

森林与土壤生态国家重点实验室

State Key Laboratory of Forest and Soil Ecology

开放式臭氧浓度升高对土壤生物的影响

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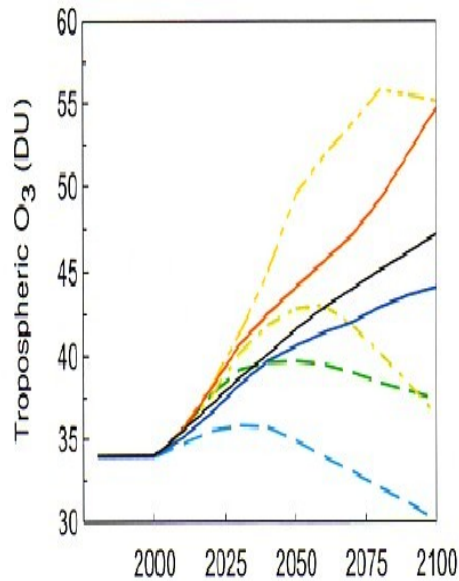
报告内容

- ⊕ 研究背景
- ⊕ 科学问题
- ⊕ 结果分析
- ⊕ 初步结论

研究背景

What impacts ?

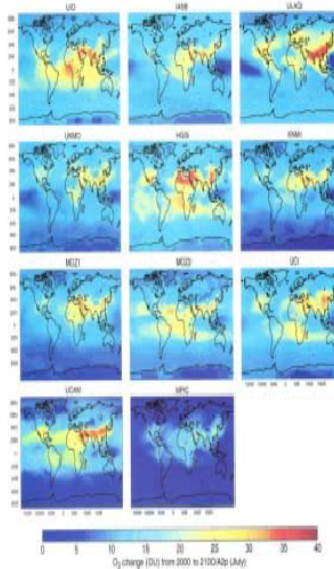
Tropospheric O₃ will increase in most scenarios



Source: IPCC 2001

Tropospheric O₃

Largest increase in total tropospheric O₃ predicted in Asia with most CTMs



Community effects

- ↓ Net primary productivity
- ↑ Shifts in composition of species and genotypes



Whole-plant effects

- ↓ Biomass
- ↓ Leaf area
- ↓ Reproductive output
- ↑ Defense
- ↑ Senescence



Leaf effects

- ↓ Photosynthesis
- ↓ Starch metabolism
- ↓ Sucrose metabolism
- ↑ Respiration
- ↑ Foliar damage
- ↑ Wax accumulation



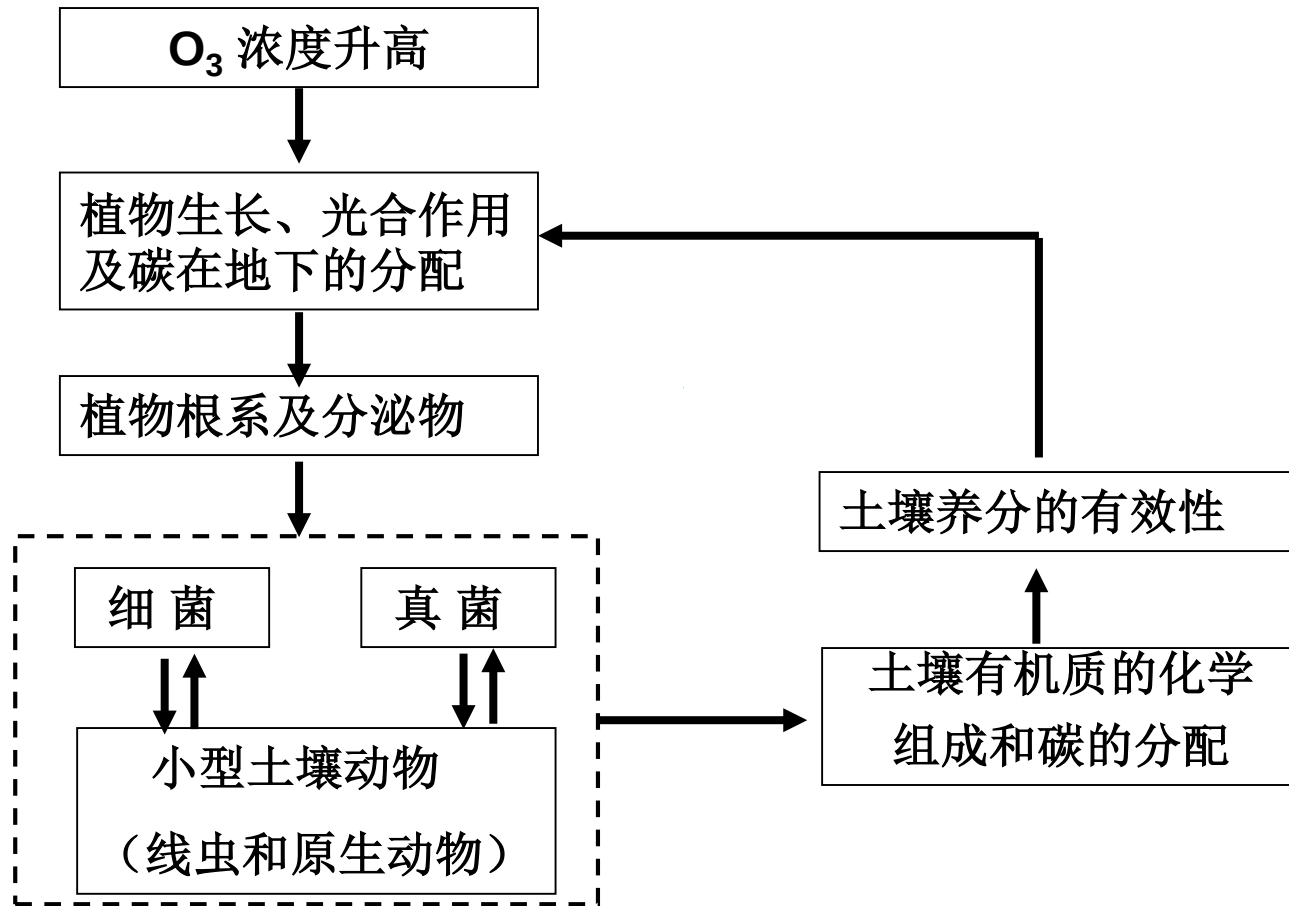
Cellular effects

- ↓ RuBisCO content and activity
- ↑ Reactive oxygen species scavenging capacity
- ↑ Protein repair and turnover
- ↑ Flavonoid biosynthesis

