白马雪山东西坡植物多样性比较

forests

MDPI

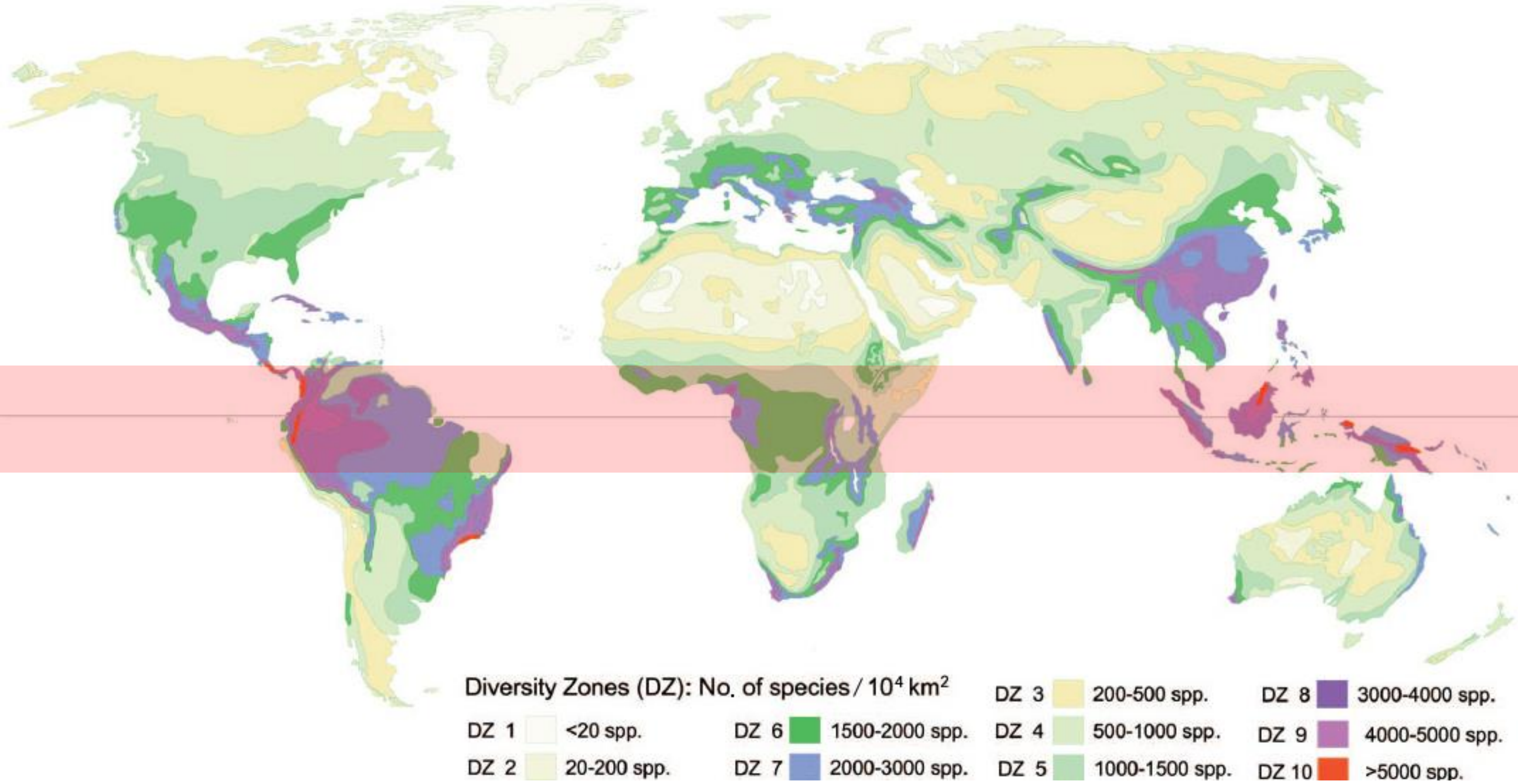
Article

Plant Diversity along the Eastern and Western Slopes of Baima Snow Mountain, China

Yang Yang [1], Zehao Shen [1,*], Jie Han [1] and Ciren Zhongyong [2]

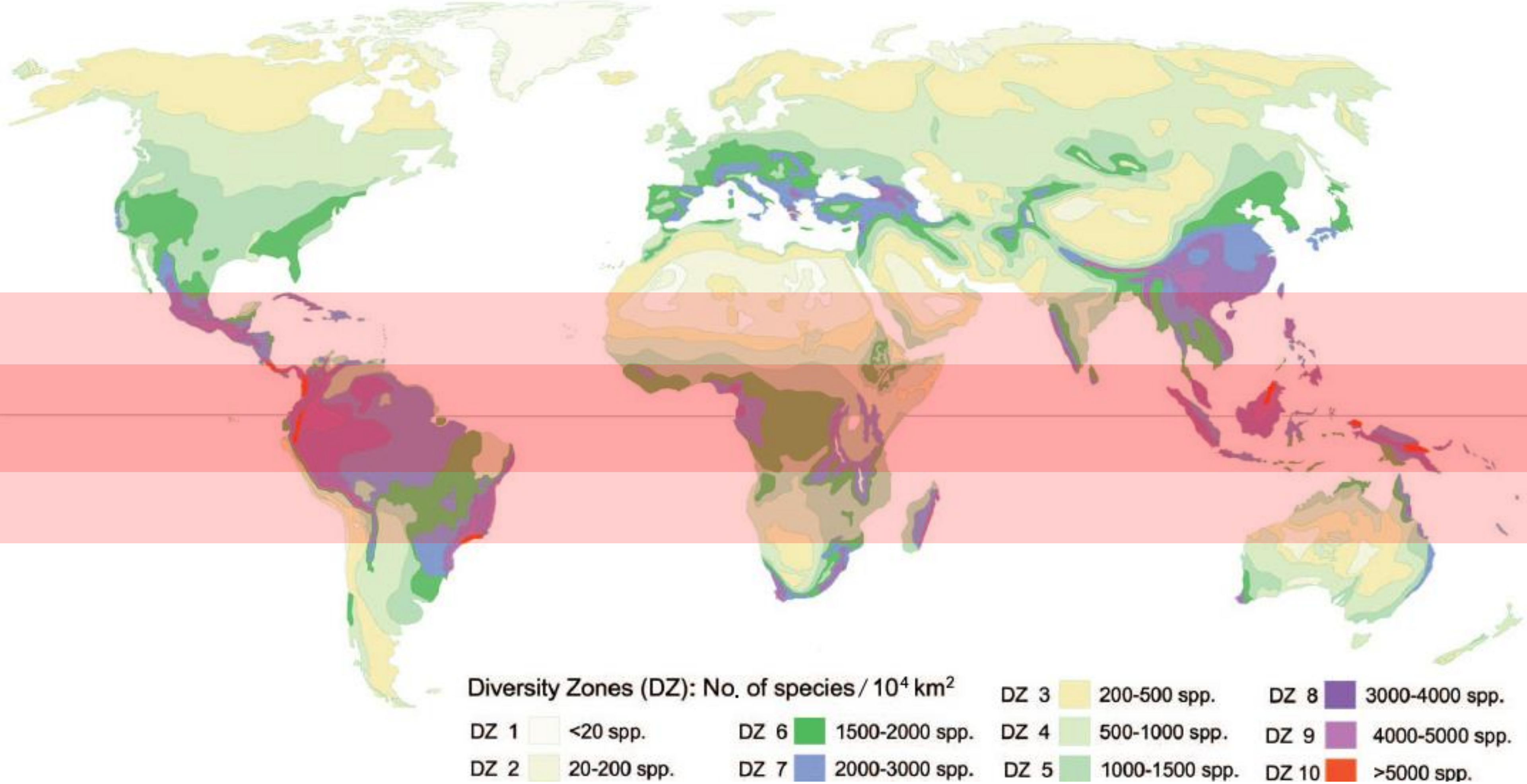
Forests **2016**, *7*, 89

全球维管束植物多样性格局



(Barthlott et al., 2007)

