The Permanence, Intensity and Seasonality of Early Crop Cultivation in Western-Central Europe

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Volume 2
Figures, Tables, Appendix, Bibliography

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Department of Archaeology and Prehistory, University of Sheffield

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5.1 Histograms showing proportions of perennials in the archaeobotanical samples

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- **c** all samples with at least 10 wild/weed taxa
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5.2

- **a** The relationship of autumn-sown and spring-sown weed associations from Germany to the discriminant function extracted to distinguish autumn- and spring-sown weed associations from Germany based on semi-quantitative data
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- **b** The relationship of Asturias plots to the discriminant function
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- **a** unthreshed and unsieved 'spikelet' samples
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5.6

- **a** Proportions of long-flowering, late-flowering and early-intermediate/short-flowering taxa in the unthreshed cereal samples based on semi-quantitative data (taxon counts)
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5.8

a The relationship of Evvia pulse gardens and fields to the discriminant function extracted to distinguish Evvia gardens and fields based on semi-quantitative data

b The relationship of Asturias plots to the discriminant function

c The relationship of archaeobotanical samples to the discriminant function

5.9 The relationship of archaeobotanical samples from different processing stages to the distriminant function based on semi-quantitative data

a unthreshed and unsieved 'spikelet' samples

b fine sieve by-product samples

c sieved 'spikelet' and fine sieve product samples

5.10.

a The relationship of Evvia pulse gardens and fields to the discriminant function extracted to distinguish Evvia gardens and fields based on quantitative data

b The relationship of Asturias plots to the discriminant function

c The relationship of archaeobotanical samples to the discriminant function

5.11 The relationship of archaeobotanical samples from different processing stages to the distriminant function based on quantitative data

a unthreshed and unsieved 'spikelet' samples

b fine sieve by-product samples

c sieved 'spikelet' and fine sieve product samples

6.1

a Correspondence analysis plot of all glume wheat samples showing life history

b Correspondence analysis plot of glume wheat glume base samples showing life history

6.2

a Correspondence analysis plot of all glume wheat samples showing germination time

b Correspondence analysis plot of glume wheat glume base samples showing germination time

6.3

a Correspondence analysis plot of all glume wheat samples showing flowering onset/length

b Correspondence analysis plot of glume wheat glume base samples showing flowering onset/length

6.4

a Correspondence analysis plot of all glume wheat samples showing estimated epidermal cell endopolyploidy

b Correspondence analysis plot of glume wheat glume base samples showing estimated epidermal cell endopolyploidy

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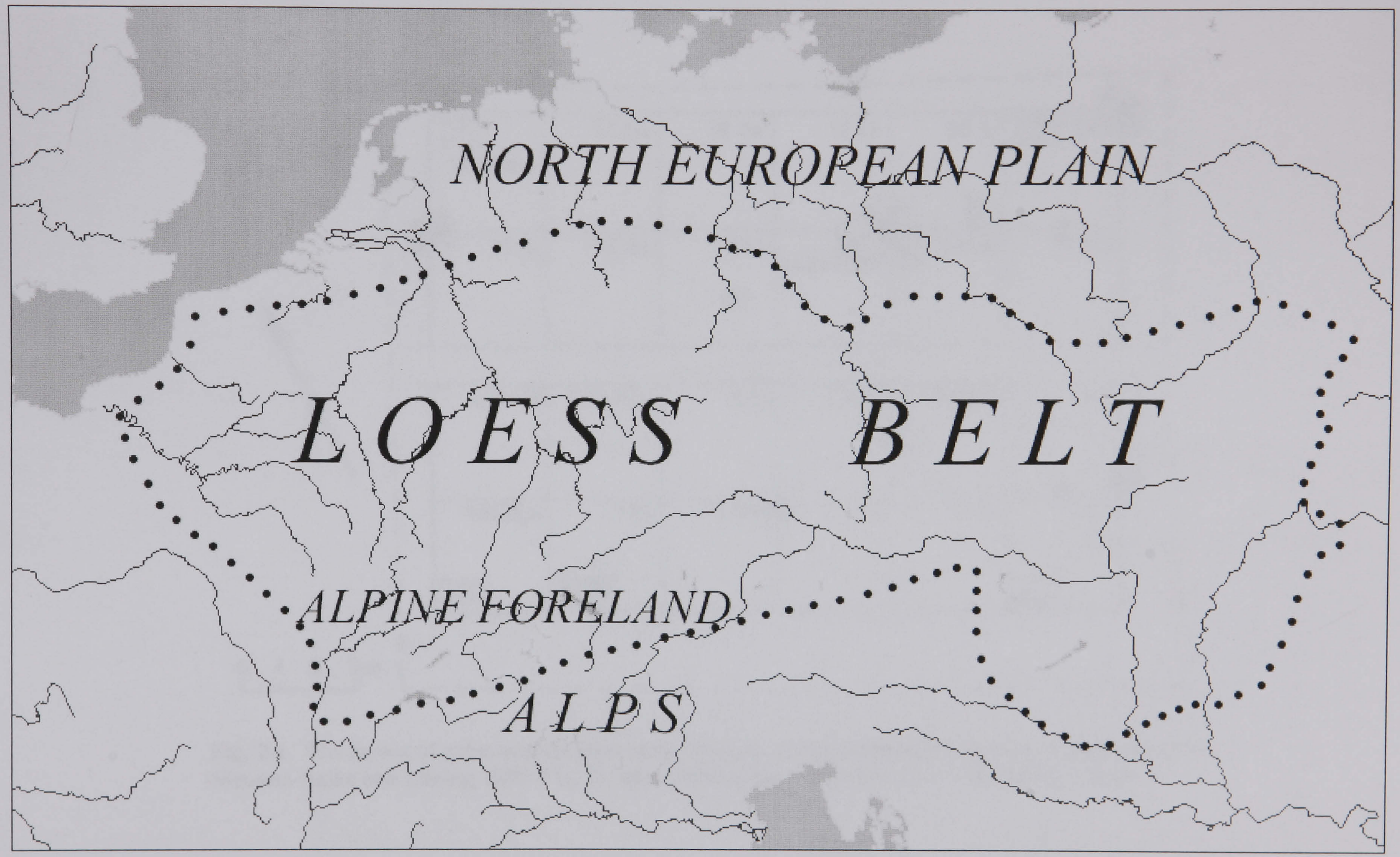


Fig. 1.1. Map showing the study area, which encompasses the loess belt of western-central Europe and the Alpine Foreland (©1988-1998 Microsoft and/or its suppliers)

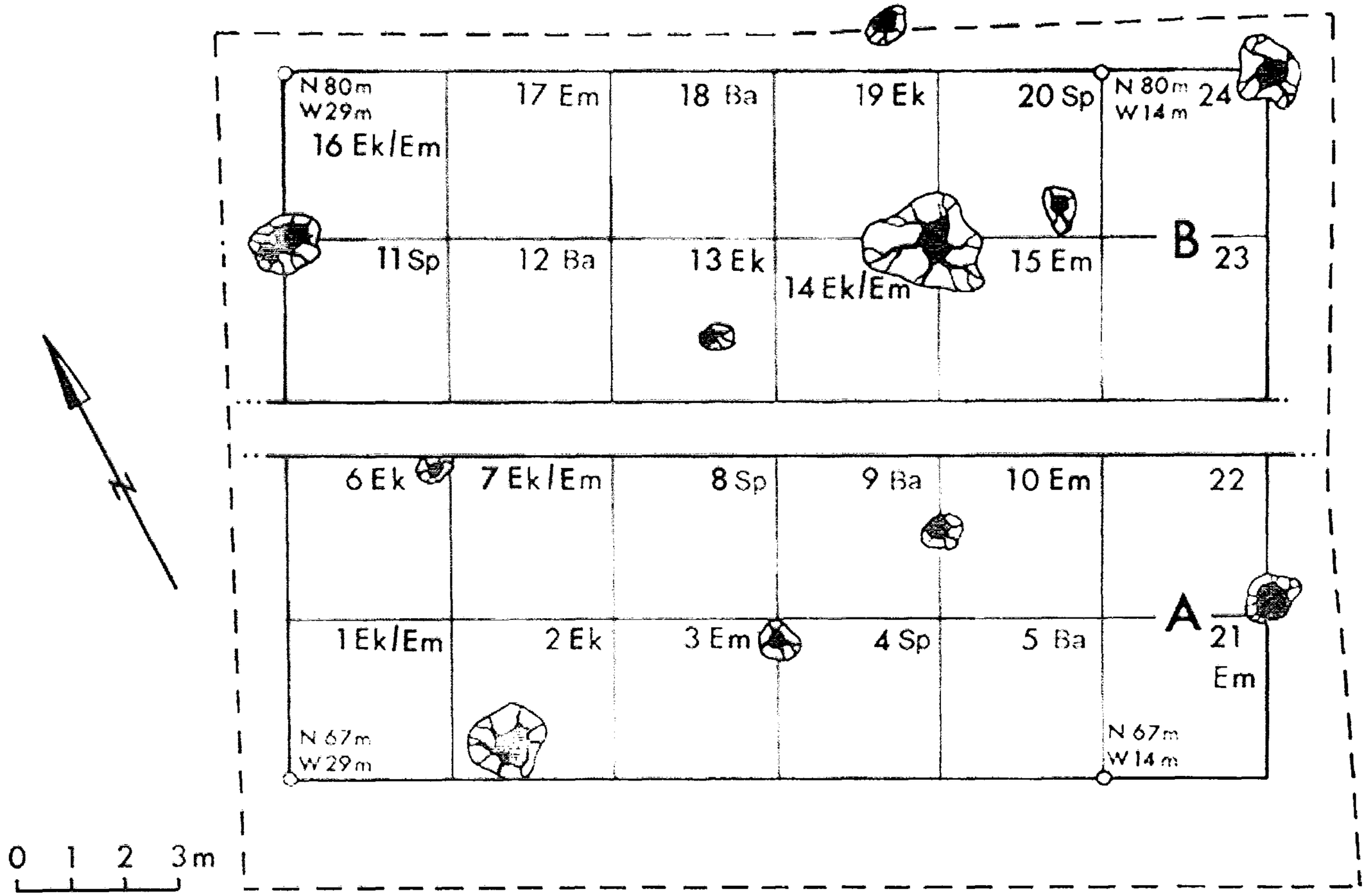
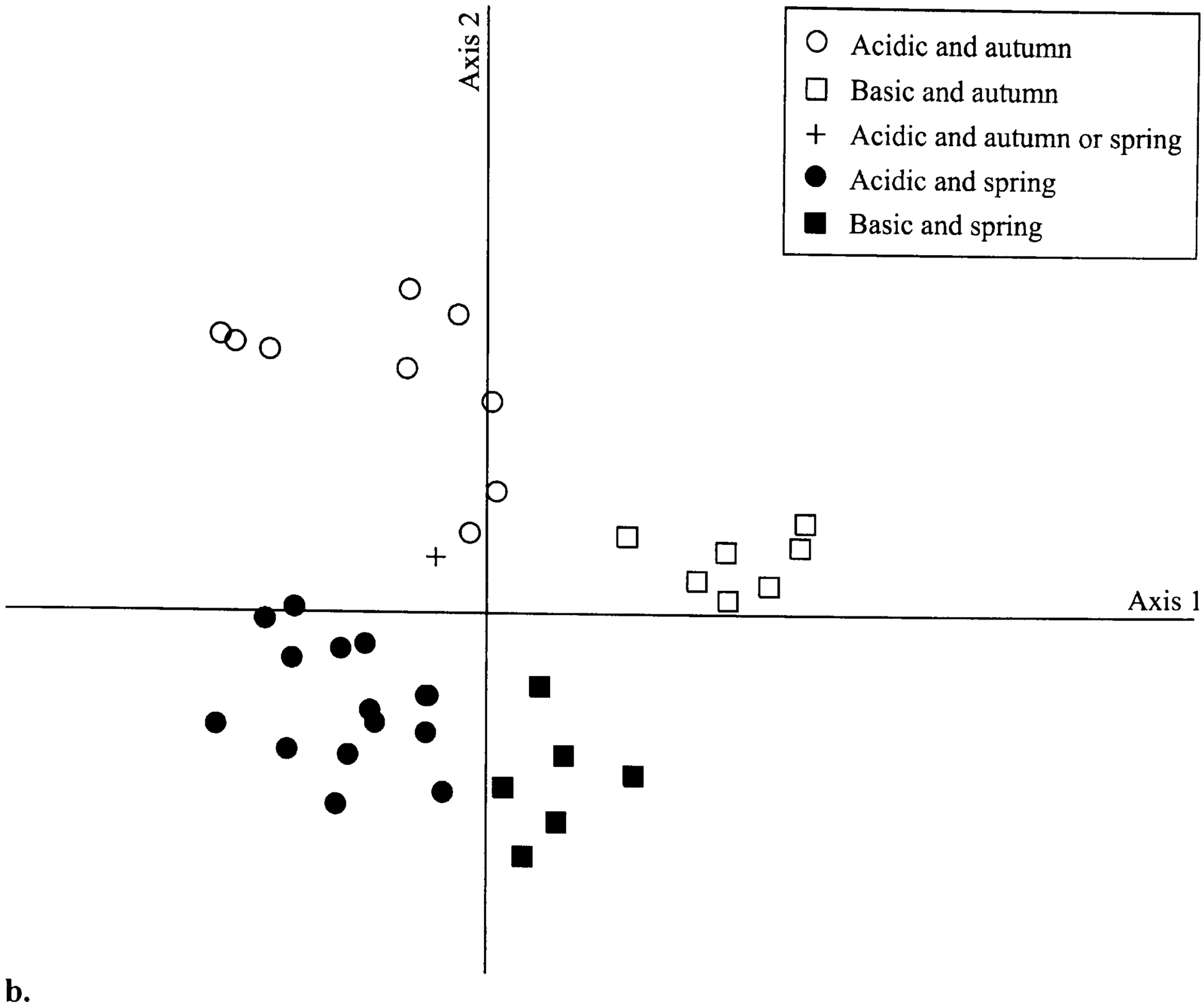


Fig. 2.1. The layout of experimental plots in the Hambach Forest and cereals grown on each plot (after Meurers-Balke and Lüning 1990: Fig. 2); Ba = Barley; Ek = Einkorn; Em = emmer; Sp = Spelt

a.



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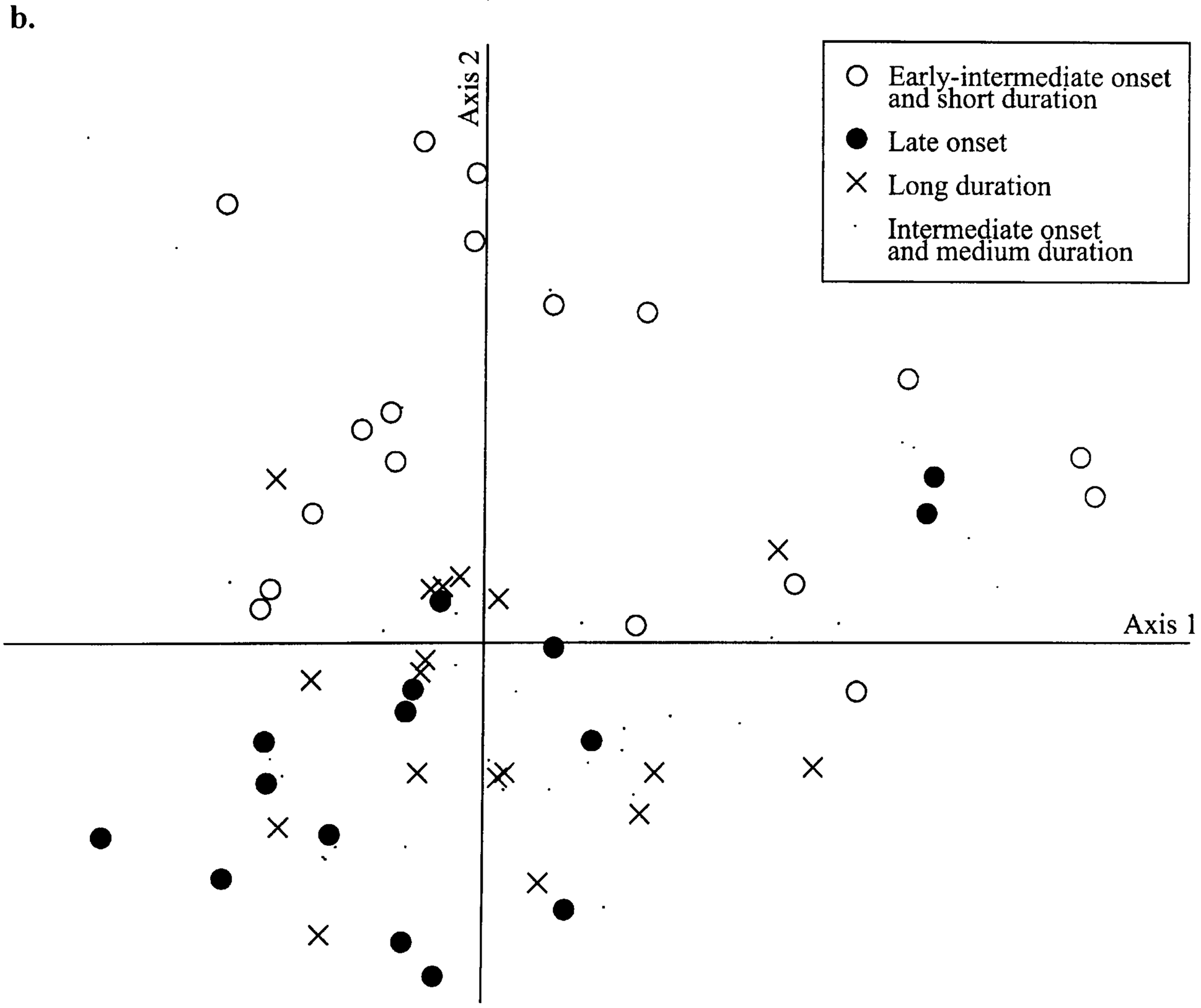
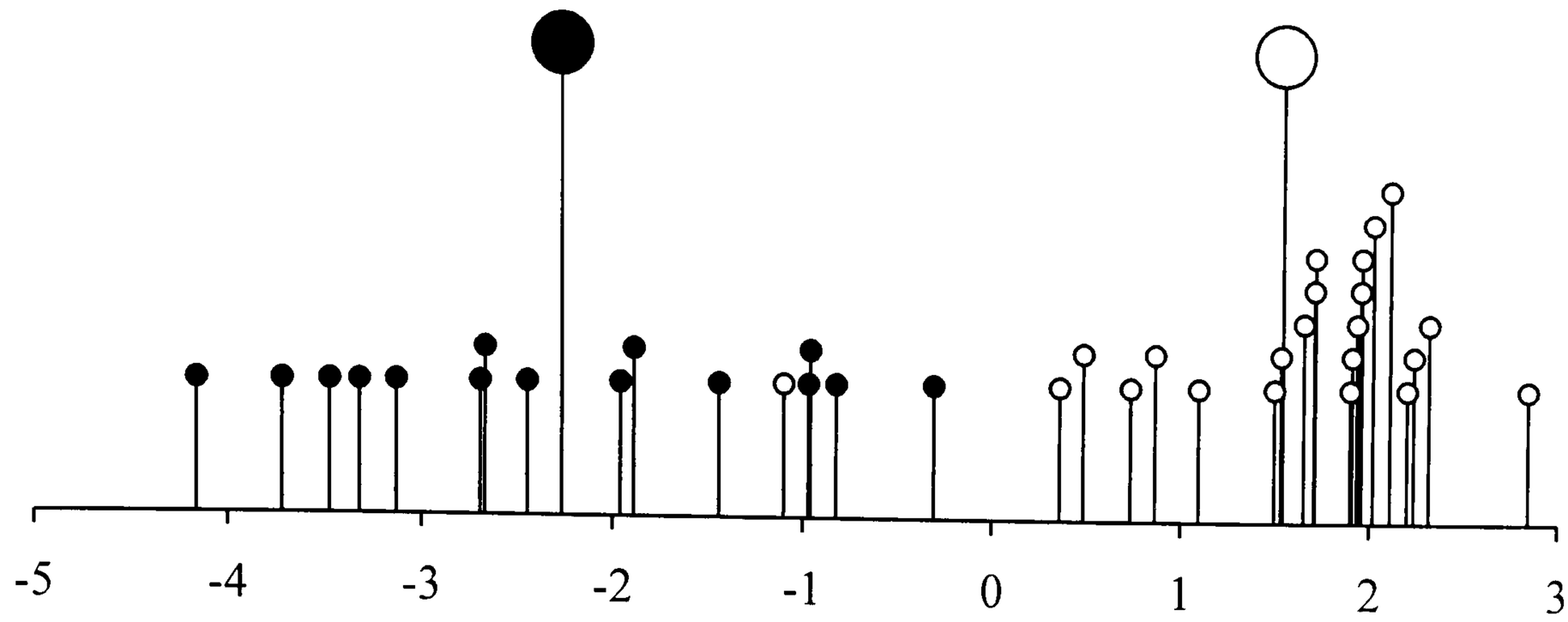


Fig. 3.1. Correspondence analysis of the sowing time study in Germany: a. plot of studied weed associations, showing soil pH and crop sowing time; b. plot of species, showing flowering onset/length classes (see Table 2.8)

a.



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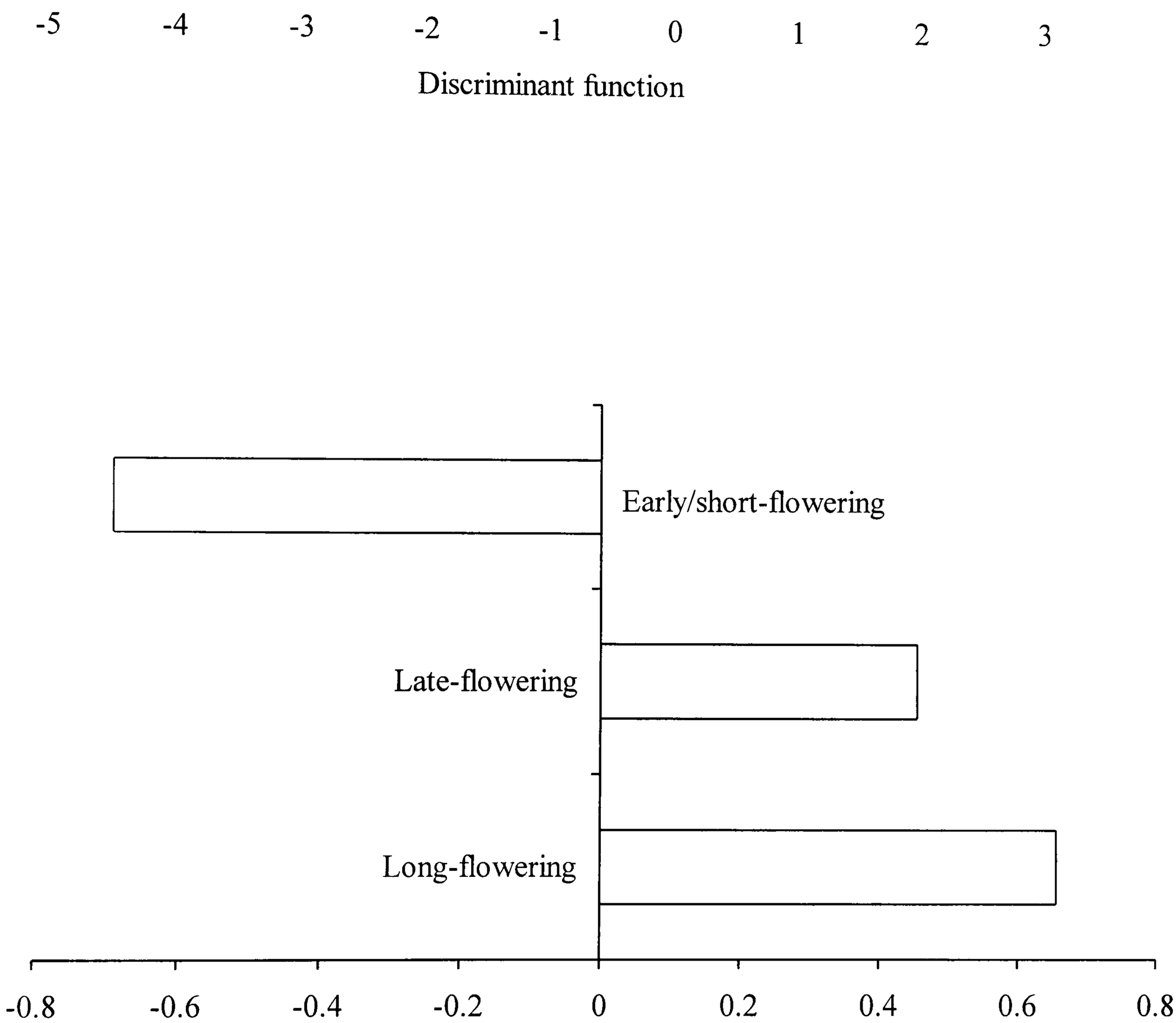
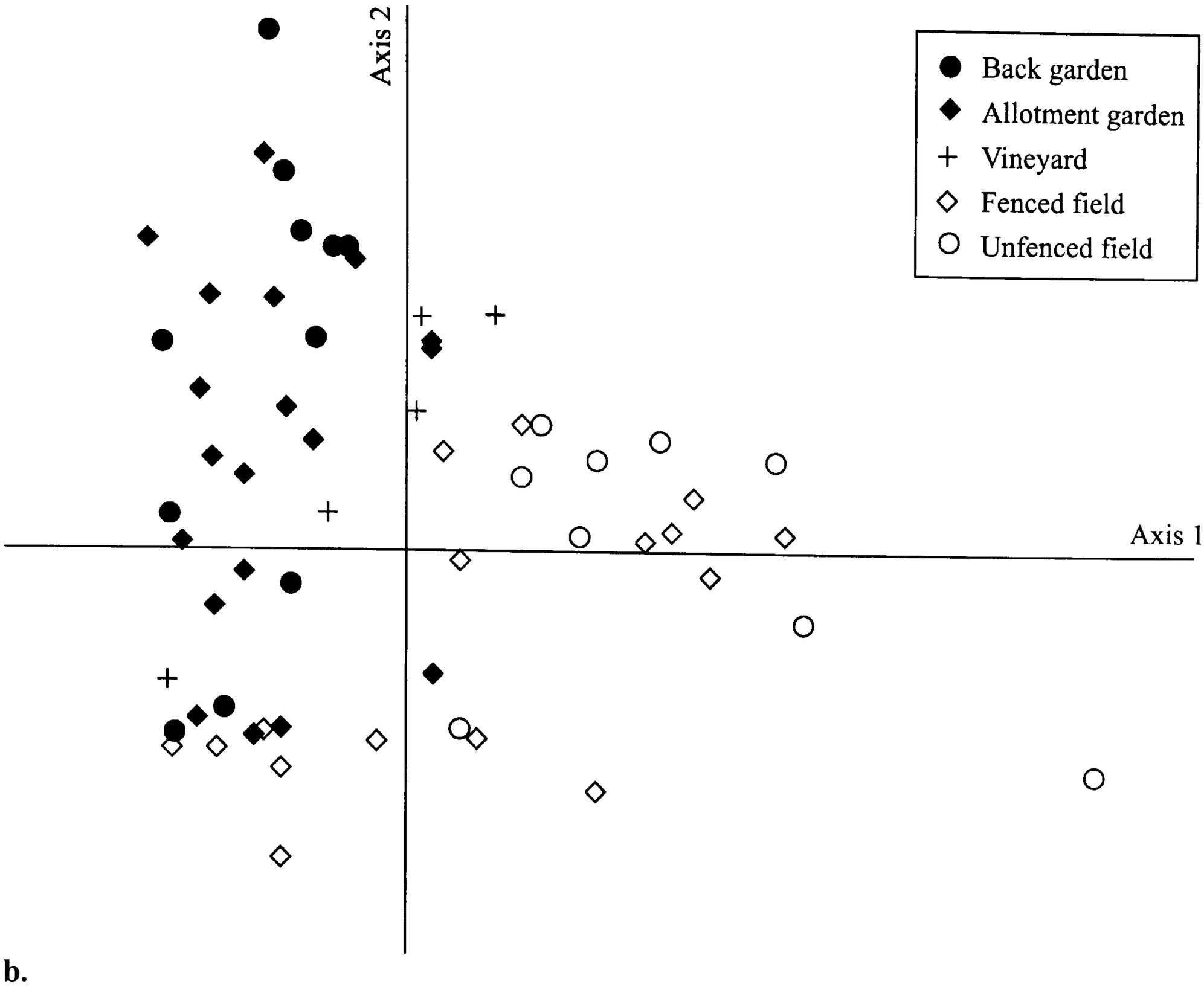


Fig. 3.2. Results of the discriminant analysis separating autumn- and spring-sown weed associations in Germany: a. the relationship of autumn-sown (●) and spring-sown (○) weed associations to the discriminant function (larger circles indicate the position of centroids); b. plot of correlations between the functional attributes and the discriminant function

a.



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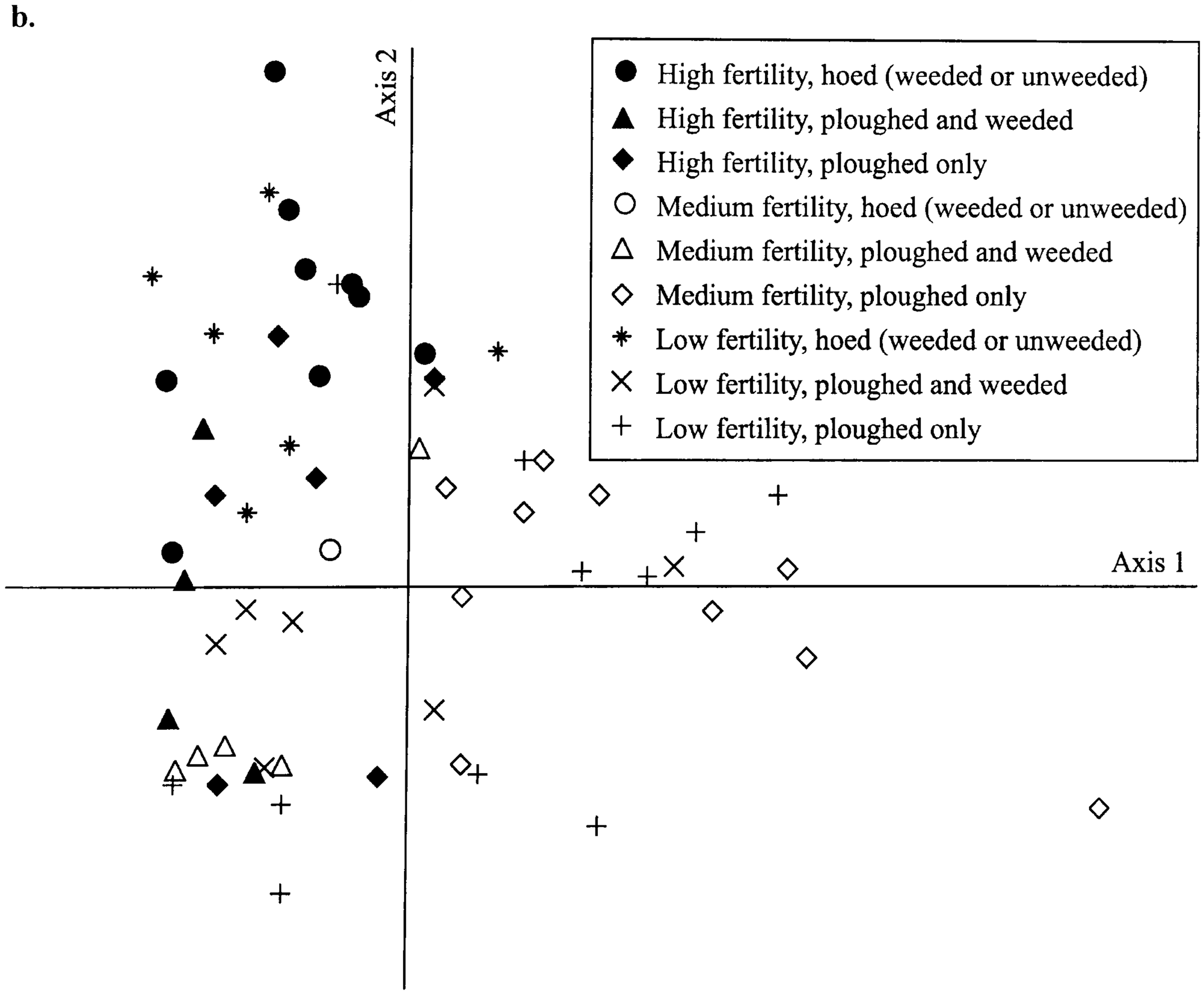
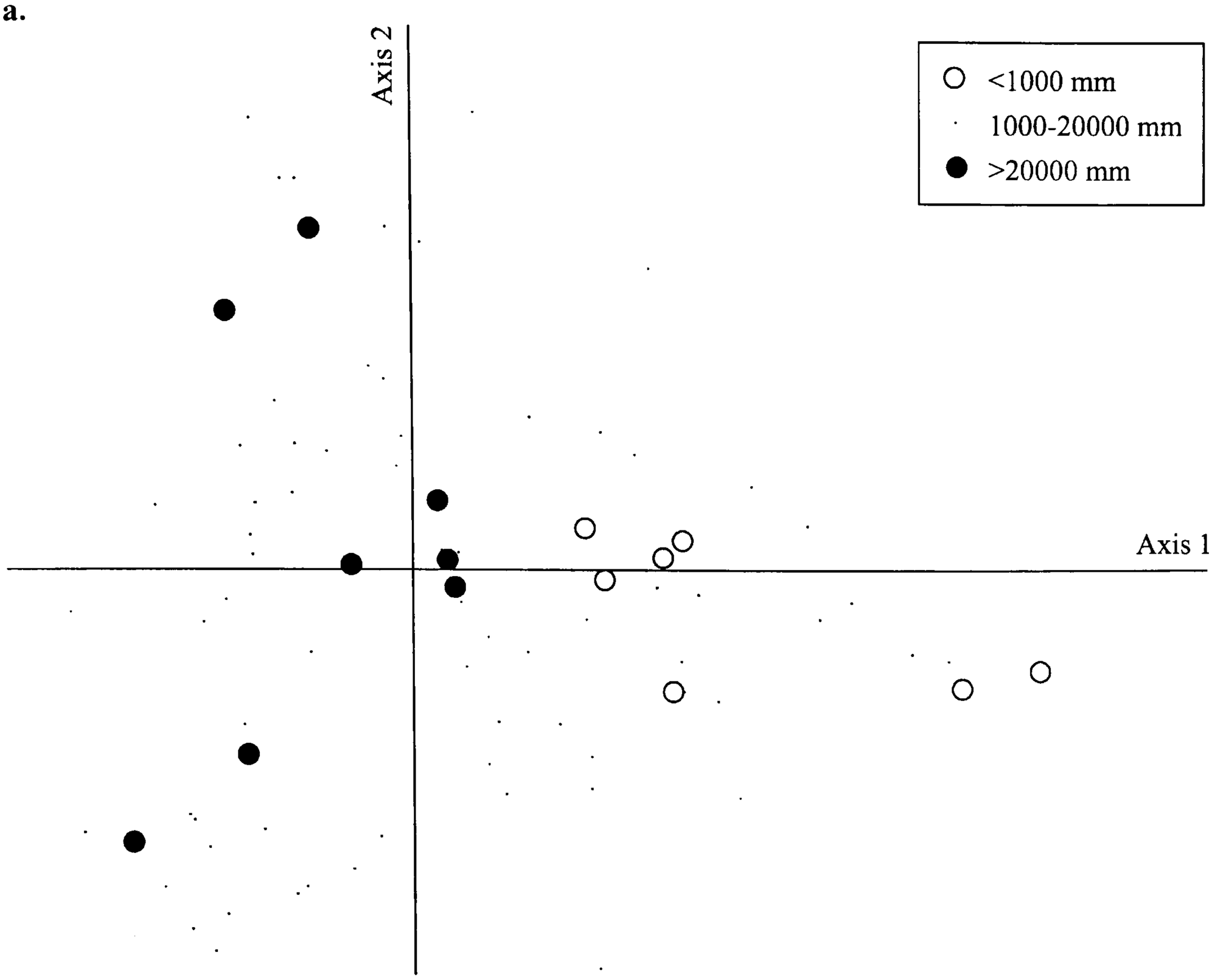


Fig. 3.3. Correspondence analysis diagram of pulse plots in the Evvia study showing: a. plot type; b. combined fertility and disturbance categories

a.



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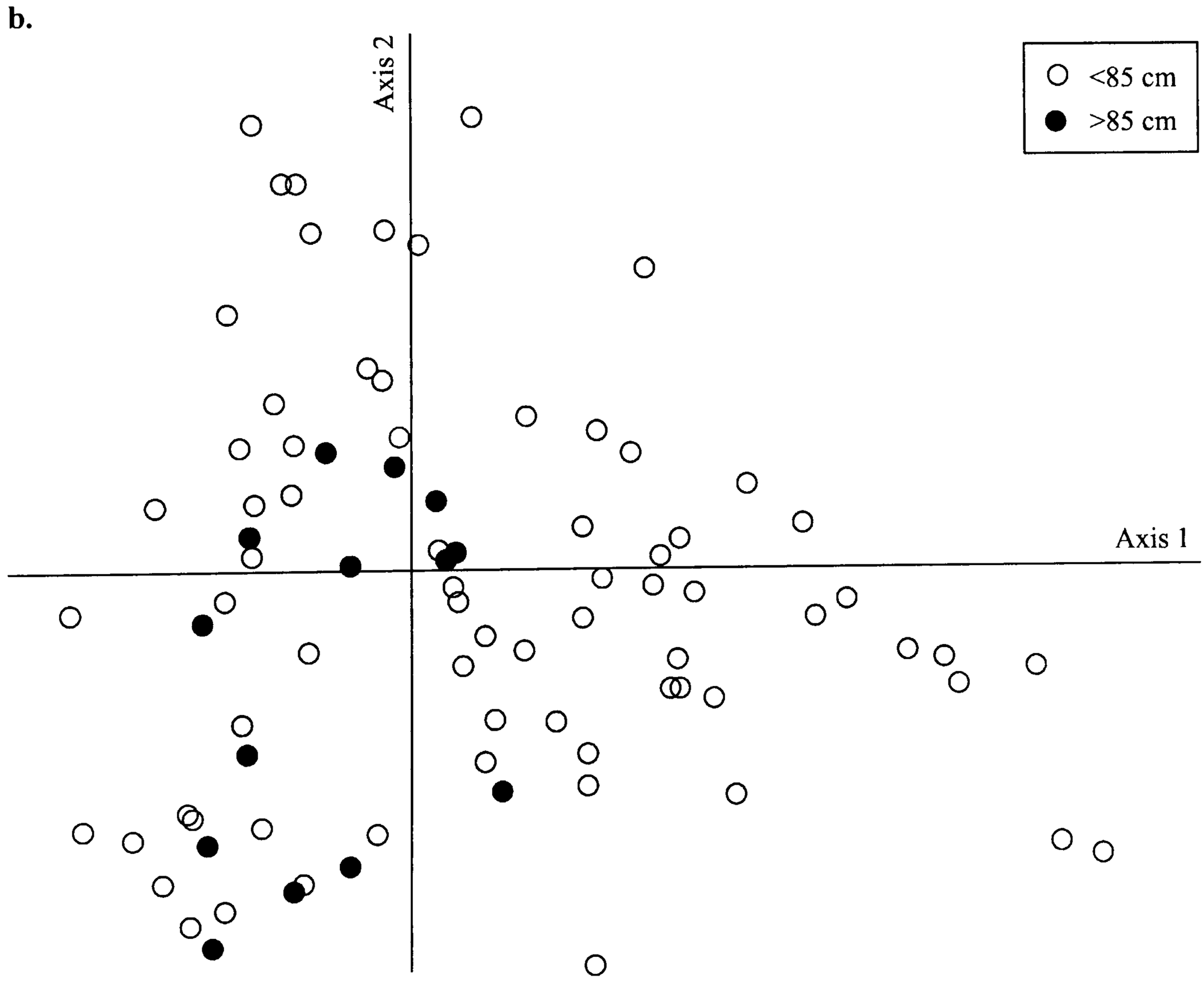


Fig. 3.4. Correspondence analysis plot of species in the Evvia study showing: a. leaf area per node:thickness; b. maximum canopy height

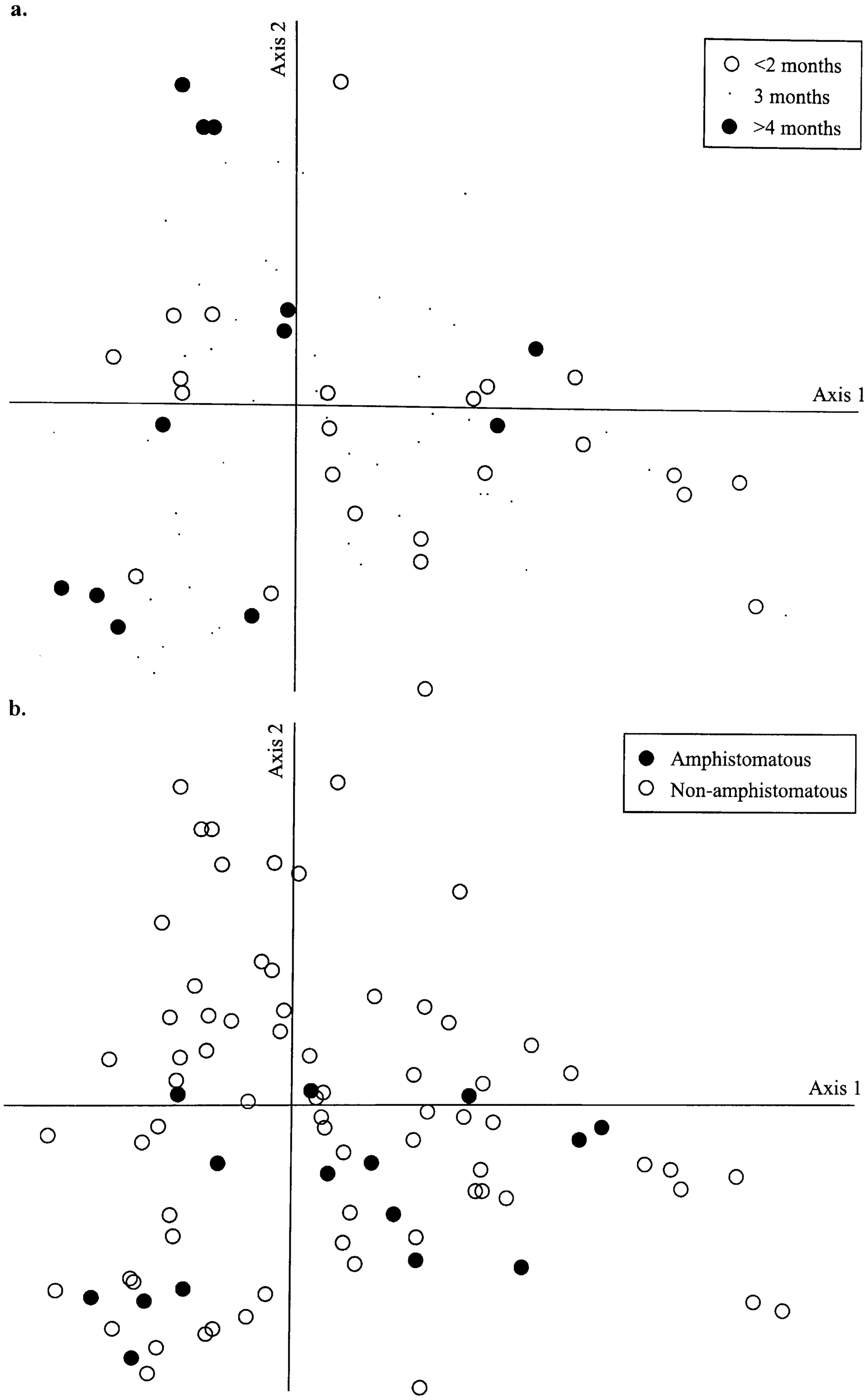
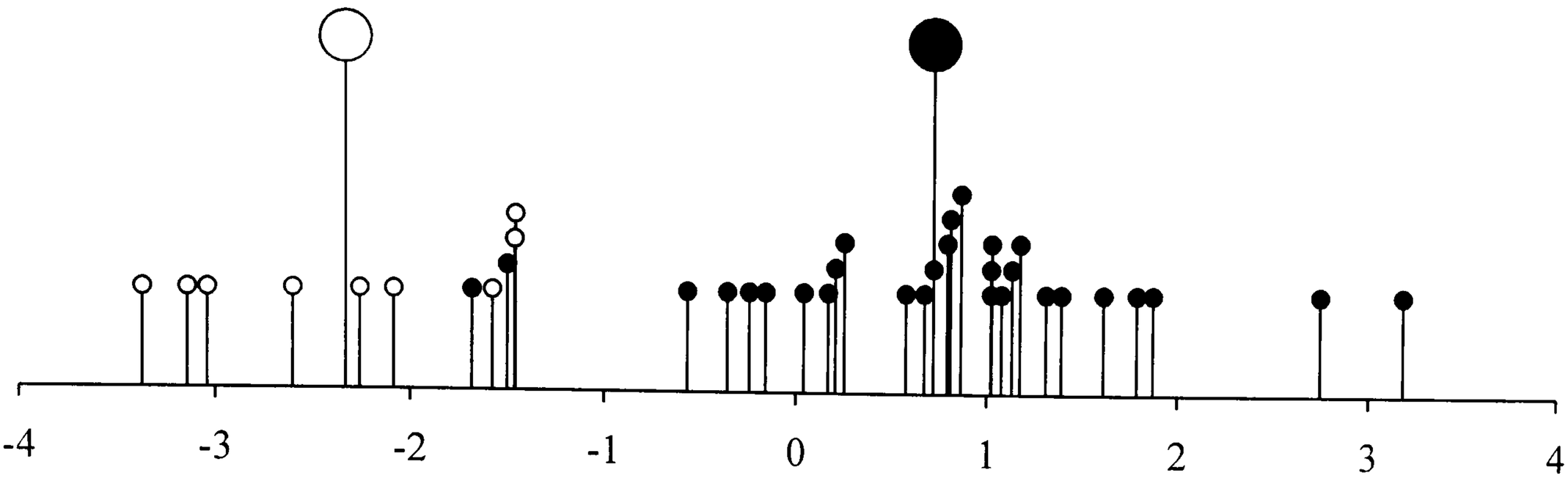


Fig. 3.5. Correspondence analysis plot of species in the Evvia study showing: a. length of the flowering period; b. stomatal distribution

a.



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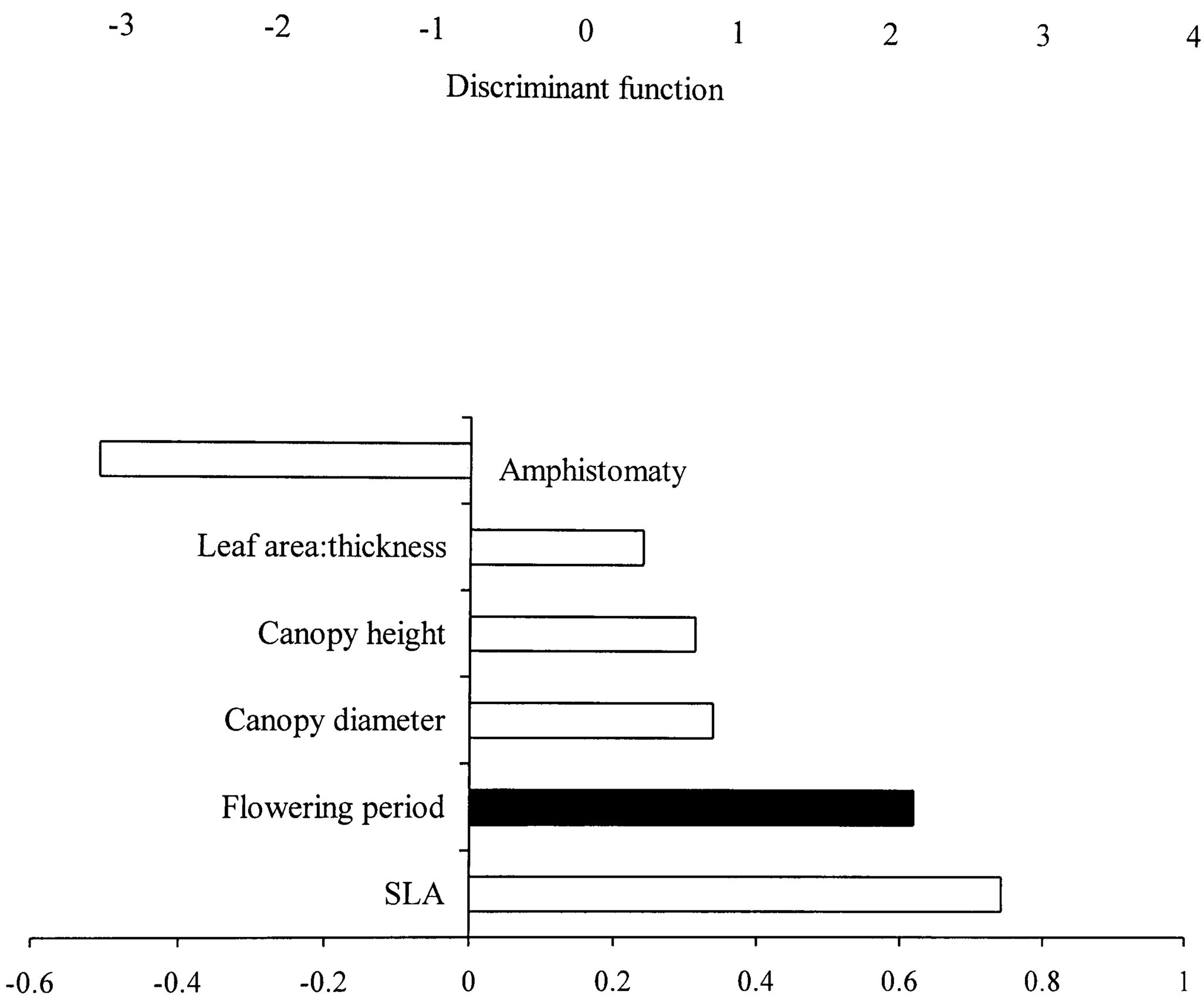
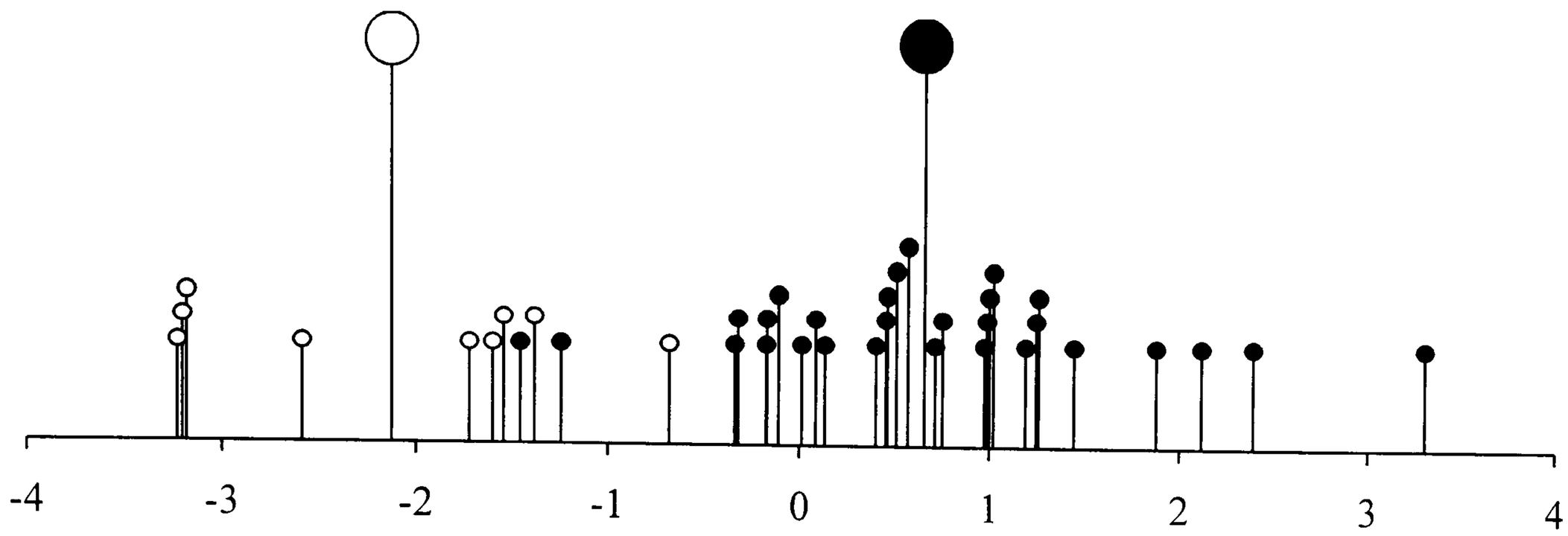


Fig. 3.6. Results of the discriminant analysis separating Evvia pulse gardens and fields: a. the relationship of gardens (●) and fields (○) to the discriminant function (larger circles indicate the position of centroids); b. plot of correlations between the functional attributes and the discriminant function, where open bars = attributes relating to the duration and quality of the growth period, black bar = attribute relating to the capacity to regenerate under conditions of high disturbance and grey bar = attribute relating to shade tolerance

a.



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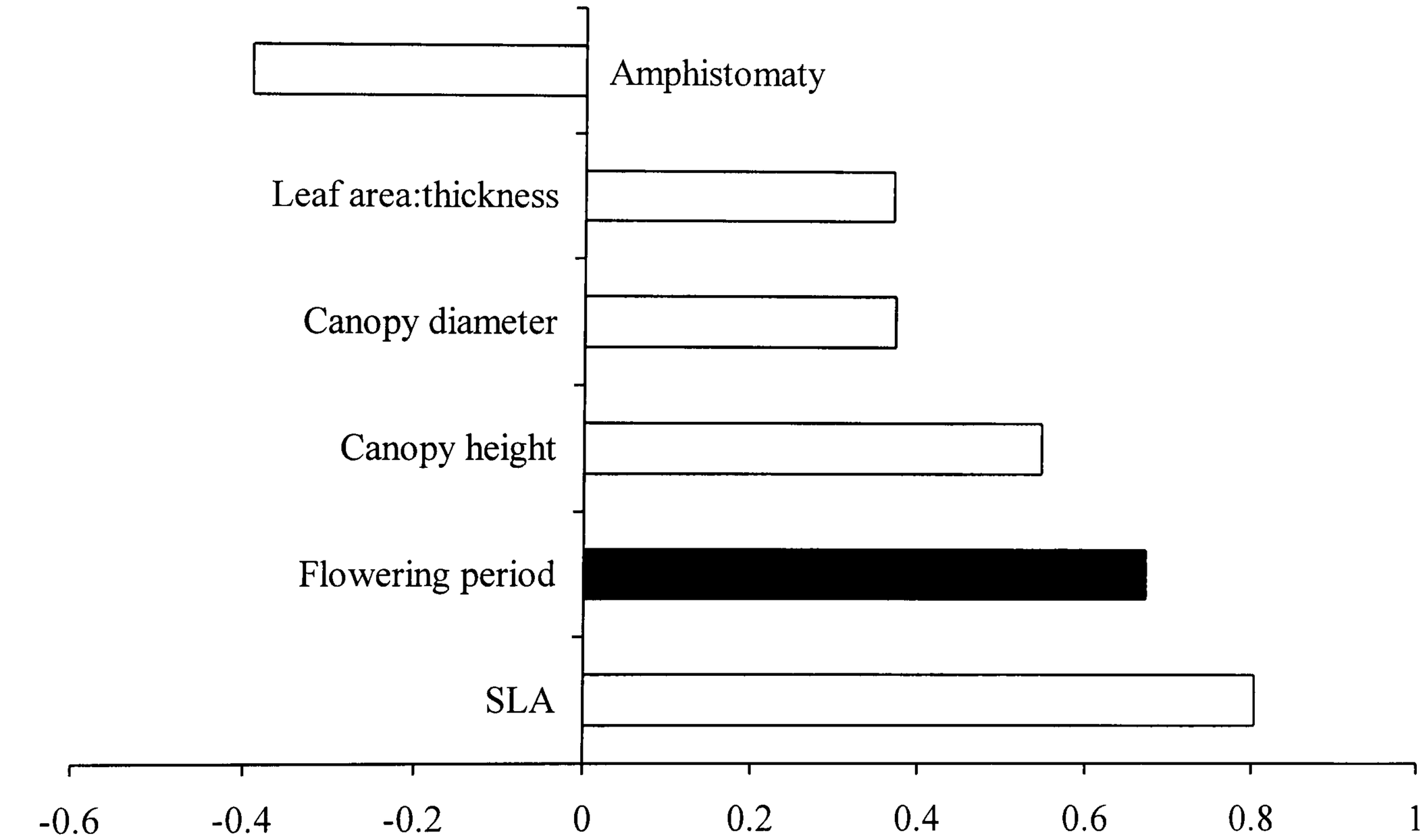
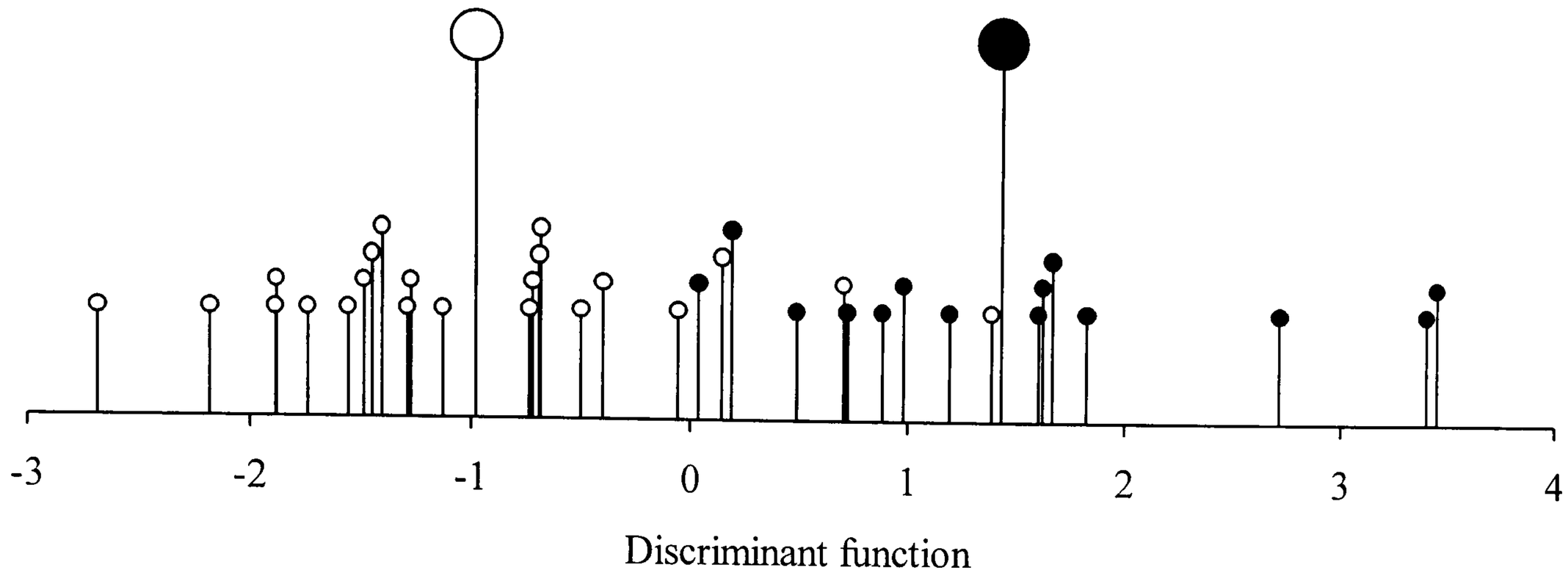


Fig. 3.7. Results of the discriminant analysis separating Evvia pulse gardens and fields (using 'pan-European' functional attribute data): a. the relationship of gardens (●) and fields (○) to the discriminant function (larger circles indicate the position of centroids); b. plot of correlations between the functional attributes and the discriminant function, where open bars = attributes relating to the duration and quality of the growth period, black bar = attribute relating to the capacity to regenerate under conditions of high disturbance and grey bar = attribute relating to shade tolerance

a.



