Análise de Correspondência - CA

Ordenação

- A ordenação refere-se a um grupo utilizado de métodos que tentam revelar as relações entre as comunidades ecológicas.

Why ordination?

- Ordenação concentra esforços para representar os relacionamentos entre amostras e espécies/variáveis, tão fielmente quanto possível, em um espaço de poucas dimensões.

Why ordination?

- 1) It is impossible to visualize multiple dimensions simultaneously. While physicists grumble if space exceeds four dimensions, ecologists typically grapple with dozens of dimensions (species and/or samples).
- 2) A single multivariate analysis saves time, in contrast to a separate univariate analysis for each species.
- 3) Ideally and typically, dimensions of this 'low dimensional space' will represent important and interpretable environmental gradients.

Why ordination?

- 4) If statistical tests are desired, problems of multiple comparisons are diminished when species composition is studied in its entirety
- 5) Statistical power is enhanced when species are considered in aggregate, because of redundancy
- 6) By focusing on ‘important dimensions’, we avoid interpreting (and misinterpreting) noise. Thus, ordination is a ‘noise reduction technique’

Why ordination?

- 7) We can determine the relative importance of different gradients; this is virtually impossible with univariate techniques.
- 8) Community patterns may differ from population patterns.
- 9) Some techniques provide a measure of beta diversity
- 10) The graphical results from most techniques often lead to ready and intuitive interpretations of species-environment relationships.

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

Table 6.7 *(Continued)*

	Quadrats												Quadrat totals	
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)	W
Species														
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10	0.00
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10	9.09
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6	18.18
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3	27.27
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5	36.36
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7	45.45
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2	54.55
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3	63.64
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4	72.73
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9	81.82
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5	90.91
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2	100.00
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5		

Dar pesos iguais às 12 espécies

100/11=9,09

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patula*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	

X

Table 6.7 (*Continued*)

W
0.00
9.09
18.18
27.27
36.36
45.45
54.55
63.64
72.73
81.82
90.91
100.00

Inicia-se o processo de cálculo de médias recíprocas iterativamente

- Faz-se o somatório das multiplicações indicadas

(1x0,00)+(0x9,09)+(0x0,18)+...+(0x100)=127,7

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	

X

Table 6.7 (*Continued*)

W
0.00
9.09
18.18
27.27
36.36
45.45
54.55
63.64
72.73
81.82
90.91
100.00

(1x0,00)+(0x9,09)+(0x0,18)+...+(0x100)=127,7

Este total é dividido pelo total de espécies da parcela 1: 3

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

Species	Quadrats 1	2	3	4	5	6	7	8	9	10	11	12	Quadrat totals (Q)
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	

Table 6.7 *(Continued)*

W
0.00
9.09
18.18
27.27
36.36
45.45
54.55
63.64
72.73
81.82
90.91
100.00

(1x0,00)+(0x9,09)+(0x0,18)+...+(0x100)=127,27

Este total é dividido pelo total de espécies da parcela 1: 3

127,27/3 = 42,42

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals	**Table 6.7** *(Continued)*
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)	W
Species														
1. *Atriplex patula*	1	1	1	1	1	1	1	0	1	0	1	1	10	0.00
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10	9.09
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6	18.18
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3	27.27
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5	36.36
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7	45.45
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2	54.55
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3	63.64
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4	72.73
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9	81.82
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5	90.91
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2	100.00
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5		
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64		

(1x0,00)+(0x9,09)+(0x0,18)+...+(0x100)=127,27

Este total é dividido pelo total de espécies da parcela 1: 3

127,27/3 = 42,42

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

Table 6.7 (*Continued*)

	Quadrats												Quadrat totals	
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)	W
Species														
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10	0.00
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10	9.09
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6	18.18
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3	27.27
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5	36.36
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7	45.45
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2	54.55
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3	63.64
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4	72.73
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9	81.82
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5	90.91
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2	100.00
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5		
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64		

Os demais valores da linha Q1 são calculados exatamente da mesma maneira.

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	[illegible]	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	[illegible]	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	

X

Table 6.7 (*Continued*)

W	S1	
0.00	40.83	
9.09	41.35	
18.18	42.86	
27.27	35.15	
36.36	44.12	
45.45	40.93	
54.55	48.49	1
63.64	38.10	
72.73	43.32	
81.82	42.00	
90.91	42.60	
100.00	48.49	1

(1 x 42,42) + (1 x 34,09) + (1 x 32,73) + ... + (1 x 43,64) = 408,30

408,30/10 = 40,83

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	[illegible]	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	[illegible]	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	

X

Table 6.7 *(Continued)*

W	S1	
0.00	40.83	
9.09	41.35	
18.18	42.86	
27.27	35.15	
36.36	44.12	
45.45	40.93	
54.55	48.49	1
63.64	38.10	
72.73	43.32	
81.82	42.00	
90.91	42.60	
100.00	48.49	1

(1 x 42,42) + (1 x 34,09) + (1 x 32,73) + ... + (1 x 43,64) = 408,30

408,30/10 = 40,83

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

Species	1	2	3	4	5	6	7	8	9	10	11	12	Quadrat totals (Q)
	Quadrats												
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	

Table 6.7 (*Continued*)

W	S1	S1 (Sc)
0.00	40.83	42.58
9.09	41.35	46.44
18.18	42.86	57.52
27.27	35.15	0.00
36.36	44.12	67.21
45.45	40.93	43.34
54.55	48.49	100.00
63.64	38.10	22.08
72.73	43.32	61.28
81.82	42.00	51.32
90.91	42.60	55.84
100.00	48.49	100.00

$$S1(Sc) = \frac{(\text{Species value} - \text{lowest species value})}{\text{Range of species values}} \times 100.0$$

(40,83 – 35,15)/13,34 = 0,4258 x 100 = 42,58

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patula*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	

Table 6.7 (*Continued*)

W	S1	S1 (Sc)
0.00	40.83	42.58
9.09	41.35	46.44
18.18	42.86	57.52
27.27	35.15	0.00
36.36	44.12	67.21
45.45	40.93	43.34
54.55	48.49	100.00
63.64	38.10	22.08
72.73	43.32	61.28
81.82	42.00	51.32
90.91	42.60	55.84
100.00	48.49	100.00

$$S1(Sc) = \frac{(\text{Species value} - \text{lowest species value})}{\text{Range of species values}} \times 100.0$$

(40,83 – 35,15)/13,34 = 0,4258 x 100 = 42,58

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patula*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	

Table 6.7 (*Continued*)

W	S1	S1 (Sc)
0.00	40.83	42.58
9.09	41.35	46.44
18.18	42.86	57.52
27.27	35.15	0.00
36.36	44.12	67.21
45.45	40.93	43.34
54.55	48.49	100.00
63.64	38.10	22.08
72.73	43.32	61.28
81.82	42.00	51.32
90.91	42.60	55.84
100.00	48.49	100.00

$$S1(Sc) = \frac{(\text{Species value} - \text{lowest species value})}{\text{Range of species values}} \times 100.0$$

(40,83 – 35,15)/13,34 = 0,4258 x 100 = 42,58

A coluna Sc é reescalada de 0 a 100 novamente

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats 1	2	3	4	5	6	7	8	9	10	11	12	Quadrat totals (Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	
Q2	45.75	45.92	36.74	63.95	63.95	32.48	38.26	55.67	54.60	54.52	50.42	56.89	
Q3	49.41	49.34	39.48	66.23	66.23	32.73	38.98	55.64	55.67	56.43	50.58	57.74	
Q14	53.98	51.08	50.02	67.39	67.39	41.92	32.66	20.65	21.29	27.37	17.11	10.85	
Q15	54.22	51.31	50.32	67.54	67.54	42.27	32.94	20.77	21.42	27.50	17.27	10.93	
Q20	54.54	51.62	50.74	67.75	67.75	42.75	33.33	20.95	21.59	27.67	17.49	11.05	
Q20(Sc)	76.70	71.55	70.00	100.00	100.00	55.34	39.29	17.46	18.59	29.31	11.36	0.00	

(Sc); Axis rescaled from 0–100 at the end of each iteration

Table 6.7 (*Continued*)

W	S1	S1 (Sc)	S2	S2 (Sc)
0.00	40.83	42.58	48.90	46.47
9.09	41.35	46.44	49.65	49.16
18.18	42.86	57.52	51.73	56.54
27.27	35.15	0.00	35.83	0.00
36.36	44.12	67.21	54.42	66.12
45.45	40.93	43.34	49.87	49.93
54.55	48.49	100.00	63.95	100.00
63.64	38.10	22.08	40,39	16.22
72.73	43.32	61.28	54.11	65.01
81.82	42.00	51.32	50.40	51.81
90.91	42.60	55.84	51.17	54.55
100.00	48.49	100.00	63.95	100.00

$$S1(Sc) = \frac{(\text{Species value} - \text{lowest species value})}{\text{Range of species values}} \times 100.0$$

Table 6.7 (*Continued*)

