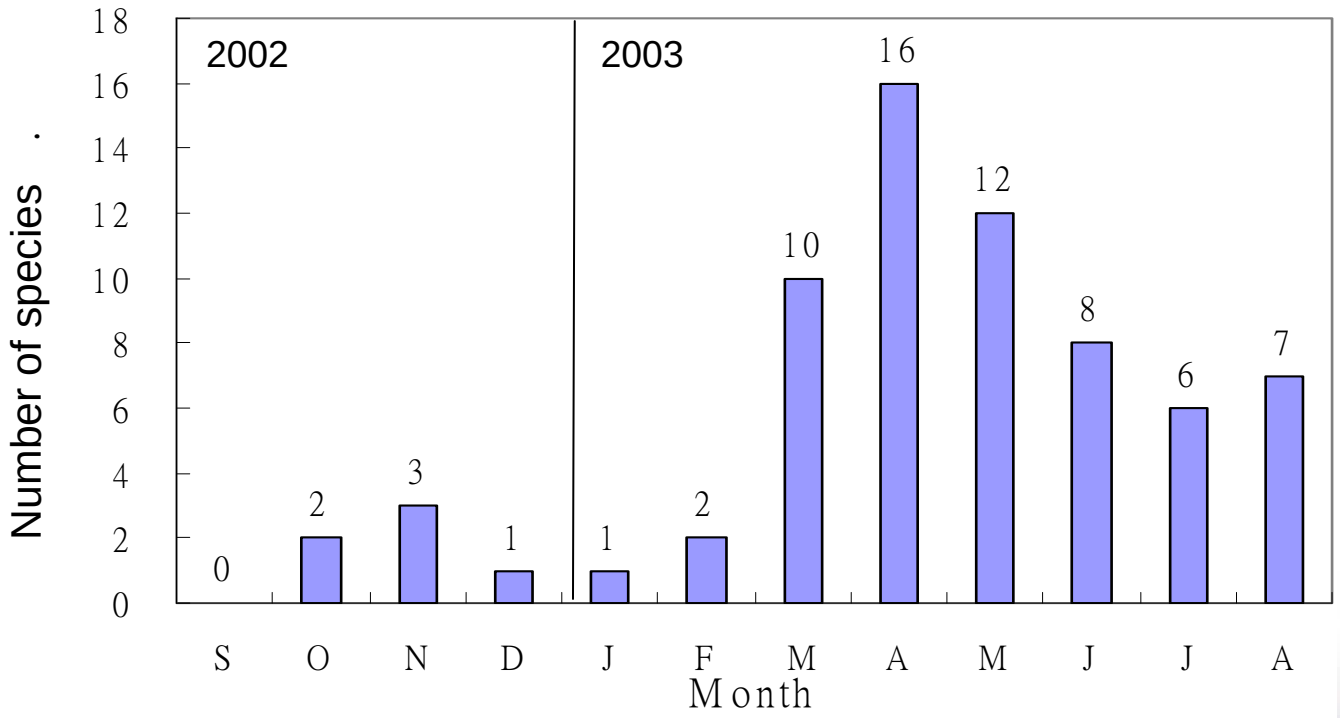




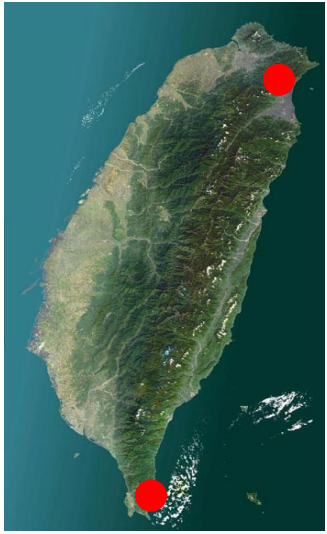
(Taxon number:27; total weight > 30 g)

•**A high proportion of taxa had leaffall peak during March to June.**

•**The phenomenon of leaffall peak during growth period is common in temperate evergreen forest.** (Facelli & Pickett, 1991)



