福山亞熱帶森林樹種空間分布特性

Spatial patterns of tree distribution in Fushan subtropical rainforest

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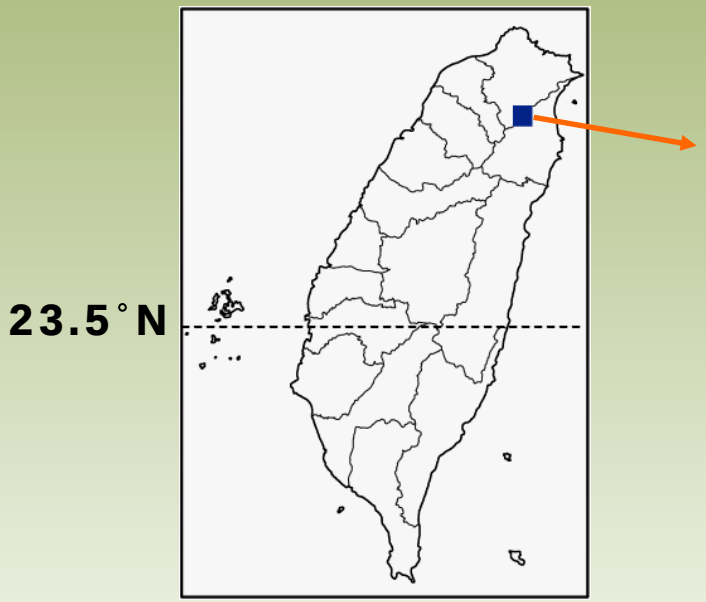
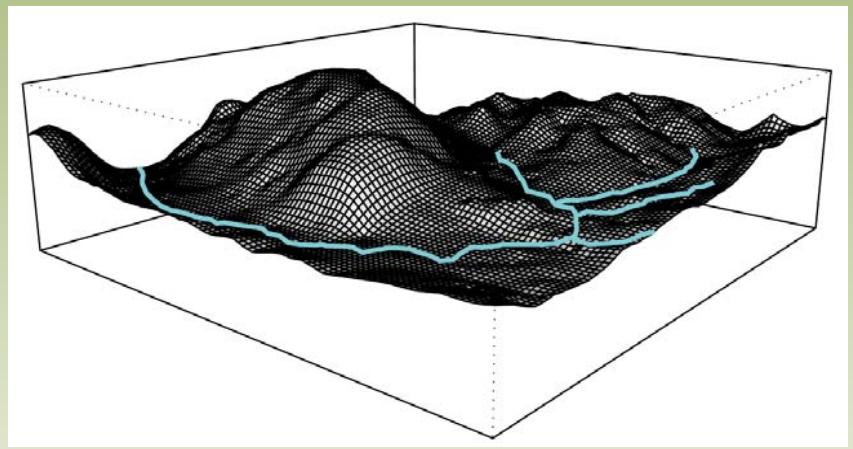
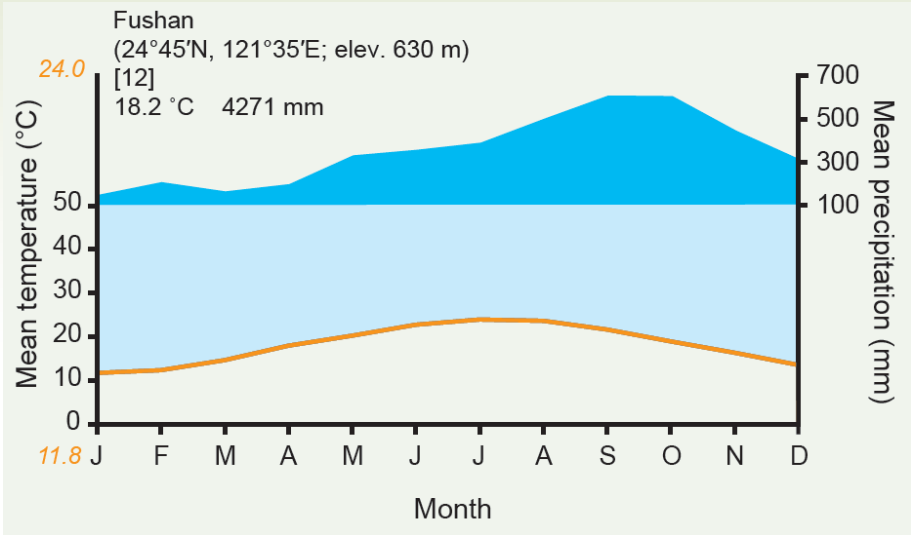
Fushan Forest Dynamics Plot

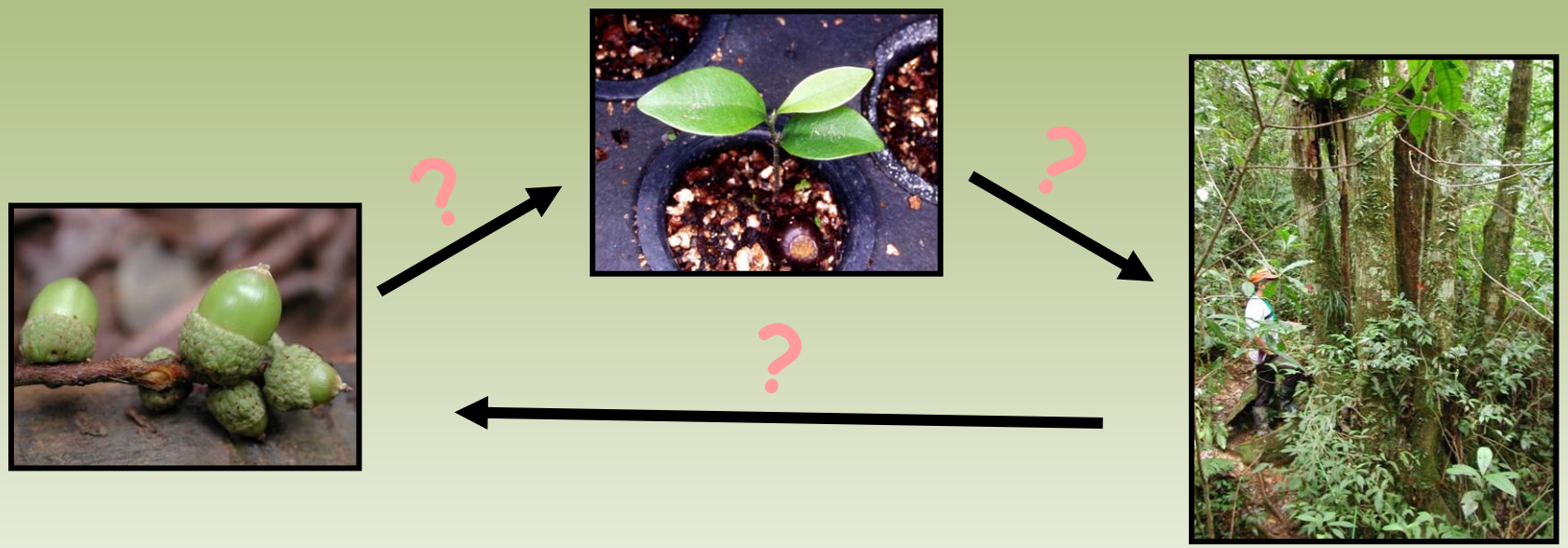




- Location: 121˚35'E, 24 ˚45'N
- Altitude: 616-748 m
- Subtropical montane forest,
- Warm and humid climate; frequent typhoon disturbances



The implication of tree distribution



- Biology and environment
  - dispersal, recruitment, growth, mortality
- History
  - disturbance, pest, disease
- Chance

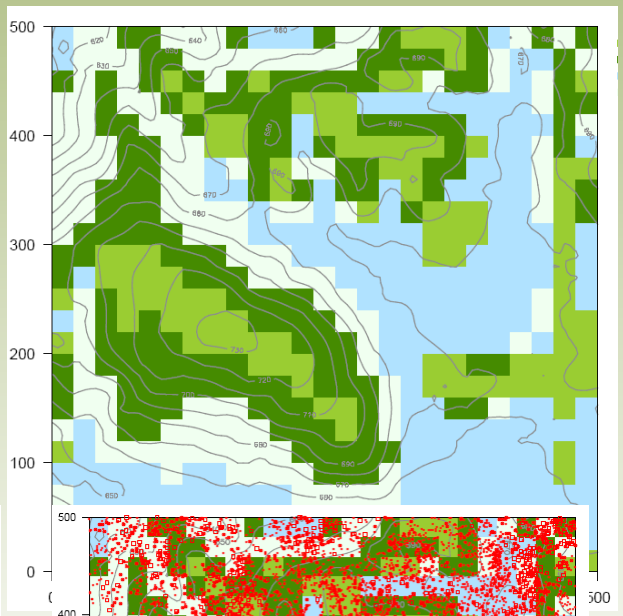
Spatial analyses on tree distribution

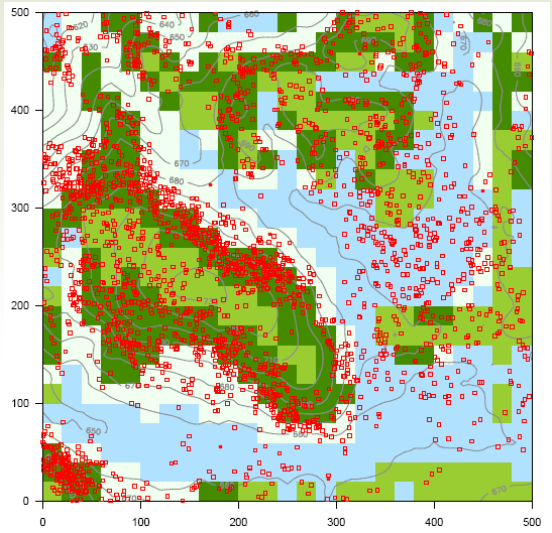
- Environmental effect
  - Habitat association
- Biological process
  - Intra-species interaction
    - Univariate point pattern analysis
    - Marked point pattern analysis
    - Cluster analysis (Plotkin et al., 2002)
  - Inter-species interaction (species association)
    - Bivariate point pattern analysis
- Spatial modeling (*e.g.* PCNM approach)

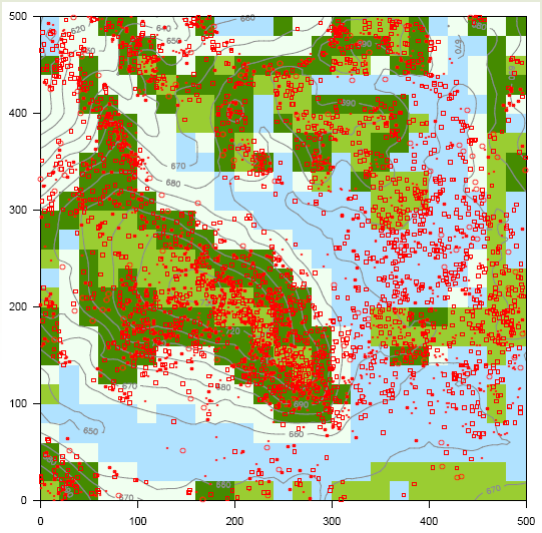
Habitat association

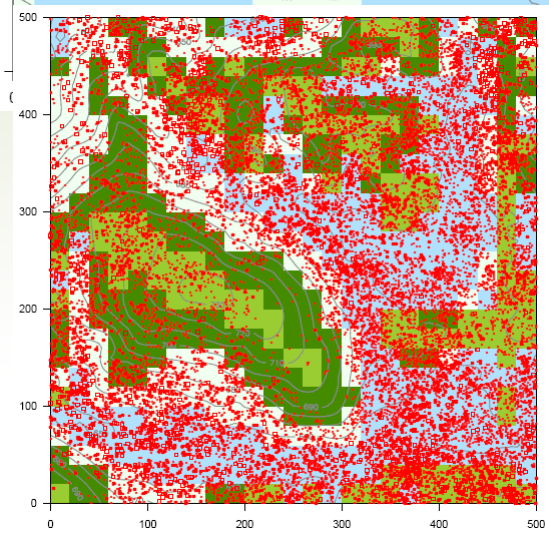
- Four micro-topographic habitat types

	Convexity	Mean slope
Plateau	+	-
High-slope	+	+
Valley	-	-
Foothill	-	+



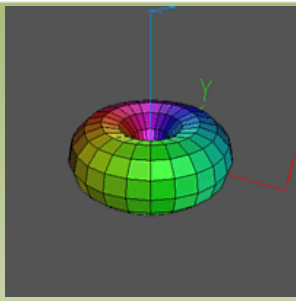






Torus translation test (Harms et al., 2001)

- 57 out of 69 species > 50 individuals/25 ha (83%) show significant associations with habitats