W	S1	S1 (Sc)	S2	S2 (Sc)	S3	S3 …. (Sc)	S15	S15 (Sc)	S16	S16 …. (Sc)	S21	S21 (Sc)
0.00	40.83	42.58	48.90	46.47	50.64	46.57 ….	41.37	46.05	41.57	46.20 ….	41.86	46.40
9.09	41.35	46.44	49.65	49.16	51.13	48.22 ….	39.69	42.57	39.89	42.71 ….	40.16	42.89
18.18	42.86	57.52	51.73	56.54	52.50	52.94 ….	21.65	5.18	21.80	5.23 ….	22.01	5.30
27.27	35.15	0.00	35.83	0.00	37.06	0.00 ….	41.53	46.40	41.84	46.76 ….	42.28	47.26
36.36	44.12	67.21	54.42	66.12	55.21	62.22…	19.45	0.62	19.56	0.62 ….	19.75	0.62
45.45	40.93	43.34	49.87	49.93	52.30	52.24 ….	49.99	63.92	50.19	64.06 ….	50.49	64.26
54.55	48.49	100.00	63.95	100.00	66.23	100.00 ….	67.39	100.00	67.54	100.00 ….	67.75	100.00
63.64	38.10	22.08	40,39	16.22	40.76	12.69 ….	30.56	23.66	30.82	23.93 ….	31.19	24.31
72.73	43.32	61.28	54.11	65.01	55.10	61.84 ….	19.15	0.00	19.27	0.00 ….	19.45	0.00
81.82	42.00	51.32	50.40	51.81	52.35	52.41 ….	44.57	52.69	44.76	52.81 ….	45.03	52.98
90.91	42.60	55.84	51.17	54.55	51.72	50.25 ….	20.51	2.81	20.66	2.88 ….	20.88	2.96
100.00	48.49	100.00	63.95	100.00	66.23	100.00 ….	67.39	100.00	67.54	100.00 ….	67.75	100.00

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats												Quadrat totals
	1	2	3	4	5	6	7	8	9	10	11	12	(Q)
Species													
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5	
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64	
Q2	45.75	45.92	36.74	63.95	63.95	32.48	38.26	55.67	54.60	54.52	50.42	56.89	
Q3	49.41	49.34	39.48	66.23	66.23	32.73	38.98	55.64	55.67	56.43	50.58	57.74	
Q14	53.98	51.08	50.02	67.39	67.39	41.92	32.66	20.65	21.29	27.37	17.11	10.85	
Q15	54.22	51.31	50.32	67.54	67.54	42.27	32.94	20.77	21.42	27.50	17.27	10.93	
Q20	54.54	51.62	50.74	67.75	67.75	42.75	33.33	20.95	21.59	27.67	17.49	11.05	
Q20(Sc)	76.70	71.55	70.00	100.00	100.00	55.34	39.29	17.46	18.59	29.31	11.36	0.00	

(Sc); Axis rescaled from 0–100 at the end of each iteration

Table 6.7 (*Continued*)

W	S1	S1 (Sc)	S2	S2 (Sc)
0.00	40.83	42.58	48.90	46.47
9.09	41.35	46.44	49.65	49.16
18.18	42.86	57.52	51.73	56.54
27.27	35.15	0.00	35.83	0.00
36.36	44.12	67.21	54.42	66.12
45.45	40.93	43.34	49.87	49.93
54.55	48.49	100.00	63.95	100.00
63.64	38.10	22.08	40,39	16.22
72.73	43.32	61.28	54.11	65.01
81.82	42.00	51.32	50.40	51.81
90.91	42.60	55.84	51.17	54.55
100.00	48.49	100.00	63.95	100.00

Table 6.7 (*Continued*)

W	S1	S1 (Sc)	S2	S2 (Sc)	S3	S3 .... (Sc)	S15	S15 (Sc)	S16	S16 .... (Sc)	S21	S21 (Sc)
0.00	40.83	42.58	48.90	46.47	50.64	46.57	41.37	46.05	41.57	46.20	41.86	46.40
9.09	41.35	46.44	49.65	49.16	51.13	48.22	39.69	42.57	39.89	42.71	40.16	42.89
18.18	42.86	57.52	51.73	56.54	52.50	52.94	21.65	5.18	21.80	5.23	22.01	5.30
27.27	35.15	0.00	35.83	0.00	37.06	0.00	41.53	46.40	41.84	46.76	42.28	47.26
36.36	44.12	67.21	54.42	66.12	55.21	62.22...	19.45	0.62	19.56	0.62	19.75	0.62
45.45	40.93	43.34	49.87	49.93	52.30	52.24	49.99	63.92	50.19	64.06	50.49	64.26
54.55	48.49	100.00	63.95	100.00	66.23	100.00	67.39	100.00	67.54	100.00	67.75	100.00
63.64	38.10	22.08	40,39	16.22	40.76	12.69	30.56	23.66	30.82	23.93	31.19	24.31
72.73	43.32	61.28	54.11	65.01	55.10	61.84	19.15	0.00	19.27	0.00	19.45	0.00
81.82	42.00	51.32	50.40	51.81	52.35	52.41	44.57	52.69	44.76	52.81	45.03	52.98
90.91	42.60	55.84	51.17	54.55	51.72	50.25	20.51	2.81	20.66	2.88	20.88	2.96
100.00	48.49	100.00	63.95	100.00	66.23	100.00	67.39	100.00	67.54	100.00	67.75	100.00

As iterações ocorrem até os valores ficarem aproximadamente estáveis: S15

autovalores

- A estimativa do autovalor do primeiro eixo é obtida pela razão entre a amplitude dos valores não escalados da iteração final e a amplitude dos valores escalados na iteração anterior (S20), que obviamente é igual a 100:

  coluna S21: max. = 67,75; min. = 19,75

  Amplitude = 48

- 0,48 é a aproximação do autovalor do primeiro eixo de ordenação, sendo uma medida da proporção da variação total dos dados explicada pelo eixo.
- São considerados significativos autovalores > 0,3.

autovalores

- O autovalor das parcela é calculado da mesma forma, mas deve-se re-escalar o último eixo da iteração, como nas colunas de espécies S(Sc).

$$\mathrm{S1(Sc)} = \frac{\text{(Species value} - \text{lowest species value)}}{\text{Range of species values}} \times 100.0$$

Table 6.7 Calculations for the first axis of a reciprocal averaging (correspondence analysis) of the New Jersey salt marsh data (Table 4.2). Original work of author.

	Quadrats															
	1	2	3	4	5	6	7	8	9	10	11	12	Quadrat totals (Q)	…	S21	S21 (Sc)
Species																
1. *Atriplex patuila*	1	1	1	1	1	1	1	0	1	0	1	1	10	…	41.86	46.40
2. *Distichlis spicata*	0	1	1	1	1	1	1	1	1	1	1	0	10	…	40.16	42.89
3. *Iva frutescens*	0	0	0	0	0	0	1	1	1	1	1	1	6	…	22.01	5.30
4. *Juncus gerardii*	0	0	1	0	0	1	1	0	0	0	0	0	3	…	42.28	47.26
5. *Phragmites communis*	0	0	0	0	0	0	0	1	1	1	1	1	5	…	19.75	0.62
6. *Salicornia europaea*	1	1	1	1	1	0	1	0	0	1	0	0	7	…	50.49	64.26
7. *Salicornia virginica*	0	0	0	1	1	0	0	0	0	0	0	0	2	…	67.75	100.00
8. *Scirpus olneyi*	0	0	0	0	0	1	1	0	0	0	1	0	3	…	31.19	24.31
9. *Solidago sempervirens*	0	0	0	0	0	0	0	0	1	1	1	1	4	…	19.45	0.00
10. *Spartina alterniflora*	1	1	1	1	1	1	0	1	1	1	0	0	9	…	45.03	52.98
11. *Spartina patens*	0	0	0	0	0	0	1	1	1	0	1	1	5	…	20.88	2.96
12. *Suaeda maritima*	0	0	0	1	1	0	0	0	0	0	0	0	2	…	67.75	100.00
Species totals (S)	3	4	5	6	6	5	7	5	7	6	7	5				
Q1	42.42	34.09	32.71	48 49	48.49	36.36	36.36	47.27	44.16	43.94	41.56	43.64				
Q2	45.75	45.92	36.74	63.95	63.95	32.48	38.26	55.67	54.60	54.52	50.42	56.89				
Q3	49.41	49.34	39.48	66.23	66.23	32.73	38.98	55.64	55.67	56.43	50.58	57.74				
Q14	53.98	51.08	50.02	67.39	67.39	41.92	32.66	20.65	21.29	27.37	17.11	10.85				
Q15	54.22	51.31	50.32	67.54	67.54	42.27	32.94	20.77	21.42	27.50	17.27	10.93				
Q20	54.54	51.62	50.74	67.75	67.75	42.75	33.33	20.95	21.59	27.67	17.49	11.05				
Q20(Sc)	76.70	71.55	70.00	100.00	100.00	55.34	39.29	17.46	18.59	29.31	11.36	0.00				