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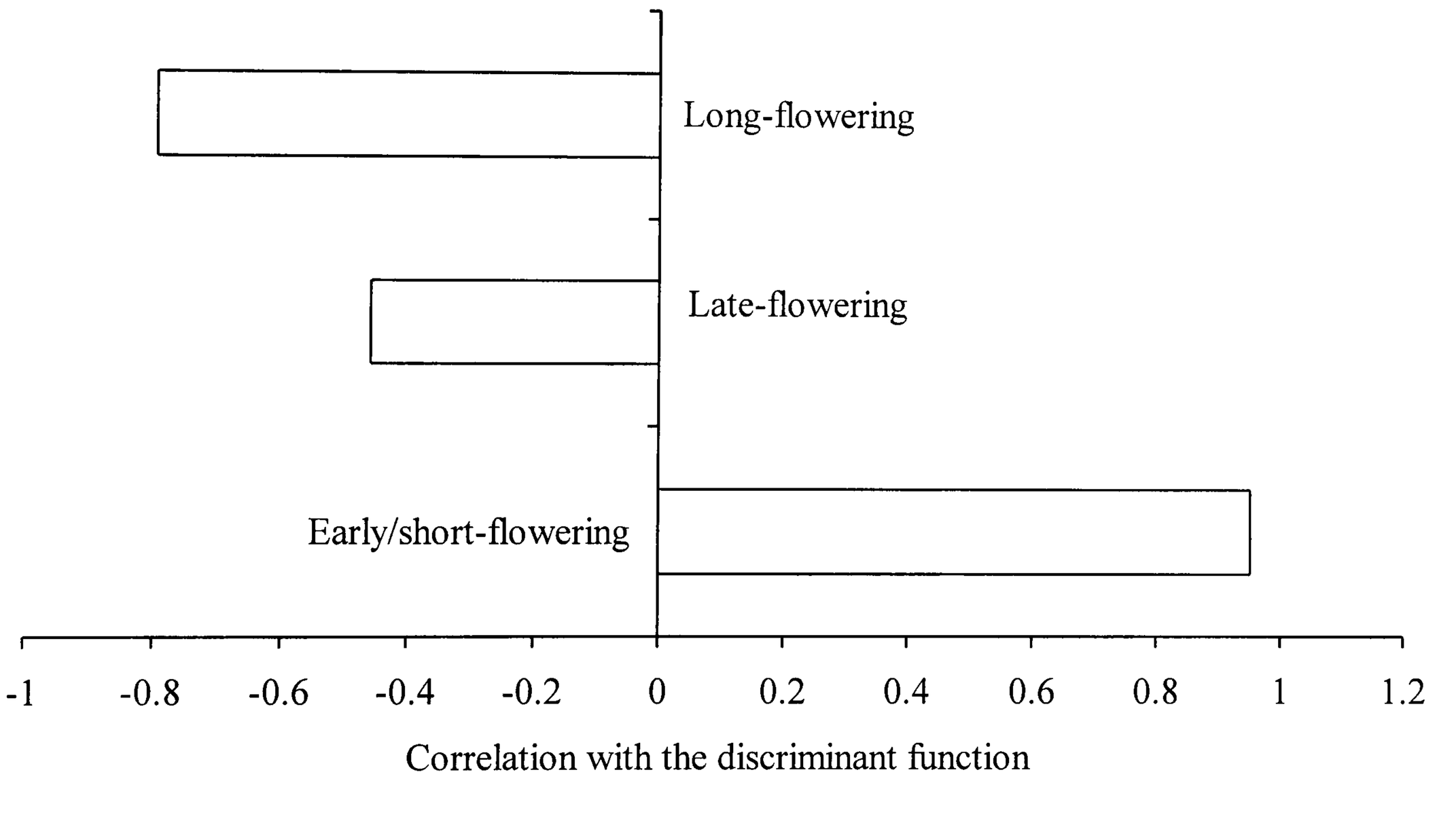
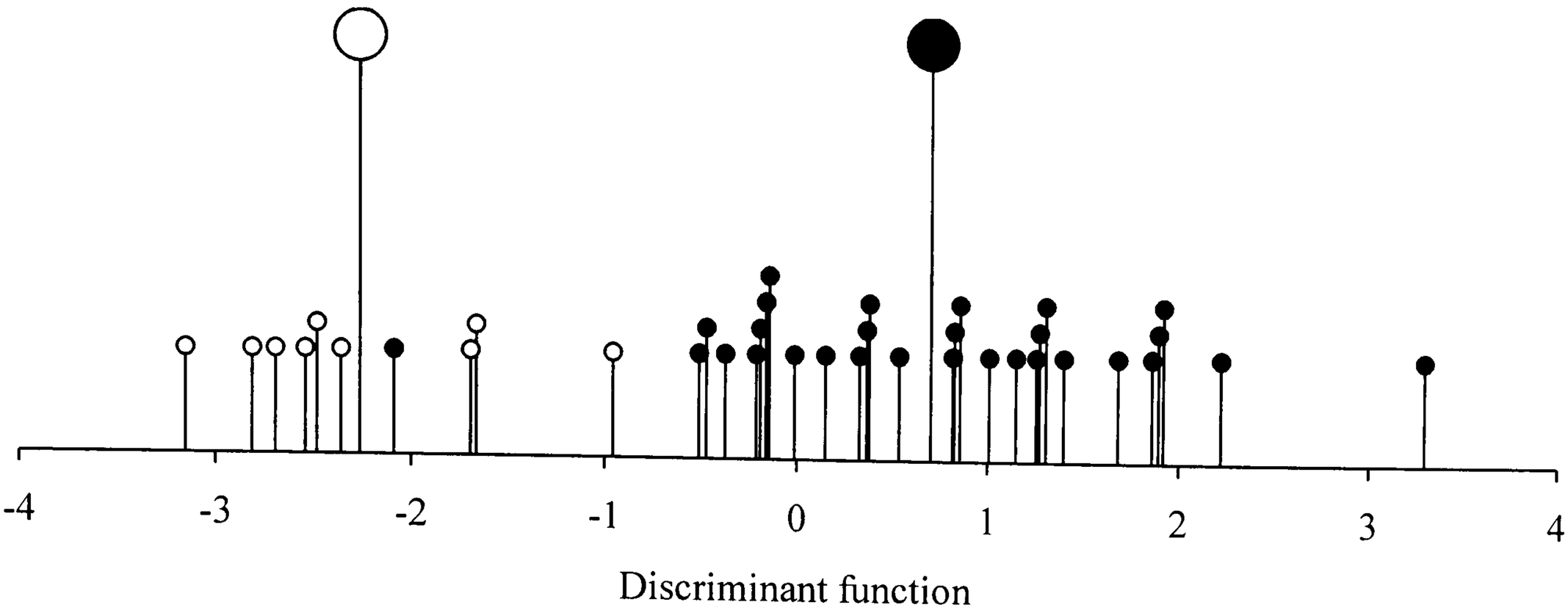


Fig. 3.8. Results of the discriminant analysis separating autumn- and spring-sown weed associations in Germany based on semi-quantitative data: a. the relationship of autumn-sown (●) and spring-sown (○) weed associations to the discriminant function (larger circles indicate the position of centroids); b. plot of correlations between the functional attributes and the discriminant function

a.



b.

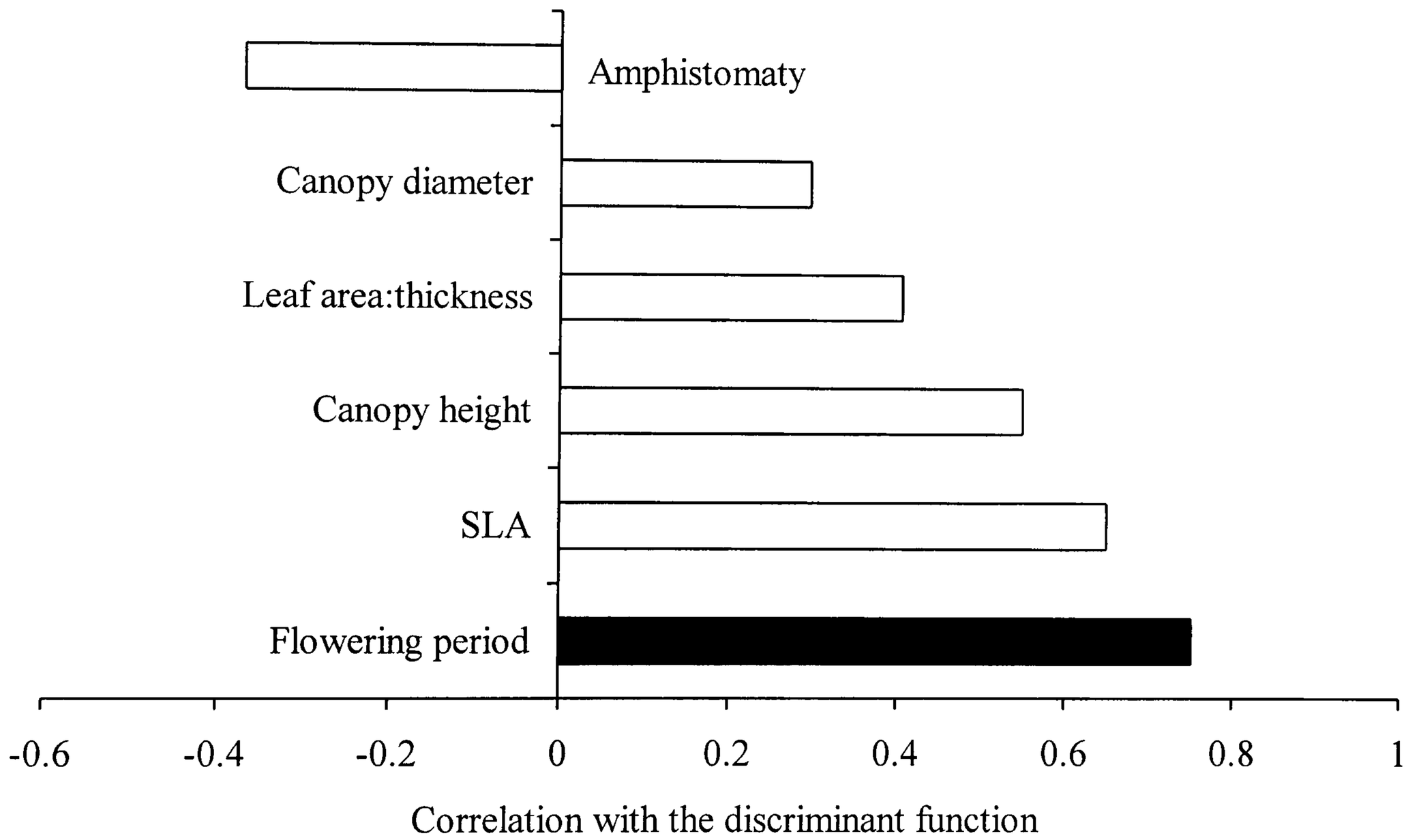
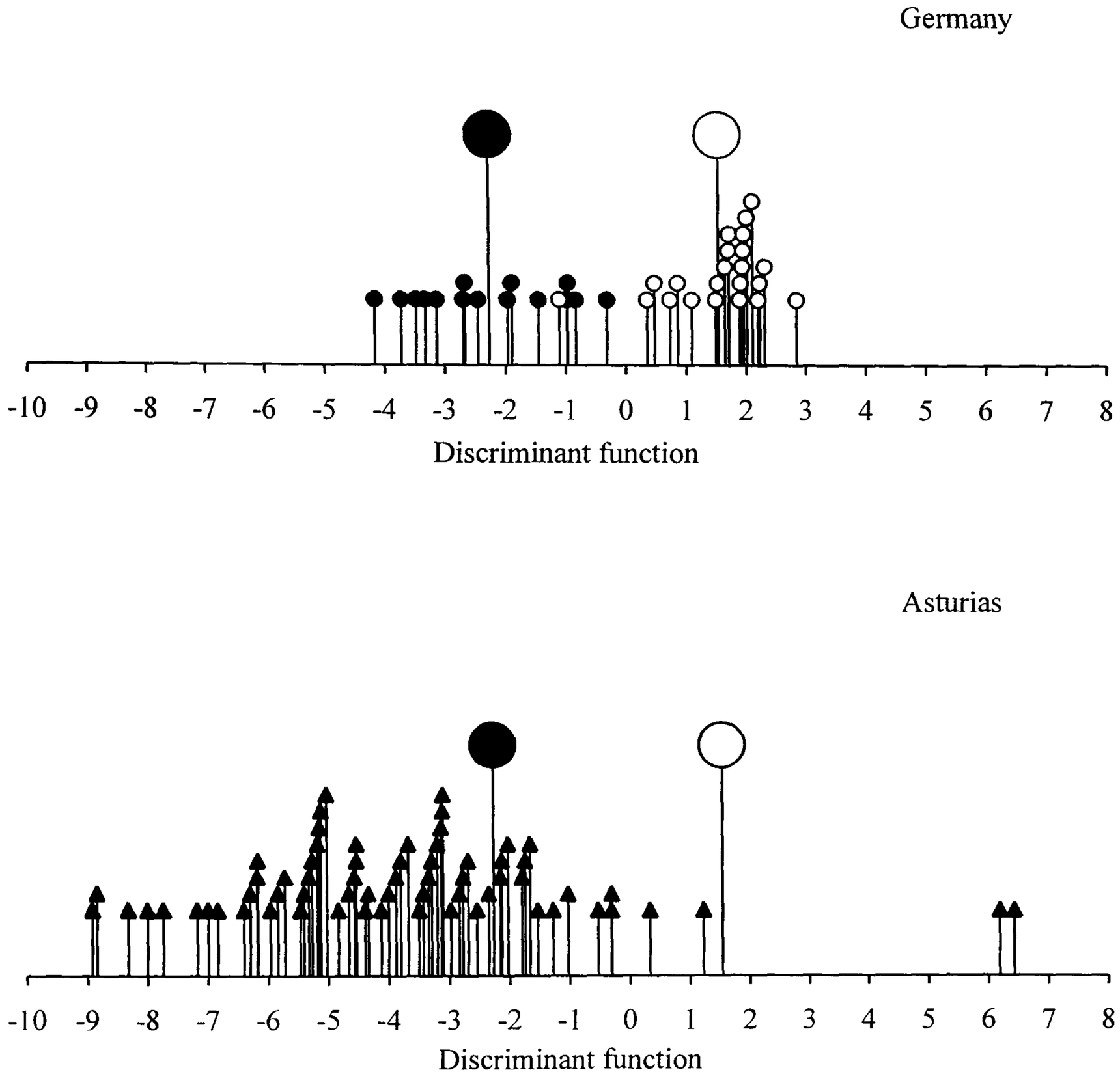


Fig. 3.9. Results of the discriminant analysis separating Evvia pulse gardens and fields based on semi-quantitative data: a. the relationship of gardens (●) and fields (○) to the discriminant function (larger circles indicate the position of centroids); b. plot of correlations between the functional attributes and the discriminant function, where open bars = attributes relating to the duration and quality of the growth period, black bar = attribute relating to the capacity to regenerate under conditions of high disturbance and grey bar = attribute relating to shade tolerance

Quantitative analysis

a.



Semi-quantitative analysis

c.

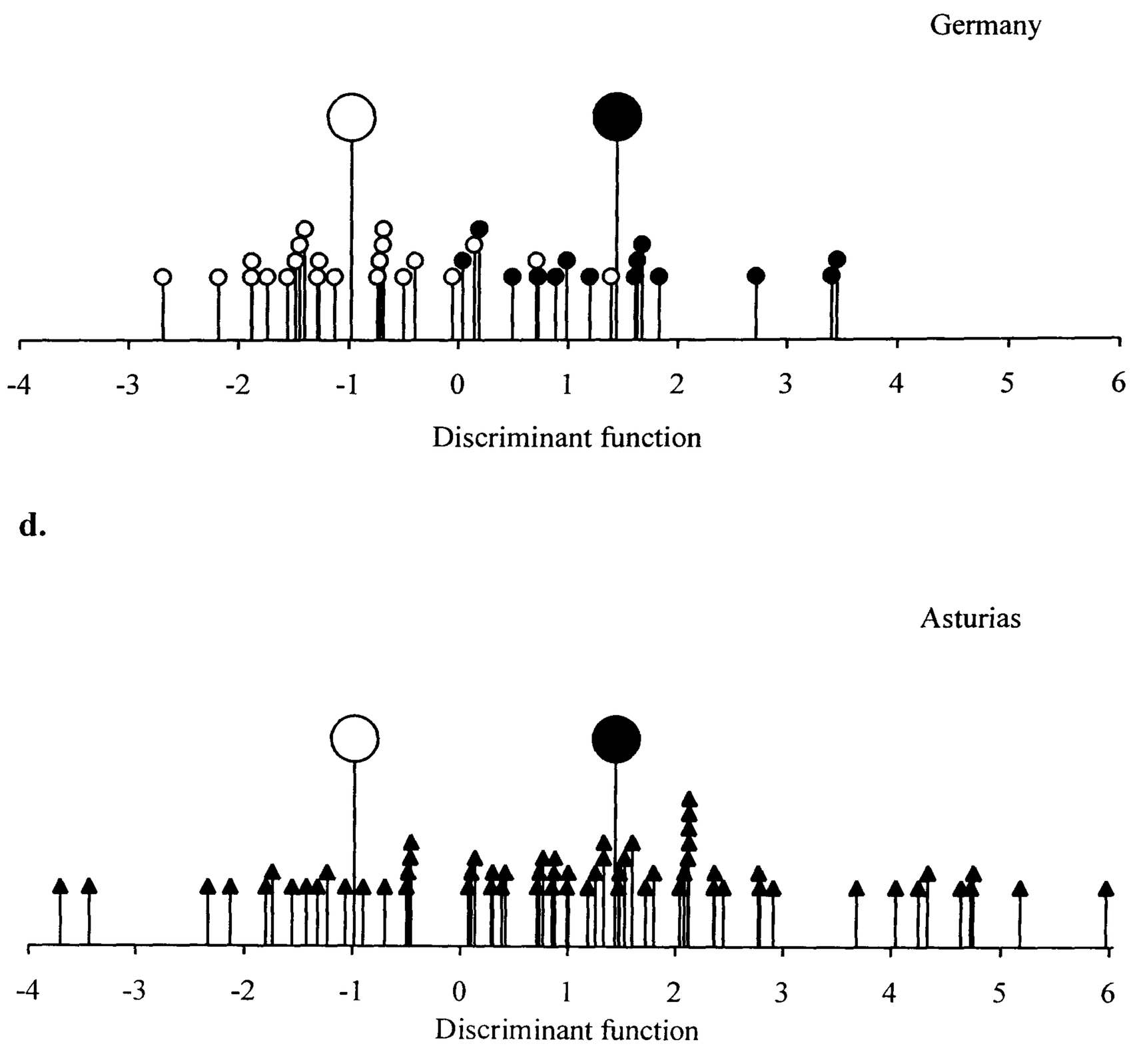
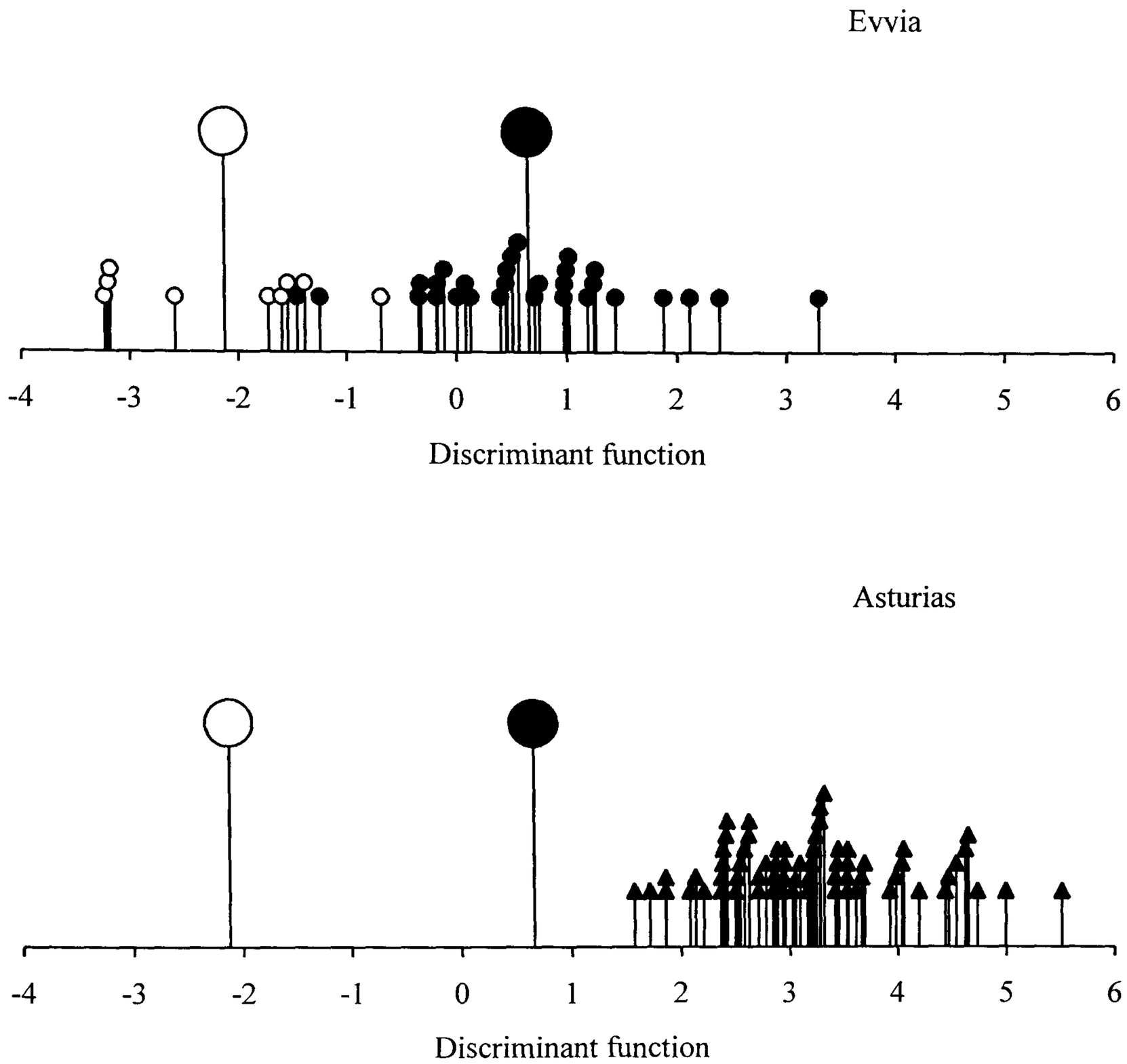


Fig. 3.10. The relationship of autumn-sown (●) and spring-sown (○) weed associations from Germany and Asturias plots (▲) to the discriminant functions (larger circles indicate the position of centroids for Germany groups)

Quantitative analysis

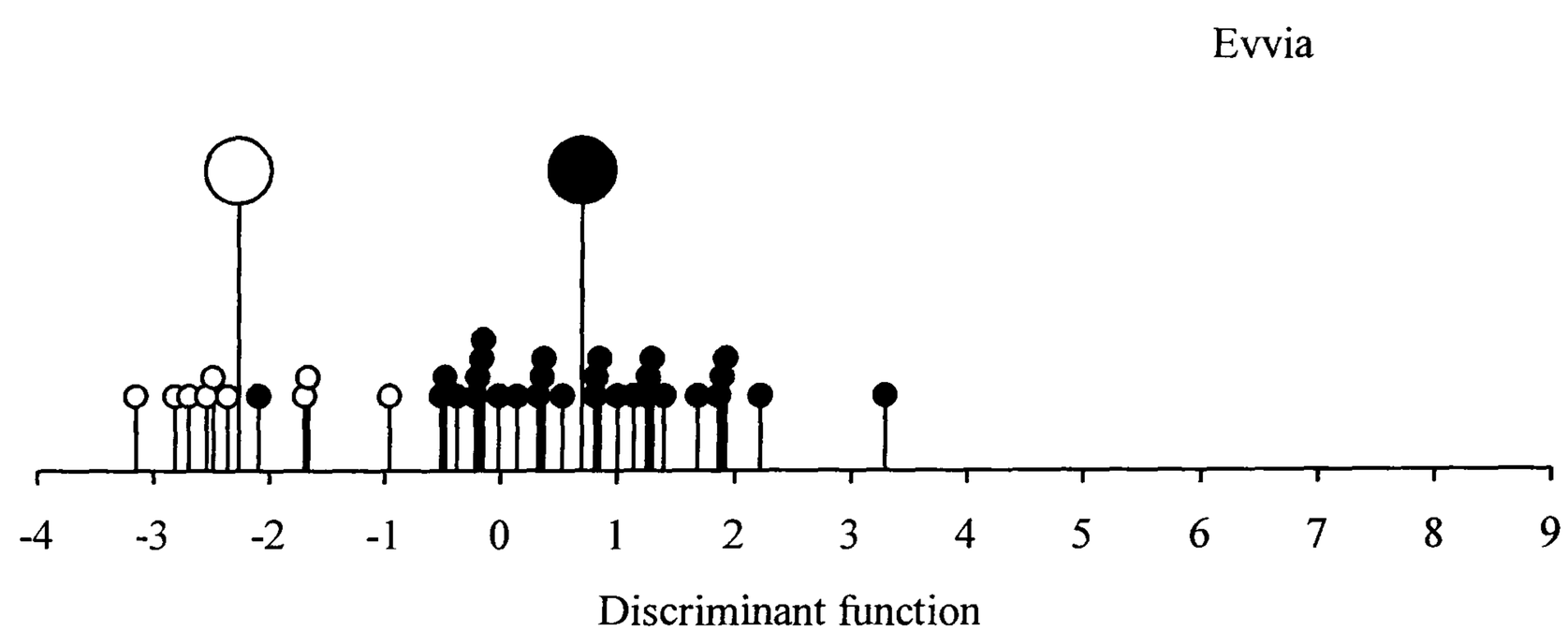
a.



b.

Semi-quantitative analysis

c.



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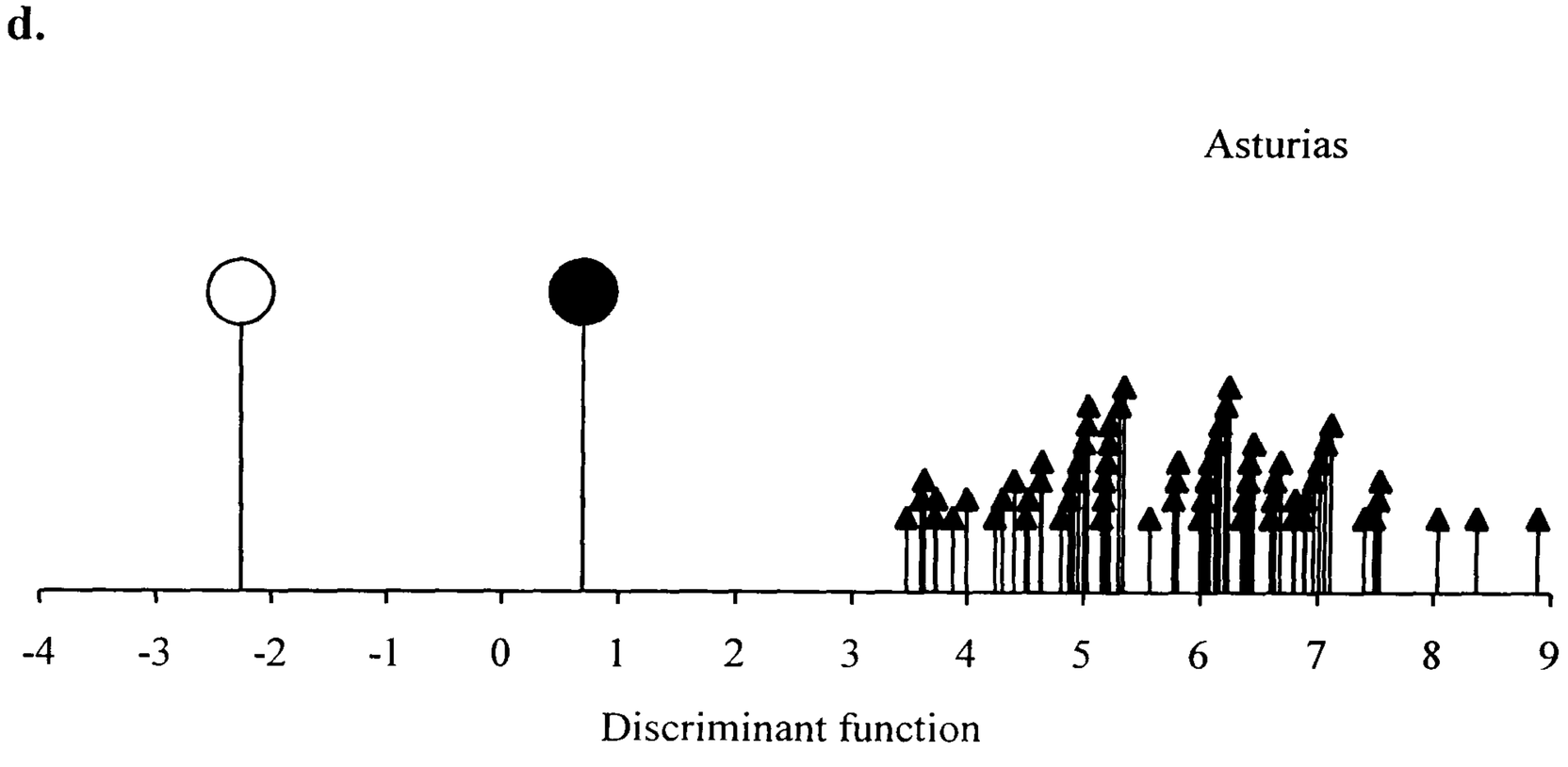


Fig. 3.11. The relationship of pulse gardens (●) and pulse fields (○) in Evvia and cereal plots (▲) in Asturias to the discriminant functions (larger circles indicate the position of centroids for Evvia groups)

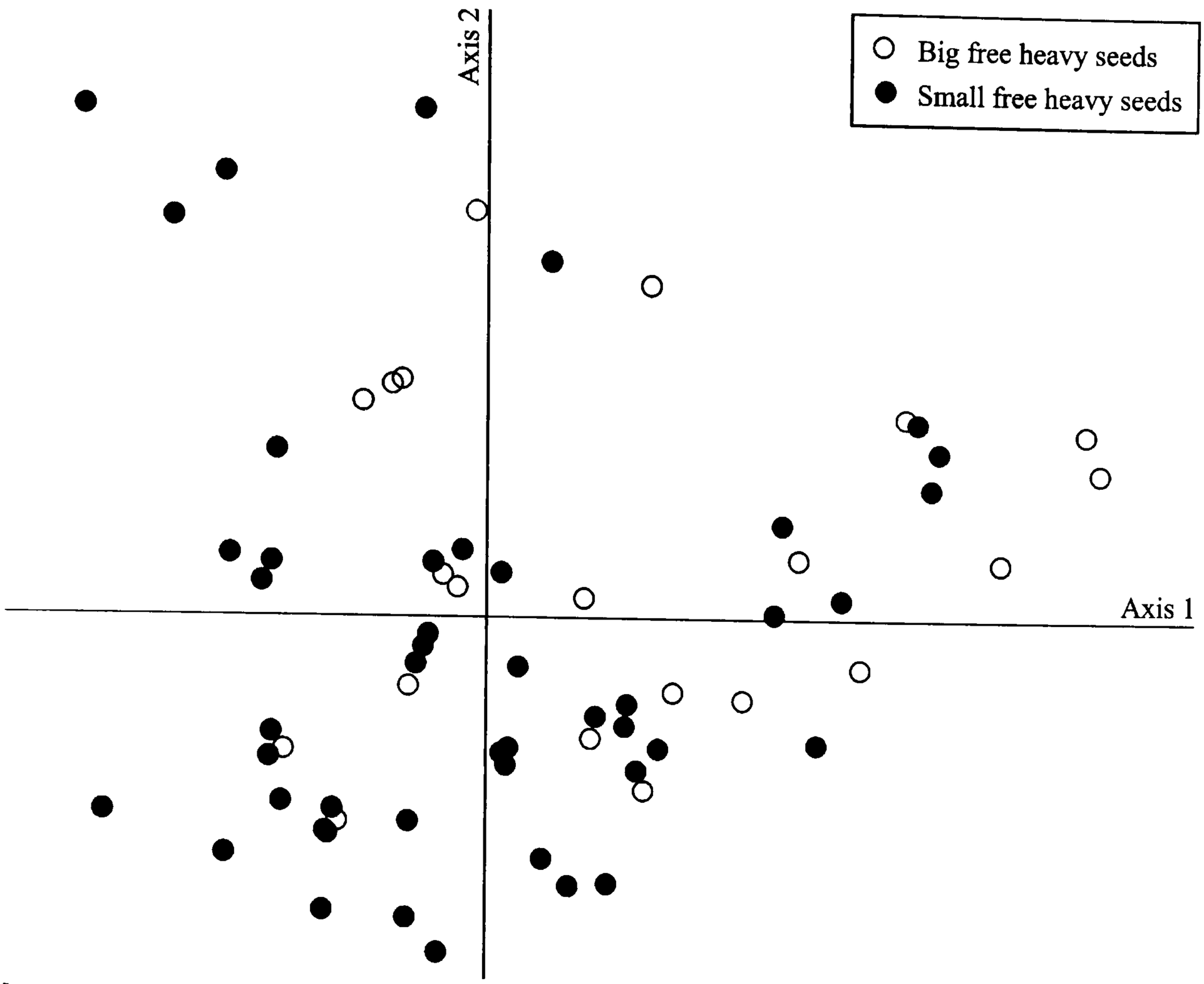
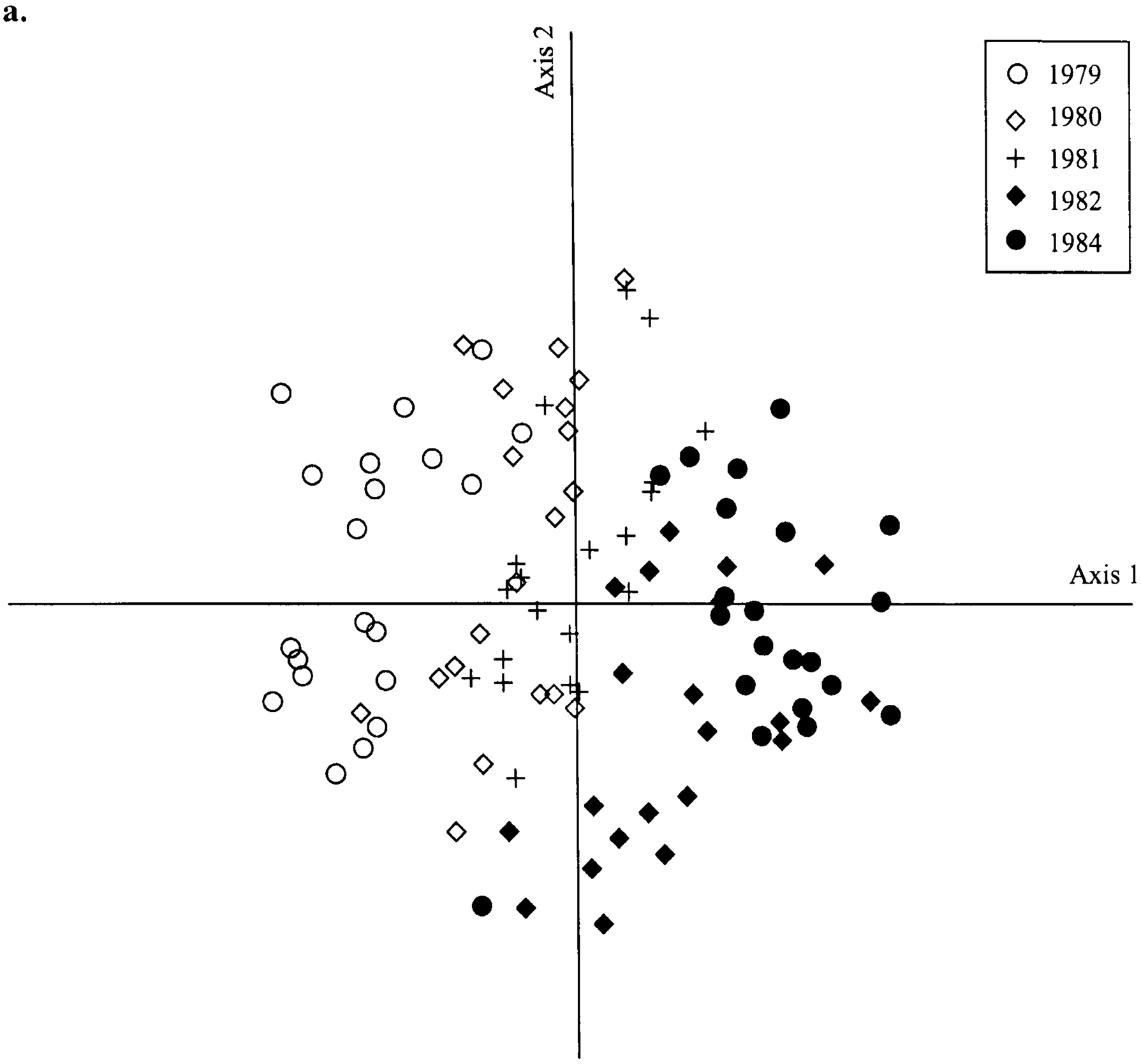


Fig. 3.12. a. Correspondence analysis plot of species from the sowing time study in Germany showing two weed seed types (big free heavy and small free heavy); b. correspondence analysis plot of species from the study of cultivation intensity in Evvia showing two weed seed types (big free heavy and small free heavy)

a.



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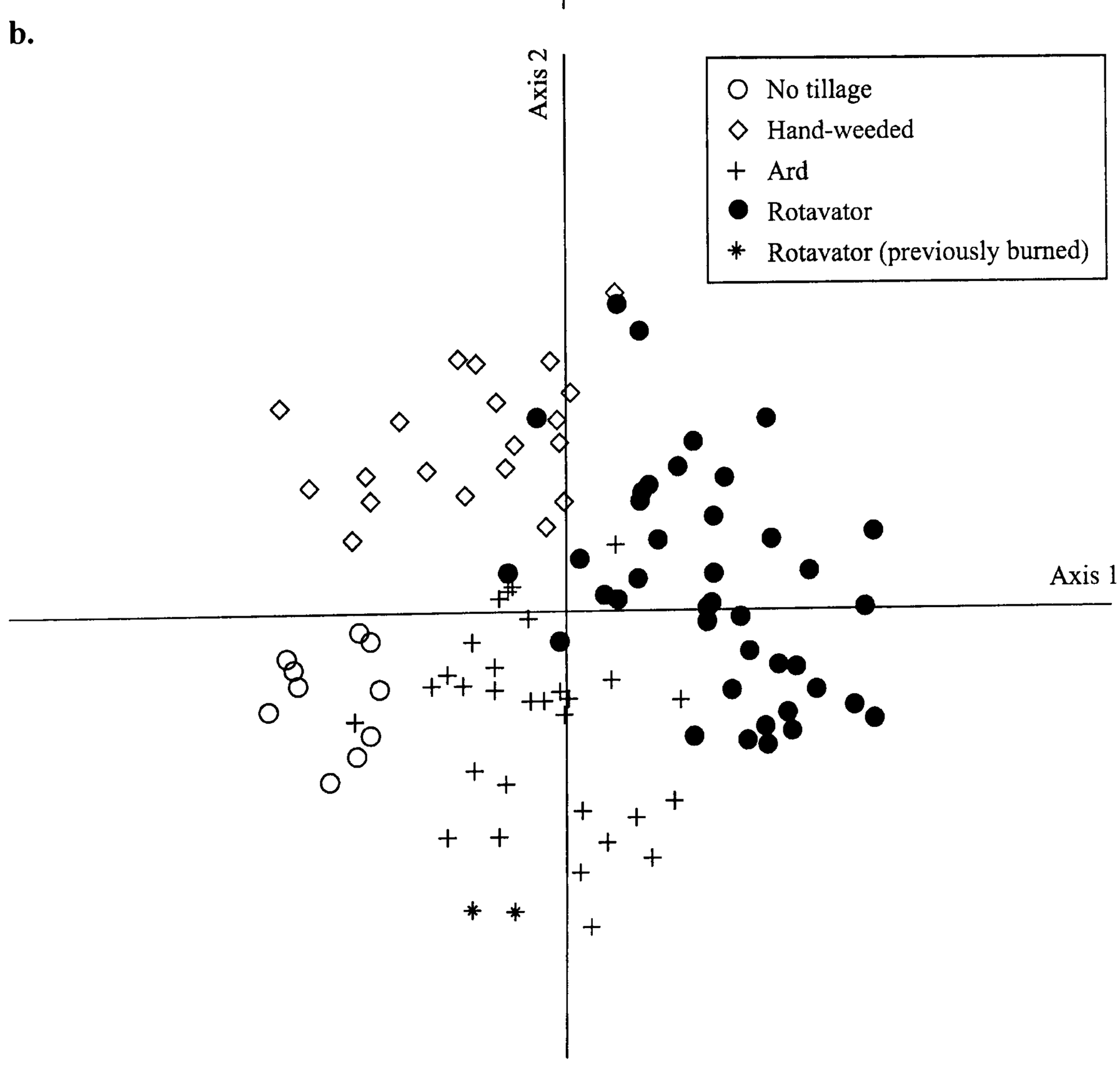
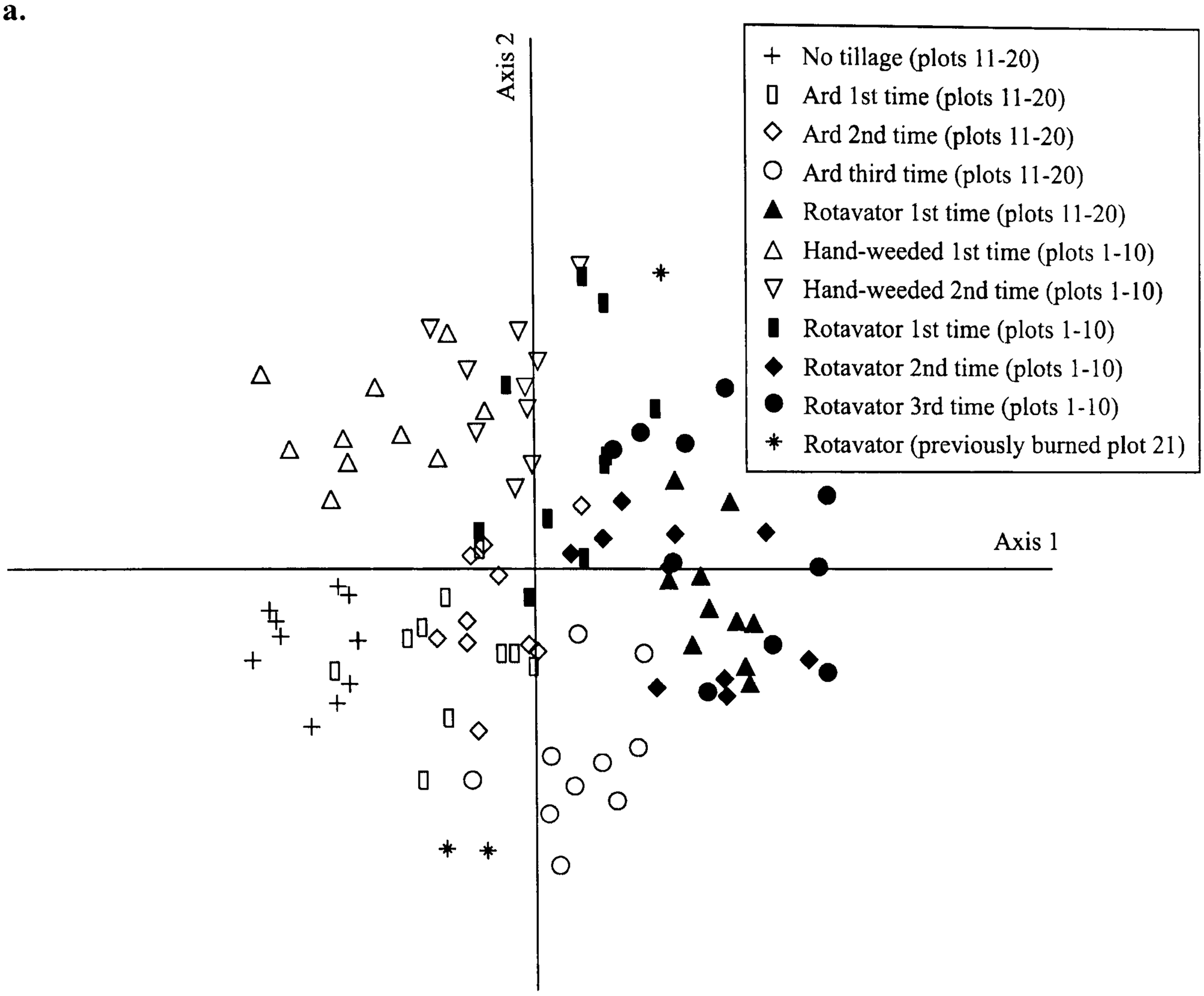


Fig. 3.13. Correspondence analysis diagram of Hambach experimental plot surveys showing: a. survey year; b. tillage method

a.



b.

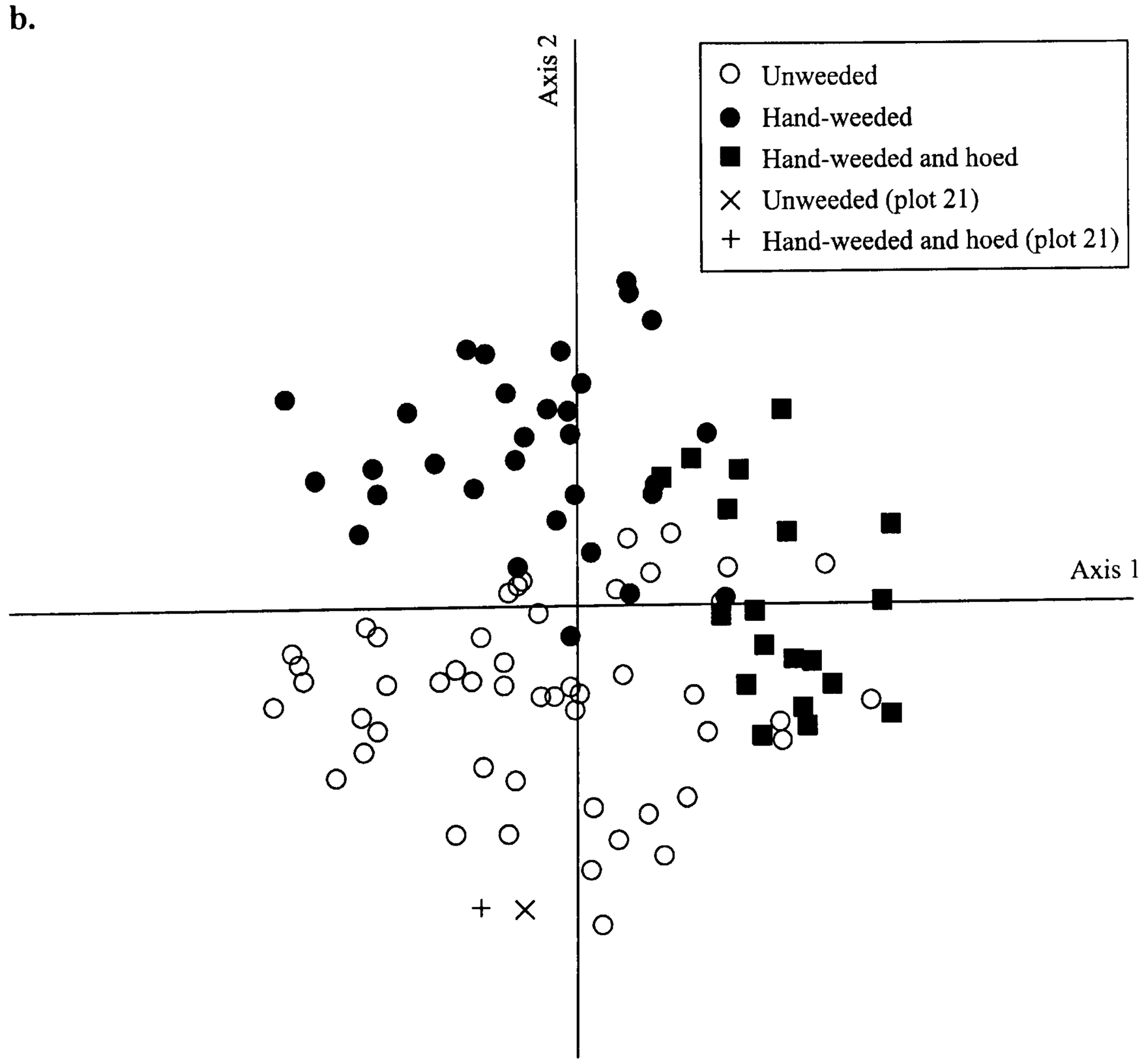
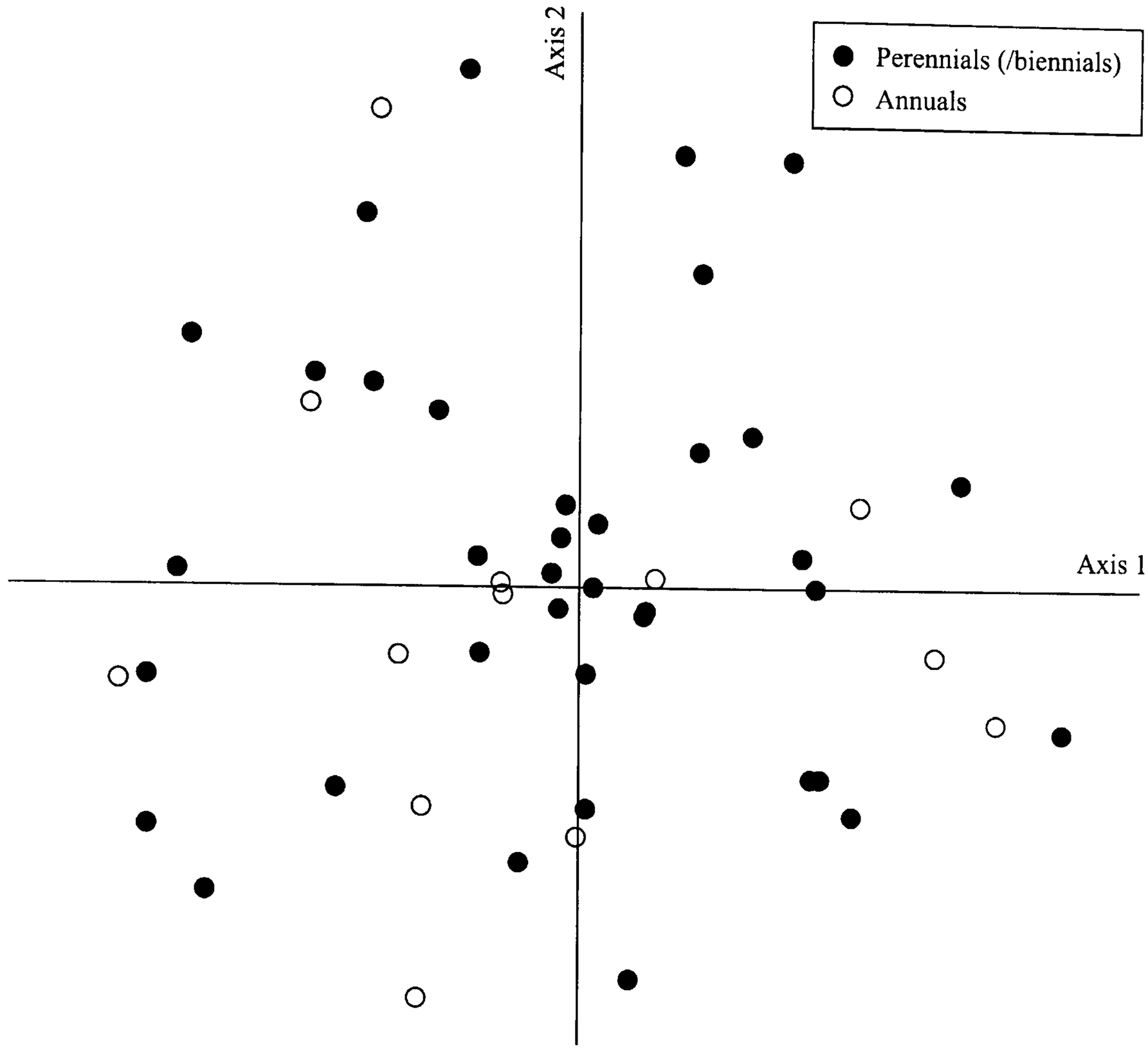


Fig. 3.14. Correspondence analysis diagram of Hambach experimental plot surveys showing: a. tillage sequence; b. weeding during crop growth

a.



b.

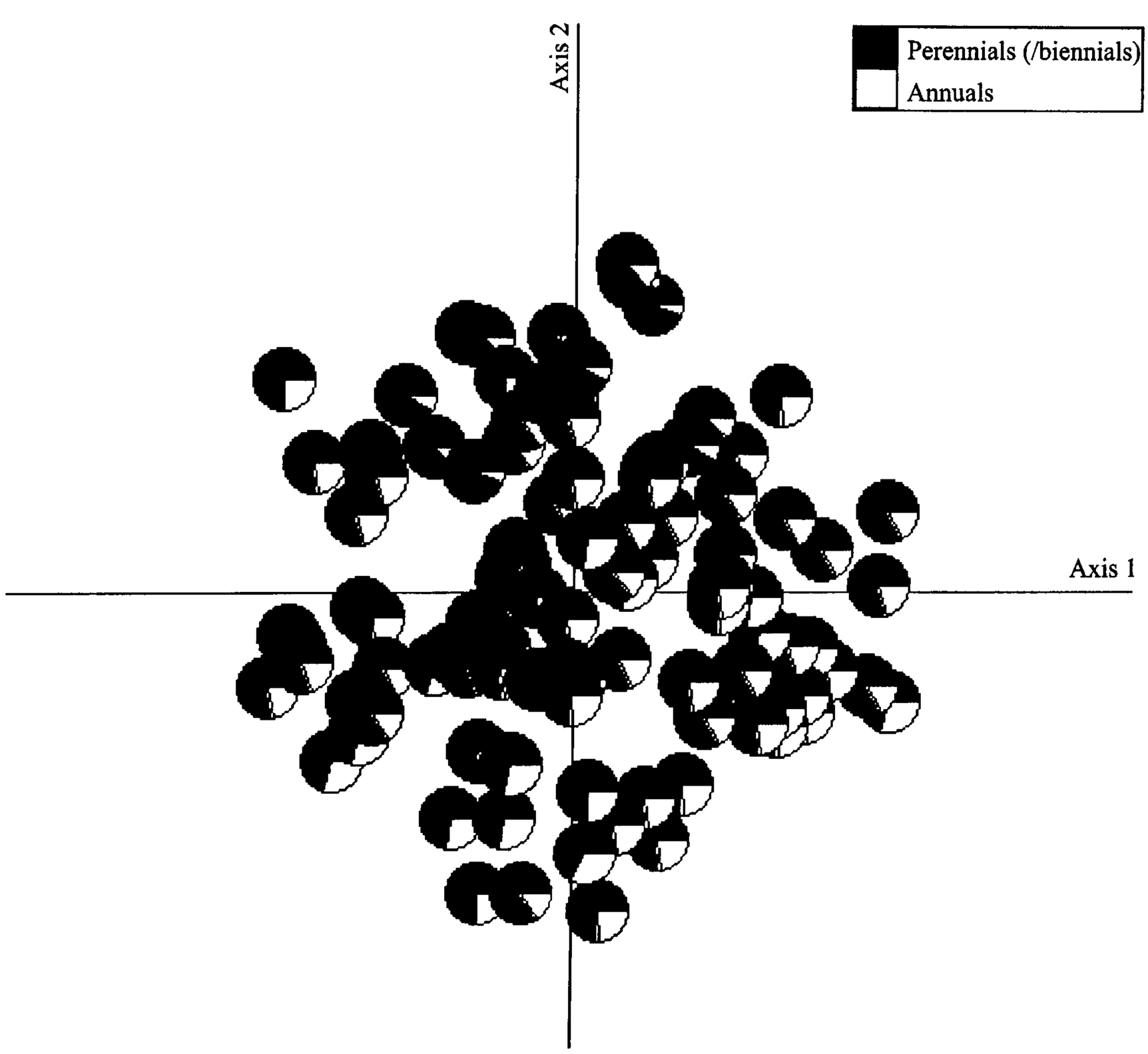
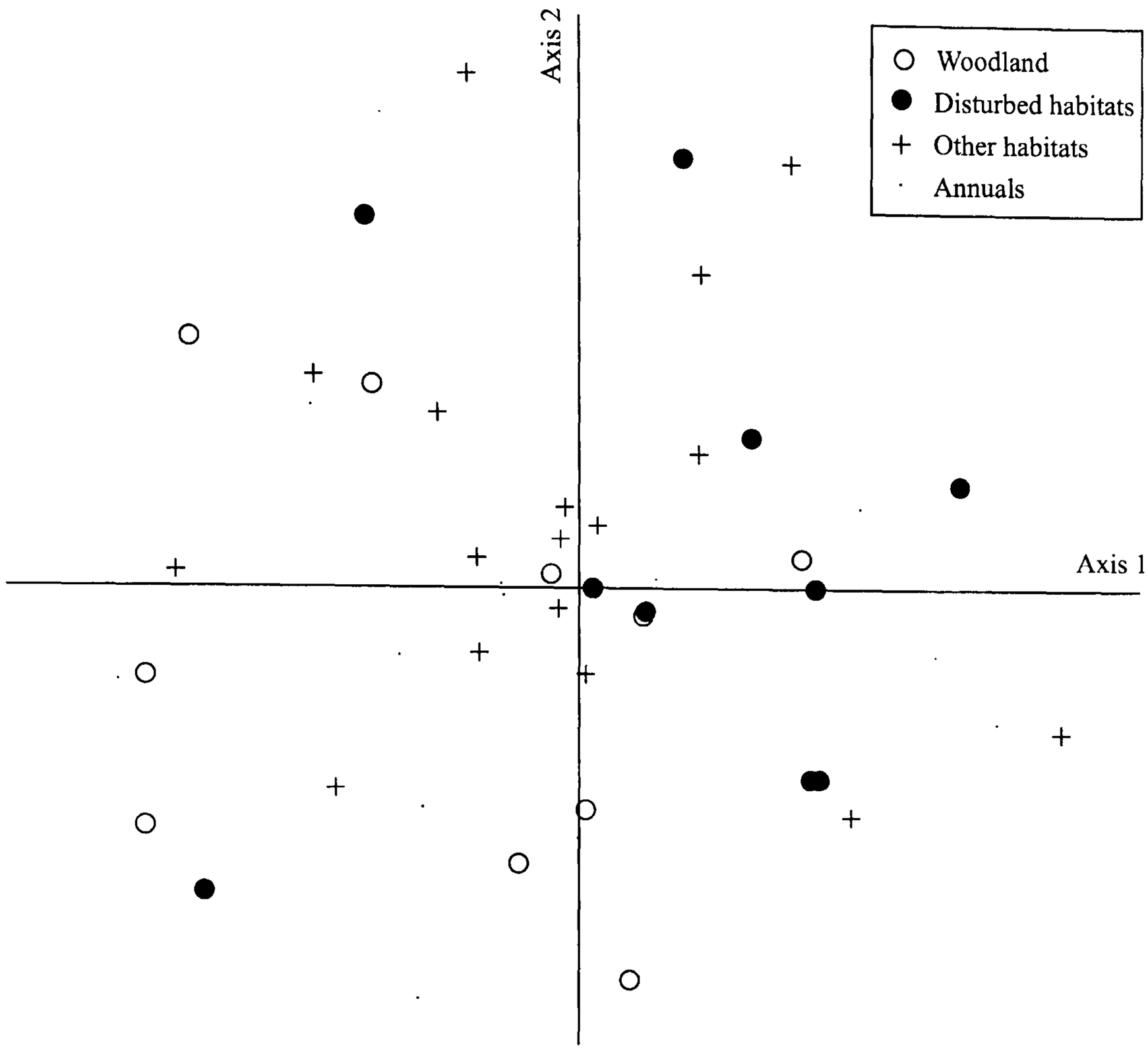


Fig. 3.15. Correspondence analysis diagram of a. species in the Hambach Forest experiment showing annual versus perennial life history; b. experimental plot surveys shown as pie-charts indicating proportions of annual and perennial species present

a.



b.