Habitat type	Positively associated species	Negatively associated species	**Subtotal**
Plateau	7	10	**17 (25%)**
High-Slope	20	13	**33 (48%)**
Foothill	15	19	**34 (49%)**
Valley	8	23	**31 (45%)**
Subtotal	**45 (65%)**	**52 (75%)**	**57 (83%)**

Density ratio test (Valencia et al., 2004)

- Bootstrapping approach
  - Randomly resample quadrats and compute density ratios among different habitat types
  - Derive reference distributions

Habitat comparison	Similar in abundance	1.5-fold different in density	5-fold different in density	Significantly different in abundance
High-slope vs. foothill	21	54	12	53
High-slope vs. plateau	45	30	5	29
High-slope vs. valley	19	58	20	55
Foothill vs. plateau	17	57	17	56
Foothill vs. valley	31	40	1	36
Plateau vs. valley	22	54	12	50

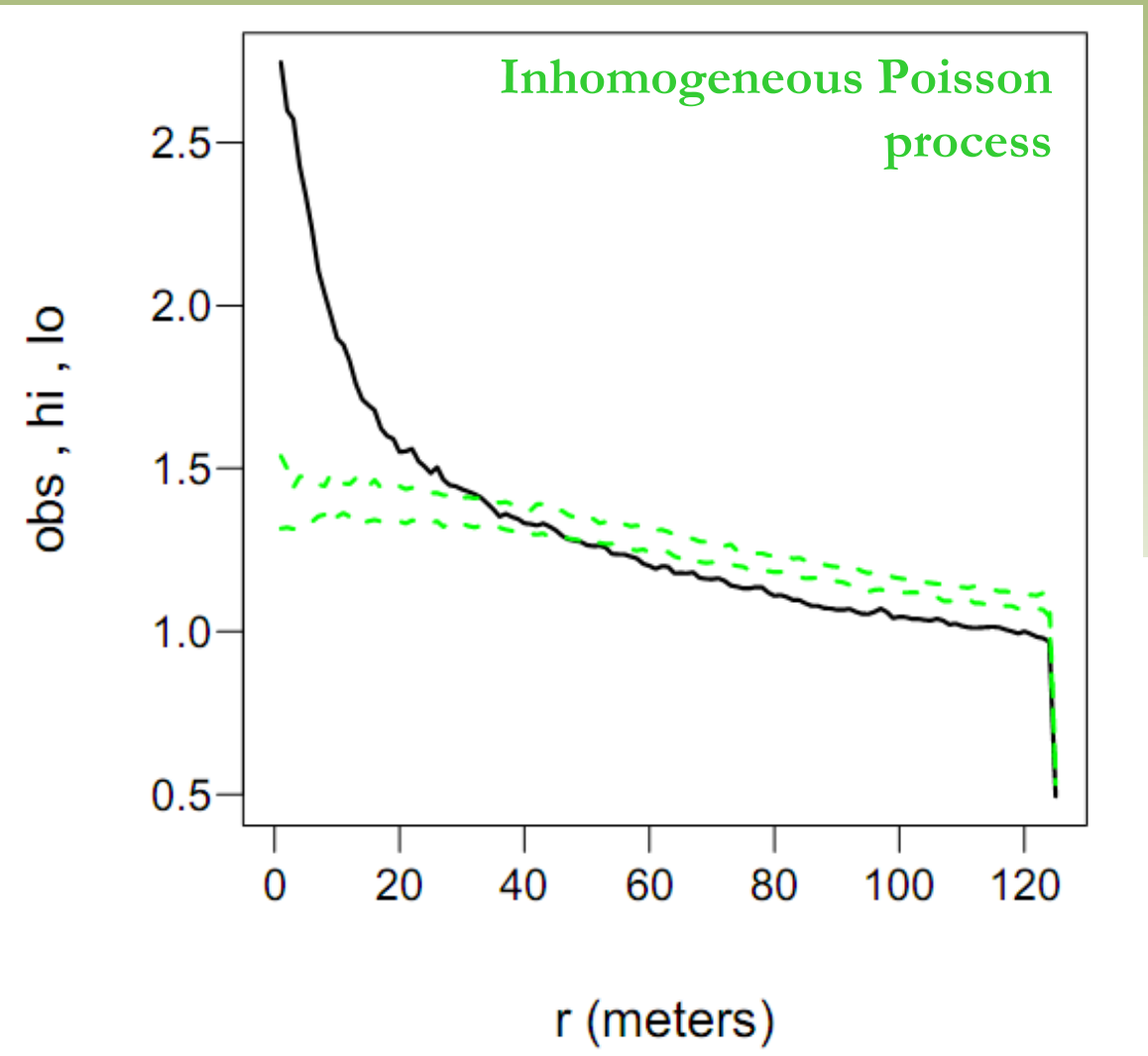
A brief summary

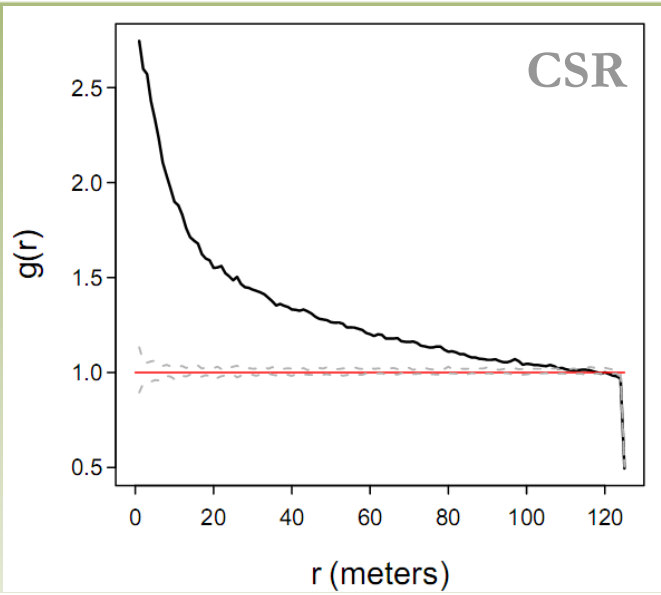
- There is strong micro-topographic habitat associations in Fushan FDP
- Over half of tree species distribute "inhomogeneously" between habitat types
- Is there any biological processes contributing to tree distributions?

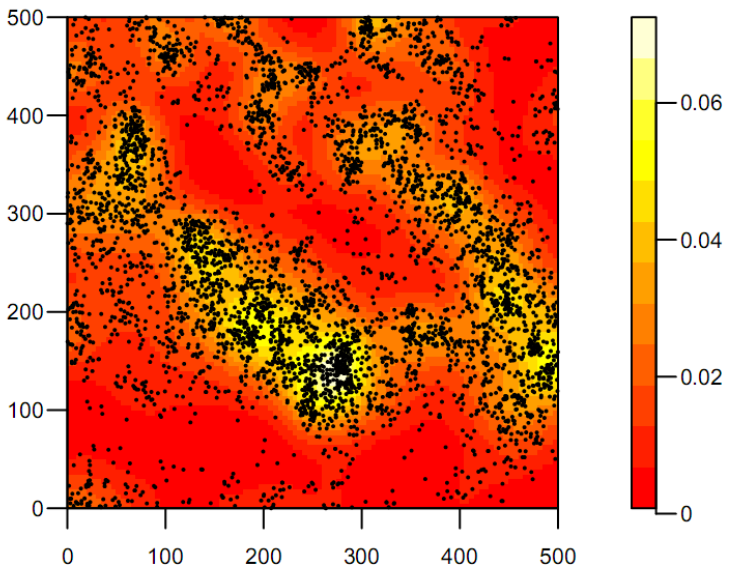
Intra-species interaction

- Spatial poiont pattern analysis
  - H_0: inhomogeneous Poisson process
    - use local intensity as a surrogate of environmental factors
  - Method: pair correlation function (O-ring statistics)
  - Performed under R package "spatstat" (Baddeley and Turner, 2005)
- Nine dominant species were selected to analyzed

Castanopsis cuspidata 長尾栲

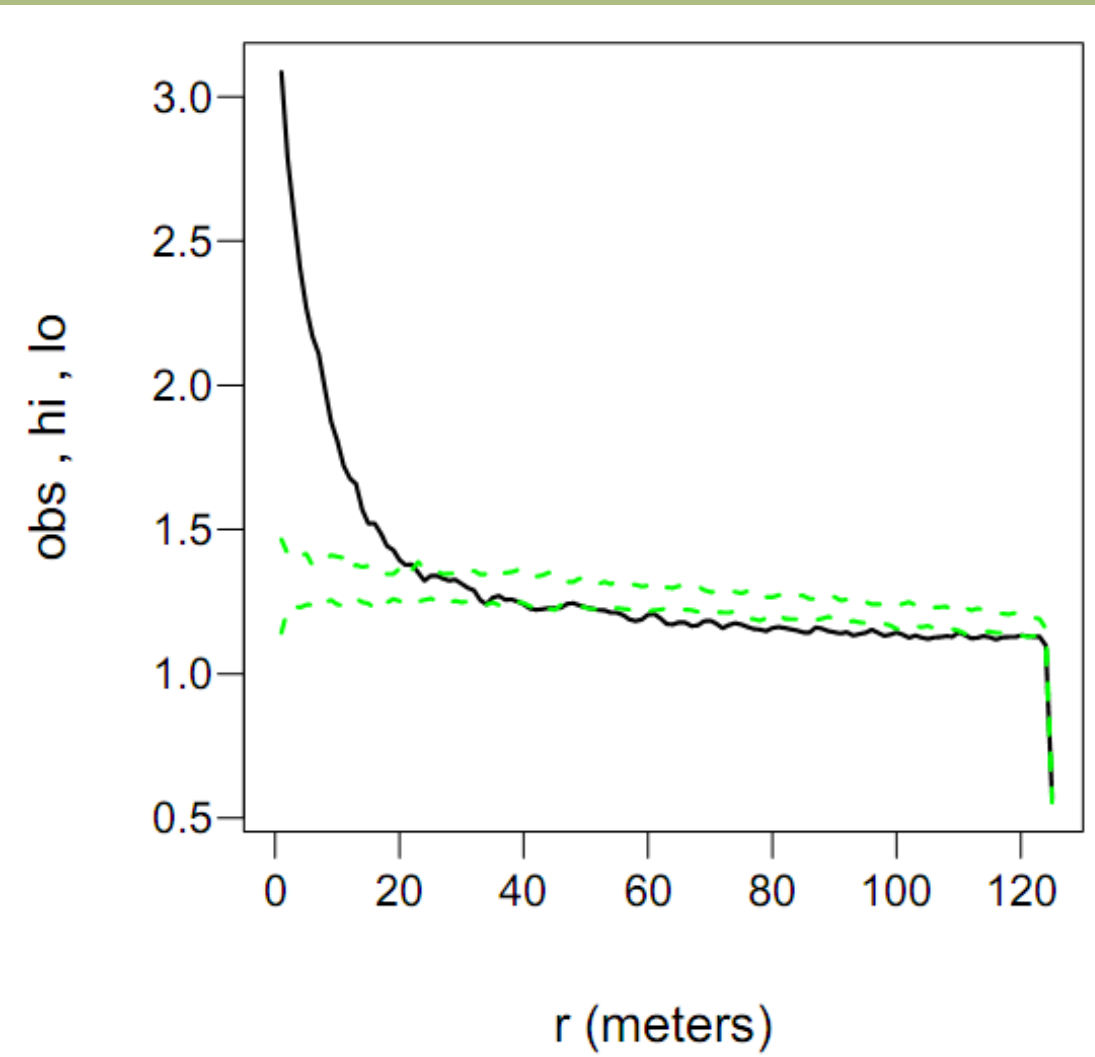


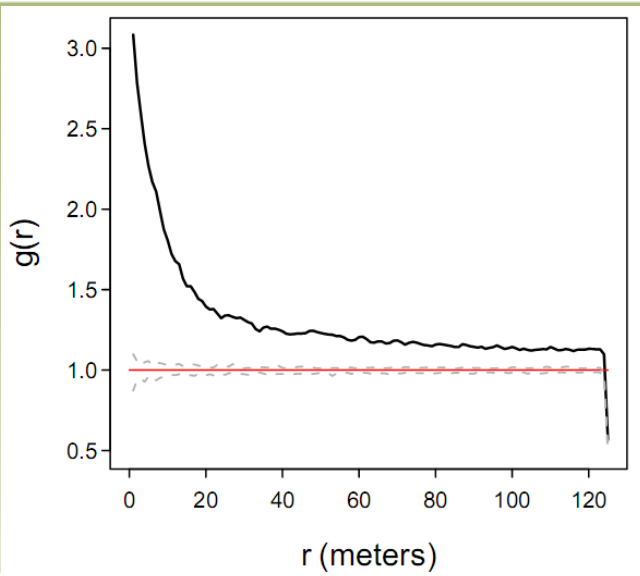


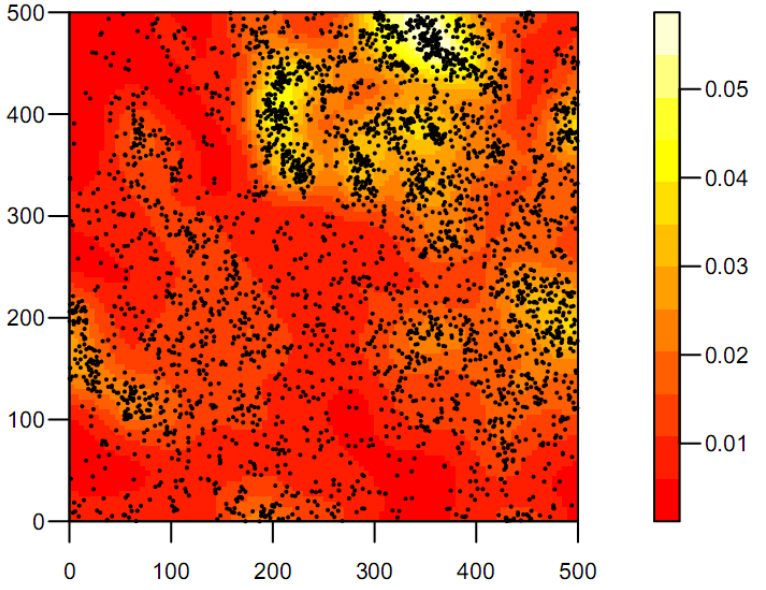


α =0.05 (39 simulations)