全球维管束植物多样性格局



(Barthlott et al., 2007)

秘诀之一：

Science

Fossil Record Reveals Tropics as Cradle and Museum

Charles R. Marshall

Science **314**, 66 (2006); DOI: 10.1126/science.1133351

PNAS

Tropical forests are both evolutionary cradles and museums of leaf beetle diversity

Duane D. McKenna[†] and Brian D. Farrell

Ecology Letters, (2008) **11**: 653–663 doi: 10.1111/j.1461-0248.2008.01197.x

IDEA AND PERSPECTIVE

The tropics: cradle, museum or casino? A dynamic null model for latitudinal gradients of species diversity

REPORTS 2010 VOL 327 SCIENCE www.sciencemag.org

Reefs as Cradles of Evolution and Sources of Biodiversity in the Phanerozoic

Wolfgang Kiessling,[1*] Carl Simpson,[1] Michael Foote[2]

Mountain Research and Development (MRD) MountainNotes

Mountains of Southern China as "Plant Museums" and "Plant Cradles": Evolutionary and Conservation Insights

Jordi López-Pujol[1,2], Fu-Min Zhang[1], Hai-Qin Sun[1], Tsun-Shen Ying[1], and Song Ge[1*]*

Annals of Botany **108**: 241–252, 2011
doi:10.1093/aob/mcr134, available online at www.aob.oxfordjournals.org

ANNALS OF BOTANY Founded 1887

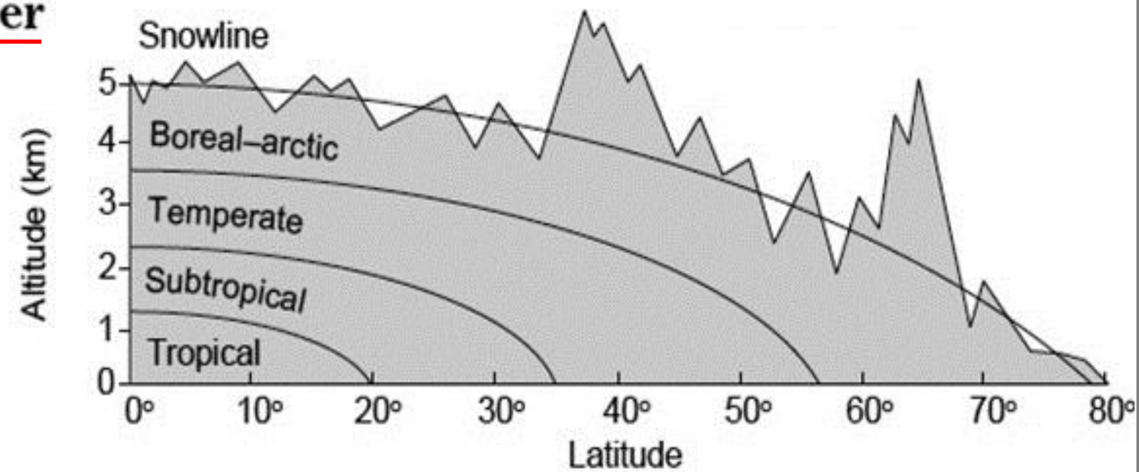
The importance of Anatolian mountains as the cradle of global diversity in *Arabis alpina*, a key arctic–alpine species

Stephen W. Ansell[1,*], Hans K. Stenøien[3], Michael Grundmann[1], Stephen J. Russell[2], Marcus A. Koch[4], Harald Schneider[1] and Johannes C. Vogel[1]

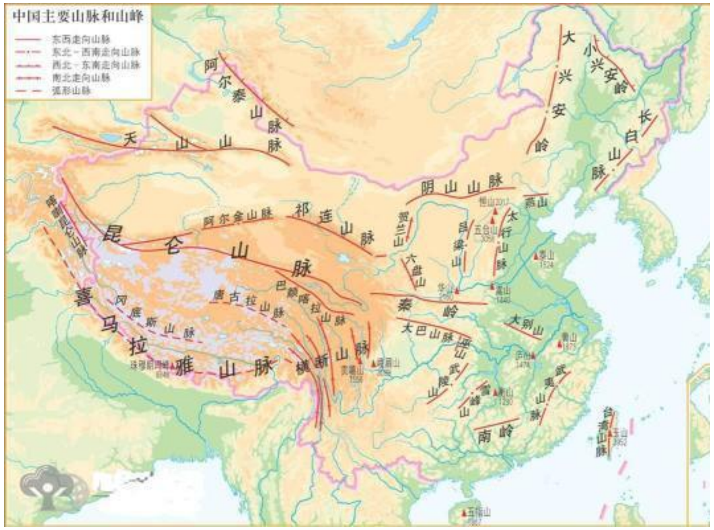
秘诀之二：

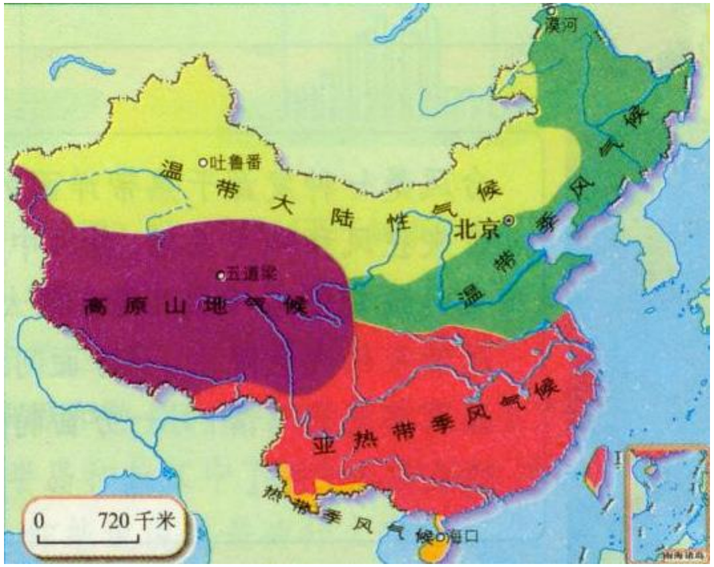
Why are there global gradients in species richness? Mountains might hold the answer