(Sc); Axis rescaled from 0–100 at the end of each iteration

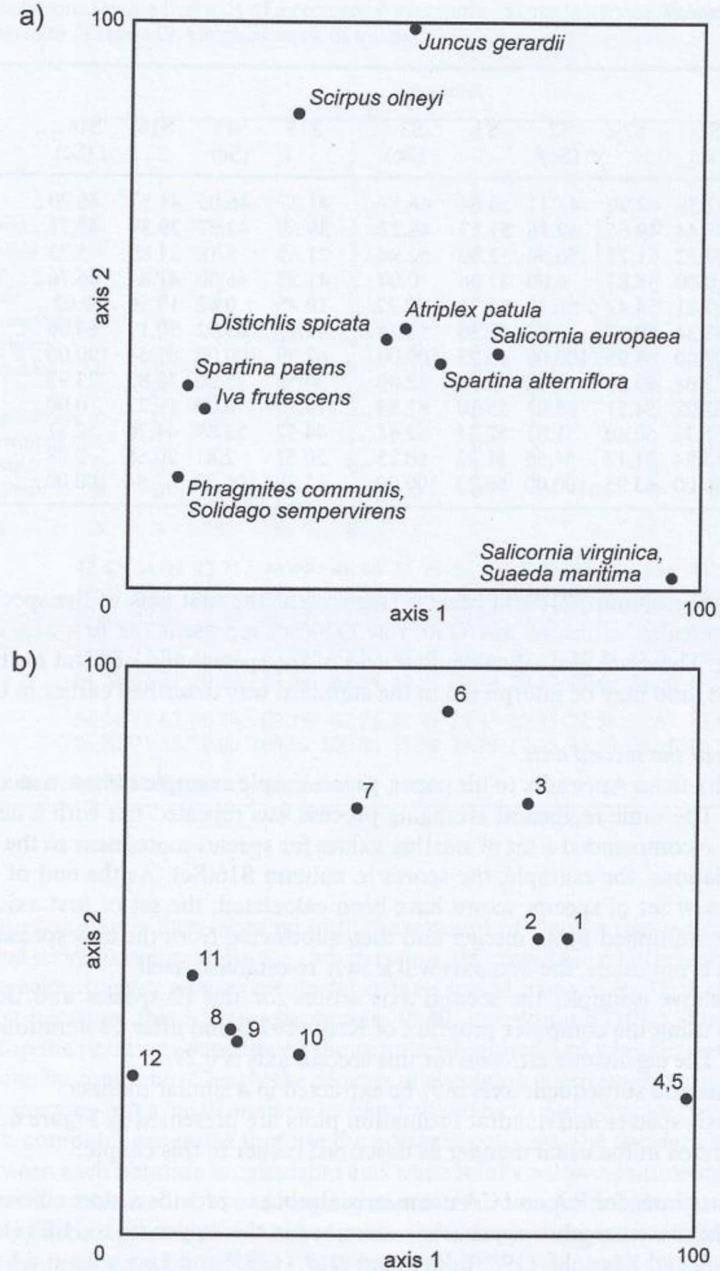


Figure 6.28 The two-dimensional ordination plots produced by reciprocal averaging/correspondence analysis of the New Jersey salt marsh presence–absence data (Table 4.2). (a) Species ordination; (b) quadrat ordination. Original work of author.

Efeito de arco e de compressão dos eixos

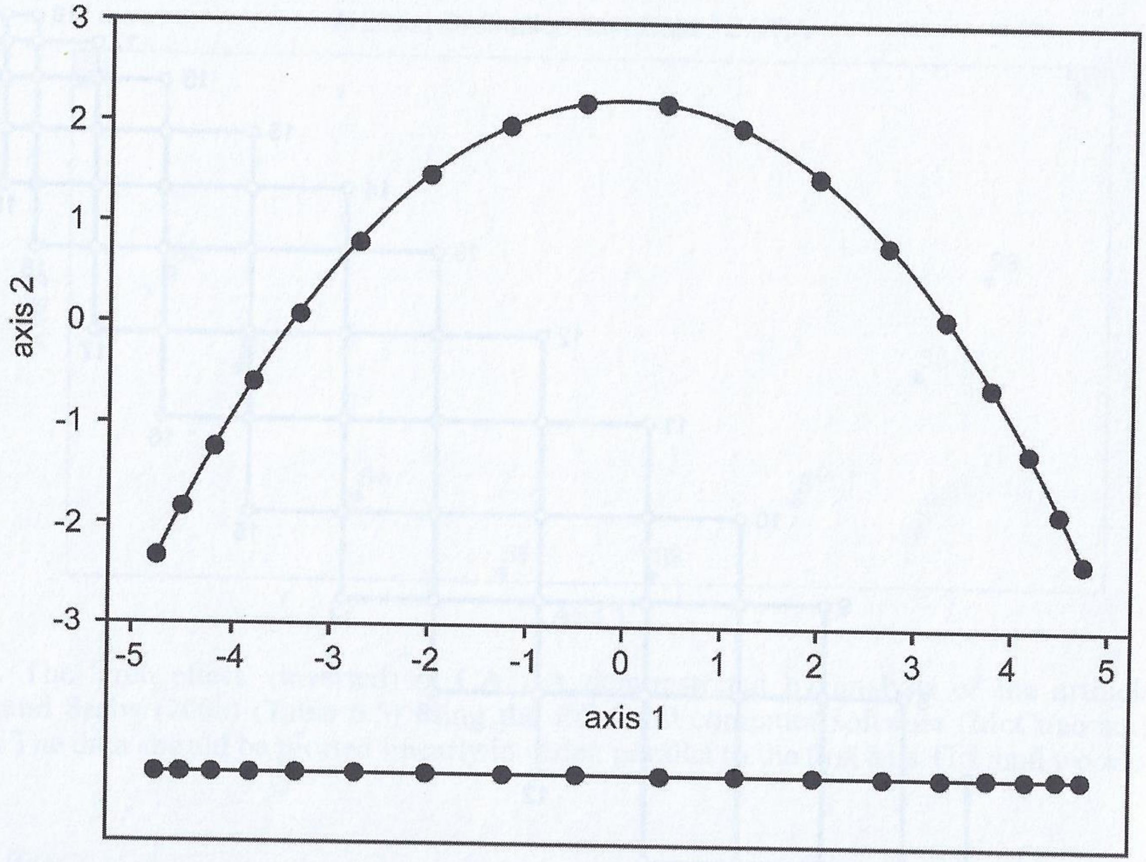


Figure 6.31 The two major faults of correspondence analysis: the arch effect and distortion of the second axis, and the compression of the ends of the first axis relative to the middle. These are the same data as for the quadrat ordination in Figure 6.30, with 18 equally spaced points in a straight line (Hill and Gauch, 1980; reproduced with kind permission of Kluwer Academic Publishers).

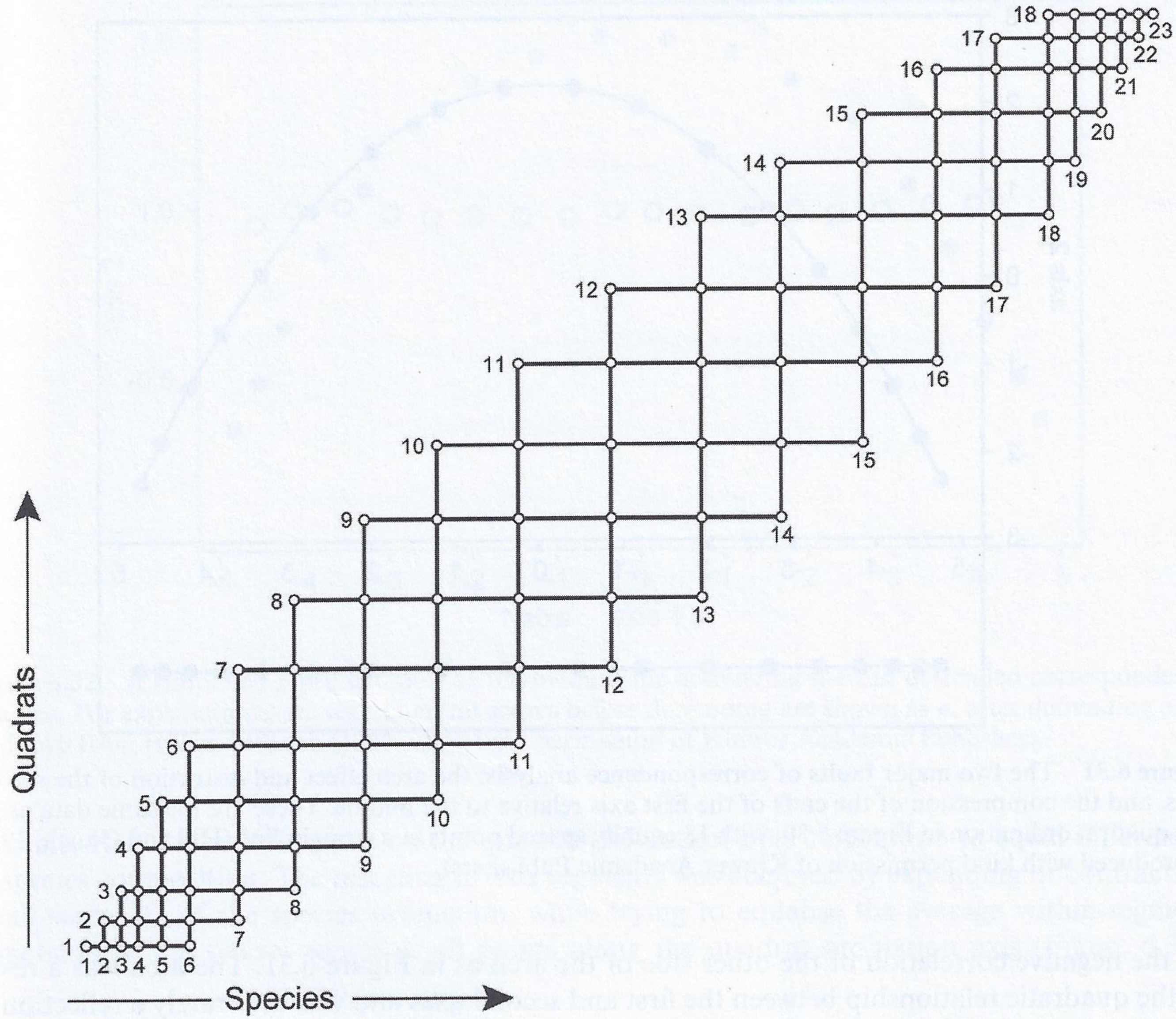


Figure 6.30 The arrangement of an artificial and regular data structure containing 18 quadrats in rows and 23 species in columns, spaced according to the first axis of a correspondence analysis ordination. The presence of a species in a sample is indicated by a dot. In theory, these quadrats and species should be spaced evenly, but the effect of correspondence analysis is to compress the ends of the axes relative to the middle (Hill and Gauch, 1980; reproduced with kind permission of Kluwer Academic Publishers).