Comparison Litterfall peak with internal studies

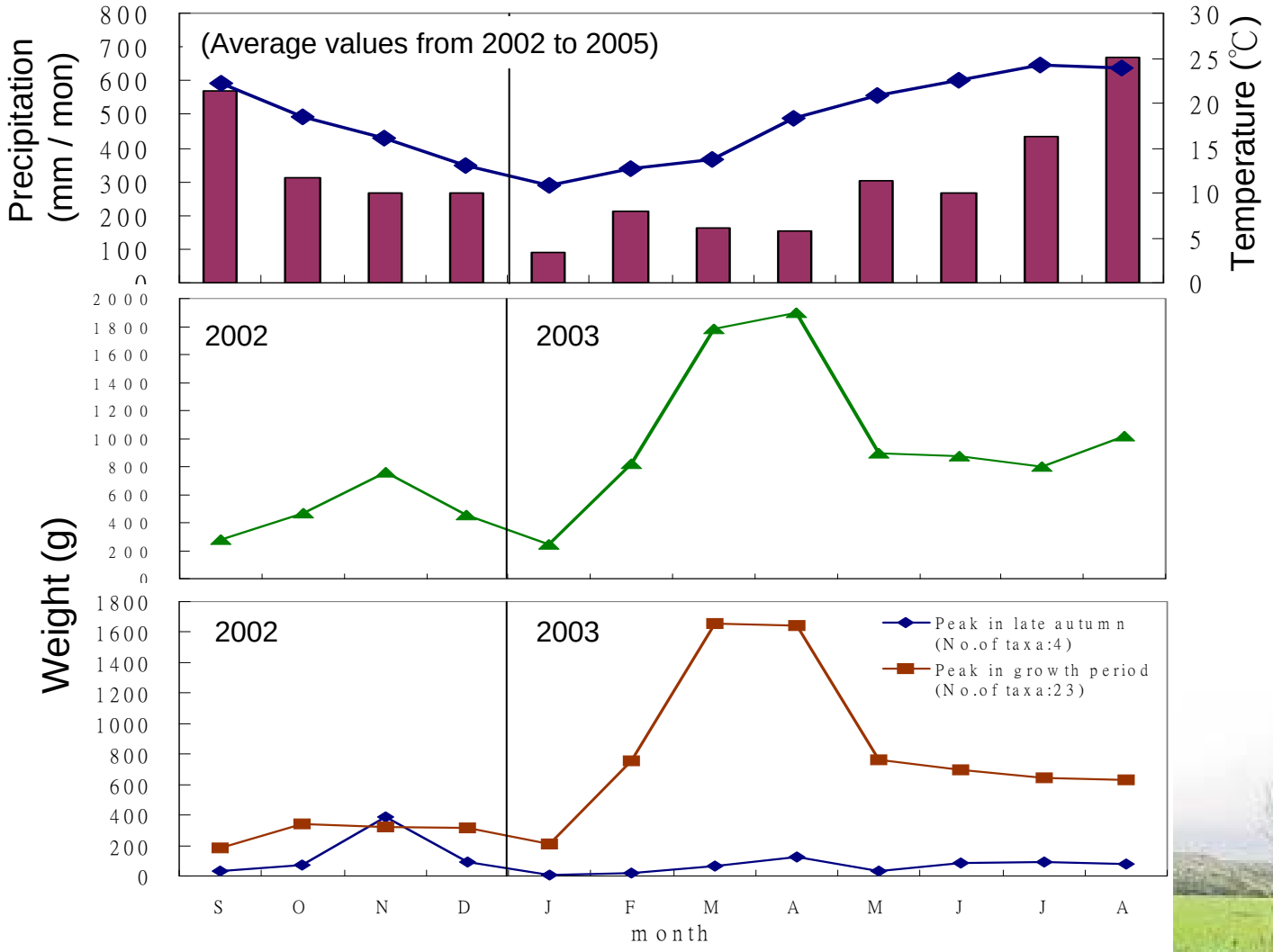


- **The peak in late autumn was special in Fushan.**