研究背景



全球变化对土壤腐屑食物网的影响

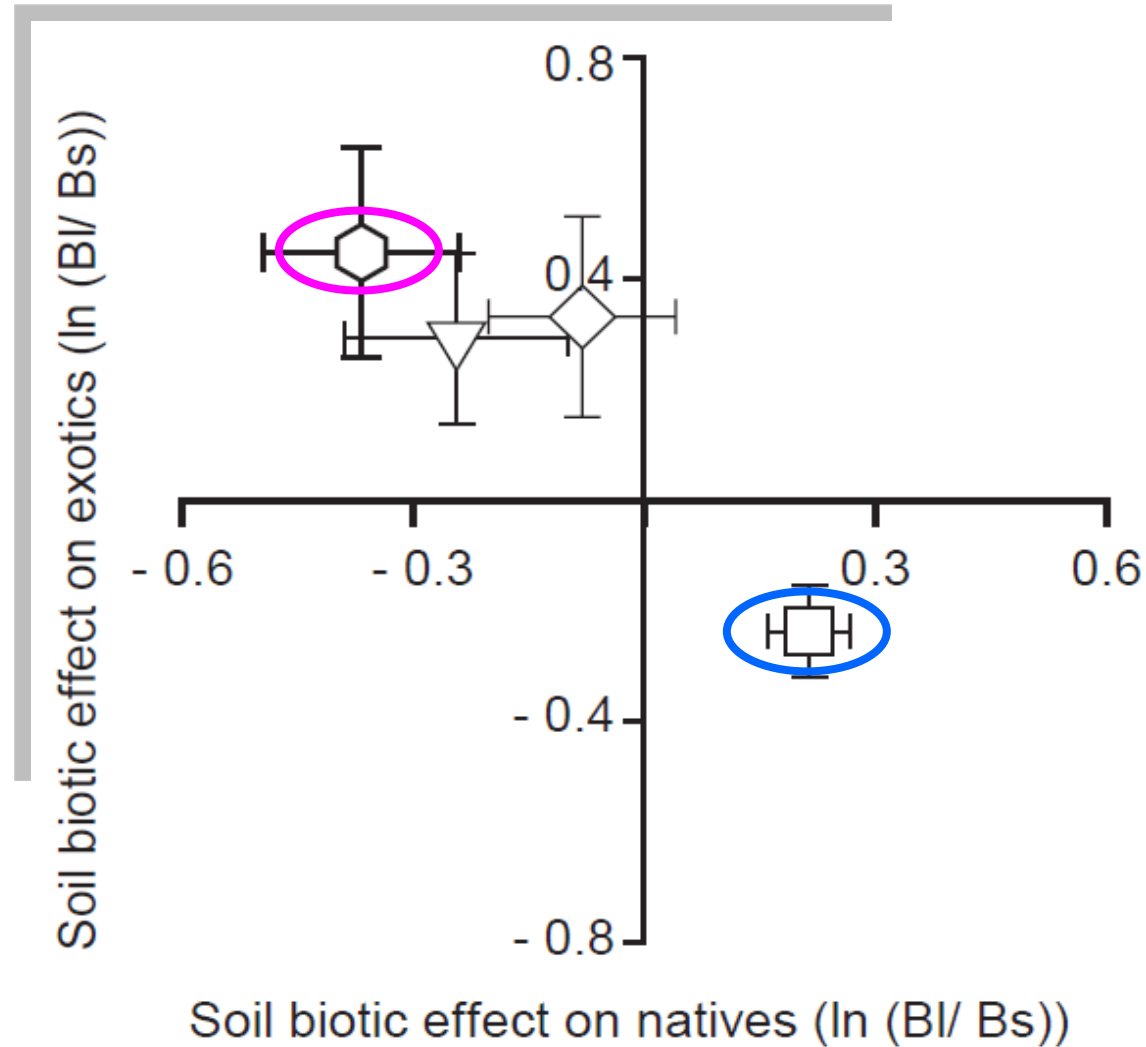


地上地下之间的**反馈作用**在控制生态系统进程和特性方面起重要作用(Bardgett and Wardle, 2010)

Soil biotic legacy effects of extreme weather events influence plant invasiveness

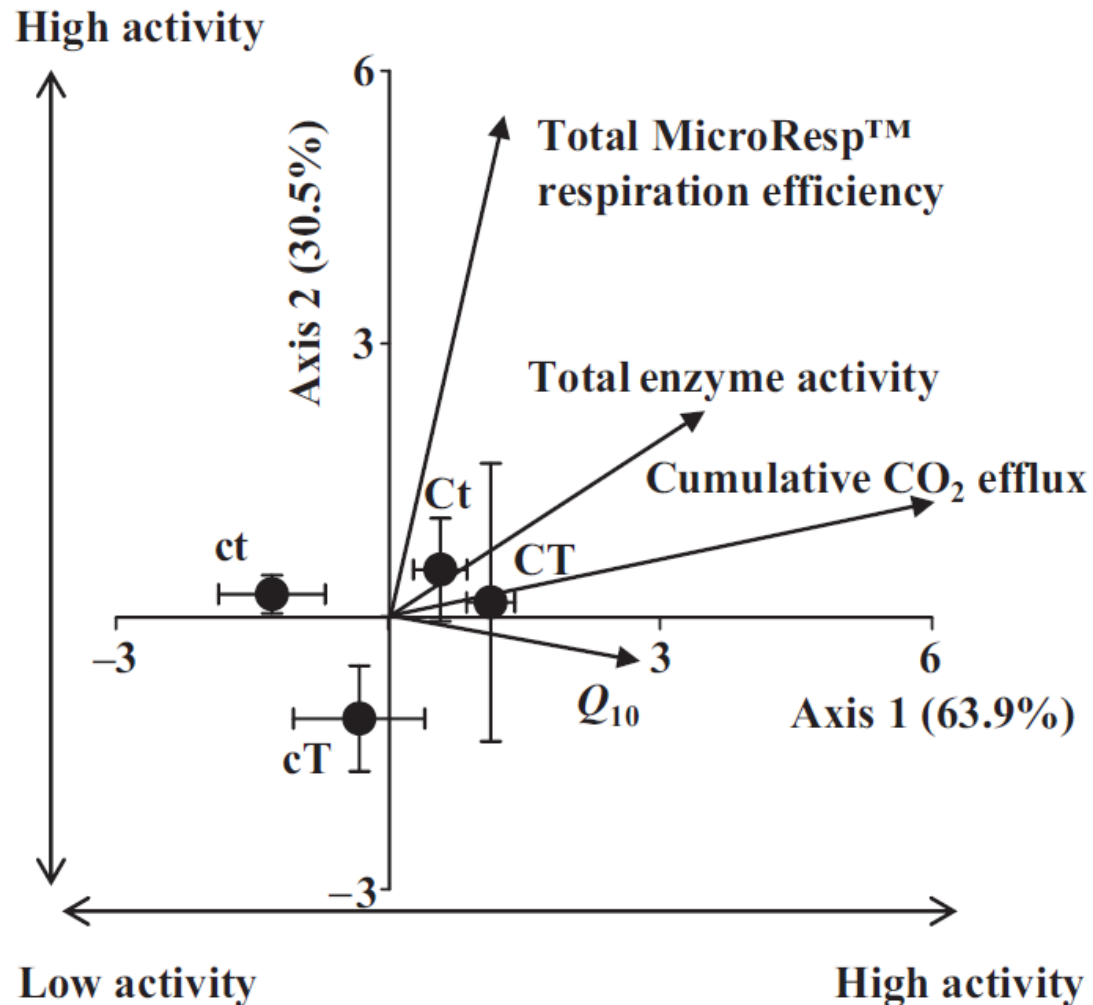
Annelein Meisner^{a,1,2}, Gerlinde B. De Deyn^{a,b}, Wietse de Boer^{b,c}, and Wim H. van der Putten^{a,d}

PNAS PNAS



LETTER

Positive climate feedbacks of soil microbial communities in a semi-arid grassland