Christian Korner

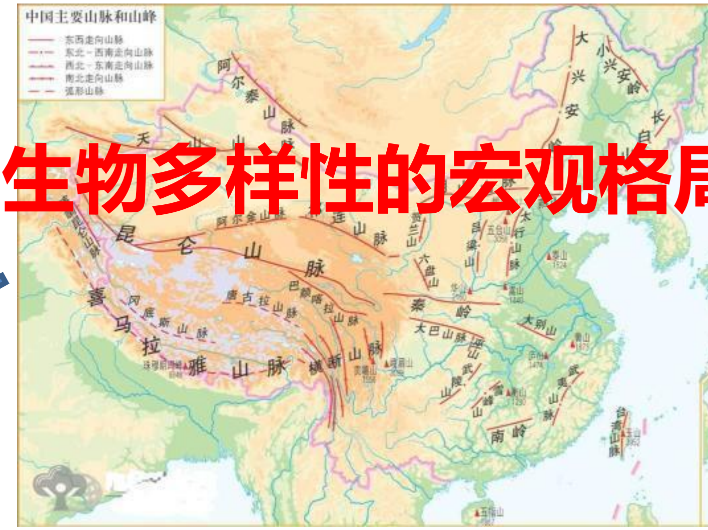


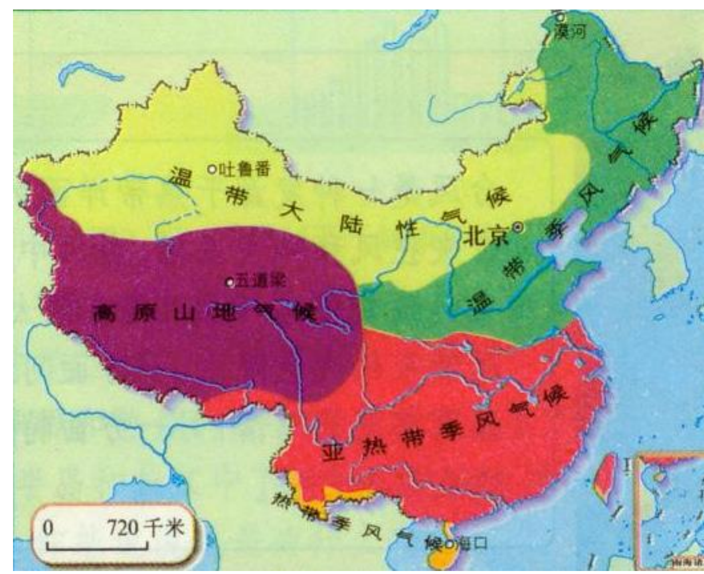
TREE vol. 15, no. 12 December 2000


中国主要山脉和山峰
东西走向山脉
东北－西南走向山脉
西北－东南走向山脉
南北走向山脉
弧形山脉
阿尔泰山脉
天山山脉
大兴安岭
小兴安岭
长白山脉
阴山山脉
阿尔金山脉
祁连山脉
昆仑山脉
唐古拉山脉
冈底斯山脉
喜马拉雅山脉
横断山脉
秦岭
大巴山脉
大别山
南岭
武夷山脉
太行山脉