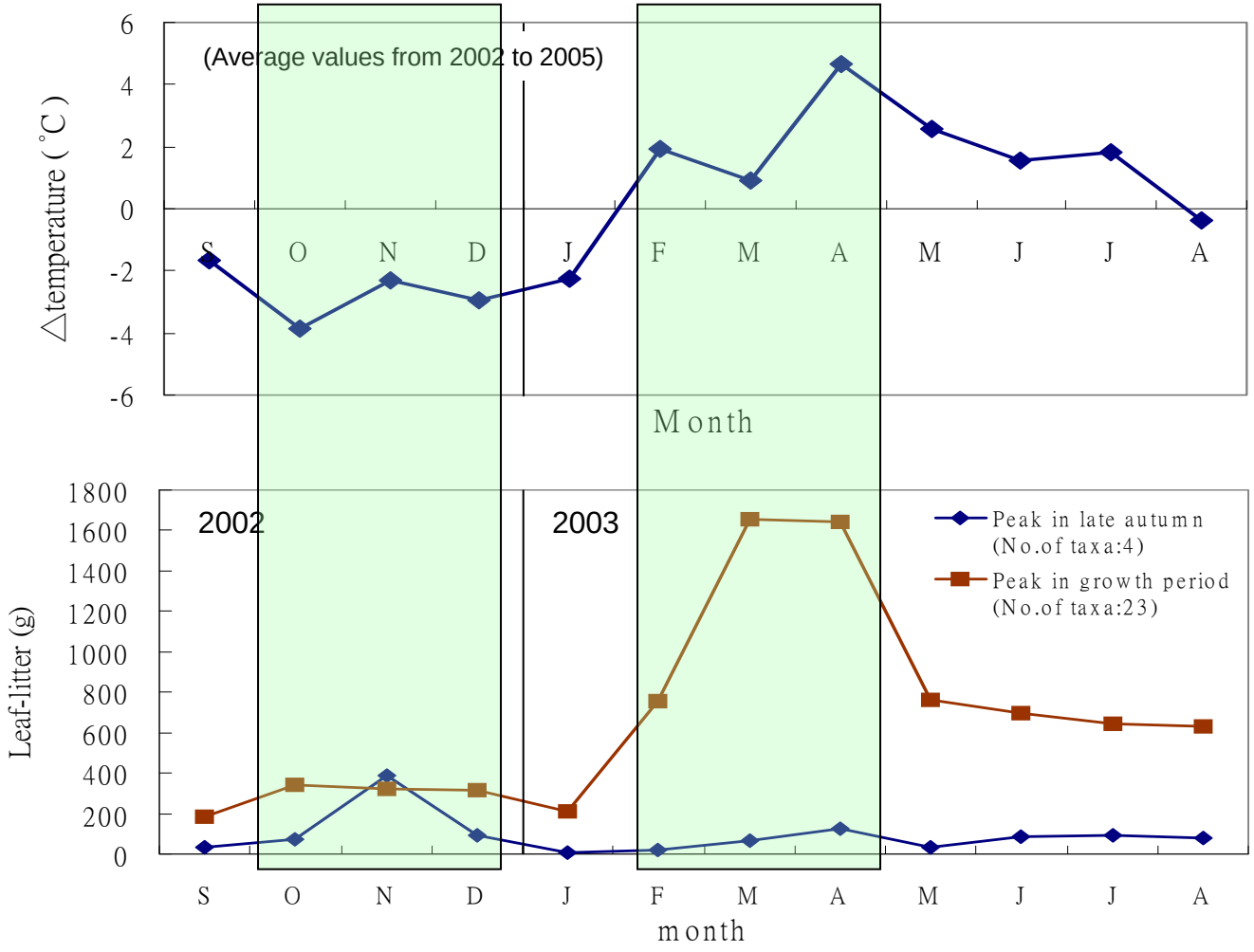
- High percentage of those taxa are temperate deciduous species. → Higher latitude? Lower temperature?