Detrended Correspondence Analysis - DCA

- O arco é uma consequência matemática do método CA.
- Remoção do efeito de arco:
  - Divisão do primeiro eixo em segmentos permitindo uma reanálise dentro de cada segmento.

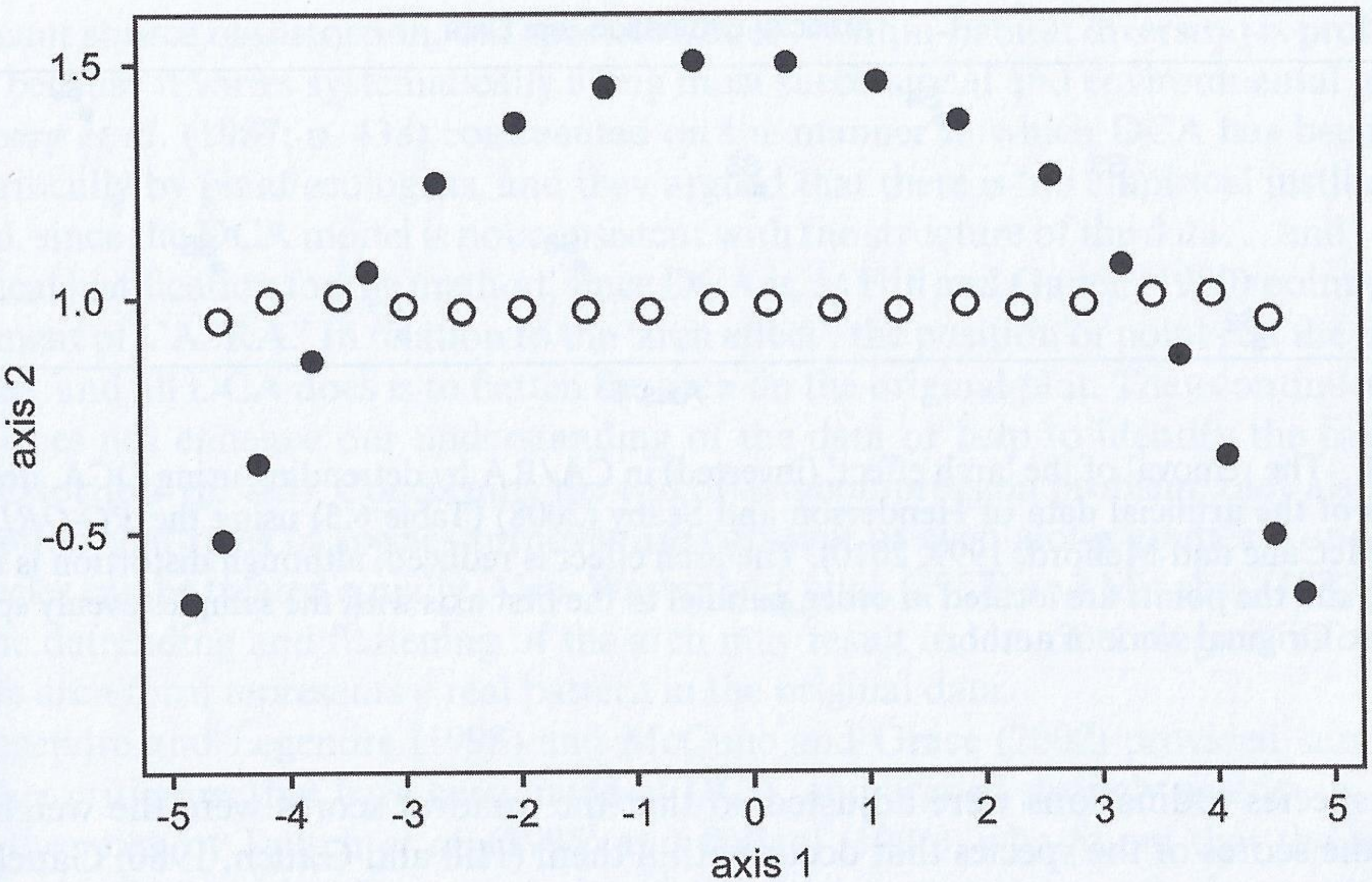


Figure 6.32 A simplified representation of the method for detrending used in detrended correspondence analysis. For explanations, see text. Quadrat scores before detrending are shown as •, after detrending as ○. Redrawn from Hill and Gauch (1980), with kind permission of Kluwer Academic Publishers.

- Com a DCA os eixos são graduados em unidades de desvio padrão da média da taxa de ocorrência das espécies.
  - Em geral, ao longo de um gradiente, as espécies aparecem, vão à sua moda e desaparecem a uma distância de aproximadamente 4 SD, distribuição normal.

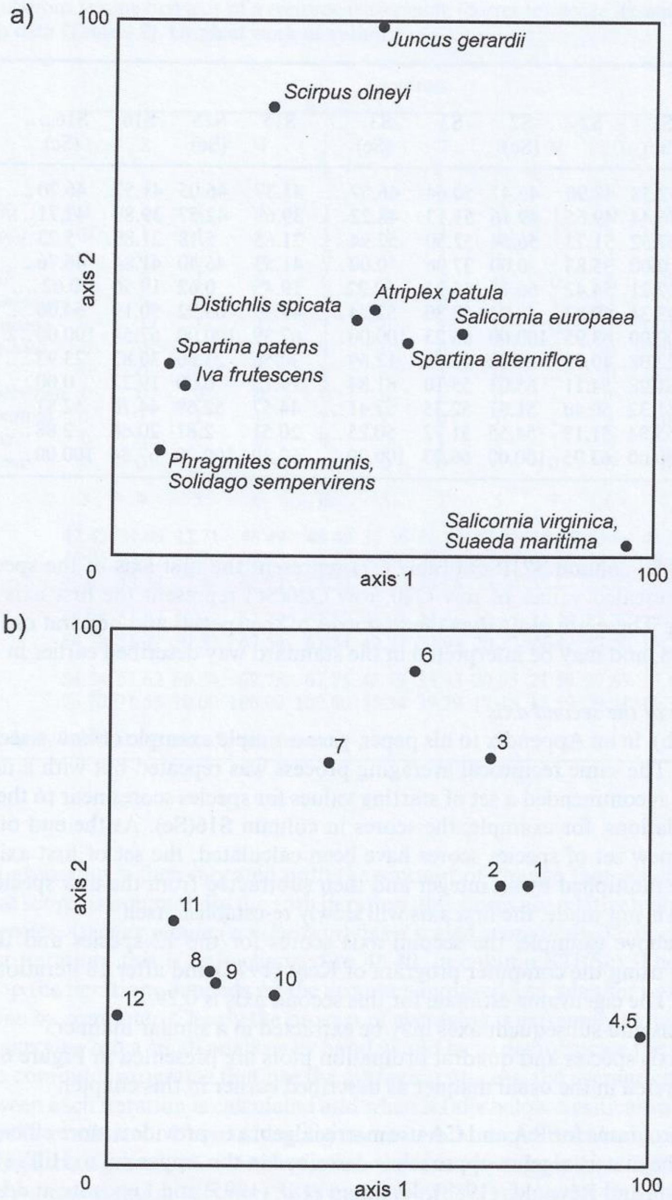


Figure 6.28 The two-dimensional ordination plots produced by reciprocal averaging/correspondence analysis of the New Jersey salt marsh presence–absence data (Table 4.2). (a) Species ordination; (b) quadrat ordination. Original work of author.