漠河
吐鲁番
温带大陆性气候
北京
温带季风气候
五道梁
高原山地气候
亚热带季风气候
热带季风气候
海口
0 720千米

纬度、季风和山地界定了中国生物多样性的宏观格局





问题：

- 山地影响植物多样性分布的机制是什么？
- 山地与季风的相互作用对植物多样性分布有何影响？

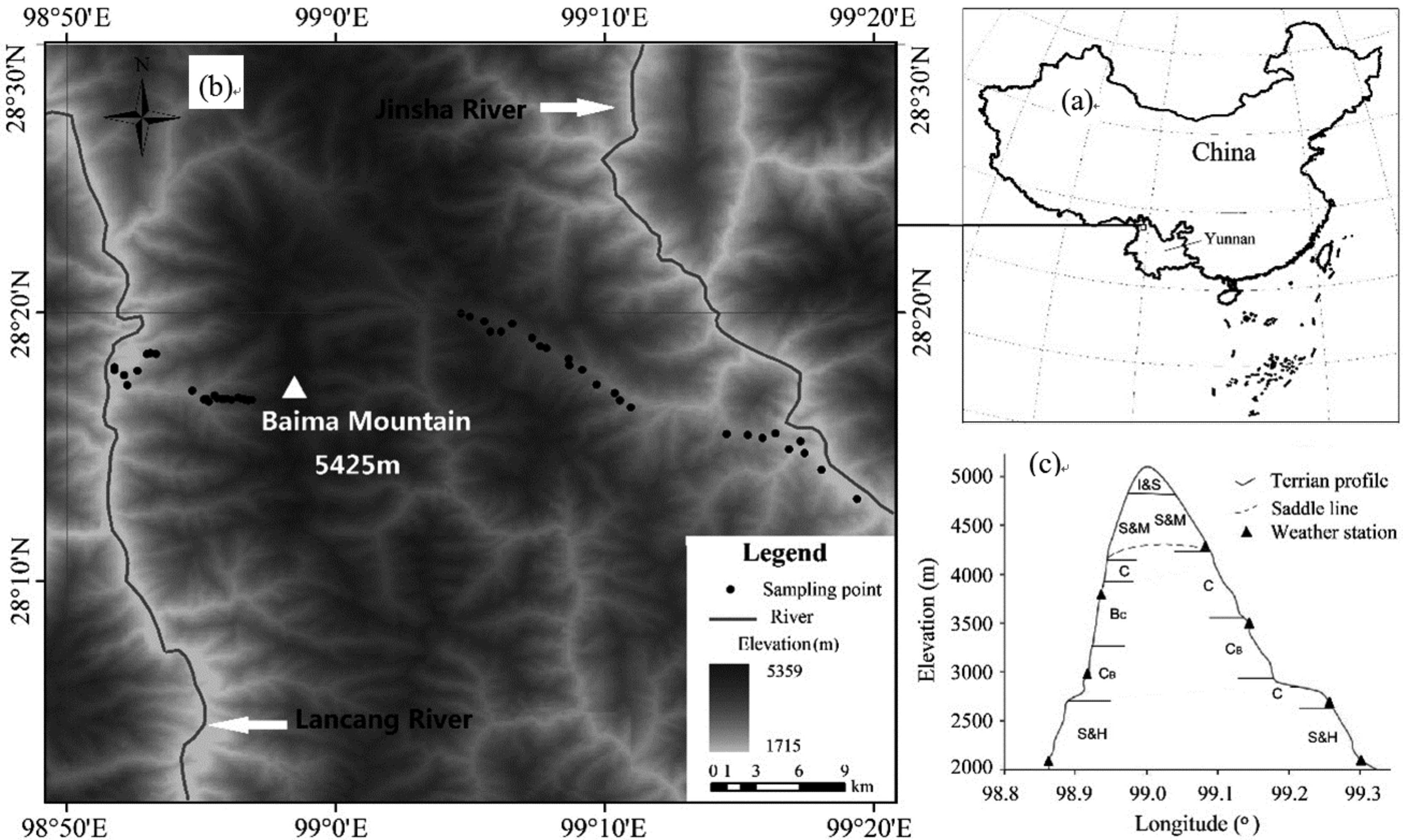
从另一角度，

- 生物多样性格局的各个形成假说对山地植物多样性分布有何影响？

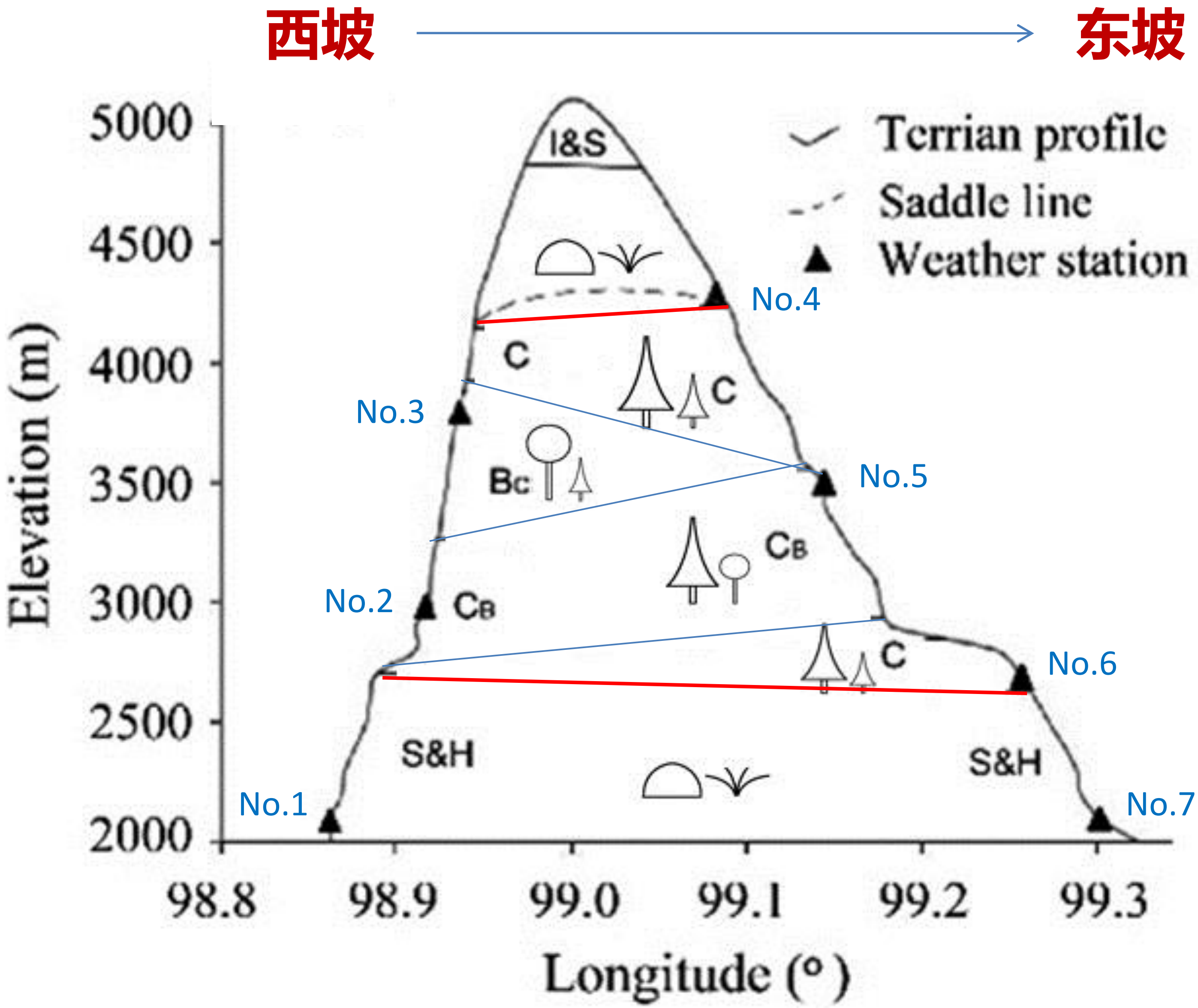
关于物种丰富度格局的假说 > 30 or ~ 100 !!!

- **Energy**
  - Productivity-richness (Hutchingson, 1959; Wright, 1983)
  - Ambient-richness (Turner, 1986)
  - Freezing-richness (Forster 1787; Humboldt 1808)
- **Area** (MacArthur & Wilson, 1967; Rozensweig, 1995)
- **Habitat heterogeneity** (Hutchinson, 1957)
- **History/regional effect** (Ricklefs, 1987; Latham & Ricklefs, 1993)
- **Geometric constraint/MDE** (Clowell et al. 1994)
- **Neutrality + speciation/dispersal** (Hubbell, 1997, 2000)
- **Evolution/speciation rate** (Rohde, 1992)
- **Species range** (Rapoport, 1989)

2. 数据与方法


98°50'E
99°0'E
99°10'E
99°20'E
28°30'N
28°20'N
28°10'N
N
(b)
Jinsha River
Baima Mountain
5425m
Lancang River
Legend
Sampling point
River
Elevation(m)
5359
1715
0 1 3 6 9
km
(a)
China
Yunnan
(c)
Terrian profile
Saddle line
Weather station
I&S
S&M
S&M
C
C
Bc
CB
CB
C
S&H
S&H
Elevation (m)
5000
4500
4000
3500
3000
2500
2000
98.8
98.9
99.0
99.1
99.2
99.3
Longitude (°)

2. 数据与方法



西坡
东坡
Terrian profile
Saddle line
Weather station
I&S
C
Bc
CB
S&H
No.1
No.2
No.3
No.4
No.5
No.6
No.7
Elevation (m)
Longitude (°)
5000
4500
4000
3500
3000
2500
2000
98.8
98.9
99.0
99.1
99.2
99.3

2. 数据与方法

植物多样性数据：

- 100m×10m样带，东坡25条，西坡24条，海拔100m间隔
- 10m×10m样方为单元调查统计

气候数据：

- 用东、西坡海拔梯度上7个样点3年观测数据插值推算海拔2000m~4500m梯度每100m间隔的月均温、月降水值

Table 1. Meteorological data from seven stations on Baima Snow Mountain: 1987–1988.

Parameter	Western Aspect			Saddle	Eastern Aspect		
Station	No.1	No.2	No.3	No.4	No.5	No.6	No.7
Elevation, m	2080	2747	3485	4292	3760	2988	2025
Mean annual temperature, °C	14.74	10.83	5.24	−1.14	2.97	9.65	16.57
Annual precipitation, mm	425.0	410.6	513.8	807.1	946.1	532.8	285.6

2. 数据与方法

Table 2. Climatic variables used in the data analysis.

Factors	Index	Algorithm	Reference
Energy	Tmin	Monthly mean temperature in the coldest month (January)	[20]
	Tmax	Monthly mean temperature in the warmest month (July)	[20]
	MTWQ	Mean temperature in the wettest quarter: June, July and August	[20]
	MTCQ	Mean temperature of December, January and February	[20]
	MAT	Mean annual temperature	
	PET	Potential evapotranspiration: $58.93 \times$ ABT †	[21]
Moisture	PWQ	Precipitation in the wettest quarter: June, July and August	[21]
	PDQ	Precipitation in the driest quarter: December, January and February	[21]
	Pmin	Minimum monthly precipitation (in January)	
	Pmax	Maximum monthly precipitation (in August)	
	AP	Annual precipitation	
	AET	Actual evapotranspiration: $(P/(0.9 + (P/L)^2)^{1/2}$, $L = 300 + 25T + 0.05T^3$	[22]
	MI	Moisture index: PET/AP	[21]
	WD	Water deficiency: PET − AET	[21]
	DI	Drought index: AET/P	[21]
Productivity	NPP	Net primary productivity: $\min\{NPP_{MAP}, NPP_{MAT}\}$ $NPP_{MAP} = 0.005212(MAP^{1.12363})/e^{0.000459532(MAP)}$ $NPP_{MAT} = 17.6243/(1 + e^{(1.3496-0.071514(MAT))})$	[23]
Climate seasonality	ART	Annual range of temperature: T7 − T1	[20]
	TSN	Temperature seasonality: SD (monthly mean temperature) $\times$ 100	[20]
	PSN	Precipitation seasonality: CV (monthly mean precipitation)	[20]

† ABT: annual Biotemperature (°C). $ABT = \sum t_i/12$. t_i is mean month temperature that larger than 0 °C, when $t_i > 30$ °C, it is assigned to 30 °C.

