Tree Mortality and Recruitment in a Subtropical Forest in South China
华南地区亚热带森林树木的死亡和补员

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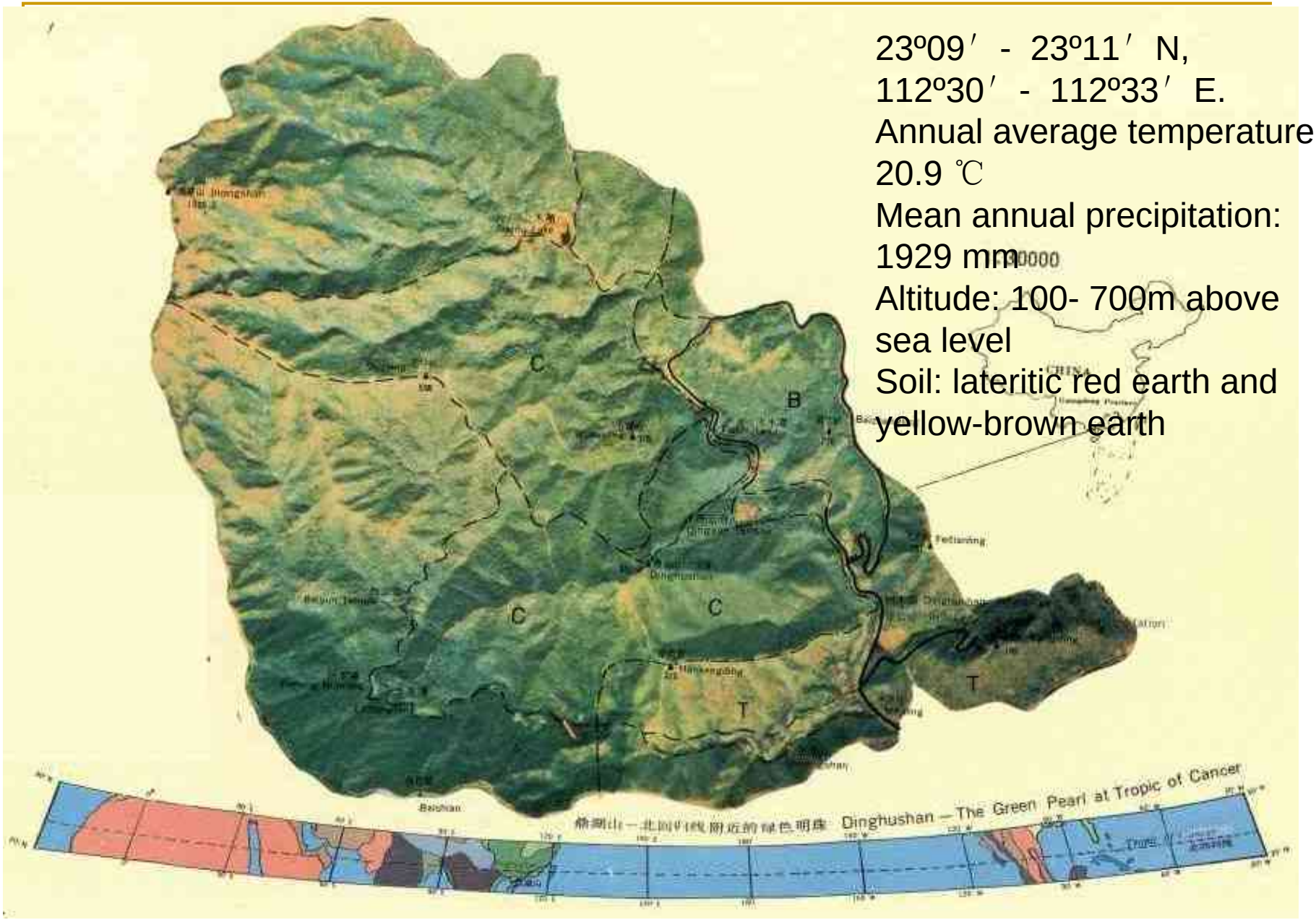
前言