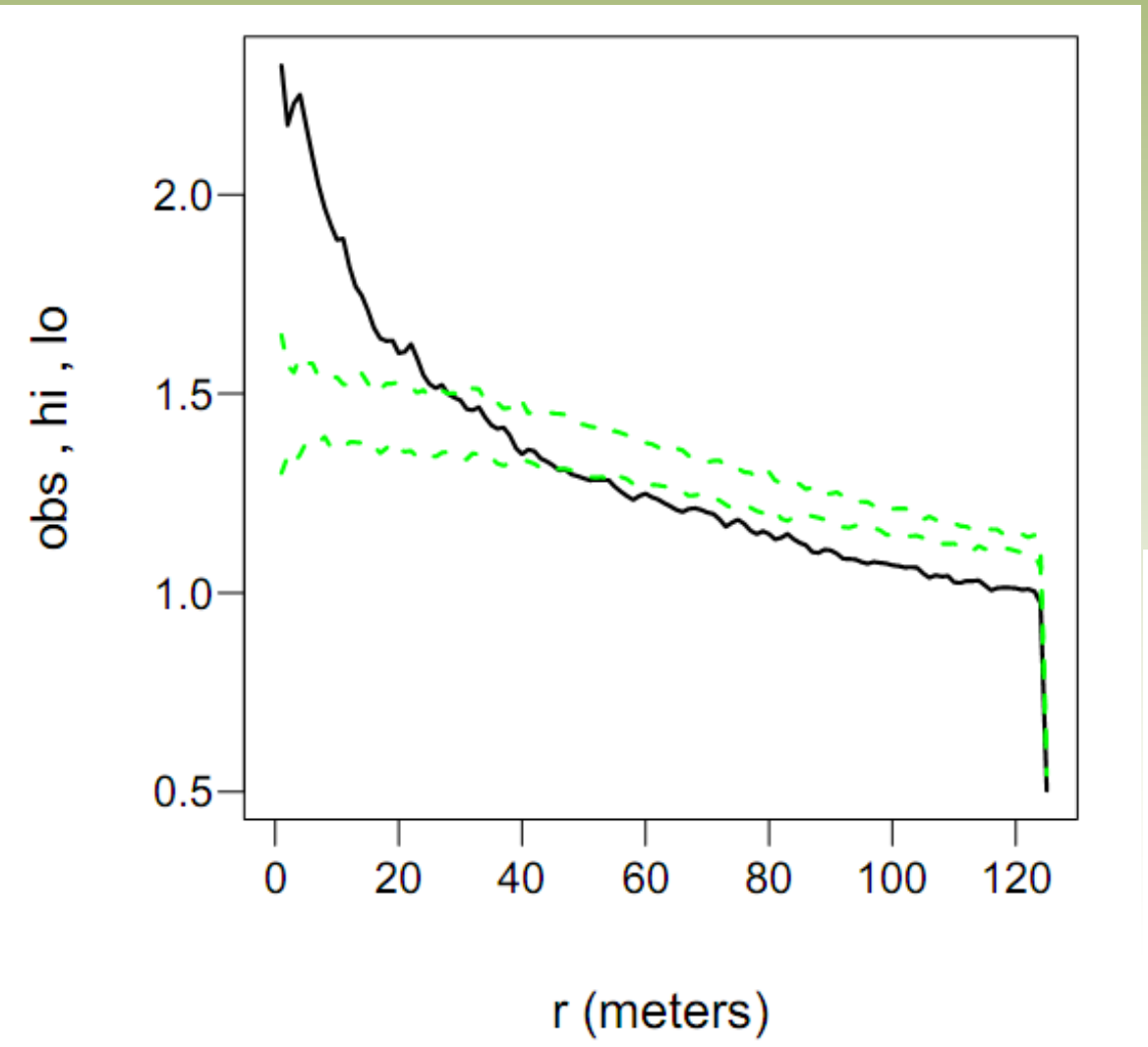
Litsea acuminata 長葉木薑子

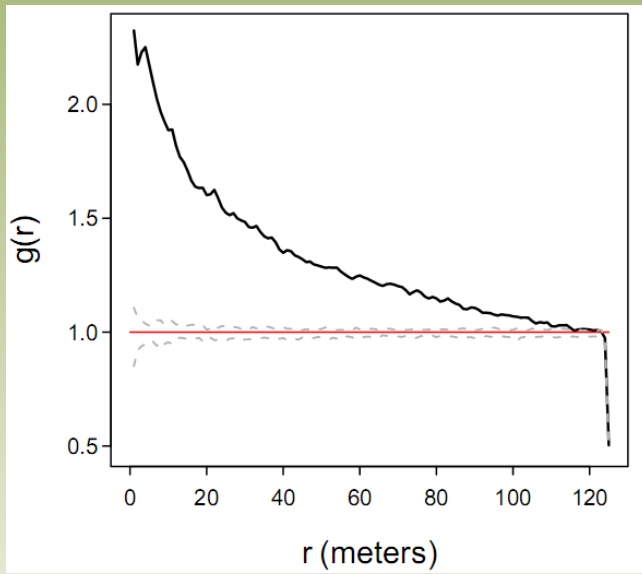


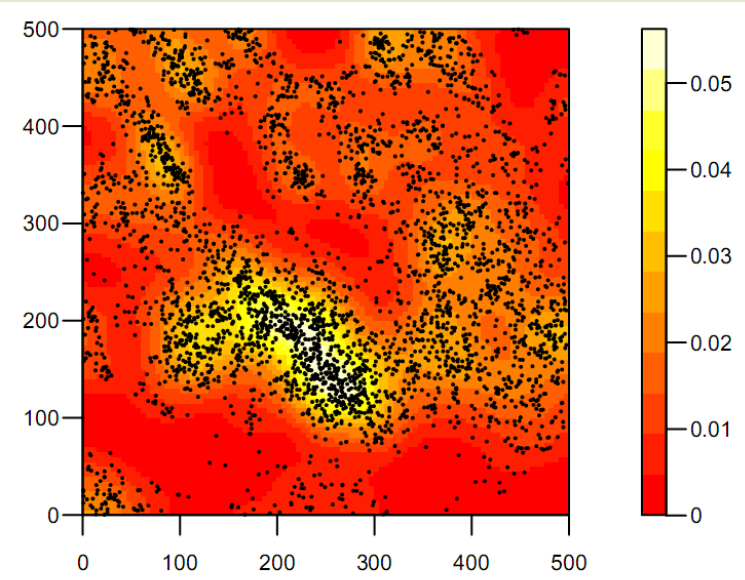




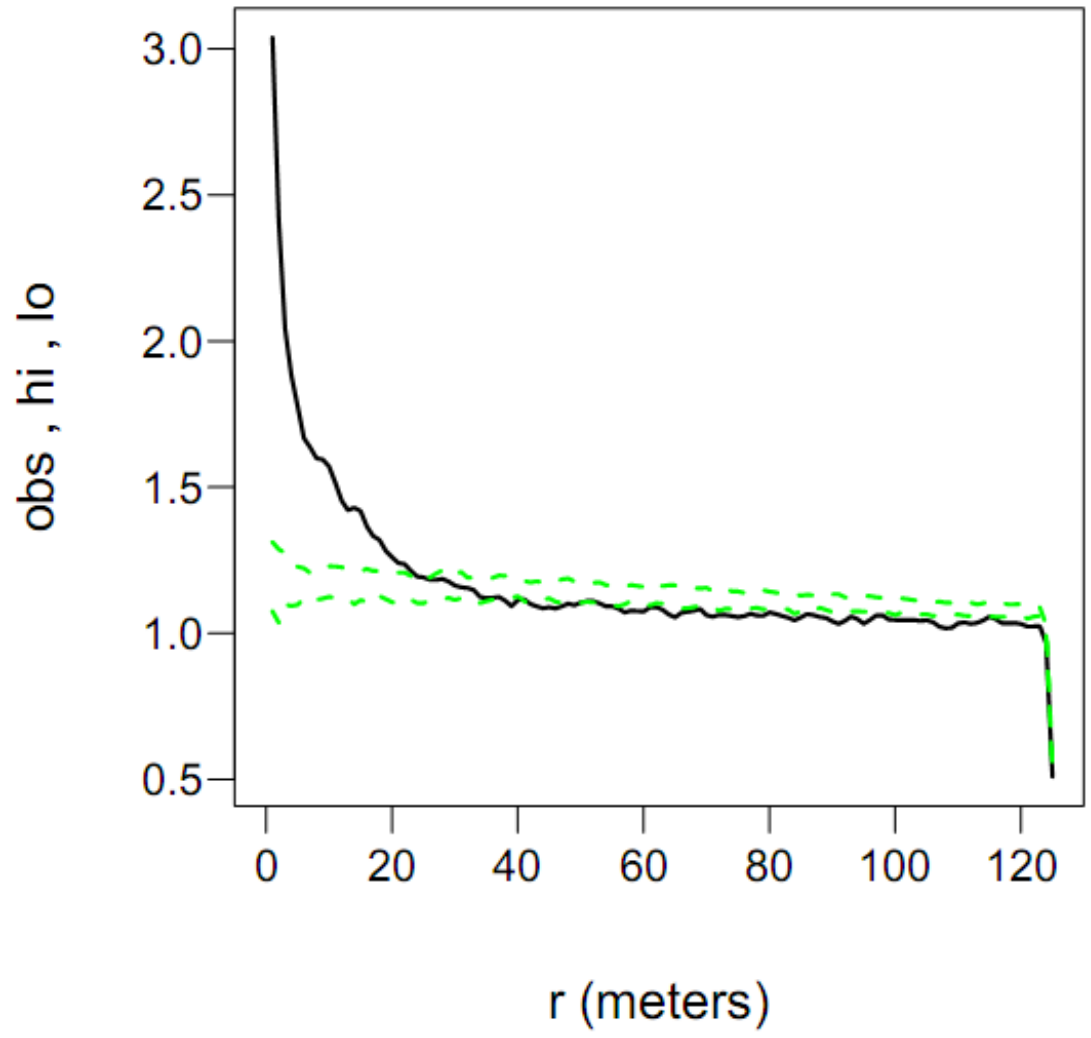
Meliosma squamulata 綠樟

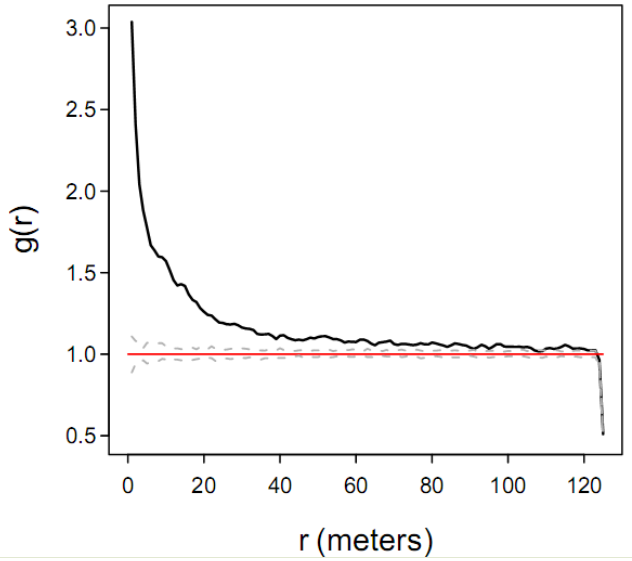


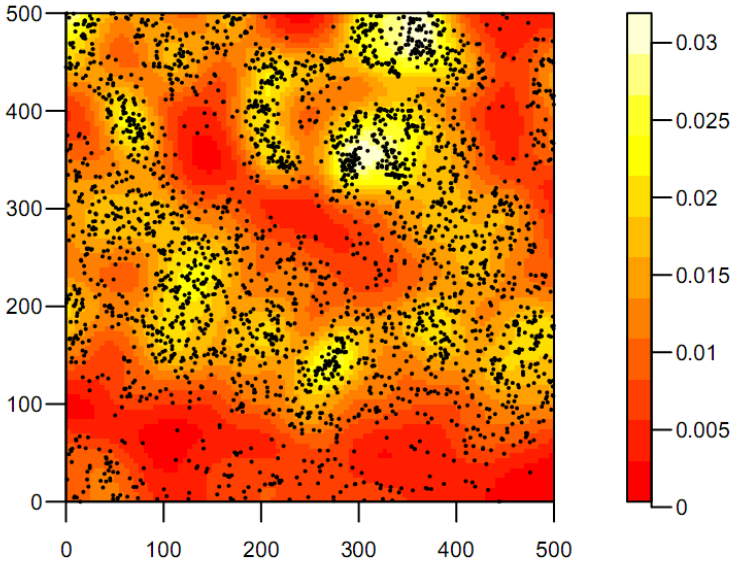




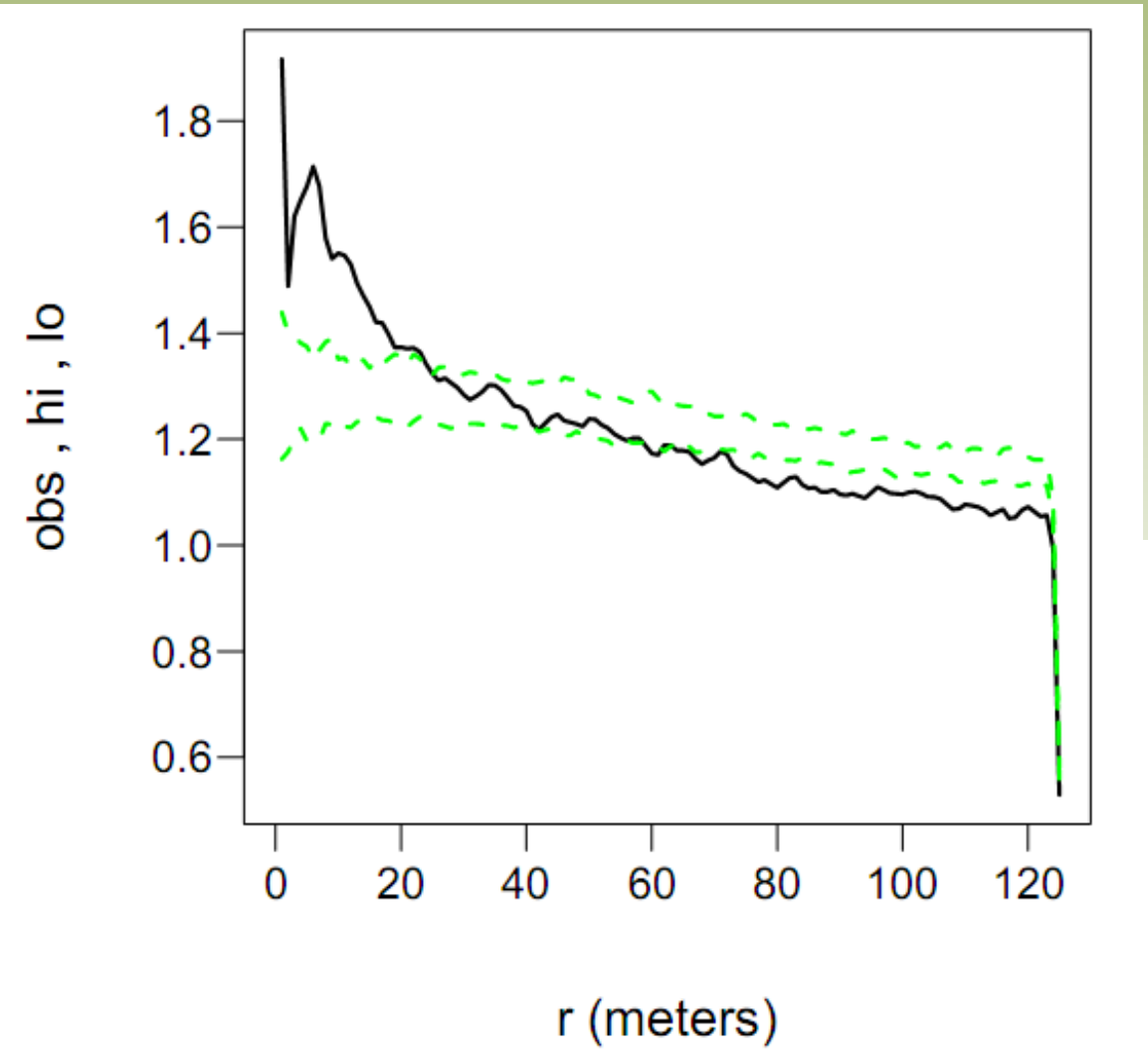