2. 数据与方法

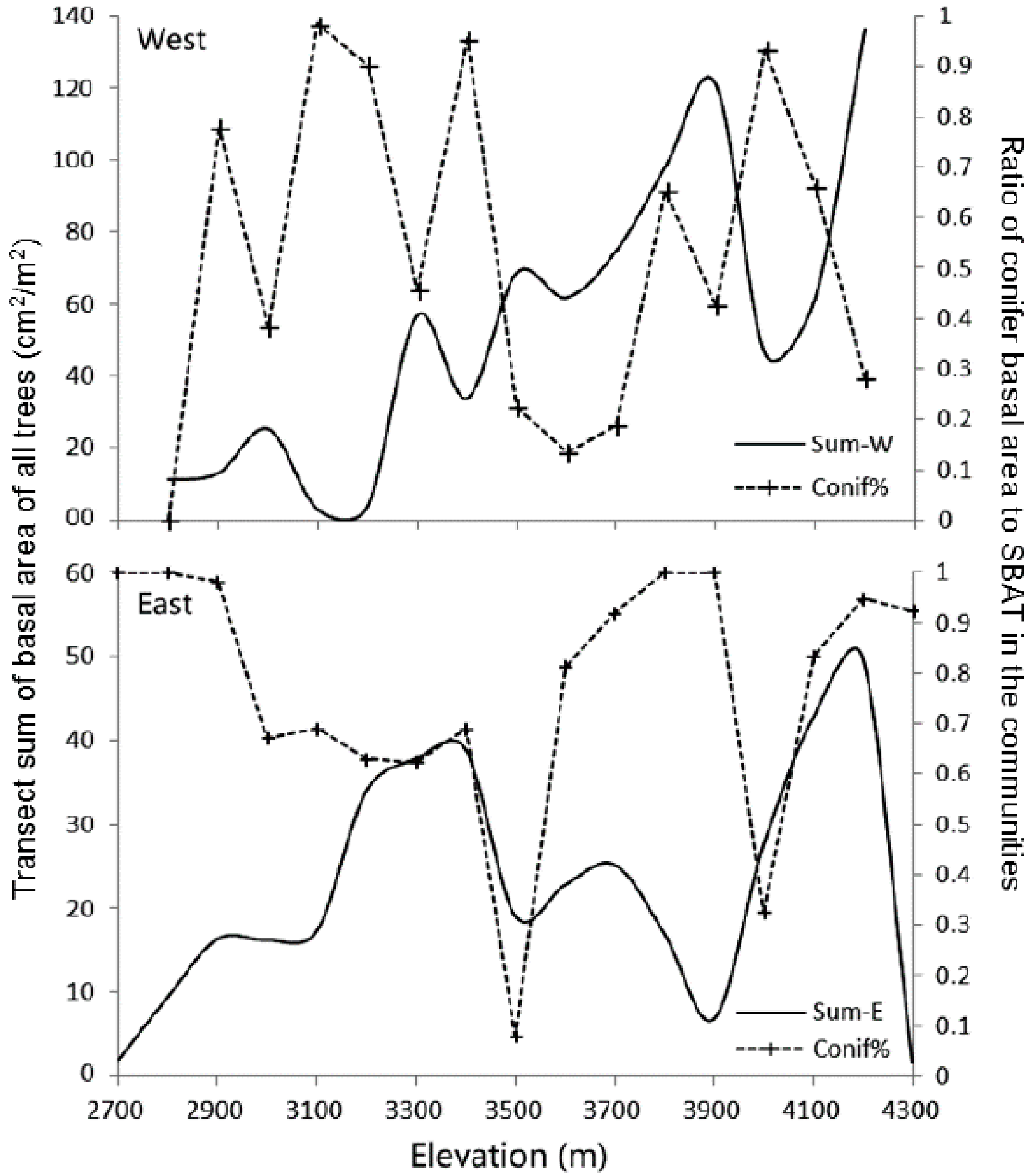
Interpretive Hypothesis	α Diversity	β Diversity	γ Diversity	Species-Area Curve
Area				
Middle-domain effect				
Historical and regional process				
Water-energy balance				
Habitat heterogeneity				