- **死亡和补员:** 植物种群重要的描述工具 (Lewis et al 2004)
- **重要性：**种群的维持，演替，物种多样性维持
- **影响的因素:** 密度制约，微气候，生境异质
- **目的:** 检验死亡和补员过程中，是否受到密度制约和生境异质性的影响；在空间上是否完全随机



23º09′ - 23º11′ N,
112º30′ - 112º33′ E.
Annual average temperature : 20.9 ℃
Mean annual precipitation: 1929 mm
Altitude: 100- 700m above sea level
Soil: lateritic red earth and yellow-brown earth

样地和物种

1号秀风林：
1公顷，建于1992年，1999年进行复查

物种：
锥栗- Caschi, 荷木-Schsup, 厚壳桂-Crychi,
黄果厚壳桂-Crycon, 肖浦桃-Acmacu,
云南银柴-Apoyun, 柏拉木-Blacoc, 九节-Psyrub

方法

- 密度制约

死亡: logistic 回归;

补员: 补员发生所在位置的邻近密度与随机产生的点的邻近两年密度进行平均值的比较 (Condit, et al., 1994)

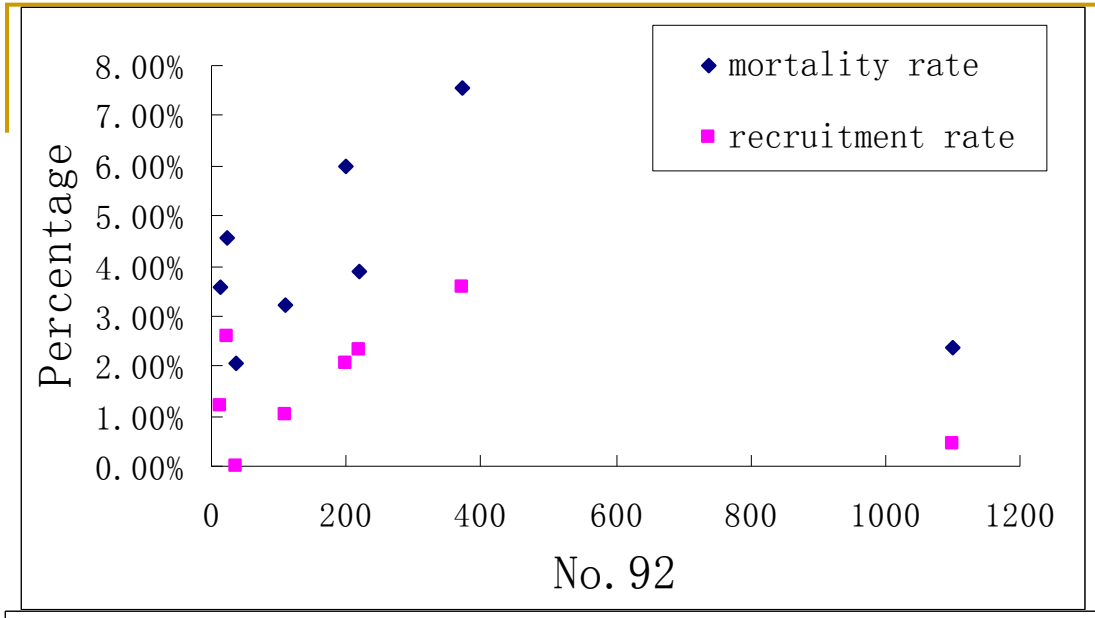
- 土壤性质：方法分析.