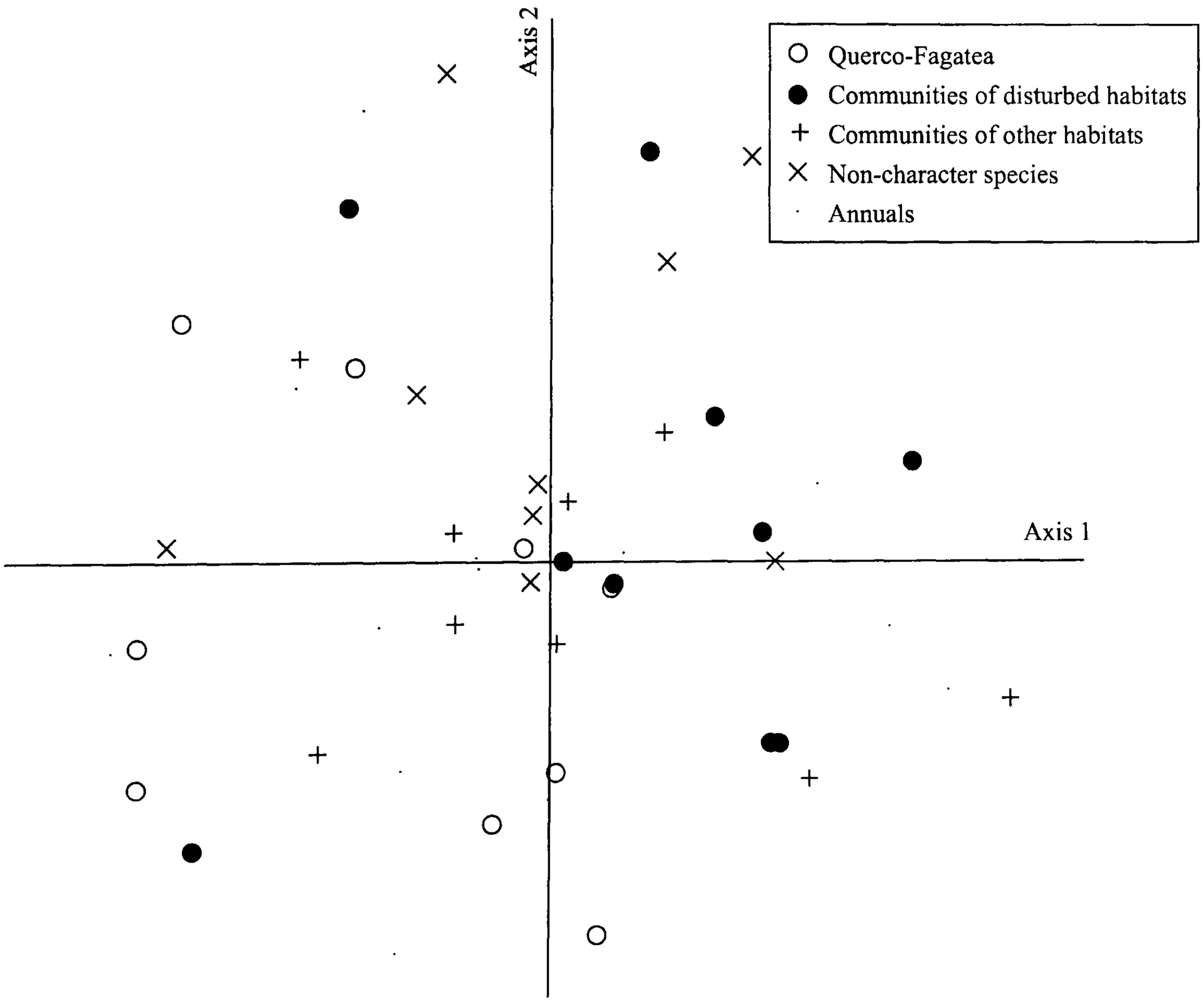
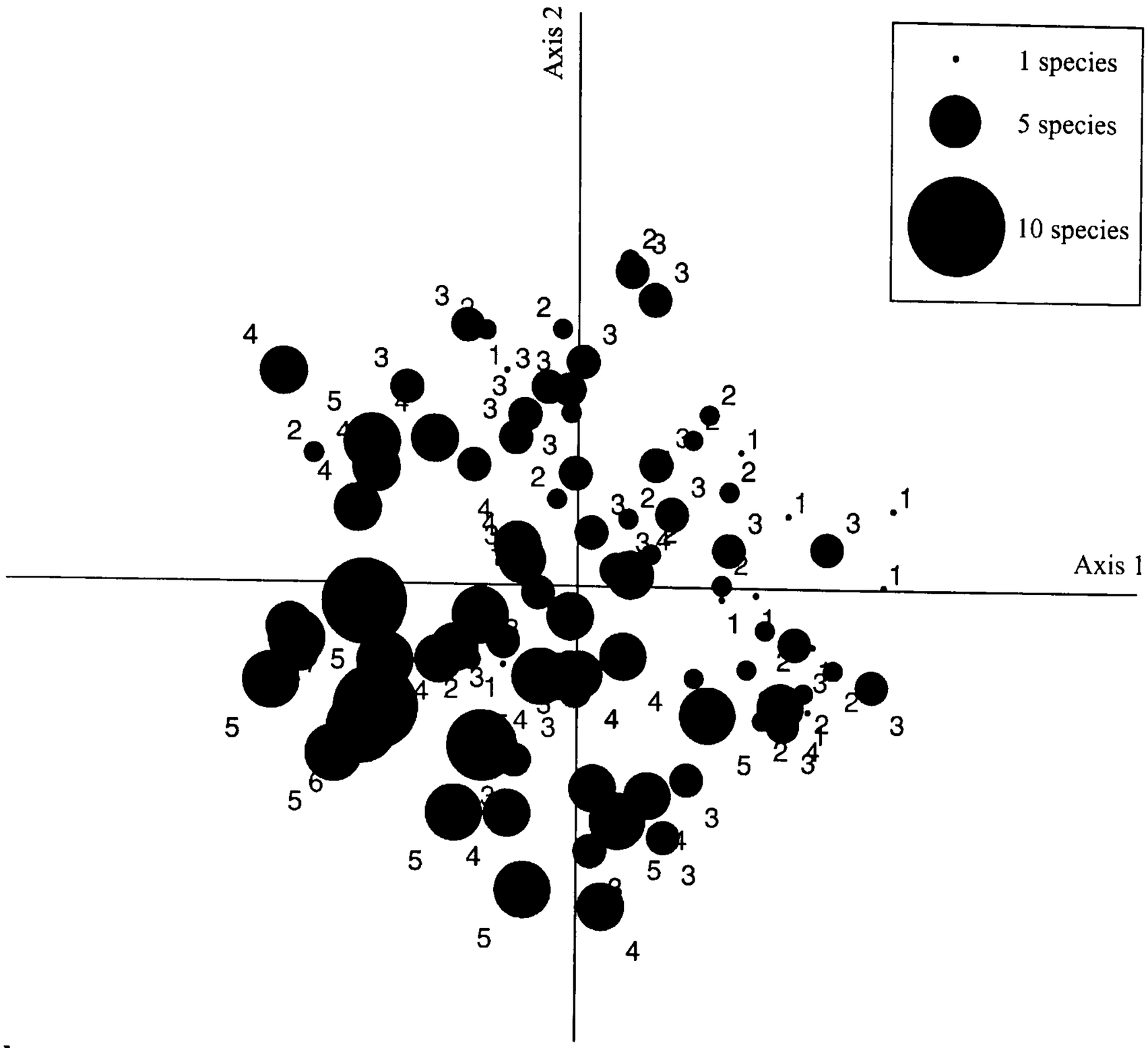


Fig. 3.16. Correspondence analysis diagram of species in the Hambach Forest experiment showing: a. habitat groupings for perennial species in Ellenberg *et al*. (1992); b. phytosociological class for perennial character species

a.



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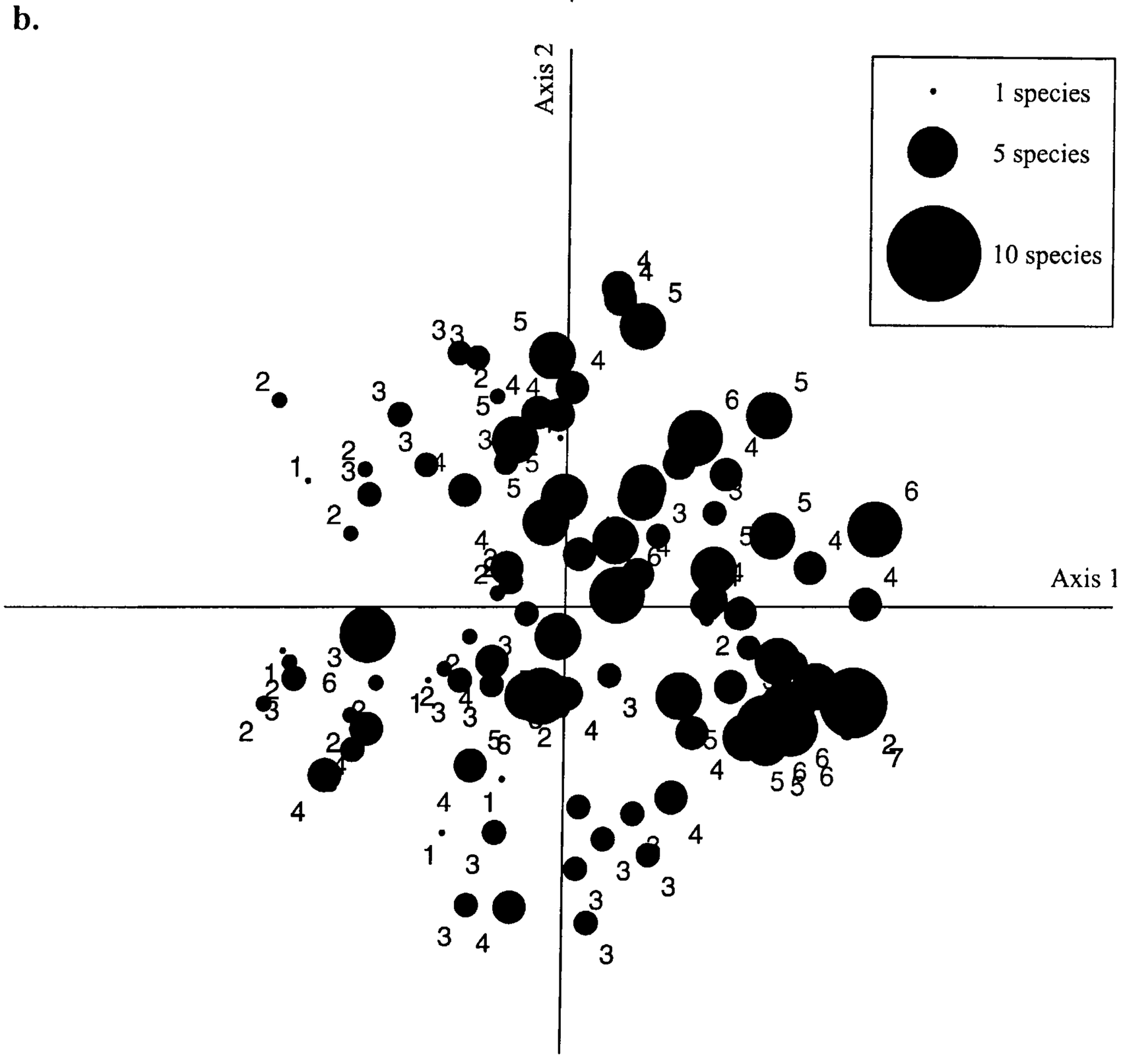
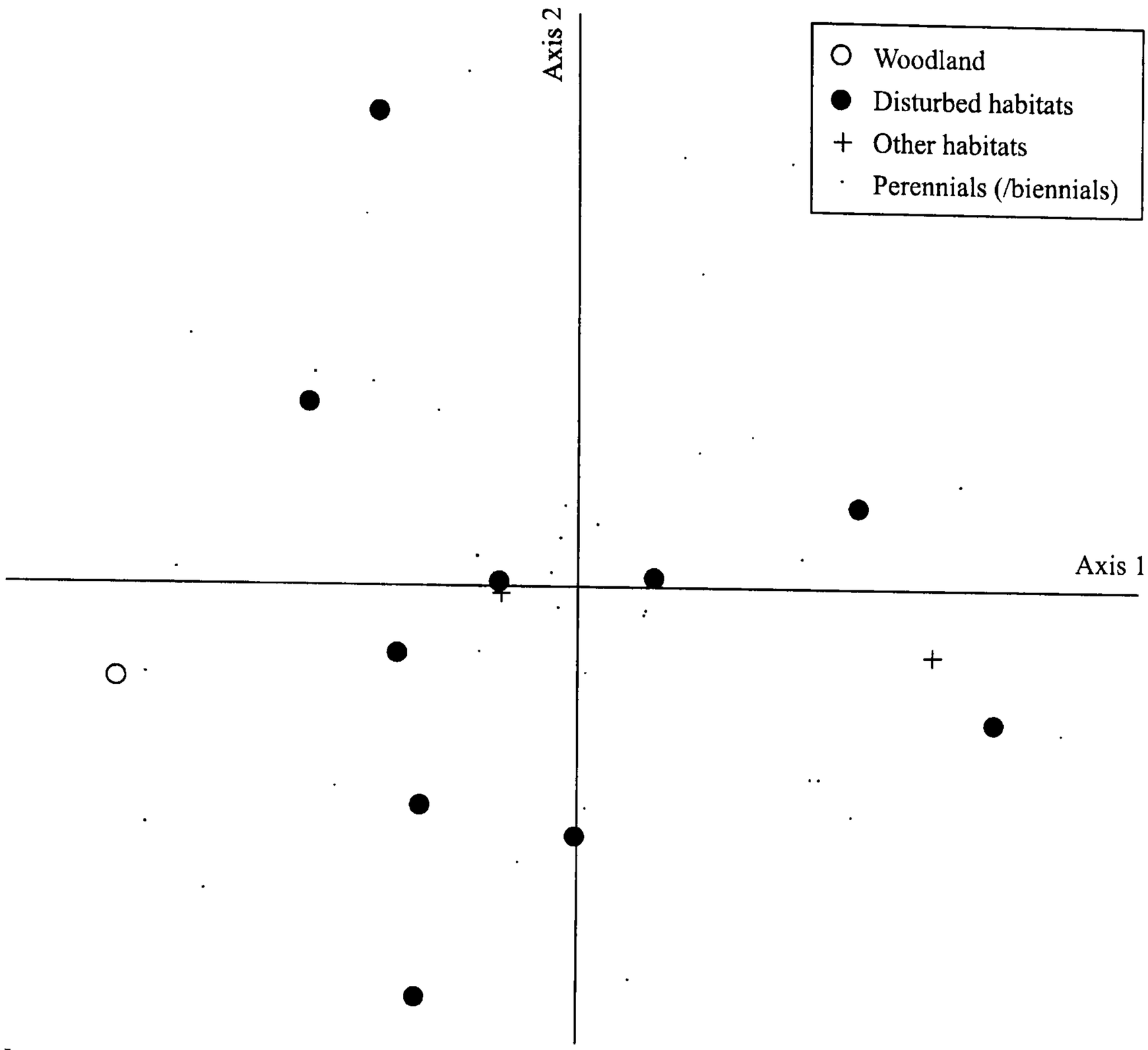


Fig. 3.17. Correspondence analysis diagram of Hambach experimental plot surveys showing: a. numbers of perennial species of woodland present; b. numbers of perennial species of disturbed habitats present

a.



b.

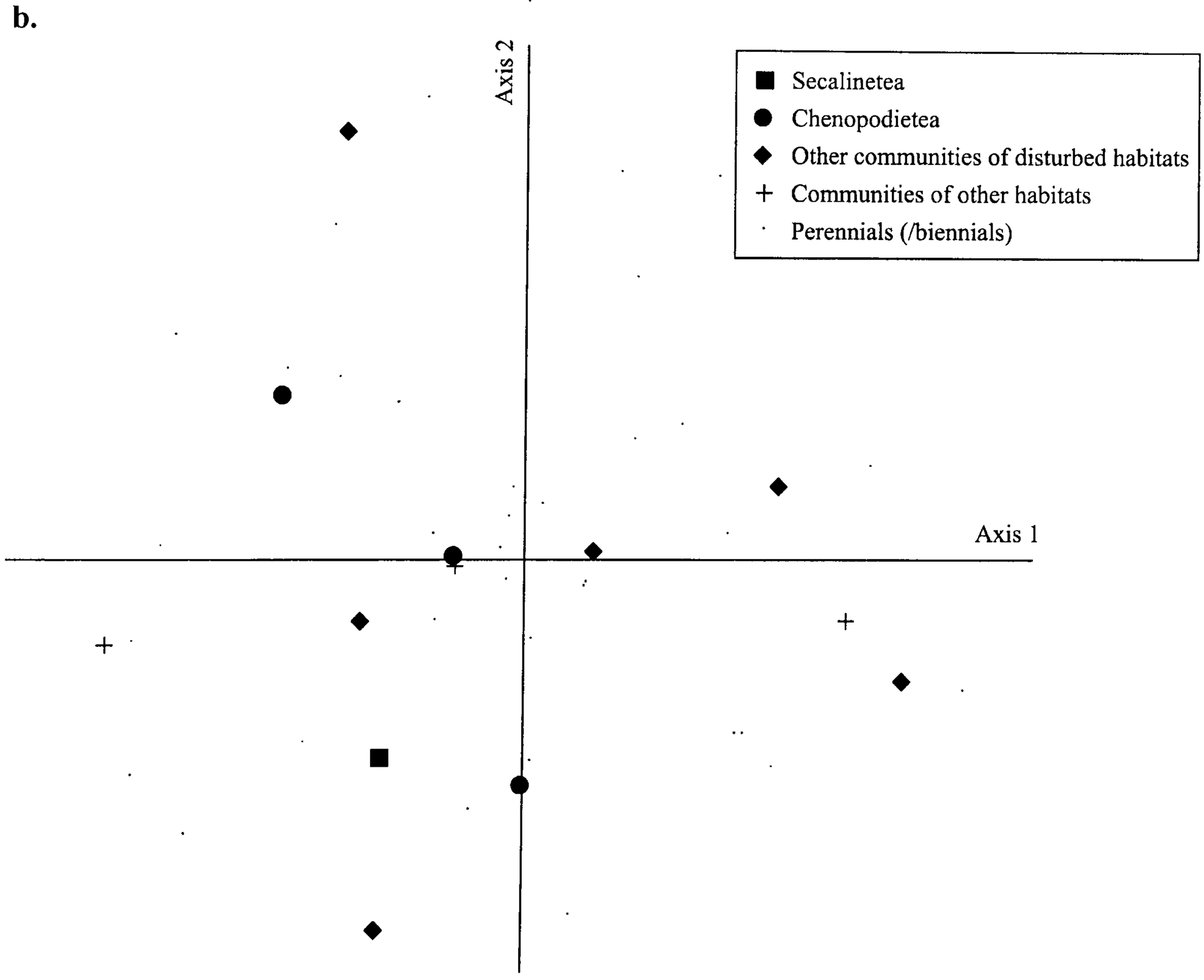


Fig. 3.18. Correspondence analysis diagram of species in the Hambach Forest experiment showing: a. habitat groupings for annual species in Ellenberg *et al*. (1992); b. phytosociological class for annual character species

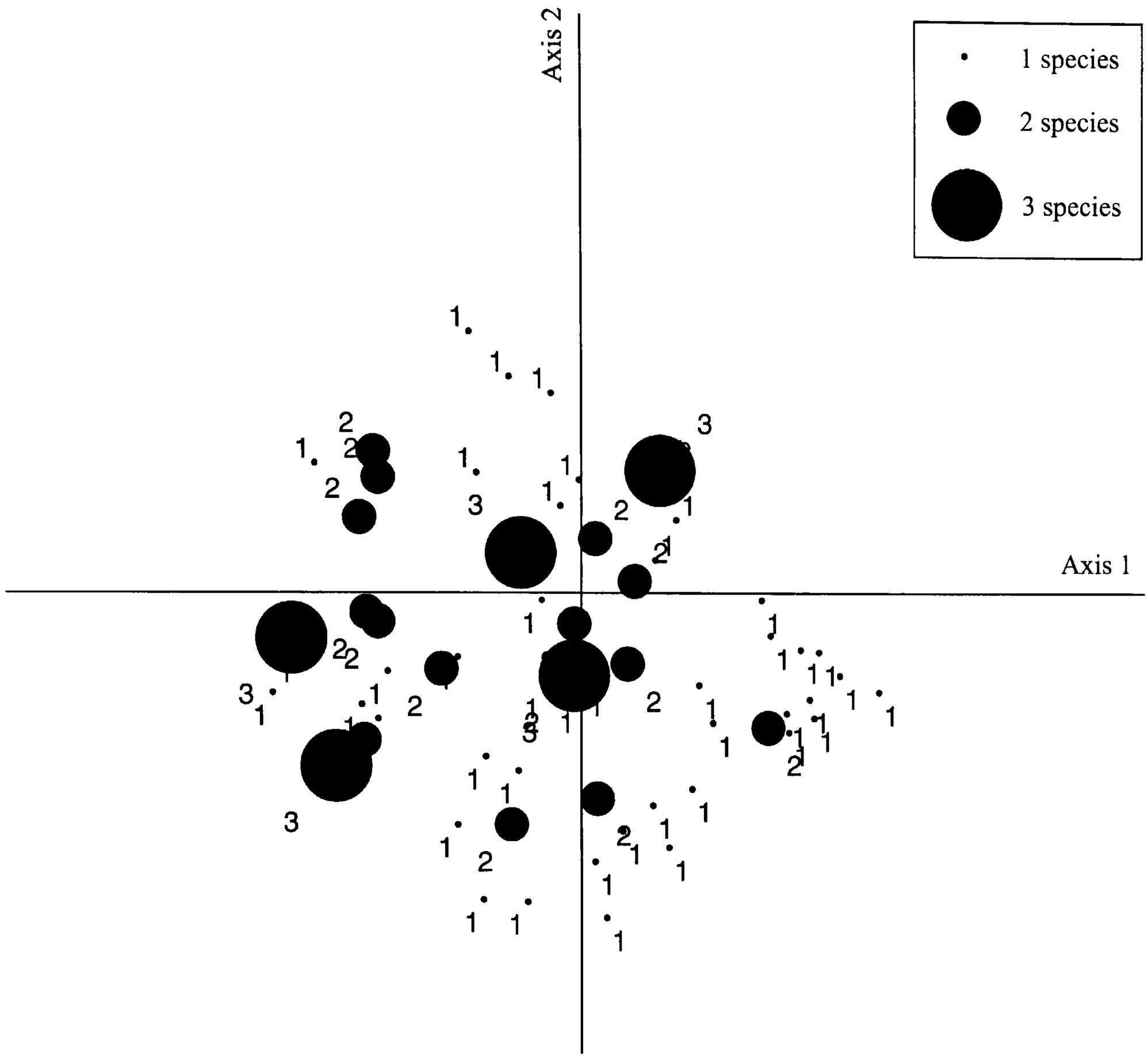
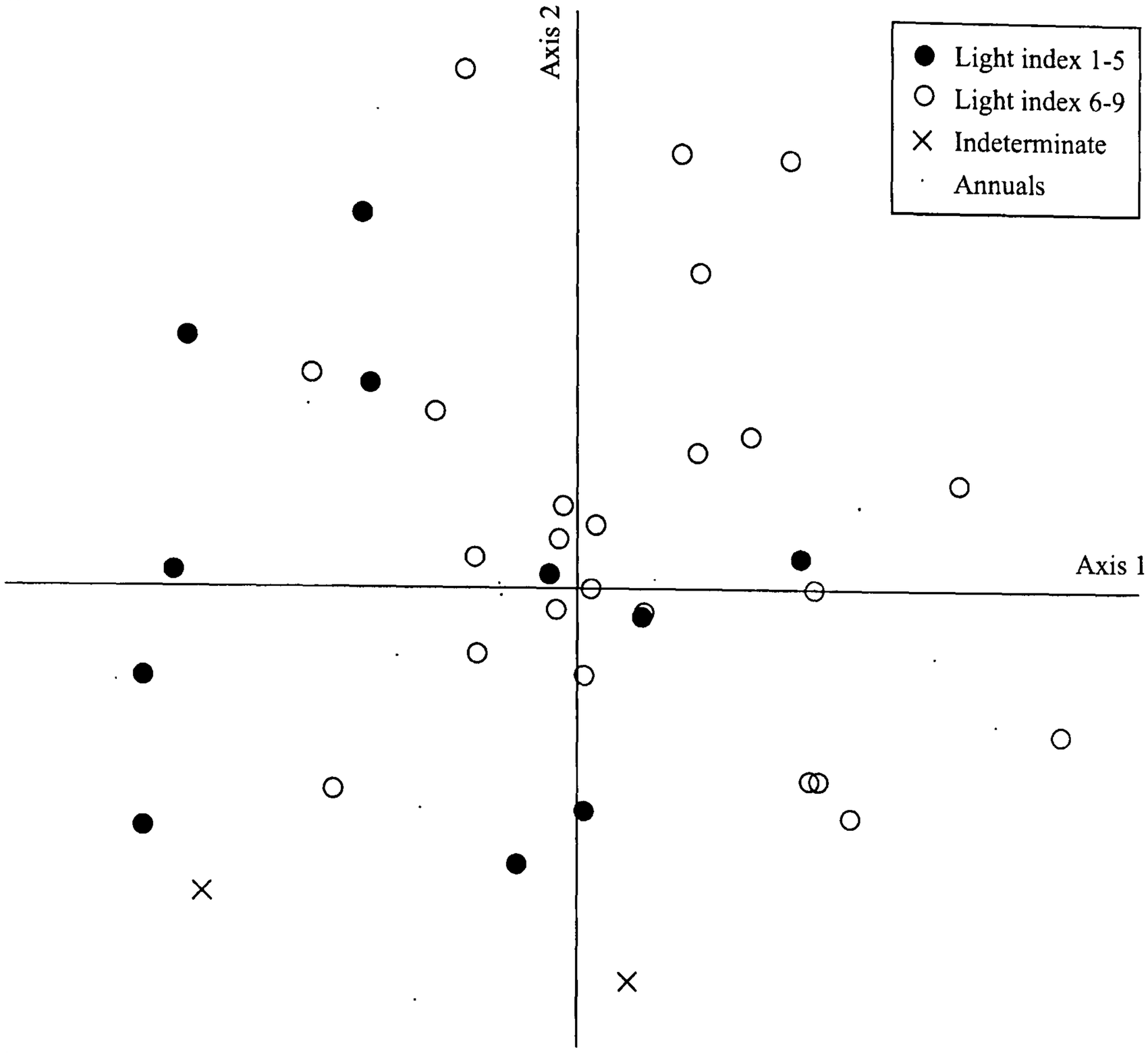


Fig. 3.19. Correspondence analysis diagram of Hambach experimental plot surveys showing numbers of annual character species of the Chenopodietea and Secalinetea present

a.



b.

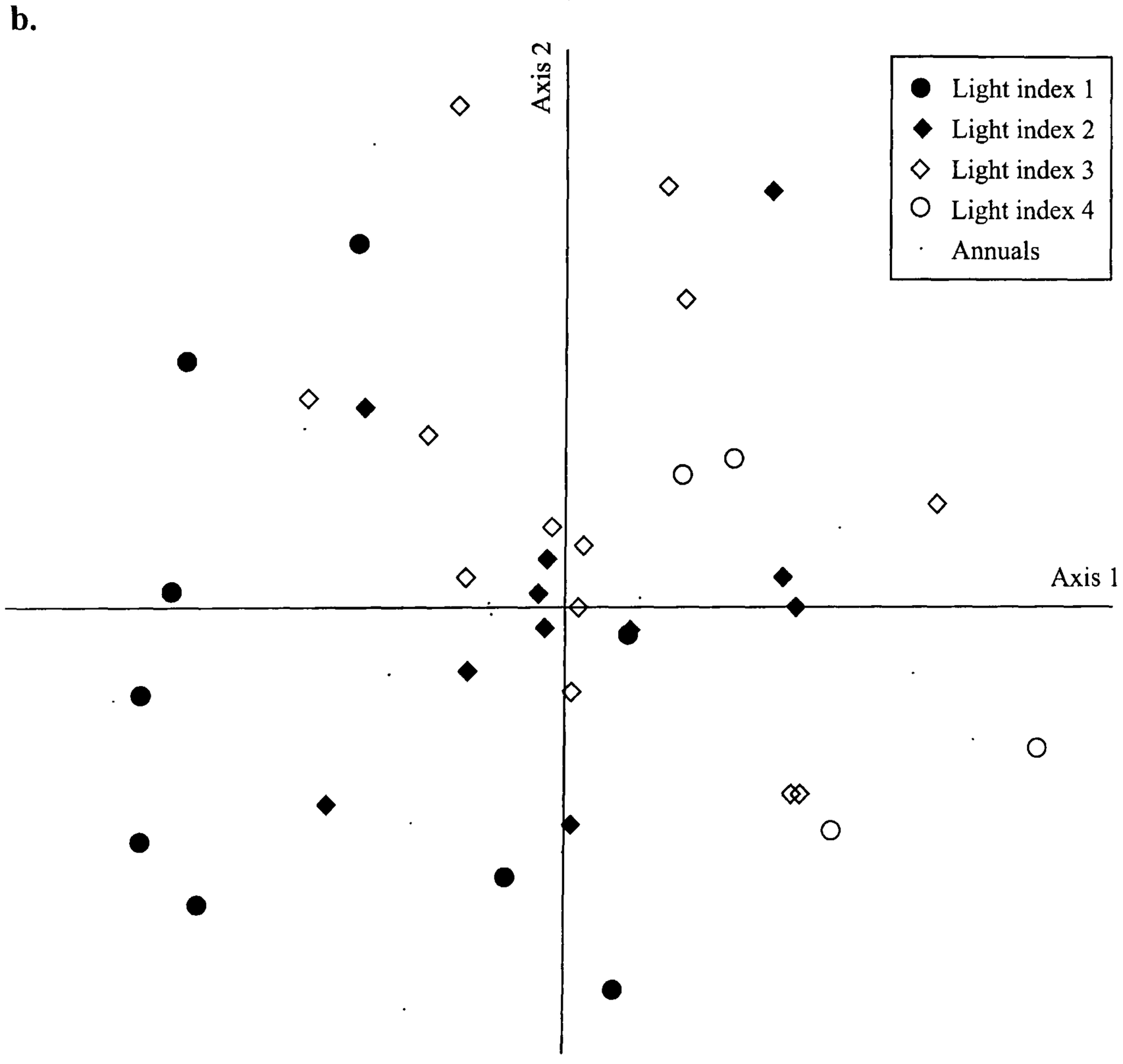
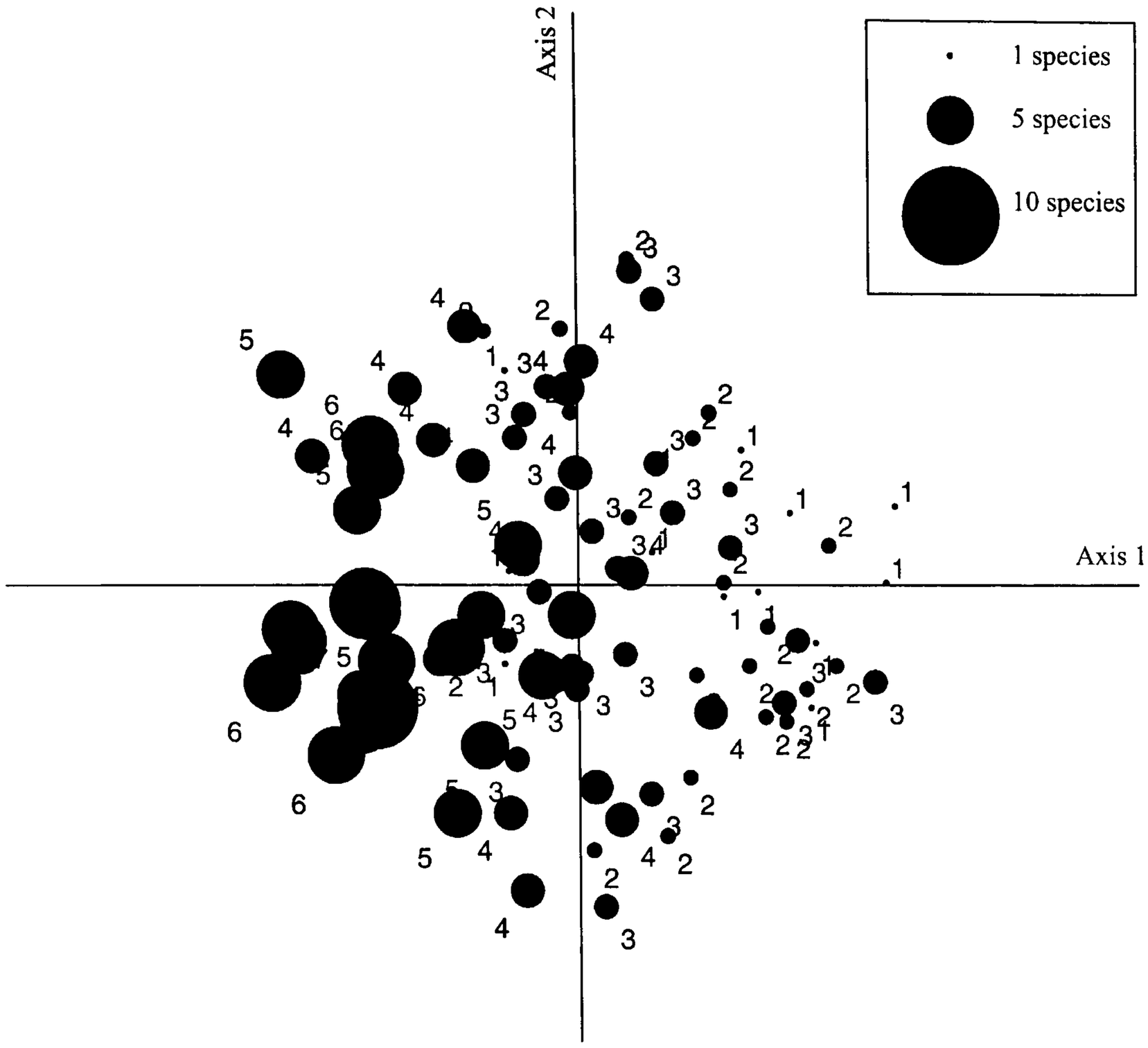


Fig. 3.20. Correspondence analysis diagram of species in the Hambach Forest experiment showing: a. light index values from Ellenberg *et al*. (1992) for perennials; b. light index values based on survey data from the Sheffield region (J. Hodgson pers. comm.) for perennials

a.



b.

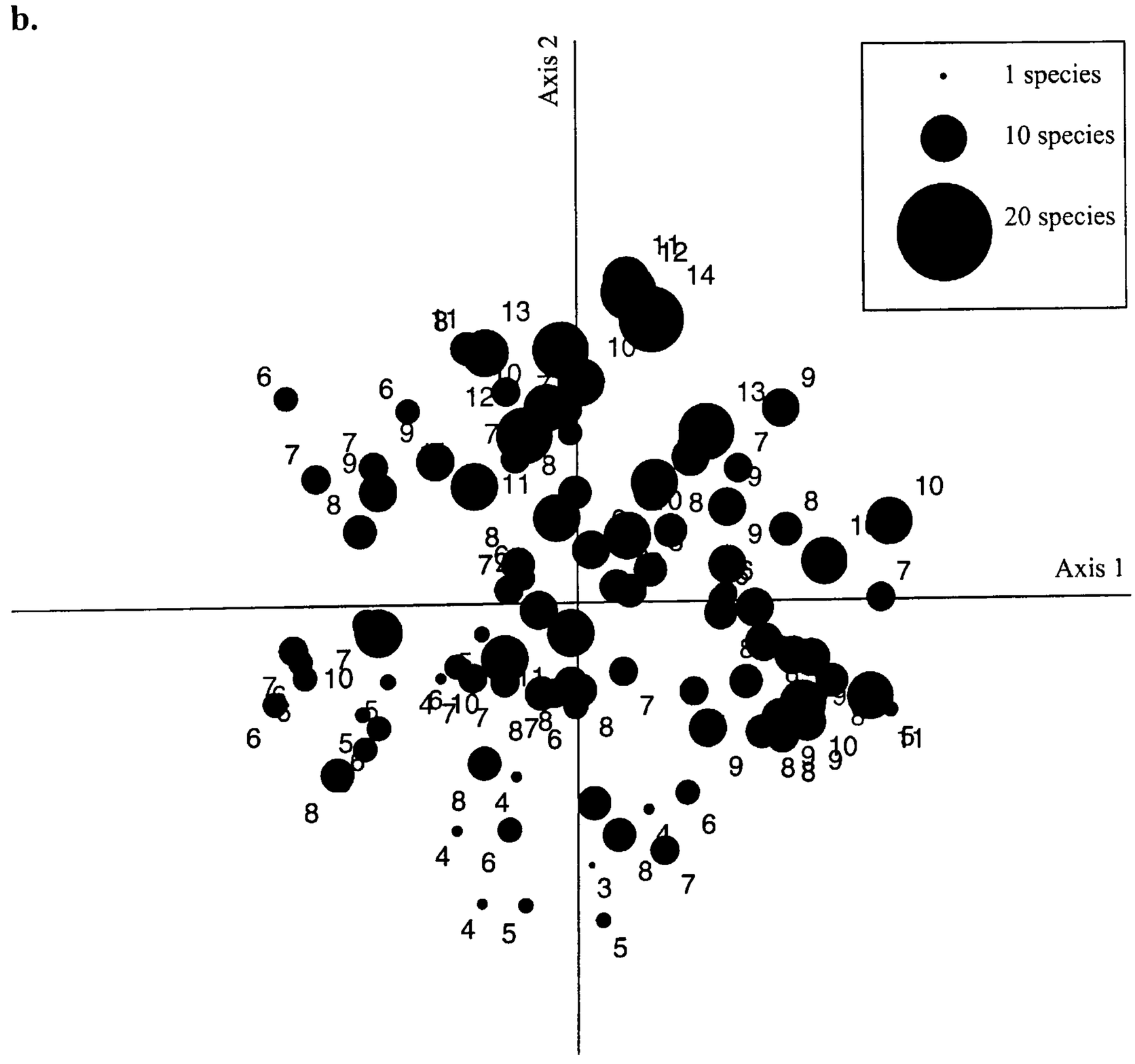
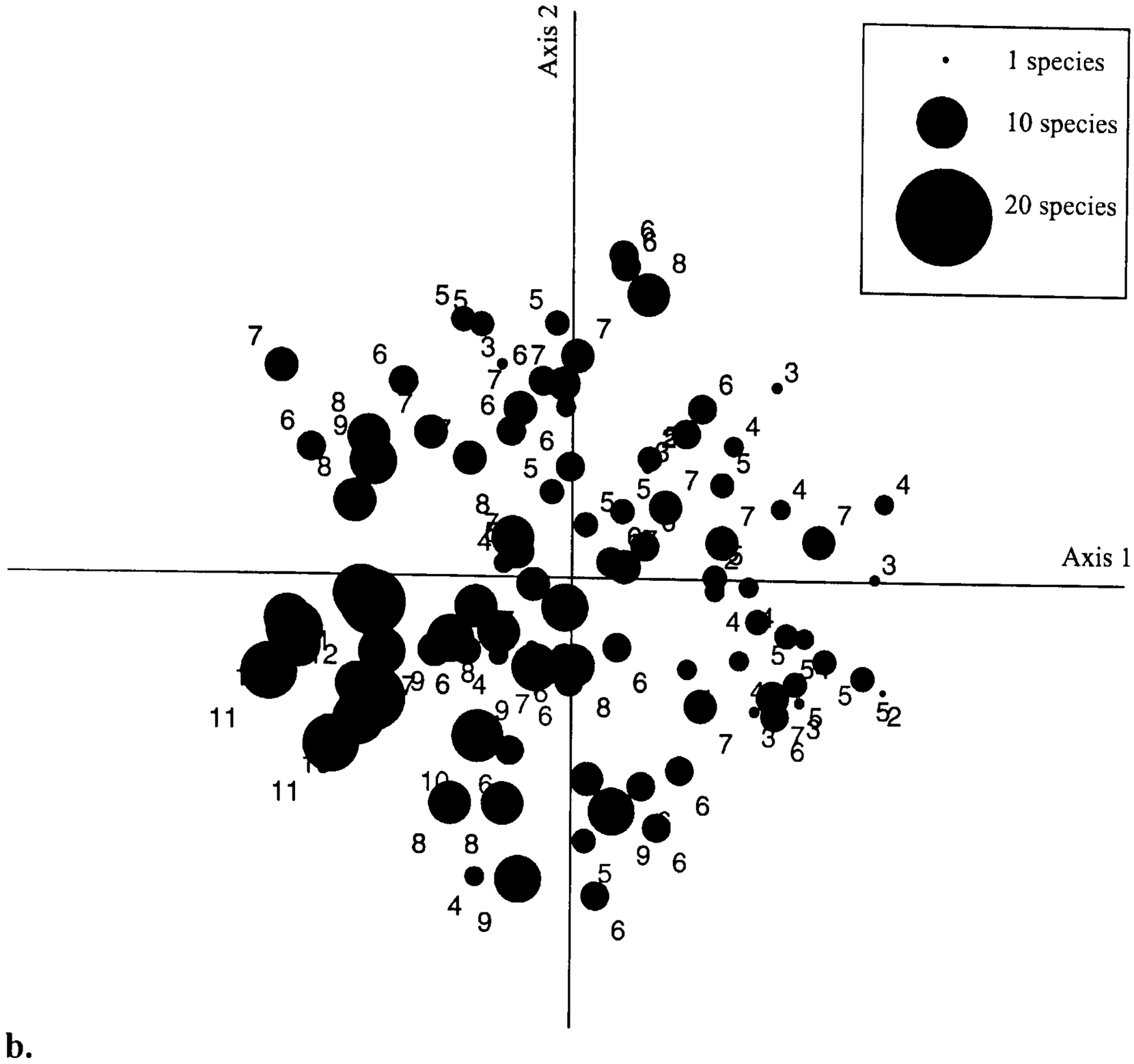


Fig. 3.21. Correspondence analysis diagram of Hambach experimental plot surveys showing: a. numbers of perennial species with low light indices (1-5) in Ellenberg *et al.* (1992); b. numbers of perennial species with high light indices (6-9) in Ellenberg *et al.* (1992)

a.



b.

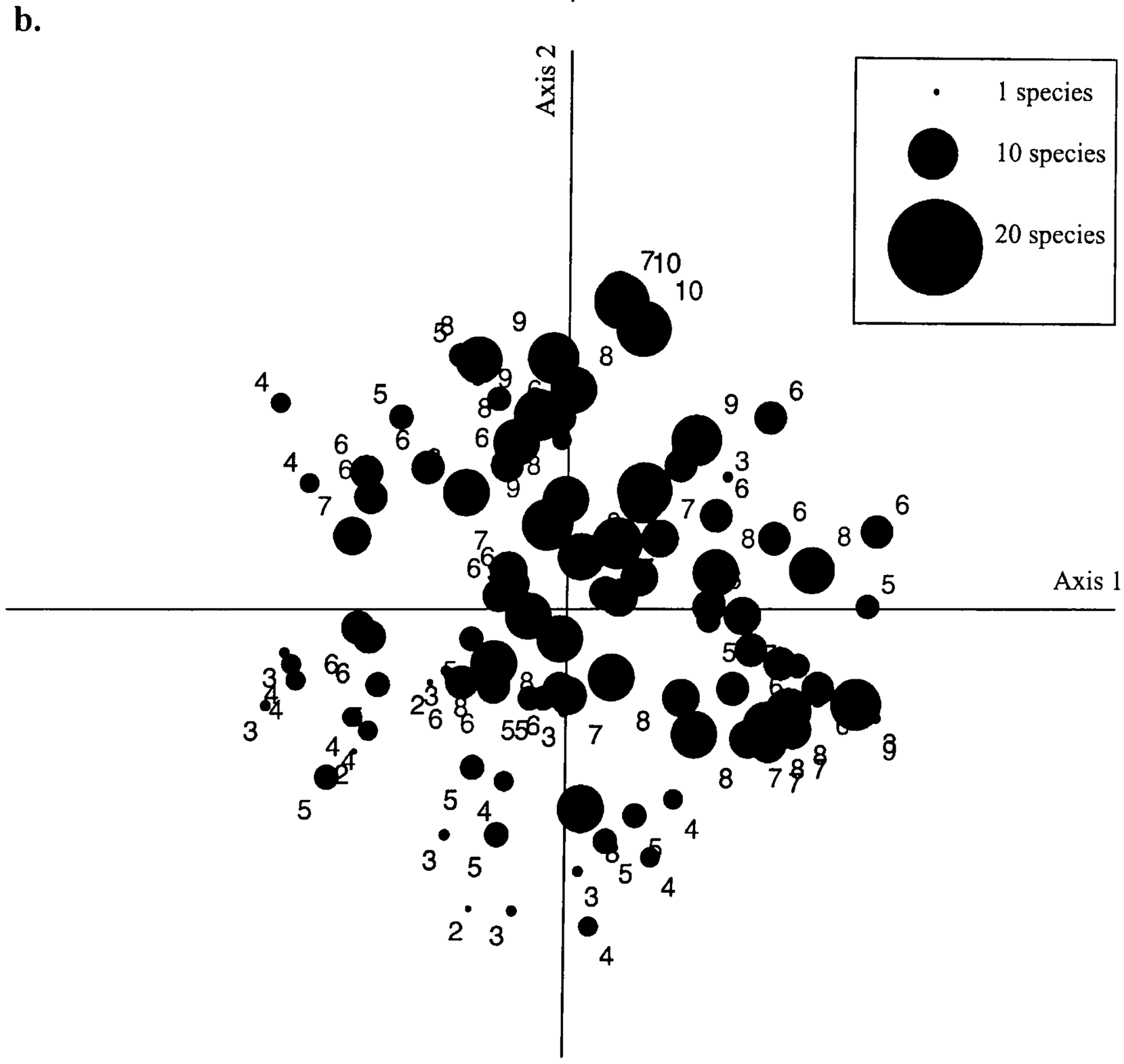
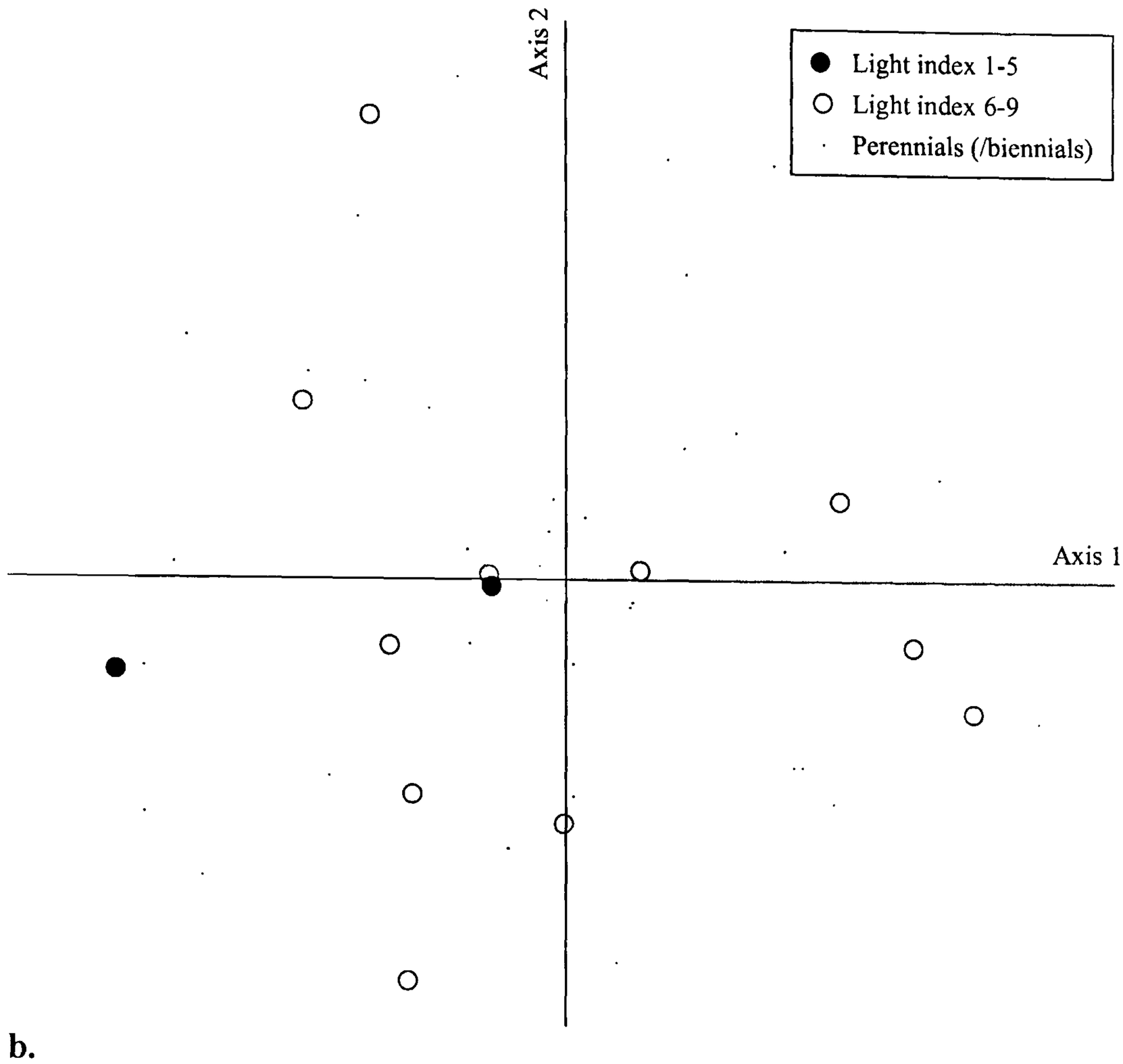


Fig. 3.22. Correspondence analysis diagram of Hambach experimental plot surveys showing: a. numbers of perennial species with low light indices (1-2) according to J. Hodgson (pers. comm.); b. numbers of perennial species with high light indices (3-4) according to J. Hodgson (pers. comm.)

a.



b.

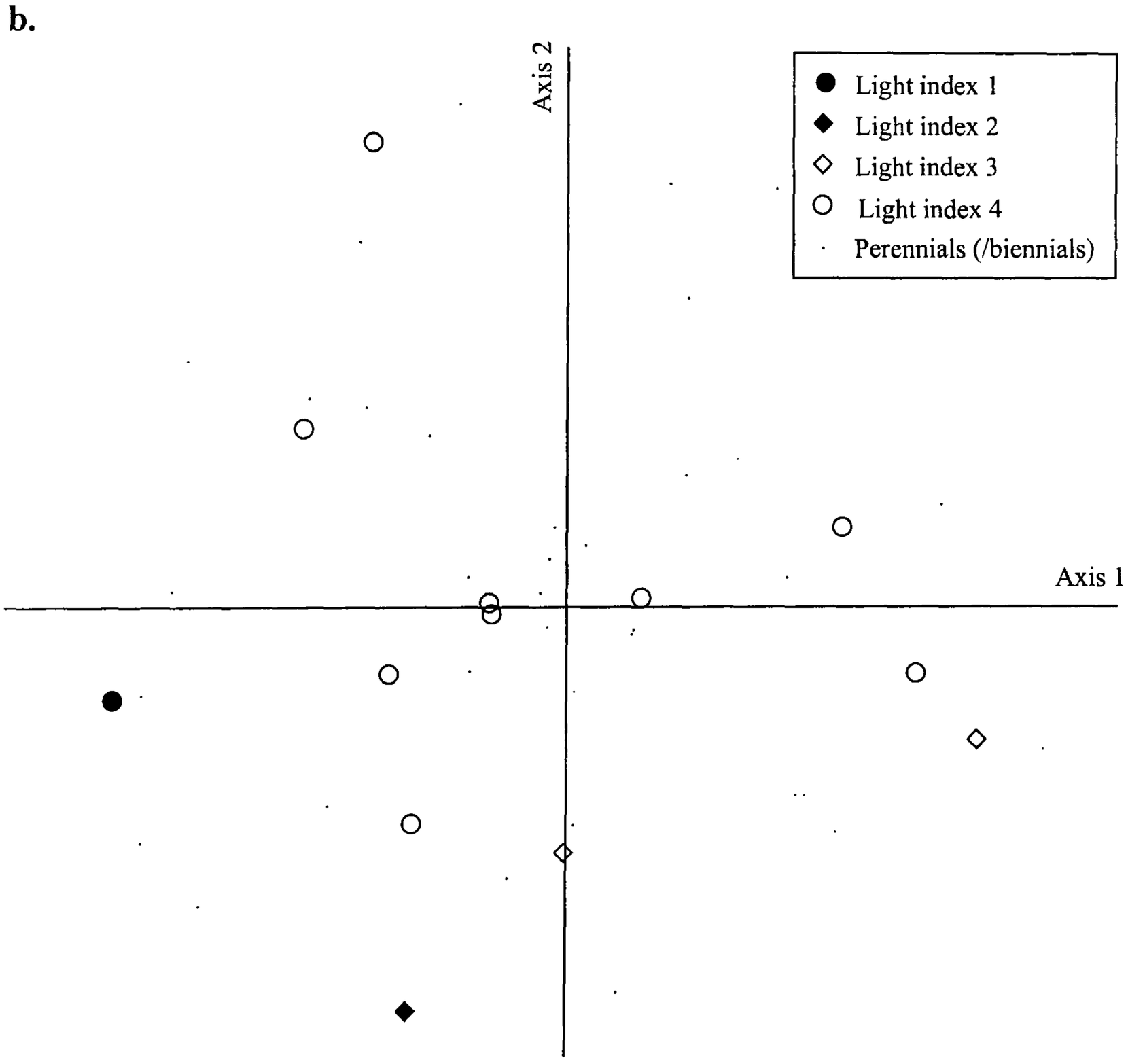


Fig. 3.23. Correspondence analysis diagram of species in the Hambach Forest experiment showing: a. light index values from Ellenberg *et al.* (1992) for annuals; b. light index values based on survey data from the Sheffield region (J. Hodgson pers. comm.) for annuals

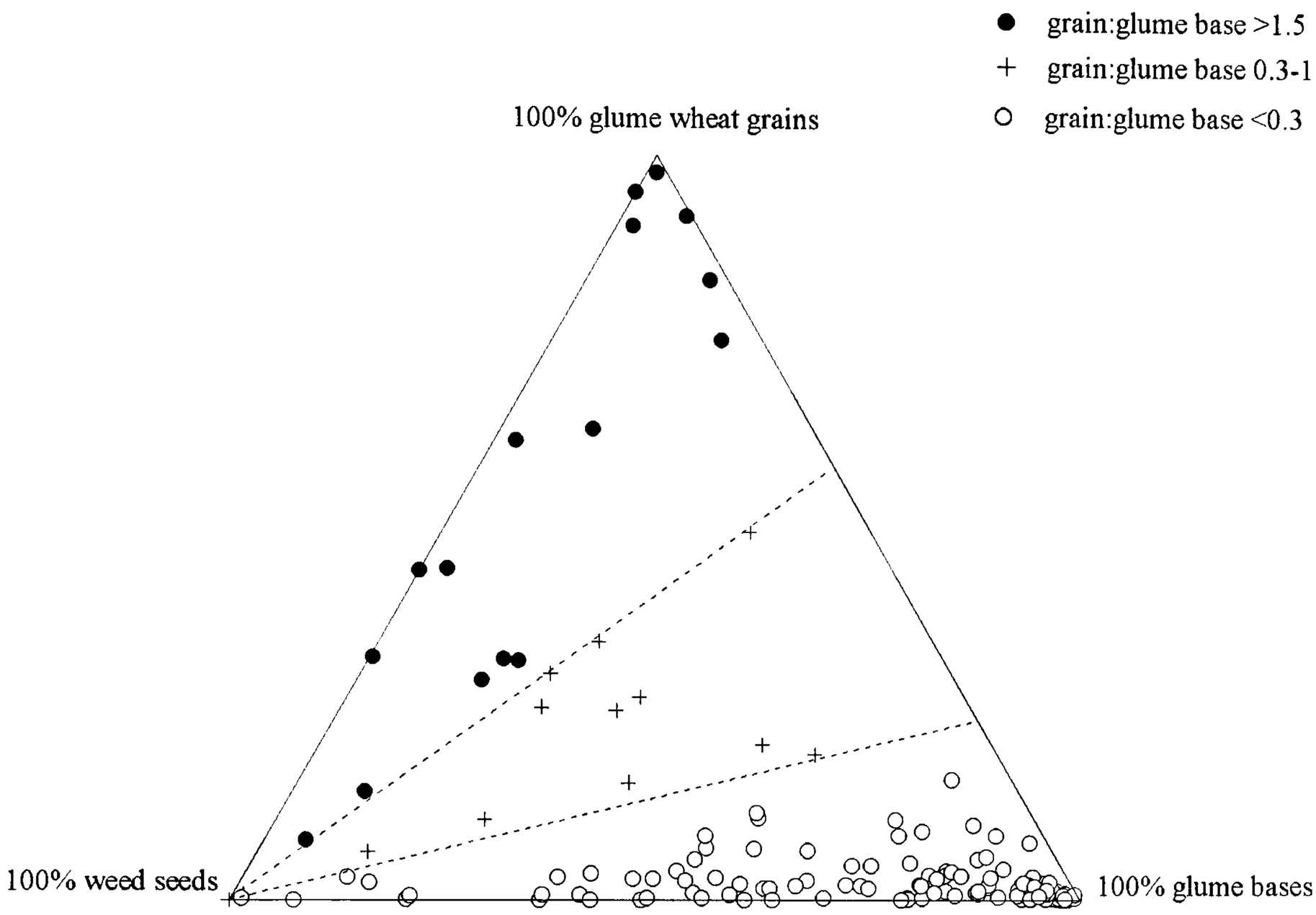
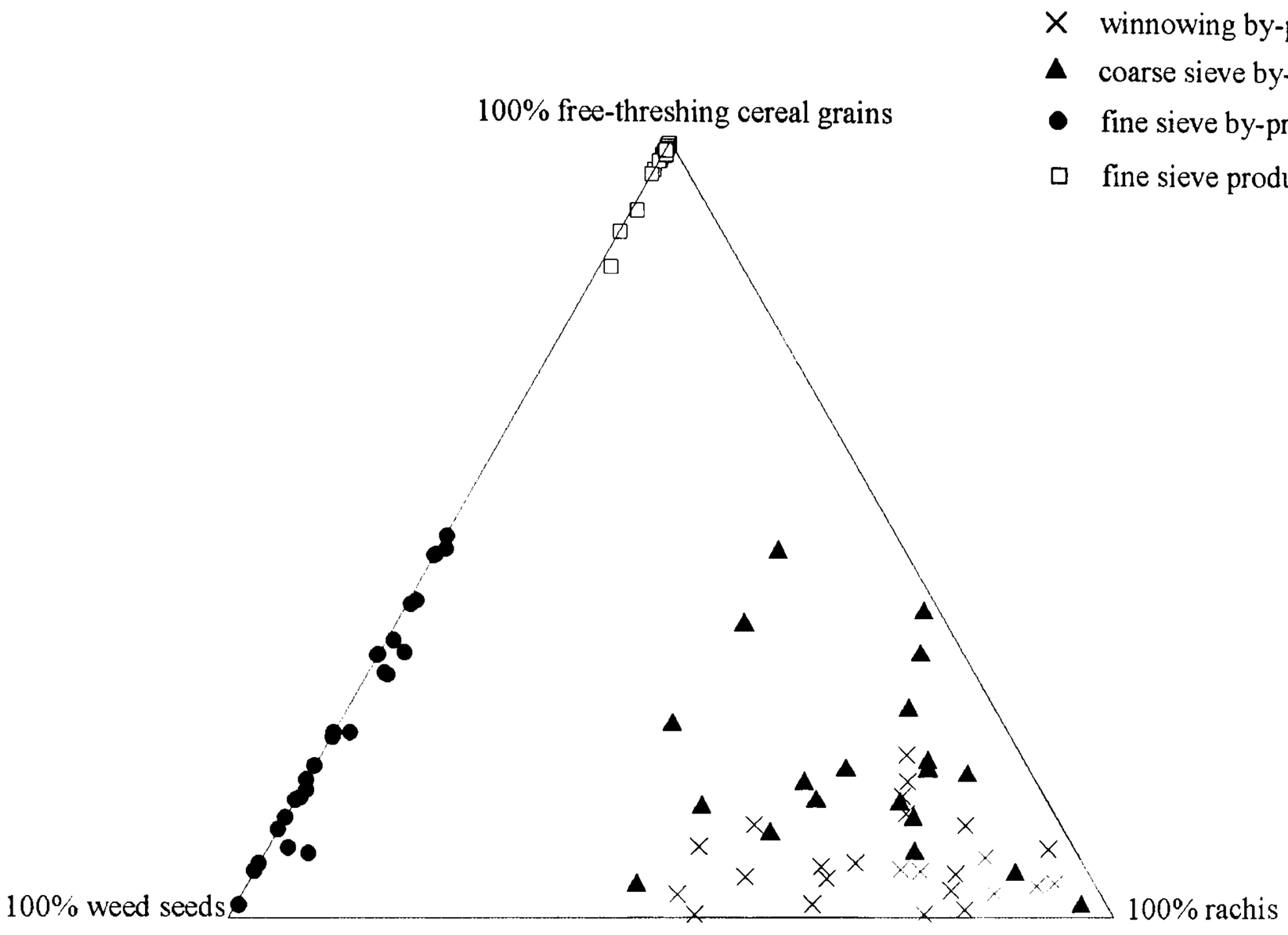


Fig. 4.1. Triangular scatter plot showing proportions of glume wheat grains, glume bases and weed seeds in the glume wheat samples; dotted lines indicate boundaries between samples dominated by glume bases (grain:glume base ratios of <0.3), samples with a possible spikelet ratio of grains:glume bases (0.3 – 1.5) and samples dominated by glume wheat grains (grain:glume base ratios of >1.5)

a.



b.