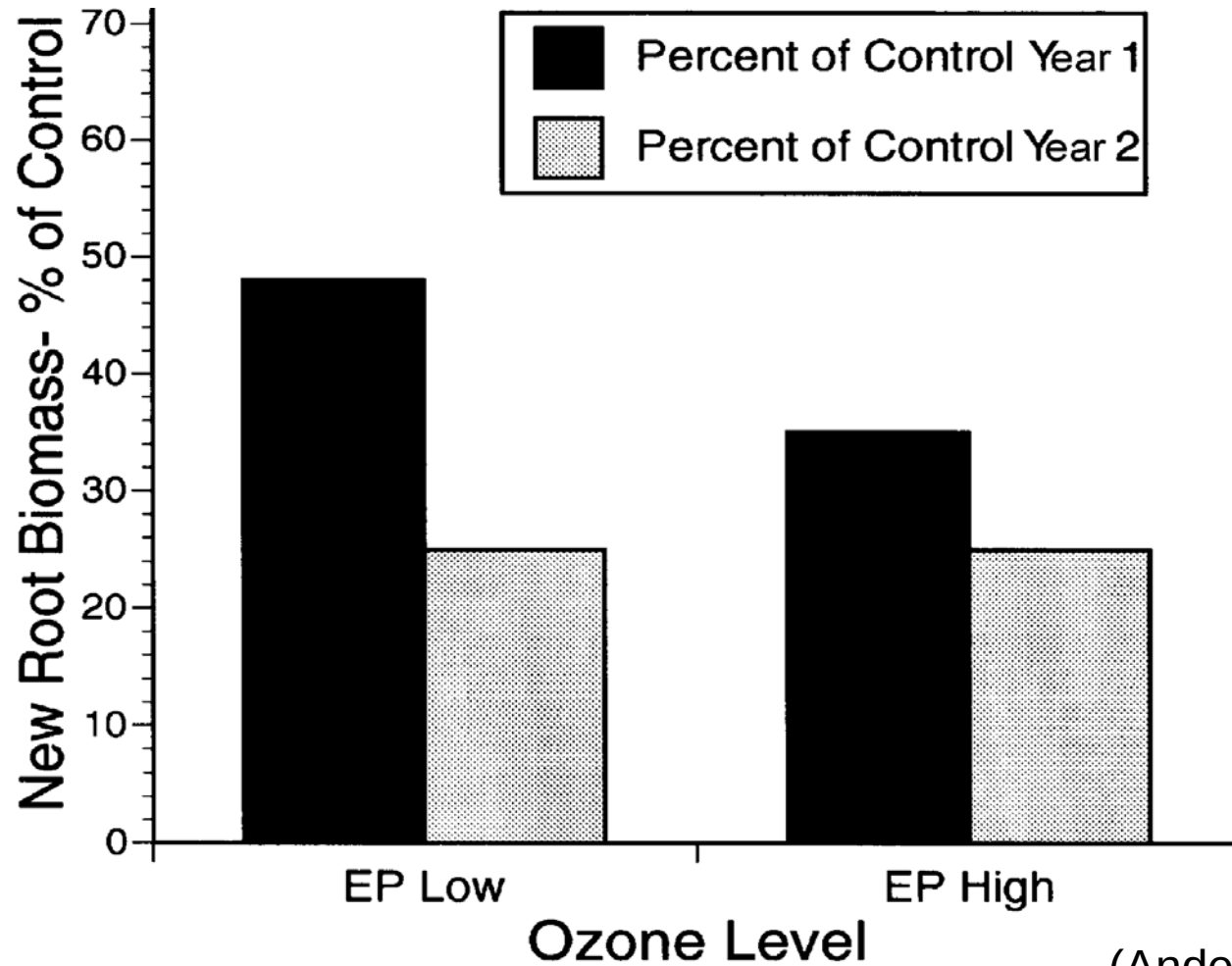


研究背景

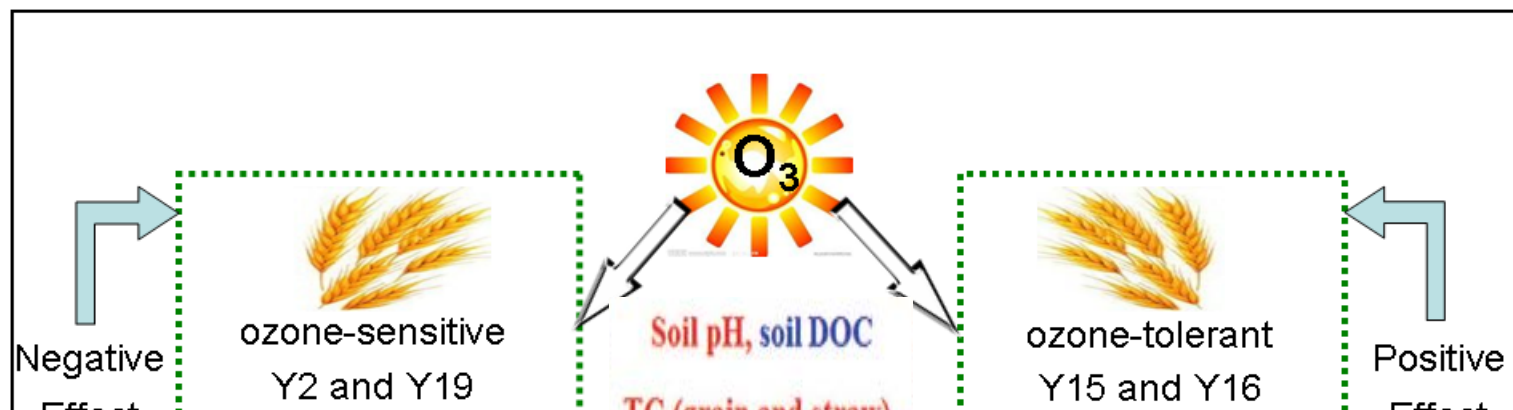


Tree Physiology 17, 805–811

© 1997 Heron Publishing—Victoria, Canada

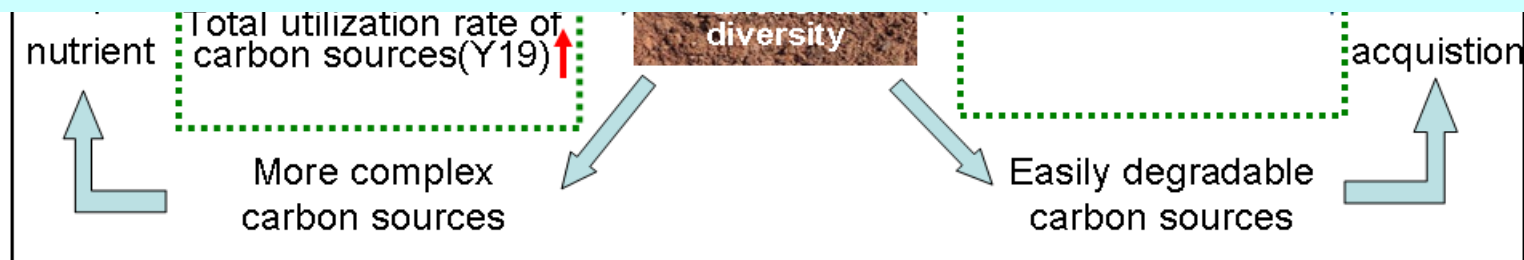


(Andersen *et al.*, 1997).



臭氧浓度升高对地下生态过程的影响是暂时的还是长期的？

臭氧升高对土壤生物的印痕效应将如何影响植物生长？



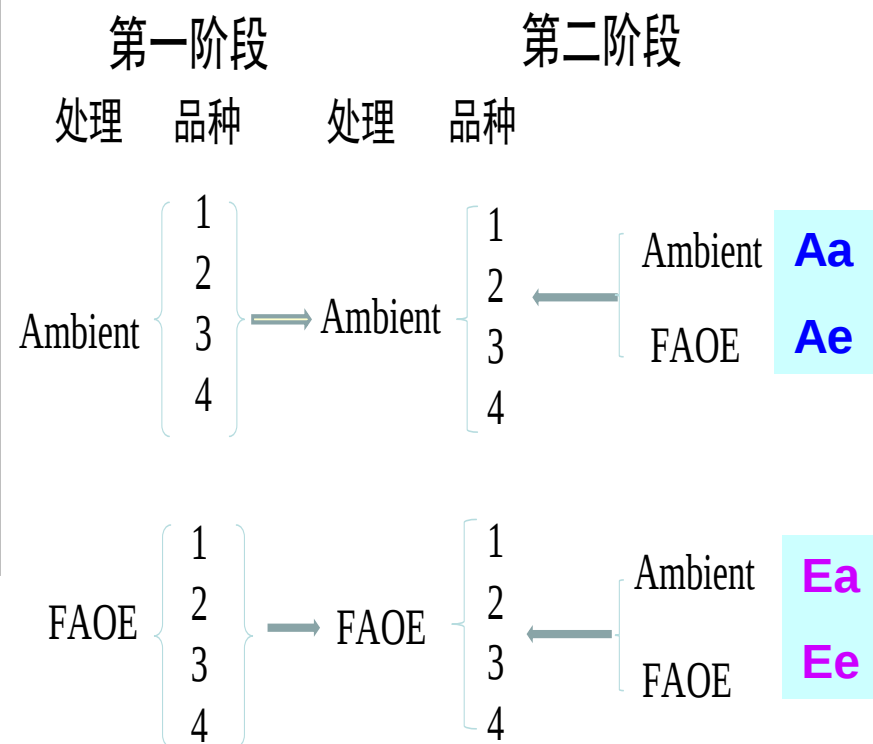
Li *et al.*, SBB, 2012

Li *et al.*, ISME, 2013

Zhang *et al.*, Plant soil, 2014

实验设计

研究假设: 臭氧升高对土壤生物产生的印痕效应要比直接效应更明显, 上述影响还会植物生长产生一定的反馈作用.