响应变量：死亡率和补员率；预测变量：全N，有效N，有效P，有效K，有机质，pH，水分含量（周霞于2002年测定）。尺度：5m*5m小样方

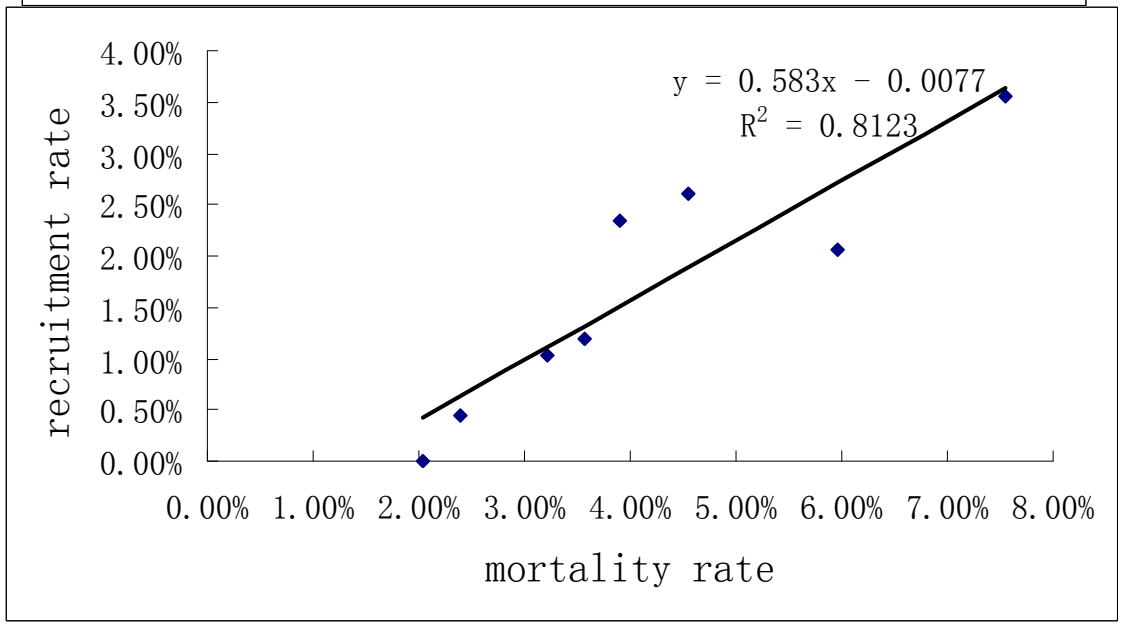
- 是否随机：Ripley's K 方程

鼎湖山季风林1号重要物种7年间种群变化

物种	No.92	No.99	No. died	No. recruit	death rate	recruitment rate
锥栗	12	10	3	1	3.57%	1.19%
荷木	35	30	5	0	2.04%	0.00%
厚壳桂	22	19	7	4	4.55%	2.60%
黄果厚壳桂	201	146	84	29	5.97%	2.06%
肖蒲桃	111	94	25	8	3.22%	1.03%
云南银柴	1100	950	184	34	2.39%	0.44%
柏拉木	373	269	197	93	7.55%	3.56%
九节	220	196	60	36	3.90%	2.34%



除云南银柴外,死亡率和补员率随初始密度增加而增加



死记率与补员率呈良好的正相关

最近邻体距离对死亡的影响

物种	r=5		r=7.5		r=10	
	coef.	sig	coef.	sig	coef.	sig
黄果厚壳桂	0.4137		0.3935		0.4086	
肖蒲桃	0.1033		-0.1161		0.1269	
云南银柴	-0.0285		-0.0588		-0.0586	
柏拉木	0.5197	.	0.2327		0.1918	
九节	-0.6044		-0.661	.	-0.6107	

都不显著(P>0.05), 回归系数>0,促进死亡;
<0, 降低死亡的可能性

同种个体对死亡的影响

物种	自变量	r=5		r=7.5		r=10	
		coef.	sig	coef.	sig	coef.	sig
黄果厚壳桂	CN	-0.0441		-0.0543		-0.04	
	CA	-0.0002		-0.0002		-0.0001	
肖蒲桃	CN	0.4526	**	0.3634	**	0.255	**
	CA	0.0017		0.0003		0.0001	
云南银柴	CN	0.0038		0.0003		0.0023	
	CA	0.001		0.0002		0.0002	
柏拉木	CN	-0.0024		0.0076		0.0243	
	CA	-0.003		0.0003		0.0051	
九节	CN	0.0078		0.0022		0.0065	
	CA	0.0008		0.0001		0.0006	