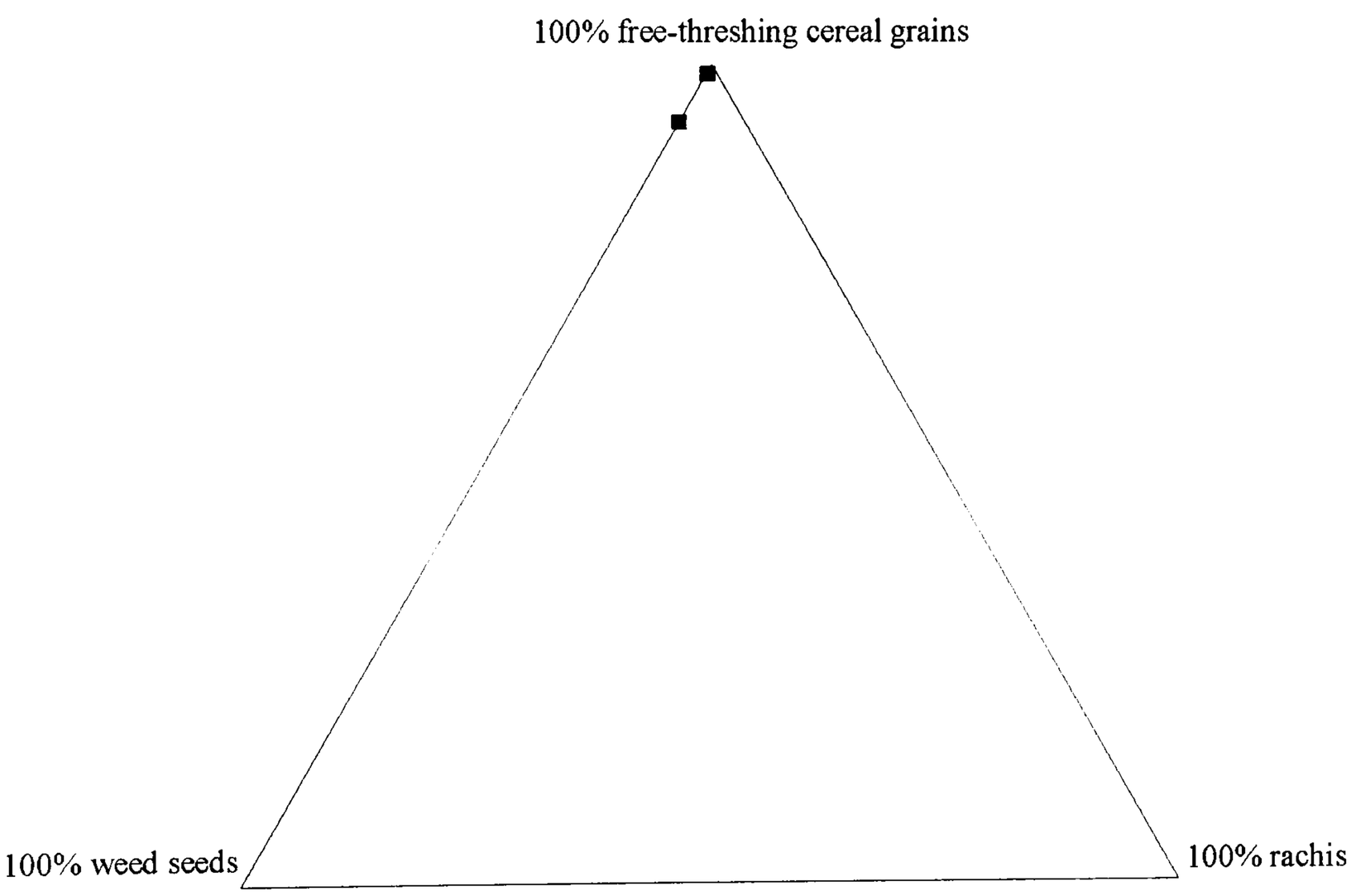


Fig. 4.2. Triangular scatter plots showing: a. proportions of free-threshing cereal grains, rachis internodes and weed seeds in the Amorgos samples (after G. Jones 1990); b. proportions of free-threshing cereal grains, rachis internodes and weed seeds in the archaeobotanical free-threshing cereal samples. Note that two further archaeobotanical free-threshing cereal samples from Hornstaad-Hörnle (Maier 1991, 1996, 1999, unpublished) are not shown in Fig. 4.2b since full chaff data are not available

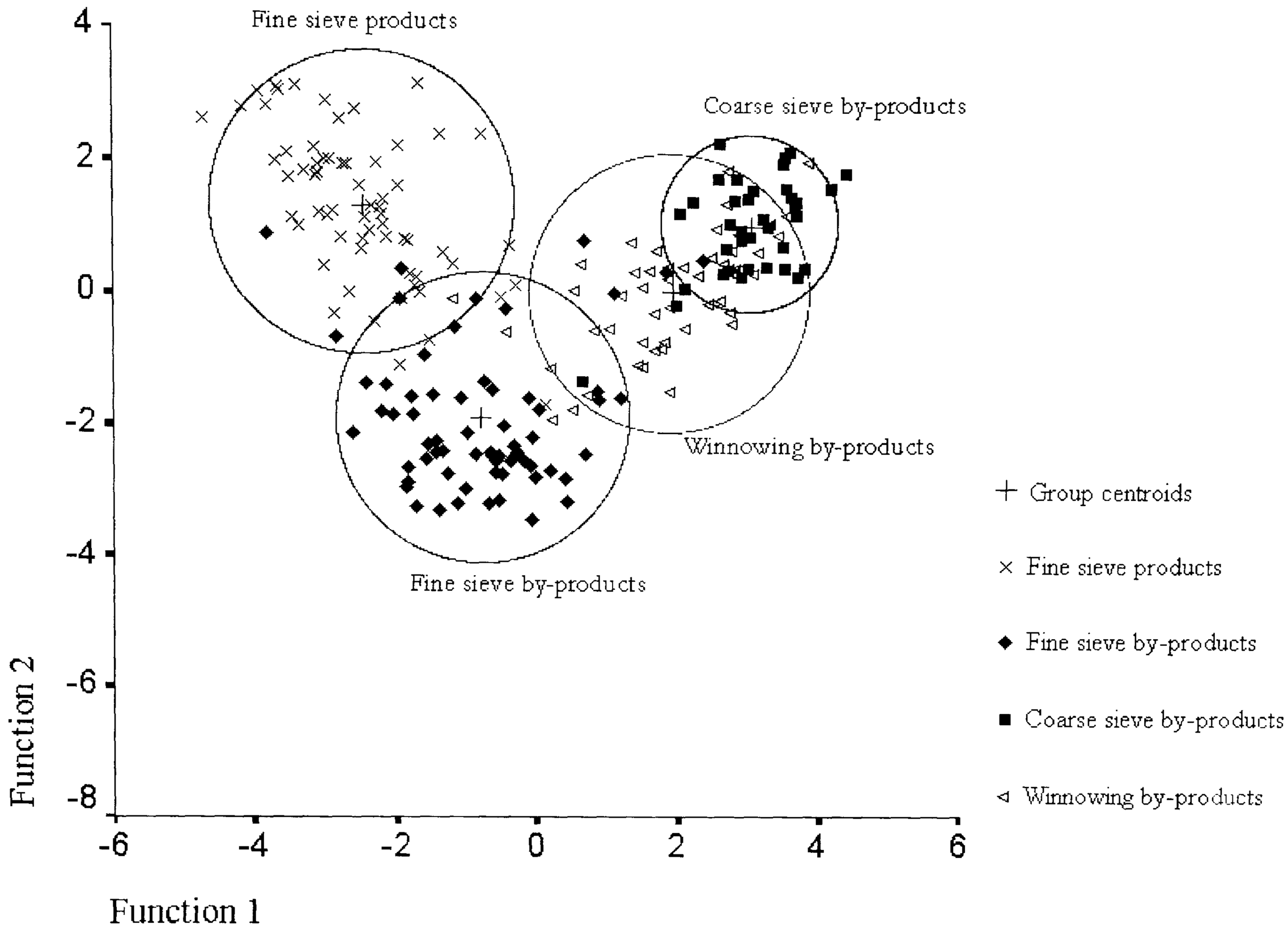


Fig. 4.3. Scatter plot of the scores of the Amorgos samples on the first two discriminant functions; circles enclose ca. 90% of the samples in each processing group (after G. Jones 1984)

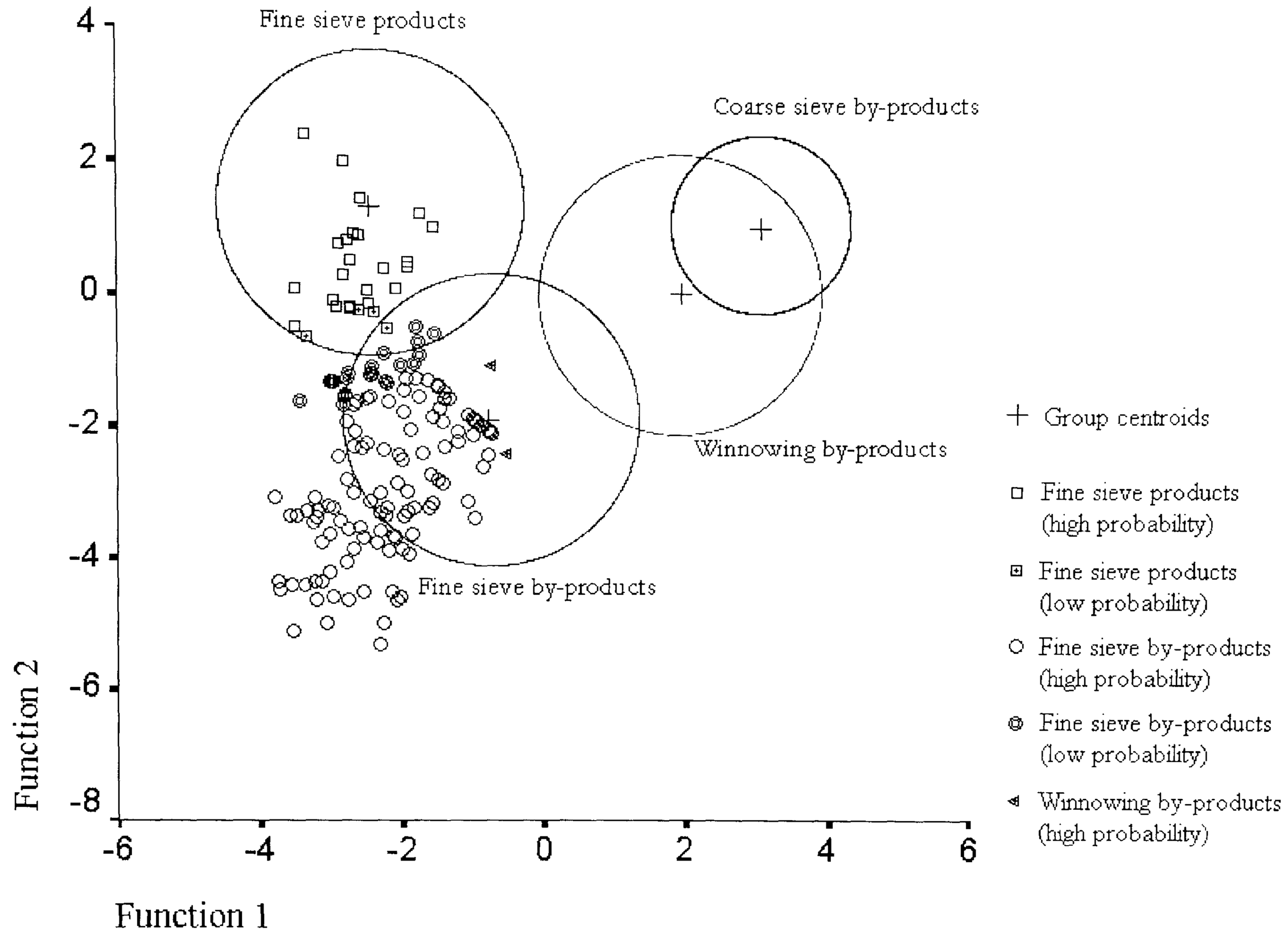


Fig. 4.4. Scatter plot of the scores of the archaeobotanical samples on the first two discriminant functions; the circles indicate the position of the Amorgos processing groups, each enclosing ca. 90% of the group

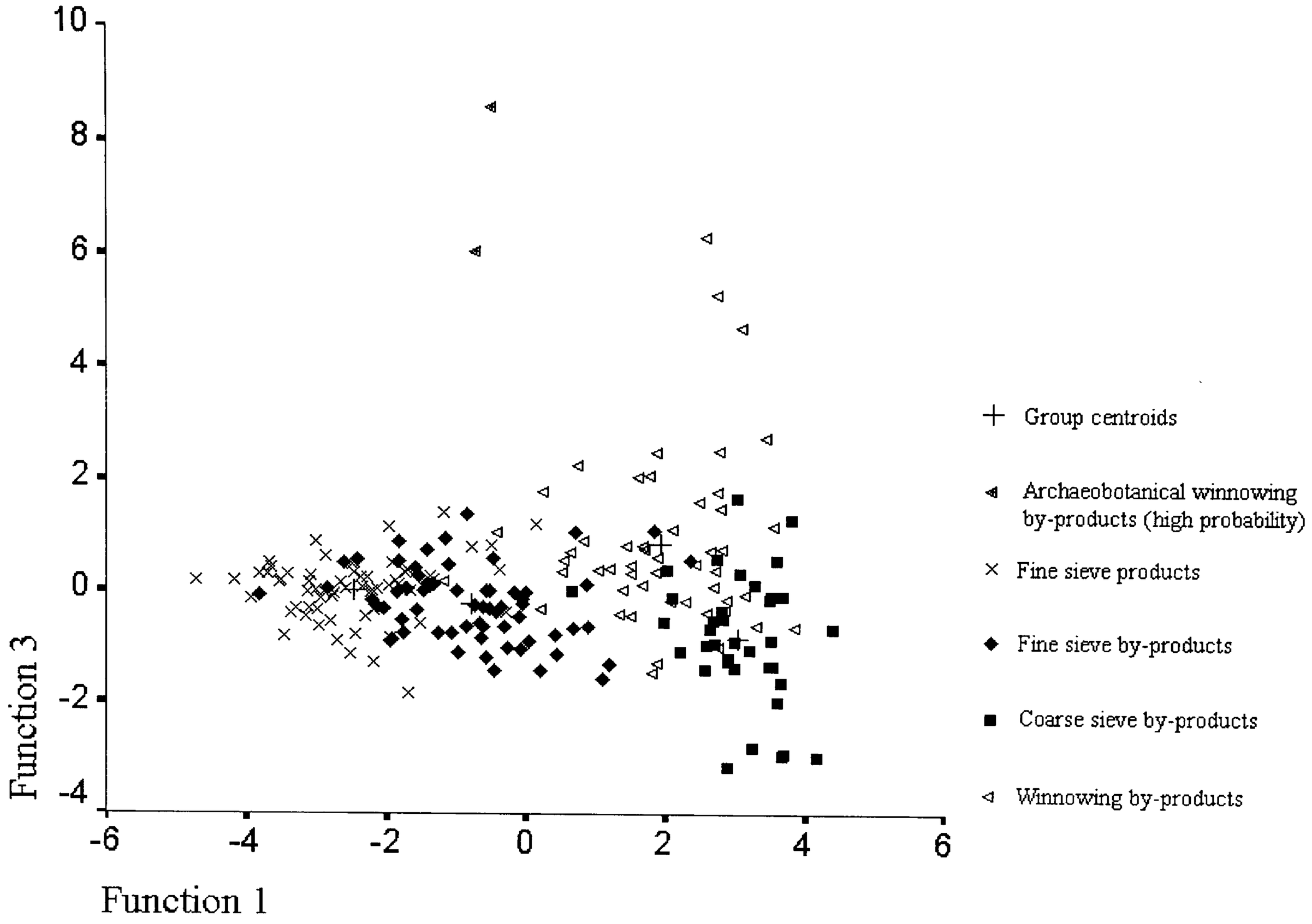


Fig. 4.5. Scatter plot of the scores of the Amorgos samples and two archaeobotanical samples classified as winnowing by-products on the first and third discriminant functions

a.

b.

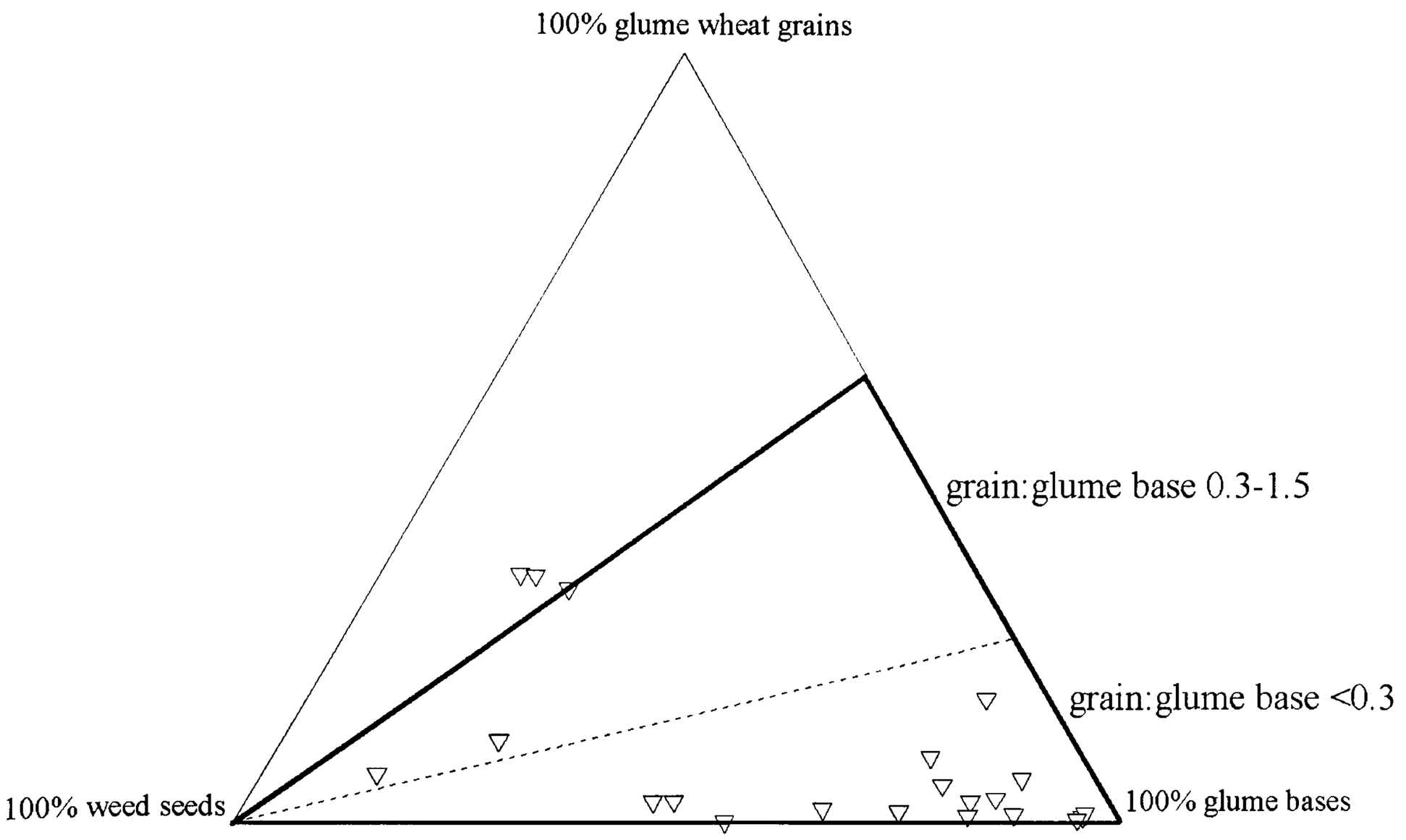
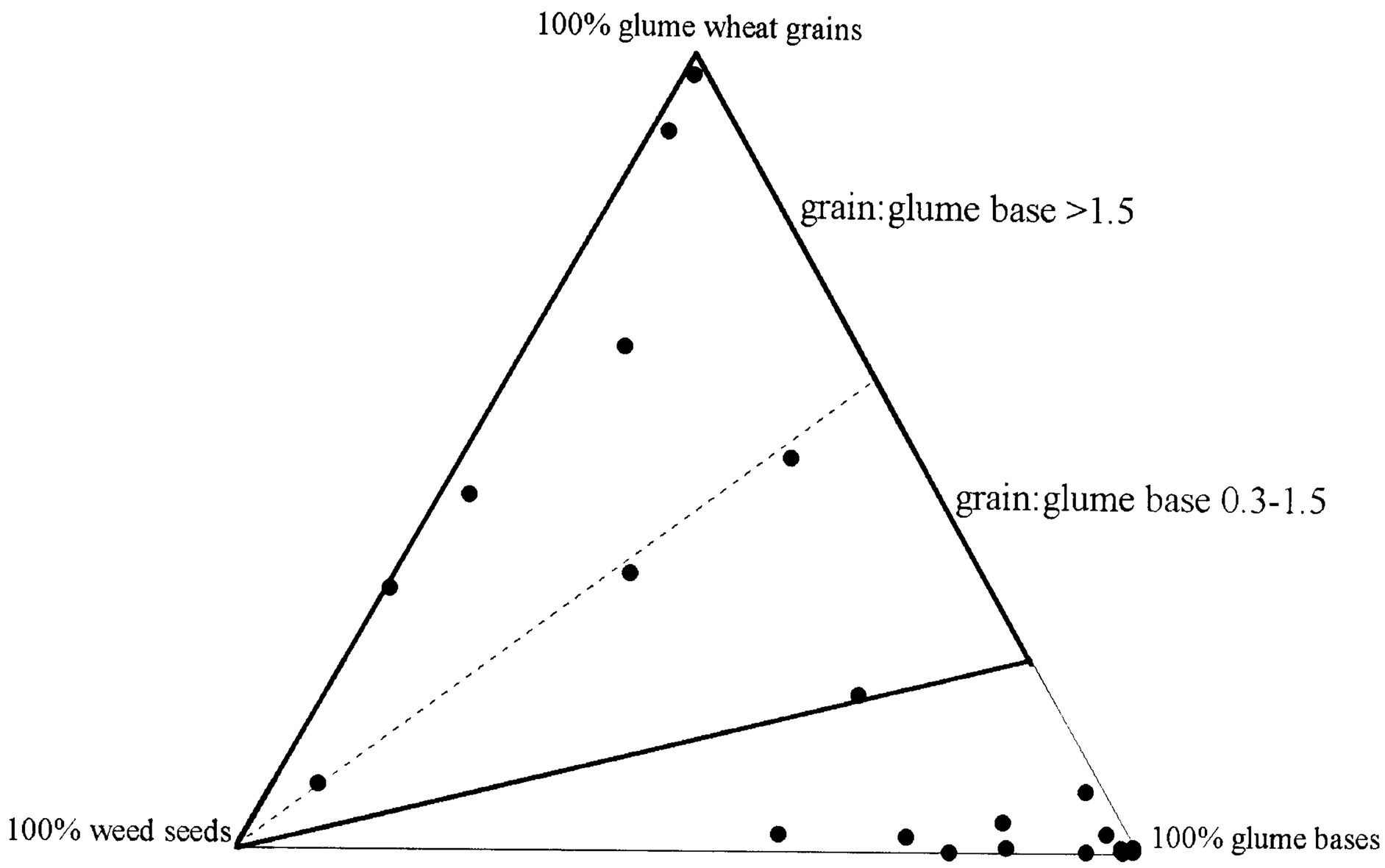


Fig. 4.6. Triangular scatter plot showing proportions of glume wheat grains, glume bases and weed seeds in glume wheat samples classified as fine sieve by-products with: a. high probability (≥0.90); b. low probability (<0.90). The bold line in each plot encloses the zone where samples are expected

a.



b.

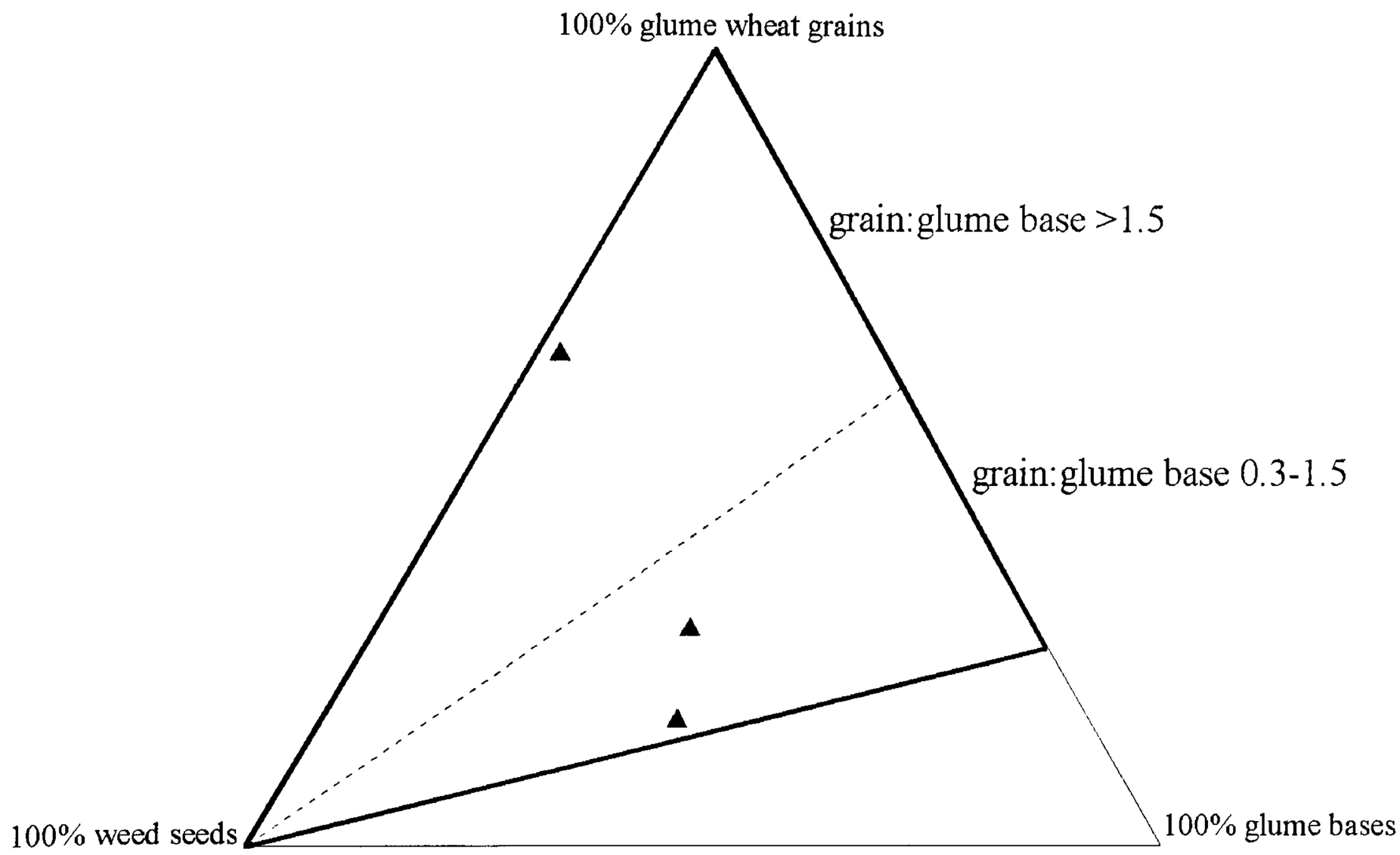


Fig. 4.7. Triangular scatter plot showing proportions of glume wheat grains, glume bases and weed seeds in glume wheat samples classified as fine sieve products with: a. high probability (≥0.90); b. low probability (<0.90). The bold line in each plot encloses the zone where samples are expected

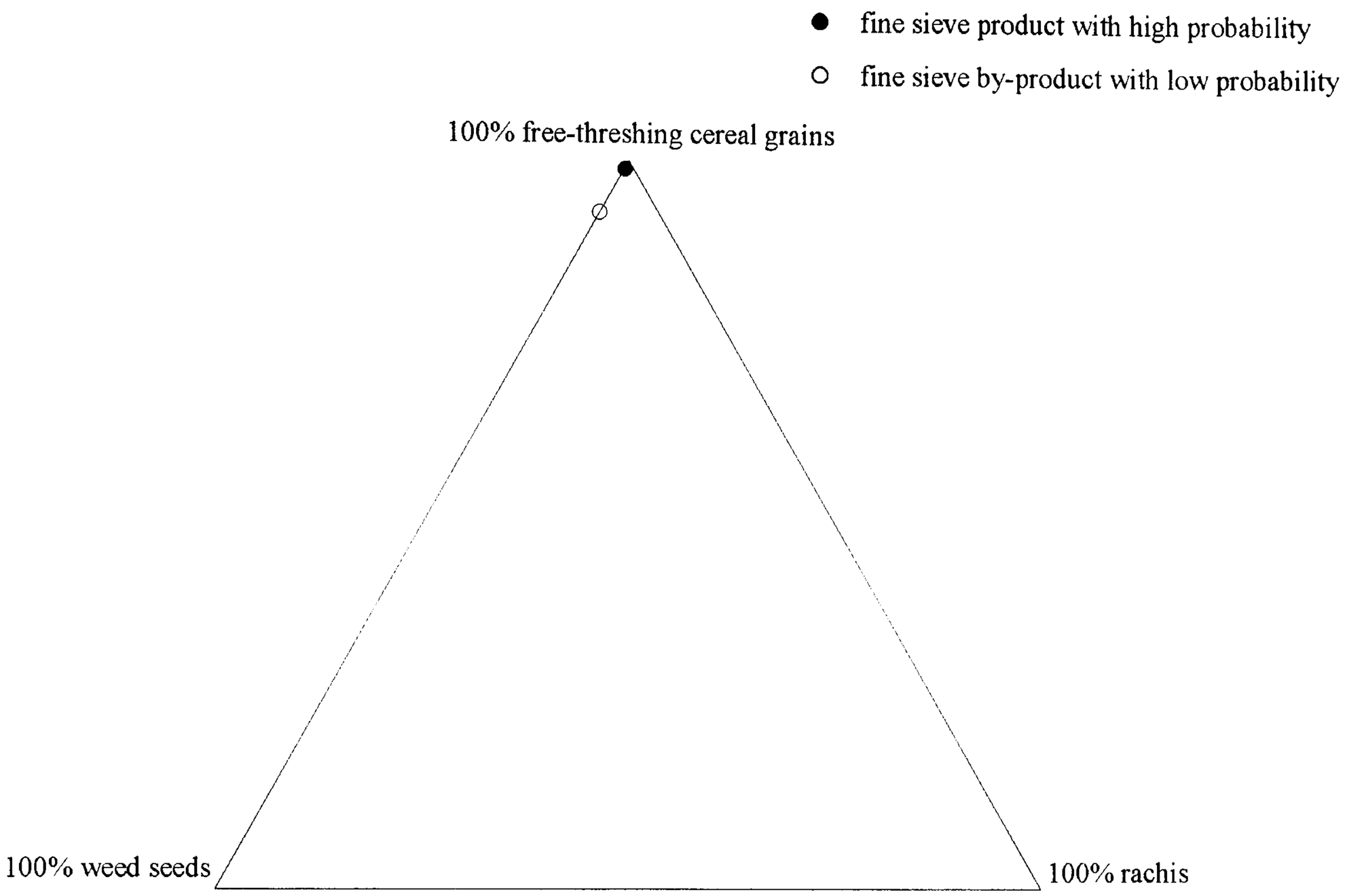


Fig. 4.8. Triangular scatter plot showing proportions of free-threshing cereal grains, rachis internodes and weed seeds in the archaeobotanical free-threshing cereal samples. Note that two further archaeobotanical free-threshing cereal samples, from Hornstaad-Hörnle (Maier 1991, 1996, 1999, unpublished) are not shown since full chaff data are not available for these samples

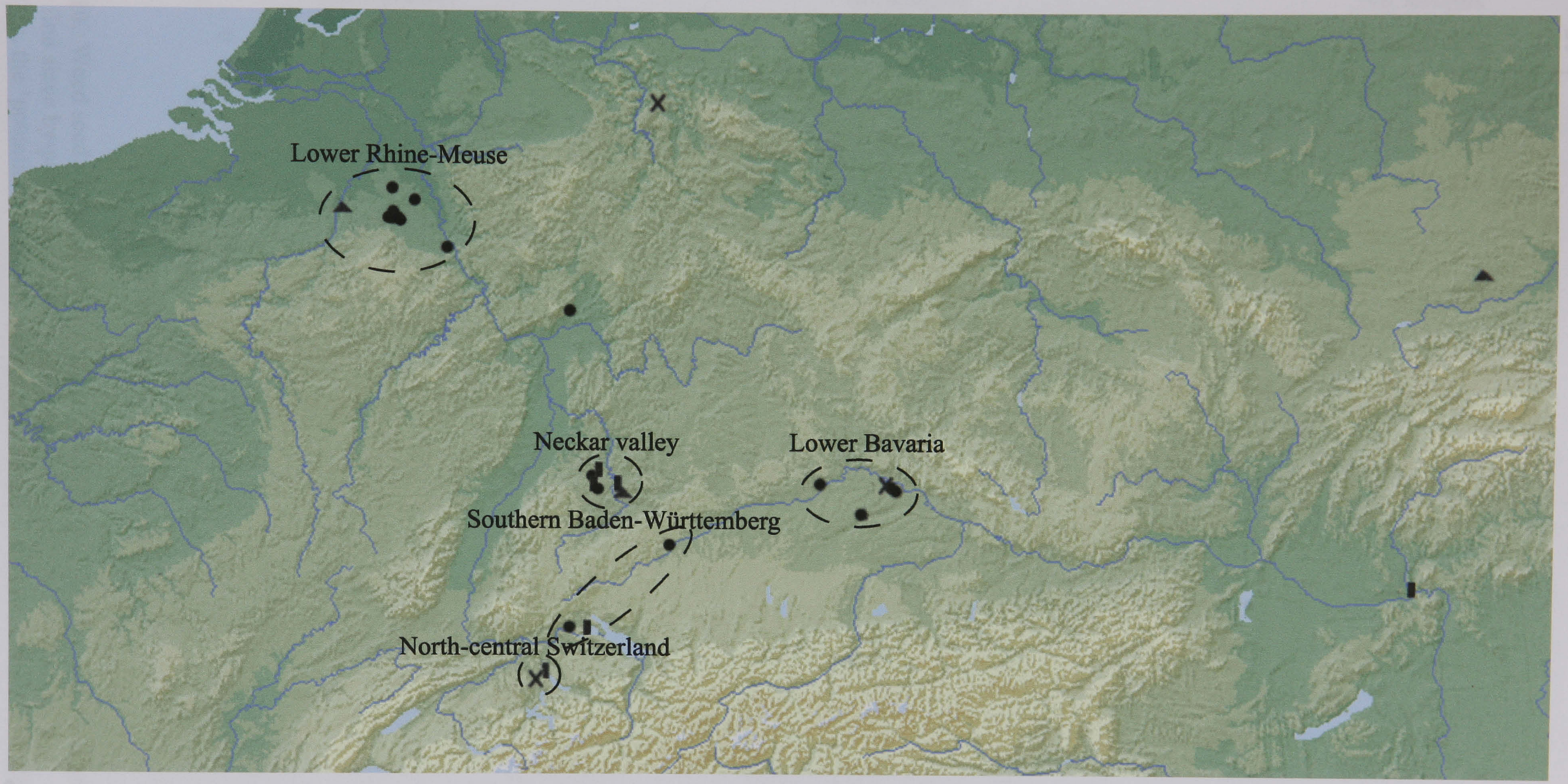
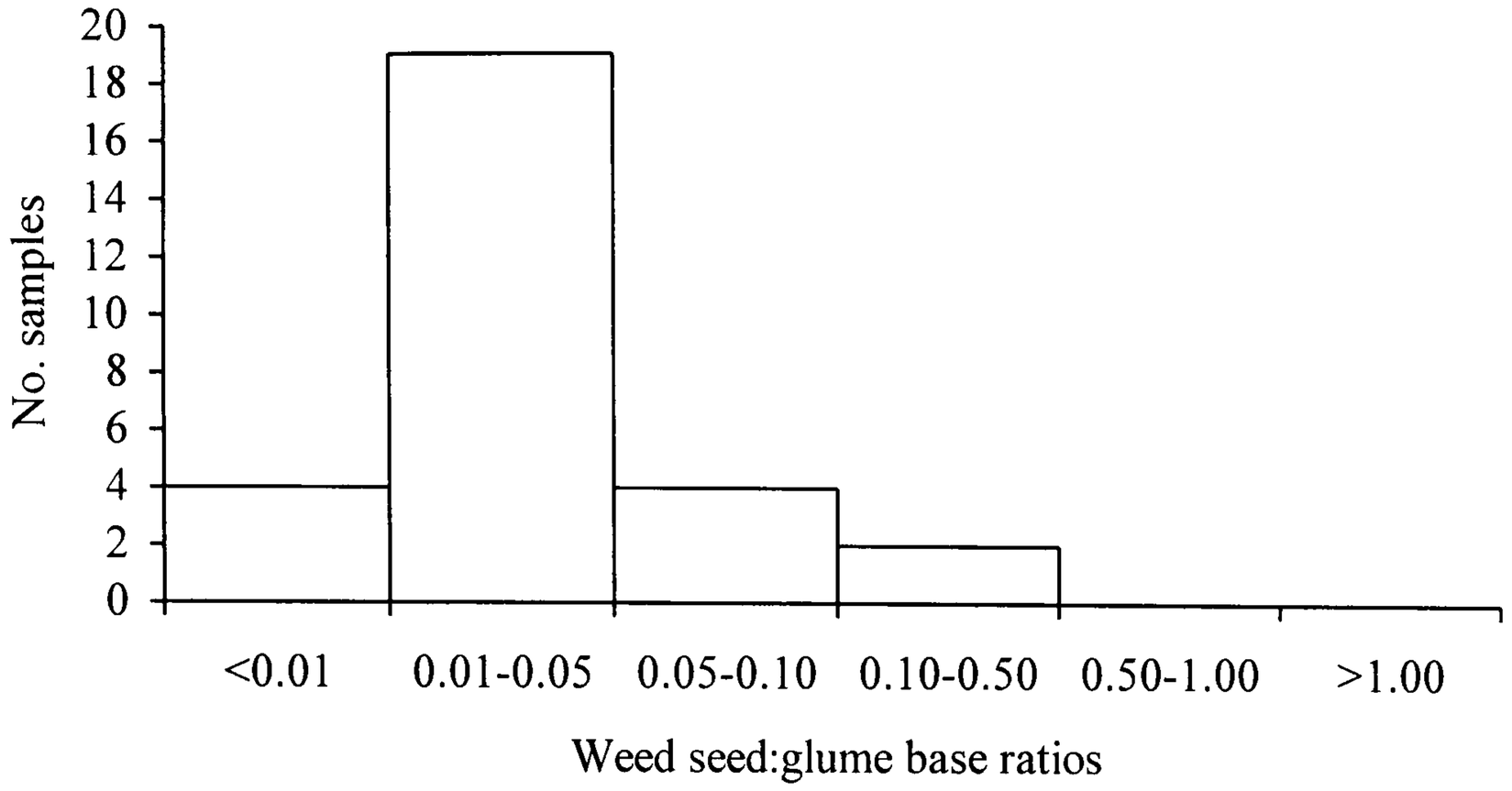
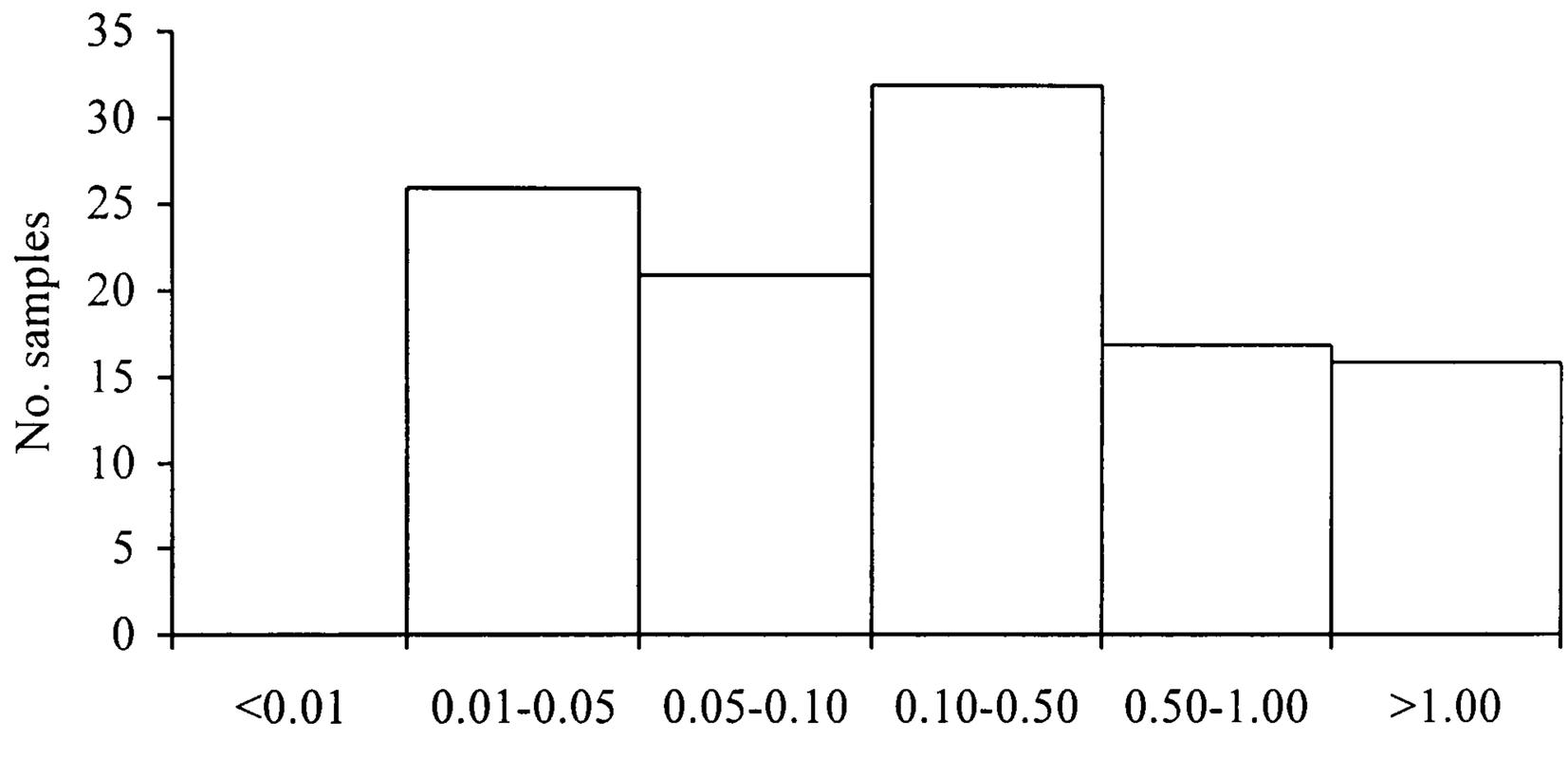


Fig. 4.9. Map showing the location of archaeological sites with 'potentially unmixed' samples (©1988-1998 Microsoft and/or its suppliers); circles = Early Neolithic (LBK), triangles = Middle Neolithic (Rössen/Lengyel etc.), rectangles = Later Neolithic, crosses = Bronze Age

a.



b.



c.

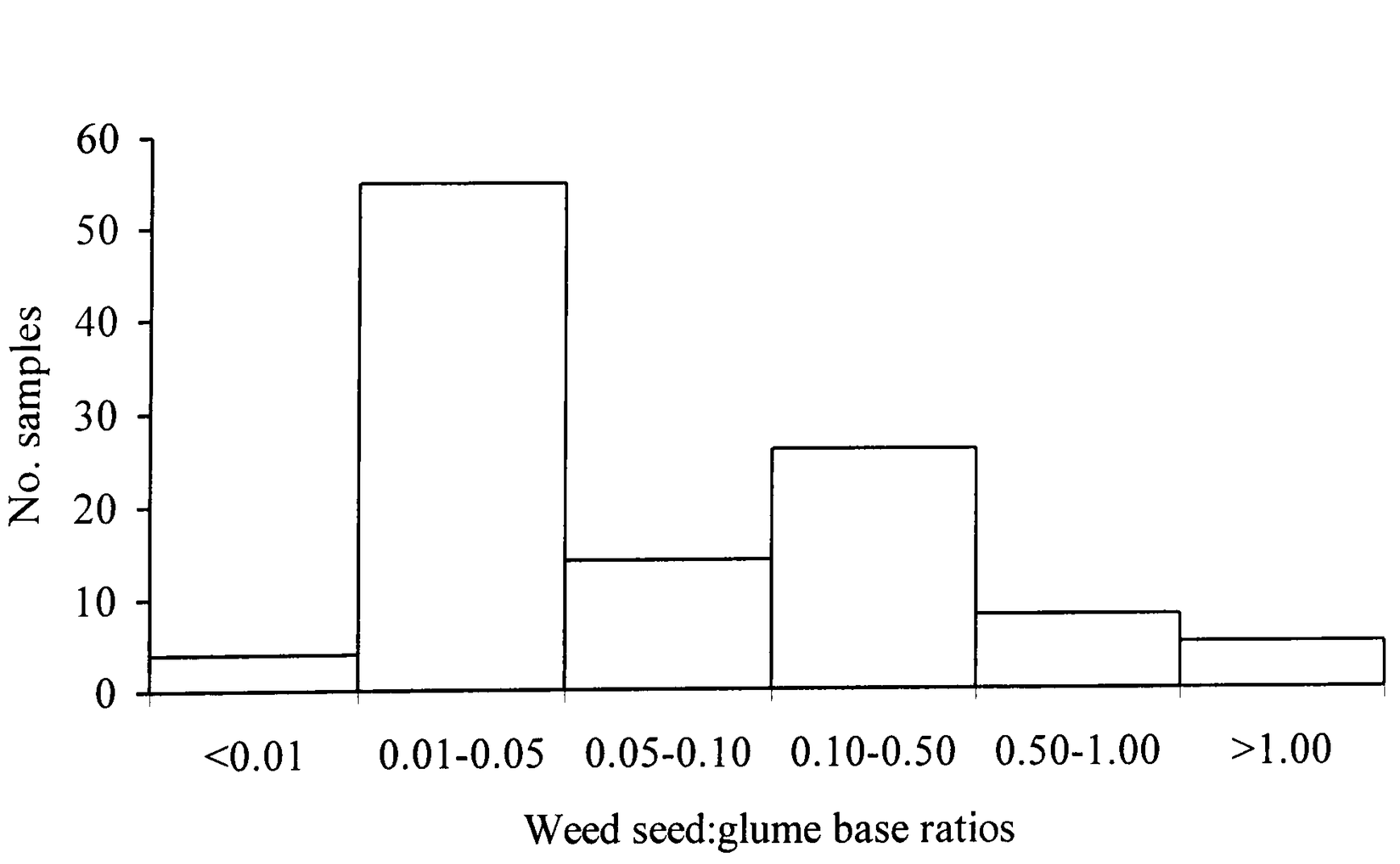


Fig. 4.10. Weed seed:glume base ratios for: a. the Amorgos samples (hypothetical emmer fine sieve by-products); b. the 'potentially unmixed' glume base samples (n=112); c. the 'potentially unmixed' glume base samples minus *Chenopodium album*

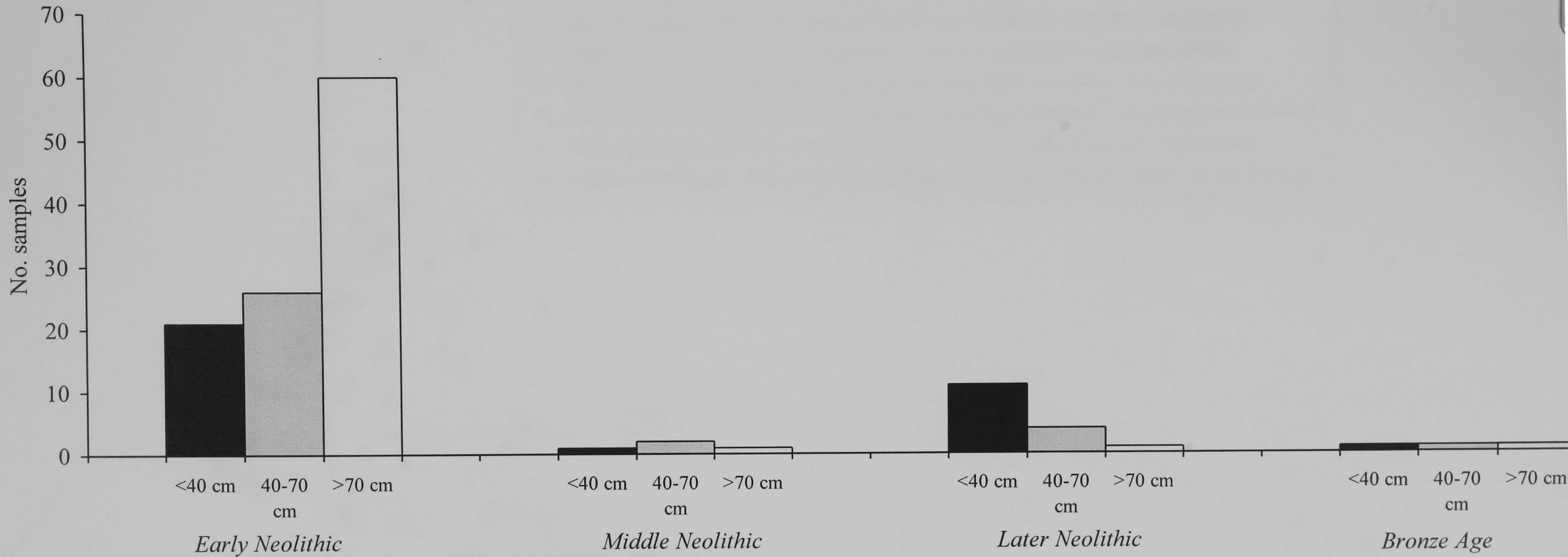


Fig. 4.11. Histogram showing 'potentially unmixed' samples grouped by chronological period and the lowest maximum plant height per sample

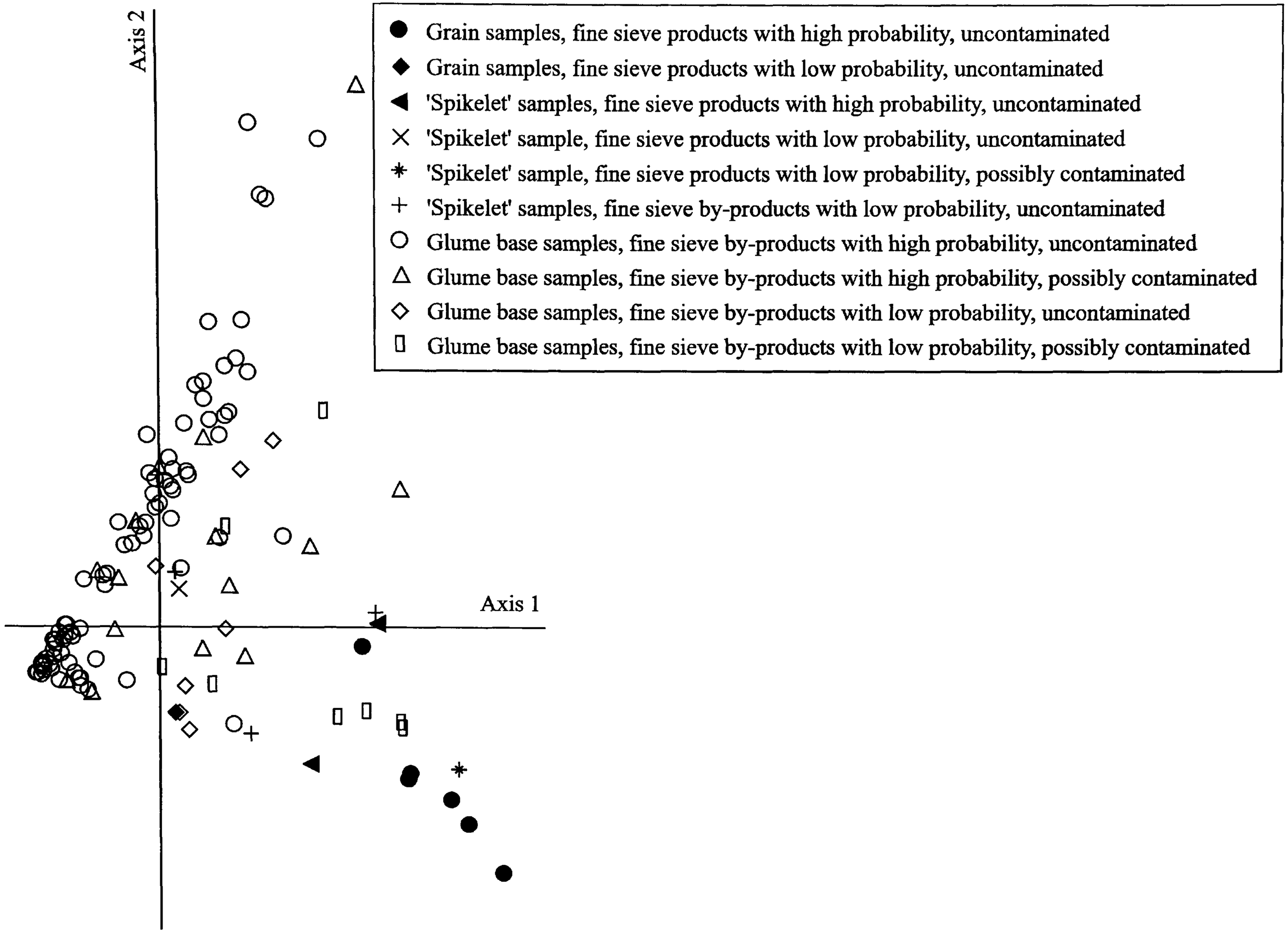


Fig. 4.12. Correspondence analysis plot of glume wheat samples showing crop processing categories