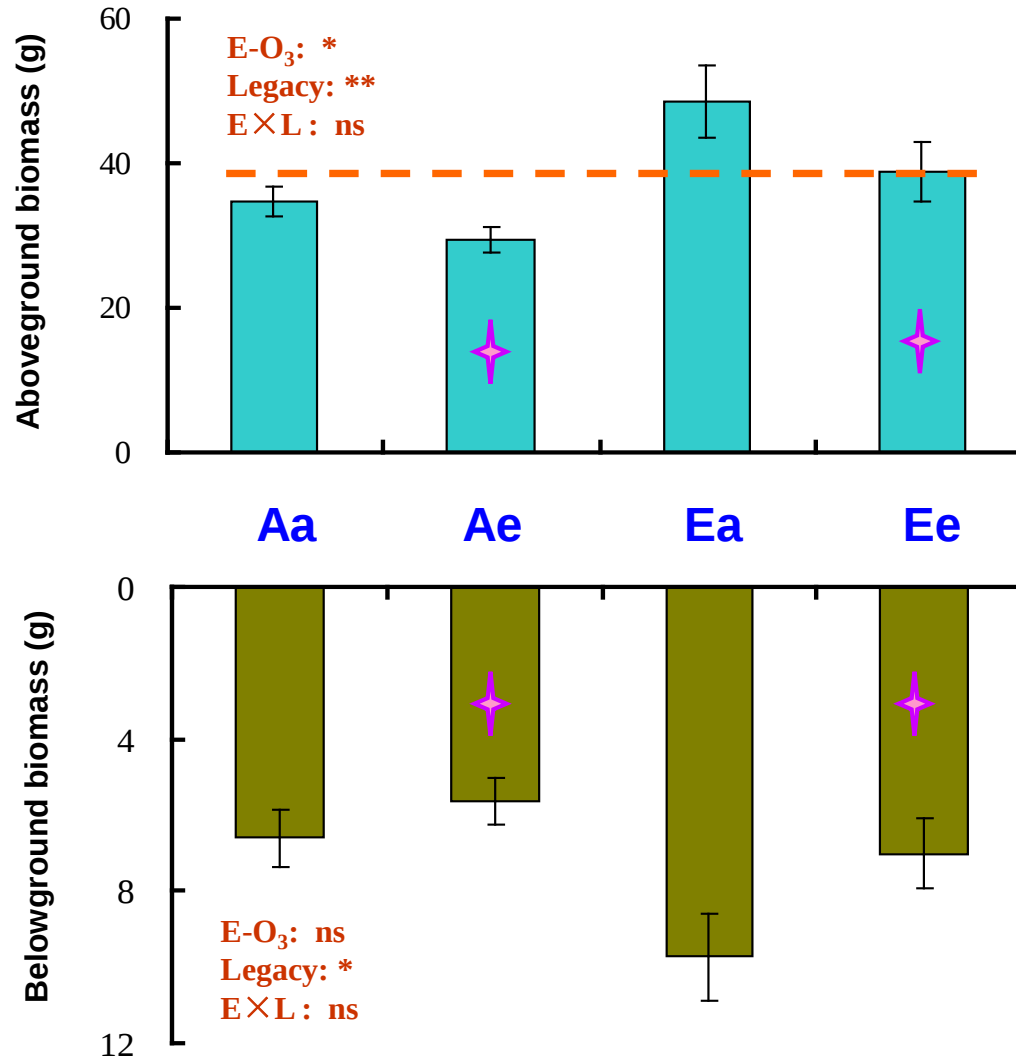


4个品种 × 2个处理 (A+E) × 6个圈 = 48

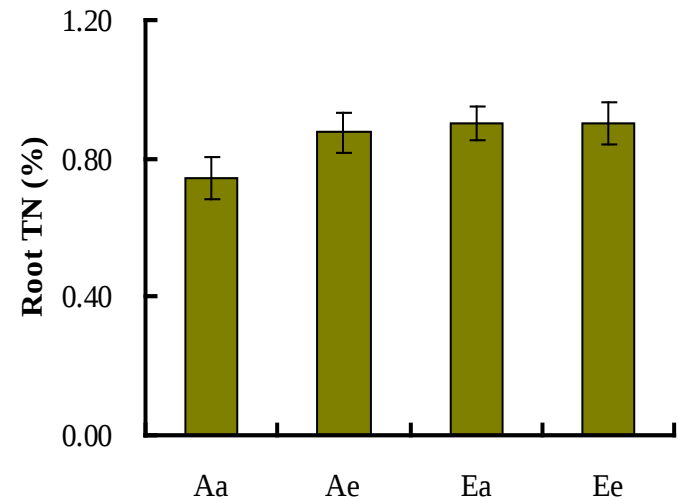
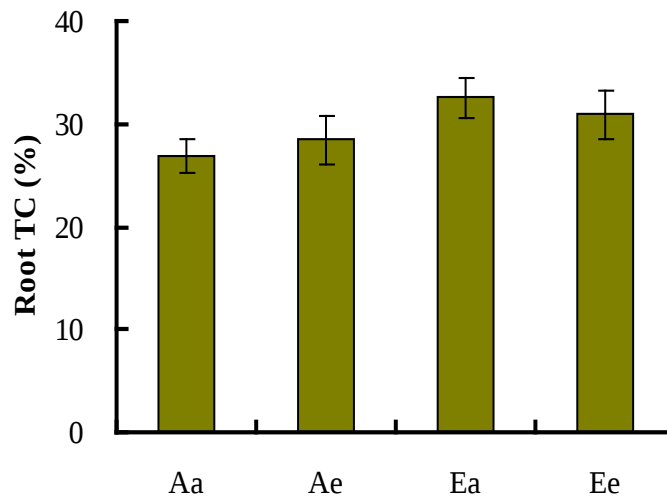
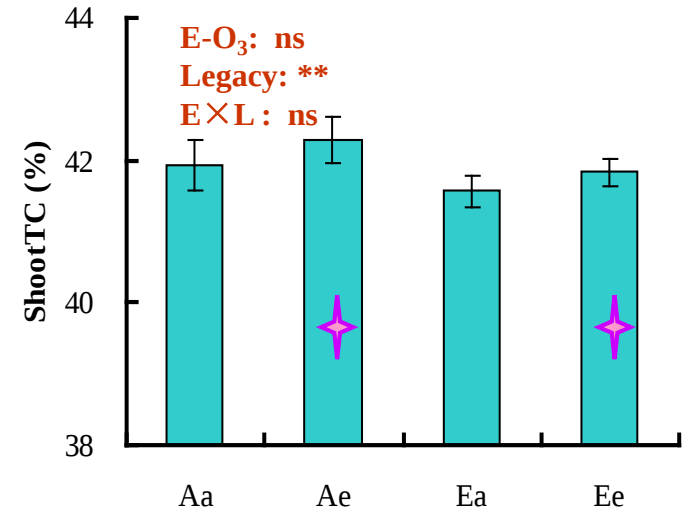
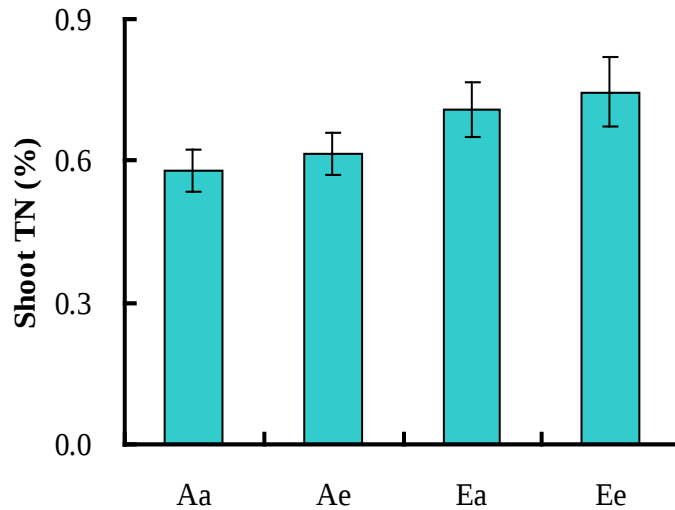
观测指标