Symplocos theophrastifolia 山豬肝

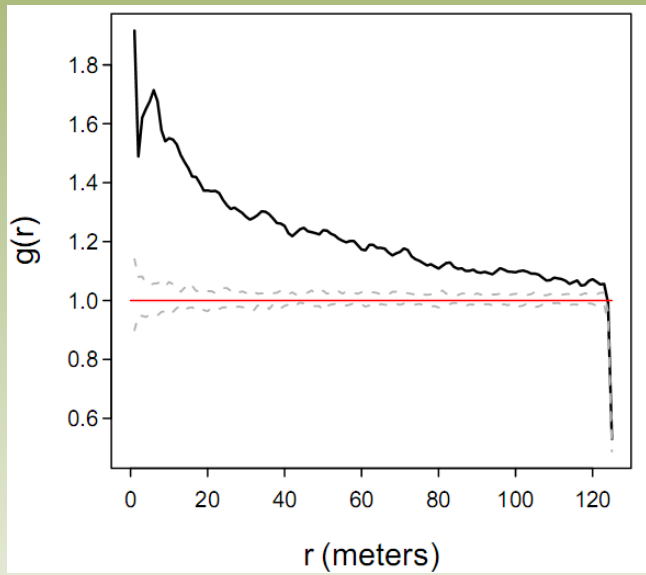


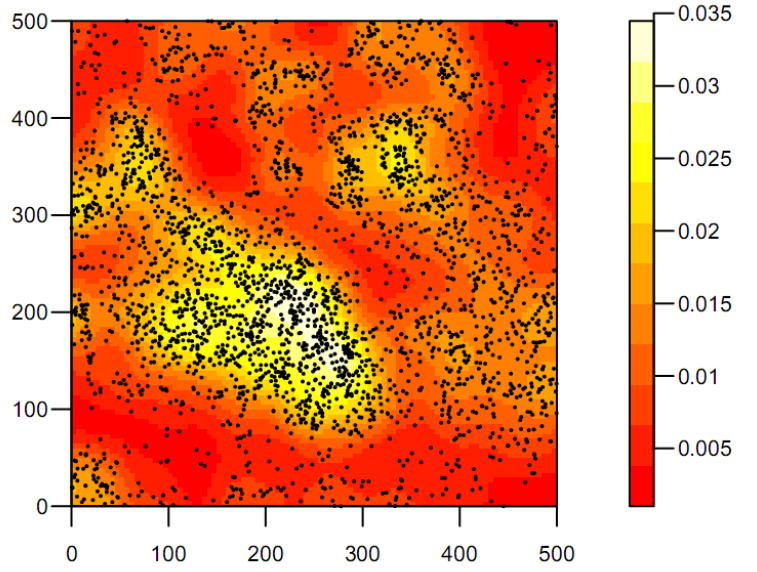




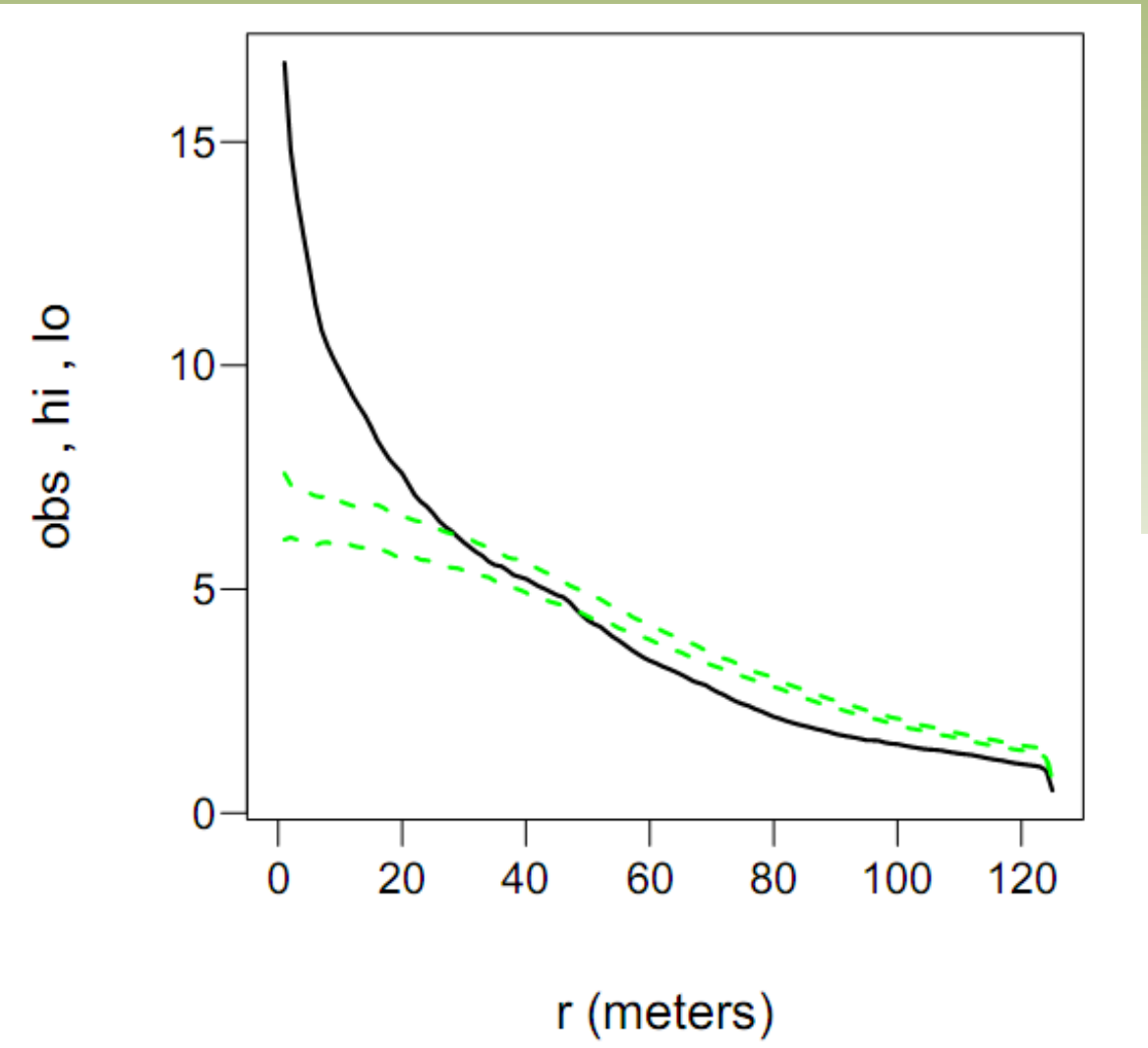
Machilus thunbergii 紅楠

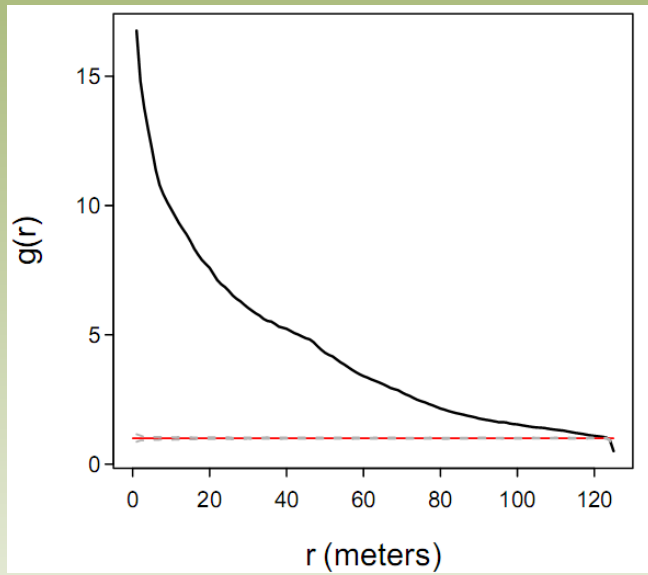


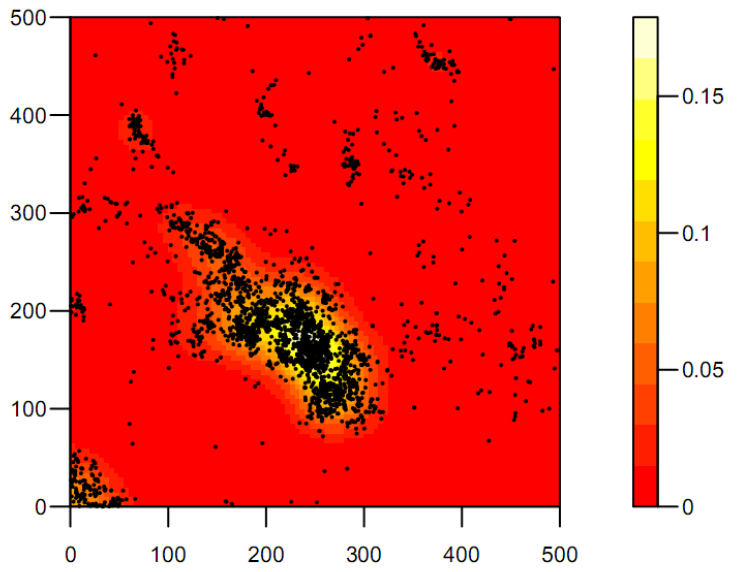




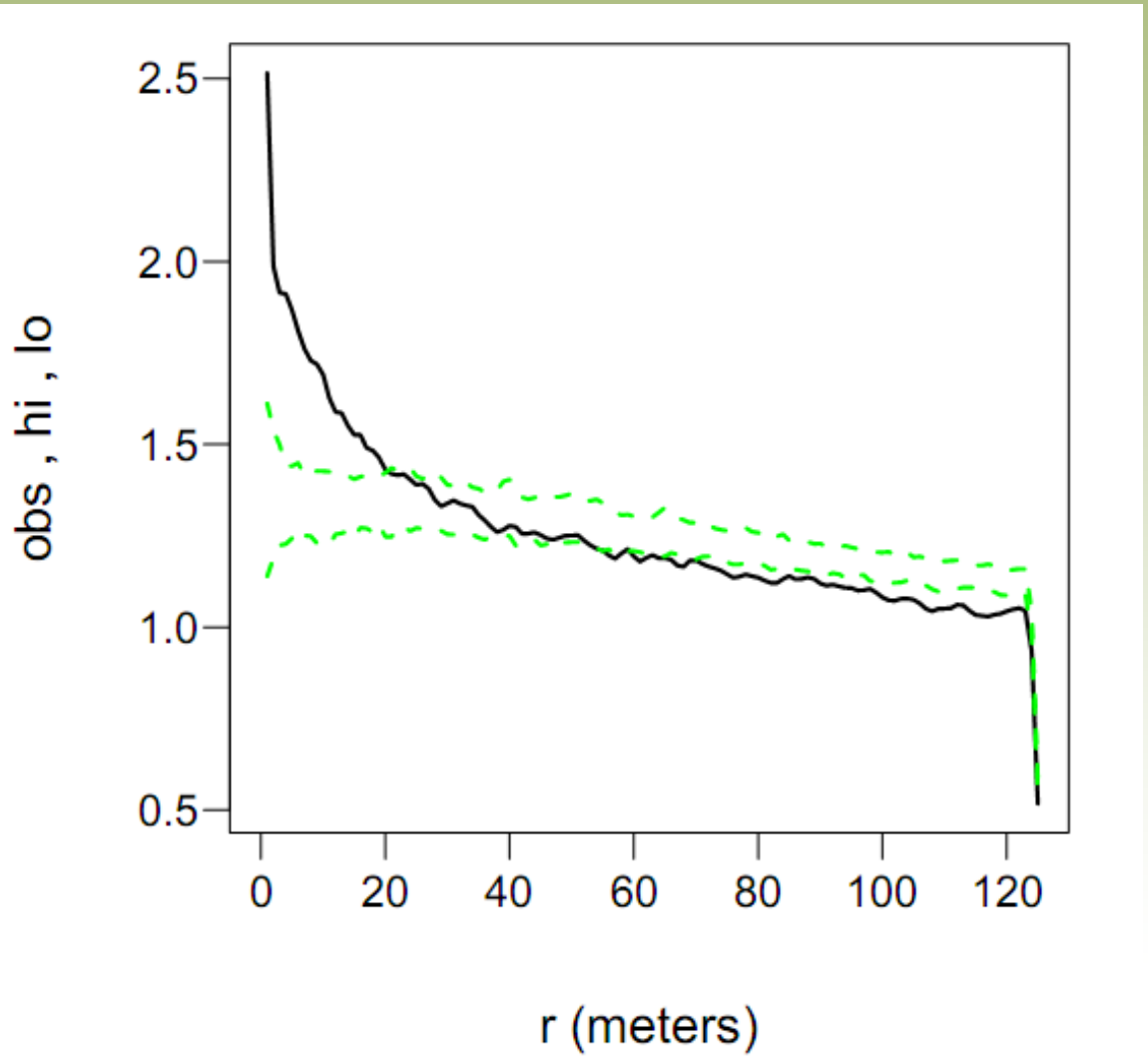
Myrsine seguinii 大明橘

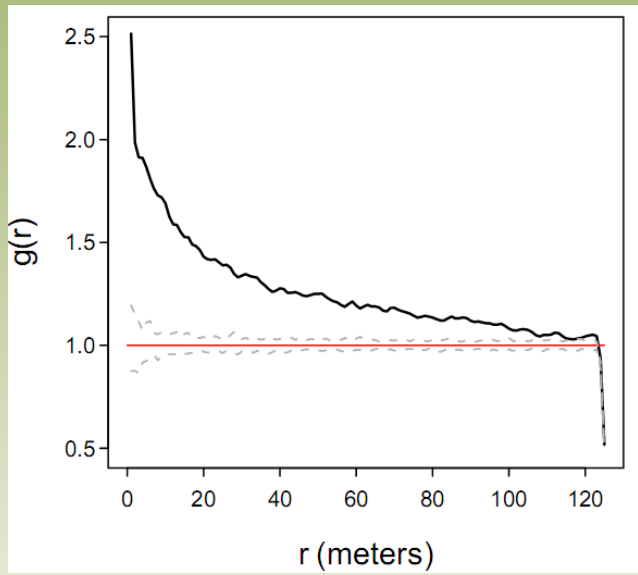