除黄果厚壳桂外,同种个体都有促进死亡的作用,但是只有肖蒲桃是显著的

不同种个体对死亡的影响

物种	自变量	r=5		r=7.5		r=10	
		coef.	sig	coef.	sig	coef.	sig
黄果厚壳桂	HN	-0.0341	*	-0.0077		-0.0023	
	HA	-0.0001		0		0.0001	
肖蒲桃	HN	-0.0362		-0.0157		-0.0161	.
	HA	0		-0.0001		-0.0001	
云南银柴	HN	0.0097		0.0049		0.0049	
	HA	0		0.0001	*	0.0001	**
柏拉木	HN	-0.0093		0.0014		0.0065	
	HA	-0.0001	**	0		0	
九节	HN	0.0303		0.0145		0.0043	
	HA	0.0001		0.0001	.	0	

同种个体对补员的影响

1.锥栗

2.厚壳桂

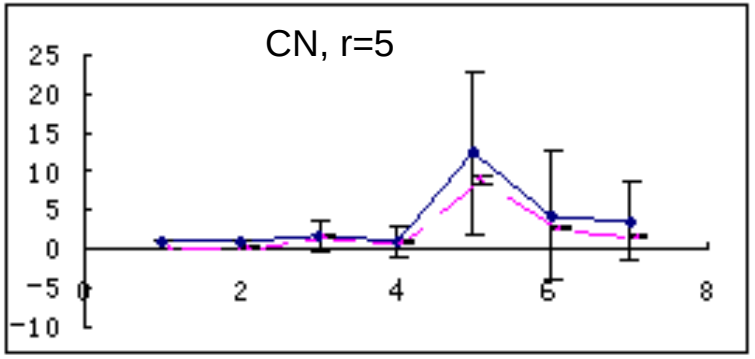
3.黄果厚壳桂

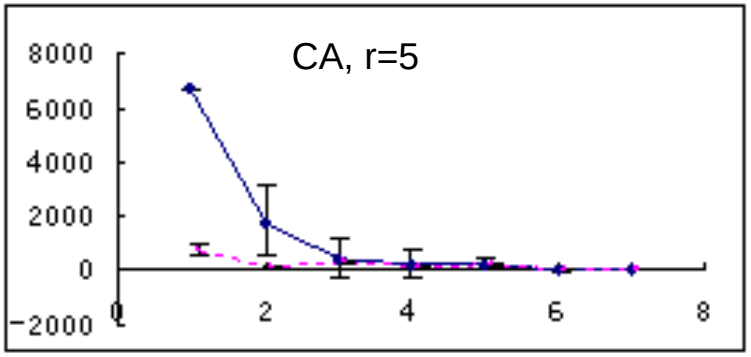
4.肖蒲桃