- 植物生长（生物量和碳氮含量）
- 土壤理化指标
- 微生物群落（PLFA）
- 线虫群落结构

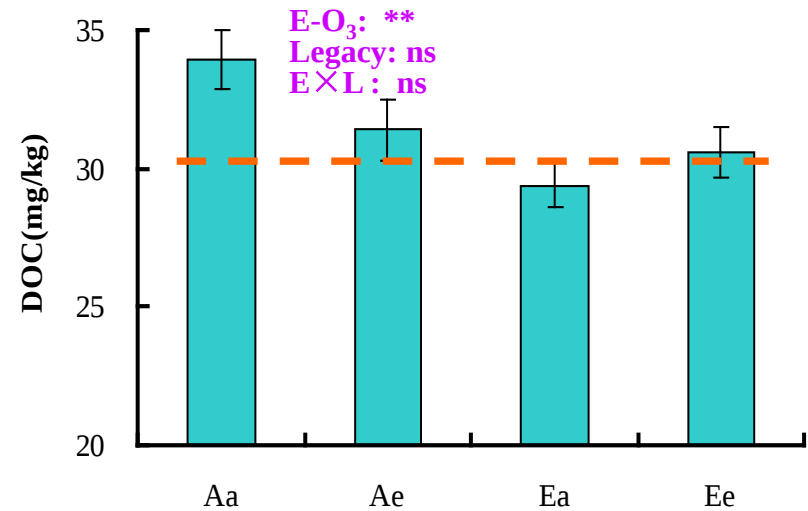
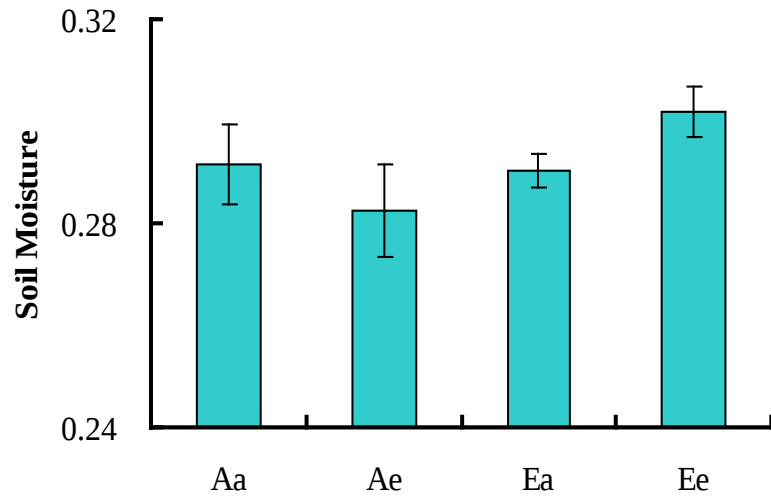
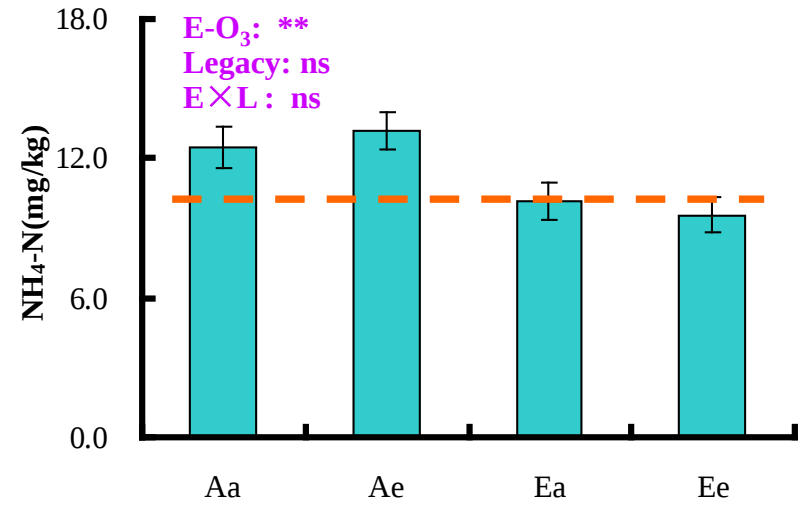
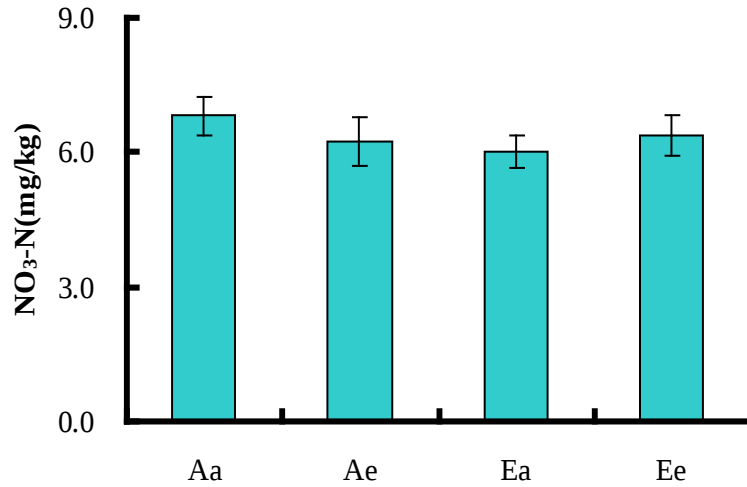
结果分析—对植物生长的影响