3. 结果

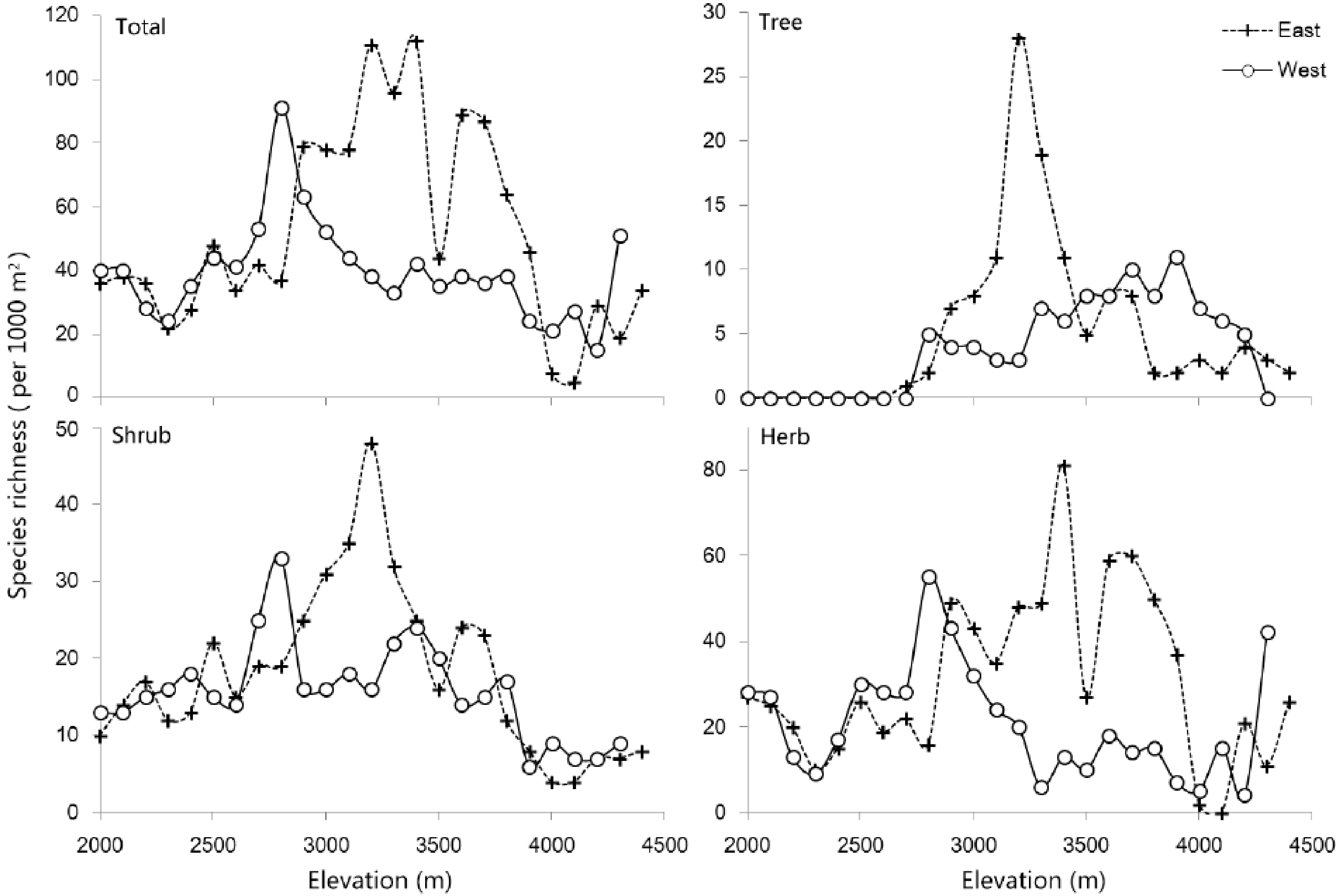
1)森林生物量海拔格局

—— 样带木材材积

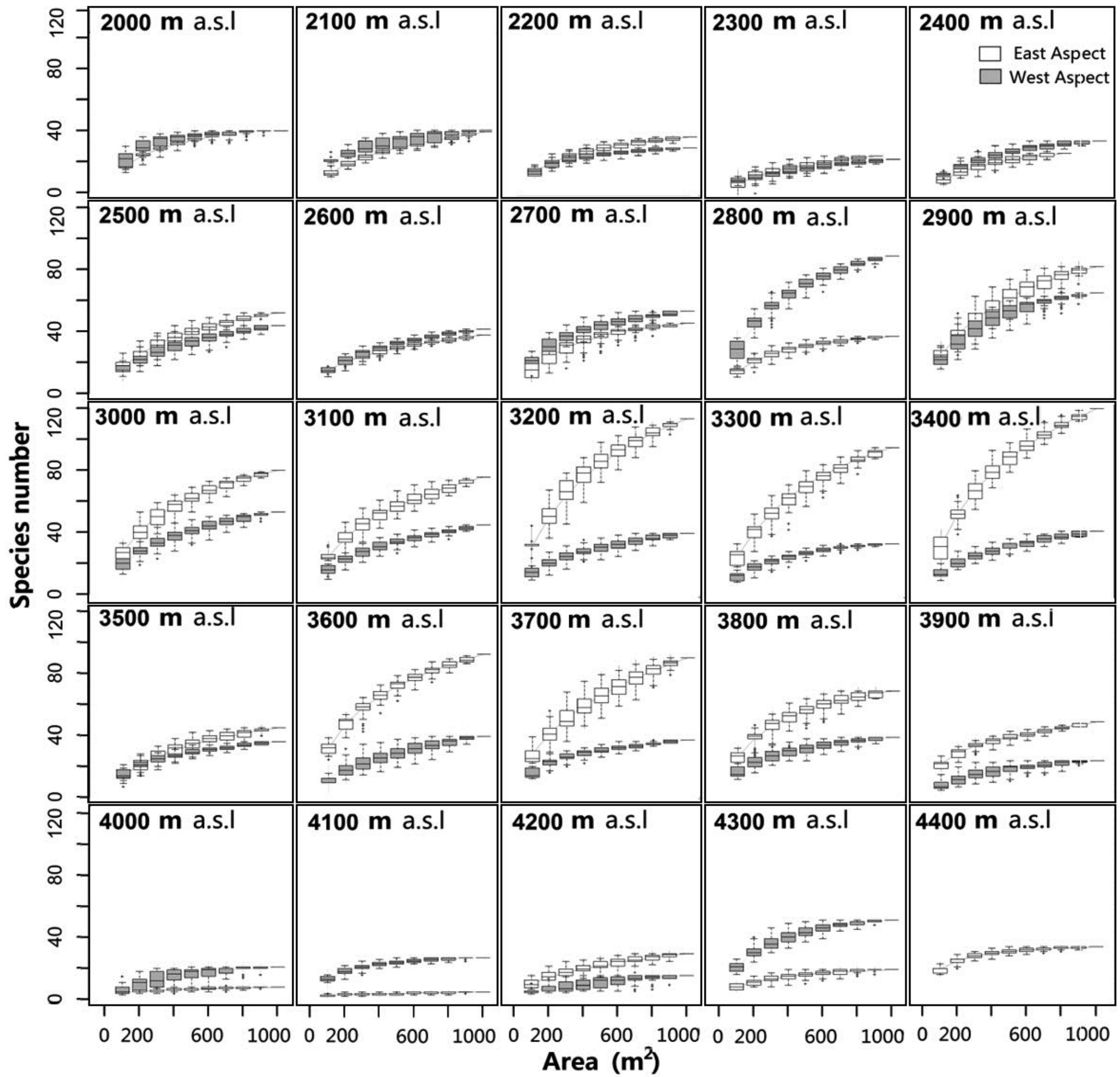
…… 针叶树材积比率



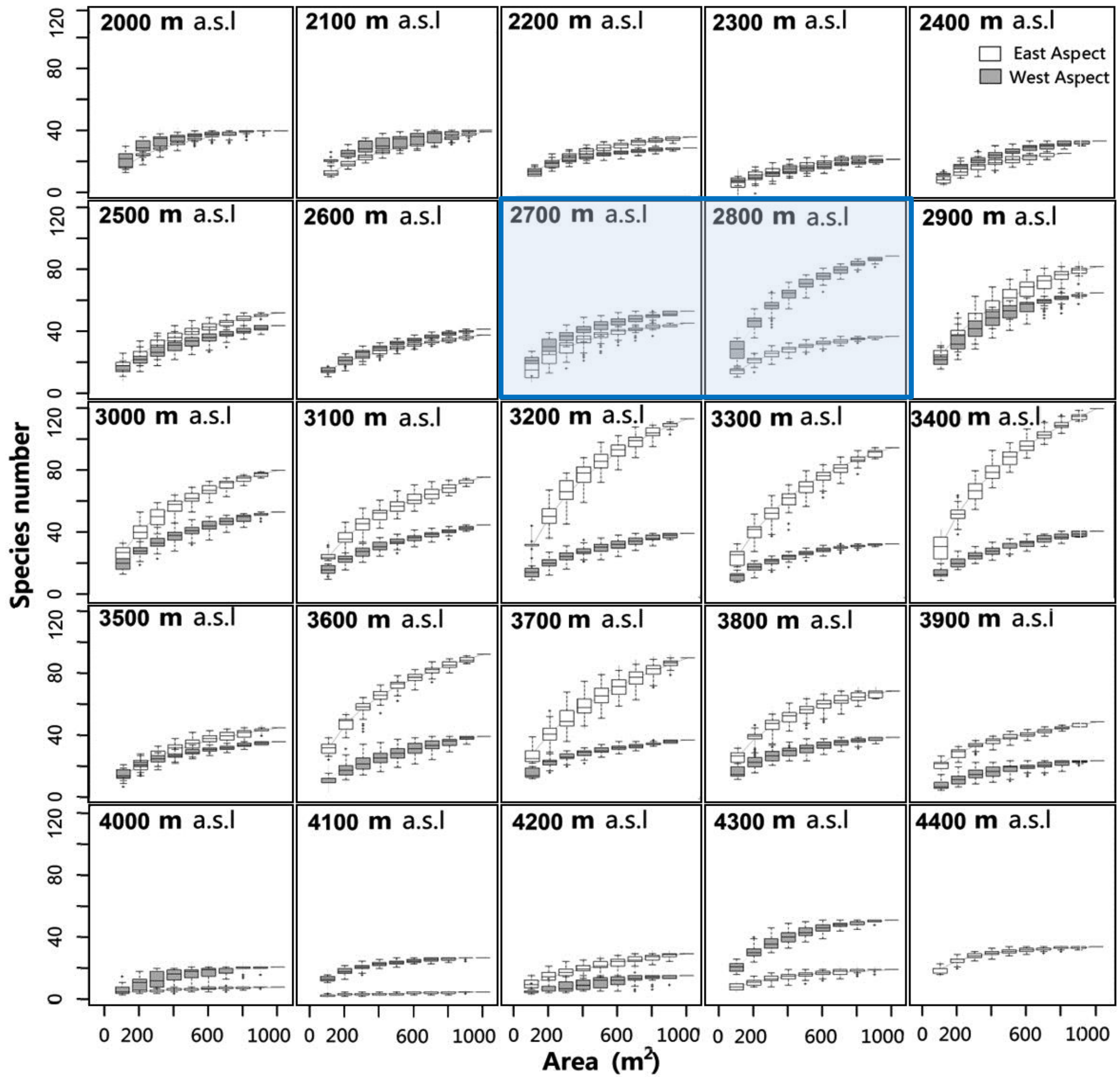
2) 东、西坡群落物种丰富度海拔格局



3) 东、西坡种-面积关系的海拔格局