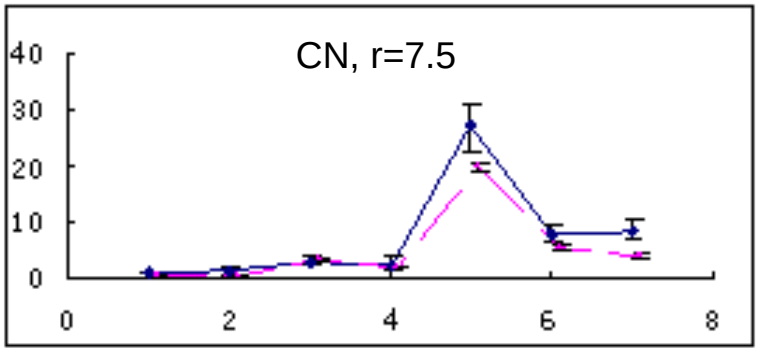
5.云南银柴

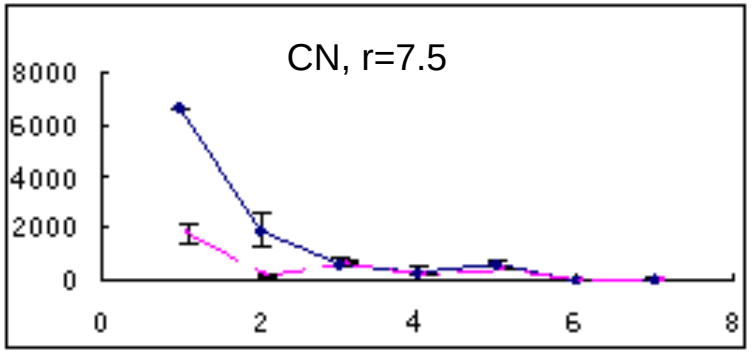
6.柏拉木

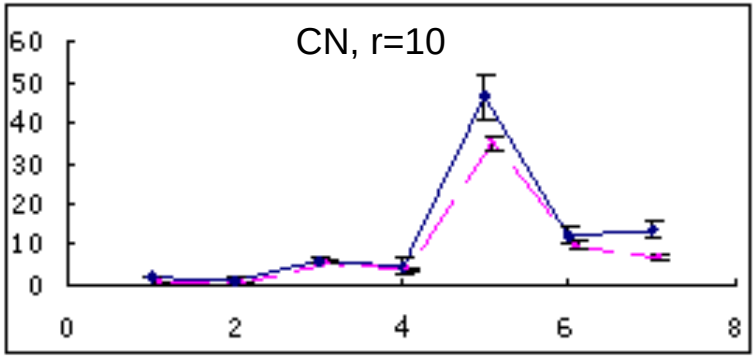
7.九节

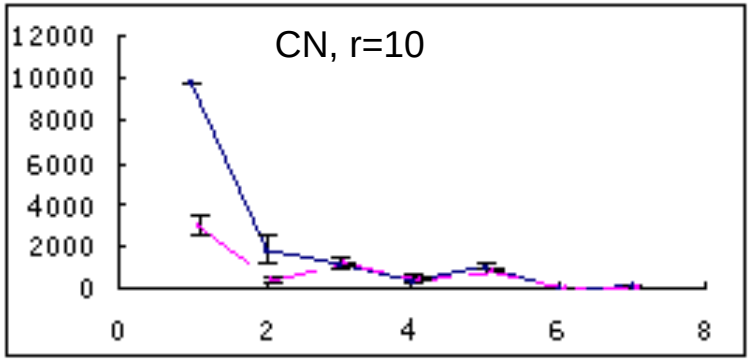












- 同种: 新补充个体5m内, 不显著

  7.5m和10m内, 有4个种显著大于随机点的CA和CN,锥栗,厚壳桂,云南银柴,九节
- 不同种:新补充个体数较多的种都不显著

土壤

土壤营养元素含量与死亡的关系

Species	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Crycon	P	4	2.0028	0.5007	2.5759	0.04022	*
	Residuals	140	27.2126	0.1944			
Apoyun	K	4	0.6837	0.1709	2.6326	0.03436	*
	organic matter	4	1.0921	0.273	4.2055	0.002487	**
	Residuals	311					