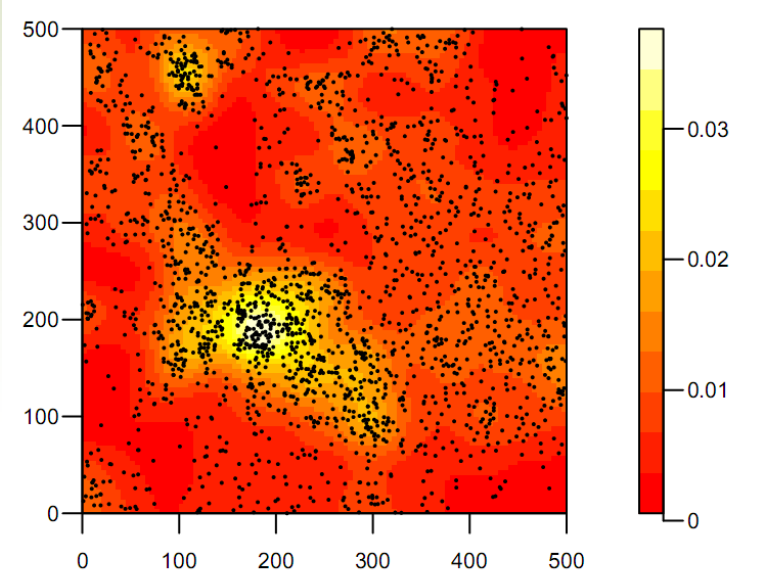




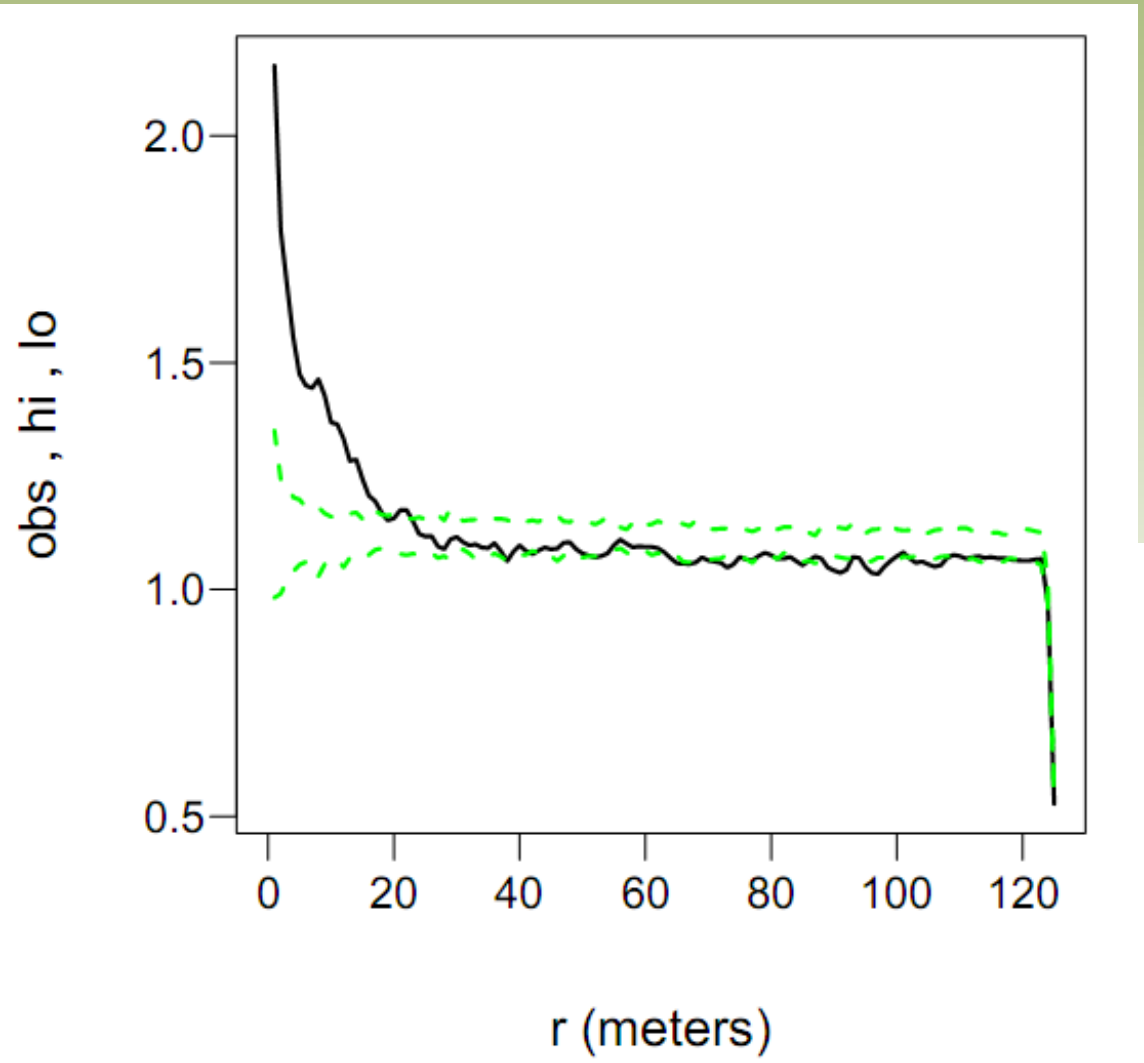
Limlia uraiana 烏來柯

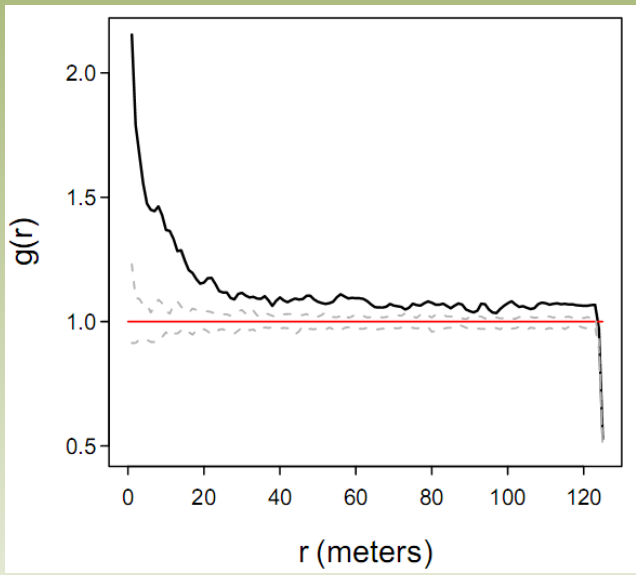


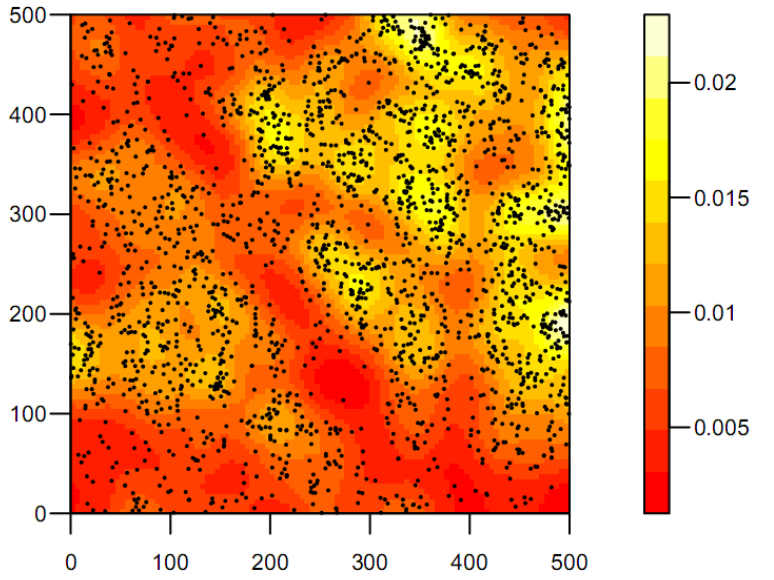




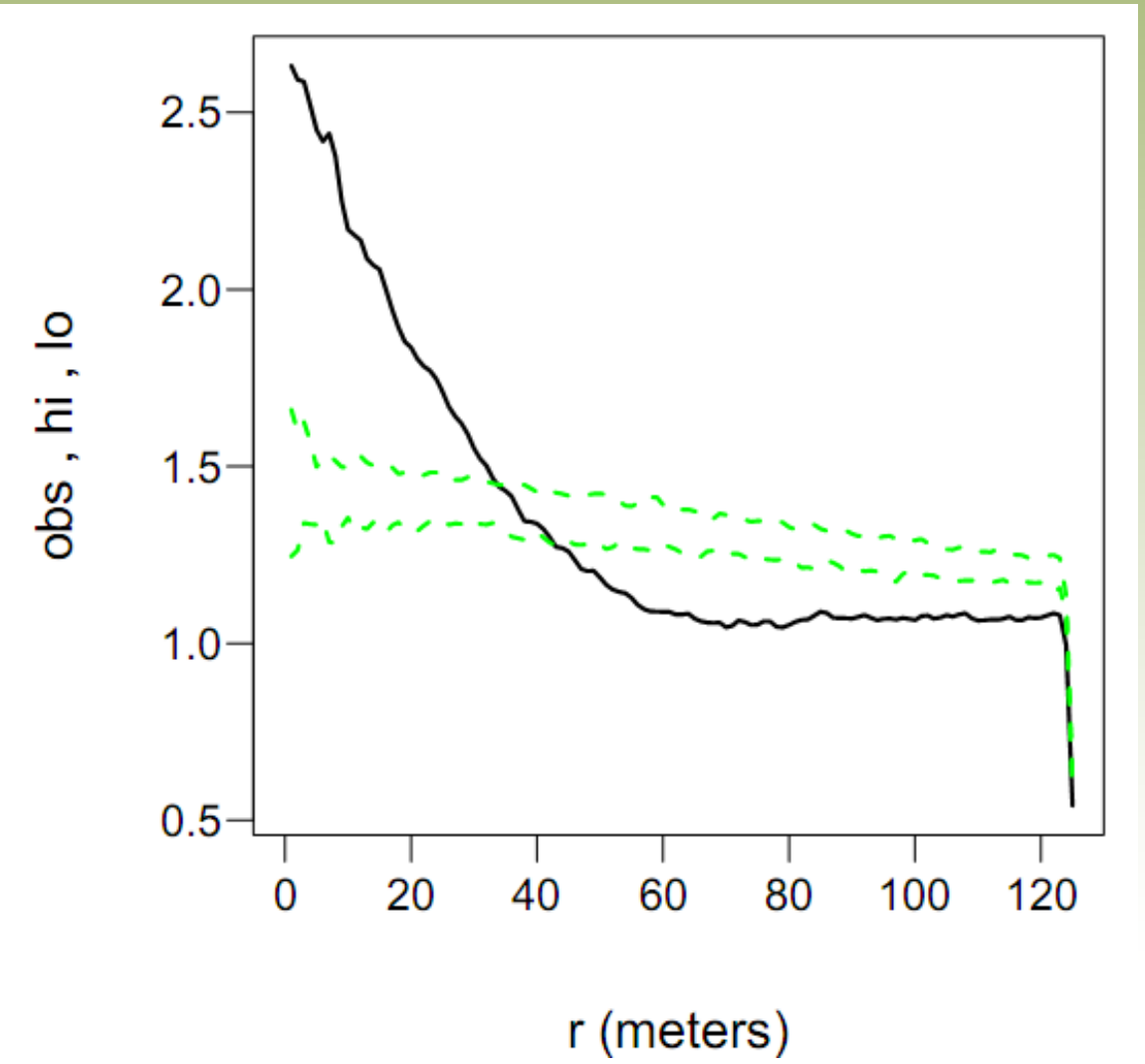
Machilus mushaensis 霧社楨楠

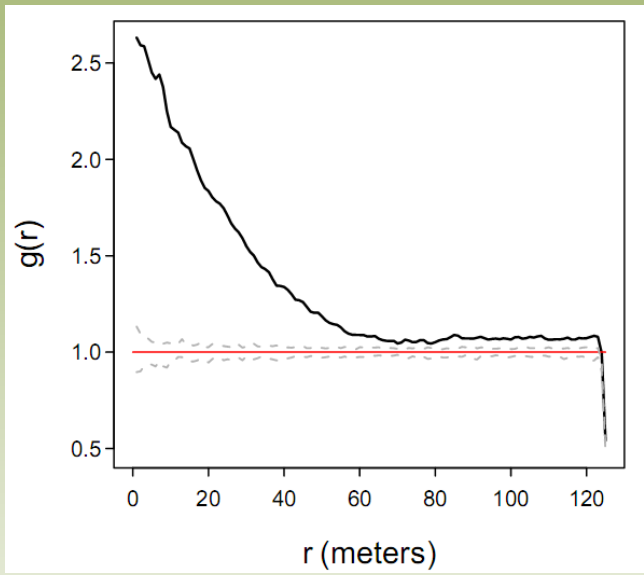


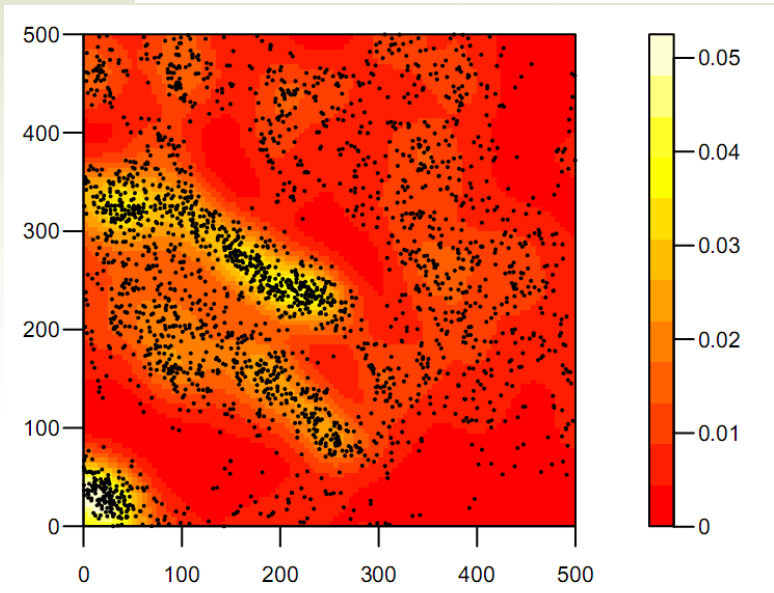