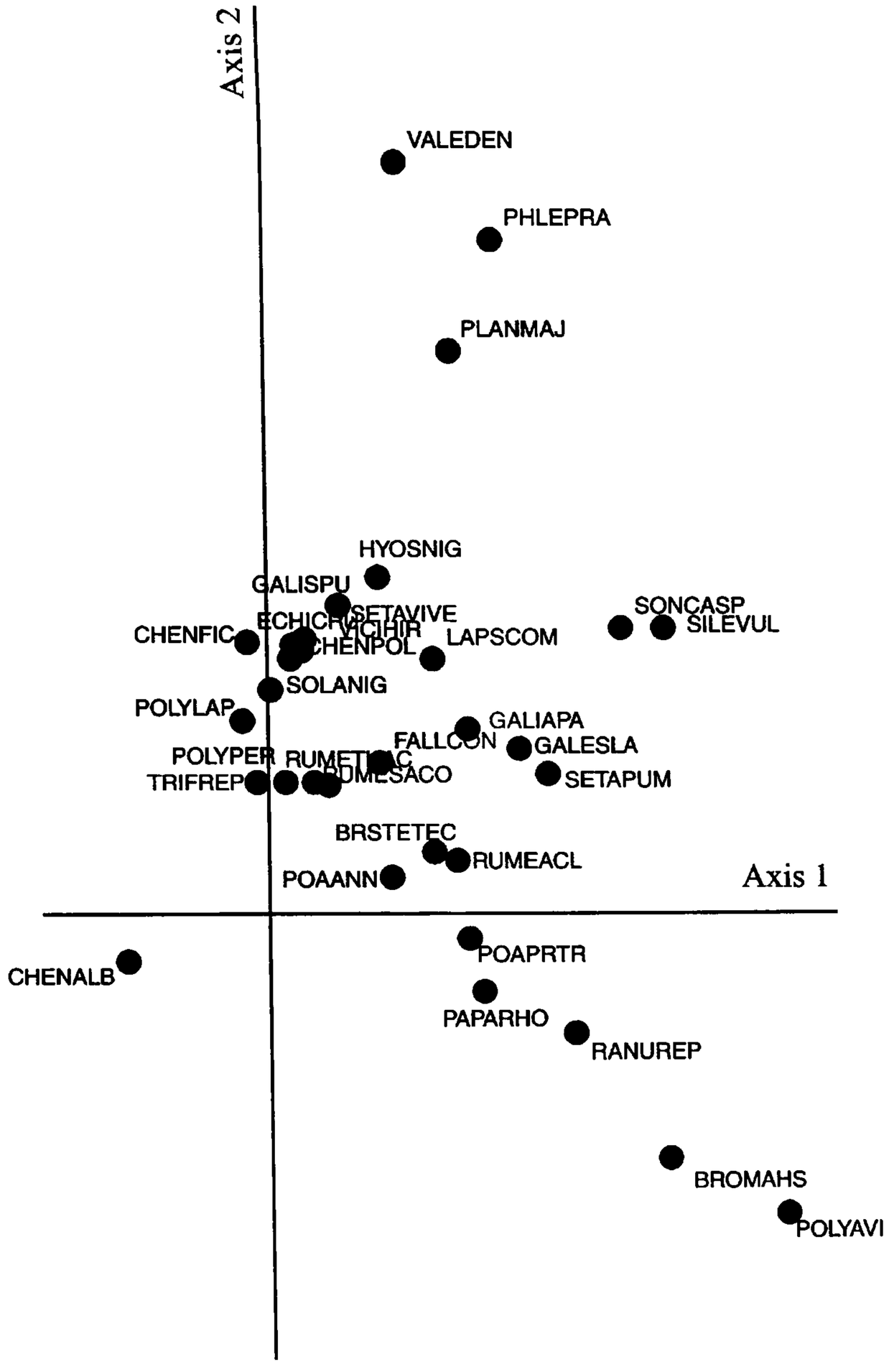


Fig. 4.13. Correspondence analysis plot of wild/weed species in the glume wheat samples (see Table 4.6 for species codes)

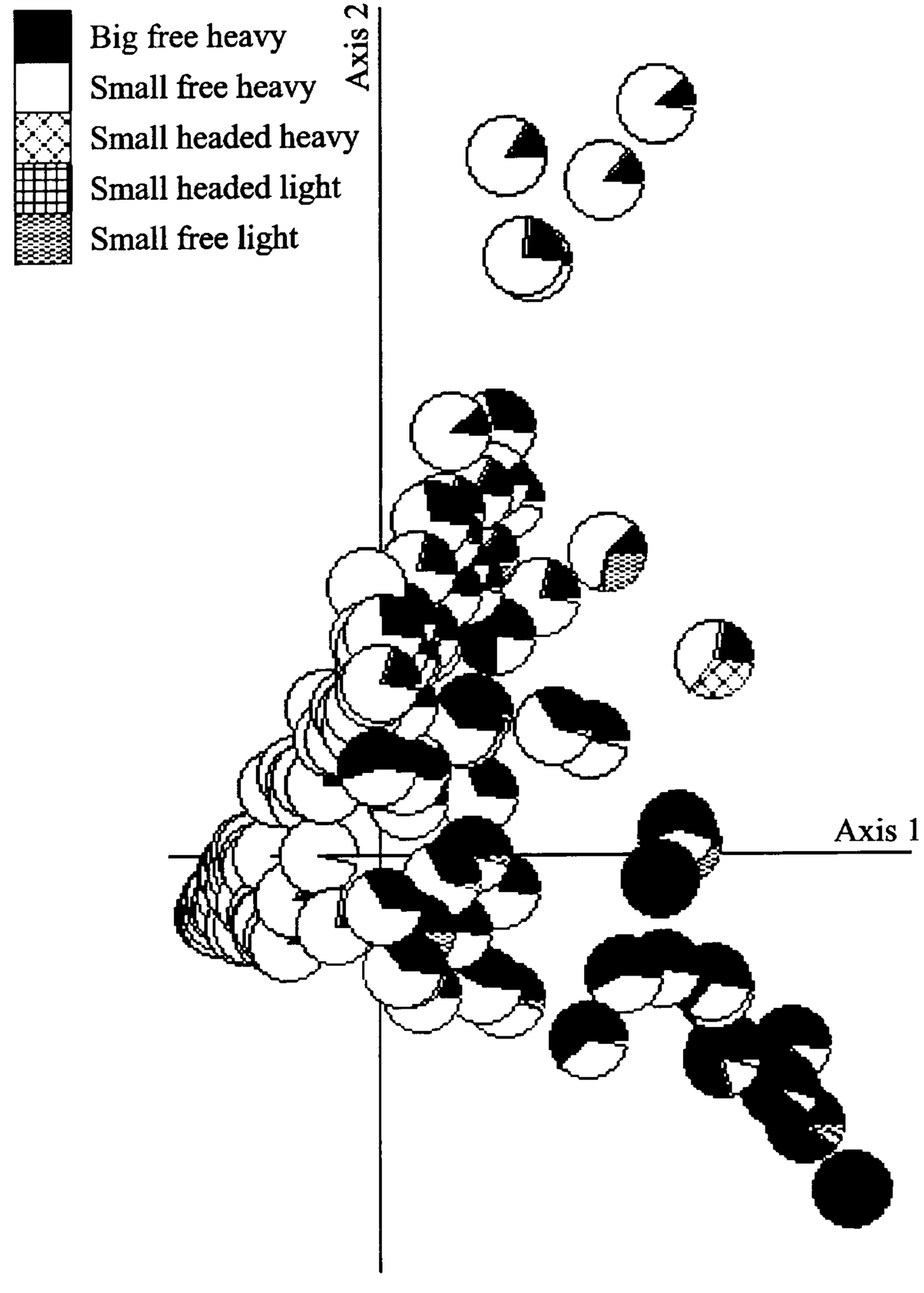


Fig. 4.14. Correspondence analysis plot of glume wheat samples shown as pie-charts indicating proportions weed seed types per sample

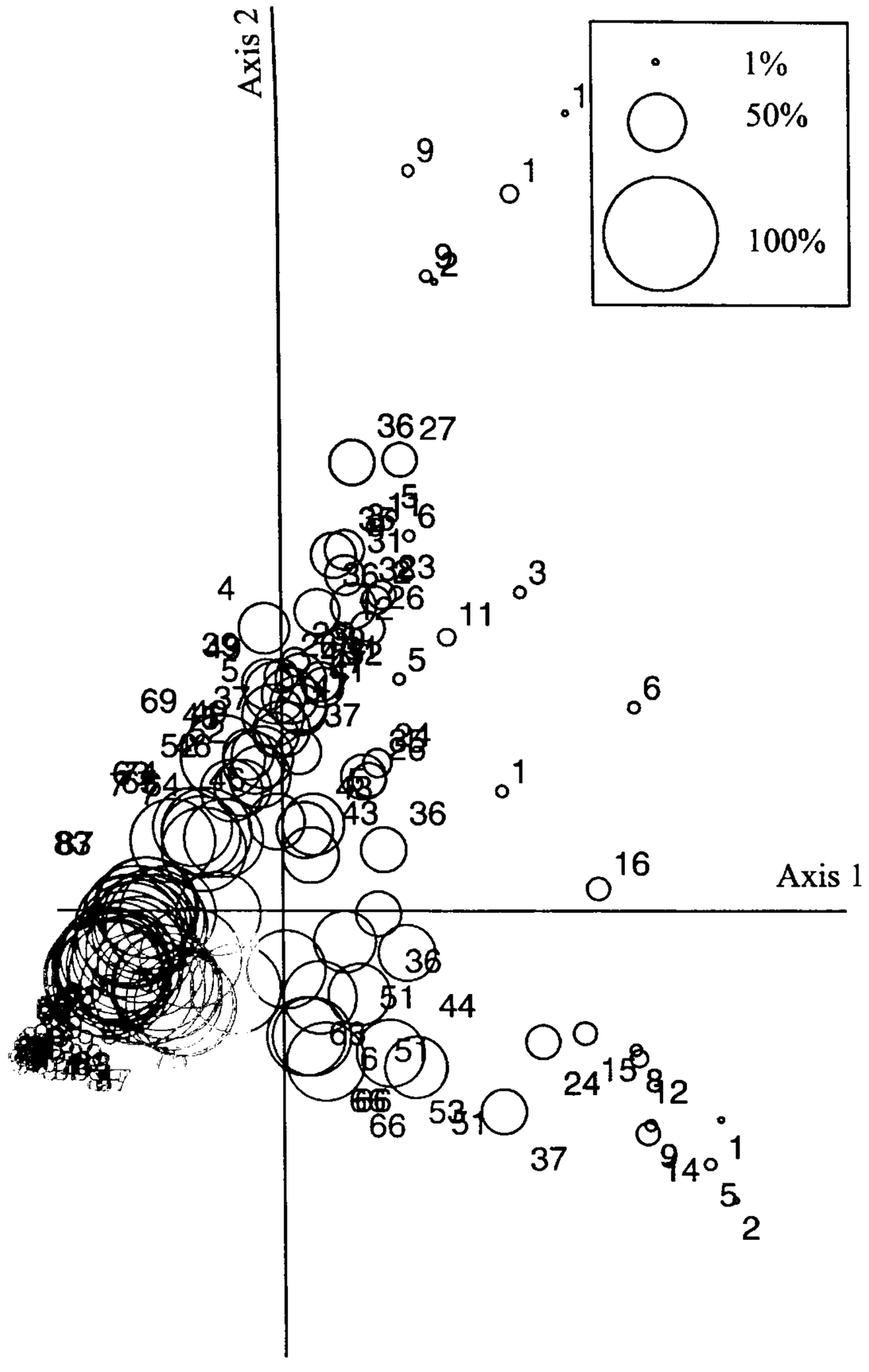


Fig. 4.15. Correspondence analysis plot of glume wheat samples, with circles showing the proportion of *Chenopodium album* seeds per sample

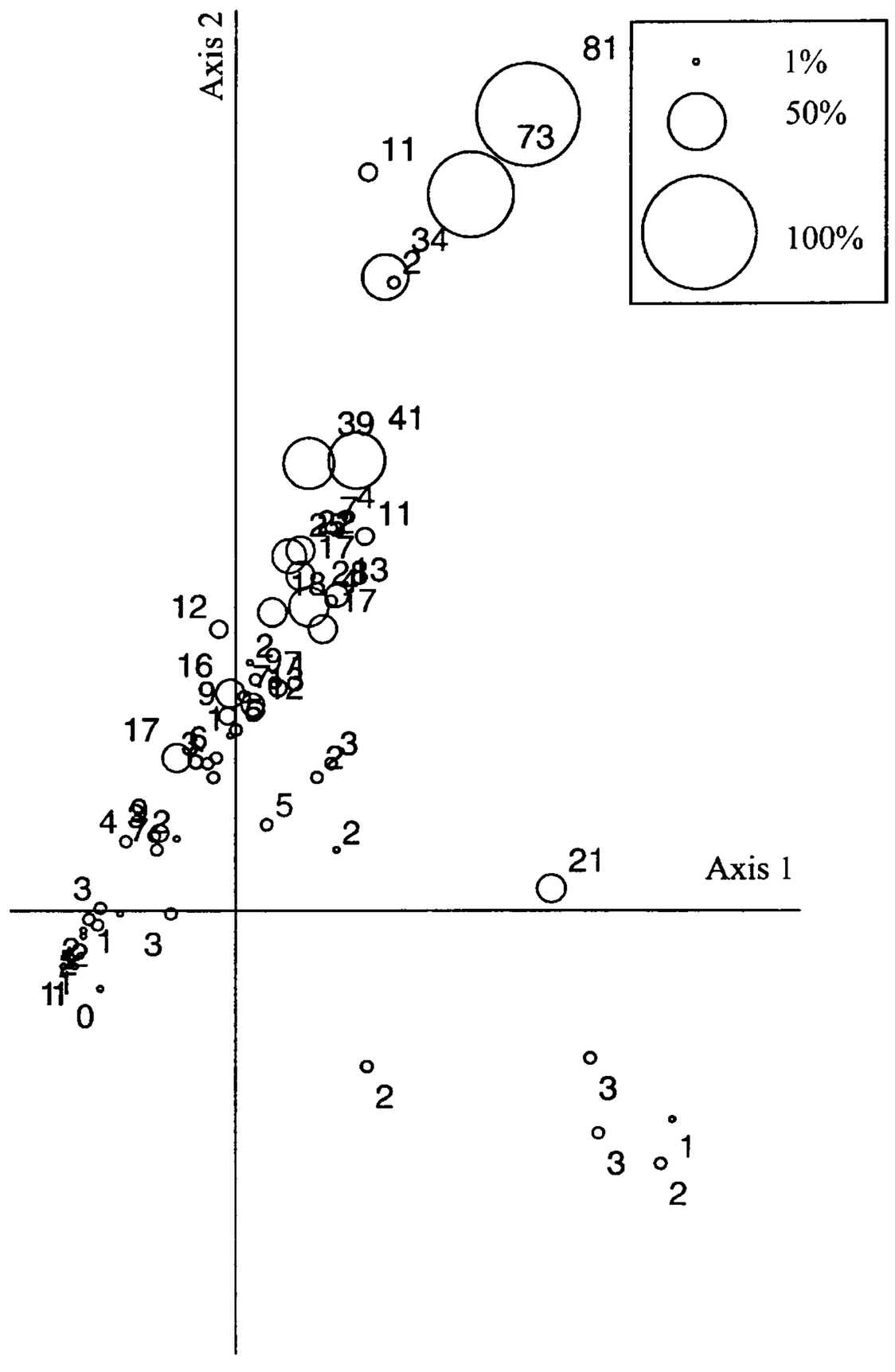


Fig. 4.16. Correspondence analysis plot of glume wheat samples, with circles showing the proportion of *Phleum pratense* seeds per sample

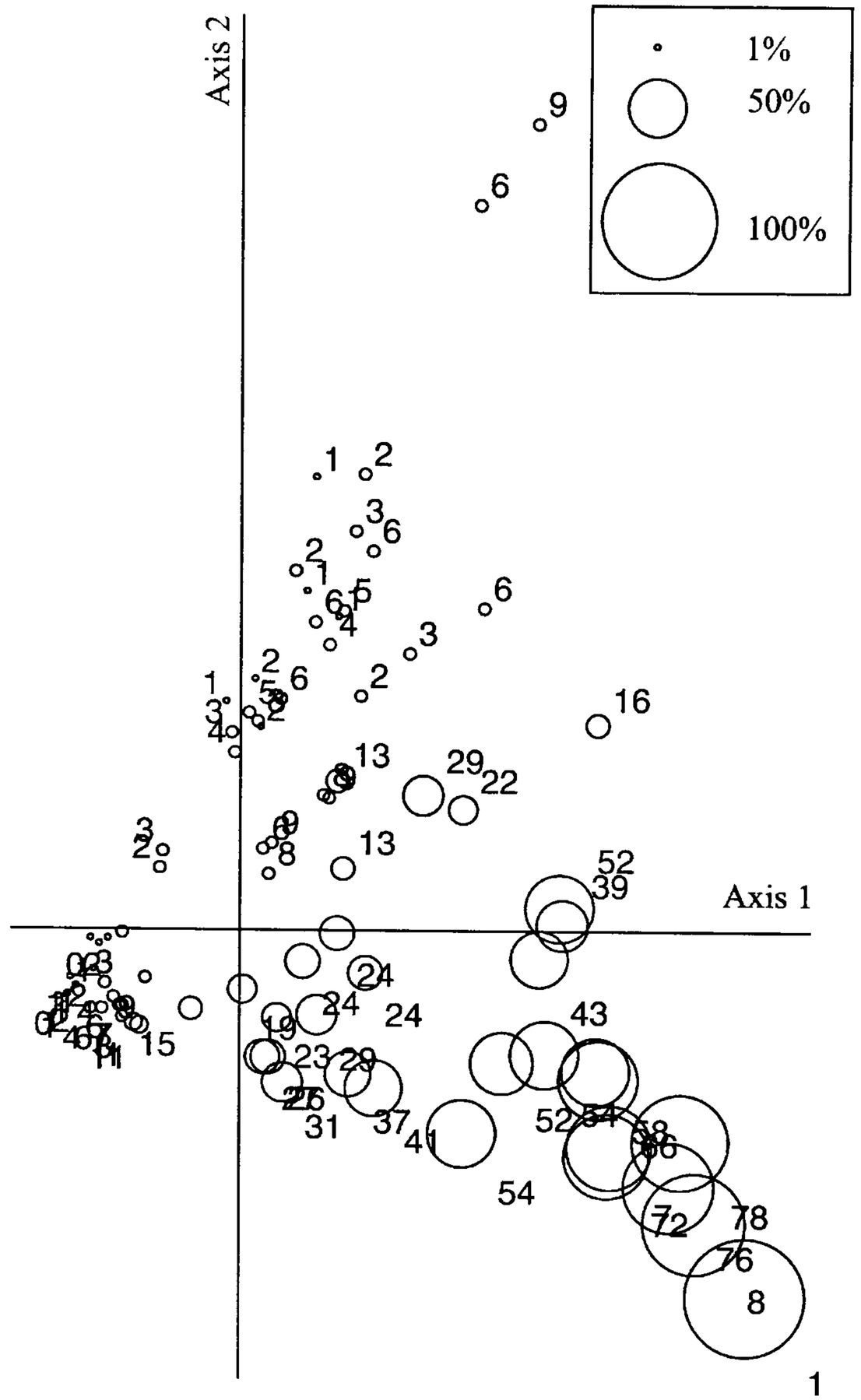


Fig. 4.17. Correspondence analysis plot of glume wheat samples, with circles showing the proportion of *Bromus arvensis/hordeaceus/secalinus* seeds per sample

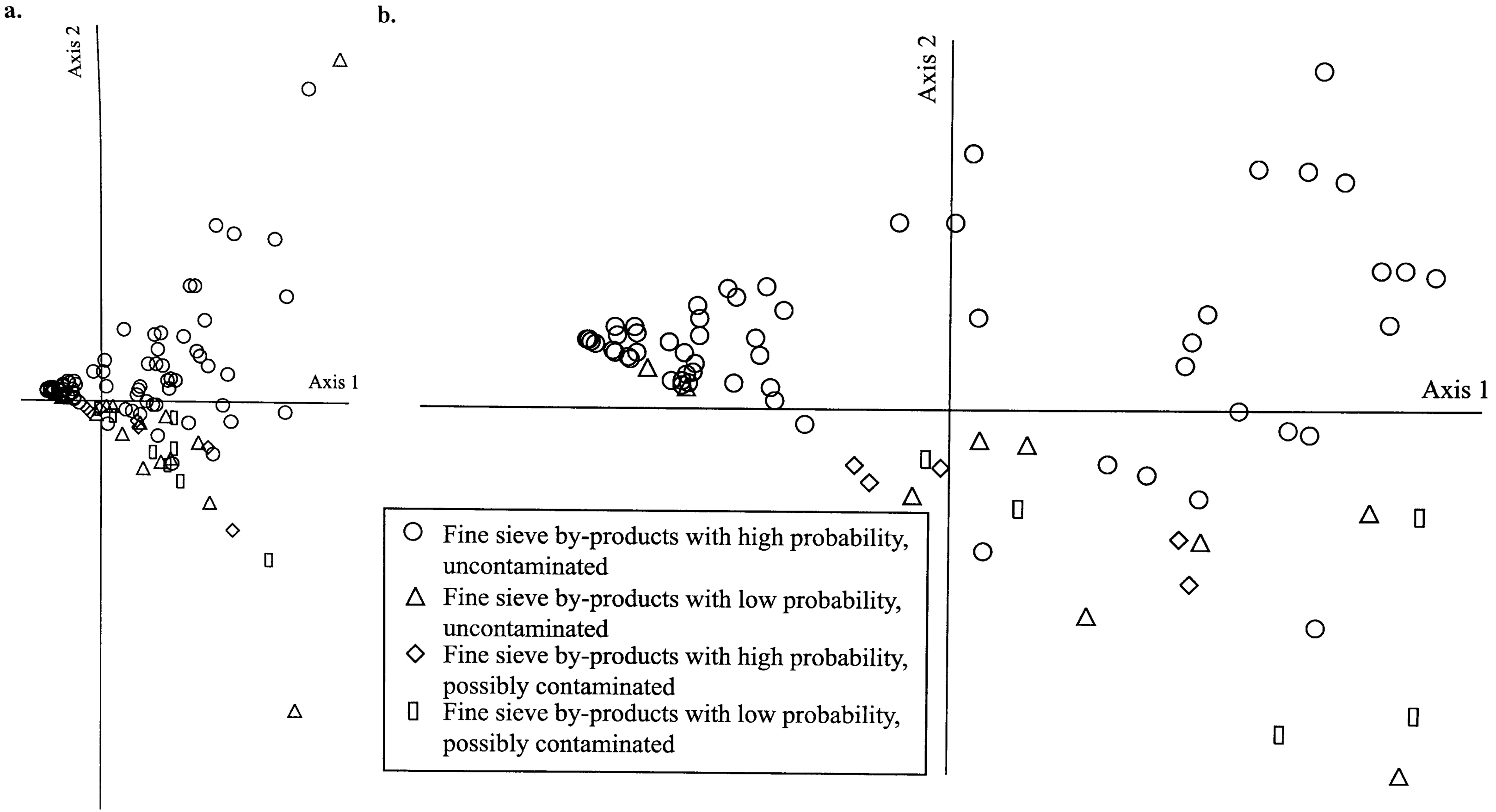


Fig. 4.18. Correspondence analysis plot of glume base samples showing crop processing categories; a. whole plot; b. expanded section around origin

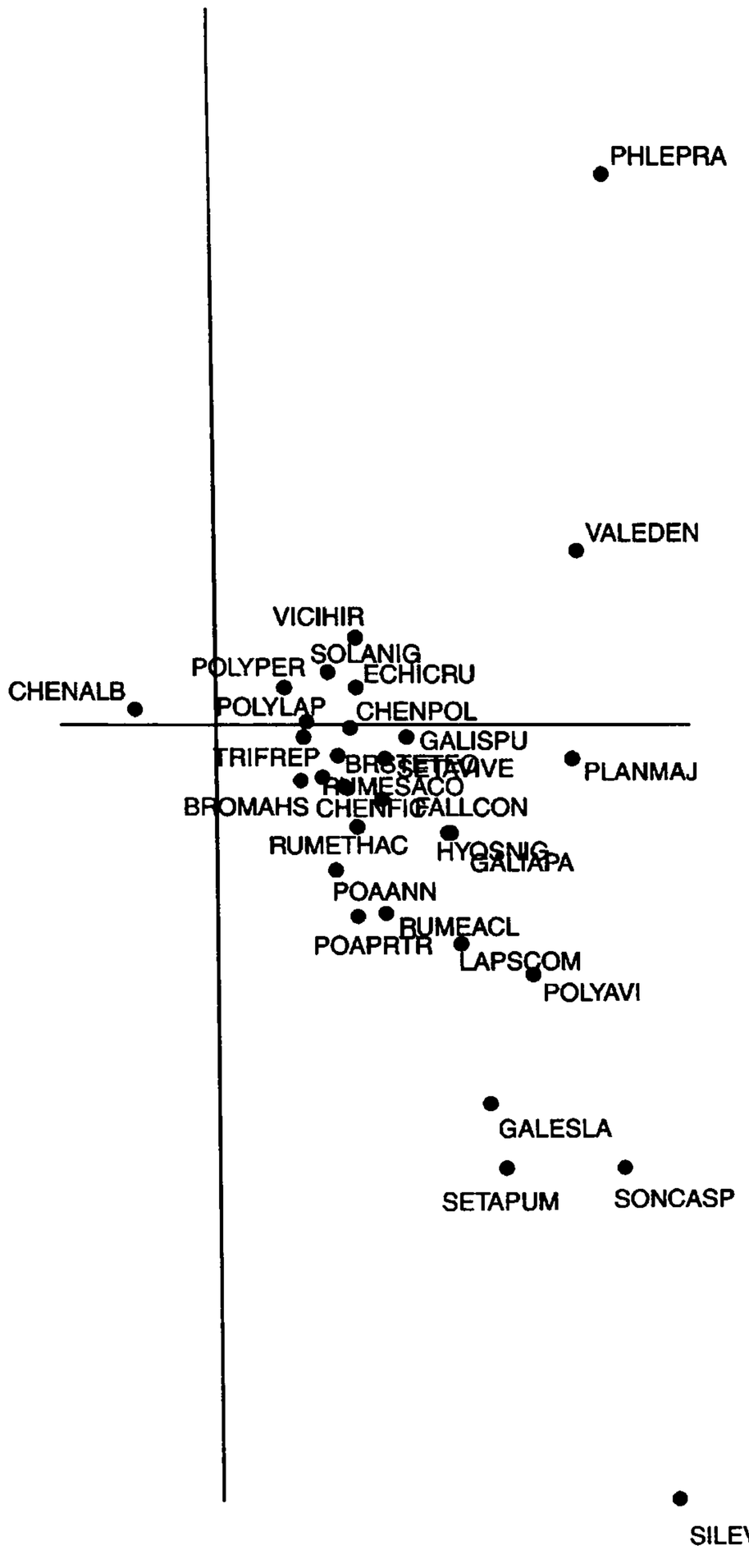


Fig. 4.19. Correspondence analysis plot of wild/weed species in the glume base samples (see Table 4.6 for species codes)

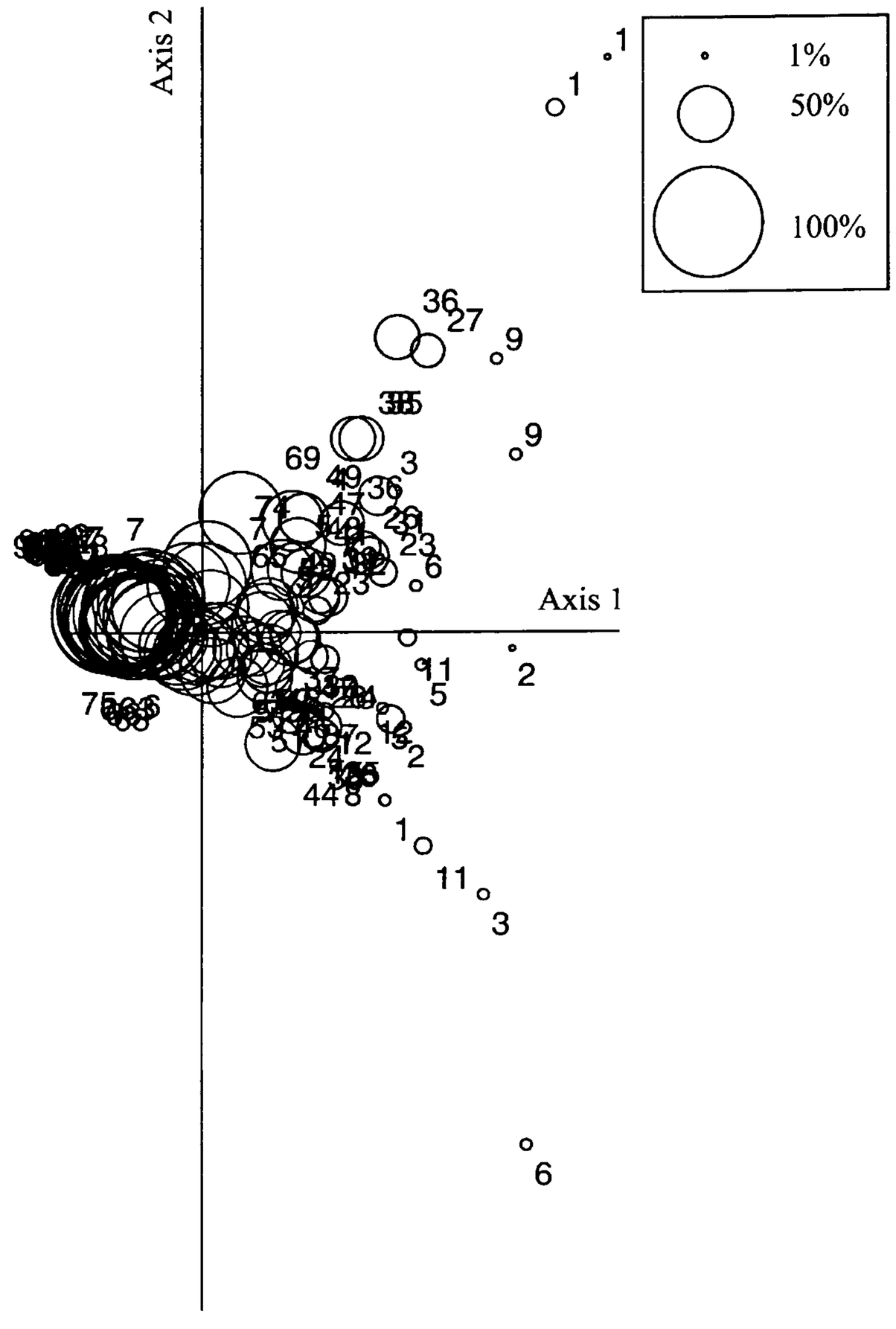


Fig. 4.20. Correspondence analysis plot of glume base samples, with circles showing the proportion of *Chenopodium album* seeds per sample

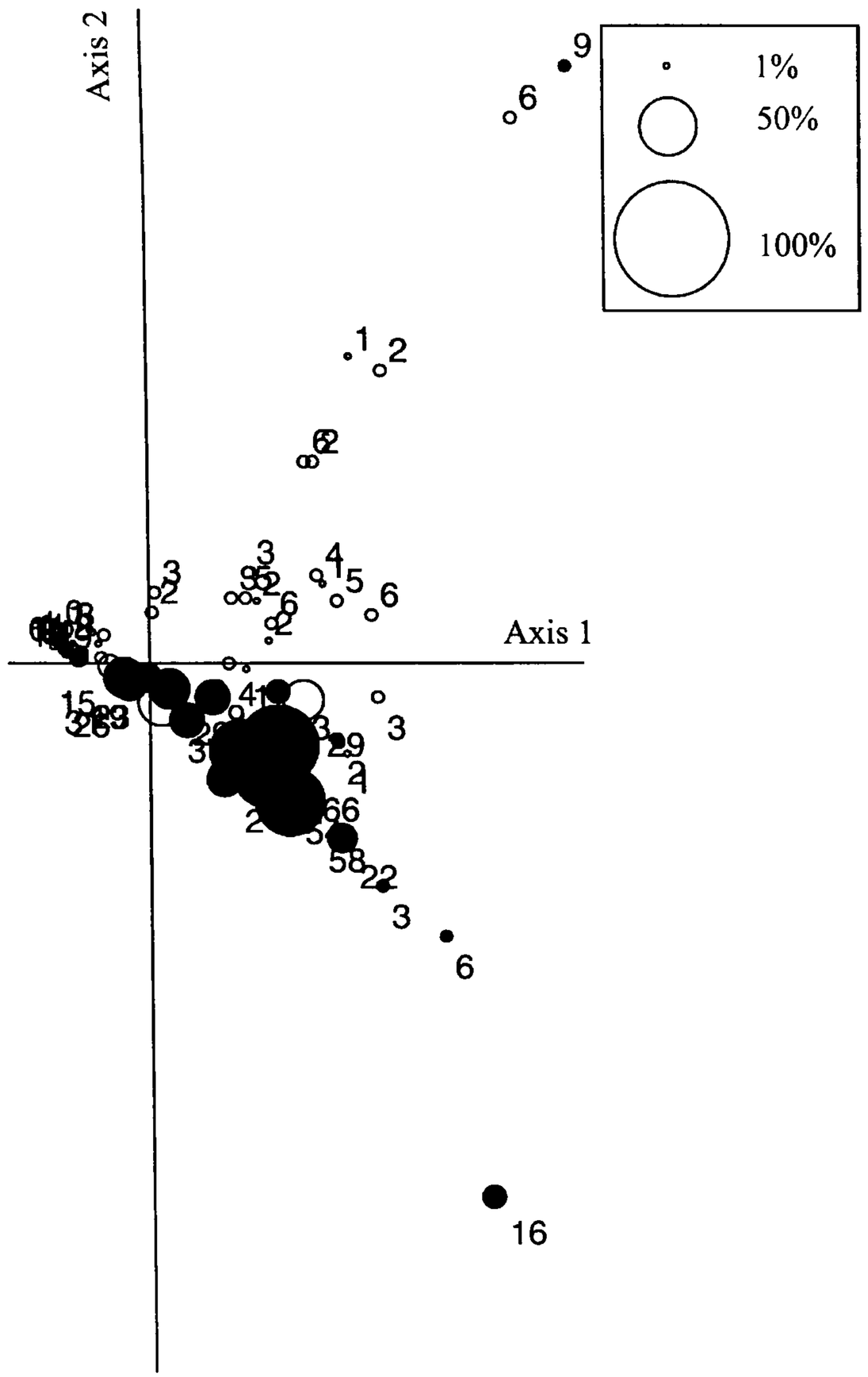


Fig. 4.21. Correspondence analysis plot of glume base samples, with circles showing the proportion of *Bromus arvensis/hordeaceus/secalinus* seeds per sample. Open symbols represent 'uncontaminated' samples classified as fine sieve by-products with high probability; filled symbols represent other samples (see Fig. 4.18)

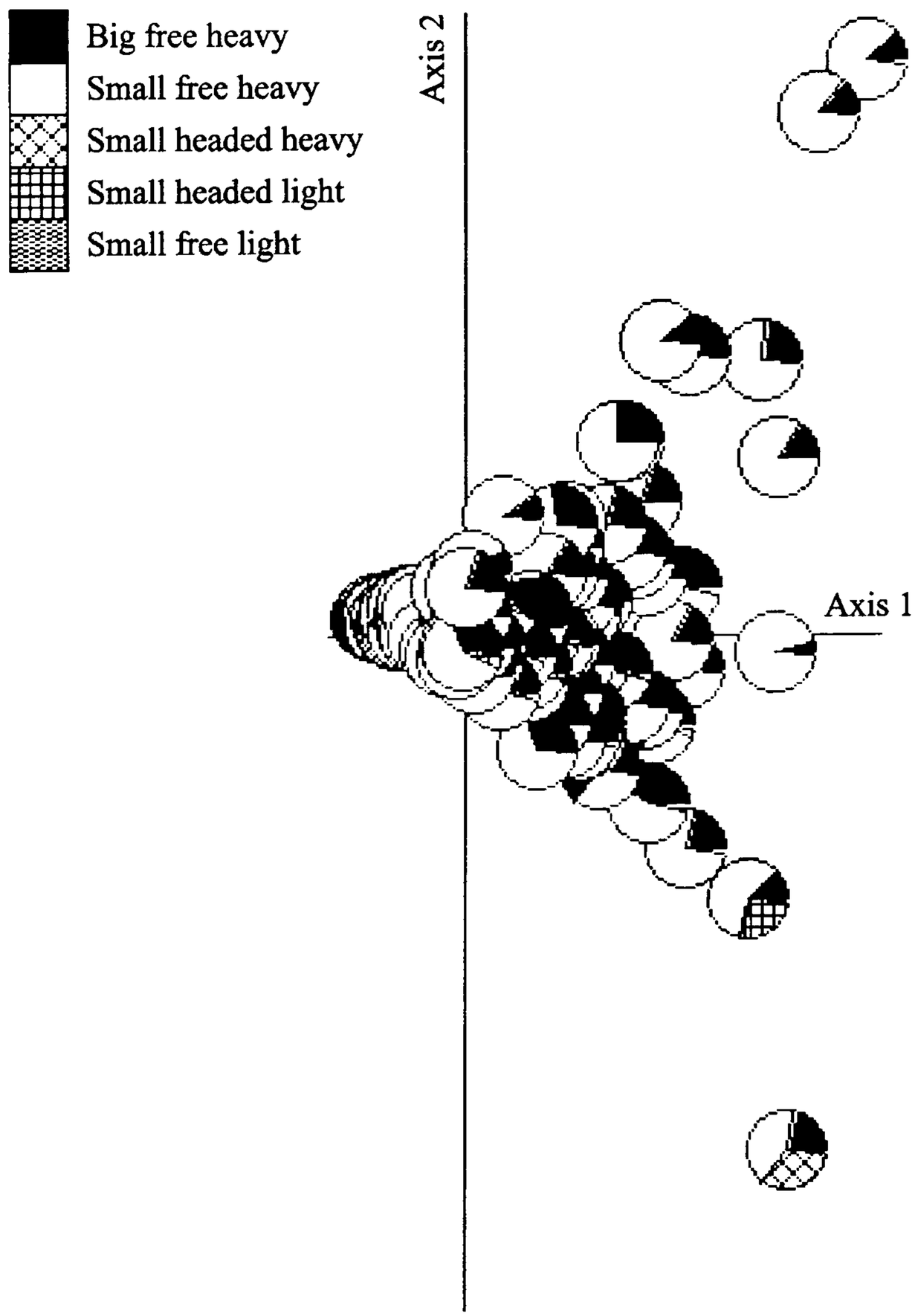


Fig. 4.22. Correspondence analysis plot of glume base samples shown as pie-charts indicating proportions weed seed types per sample

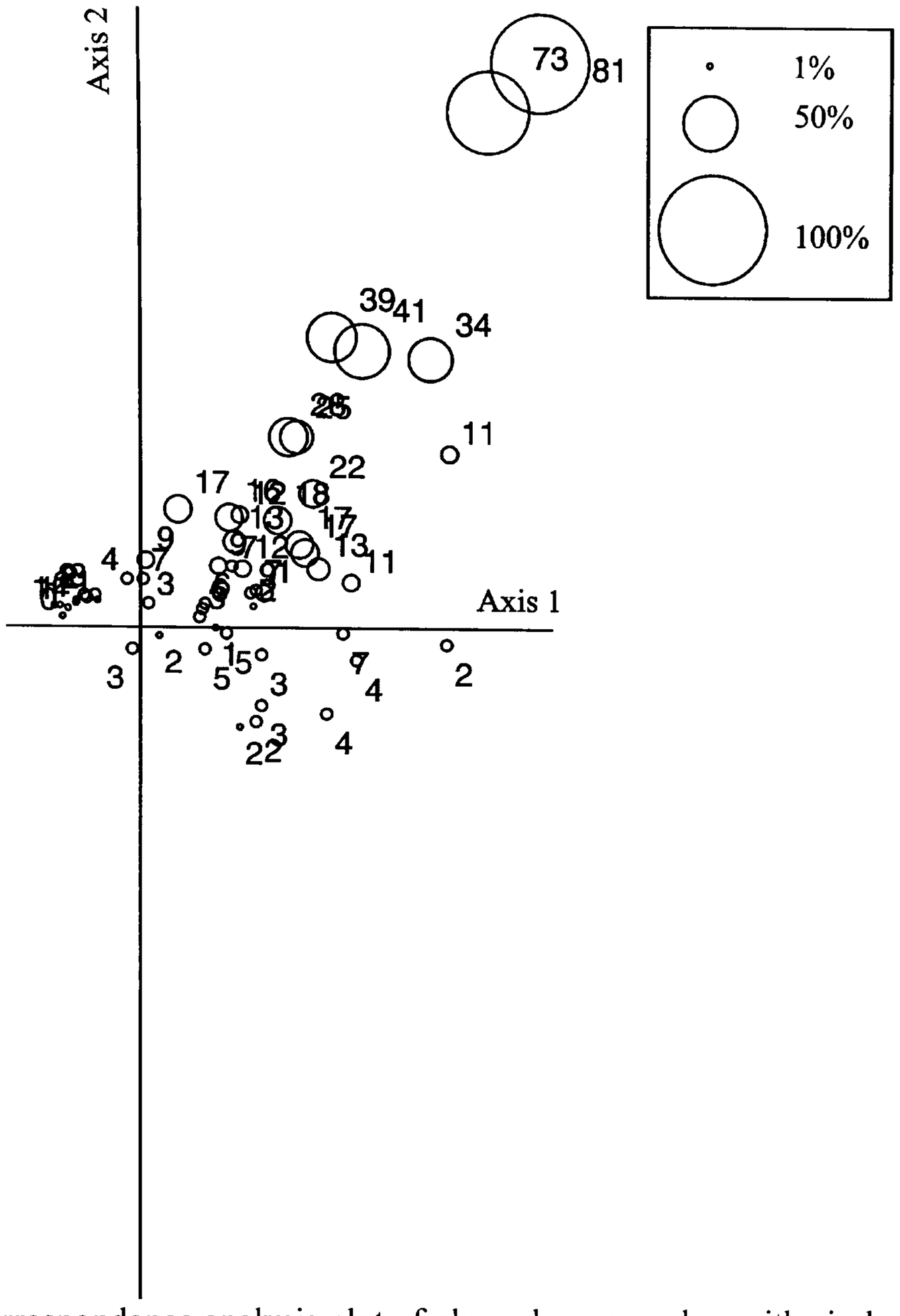


Fig. 4.23. Correspondence analysis plot of glume base samples, with circles showing the proportion of *Phleum pratense* seeds per sample

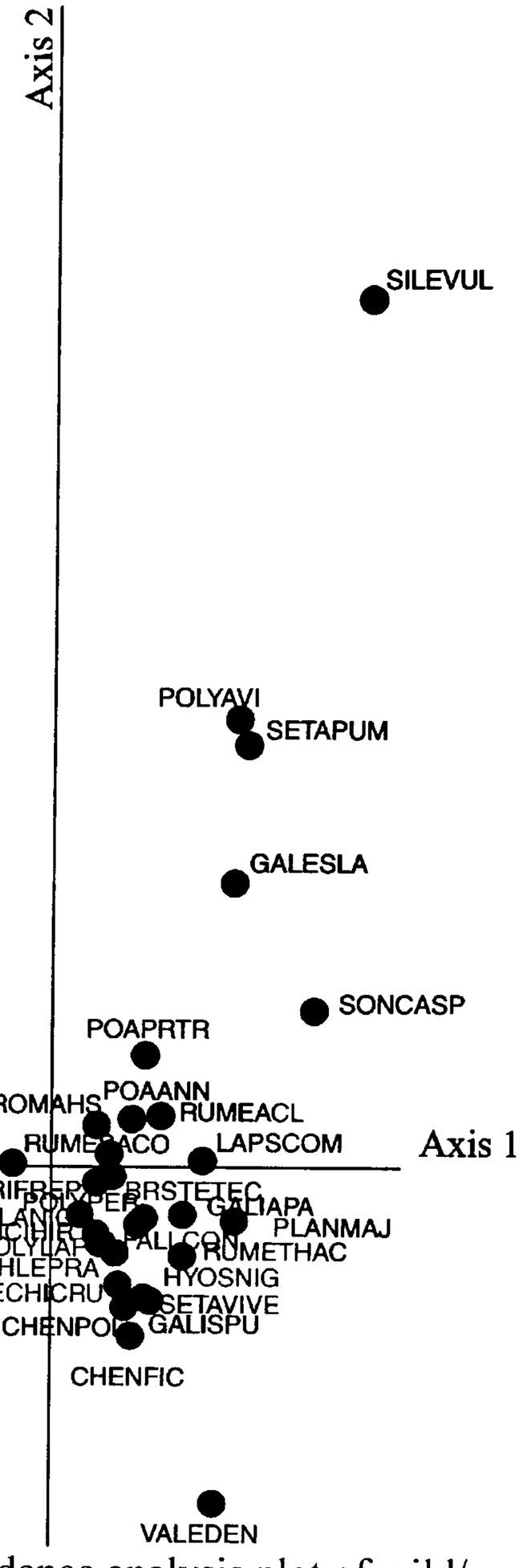


Fig. 4.24. Correspondence analysis plot of wild/weed species in the glume base samples, with two *Phleum*-rich samples removed (see Table 4.6 for species codes)

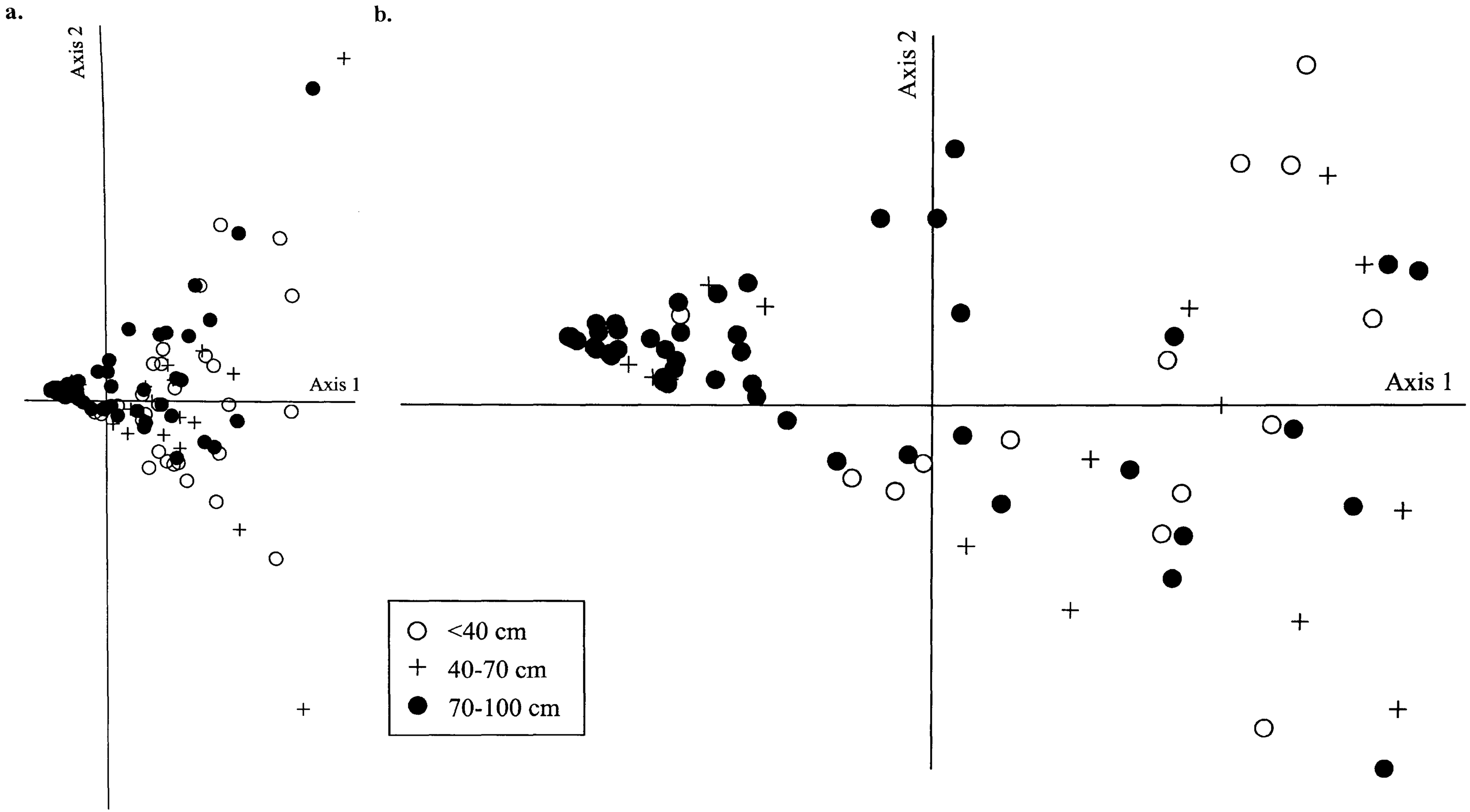


Fig. 4.25. Correspondence analysis plot of glume base samples showing the lowest maximum wild/weed plant height per sample; a. whole plot; b. expanded section around origin

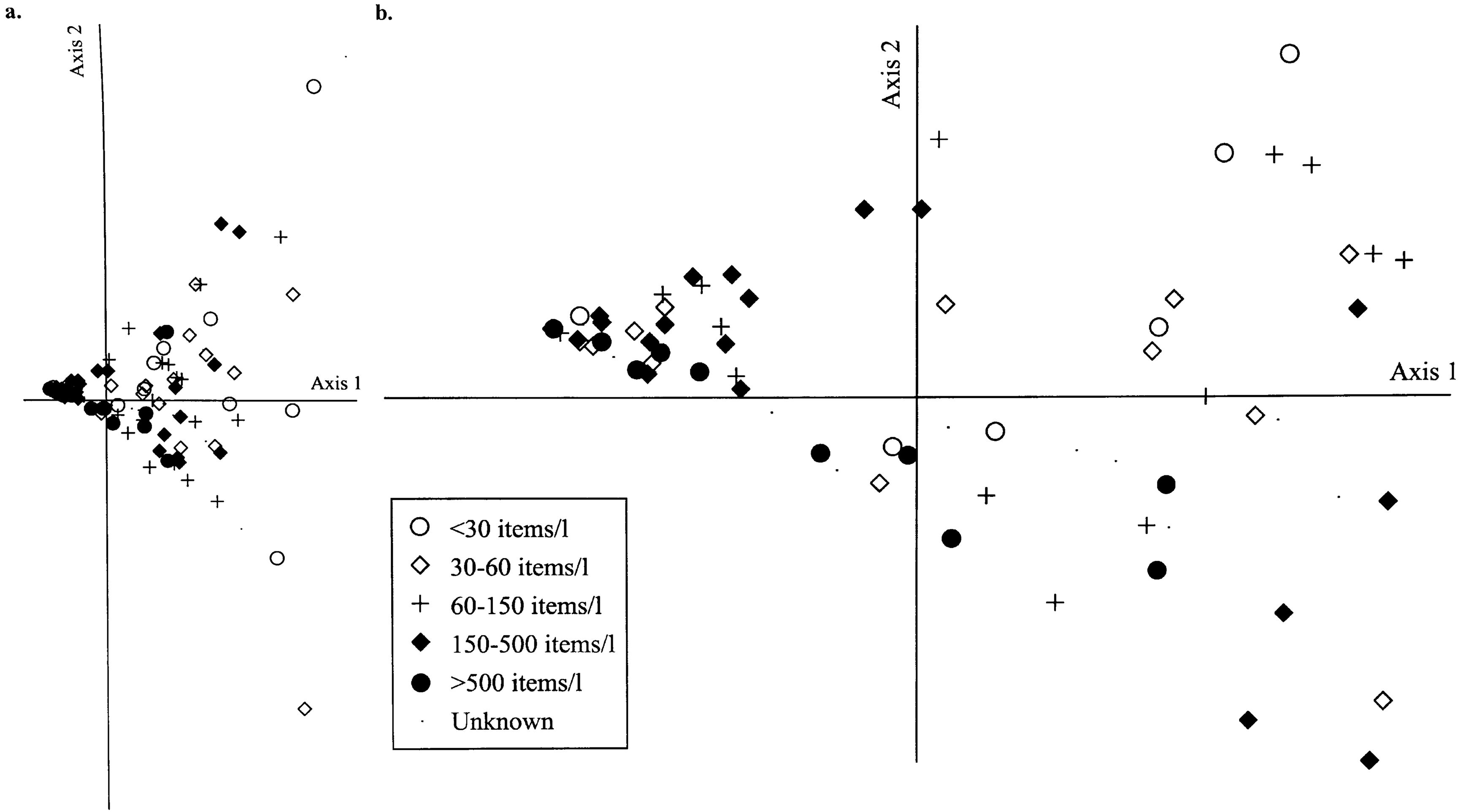


Fig. 4.26. Correspondence analysis plot of glume base samples showing the number of identifiable charred items per litre in each sample; a. whole plot; b. expanded section around origin

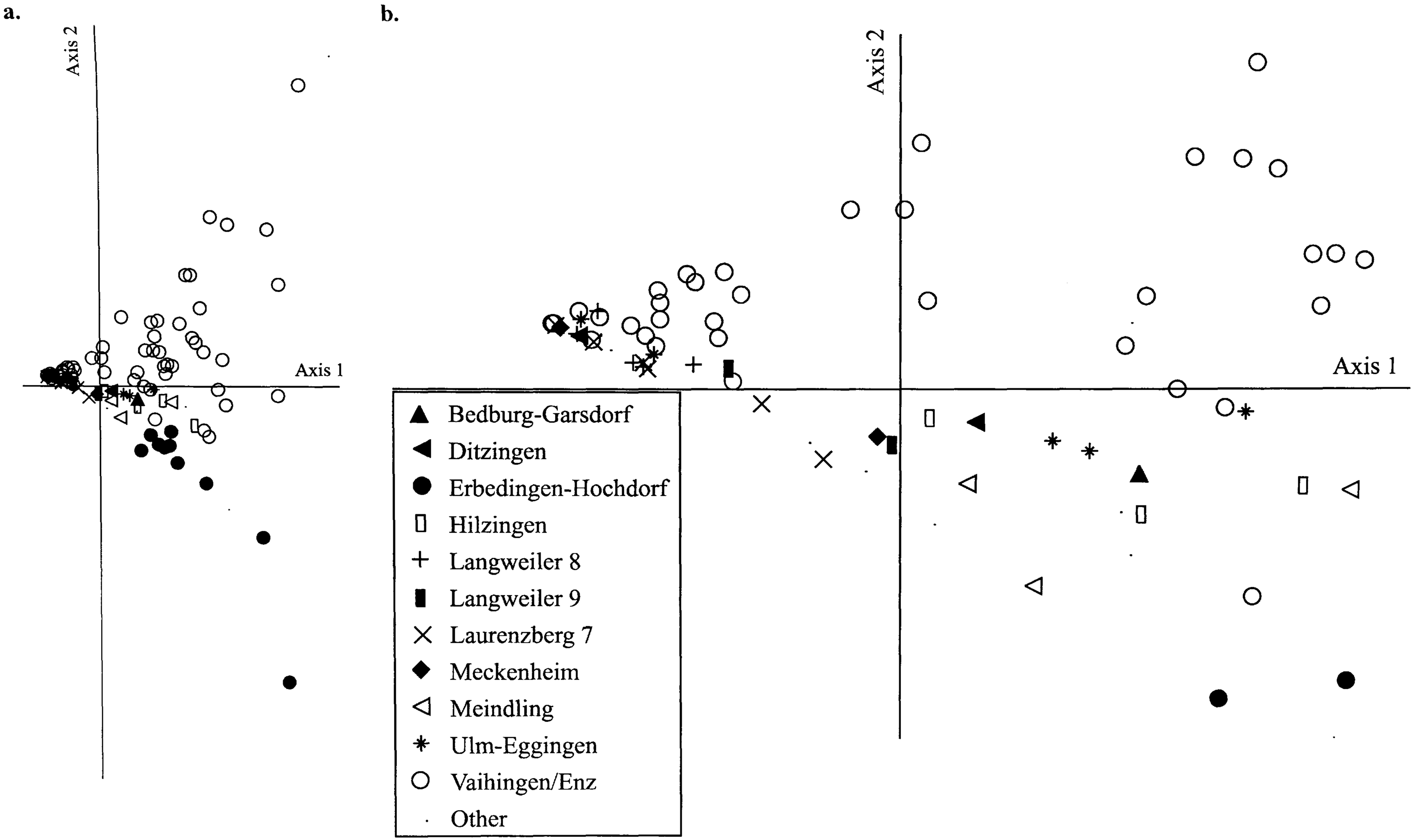


Fig. 4.27. Correspondence analysis plot of glume base samples showing the archaeological sites from which samples derive; a. whole plot; b. expanded section around origin

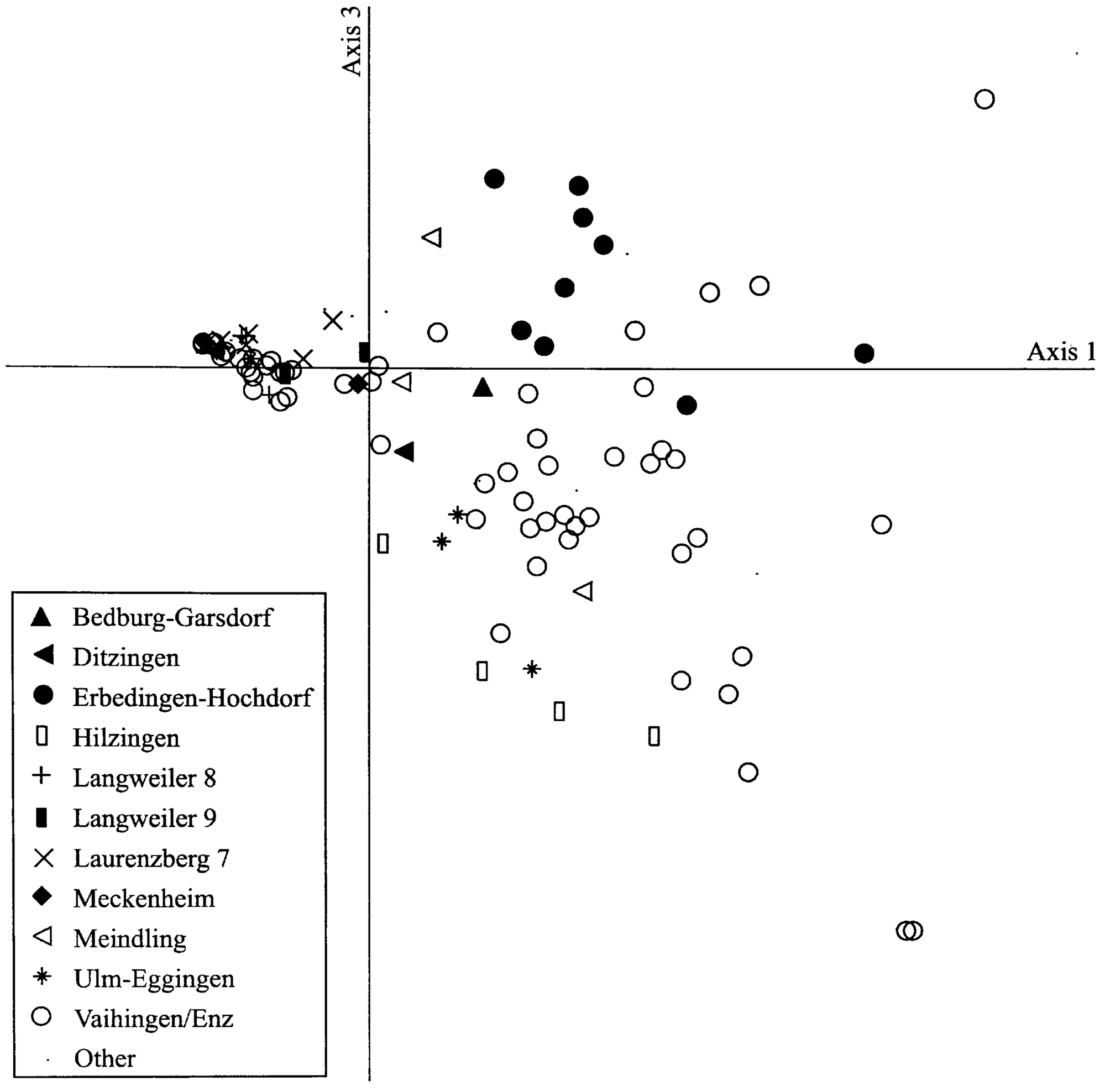


Fig. 4.28. Correspondence analysis plot (axis 1 and 3) of glume base samples showing the archaeological sites from which samples derive