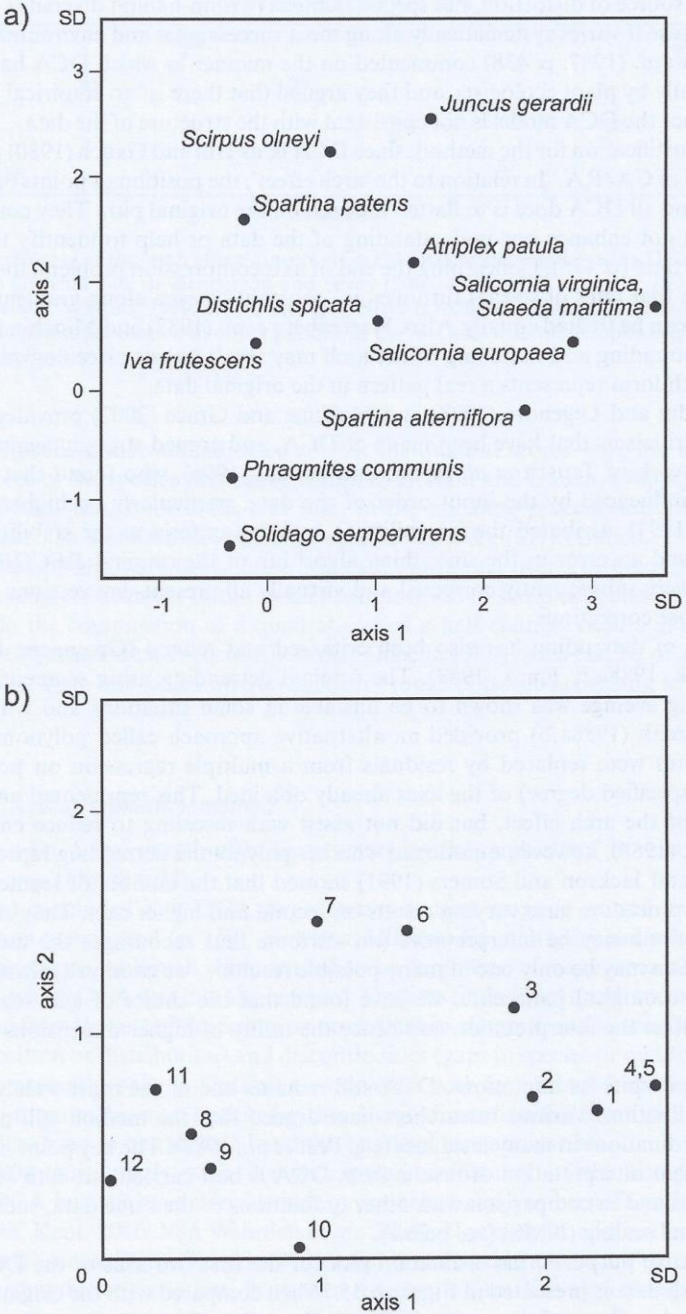


Figure 6.35 Ordination plots for the first two axes of the DCA of the New Jersey salt marsh presence–absence data (Table 4.2). Original work of author.

Canonical Correspondence Analysis - CCA

- É diferente de todos os demais métodos de ordenação.
- A ordenação é um exercício de examinar relacionamento entre distribuição de espécies e os fatores ambientais associados. Porém, na CCA são feitas correlações e regressões.
- Nos demais métodos a ordenação é realizada primeiramente com os dados das espécies e a interpretação dos gradientes ambientais é feita por sobreposição dos dados ambientais para a observação dos padrões e correlações.

Canonical Correspondence Analysis - CCA

- A CCA congrega correlação e regressão de dados florísticos e ambientais. Portanto, são duas as matrizes de dados.
- A análise é feita utilizando técnicas de regressão múltipla junto com a CA.
- Ordenação direta.
- O diagrama de ordenação resultante não expressa somente padrões da variação na composição florística, mas também demostra o relacionamento entre as espécies e os fatores ambientais.

Canonical Correspondence Analysis - CCA

- O método usa regressão múltipla para selecionar a combinação linear das variáveis que explicam a maior parte da variação nos valores das espécies sobre cada eixo.
- Usa o algoritmo iterativo da CA e dentro de cada ciclo de cálculo de médias uma regressão múltipla é executada com os valores das parcelas para um eixo (variável dependente) e combinações das variáveis ambientais (variáveis independentes).

O efeito de arco

- Na CCA pode ocorrer o efeito de arco, como na CA, porém, a remoção desse efeito é feita retirando-se das análises as variáveis supérfluas.
- Variáveis ambientais que mais provavelmente são consideradas supérfluas são as mais altamente correlacionadas com o segundo eixo (eixo do arco).

Interpretação do diagrama

- O comprimento da seta é proporcional à magnitude/intensidade de mudança nessa direção.
  - Para propósito de interpretações cada seta pode ser esticada para trás.
- Os fatores ambientais com setas longas são os mais importantes.
- O ângulo entre as setas indica o nível de correlação entre as variáveis.
- O ângulo entre a seta e o eixo de ordenação indica a correlação entre a variável e o eixo.

Interpretação do diagrama

- Um ponto que corresponde a uma espécie individualmente pode ser relacionada a cada seta (fator ambiental) desenhando-se uma perpendicular a partir da linha da seta ao ponto representando as espécies.
- A ordem na qual os pontos se projetam sobre a seta a partir da ponta em direção à base através da origem é uma indicação da posição das espécies em relação ao fator ambiental.
  - Espécies com a projeção perpendicular posicionada próxima ou além da ponta da seta estão forte e positivamente correlacionadas e são influenciadas pela seta (fator ambiental).

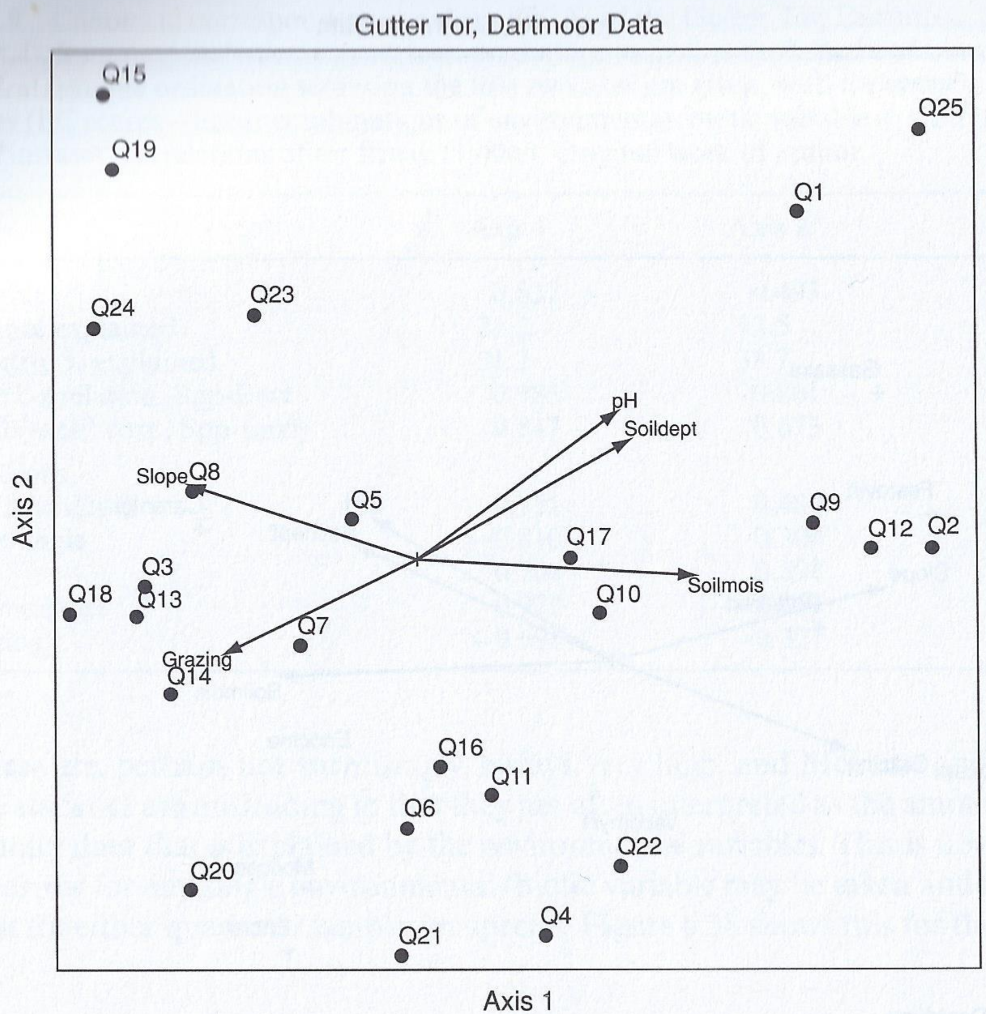


Figure 6.36 The quadrat/sample-environmental biplot from canonical correspondence analysis (CCA) of the Gutter Tor, Dartmoor, data, derived using the CCA program from the *PC-ORD* computer software (McCune and Mefford, 1999, 2010). Original work of author.