Cyathea podophylla 鬼桫欏





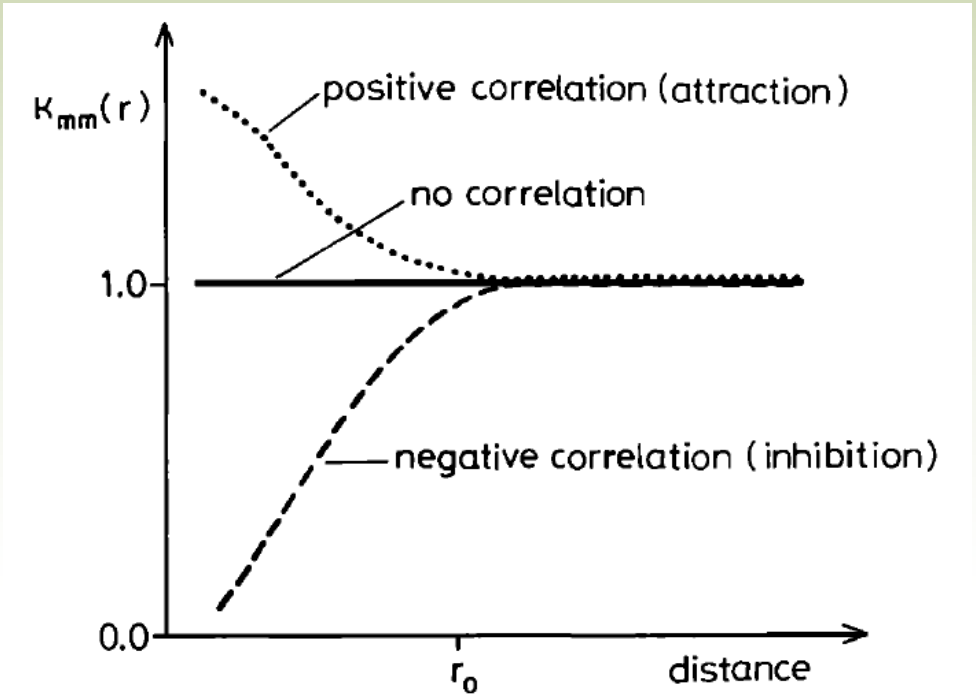


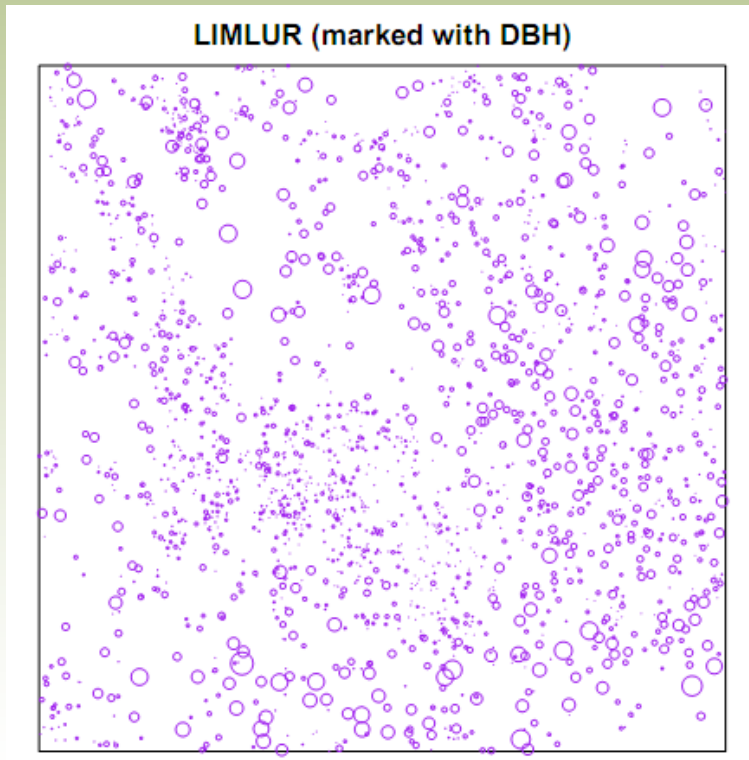
A brief summary

- All of the nine species show significant aggregated pattern within 40-m distance (mostly < 20 m)
- Assuming "Complete Spatial Randomness (CSR)" (homogeneous) would overestimate the range of aggregated pattern