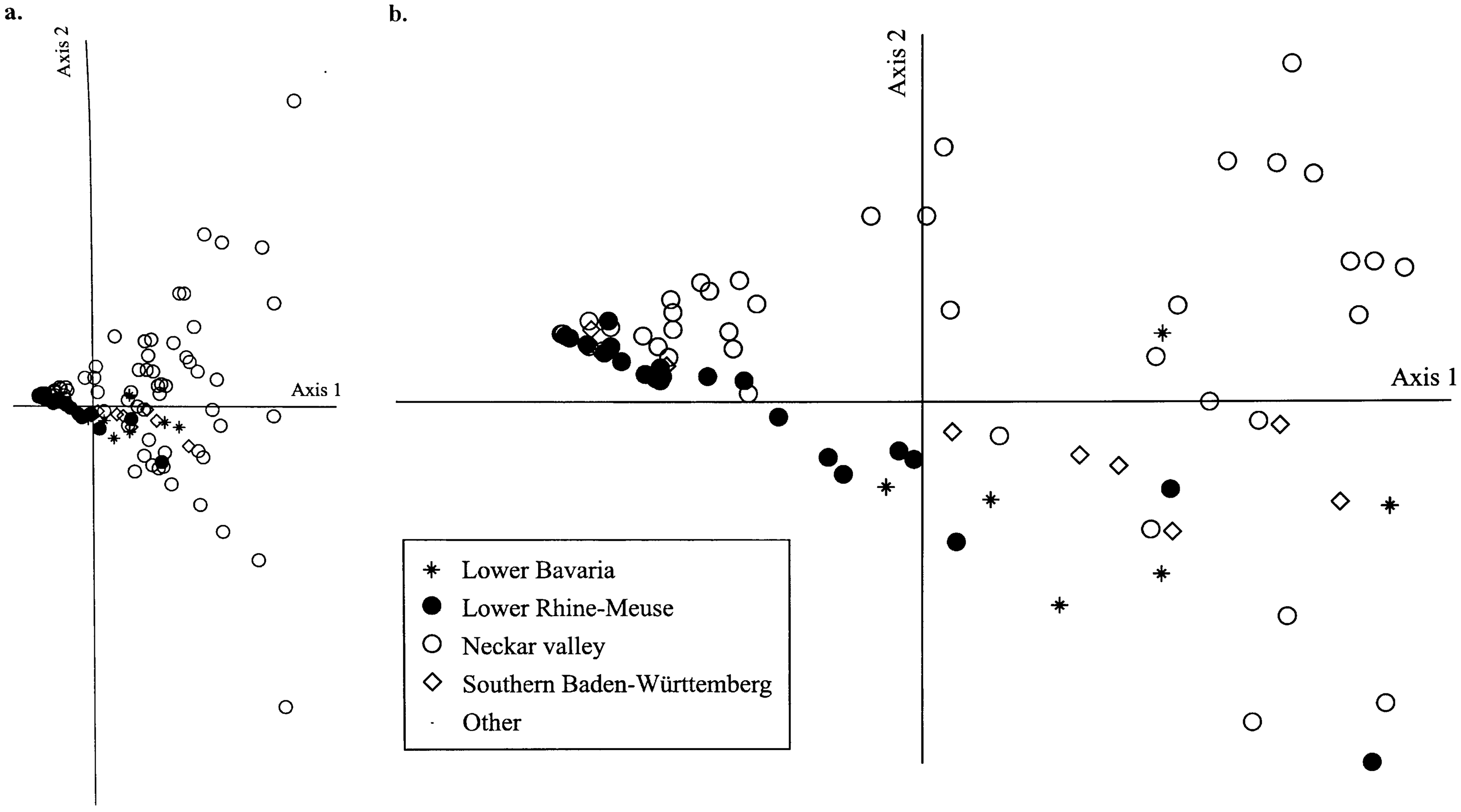


Fig. 4.29. Correspondence analysis plot of glume base samples showing the geographical regions from which samples derive; a. whole plot; b. expanded section around origin

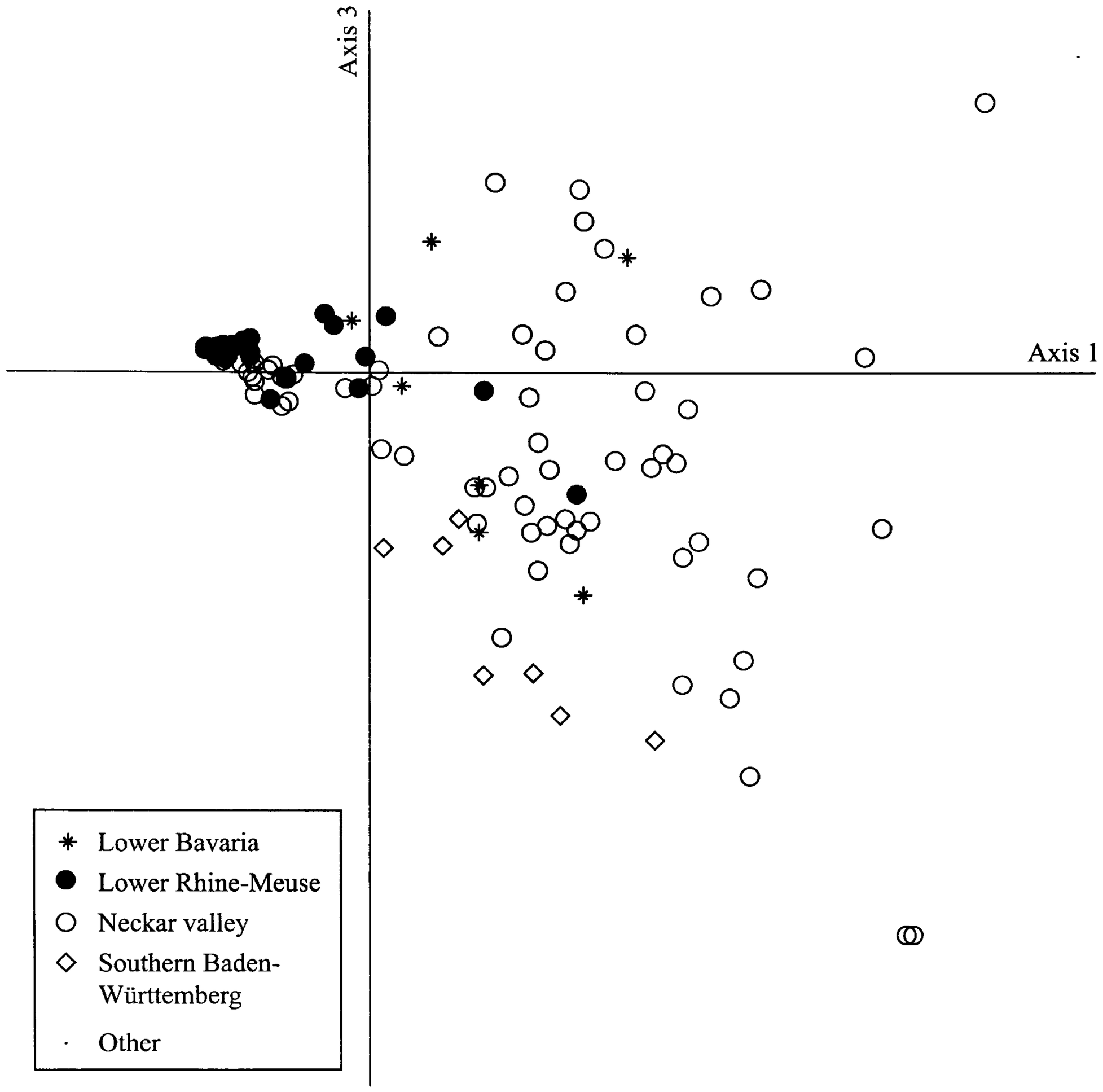


Fig. 4.30. Correspondence analysis plot (axis 1 and 3) of glume base samples showing the geographical regions from which samples derive

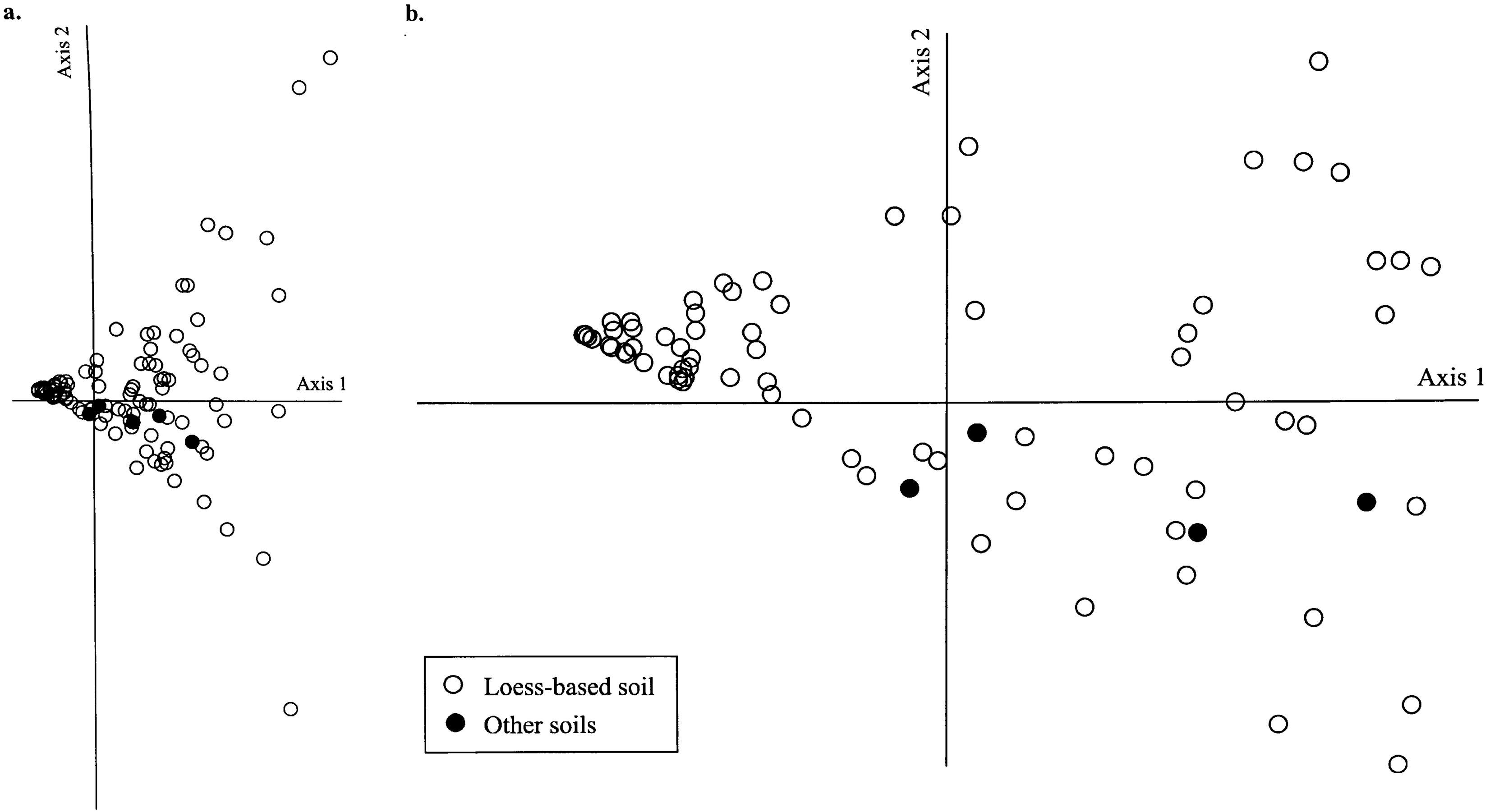


Fig. 4.31. Correspondence analysis plot of glume base samples showing the general soil type surrounding the sites from which samples derive; a. whole plot; b. expanded section around origin

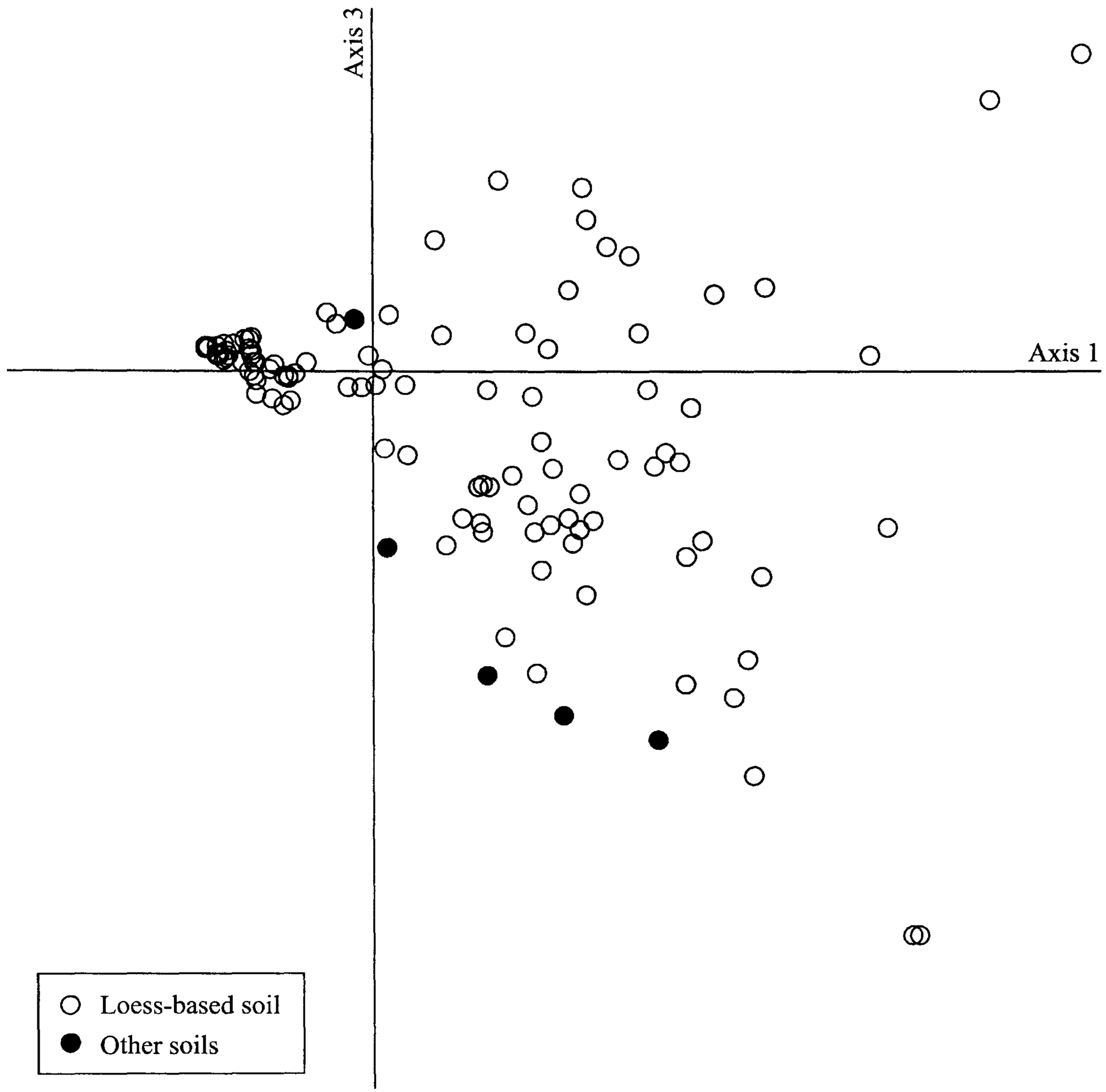


Fig. 4.32. Correspondence analysis plot (axis 1 and 3) of glume base samples showing the general soil type surrounding the sites from which samples derive

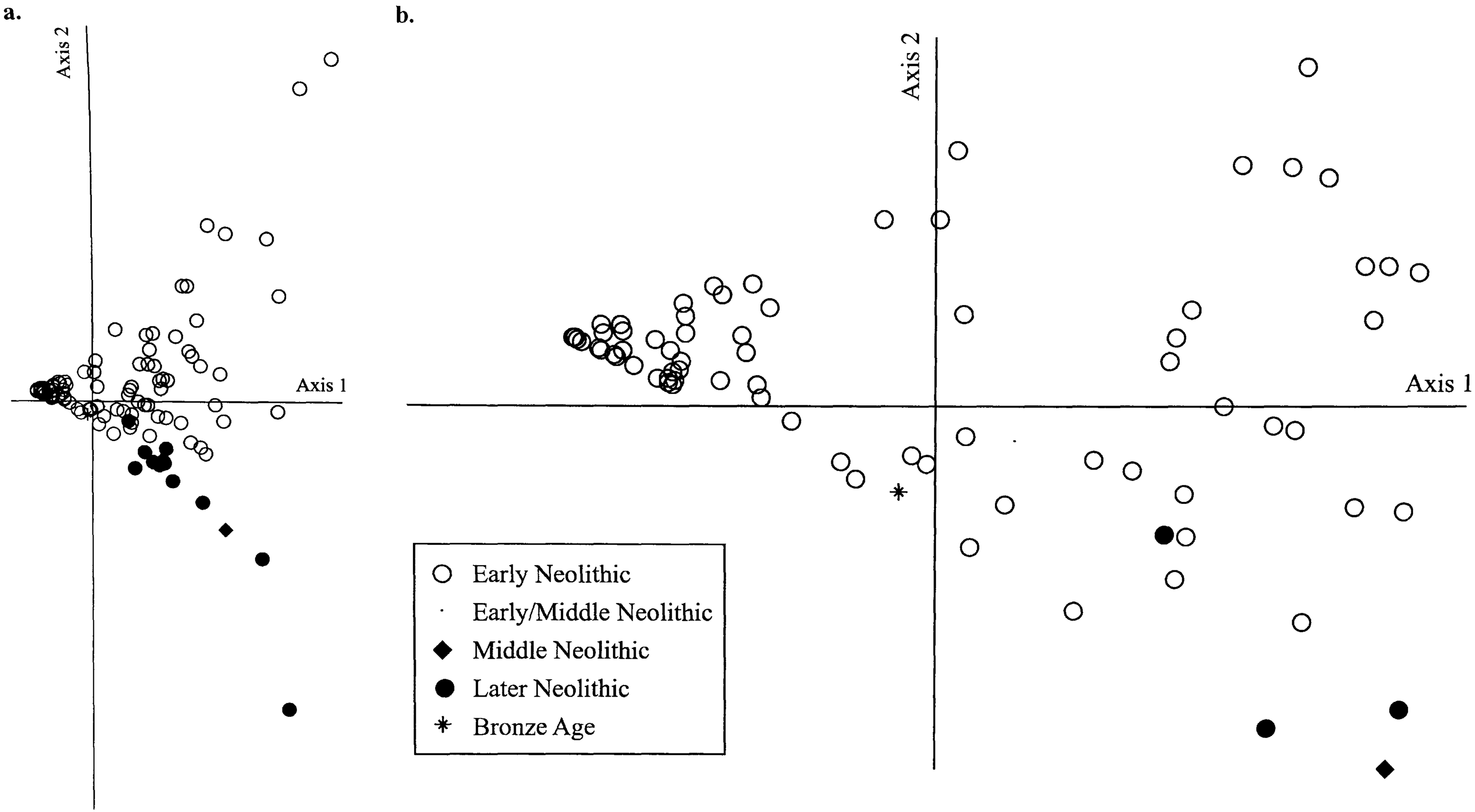


Fig. 4.33. Correspondence analysis plot of glume base samples showing the period from which samples derive; a. whole plot; b. expanded section around origin

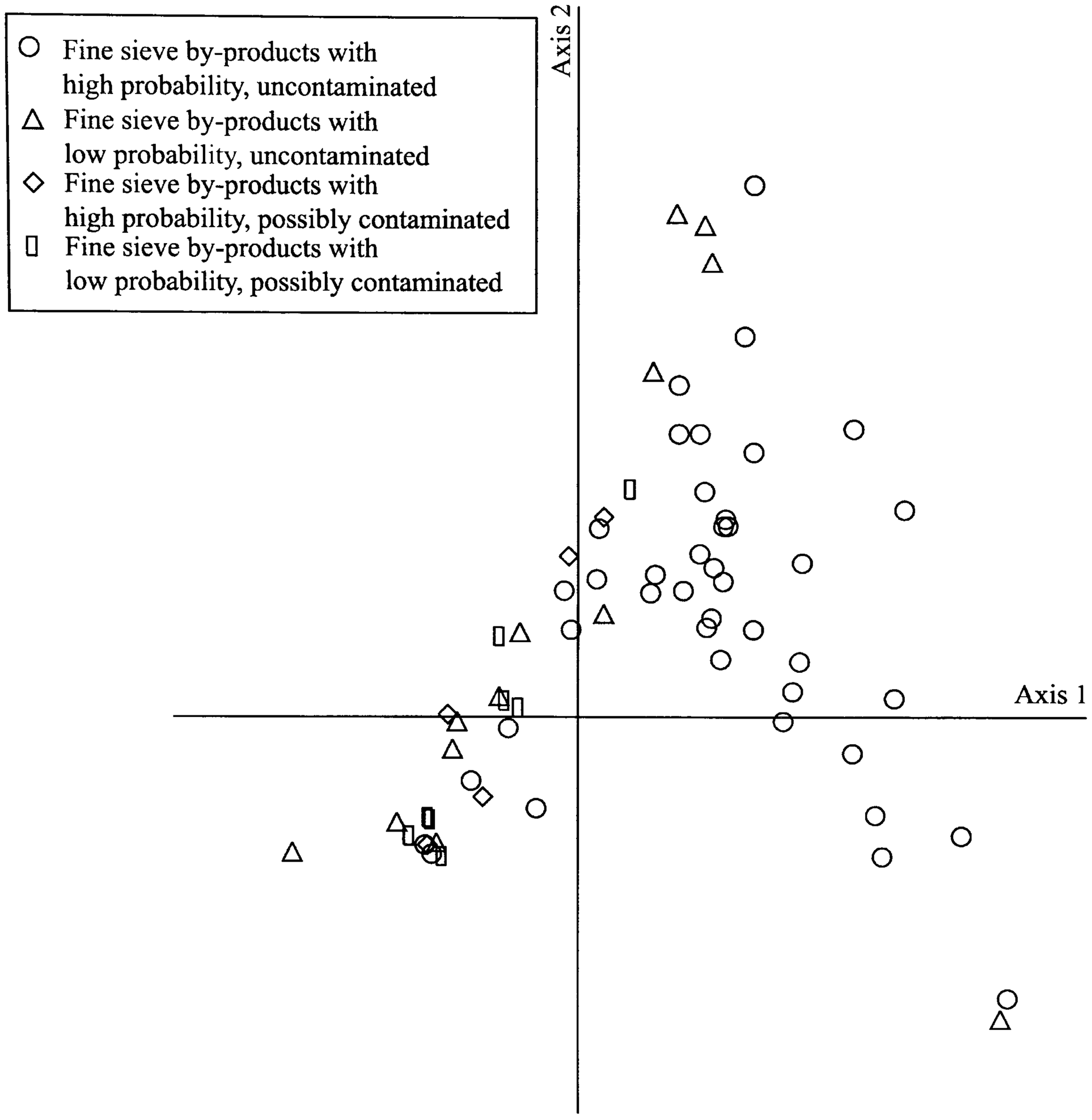


Fig. 4.34. Correspondence analysis plot of glume base samples (without *Chenopodium album*) showing crop processing categories

a.

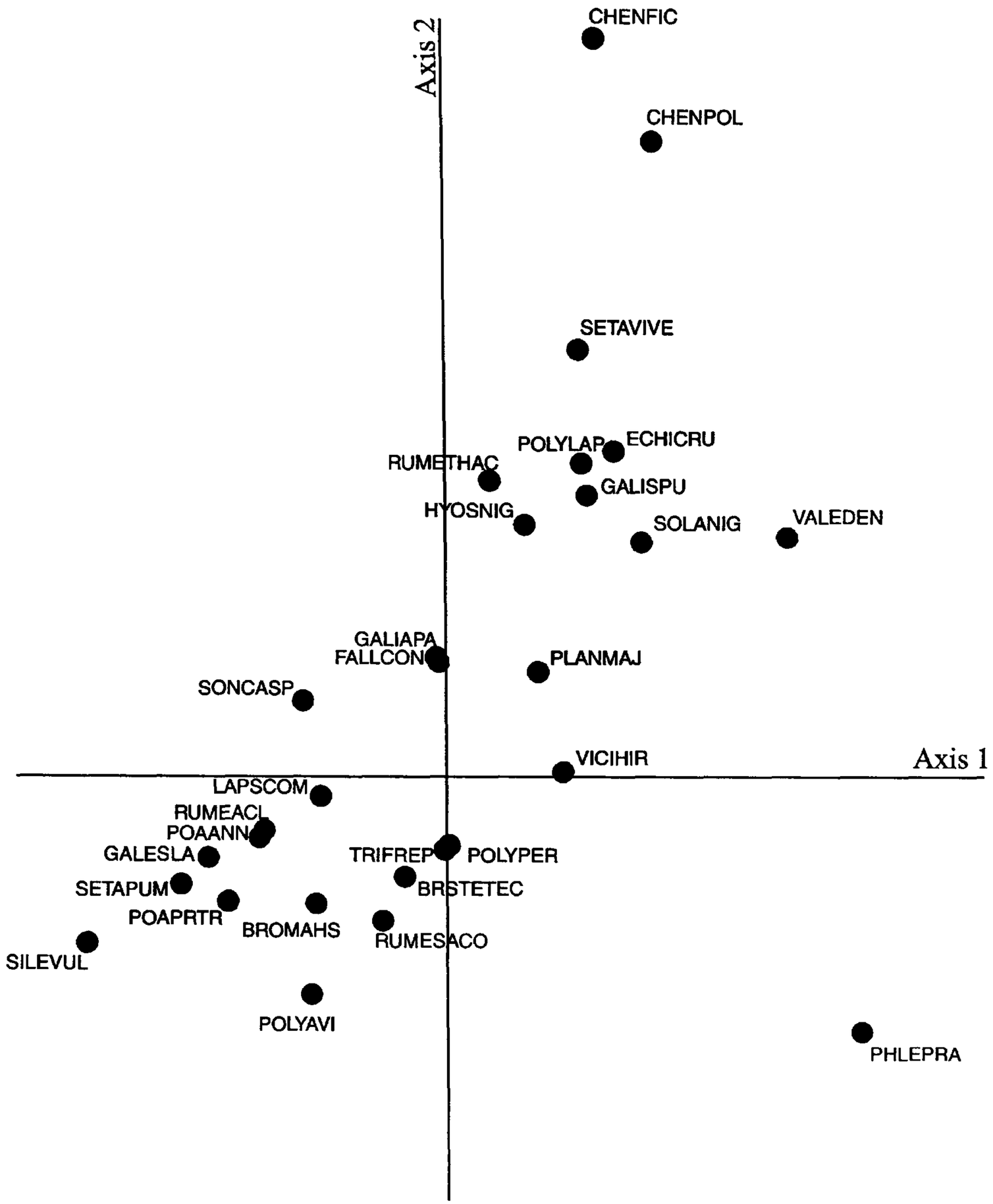


Fig. 4.35. Correspondence analysis plot of wild/weed species in the glume base samples (without *Chenopodium album*) (see Table 4.6 for species codes)

b.

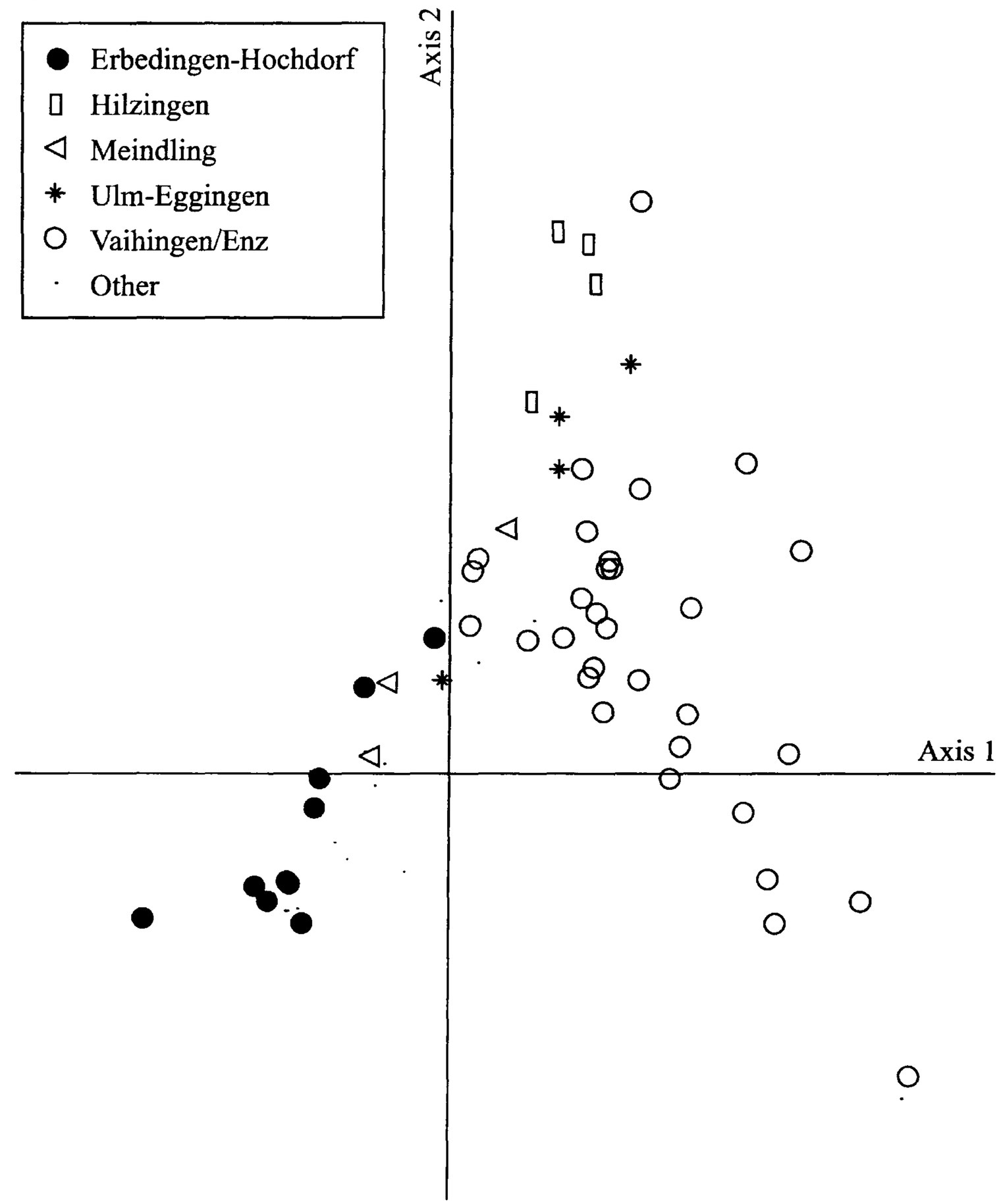


Fig. 4.36. Correspondence analysis plot of glume base samples (without *Chenopodium album*) showing the archaeological sites from which samples derive

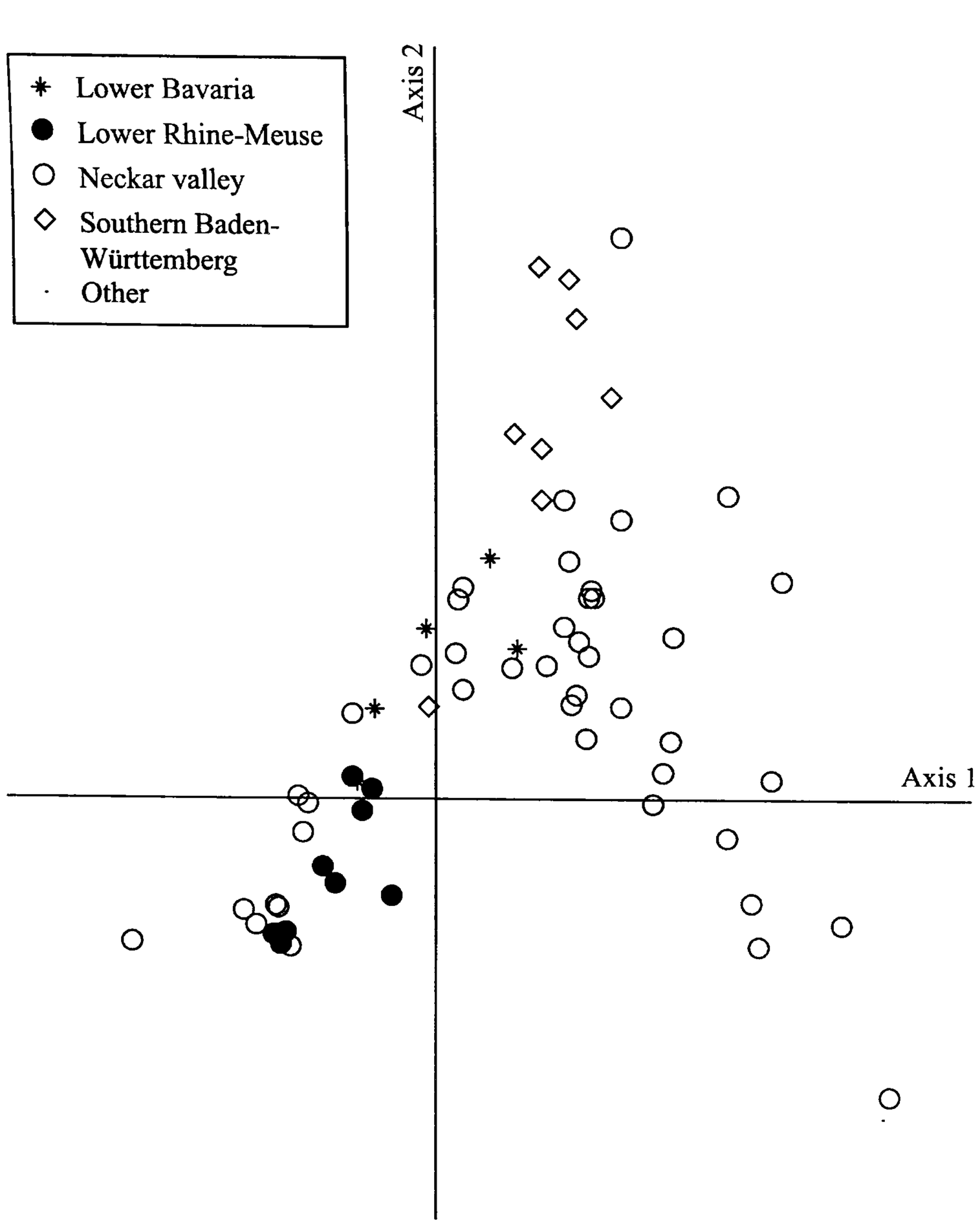


Fig. 4.37. Correspondence analysis plot of glume base samples (without *Chenopodium album*) showing the geographical regions from which samples derive

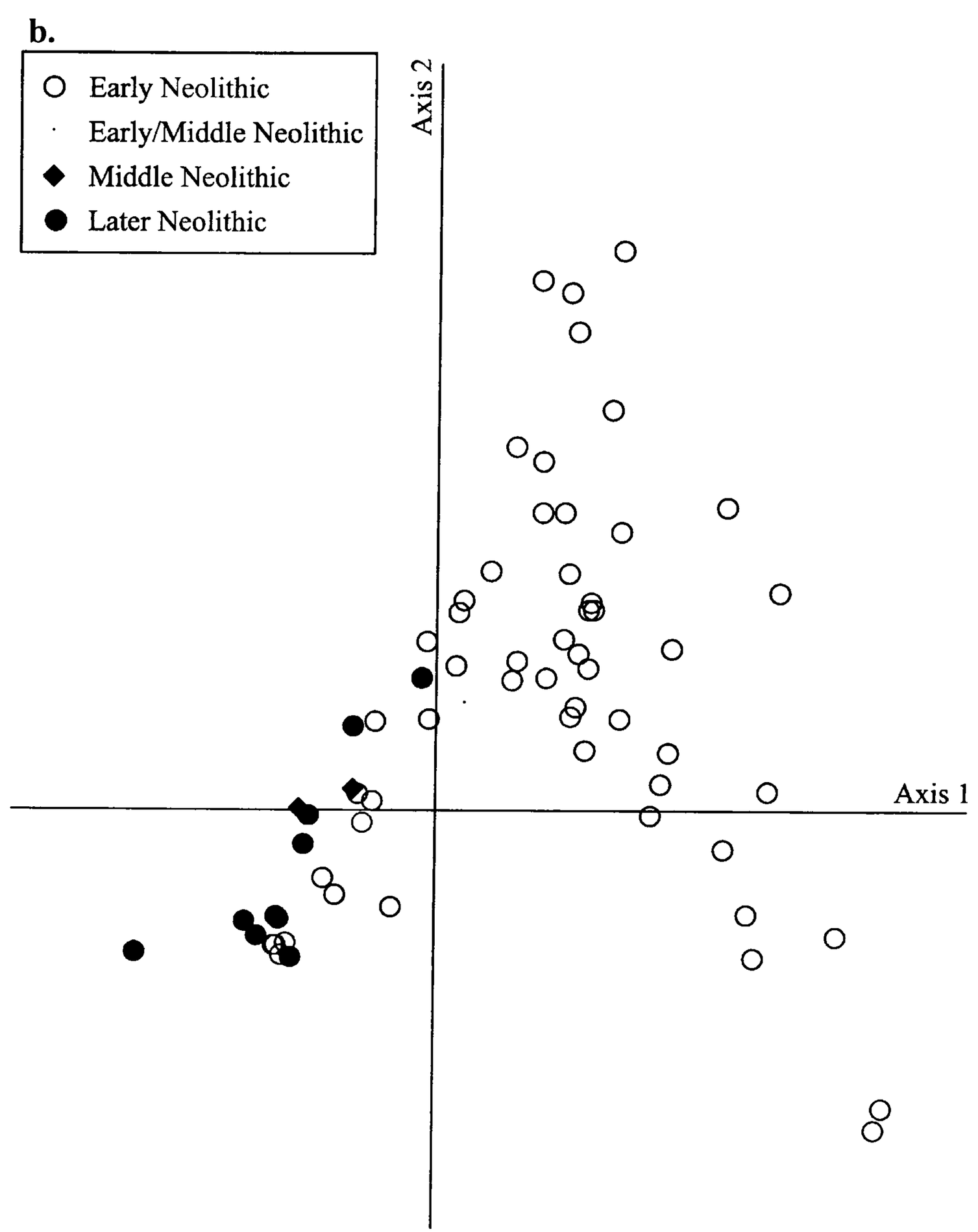
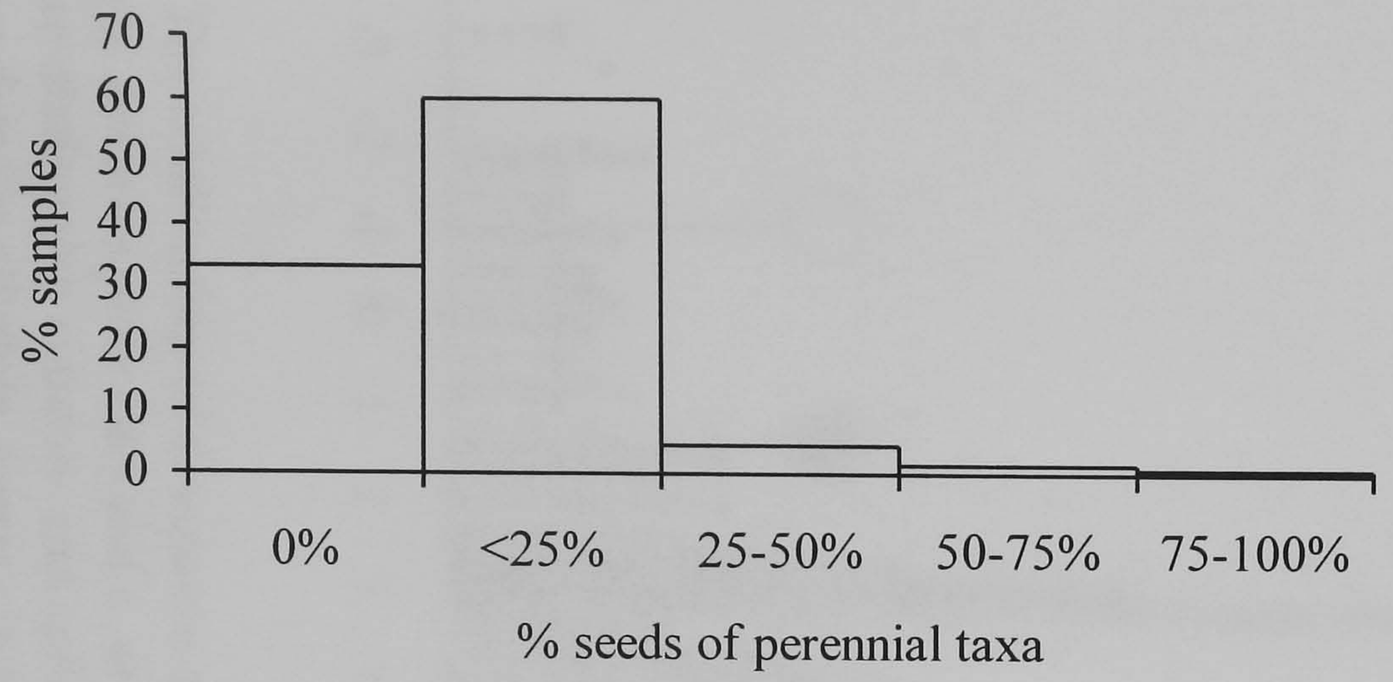


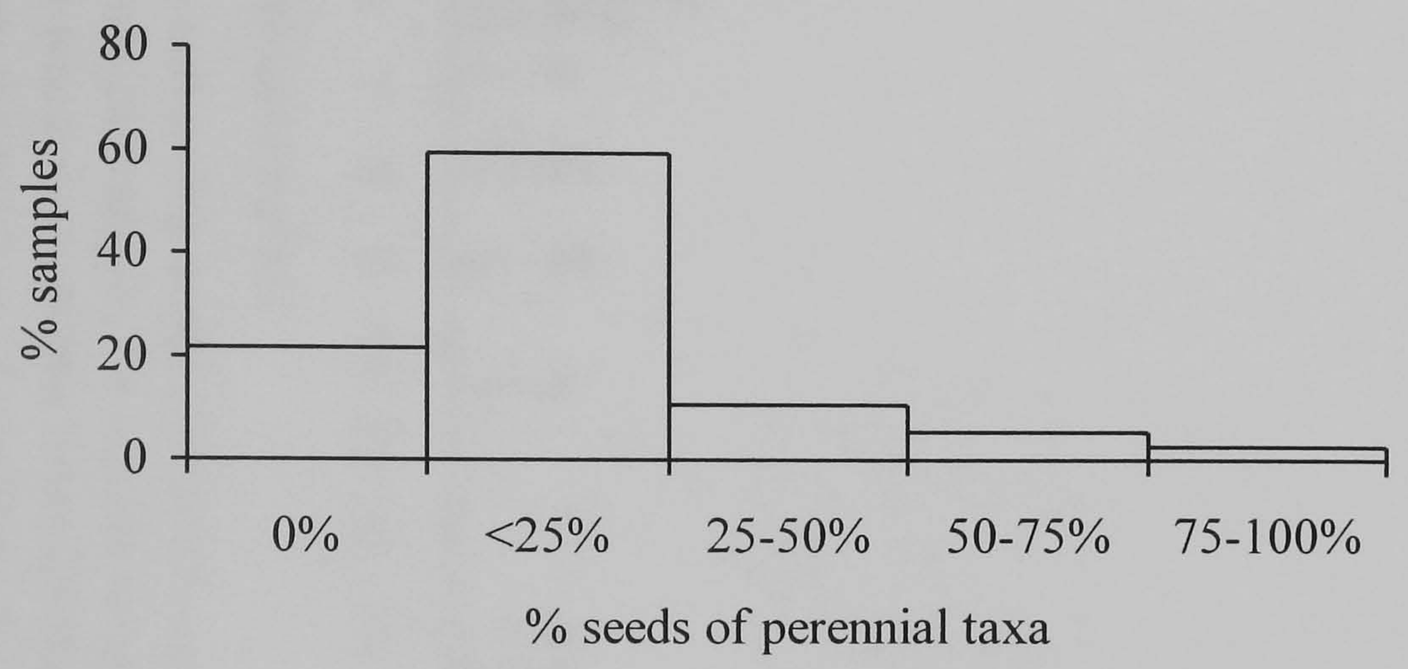
Fig. 4.38. Correspondence analysis plot of glume base samples (without *Chenopodium album*) showing the period from which samples derive

Based on seed counts

a. including *C. album*

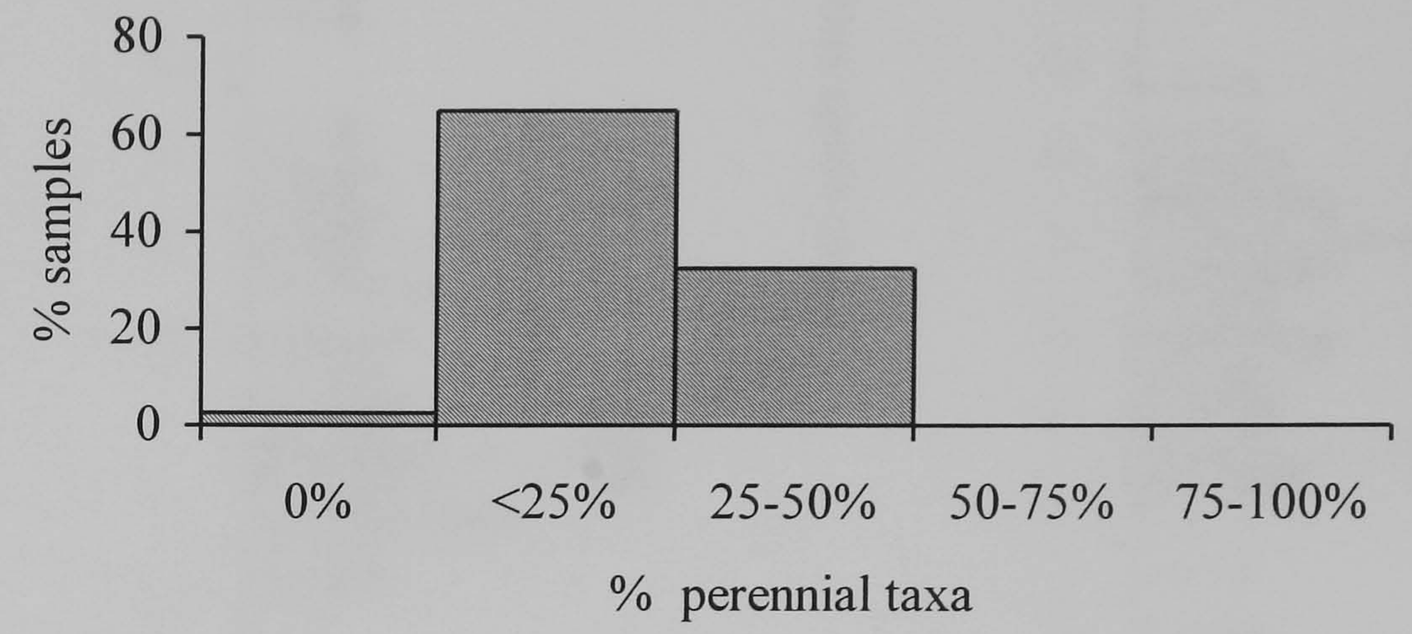


b. excluding *C. album*



Based on taxon counts

c. including *C. album*



d. excluding *C. album*

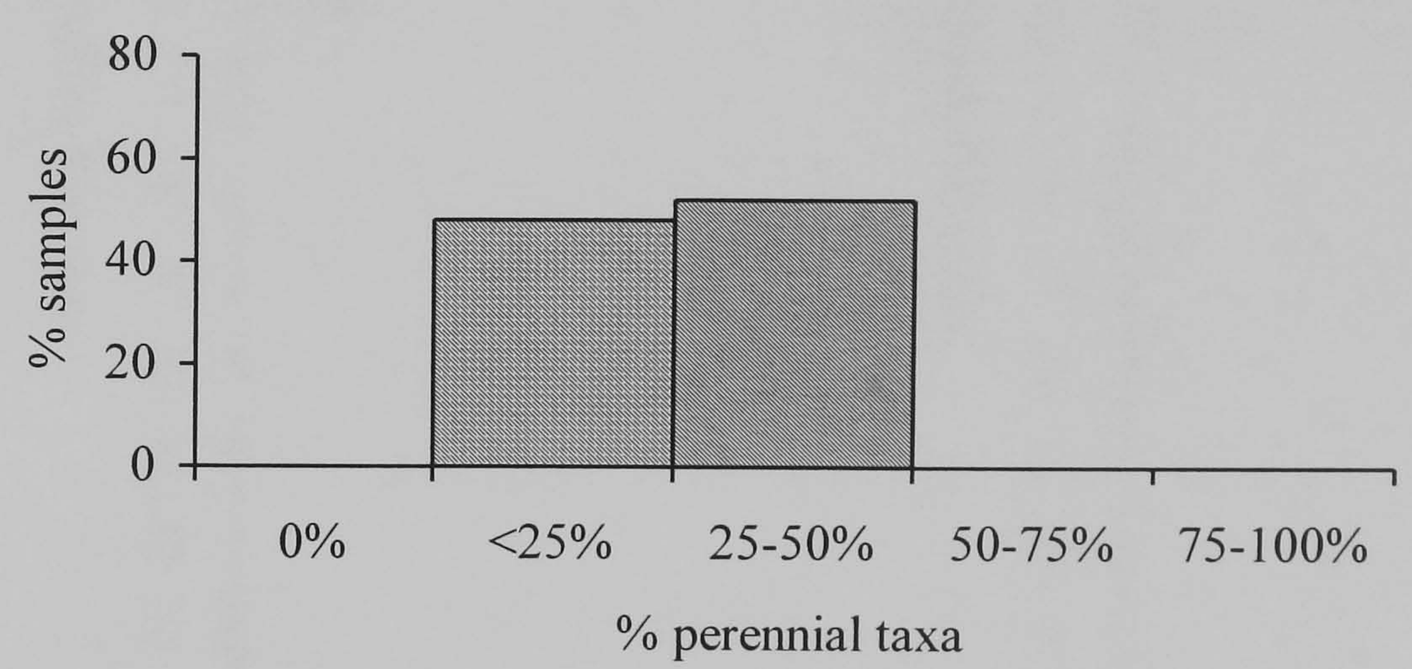
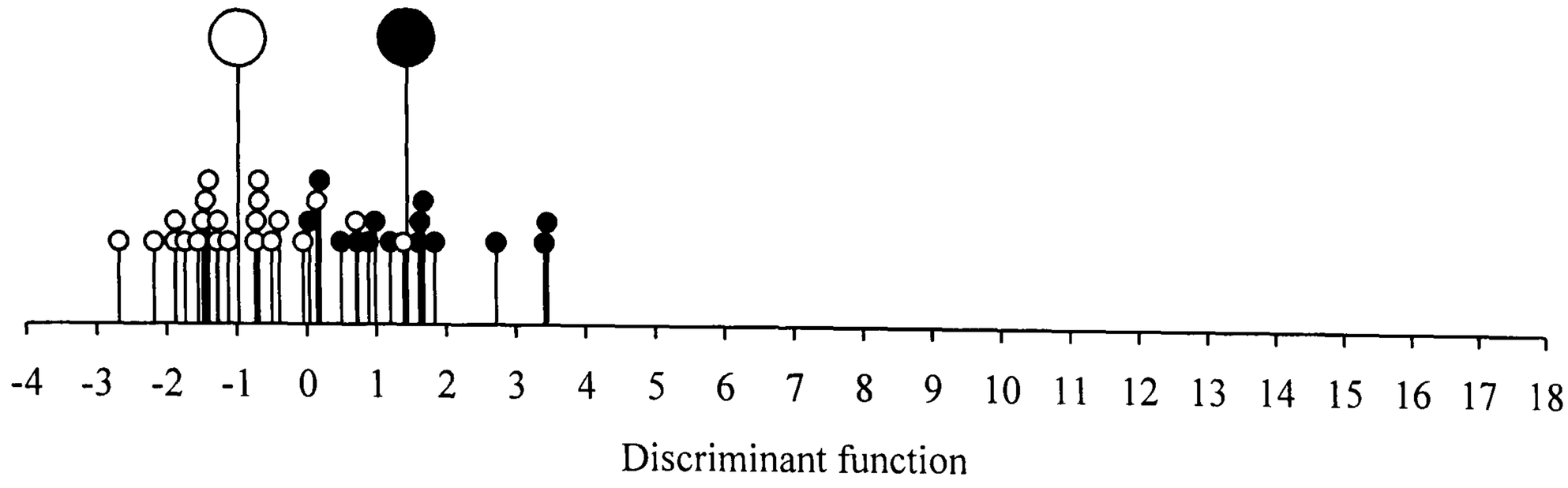
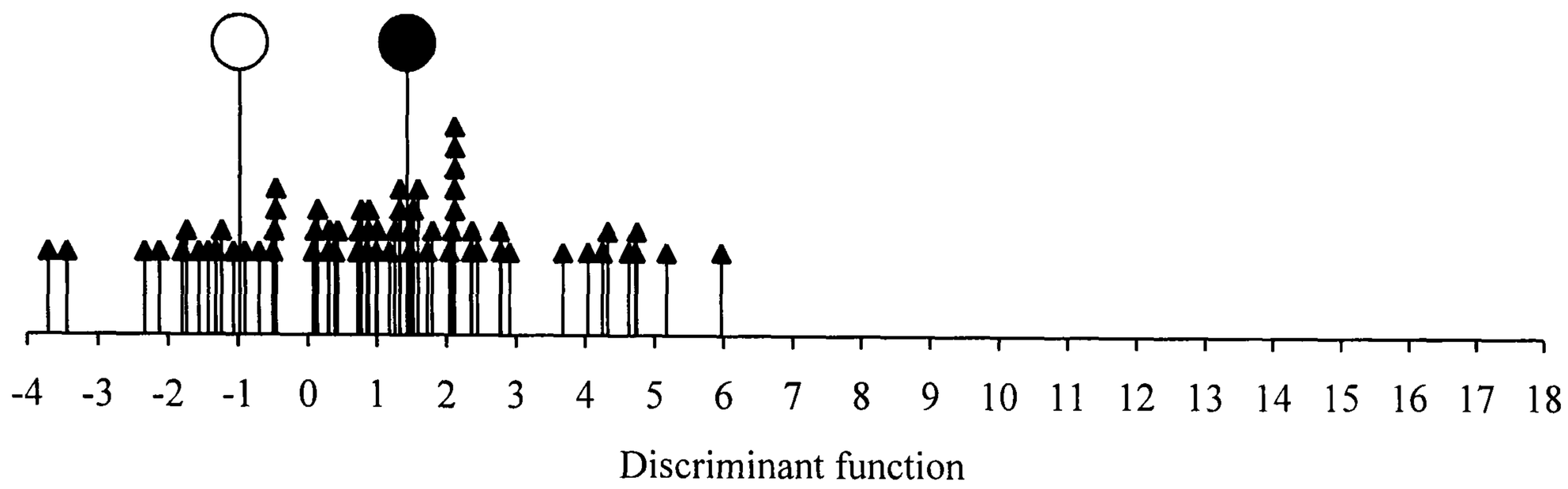


Fig. 5.1. Histograms showing proportions of perennials in the archaeobotanical samples: a. all samples (n=130); b. samples (n=74) including at least 30 wild/weed seeds after the removal of *Chenopodium album*; c. all samples (n=37) with at least 10 wild/weed taxa; d. samples (n=25) with at least 30 wild/weed seeds and 10 wild/weed taxa after the removal of *C. album*

a. Germany weed associations



b. Asturias spelt plots



c. Archaeobotanical samples

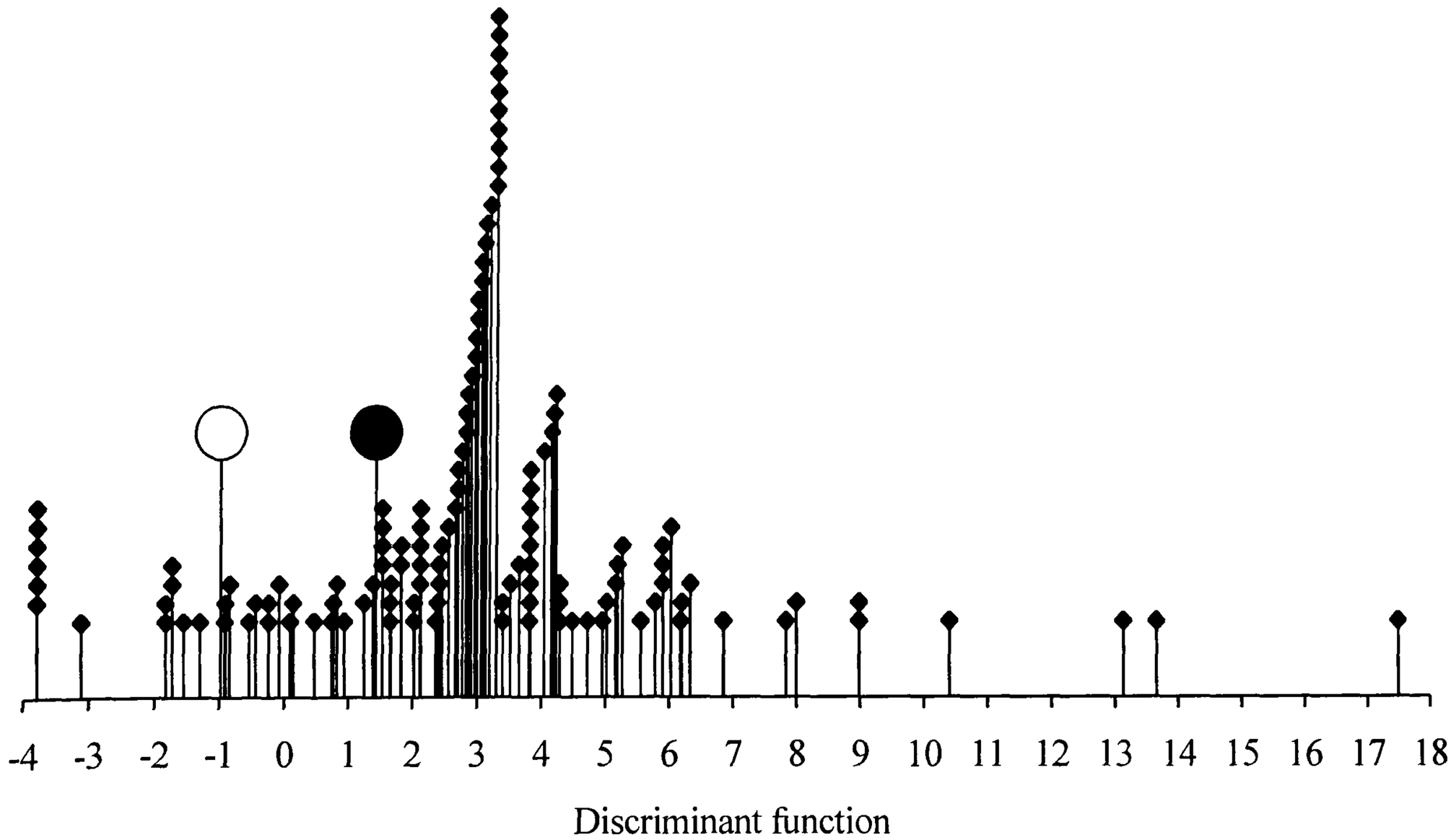
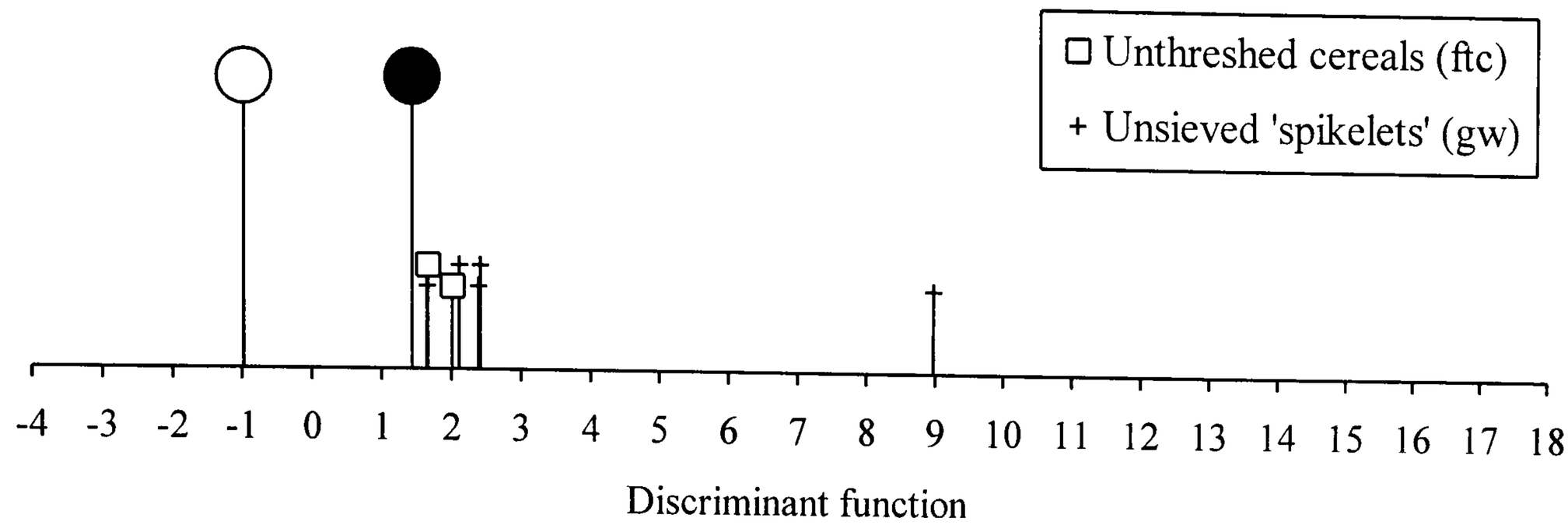
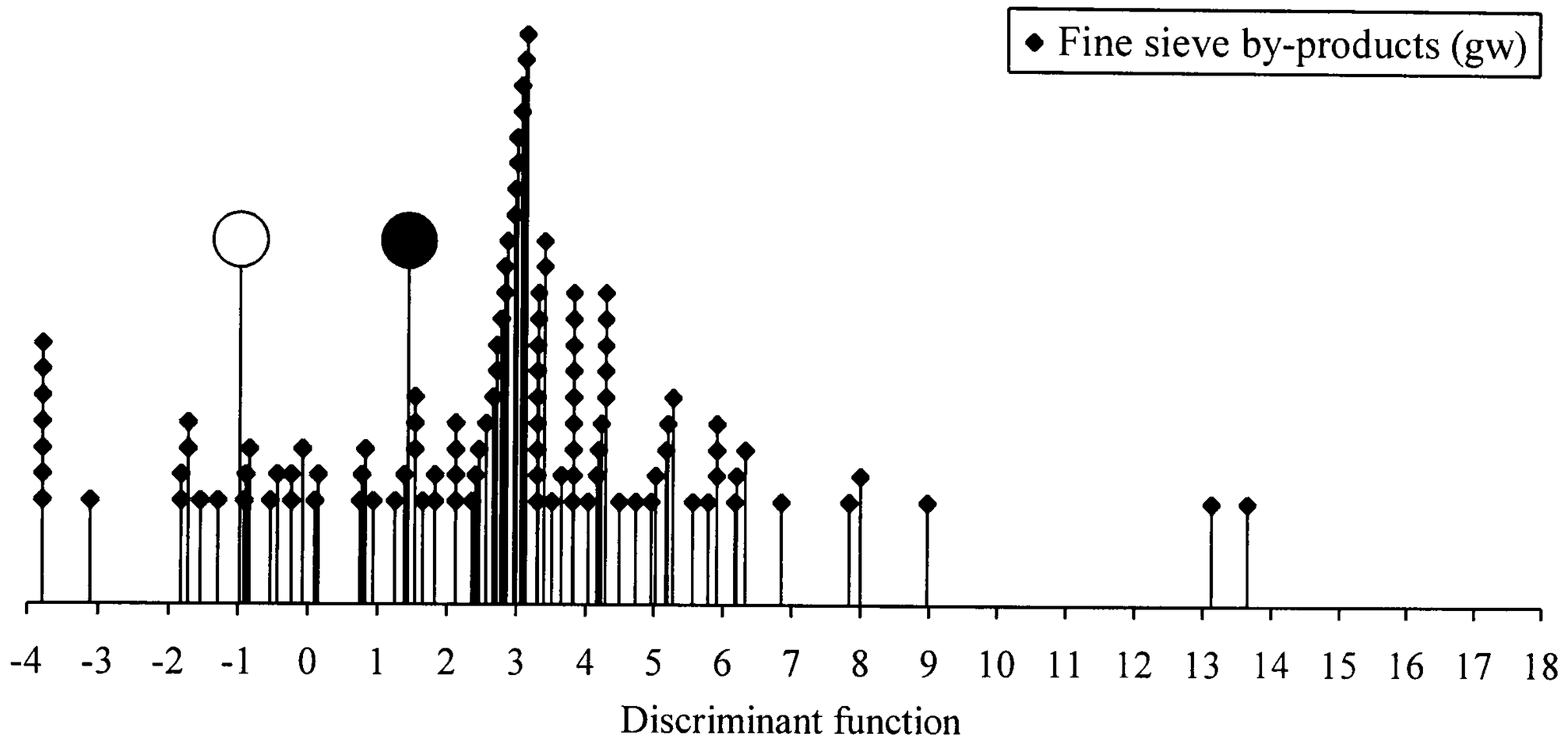


Fig. 5.2. The relationship of a. autumn-sown (●) and spring-sown (○) weed associations from Germany, b. Asturias plots (▲) and c. archaeobotanical samples (♦) to the discriminant function extracted to distinguish autumn- and spring-sown weed associations from Germany based on semi-quantitative data (in all plots, larger circles indicate the position of centroids for Germany groups)

a.



b.



c.