Study site	Forest type	Peak number	Study period
福山25公頃永久樣區	暖溫帶闊葉林	Tri-peaks: Mar.-May. → flushing period Jul.-Sep. → typhoon period Oct.-Dec. → late autumn	2002/09 -2003/08
福山試驗林	暖溫帶闊葉林	Bi-peaks: Mar.-Apr. → flushing period Jul.-Sep. → typhoon period	1992-2004 (Lin,2006)
南仁山西北坡樣帶	低地雨林	Bi-peaks: Mar.-Apr. → flushing period Jul.-Sep. → typhoon period	1995/09 -1997/08 (Chang, 1998)
南仁山欖仁樣區	亞熱帶雨林	Bi-peaks: Mar.-Apr. → flushing period Sep.-Dec. → northeast monsoon	1991/03 -1993/12 (Liu, 1994)

The correlation with environmental factors



- **Some taxa had peaks in late autumn when the △temp. was minus.**
- **Other taxa had peaks in growth period when the △temp. started to be plus.**

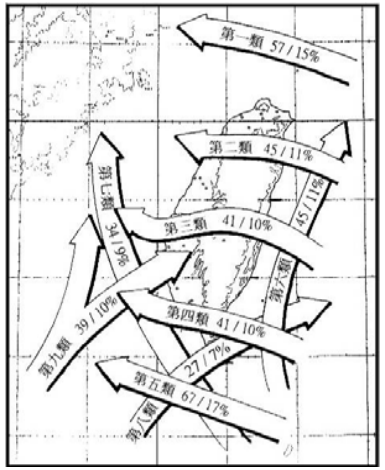


Results & Discussions

- To get the data of litterfall contributors, annual litterfall pattern, and leaffall patterns of different taxa
- To discuss the effects of typhoon disturbance

•The value of 8/27 is 11.79 times the total litterfall of 8/20.

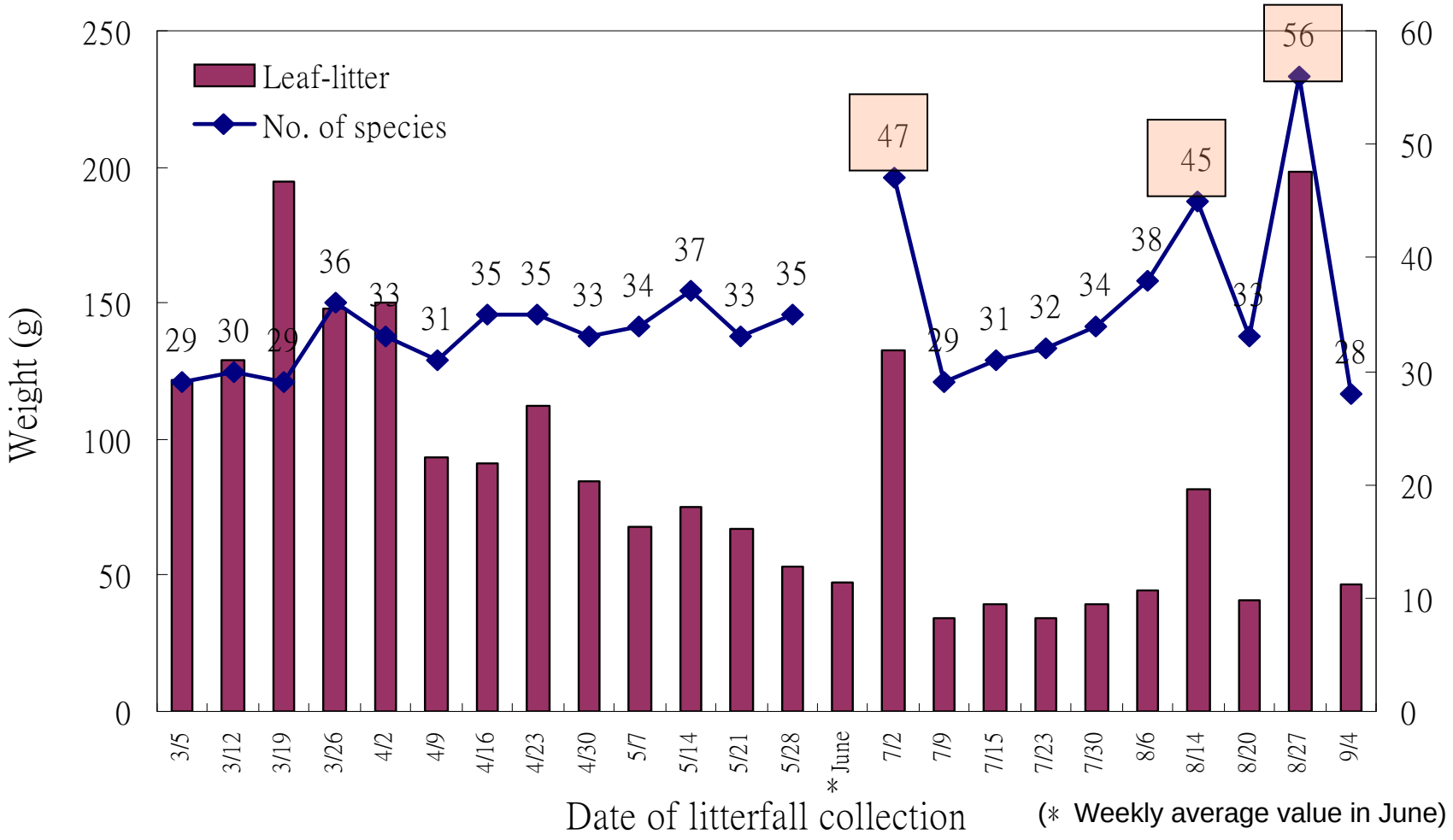
•A large amount of twig were significant increase under typhoon disturbance. (Tamotsu,2003)