3) 东、西坡种-面积关系的海拔格局



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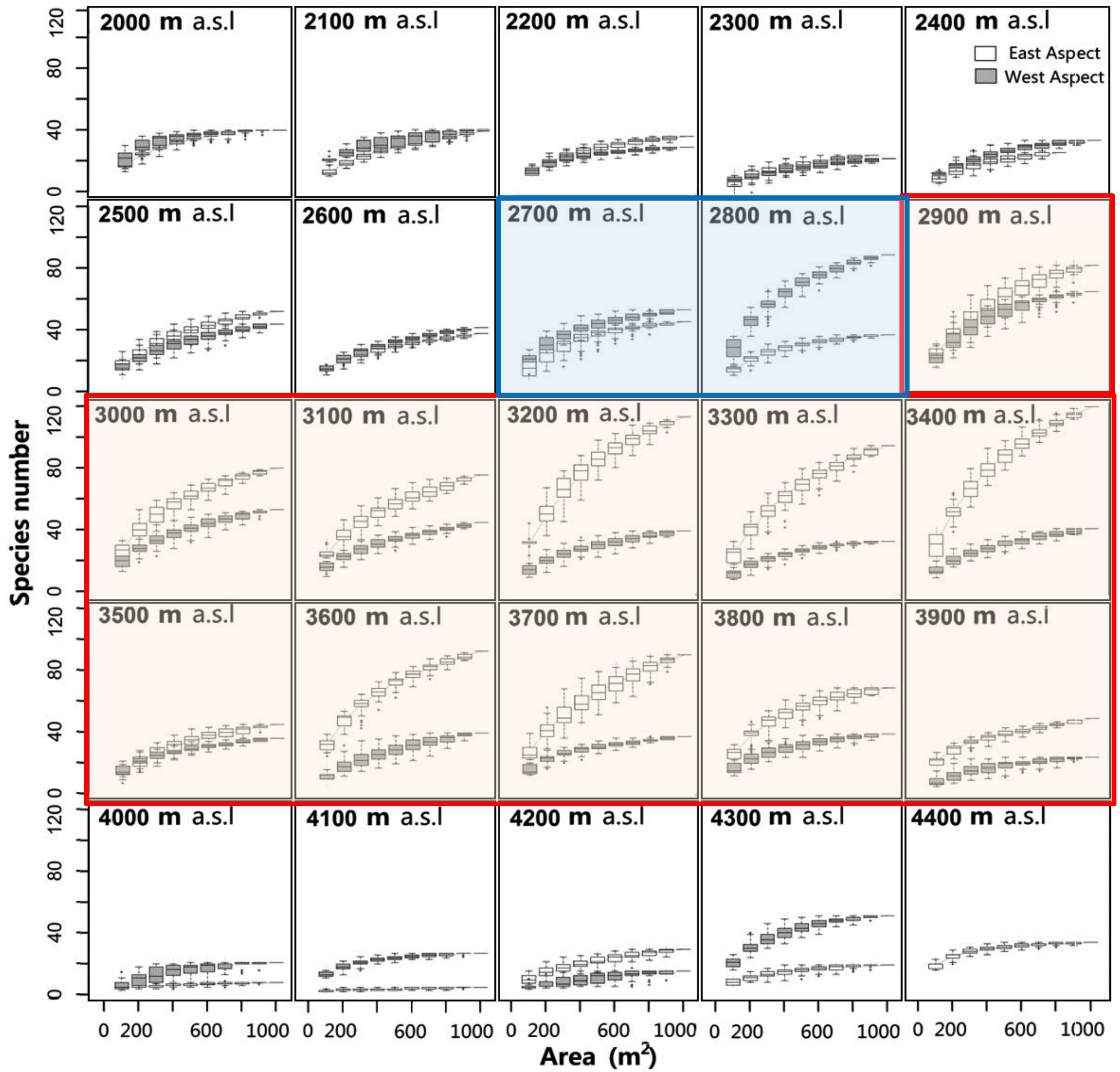
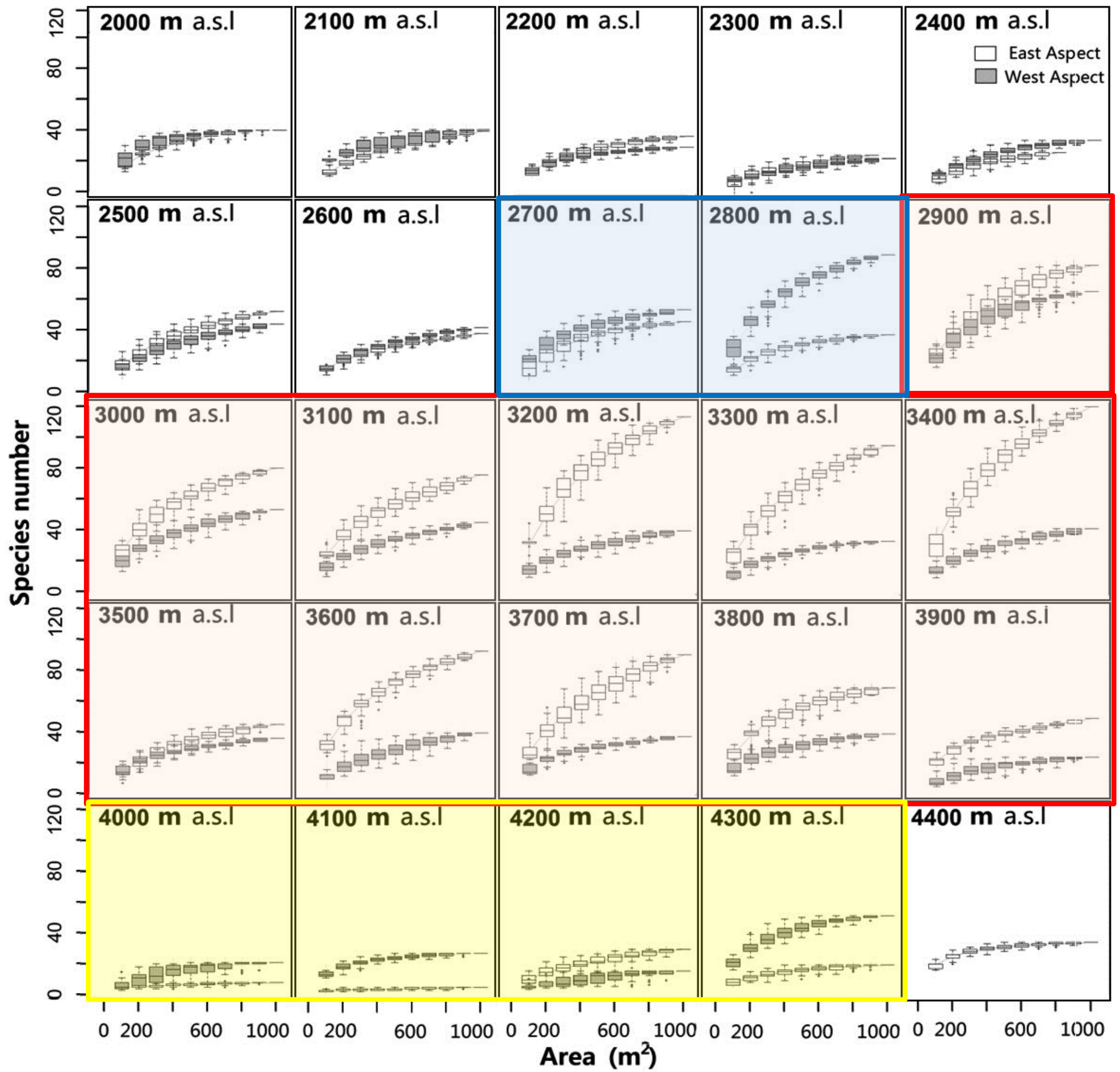
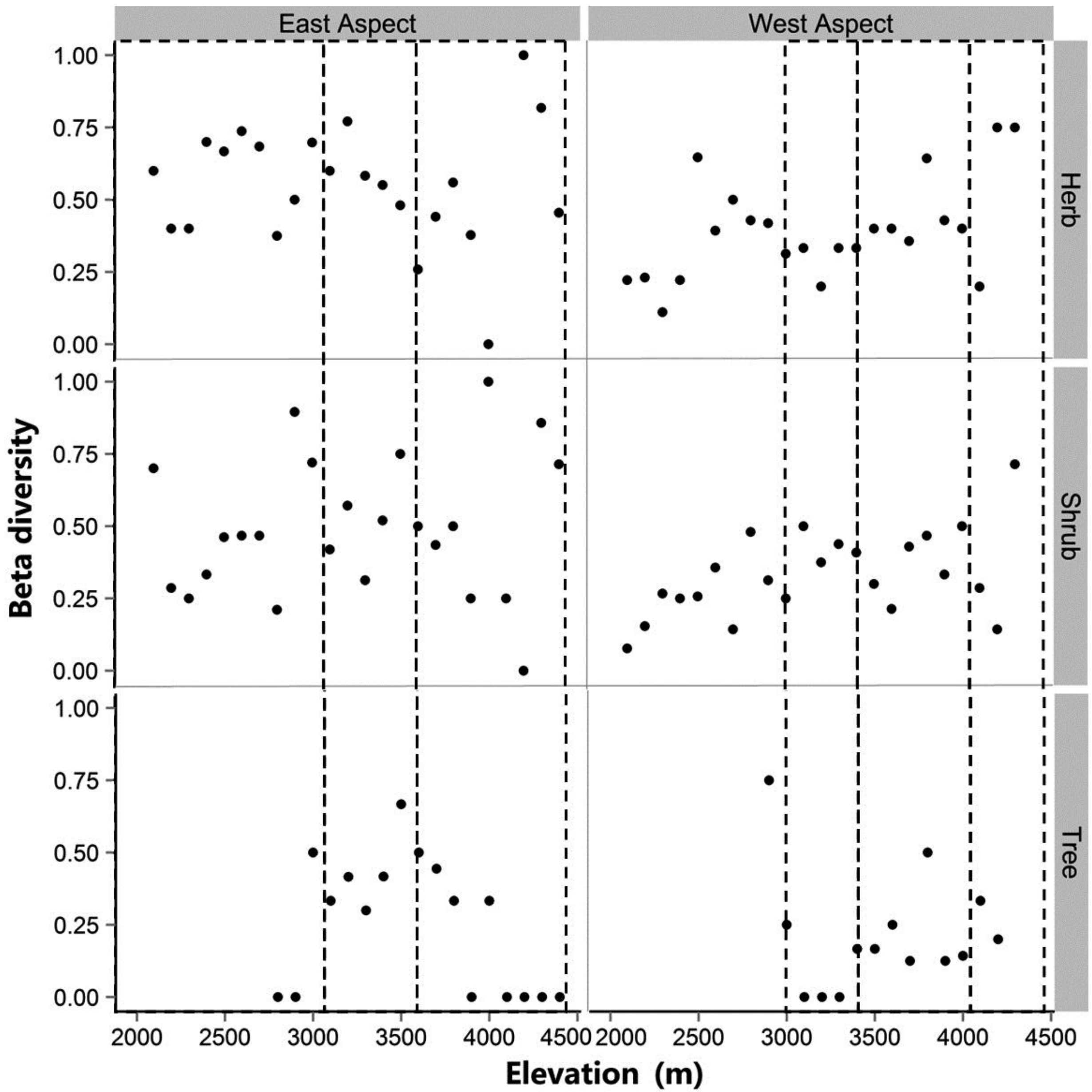