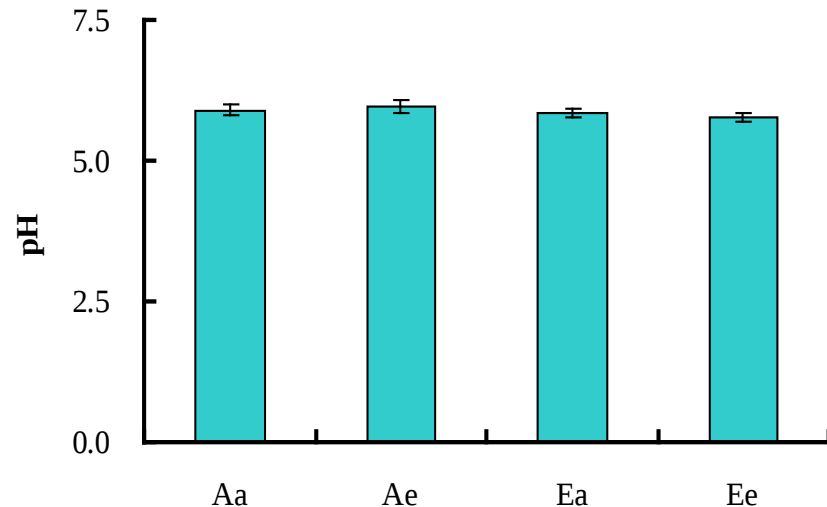
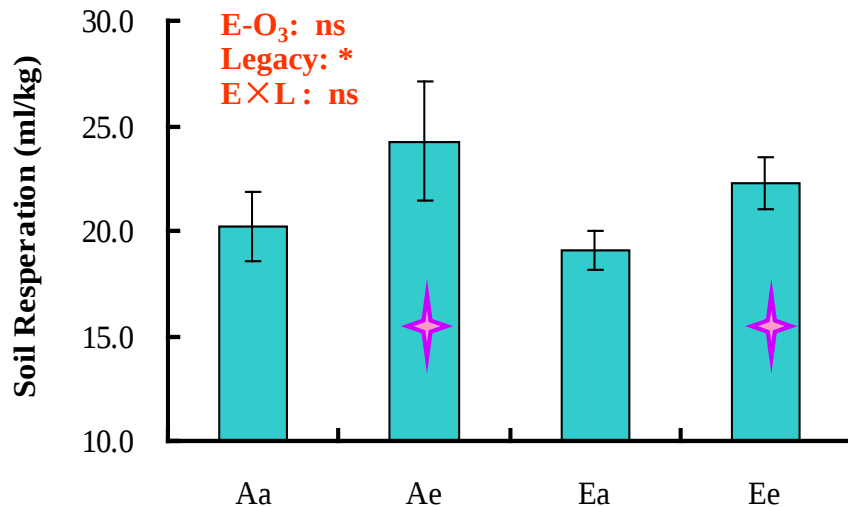
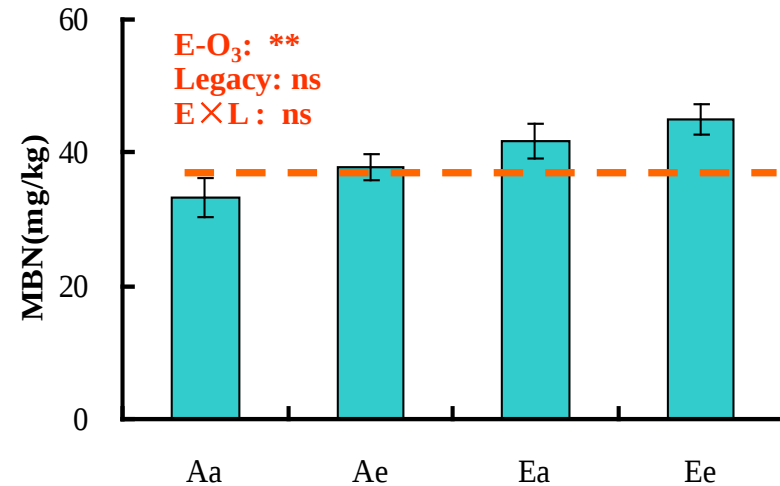
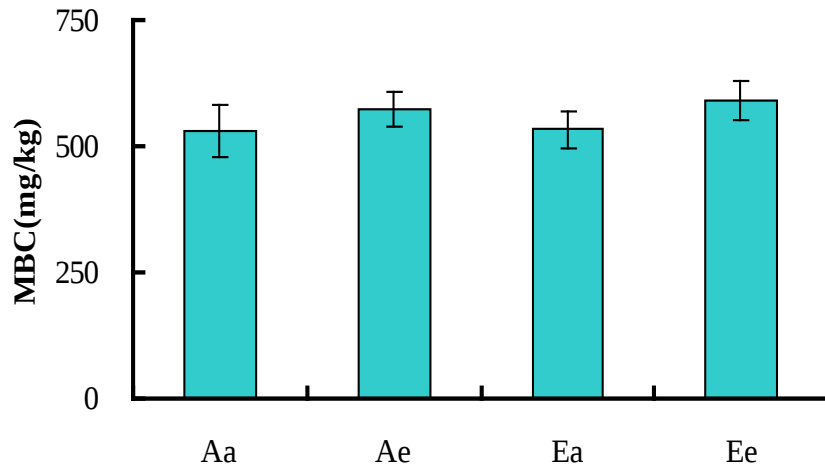
结果分析—对植物生长的影响



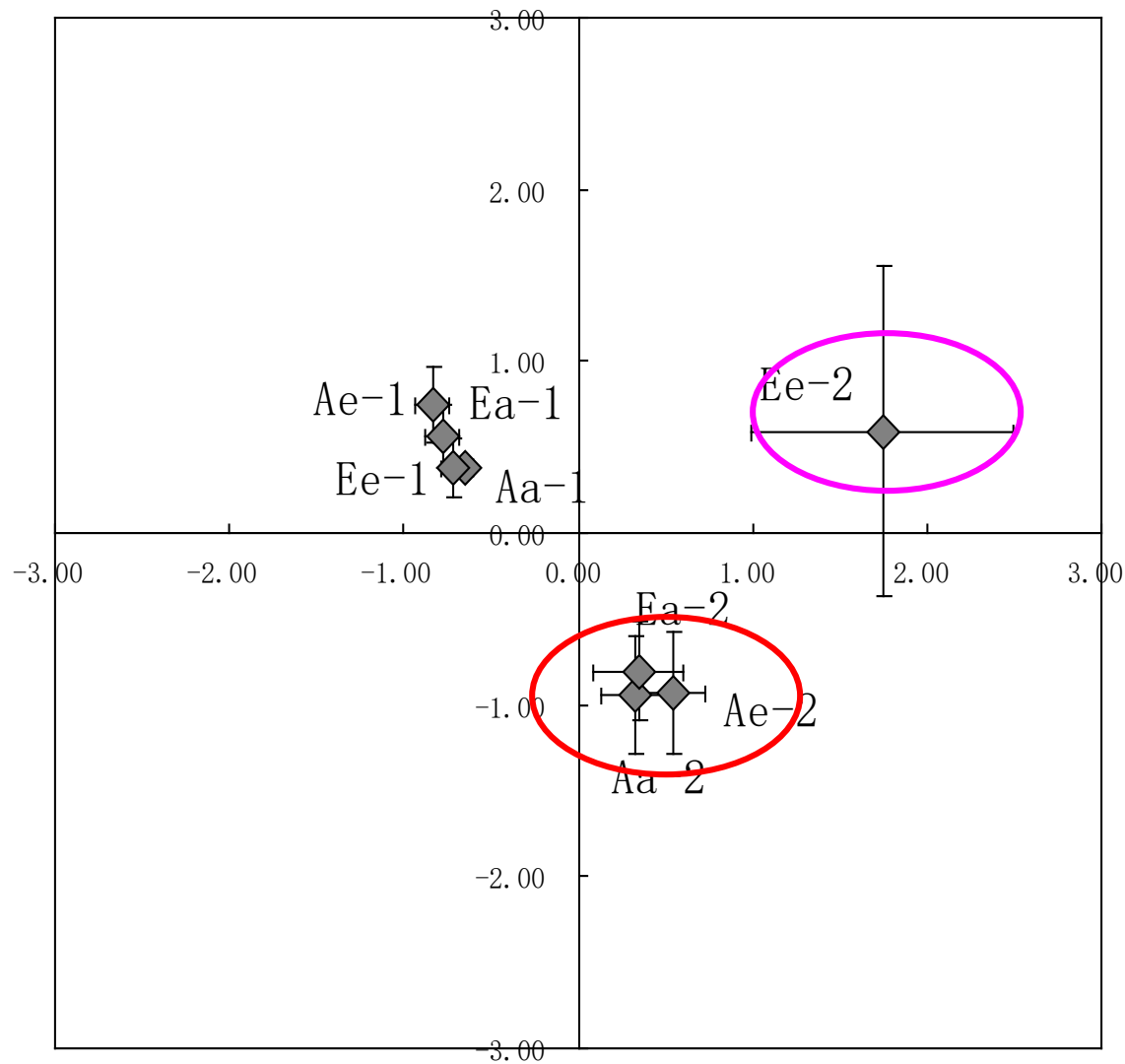
结果分析-对土壤特性的影响



结果分析-对土壤特性的影响



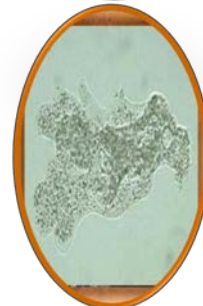
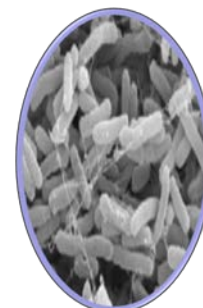
结果分析-对土壤特性的影响