Marked point pattern analysis

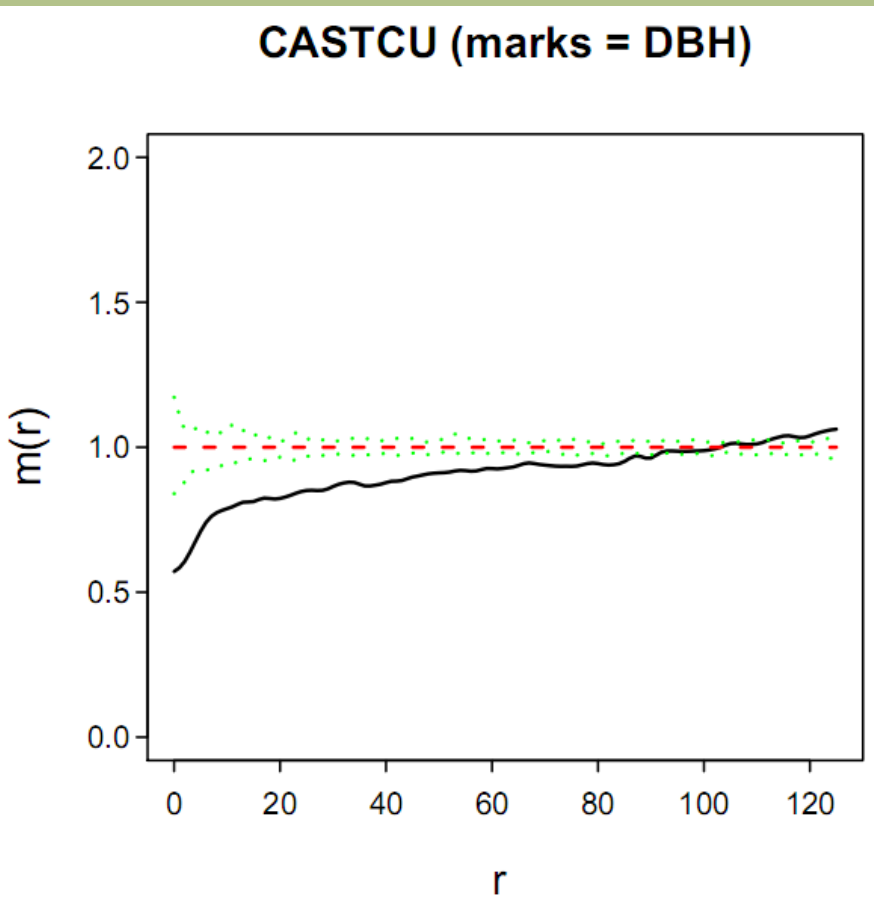
- Mark correlation function, $\kappa_{mm}(r)$
  - Describe the correlation of marks on spatial points