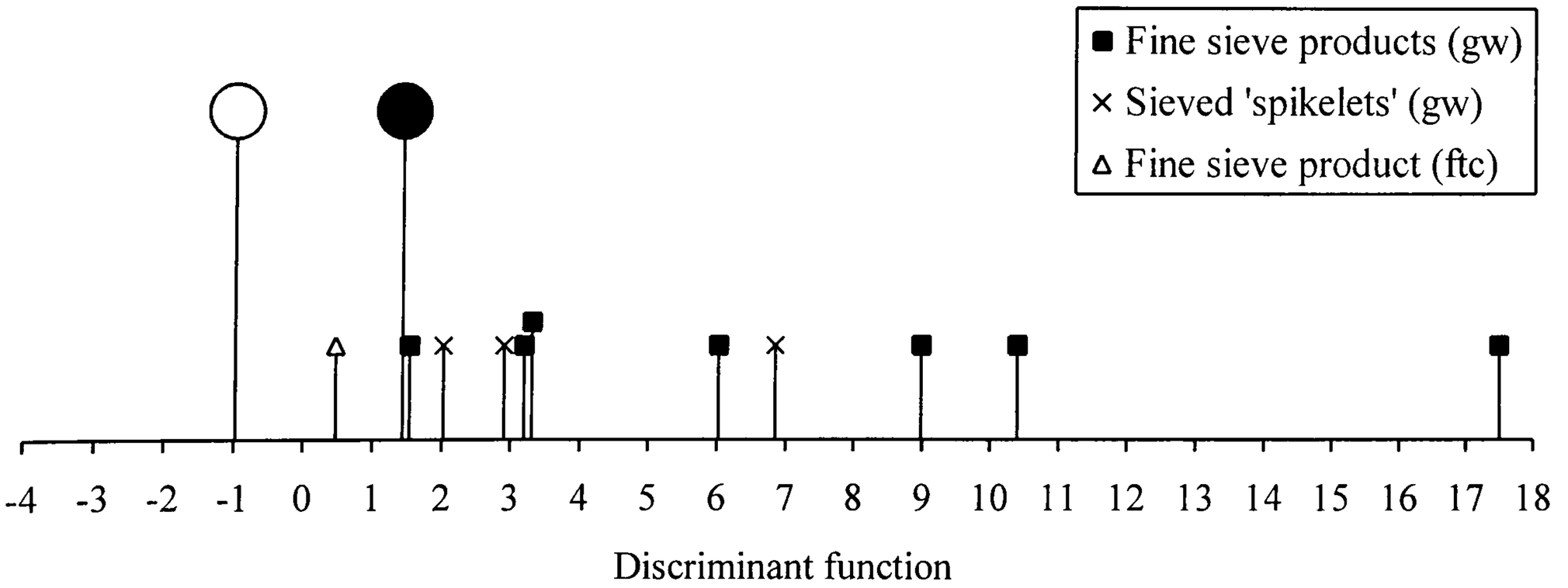
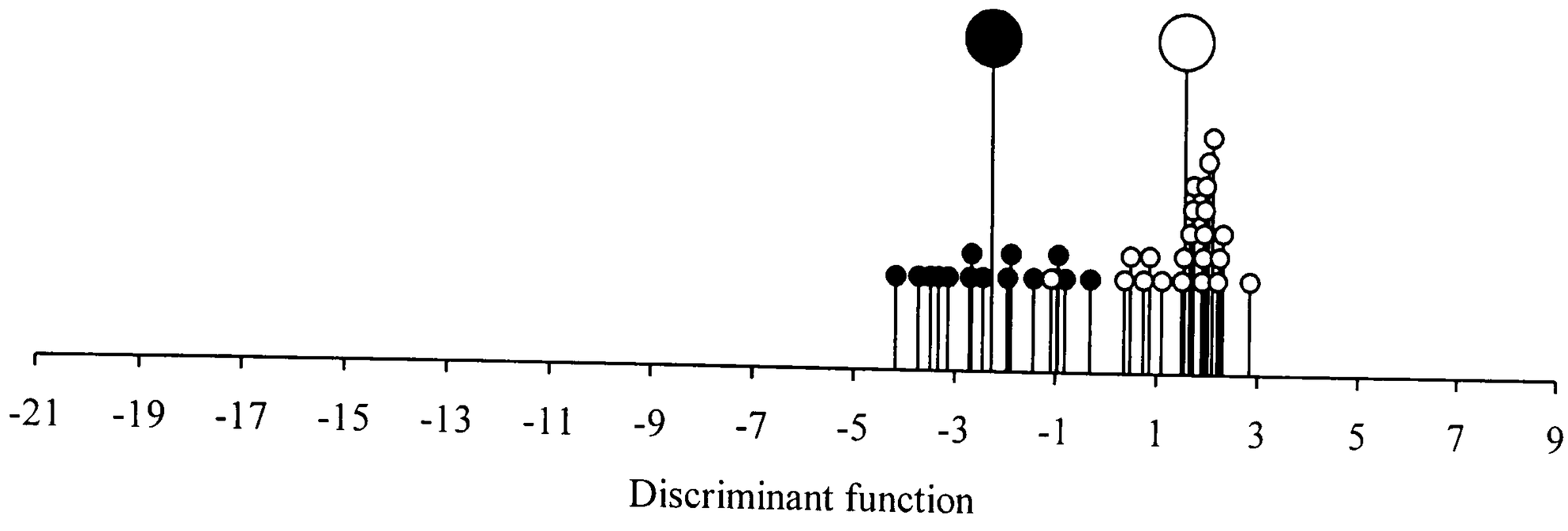
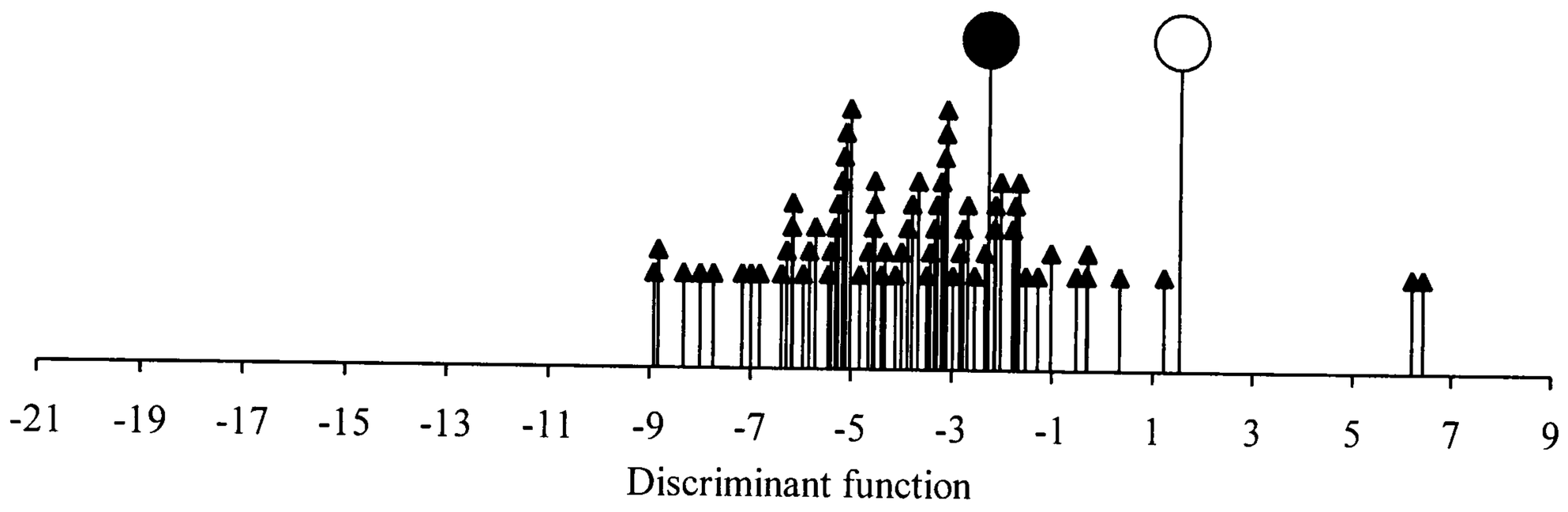


Fig. 5.3. The relationship of archaeobotanical samples from different processing stages to the distriminant function based on semi-quantitative data: a. unthreshed and unsieved 'spikelet' samples b. fine sieve by-product samples; c. sieved 'spikelet' and fine sieve product samples (ftc = free-threshing cereal, gw = glume wheat; large circles indicate the position of centroids for Germany groups)

a. Germany weed associations



b. Asturias spelt plots



c. Archaeobotanical samples

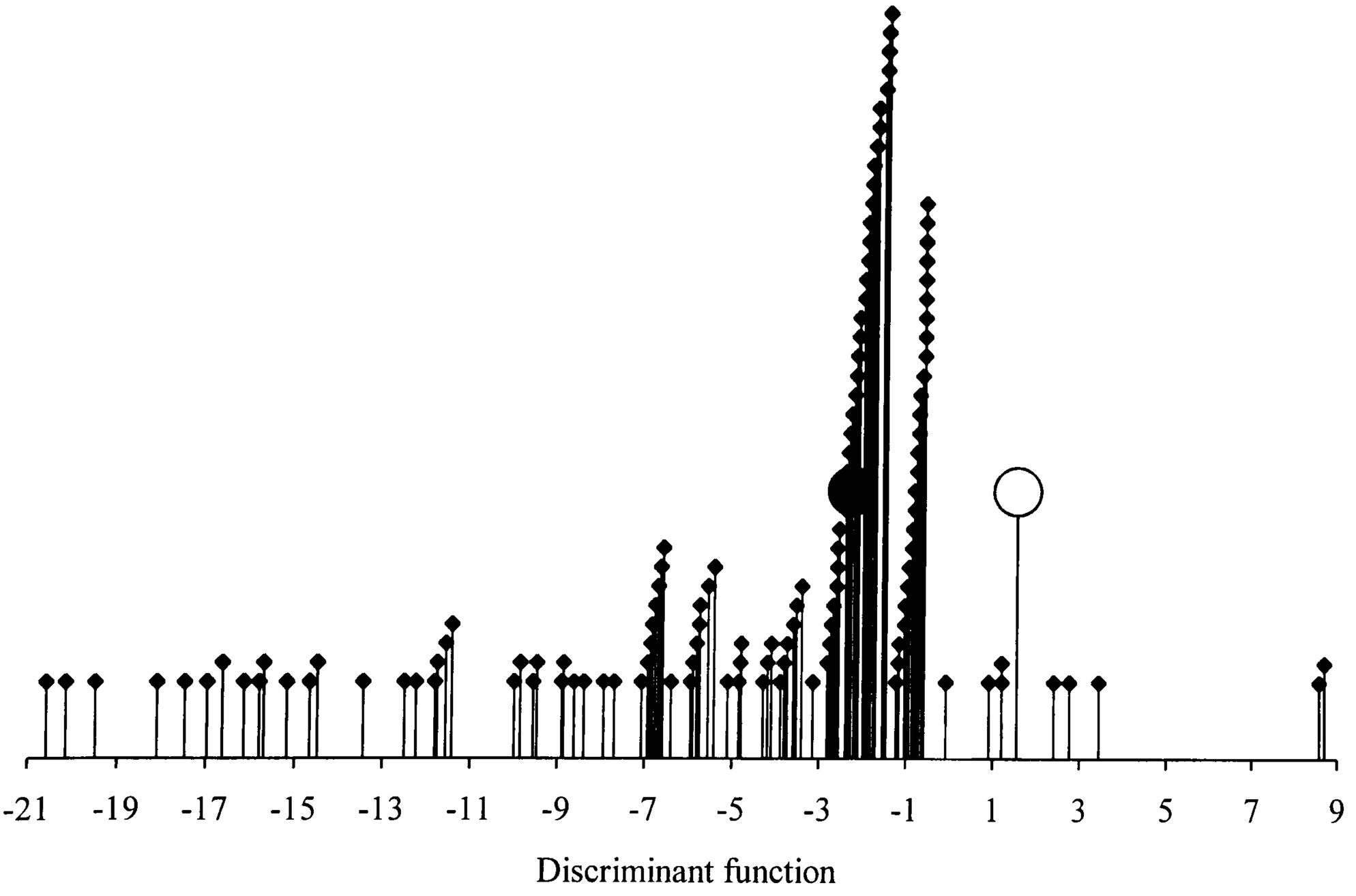
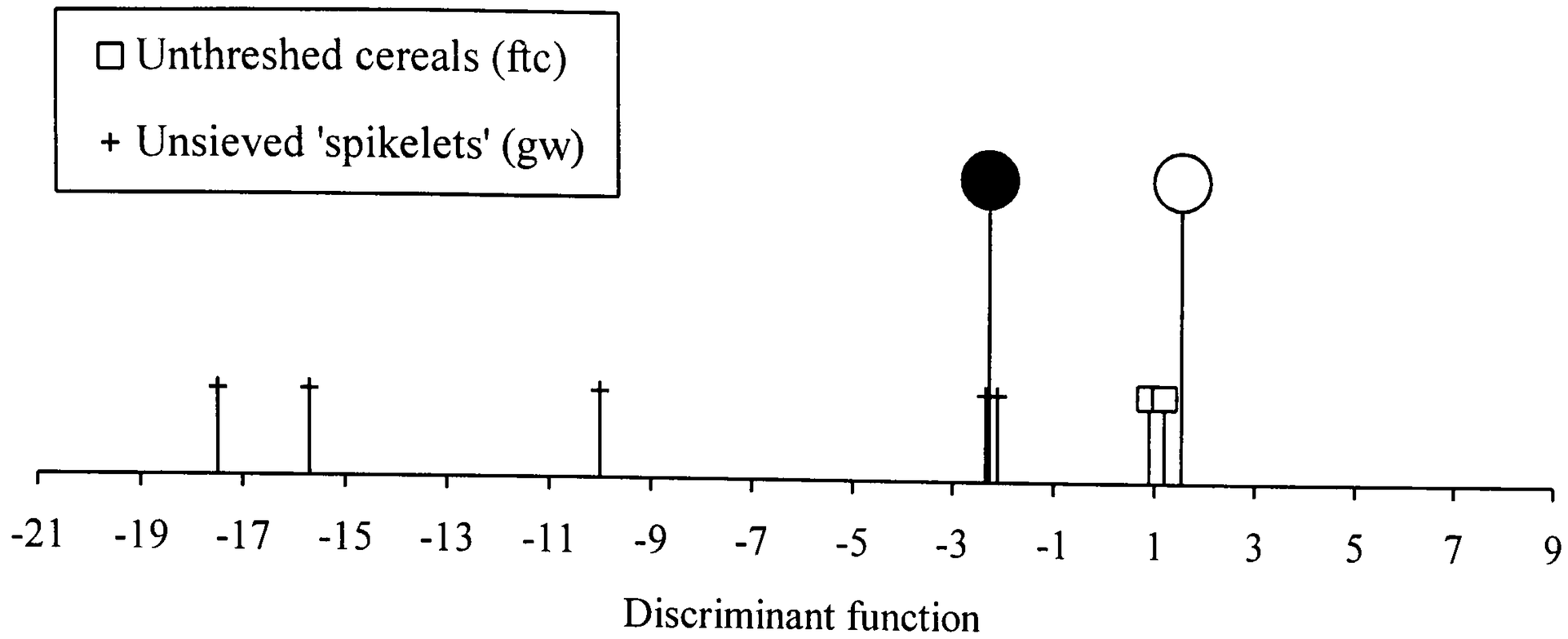
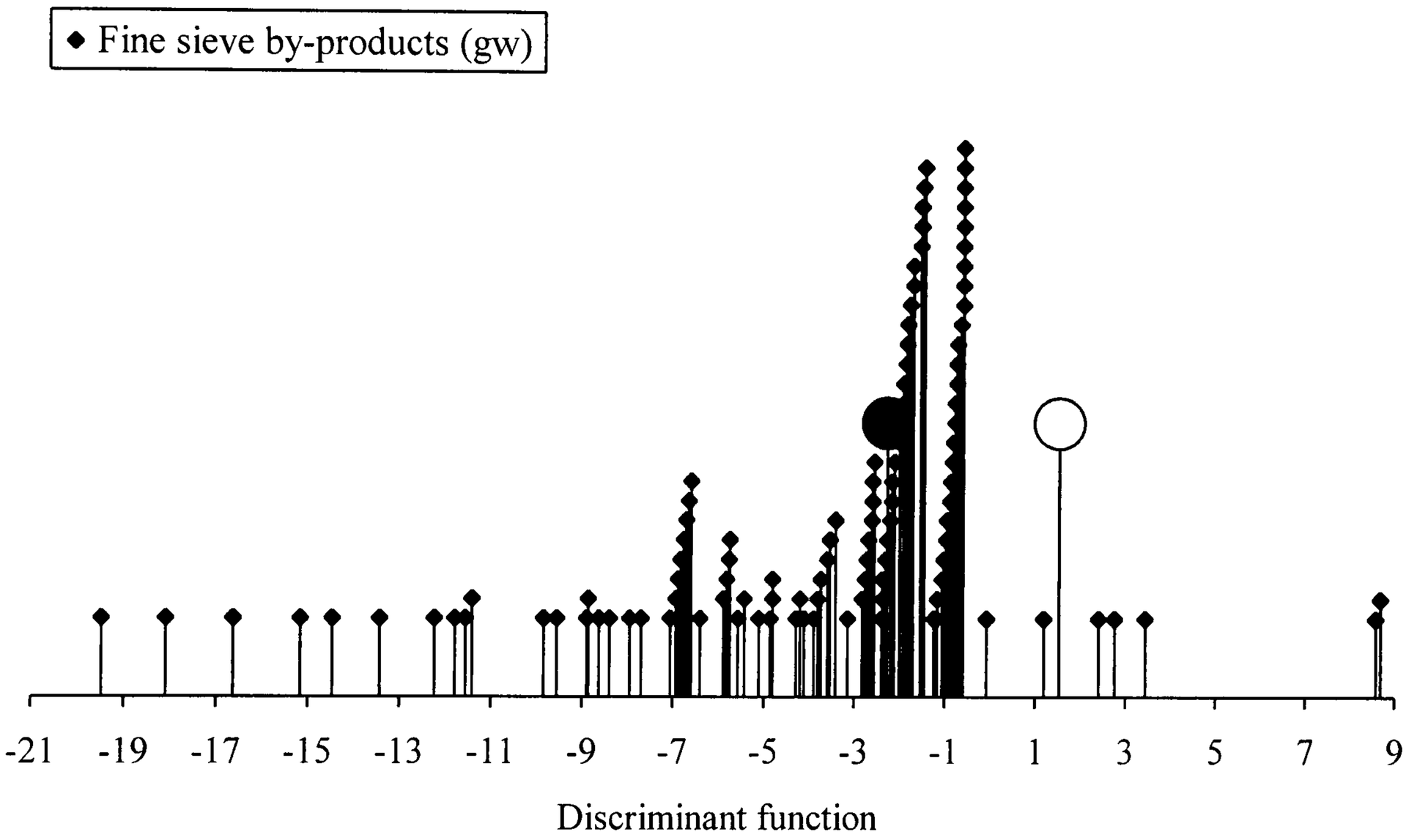


Fig. 5.4. The relationship of a. autumn-sown (●) and spring-sown (○) weed associations from Germany, b. Asturias plots (▲) and c. archaeobotanical samples (♦) to the discriminant function extracted to distinguish autumn- and spring-sown weed associations from Germany based on quantitative data (in all plots, larger circles indicate the position of centroids for Germany groups)

a.



b.



c.

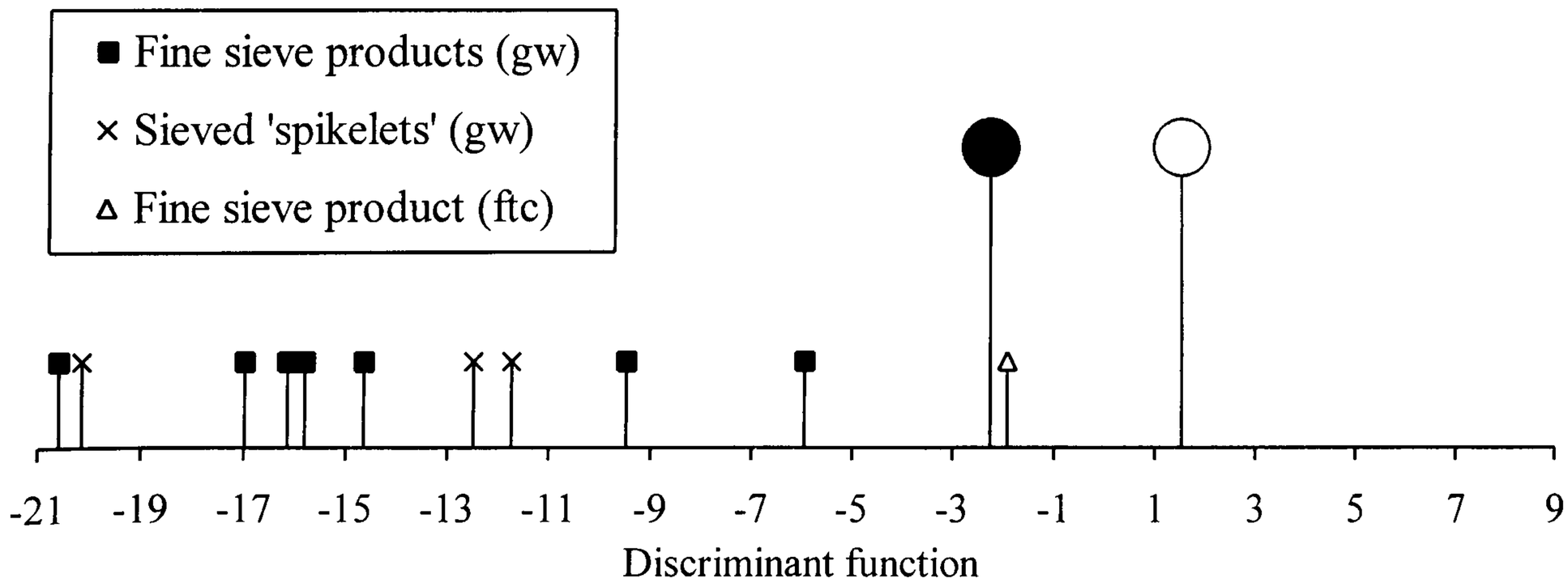
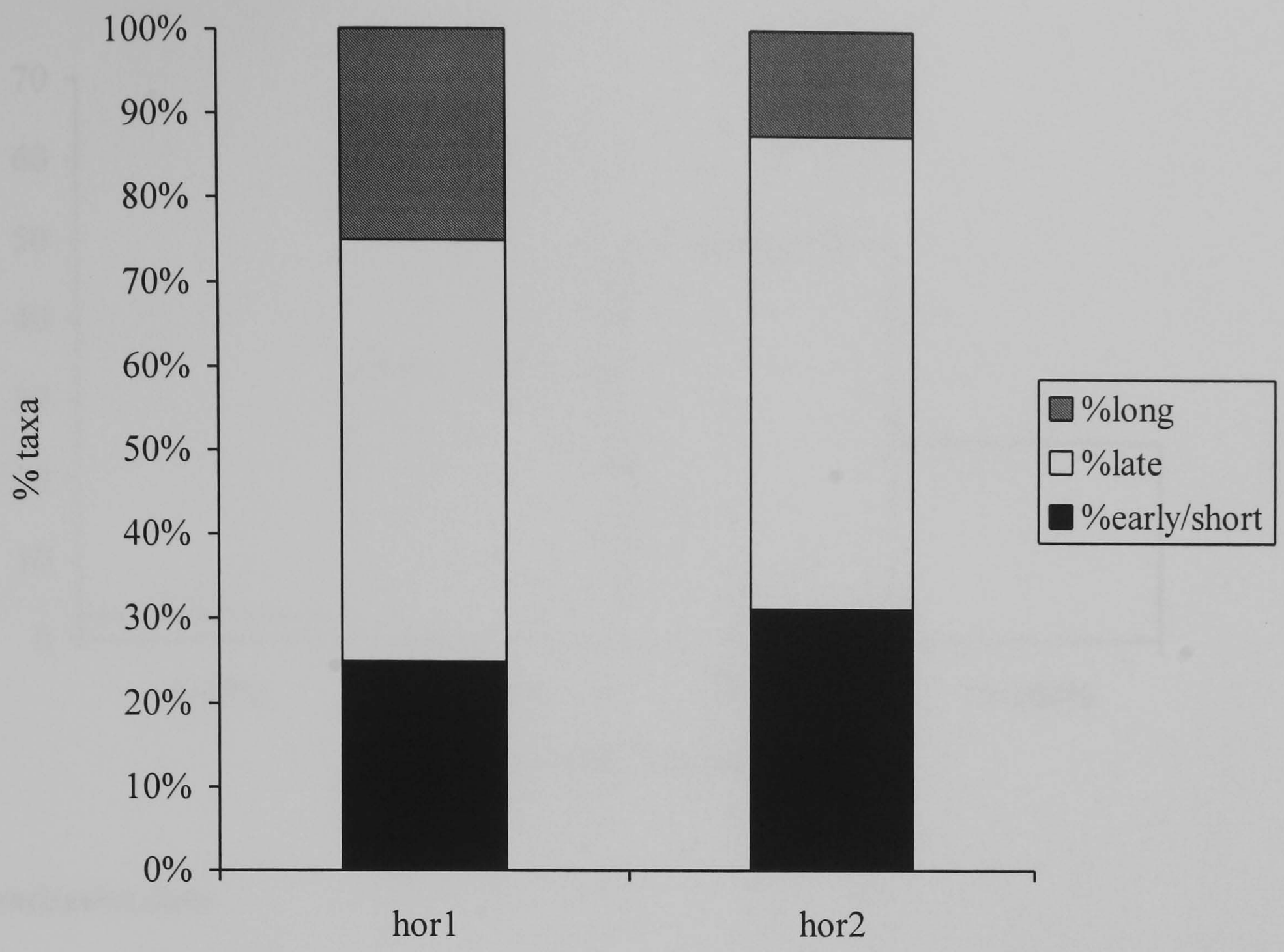


Fig. 5.5. The relationship of archaeobotanical samples from different processing stages to the discriminant function based on quantitative data: a. unthreshed and unsieved 'spikelet' samples; b. fine sieve by-product samples; c. sieved 'spikelet' and fine sieve product samples (ftc = free-threshing cereal, gw = glume wheat; large circles indicate the position of centroids for Germany groups)

a. Semi-quantitative data



b. Quantitative data

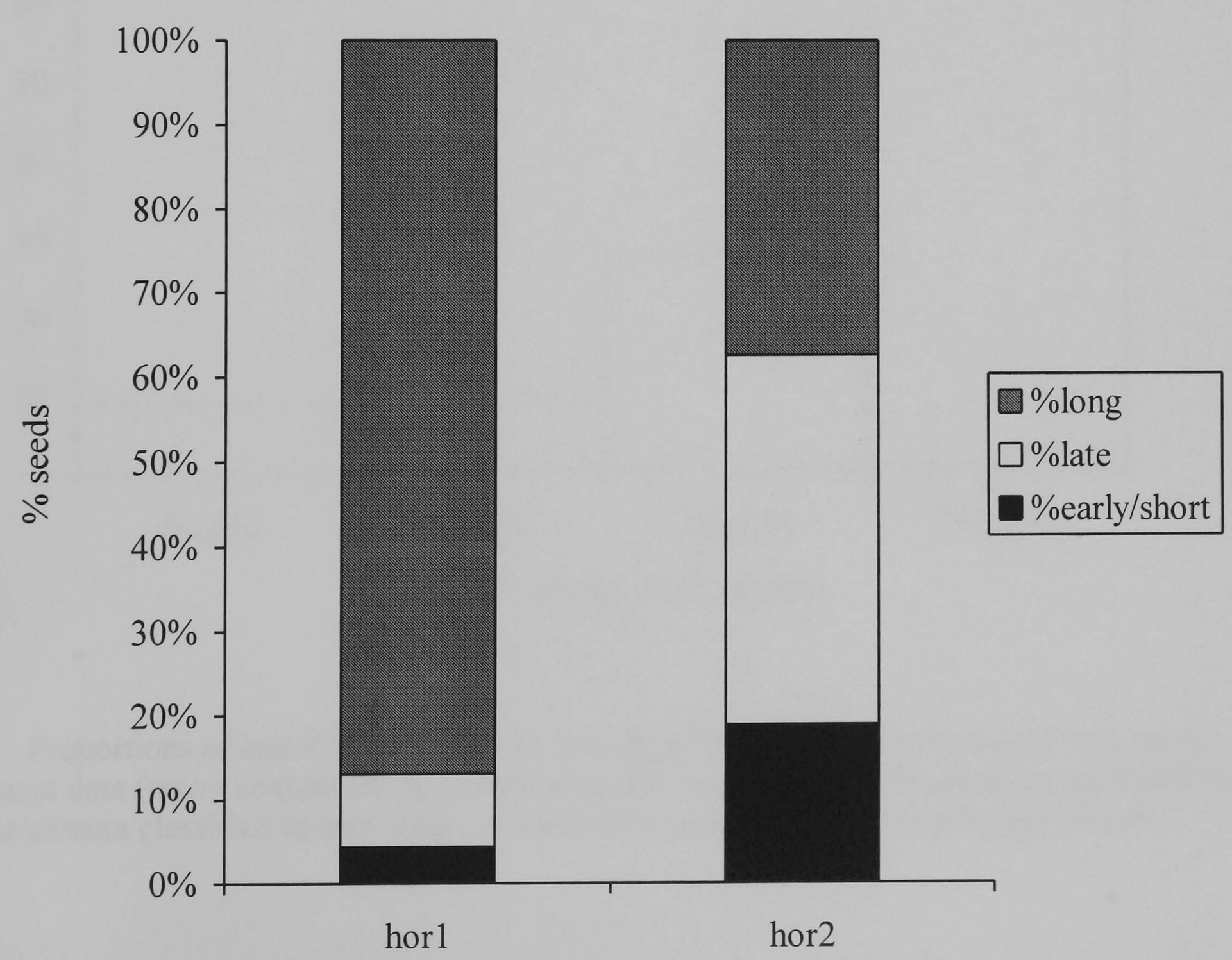
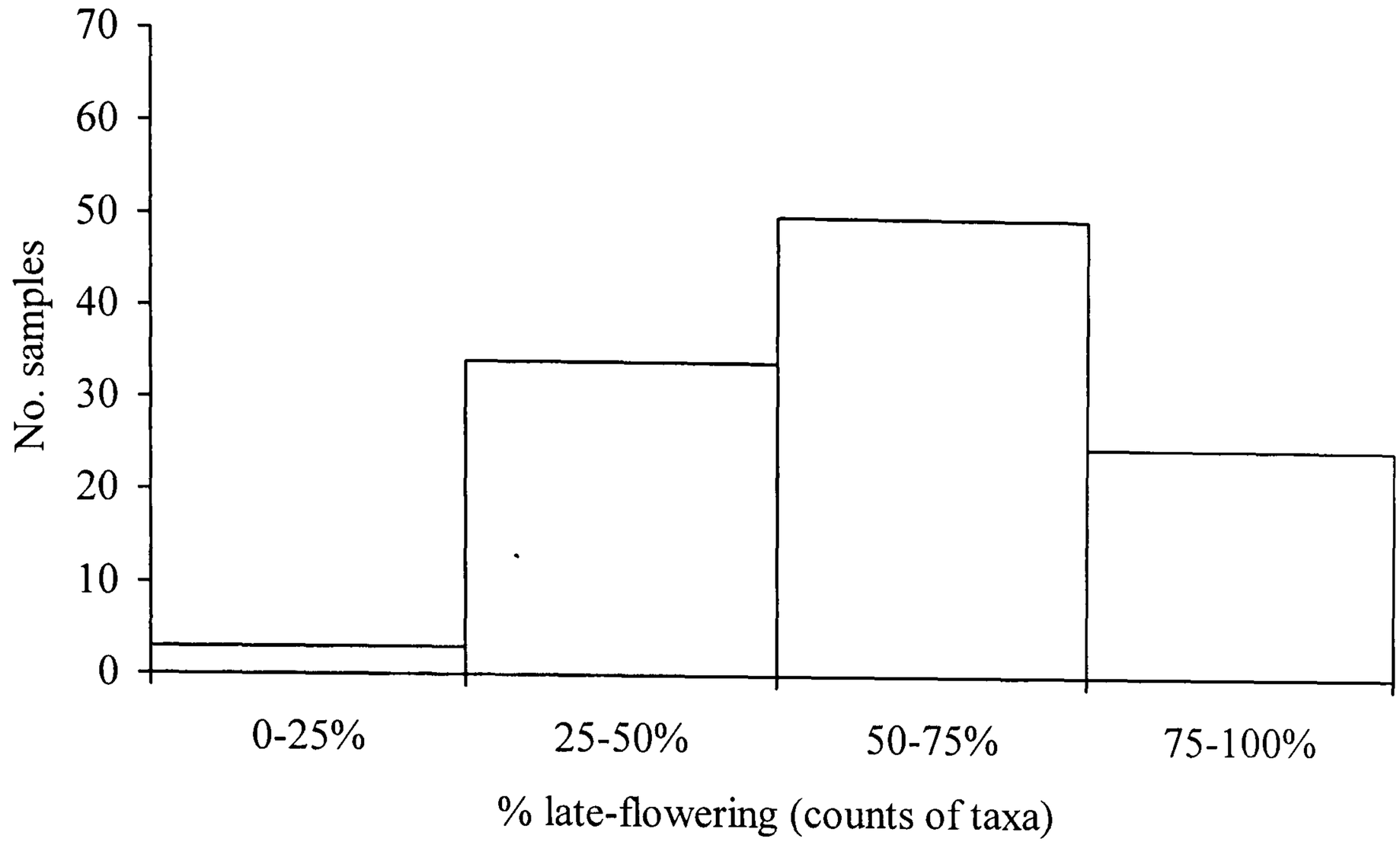


Fig. 5.6. Proportions of long-flowering, late-flowering and early-intermediate/short-flowering taxa in the unthreshed cereal samples based on a. semi-quantitative data (taxon counts) and b. quantitative data (seed counts) (see Table 4.3 for sample codes)

a. Semi-quantitative data



b. Quantitative data

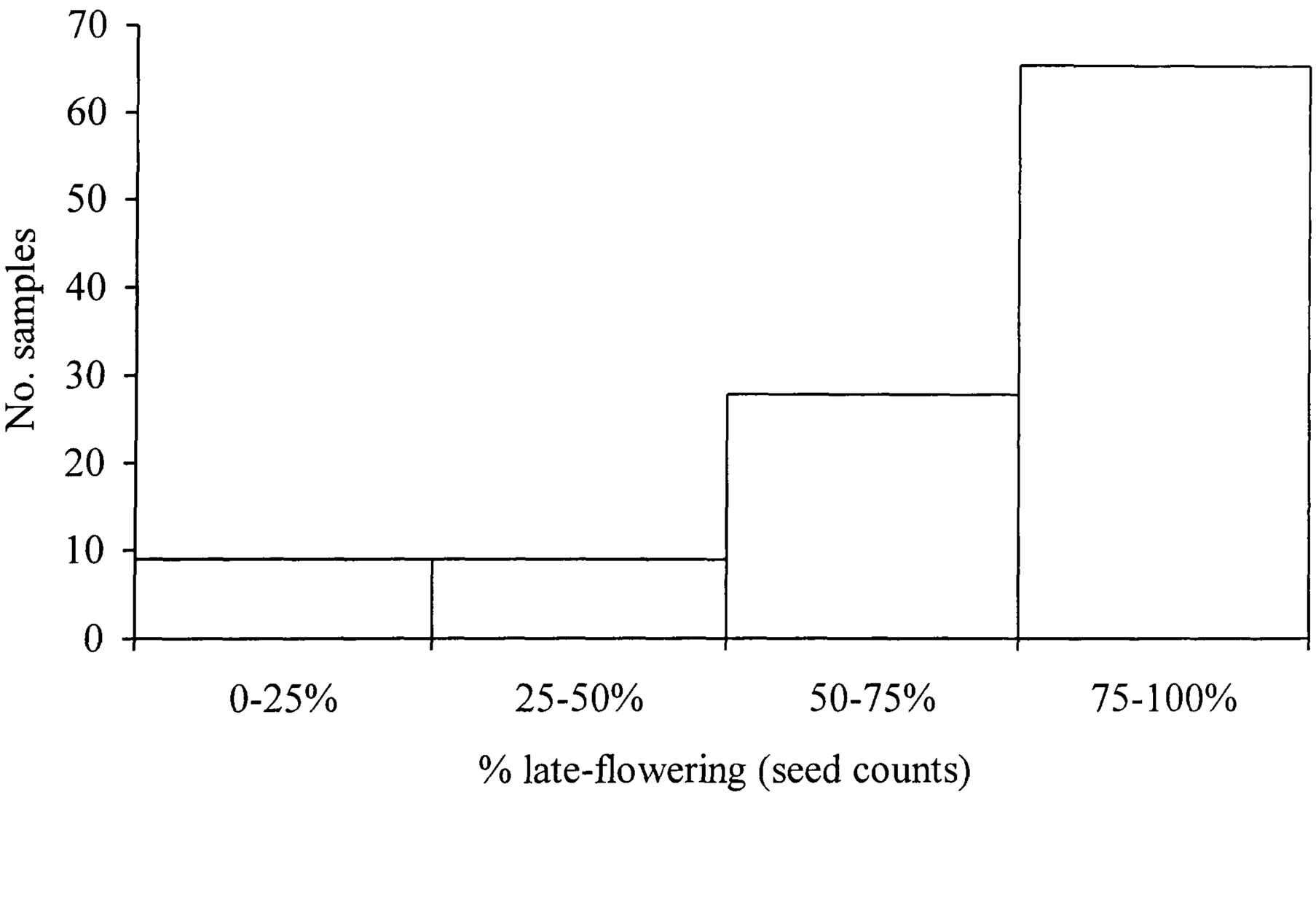
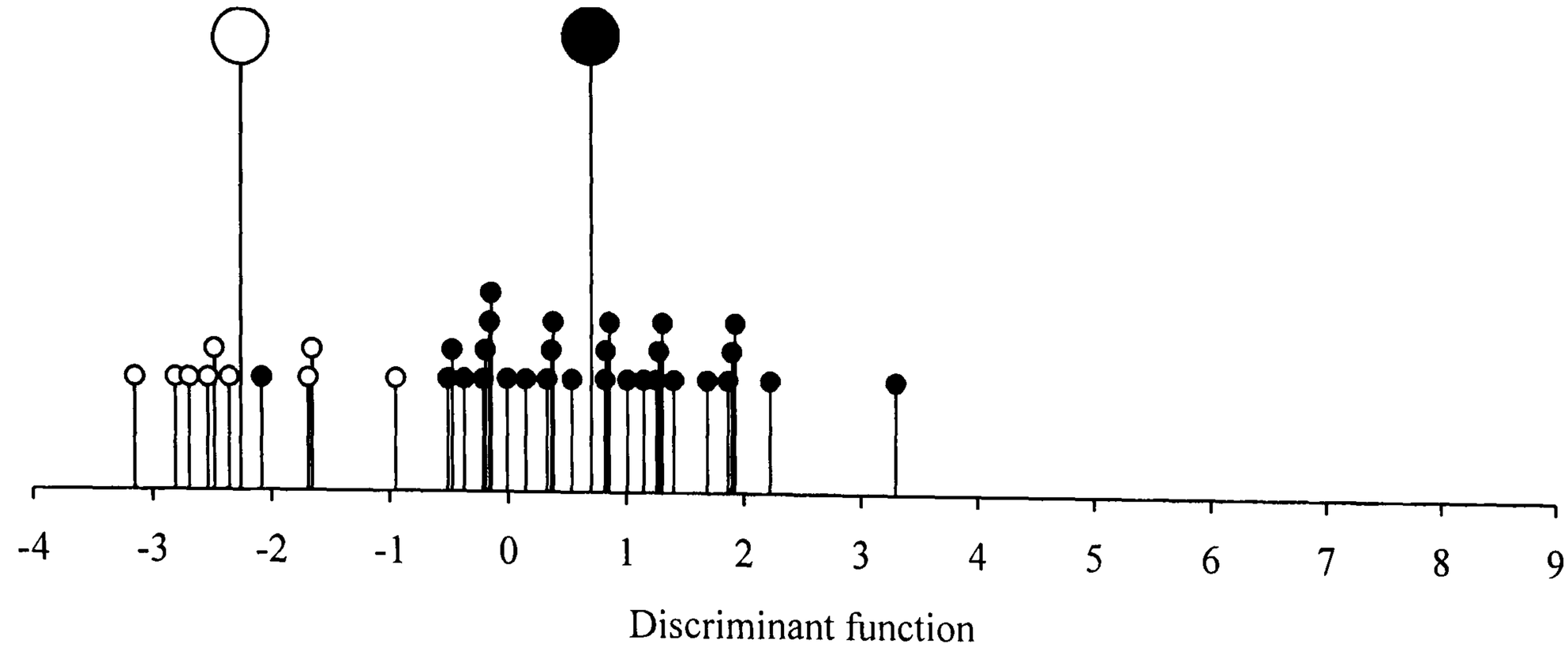
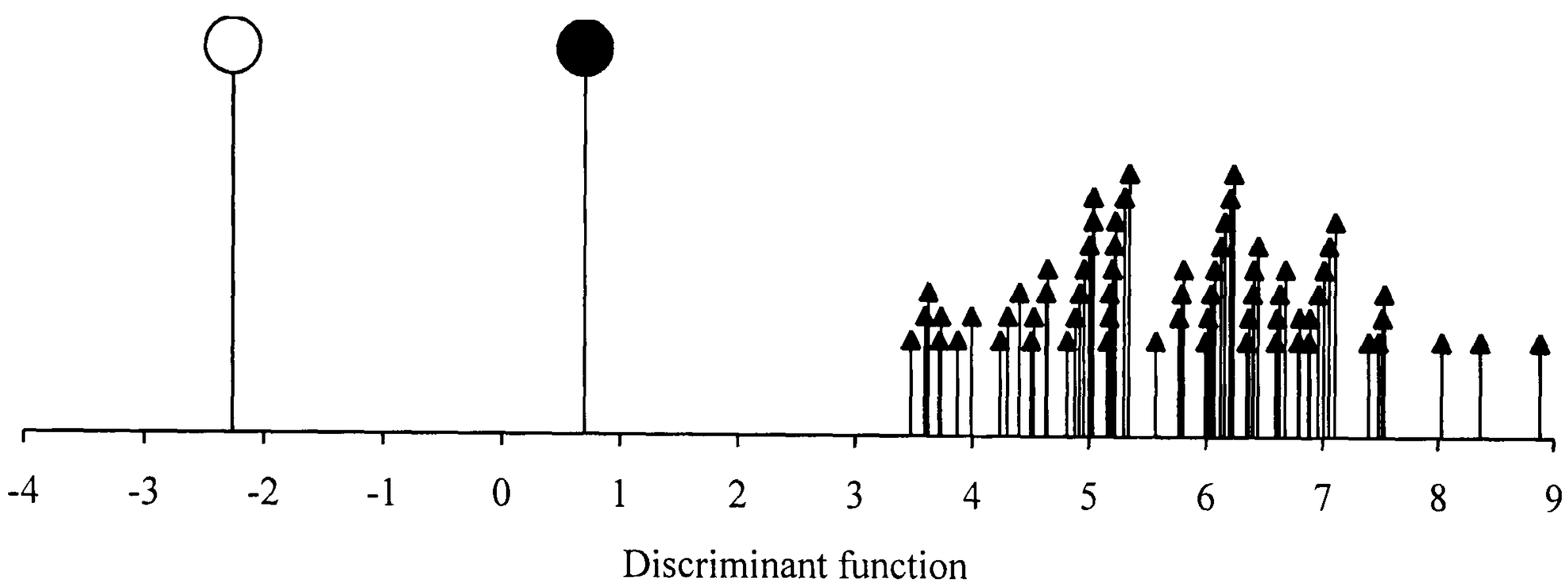


Fig. 5.7. Proportions of late-flowering taxa in fine sieve by-product samples based on a. semi-quantitative data (taxon counts) and b. quantitative data (seed counts). Proportions are based on totals for all taxa classified as late- long-, or early-intermediate/short-flowering per sample

a. Evvia pulse plots



b. Asturias spelt plots



c. Archaeobotanical samples

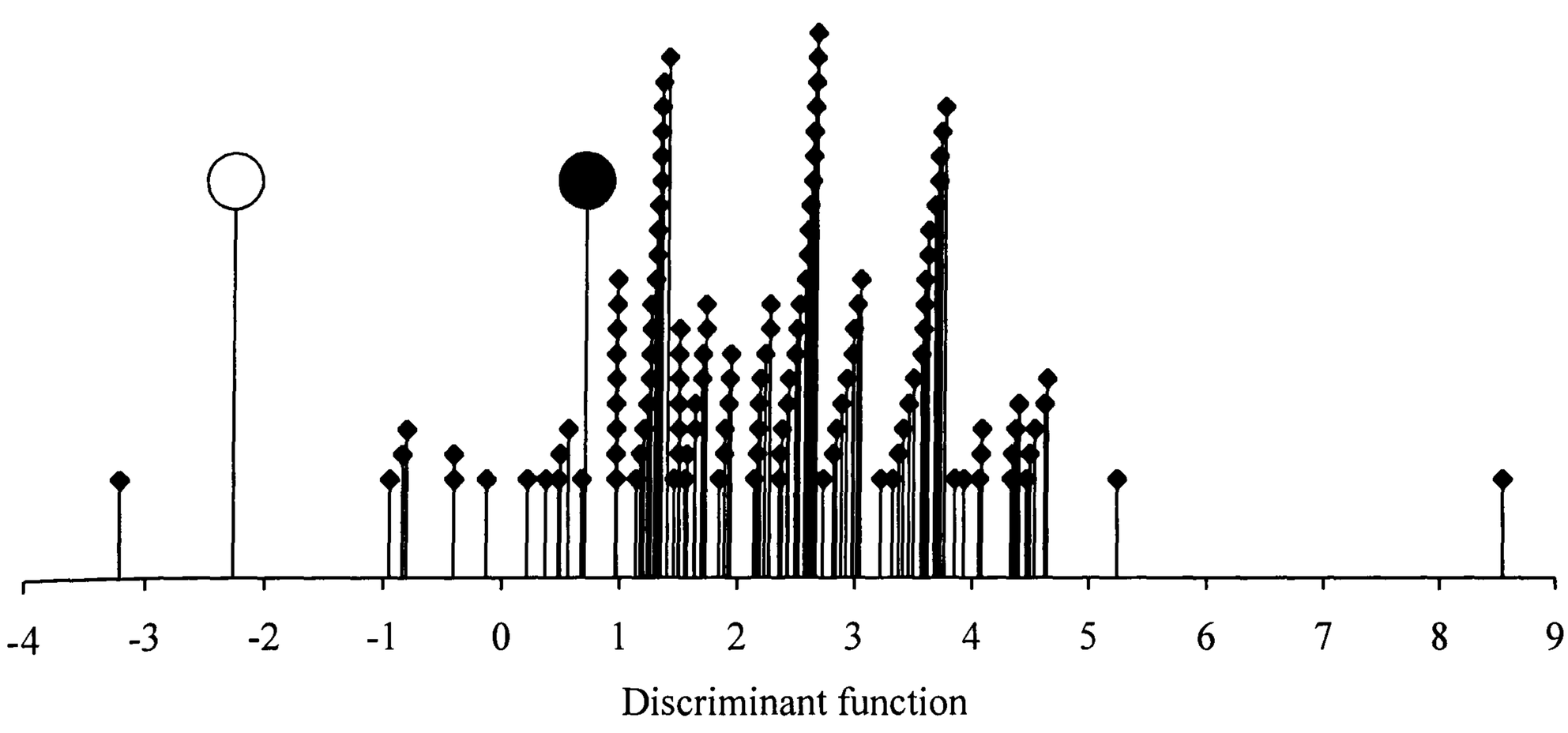
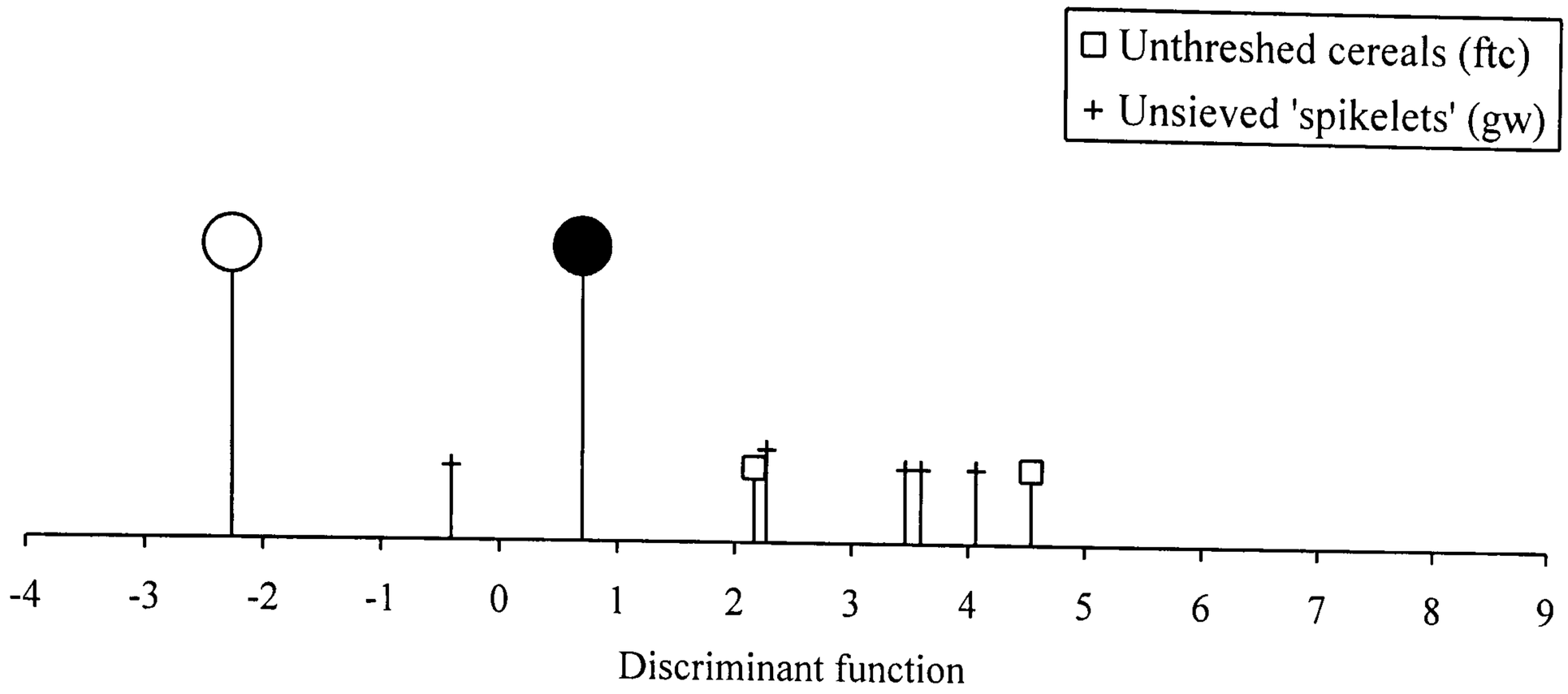
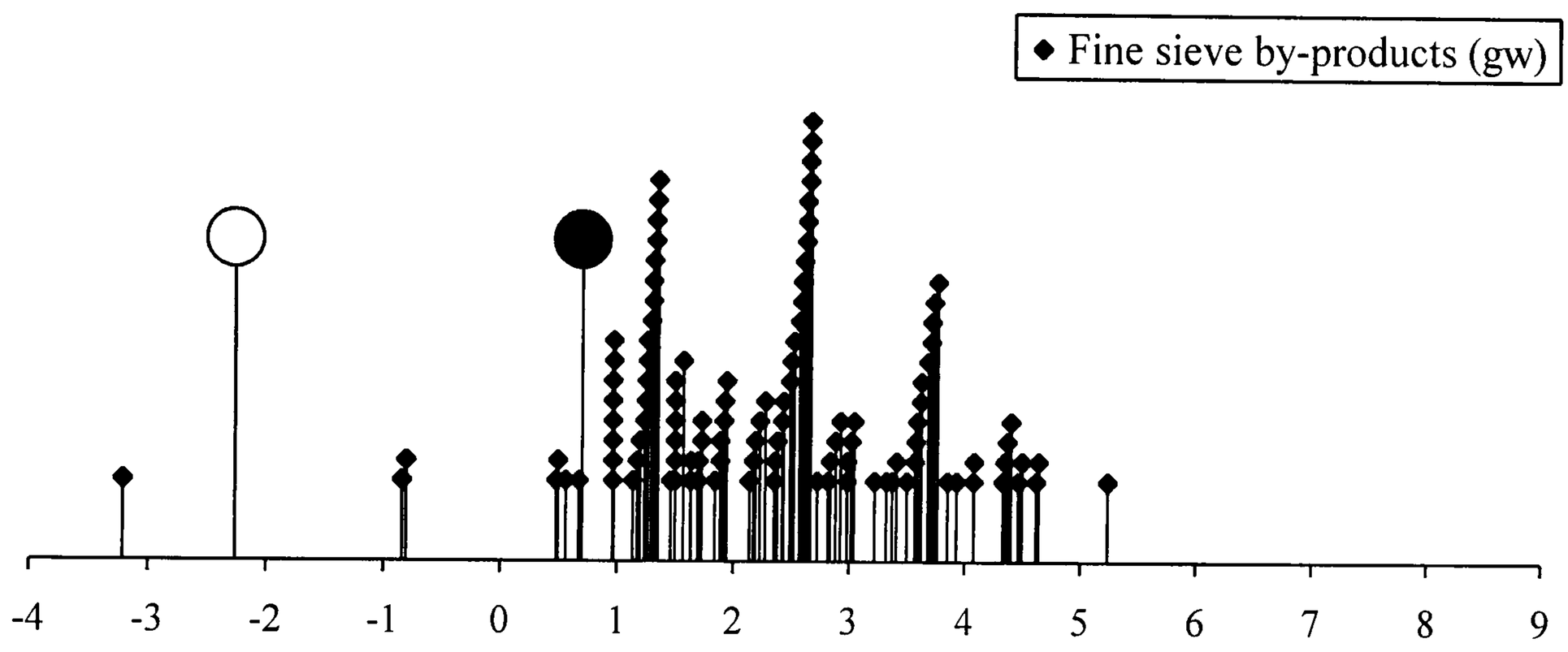


Fig. 5.8. The relationship of a. Evvia pulse gardens (●) and fields (○), b. Asturias plots (▲) and c. archaeobotanical samples (♦) to the discriminant function extracted to distinguish Evvia gardens and fields based on semi-quantitative data (in all plots, larger circles indicate the position of centroids for Evvia groups)

a.



b.



c.