3) 东、西坡种-面积关系的海拔格局



4)物种更替


East Aspect
West Aspect
Herb
Shrub
Tree
Beta diversity
Elevation (m)
1.00
0.75
0.50
0.25
0.00
2000
2500
3000
3500
4000
4500

5) Alpha多样性的解释

Table 3. Hierarchical variation partitioning of elevation-related species richness patterns of herb, shrub and tree species and of all species on the western and the eastern aspects of Baima Snow Mountain. Refer to Table 2 for abbreviation and definitions.

Variable	Western Aspect				Eastern Aspect			
	Herbs	Shrubs	Trees	All Forms	Herbs	Shrubs	Trees	All Forms
MAT		0.080	0.174 *		0.056	0.072	0.082	0.089
Tmin		0.087	0.174 *	0.107				
PET		0.118	0.281 *	0.107	0.051		0.166 *	0.078
Pmin		0.169 *			0.100			
Pmax		0.122 *		0.211 *			0.075	0.070
PDQ	0.306 *				0.091			0.107
PWQ		0.122 *		0.201 *	0.048	0.073	0.081	0.070
WD		0.073		0.114 *				
AET			0.167 *		0.050	0.123	0.064	0.072
NPP	0.068				0.159 *			
ART	0.223 *	0.096			0.110	0.238 *	0.178 *	
TSN	0.200 *			0.169 *		0.257 *	0.171 *	0.221 *
PSN			0.072					
Exposure	0.061				0.042	0.028		0.027
Slope					0.174 *	0.077		0.171 *
Interpreted variation (%)	85.7	88.8	92.7	90.2	83.6	95.2	95.8	92.5

* Significant at 95% by the Z test.

6) Beta多样性的解释

Table 4. Regression coefficients and regression R-squared values: multiple regression on distance matrices of beta diversity on the eastern and the western aspects of Baima Snow Mountain. D_e and D_g: Euclidian distance between two transects calculated for environmental variables or geographic coordinates (including elevation), respectively.

Distance	Variables	Eastern Aspect			Western Aspect		
		Herb	Shrub	Tree	Herb	Shrub	Tree
D_e	Energy	0.156	0.335	0.995 ***	0.180	0.035	1.269 *
	Moisture	0.385 **	0.525 **	0.289	0.513 **	0.618 **	1.133 *
	Seasonality	0.076	0.052	0.035	0.211 *	0.321 **	0.606
	Productivity	0.172 *	0.217 **	0.035	0.204 **	0.234 **	0.224
D_g		0.359 *	0.477 **	0.682 ***	0.230	0.354 **	0.410 *
Total	R^2	47.2% ***	47.1% ***	46.5% ***	62.8% ***	64.6% ***	63.8% ***

*, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$.

Table 5. Comparison of different hypotheses to explain the elevation-related patterns of plant species diversity in Baima Snow Mountain.α diversity, species richness of transects; β diversity, species turnover rate between pairs of neighboring transects; r diversity, total species recorded in all transects of each (eastern or western) aspect of the BSM; ×, rejected; √, supported; √×, partially supported (or rejected).

Interpretive Hypothesis	α Diversity	β Diversity	R Diversity	Species-Area Curves
Area	×	×	×	√×
Middle-domain effect	√×	√×	×	×
Historical and regional process	√	×	√	√×
Water-energy balance	√	√	√	√
Habitat heterogeneity	√×	×	×	√