(Data from 2004/03/05 to 2004/09/04)

•**Leaflitter diversity during typhoon period was larger than any others.**

•**The peak in growth period resulted from physiological flushing. But typhoon disturbance may blow down everything no matter what taxon it is.**



•**Total litterfall was less than other sites in similar latitude or tropics.**

•**The total Litterfall (5.10 t ha^{-1}) was similar with those study sites in warm temperate forest.** (Bray and Gorham,1964; Lonsdale,1984)

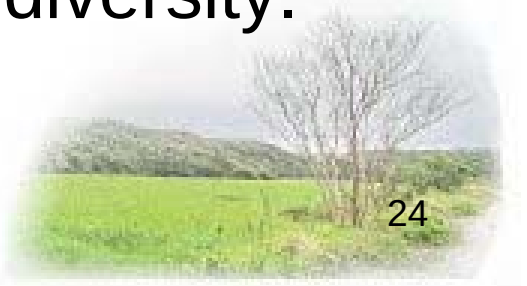
Study site	Type of forest	Latitude	Elevation (m)	Periciptation (mm)	*Total litterfall (t/ha)	Leaffall (t/ha)/ Percentage(%)	Twig (t/ha)	Debris (t/ha)
Garhwal Himalaya (India)	montane oak forest	30 24'N	1350-1500	1298	8.75	7.29 (83.8%)	1.26	
Shillong (India)	subtropical evergreen montane forest	25 00'N	1900		8.17	5.67 (69.4%)	2.5	
福山 25 ha 永久樣區	暖溫帶闊葉林	24 45'N	600-730	4271	5.1	4.12 (80.8)	0.52	0.46
福山地區 (洪富文 1995)	暖溫帶闊葉林	24 45'N	700	2700	3-8.2	2.7-5.4 (90%-66%)		
福山地區 (林國銓 1997)	暖溫帶闊葉林	24 45'N	600-700	3459	5.0-9.7	4.3-6.9 (86 - 71%)	0.7-2.8	
鼎湖山（廣東省）	亞熱帶常綠闊葉林	23 08'N	320-330	1930	6.63	4.73 (71.3)	1.9	
南仁山樣帶	低地雨林	22 03'N	250-480	3100	9.83	7.15 (72.7%)	2.1	0.58
南仁山欖仁樣區	亞熱帶雨林	22 03'N	300-330	2000	5.16	4.1 (79.5%)	0.87	0.19
黑石頂（廣東省）	亞熱帶闊葉林		400	1927	6.68	4.77 (71.4%)	1.91	
Hong Kong	evergeen oak-laurel	22 00'N	280-340	2800	5.3	4.3 (81.1%)	1.0	
Veracruz (Mexico)	lower montane forest	19 30'N	1225		8.15	5.89 (72.3%)	1.27	0.99
尖峰嶺（海南島）	熱帶山地雨林	18 37'N	850-900	1600-3000	6.0			
Jamaica	mor ridge forest	18 00'N	1550	2230	6.6	4.9 (72.4%)	1.52	