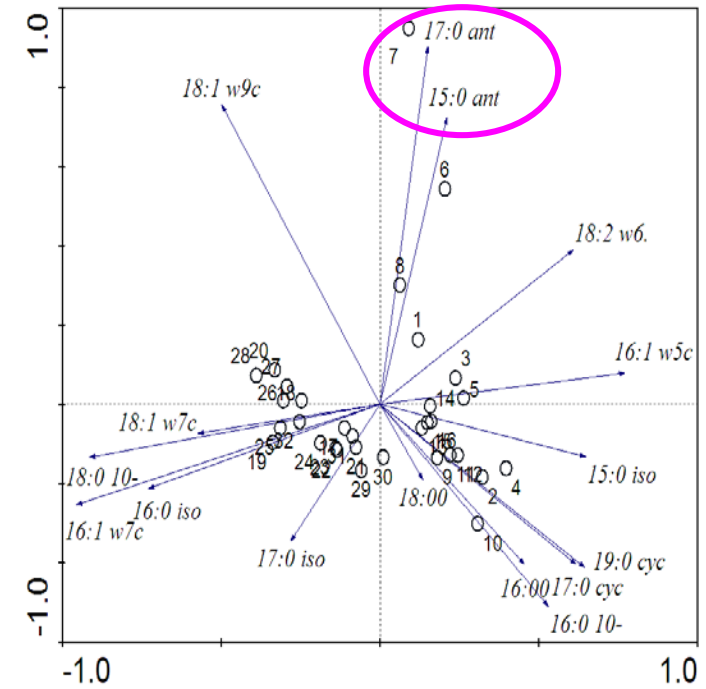
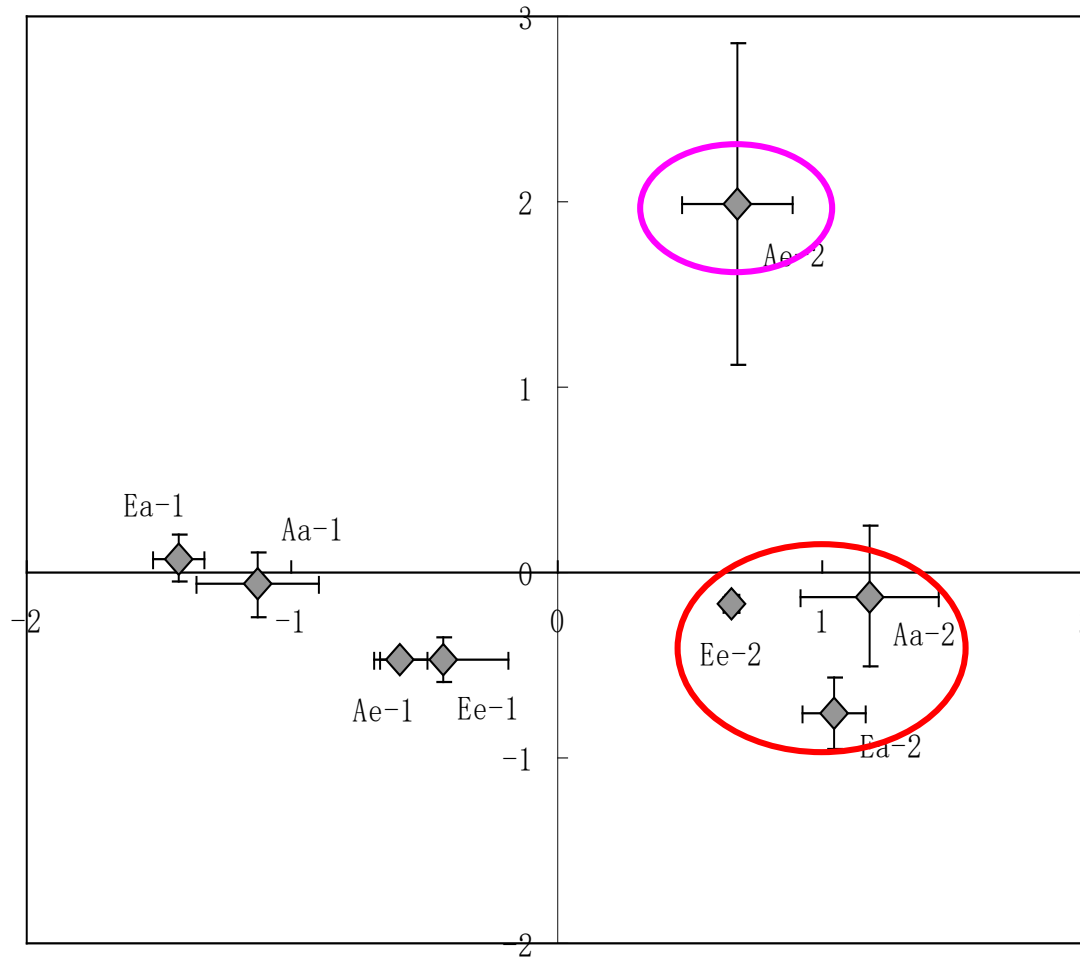
结果分析-对土壤微生物群落的影响