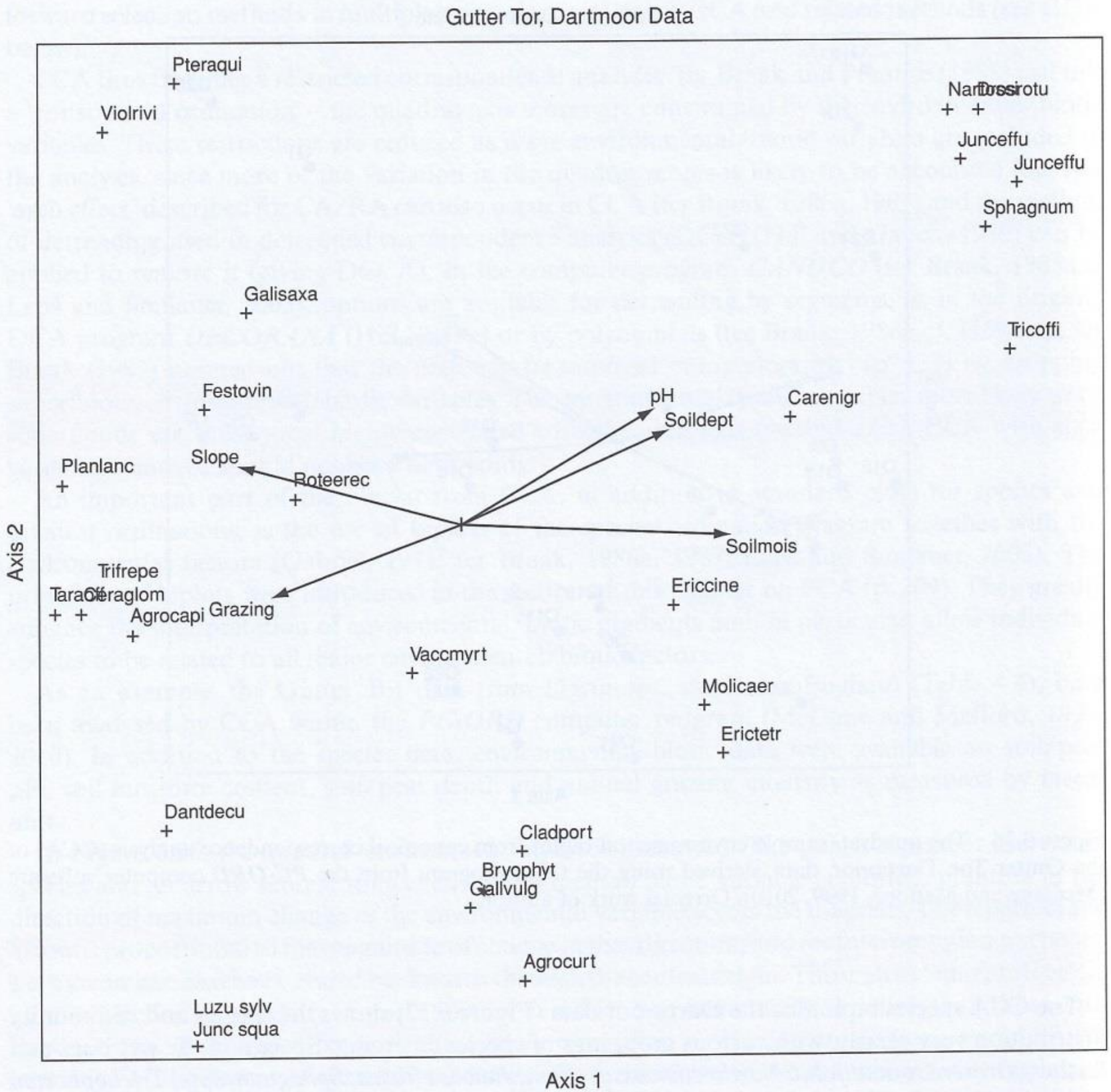


Figure 6.37 The species-environmental biplot from canonical correspondence analysis (CCA) of the Gutter Tor, Dartmoor, data, derived using the CCA program from the *PC-ORD* computer software (McCune and Mefford, 1999, 2010). Original work of author.

Table 6.9 Canonical correspondence analysis (CCA) of the Gutter Tor, Dartmoor, data (Table 4.4). Summary statistics, eigenvalues, percentage variances explained and correlations of quadrat/sample ordination scores on the first two axes are given, with the environmental variables (LC scores – linear combinations of environmental/biotic variables). Correlations are the 'intraset' correlations of ter Braak (1988a). Original work of author.

	Axis 1	Axis 2	Axis 3
Eigenvalue	0.837	0.493	0.429
% variance explained	21.2	12.5	10.9
Cumulative % explained	21.2	33.7	44.5
Pearson correlation, Spp-Envt	0.983	0.861	0.836
Kendall (rank) corr., Spp-Envt	0.847	0.673	0.600
Correlations			
Soil/peat depth	0.751	0.480	−0.156
Slope angle	−0.810	0.304	0.156
pH	0.704	0.591	−0.331
Soil moisture	0.977	−0.061	−0.197
Grazing	−0.691	−0.377	−0.580

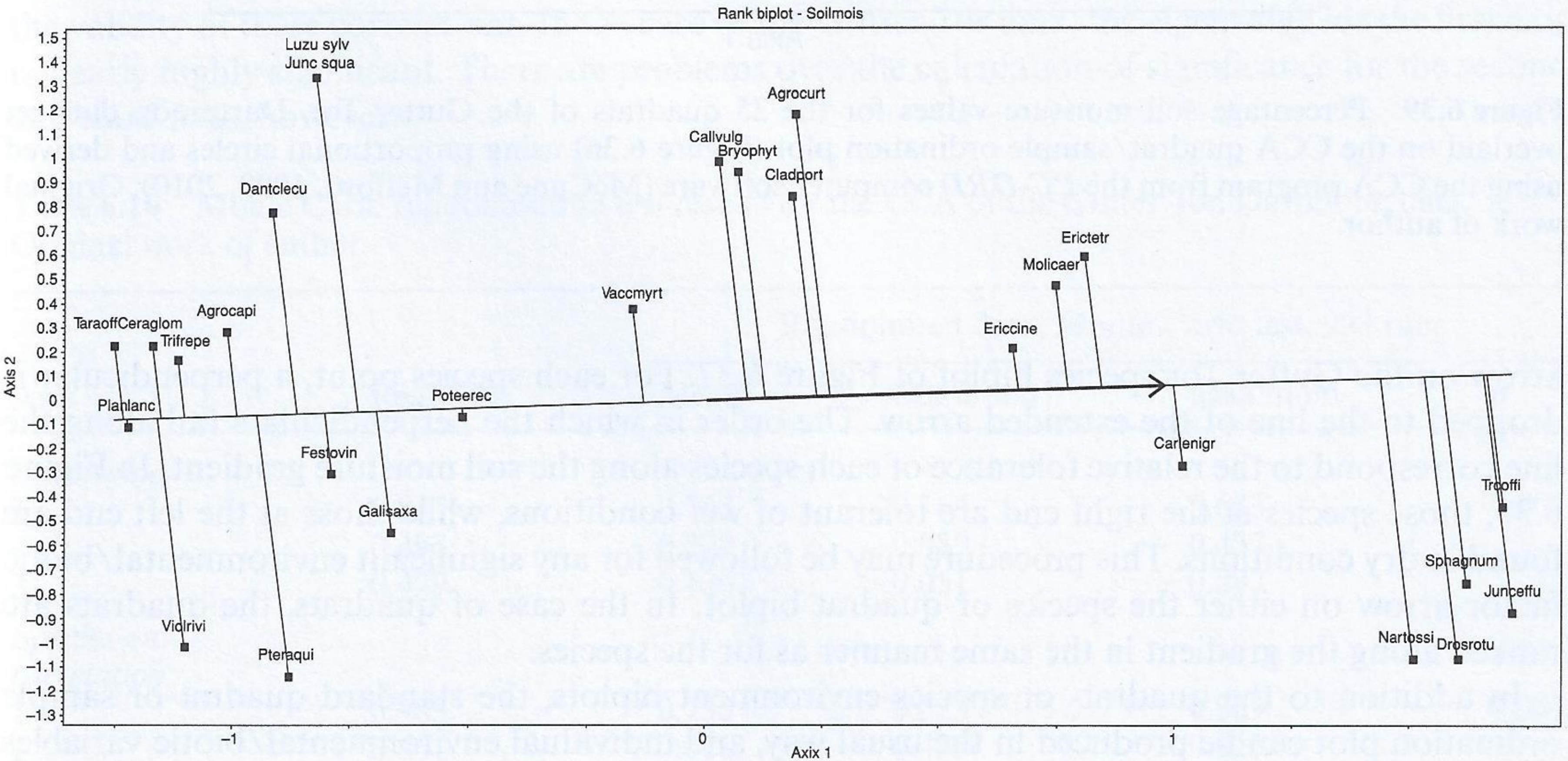


Figure 6.38 The rank order biplot for species in relation to the environmental factor of soil moisture from the CCA ordination of the Gutter Tor, Dartmoor, data. The second axis is inverted (a mirror-image) compared with the species biplot produced by the *PC-ORD* software in Figure 6.37. However, the relative inter-point distances are identical. Analysis performed using the Ecom 2 computer program of Pisces Conservation Ltd. (2008a). Original work of author.