Jamaica	mull ridge forest	18 00'N	1550	2230	5.5	5.3 (96.4%)	0.22	
Jamaica	wet slope forest	18 00'N	1550	2230	5.6	4.4 (78.6%)	1.16	
Jamaica	gap forest	18 00'N	1550	2230	6.5	5.5 (84.6%)	0.91	
Volcan Barva (Costa Rica)		10 24'N	1000	4015	6.6			
Volcan Barva (Costa Rica)		10 24'N	2000	4015	5.8			
Volcan Barva (Costa Rica)		10 24'N	2600	4015	5.3			
Sabah (Malaysia)	montane rain forest	5 00'N	280-870	3132	5.7	3.82 (67.0%)	1.15	0.73
Cameroon	tropical evergreen lowland forest	4 05'N	234	1800-2600	12.43	7.31 (58.8%)	2.85	
Maraca Is. (Brazil)	lowland evergreen forest	3 20'N	0-50	2300	8.07	6.3 (78.1%)	1.34	0.43
Pasoh (Malaysia)	dipterocarp forest	3 00'N	100	2000	8.34	6.39 (76.6%)	1.51	0.44

∗ No include reproductive bodies

(Data from Liu,1984; Jayantha,2006)

Conclusions

1. There are three litterfall peaks in Fushan FDP:
    1. Main peak: growth period (Mar.-May)
    2. Secondary peak: late autumn (Oct.-Nov.)
    3. Instable peak: typhoon period
2. There are three kinds of leaffall patterns
    1. Peak in growth period
    2. Peak in late autumn
    3. Peak from April to July
3. Typhoon are crucial to the weight of twig.
   Besides, it also increase the leaflitter diversity.



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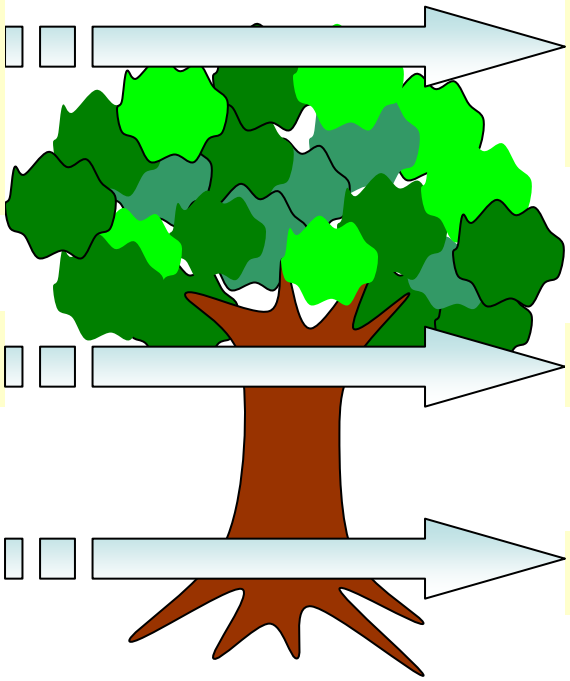
Acknowledgement


Thanks for your attention !

Different factors result in different phenomena.

Temperature
Rainfall
Photoperiod



The inter-annual patterns will be more synchronous and could be expected.

Phylogenesis

Variable leaffall patterns

Typhoon

Quantity will be large.