土壤营养元素含量与补员的关系

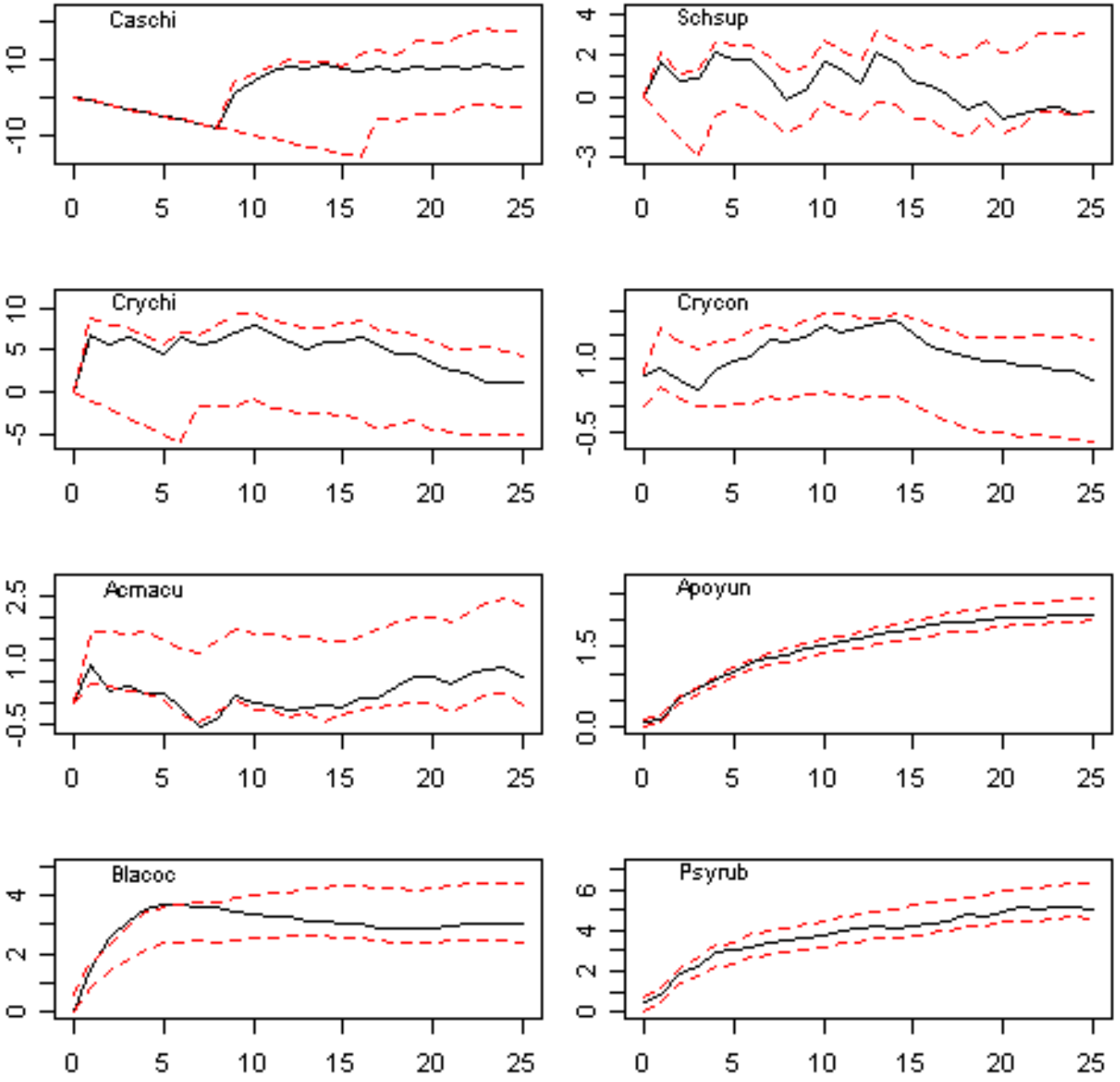
Species	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Crycon	P	4	2.1053	0.5263	2.5804	0.03994	*
	Residuals	140	28.5567	0.204			
Apoyun	K	4	0.3885	0.0971	2.4549	0.04579	*
	Residuals	315	12.4614	0.0396			
Psyrub	totalN	4	2.7412	0.6853	3.0611	0.01917	*
	Residuals	123	27.5357	0.2239			

死亡和补员在空间分布上是否完全随机

死亡是否随机？->实际活树分布格局是否与随机死亡产生的活树分布格局显著不同？->怎样模拟随机死亡?->随机删除相同数目的树木->重复很多次->得到随机死亡的分布格局95%的置信区间，用于死亡是否随机（He and Duncan, 2000)