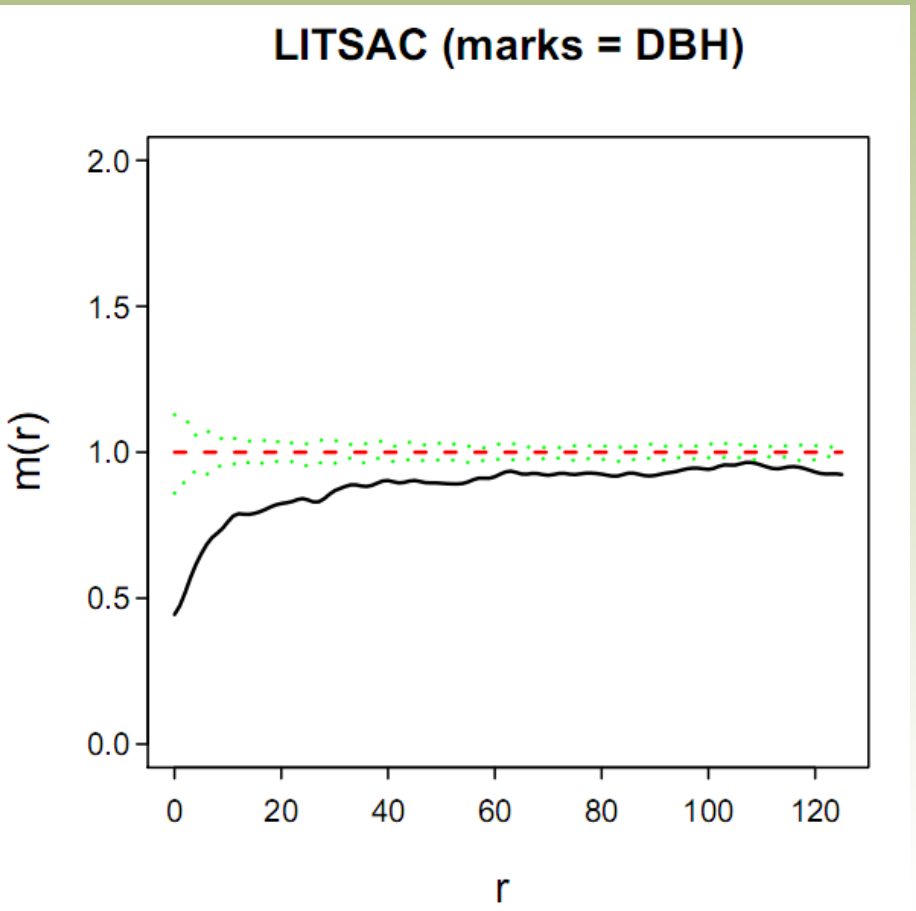




Castanopsis cuspidata 長尾栲

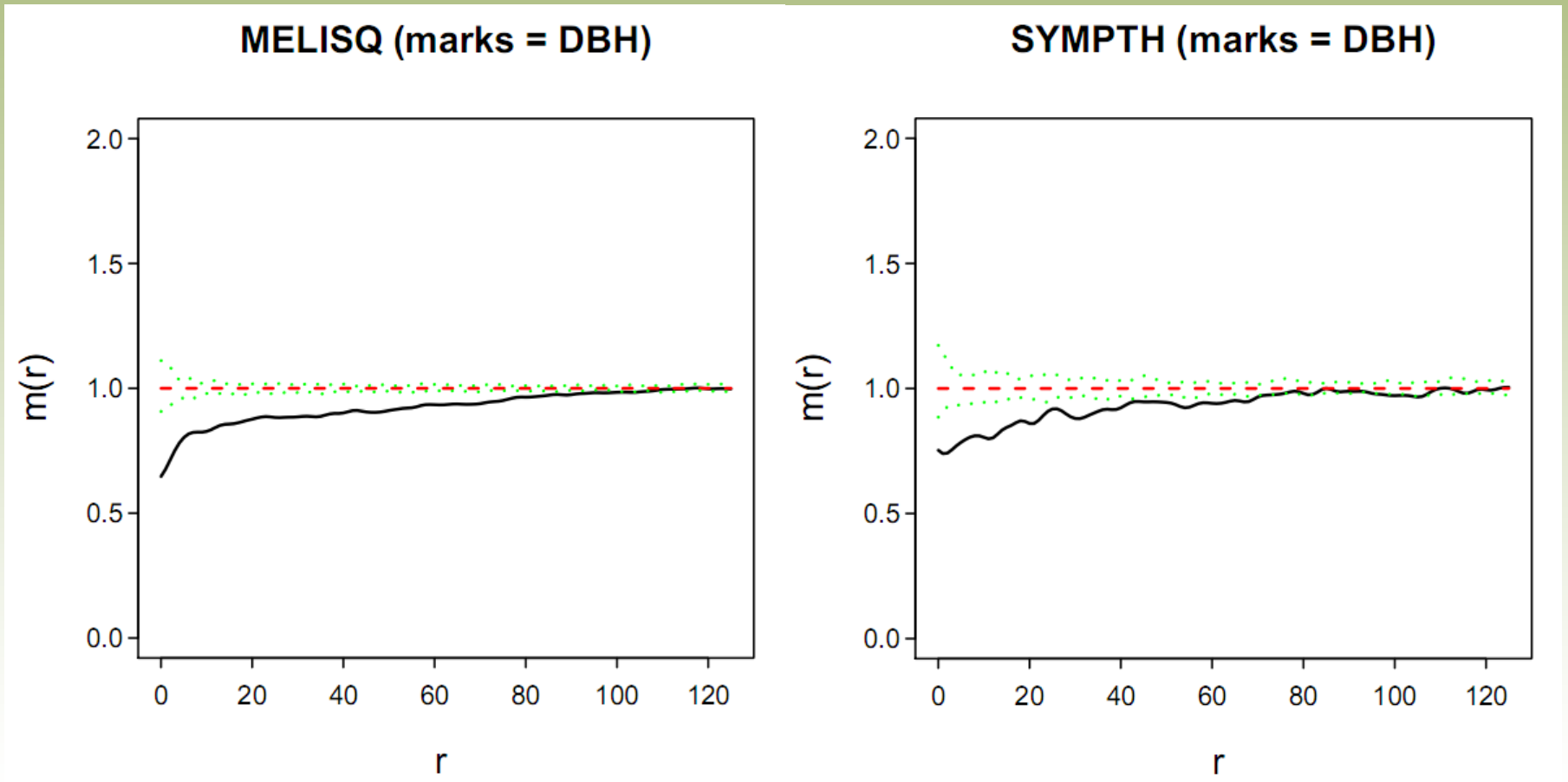
Litsea acuminata 長葉木薑子





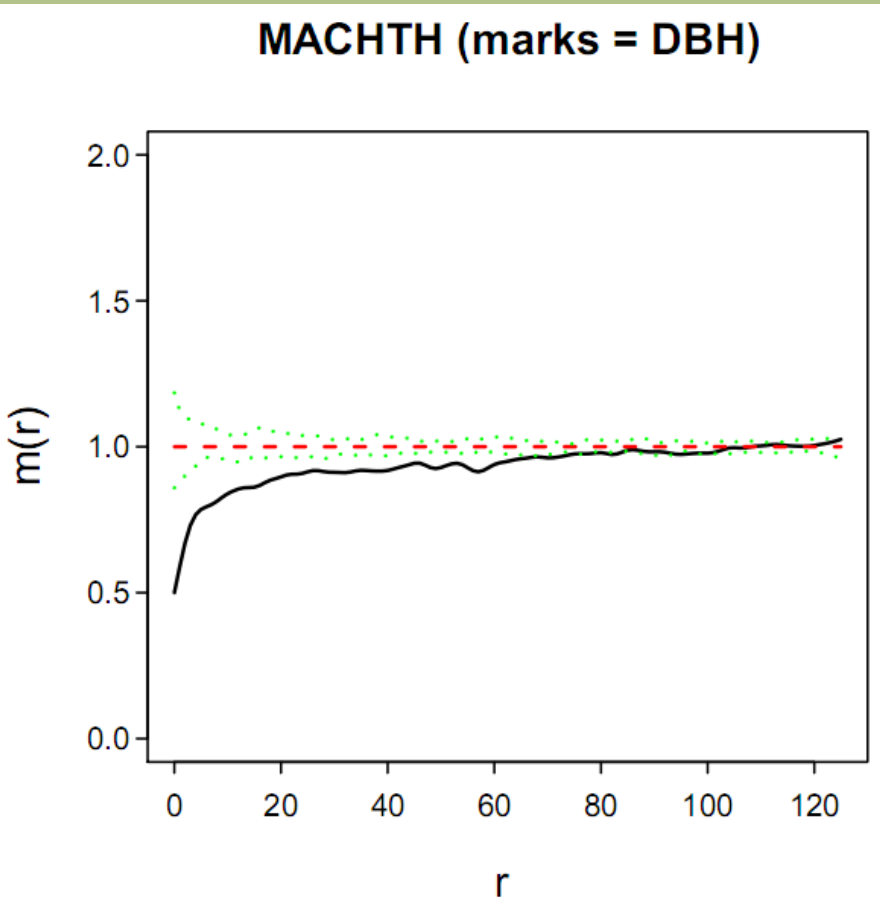
Meliosma squamulata 綠樟

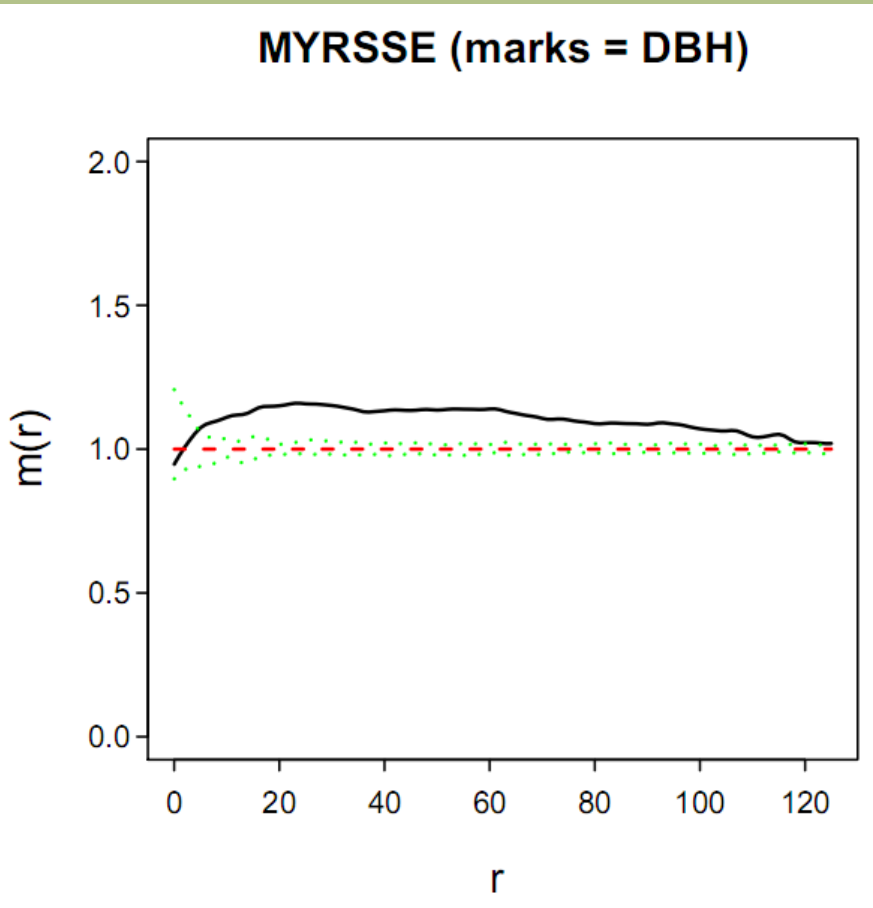
Symplocos theophrastifolia 山豬肝



Machilus thunbergii 紅楠

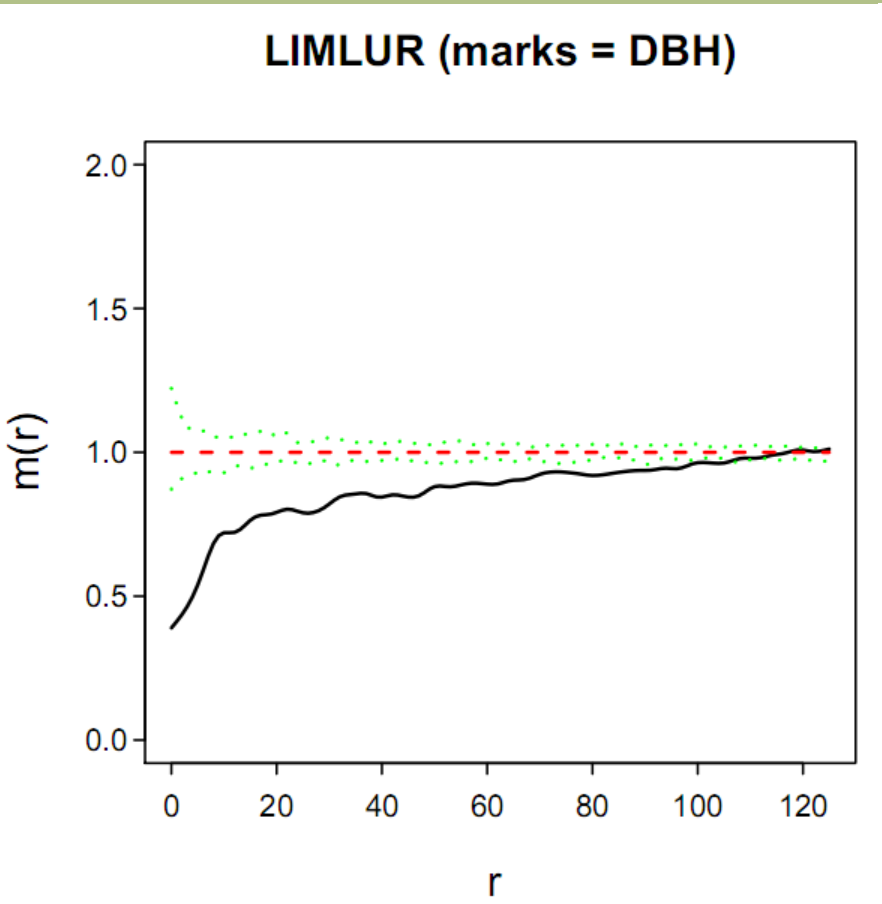
Myrsine seguinii 大明橘

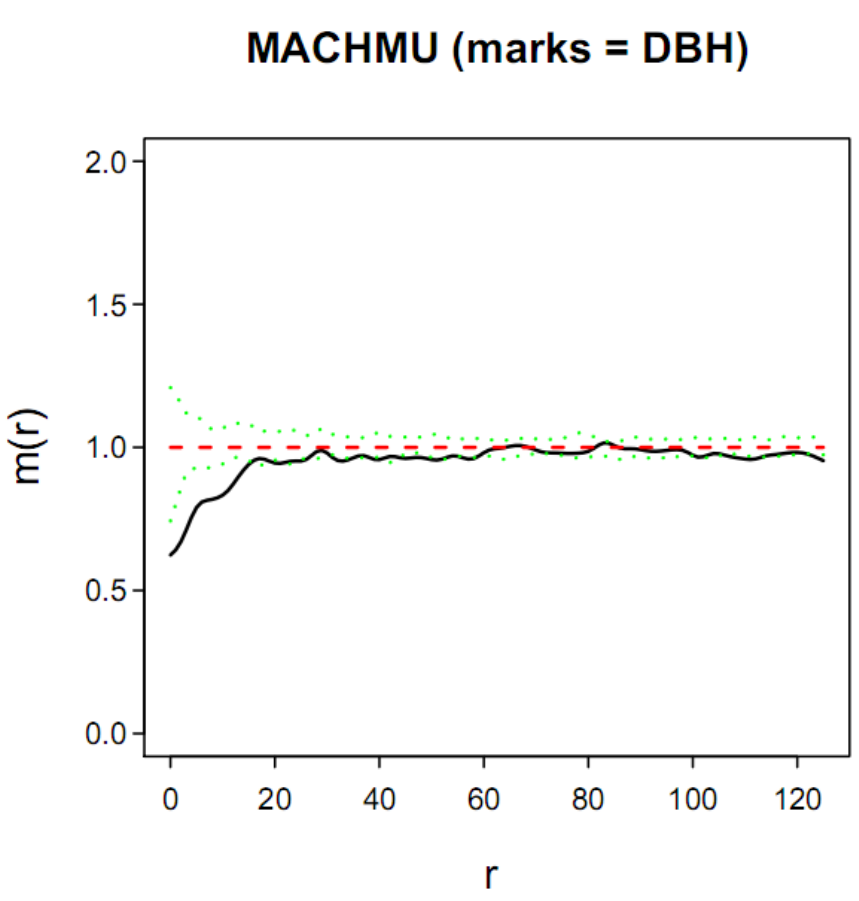




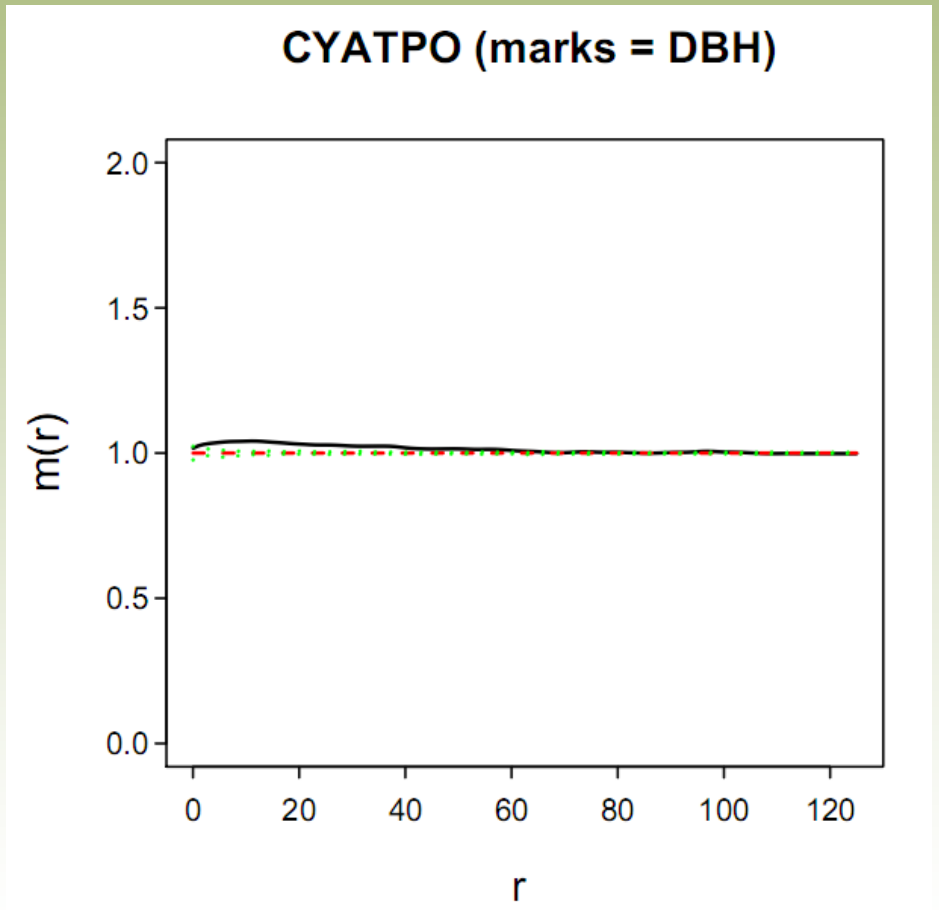
Limlia uraiana 烏來柯

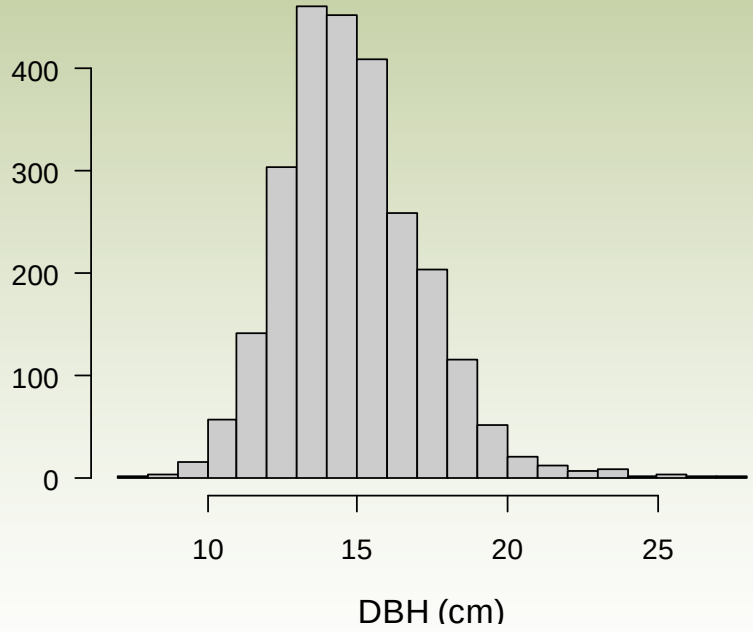
Machilus mushaensis 霧社楨楠





Cyathea podophylla 鬼桫欏





A brief summary

- Most species show significant negative correlation on DBH within a wide range, except *M. seguinii* and *C. podophylla*
- Negative correlation suggests intra-species interaction which may be inhibition or competition for resources among trees
- Positive correlation indicates adjacent trees tend to be in similar size; one possible case is the process of gap regeneration.

Conclusion

- Differentiation in micro-topography forms significant habitat association in Fushan FDP.
- Despite of inhomogeneity of tree distribution intensity, tree species still show aggregation patterns within 40 m range.
- There are significant correlations of tree size on spatial pattern, which may indicate inhibition, competition, or gap formation in the dynamics of Fushan forest.

Thank you