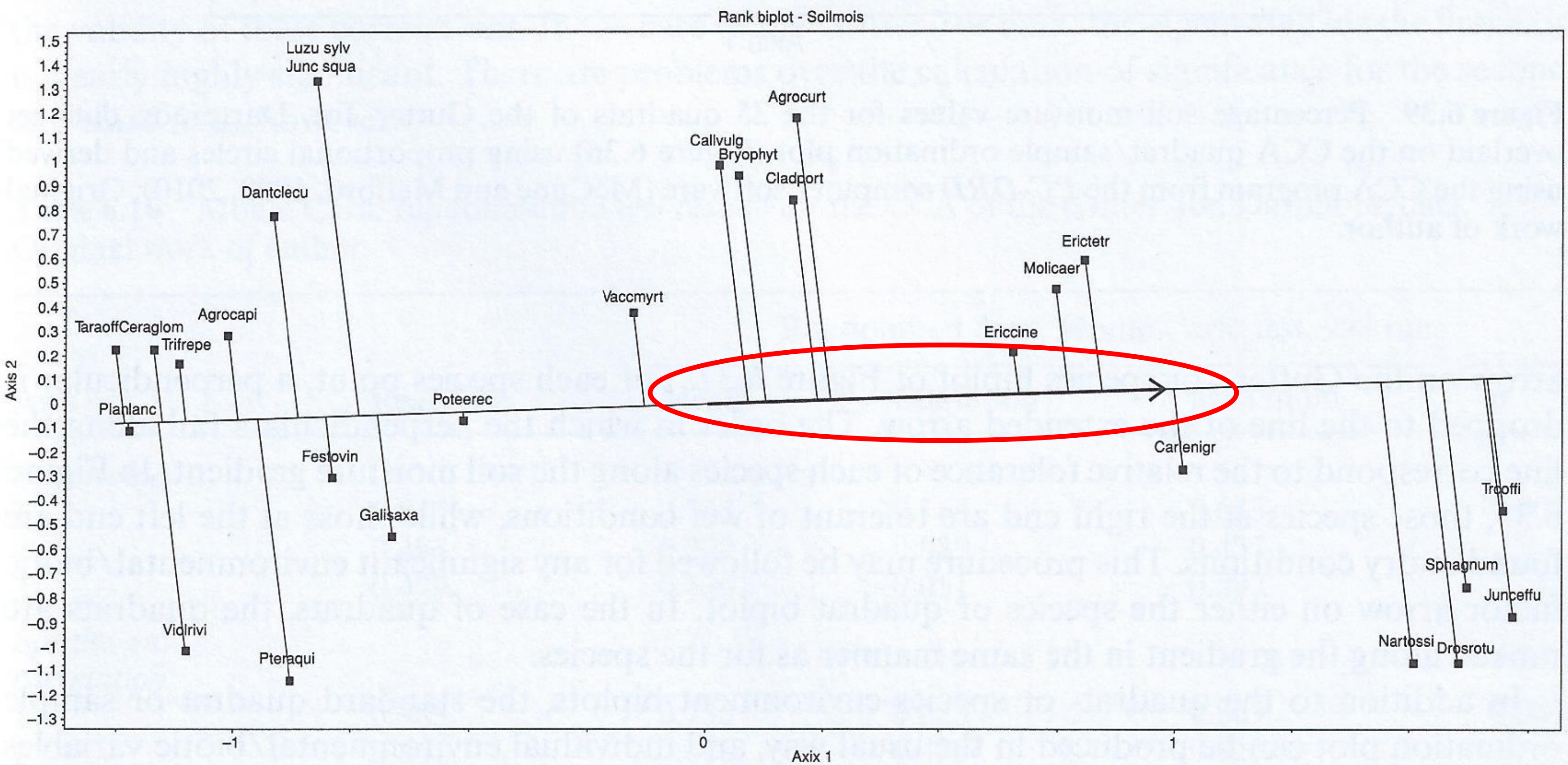
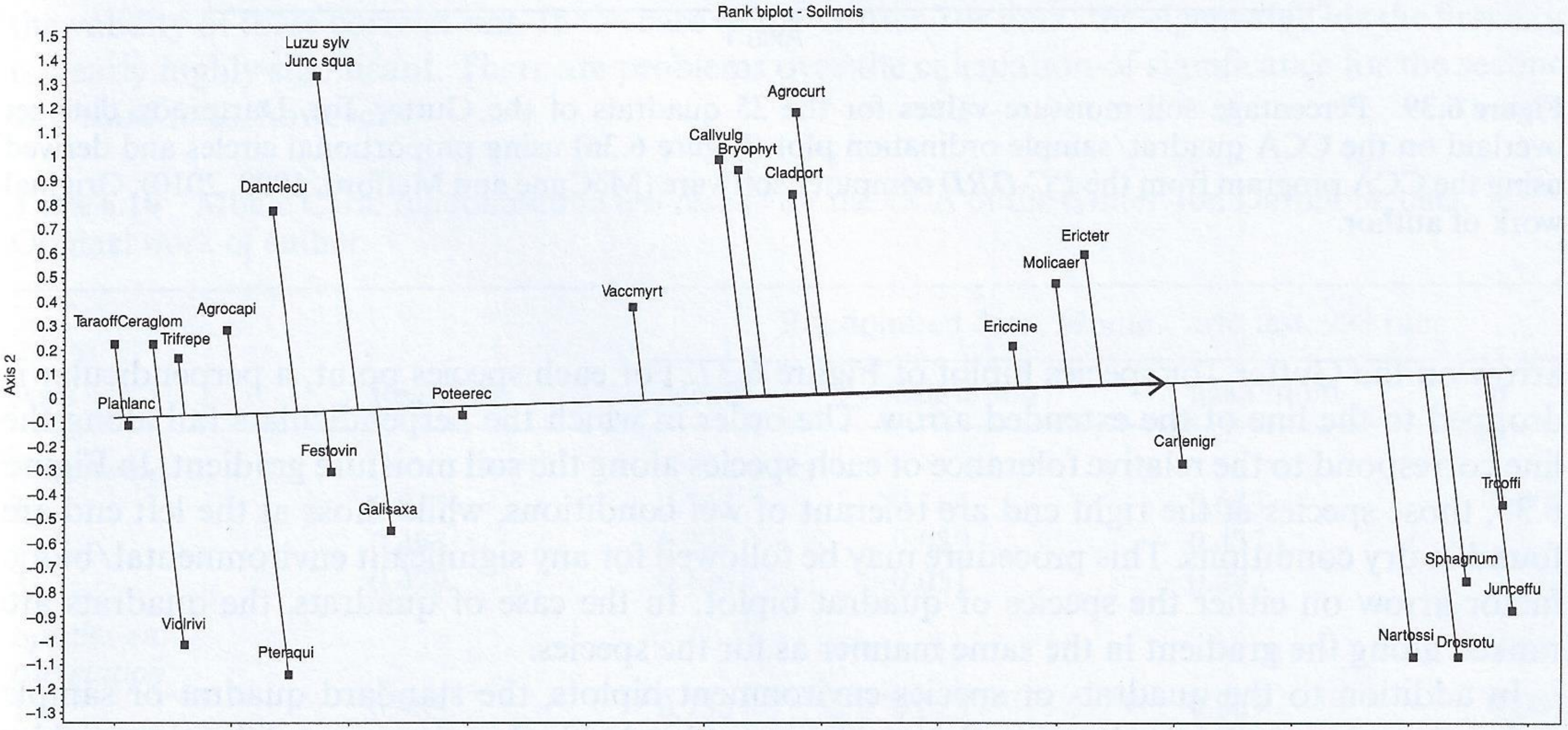


Figure 6.38 The rank order biplot for species in relation to the environmental factor of soil moisture from the CCA ordination of the Gutter Tor, Dartmoor, data. The second axis is inverted (a mirror-image) compared with the species biplot produced by the *PC-ORD* software in Figure 6.37. However, the relative inter-point distances are identical. Analysis performed using the Ecom 2 computer program of Pisces Conservation Ltd. (2008a). Original work of author.



- A ordem em que a perpendicular de cada espécie toca a linha corresponde à tolerância de cada espécie ao gradiente ambiental de umidade do solo.
- As espécies à direita são tolerantes a condições úmidas, enquanto as ao lado esquerdo são encontradas em solos bem drenados.
- A interpretação é a mesma para qualquer seta e para amostras.