同样的方法检验补员是否随机，唯一不同的是不是删除而是增加相同数目的树木

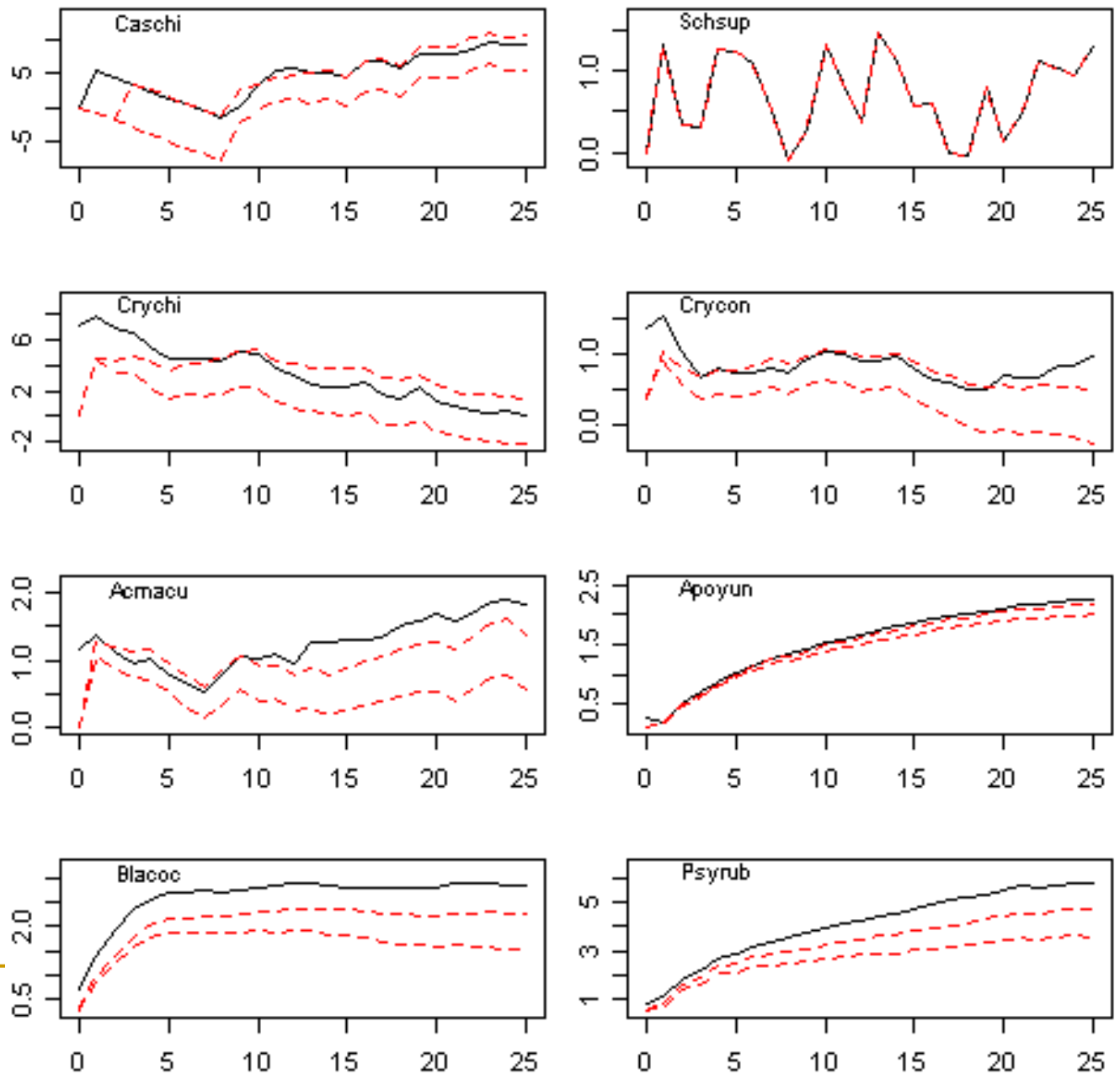
Test of random mortality using spatial pattern analysis



红线：假设随机死亡95%置信区间

黑线：观察值

Test of random recruitment using spatial pattern analysis



红线：假设补员随机发生95%的置信区间

黑线：观察值

Conclusion

- Mortality of trees in our plot is possibly regulated mainly by random process, accompanied with a couple of factors including density dependence and soil nutrient content; recruitment is largely limited by seed dispersal and subsequent seedling survival may be related to the amount of available soil nutrient.

Discussion:

- Why do we fail to find significant density dependent mortality?
- Mortality was essentially random by the time trees reach 1cm DBH Wills and Condit(1999) .
- Many studies that found significant links between density and mortality did not control spatial heterogeneity (Queenborough et al, 2007; Peters, 2003; Uriarte et al, 2004). The significant relations in these studies could be confounded with environmental factors (He and Duncan, 2000).
- Time interval is relatively short; mortality rate is low; the sample size is small.

- Why do recruits gather around conspecifics?
- Most tree seeds fail to disperse far from the maternal parent(Janzen 1970; Connell 1971; Clark J. S. et al. 1999; Hubbell et al. 1999). Even if seeds were able to disperse at much greater distances form parents along the gap edge, the available substrate was greatly less hospitable, and individual seedlings had a lower chance of becoming established(LePage, et al., 2000).


Thank you!