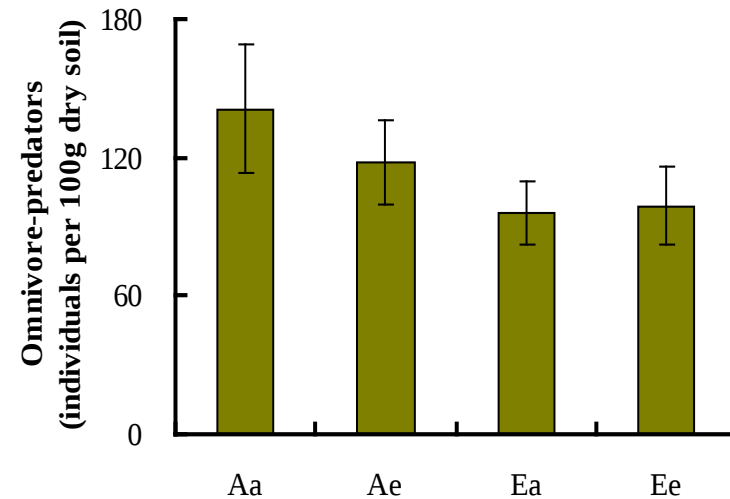
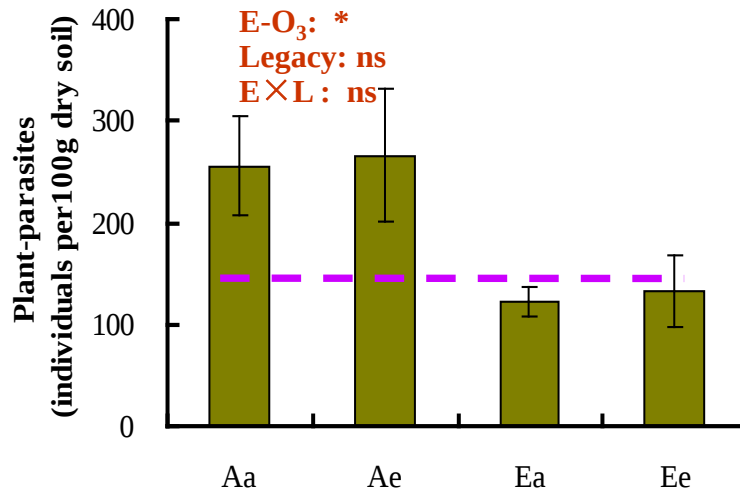
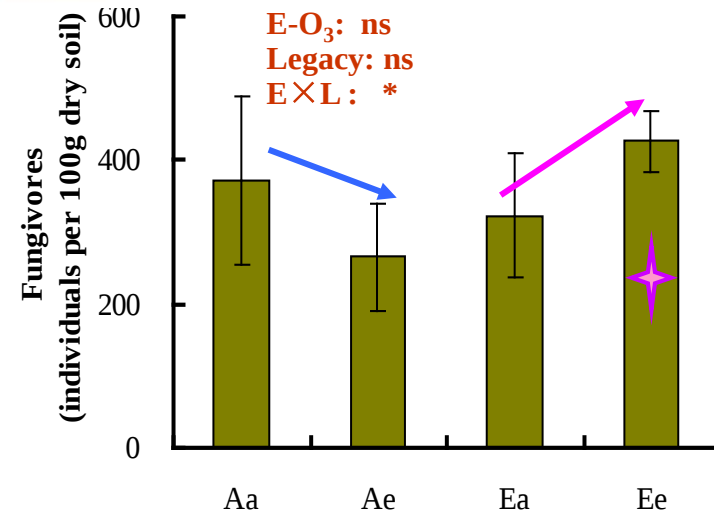
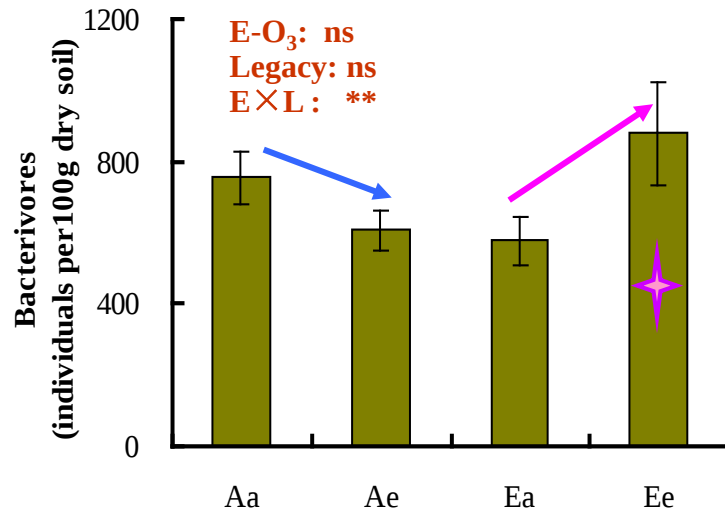
PLFA (nmol/g)	Ambient		FAOE		ANOVA (<i>P</i> values)		
	Aa	Ae	Ea	Ee	E-O ₃ (E)	Legacy (L)	E×L
Total PLFA	230.35±11.85	241.38±15.07	268.67±7.82	281.87±14.78	0.086	0.393	0.939
Fungal	6.41±0.55	6.78±0.75	7.39±0.27	7.69±0.44	0.317	0.562	0.953
AMF	6.23±0.34	6.68±0.51	7.52±0.40	7.58±0.49	0.235	0.557	0.653
Protozoa	2.97±0.31	2.51±0.31	3.58±0.16	3.72±0.17	0.043	0.557	0.256
Actinomycetes	21.76±1.35	22.59±1.19	26.20±0.83	27.34±1.58	0.028	0.486	0.911
Bacterial G+	47.61±2.71	54.99±3.36 ↑ 15.5%	57.00±2.12	62.59±3.85 ↑ 9.8%	0.072	0.072	0.798
Bacterial G-	68.63±4.61	68.76±4.99	81.31±3.33	83.17±5.02	0.121	0.838	0.859
Bacterial	178.13±9.72	188.57±12.90	208.98±6.92	220.63±12.50	0.101	0.357	0.960



结果分析-对土壤微生物群落的影响



结果分析-对土壤线虫群落的影响



结果分析—生物群落和植物/土壤特性的关系



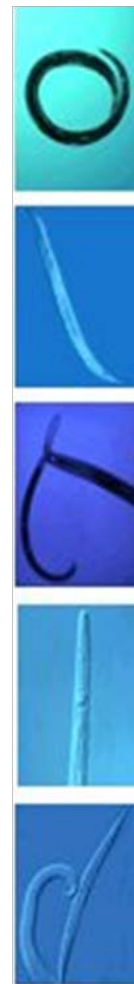
Percentage of variance in soil microbial and nematode community under Ambient and Elevated [O₃] conditions explained by soil and plant variables in RDA analysis

Factors and Vectors	Microbial community		Nematode community	
	%	<i>P</i>	%	<i>P</i>
Factor (Direct-O₃)	15.69	0.002	6.64	0.001
<i>Soil properties</i>				
SM	7.65	0.018	2.84	0.019
pH	5.94	0.038	3.36	0.010
MBC	10.51	0.010	1.87	0.051
MBN	18.10	0.002	4.64	0.002
<i>Plant biomass</i>				
Shoot biomass	7.12	0.020	-0.01	0.426
Root biomass	11.18	0.006	-0.18	0.493
<i>Groups of variables</i>				
Soil	29.43	0.001	13.8	0.001
Plant	9.88	0.018	-0.55	0.624
Soil + Plant + O₃	43.9	0.001	14.4	0.001

初步结论



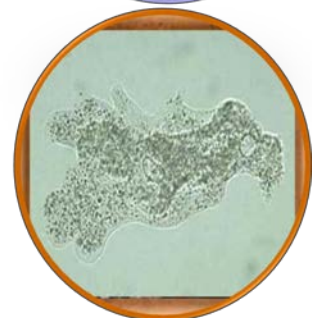
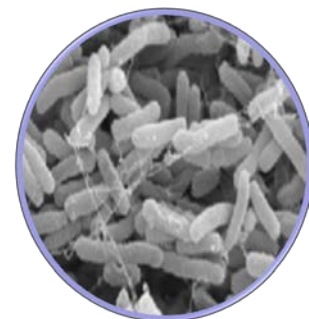
- 臭氧浓度升高对土壤生物的影响既有直接影响，也有印痕效应，且直接影响要比印痕效应更明显
- 臭氧浓度升高对微生物群落的直接影响能够促进植物的生长
- 而从长期来看，臭氧浓度生高的印痕效应会对植物生长产生负向的影响，同时加速土壤碳的流失



研究展望



- 由于地下生态过程在生物地球化学循环中发挥着重要的作用，臭氧浓度升高可能对生态系统功能产生累积的影响
- 深入揭示臭氧升高对土壤生物的印痕效应能否改变植物群落多样性和生态系统生产力
- 地下生态系统对全球变化的响应将对生态系统长期的稳定产生怎样的影响



致谢



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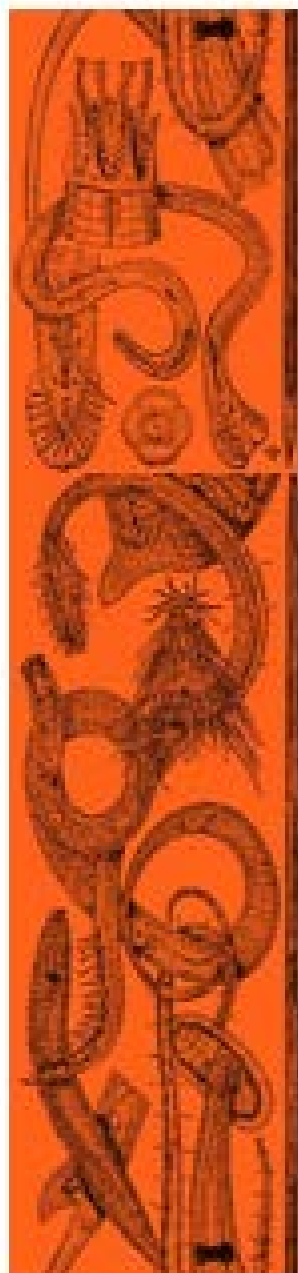
国家自然科学基金

National Natural Science Foundation of China

(No. 31270487)



沈阳应用生态研究所
青年创新群体基金



谢谢