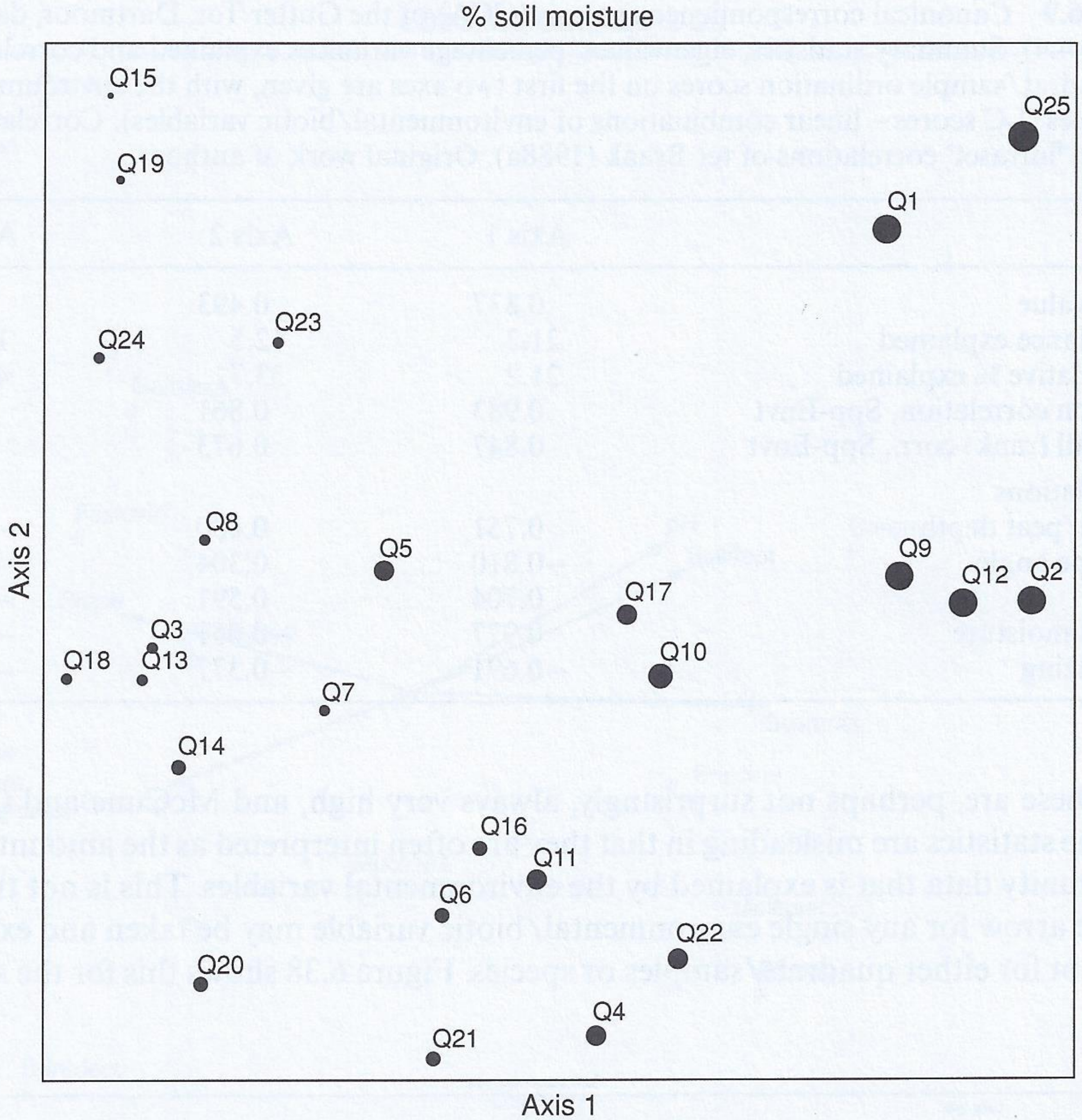


Figure 6.39 Percentage soil moisture values for the 25 quadrats of the Gutter Tor, Dartmoor, data-set overlaid on the CCA quadrat/sample ordination plot (Figure 6.36) using proportional circles and derived using the CCA program from the *PC-ORD* computer software (McCune and Mefford, 1999, 2010). Original work of author.

Teste de significância de Monte Carlo

- Utilizado para avaliar a significância das variáveis ambientais em explicar a variação no valor dos eixos de ordenação.
- O autovalor representa o total da variabilidade dos dados resumidos em cada eixo.
- O tamanho do autovalor em si não representa a significância do resultado porque o autovalor não fornece informação sobre se a variabilidade explicada pelas variáveis ambientais é maior do que seria esperado pelo acaso.
- O teste de Monte Carlo é utilizado para superar este problema.

Teste de significância de Monte Carlo

- Os dados originais são embaralhados em um procedimento aleatório para produzir novos conjuntos de dados um grande número de vezes (até 1.000) e a CCA é toda re-executada para cada novo conjunto de dados, gerando novos autovalores para cada eixo.
- A proporção de vezes que os novos autovalores são maiores ou iguais aos autovalores do conjunto de dados reais fornece a significância do teste.

Table 6.10 Monte Carlo randomisation test results for the CCA of the Gutter Tor, Dartmoor, data. Original work of author.

		Randomised data, Monte Carlo test, 998 runs			
Axis	Real data	Mean	Minimum	Maximum	p
Eigenvalue					
1	0.837	0.363	0.164	0.633	0.001
2	0.493	0.222	0.089	0.437	
3	0.429	0.130	0.051	0.297	
Species-env. correlation					
1	0.983	0.733	0.525	0.889	0.001
2	0.861	0.628	0.433	0.825	
3	0.836	0.540	0.351	0.755	

p = proportion of randomised runs with either the eigenvalue or the species-environment correlation greater than or equal to the observed eigenvalue or species-environment correlation; i.e. $p = (1 + \text{no. permutations} \geq \text{observed})/(1 + \text{no. permutations})$. p is not reported for axes 2 and 3 because using a simple randomisation test for these axes may bias the p values.

Uso de métodos de ordenação para analisar séries temporais

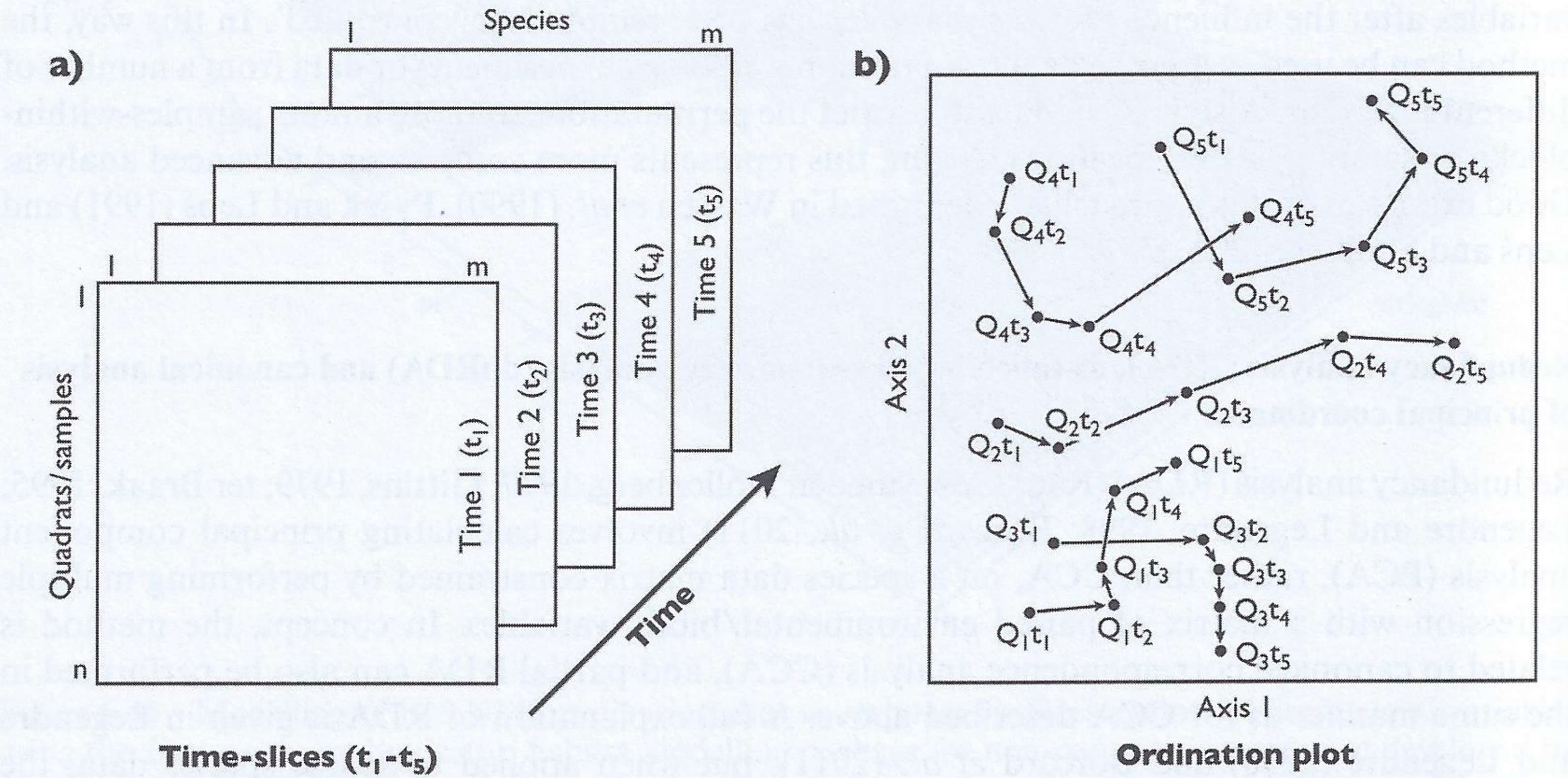


Figure 6.41 The use of ordination to analyse successional or time-series data. Each repeated set of measurements in the same set of quadrats/samples produces a quadrat/samples × species presence/abundance 'time-slice'. (a) Five 'time-slices' are shown. (b) On the associated ordination plot, each quadrat thus occurs five times and the successive points in time are joined by arrows to give a 'trajectory analysis'. Only the trajectories of the first five quadrats are shown. Original work of author.

Uso de métodos de ordenação para analisar séries temporais

- As séries temporais podem ser combinadas em uma única planilha formando um grande conjunto de dados (matriz) e qualquer método de ordenação pode ser aplicado.
- A distância que um ponto se move entre quaisquer dois pontos no tempo indicam a mudança total na composição de espécies ao longo do período de tempo.
- Essa avaliação também é chamada de análise de trajetória, pois segue uma trajetória de mudança na composição florística através do tempo e, em muitas situações, representa o processo sucessional da vegetação.
- Pode indicar o efeito de ações de manejo, tratamentos ou respostas a mudanças climáticas, por exemplo.

http://ordination.okstate.edu/