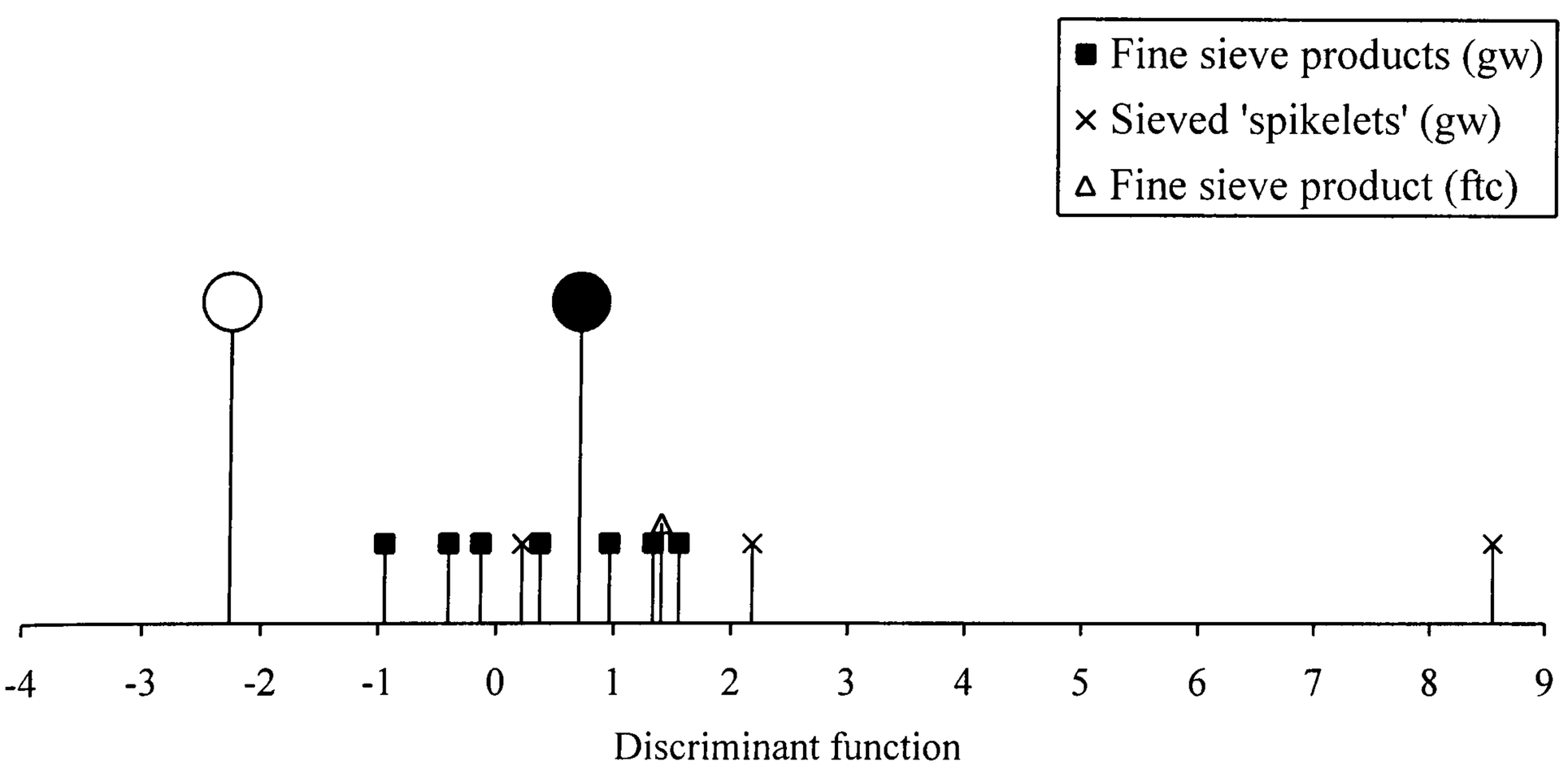
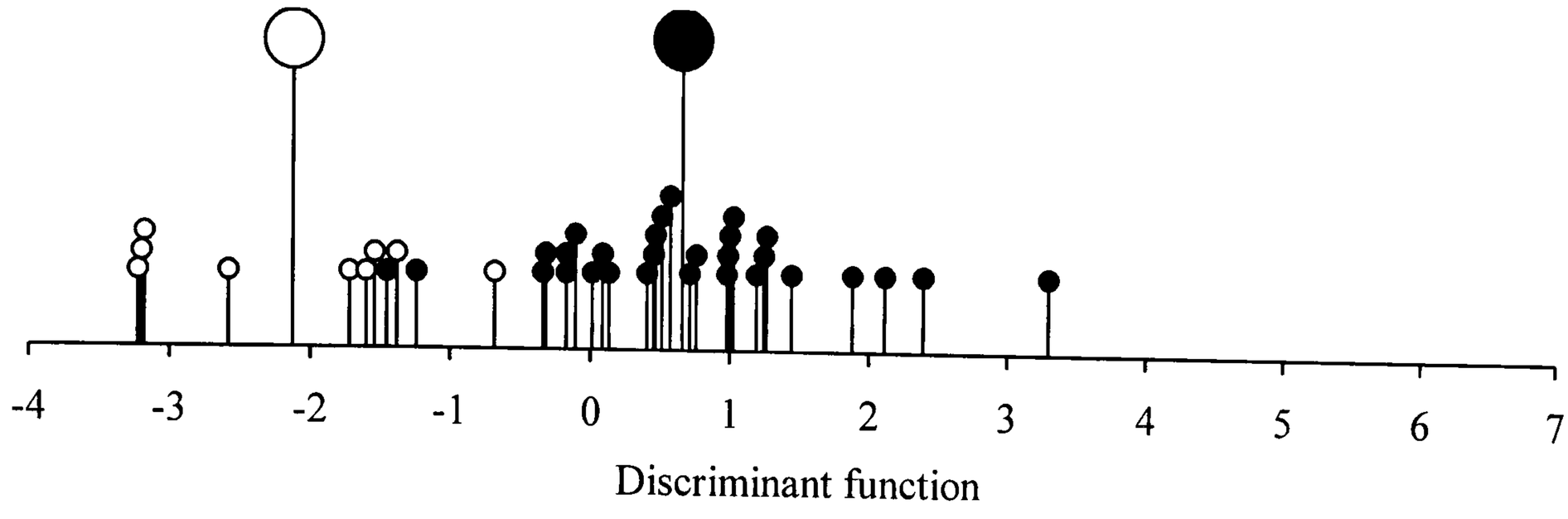
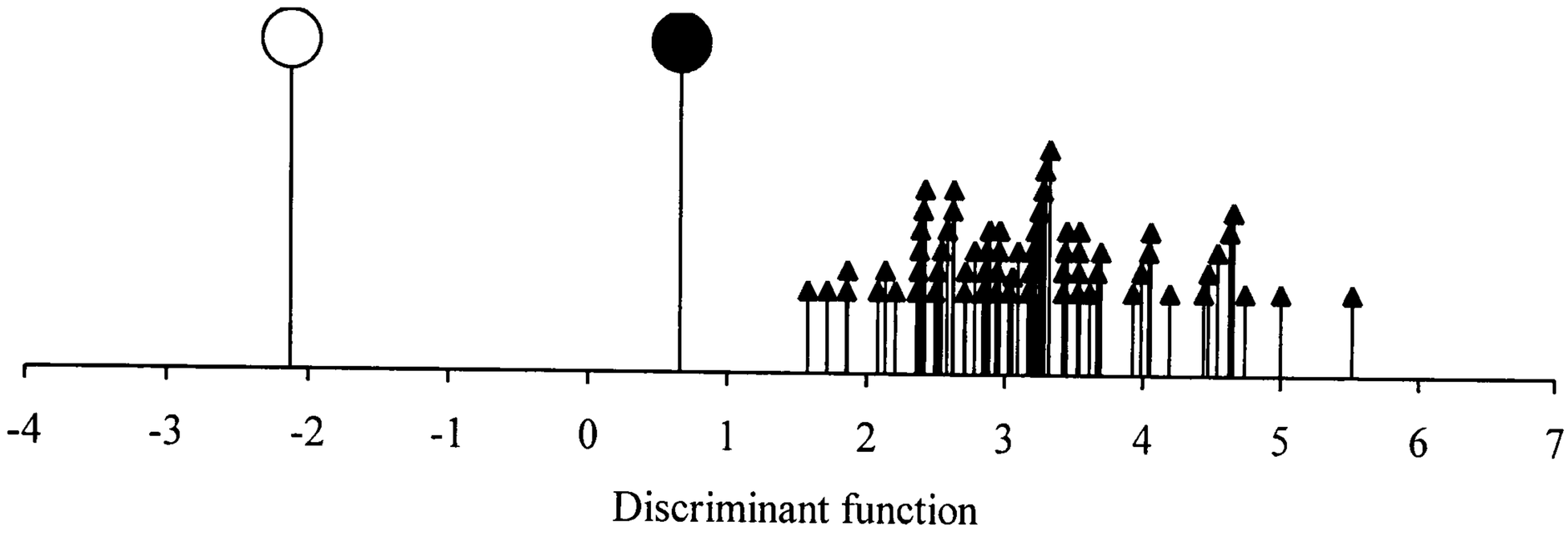


Fig. 5.9. The relationship of archaeobotanical samples from different processing stages to the distriminant function based on semi-quantitative data: a. unthreshed and unsieved 'spikelet' samples b. fine sieve by-product samples; c. sieved 'spikelet' and fine sieve product samples (ftc = free-threshing cereal, gw = glume wheat; large circles indicate the position of centroids for Evvia groups)

a. Evvia pulse plots



b. Asturias spelt plots



c. Archaeobotanical samples

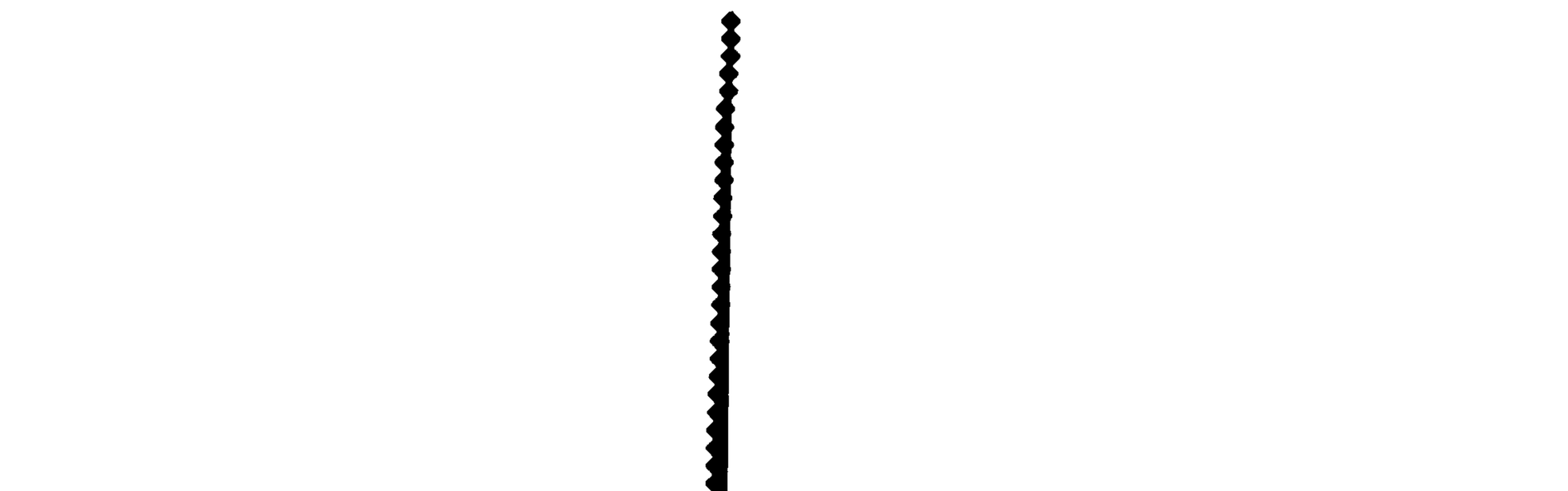
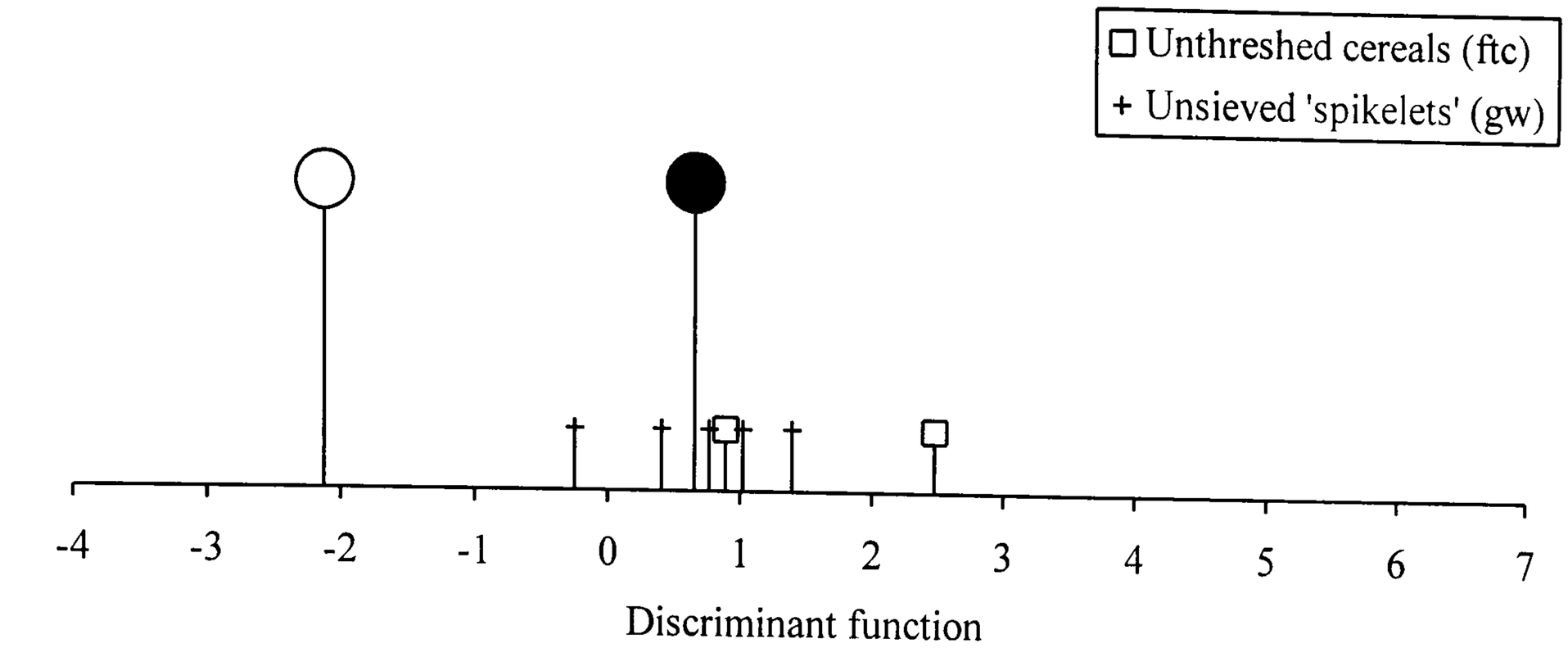
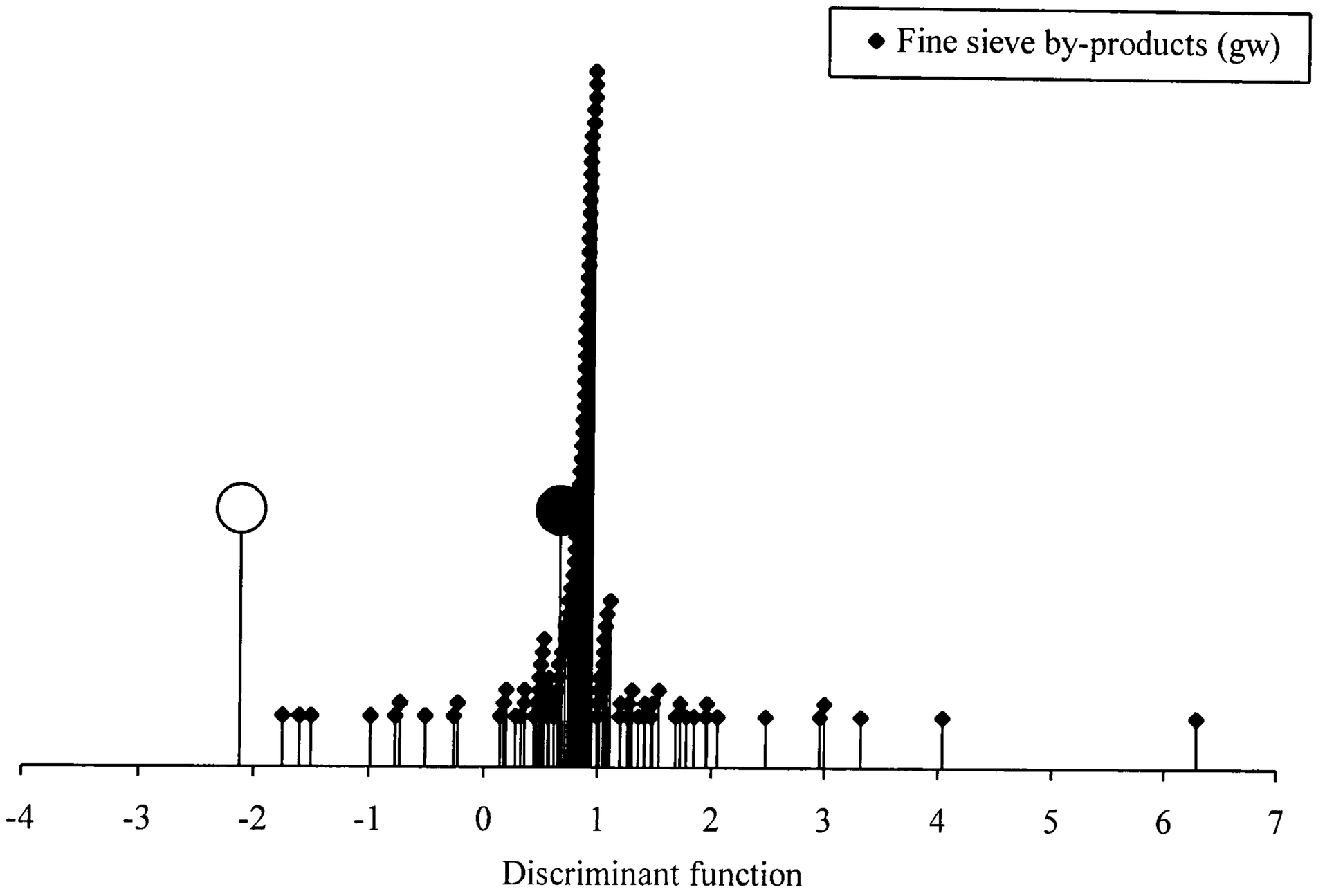


Fig. 5.10. The relationship of a. Evvia pulse gardens (●) and fields (○), b. Asturias plots (▲) and c. archaeobotanical samples (♦) to the discriminant function extracted to distinguish Evvia gardens and fields based on quantitative data (in all plots, larger circles indicate the position of centroids for Evvia groups)

a.



b.



c.

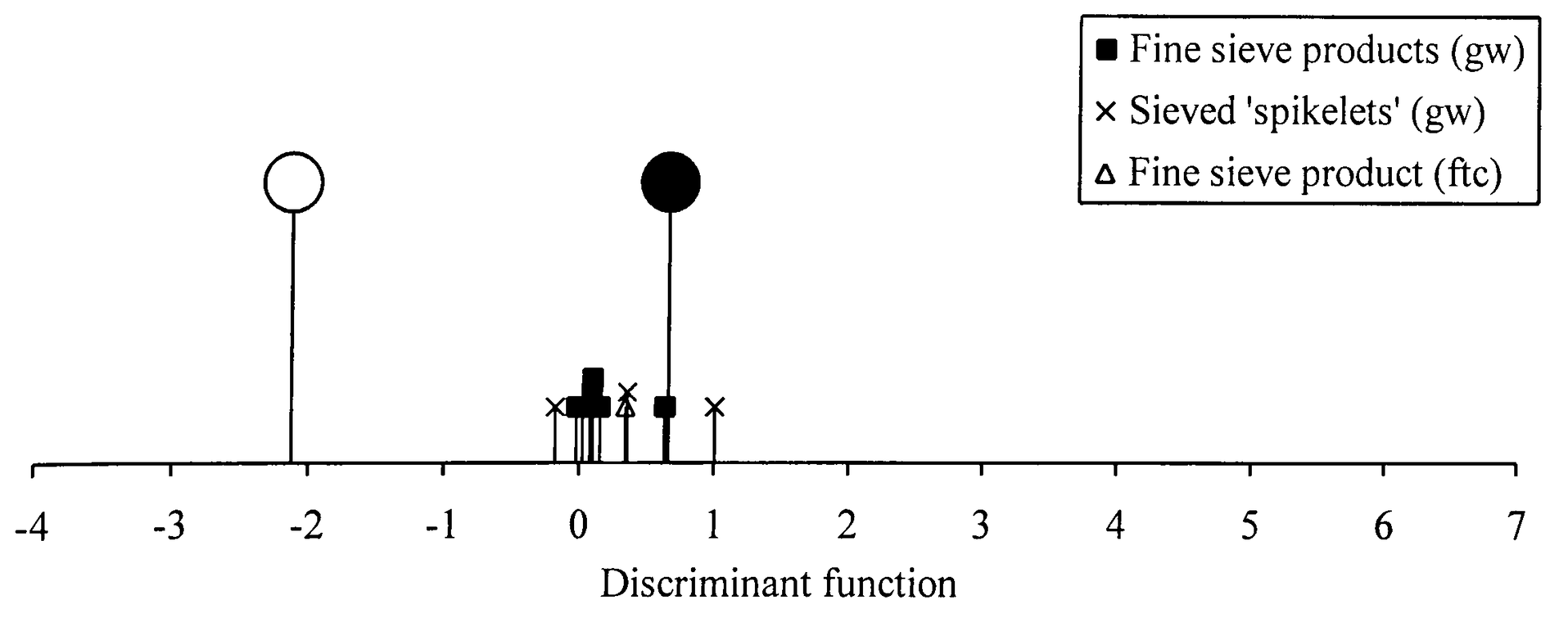
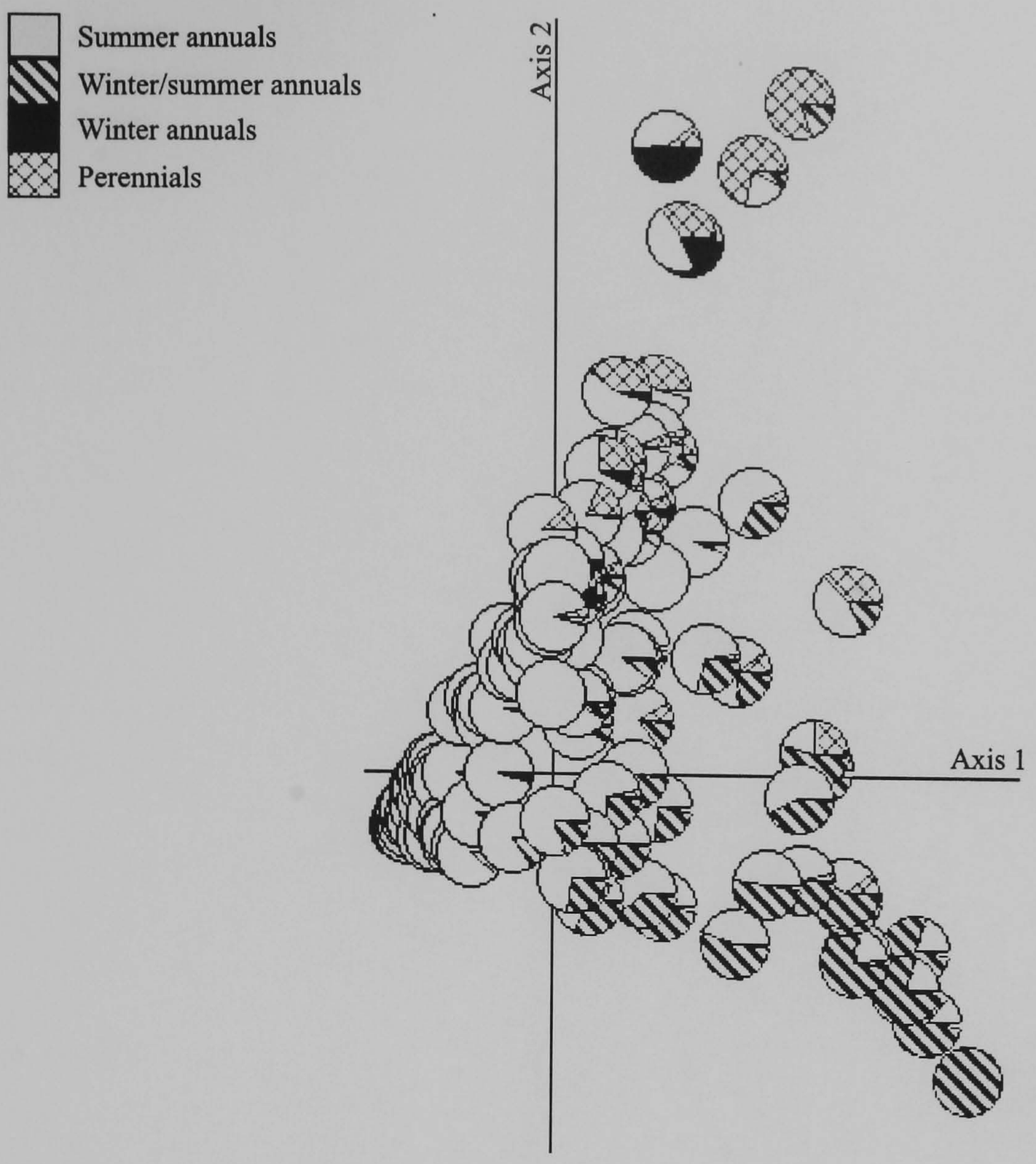


Fig. 5.11. The relationship of archaeobotanical samples from different processing stages to the distriminant function based on quantitative data: a. unthreshed and unsieved 'spikelet' samples; b. fine sieve by-product samples; c. sieved 'spikelet' and fine sieve product samples (ftc = free-threshing cereal, gw = glume wheat; large circles indicate the position of centroids for Evvia groups)

a.



b.

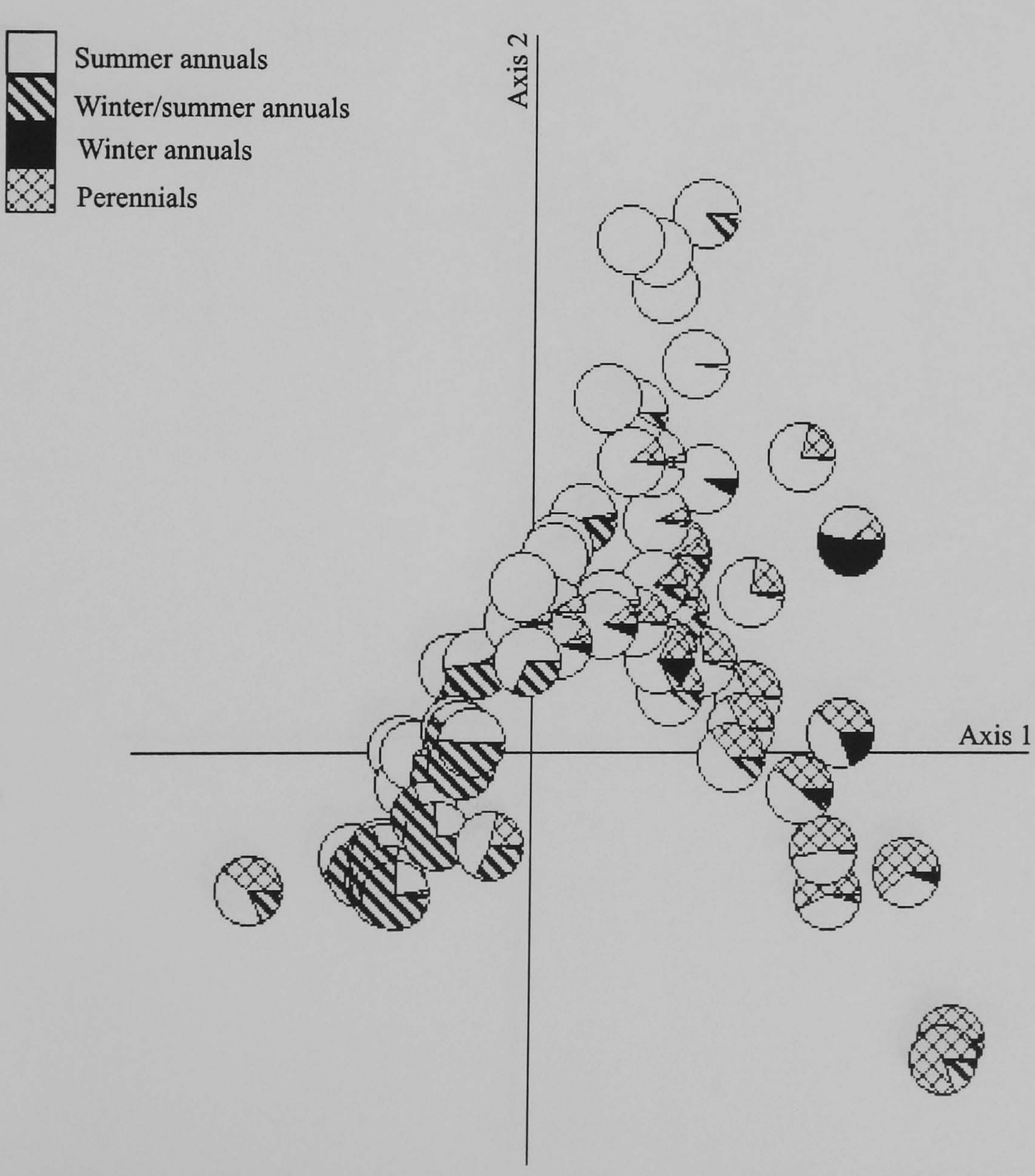
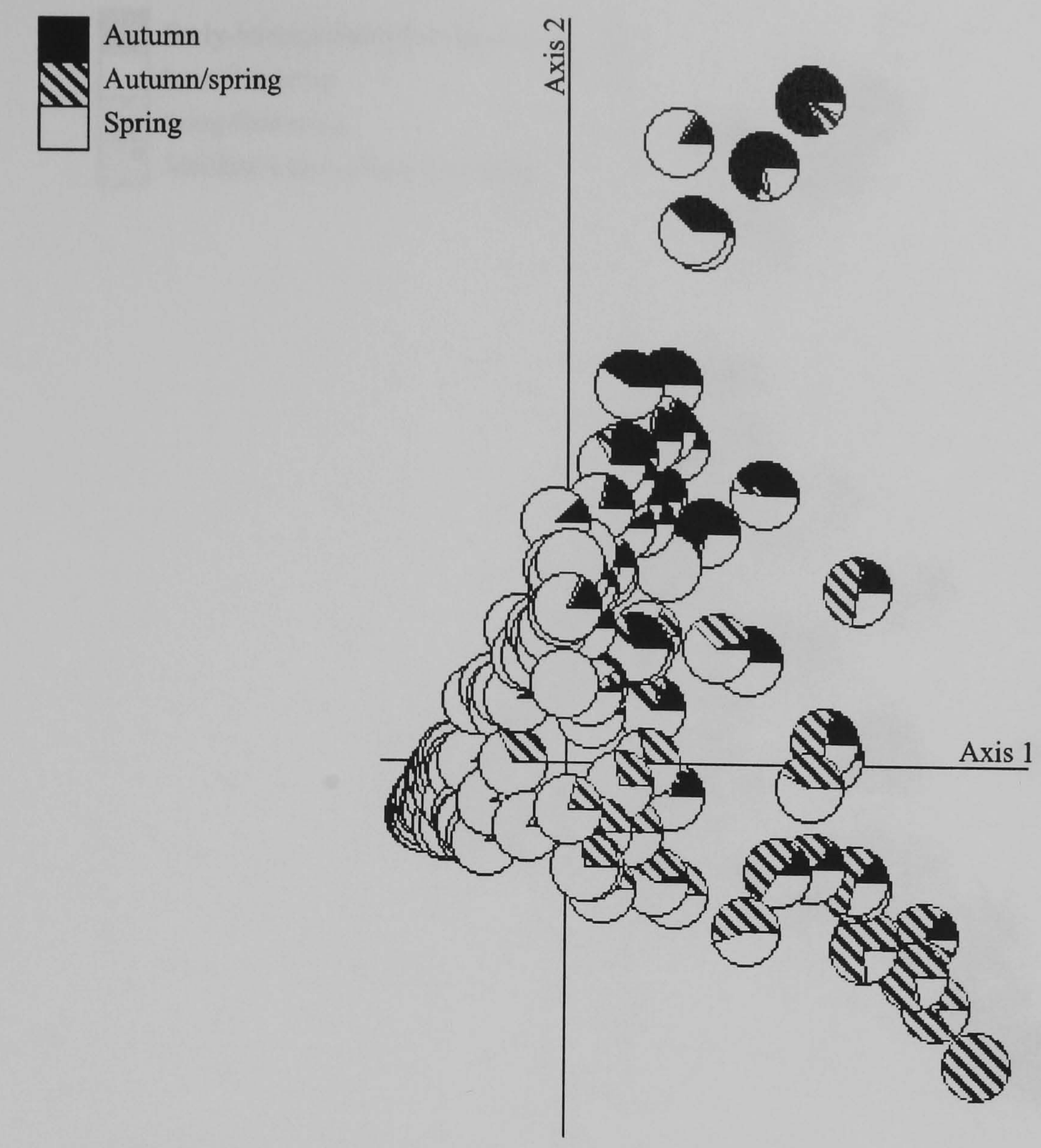


Fig. 6.1. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing life history

a.



b.

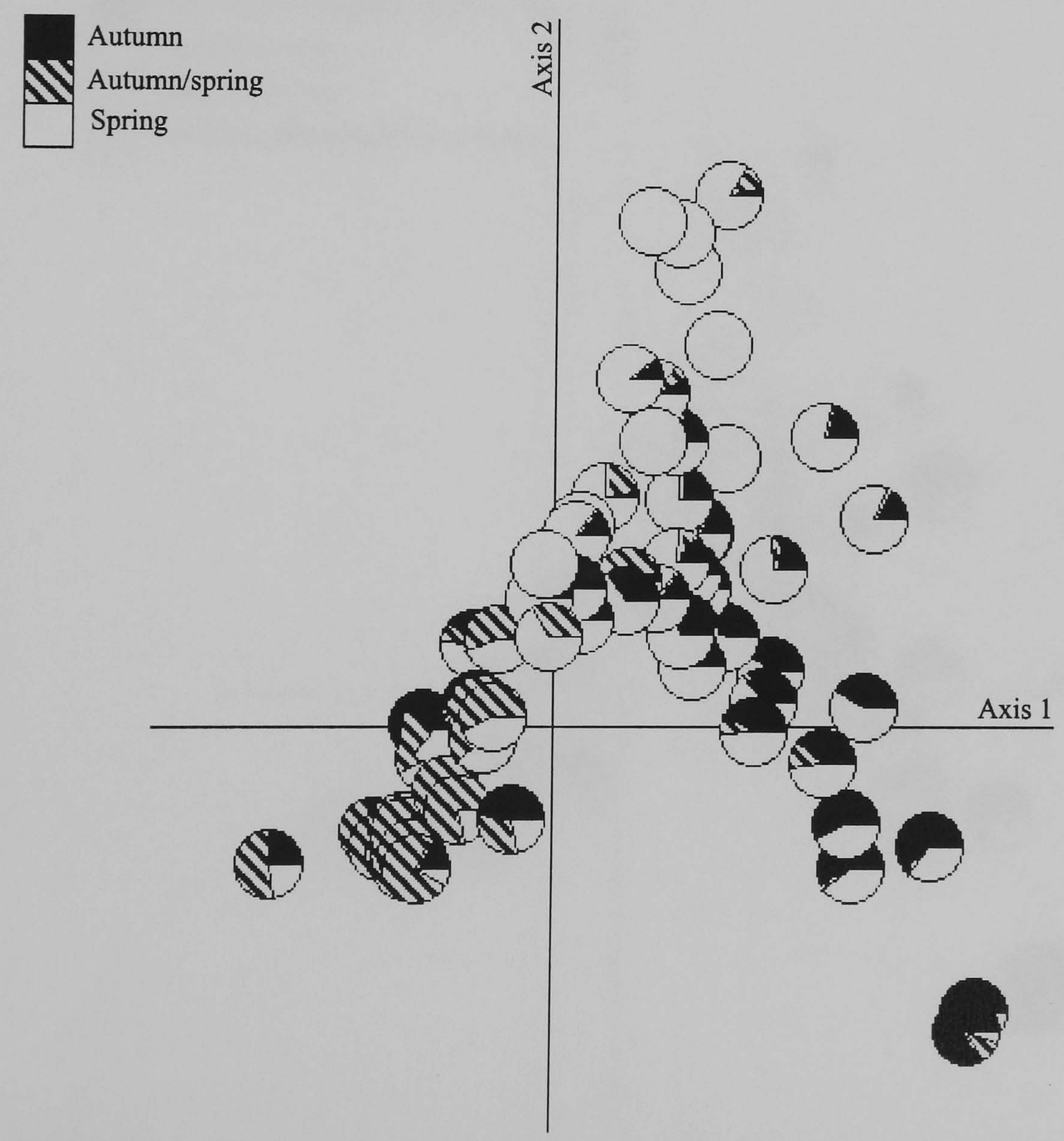


Fig. 6.2. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing germination time

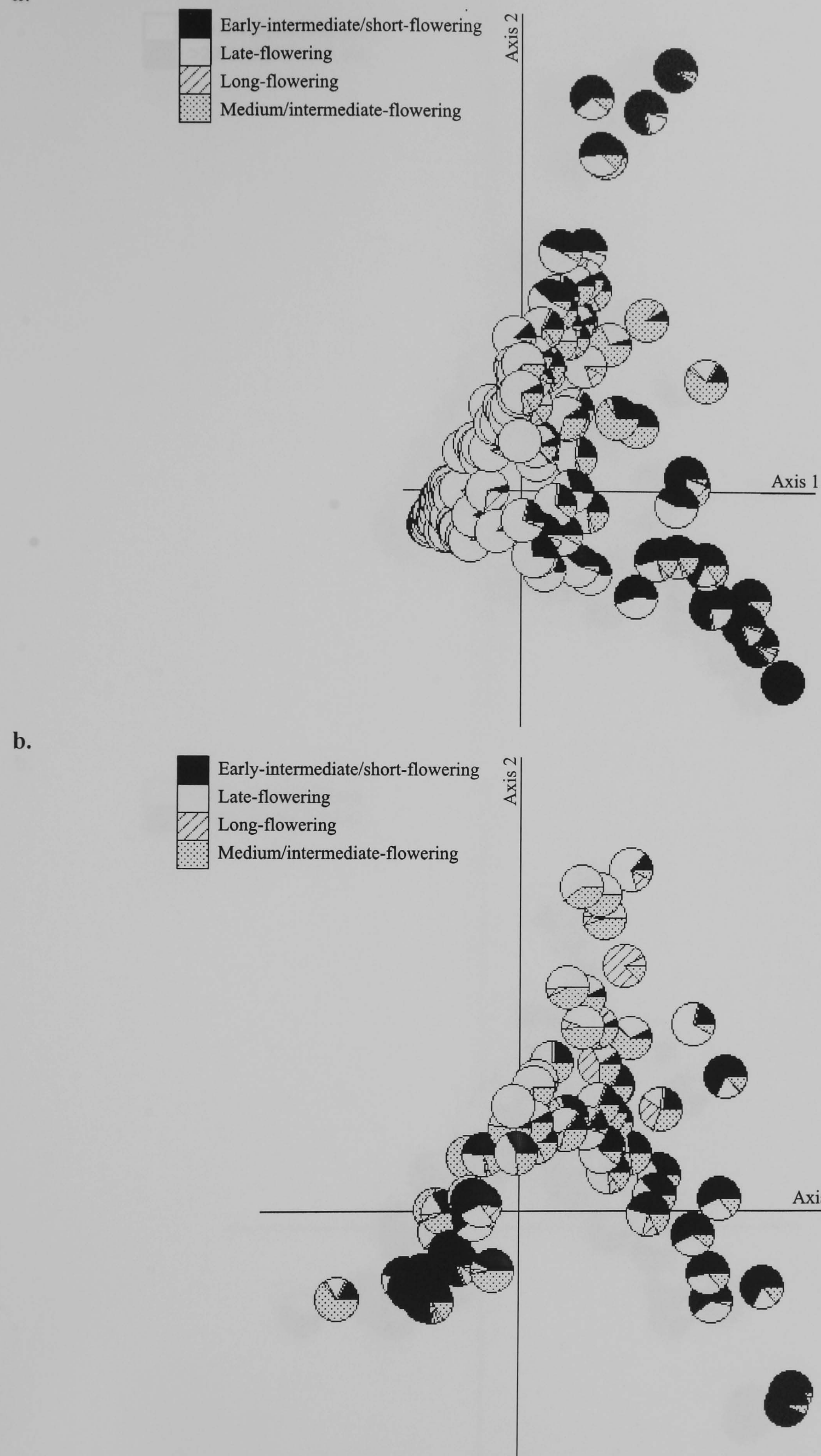
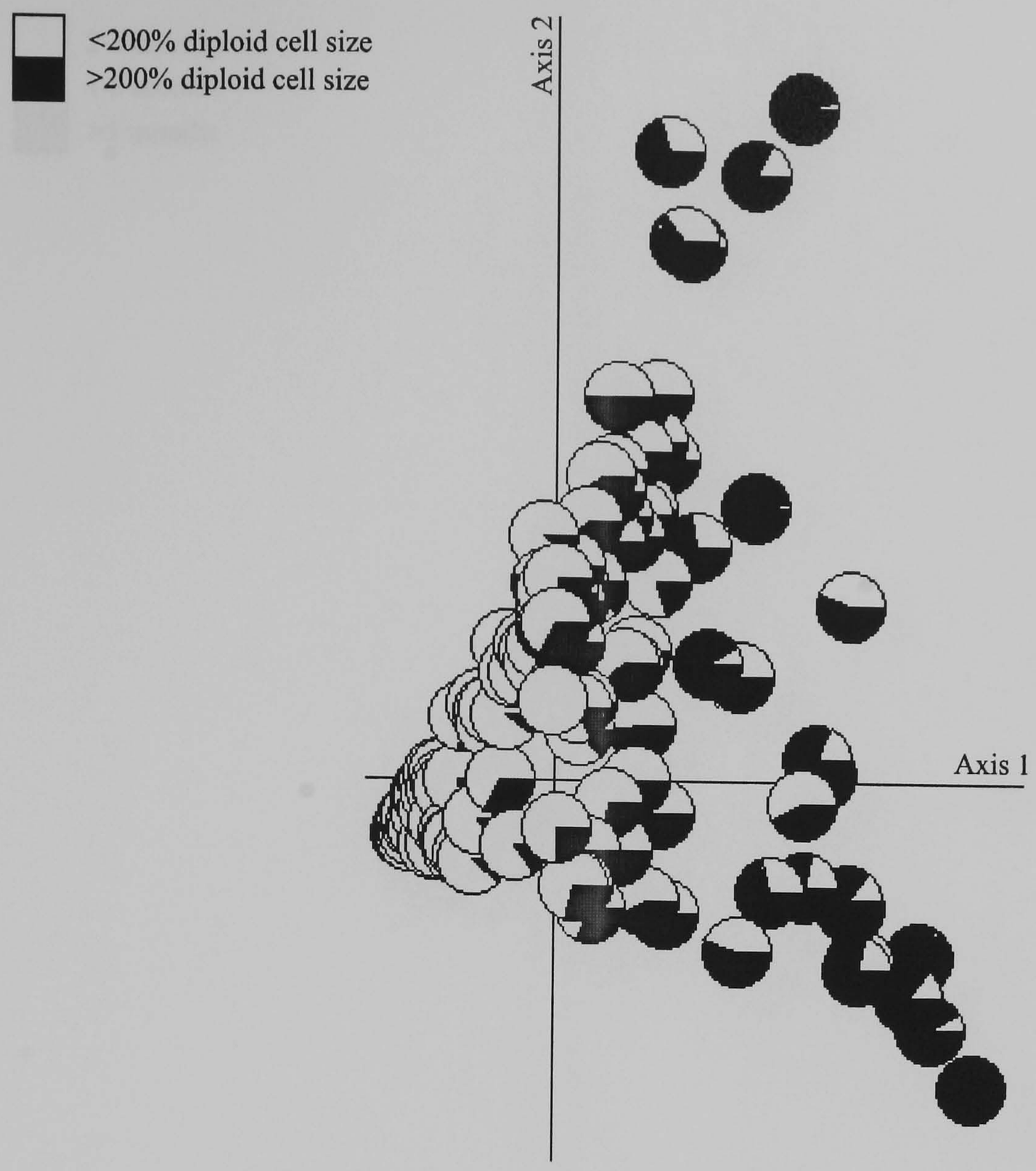


Fig. 6.3. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing flowering onset/length

a.



b.

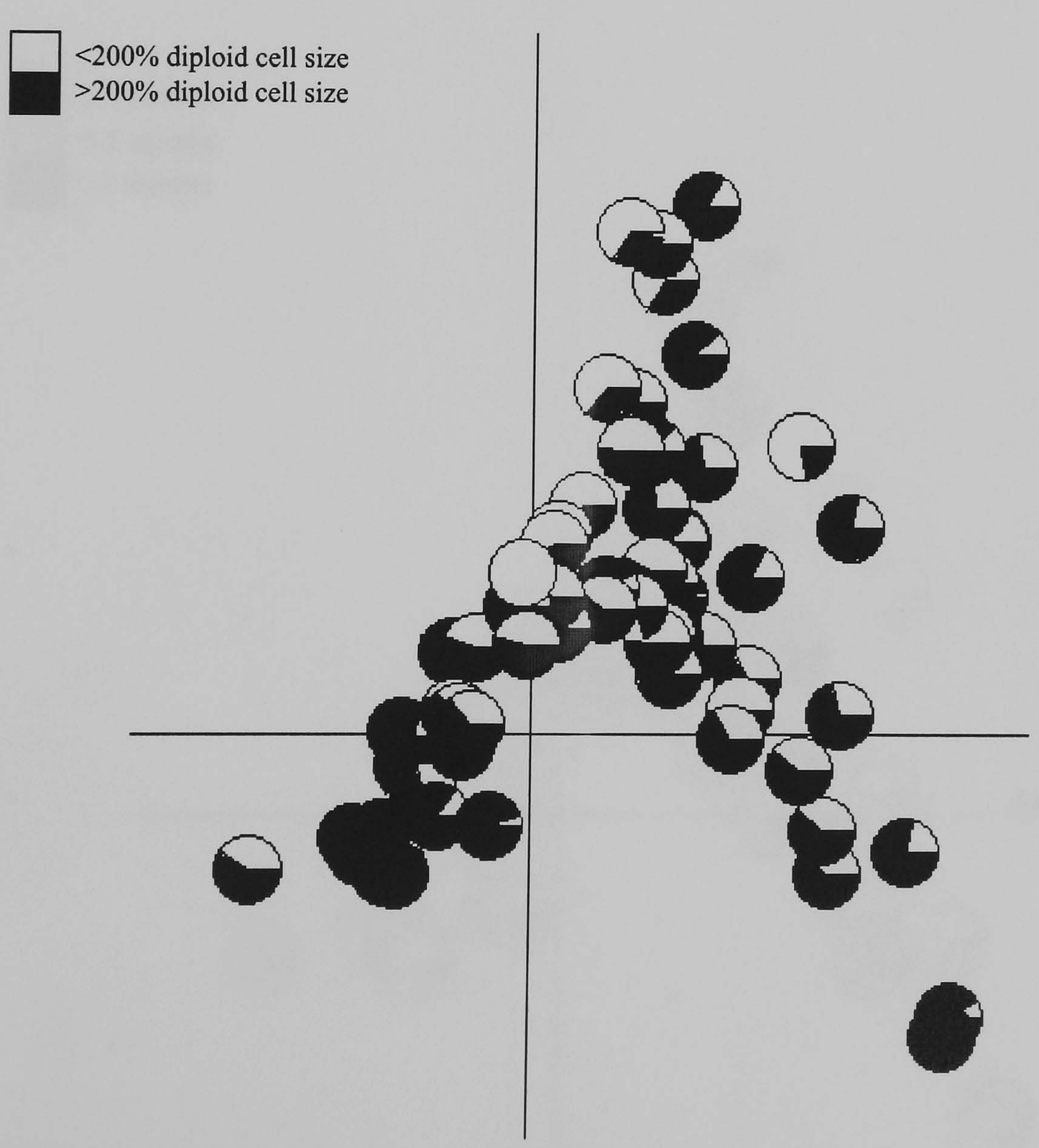
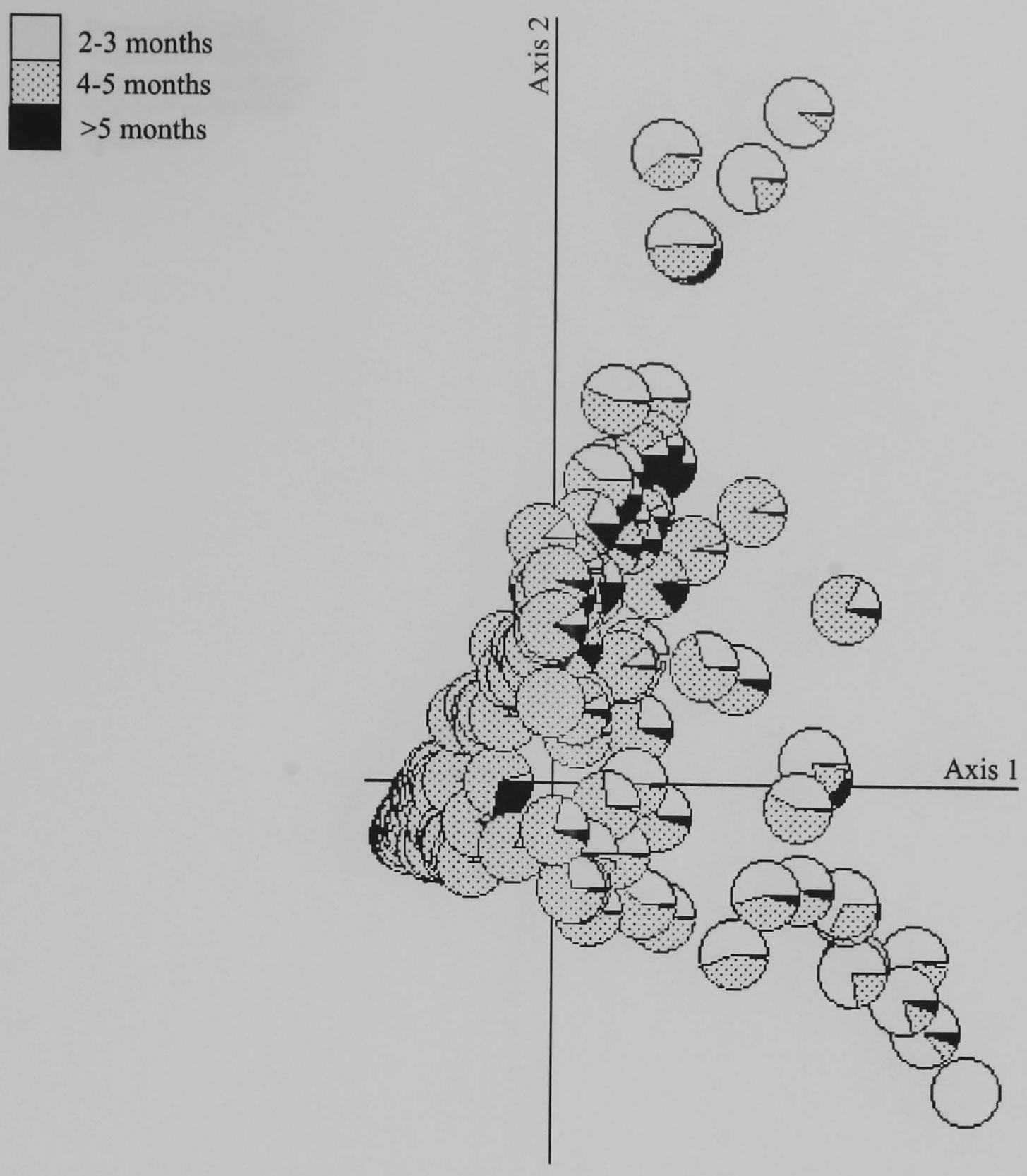


Fig. 6.4. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing estimated epidermal cell endopolyploidy

a.



b.

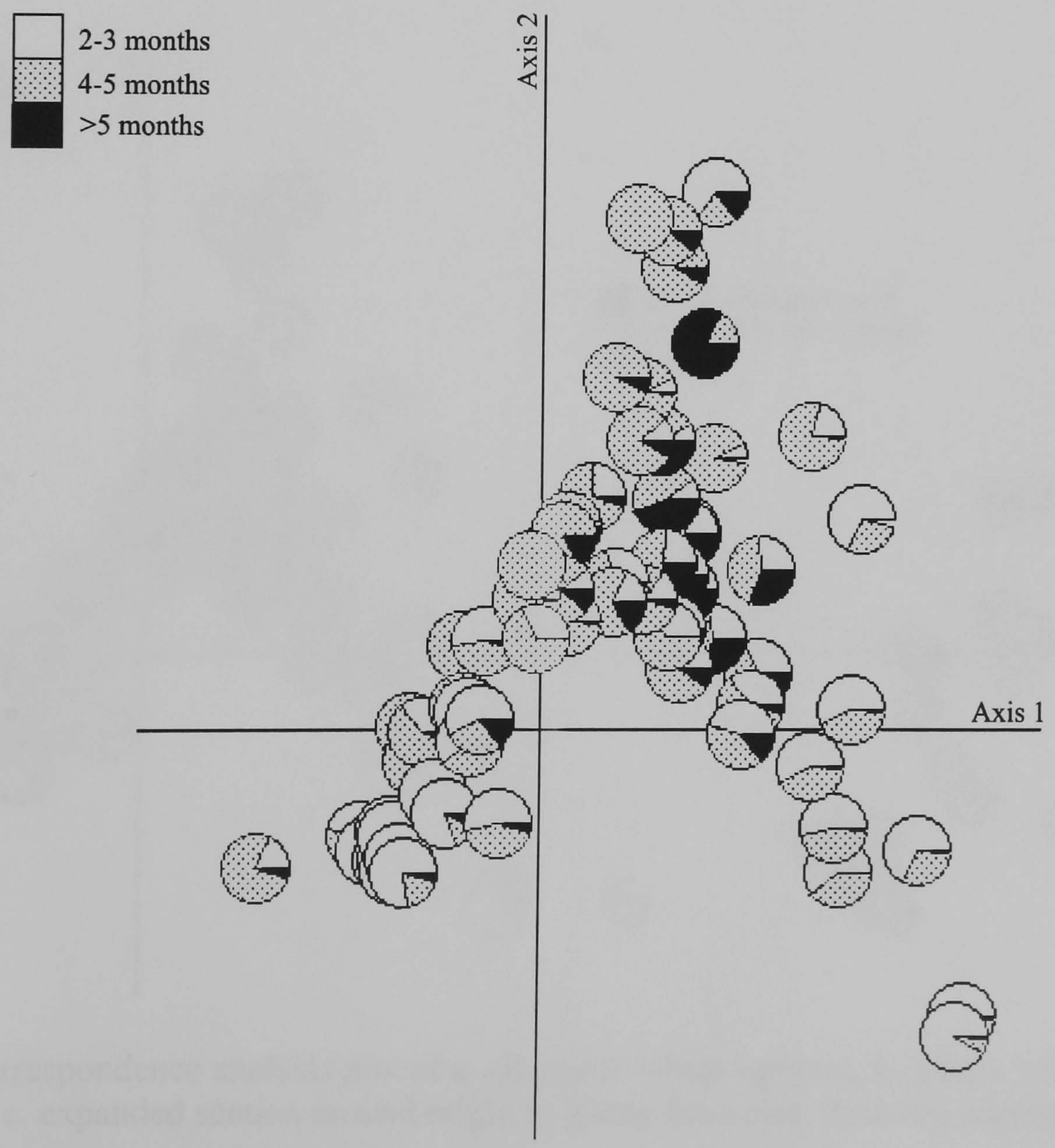


Fig. 6.5. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing length of the flowering period

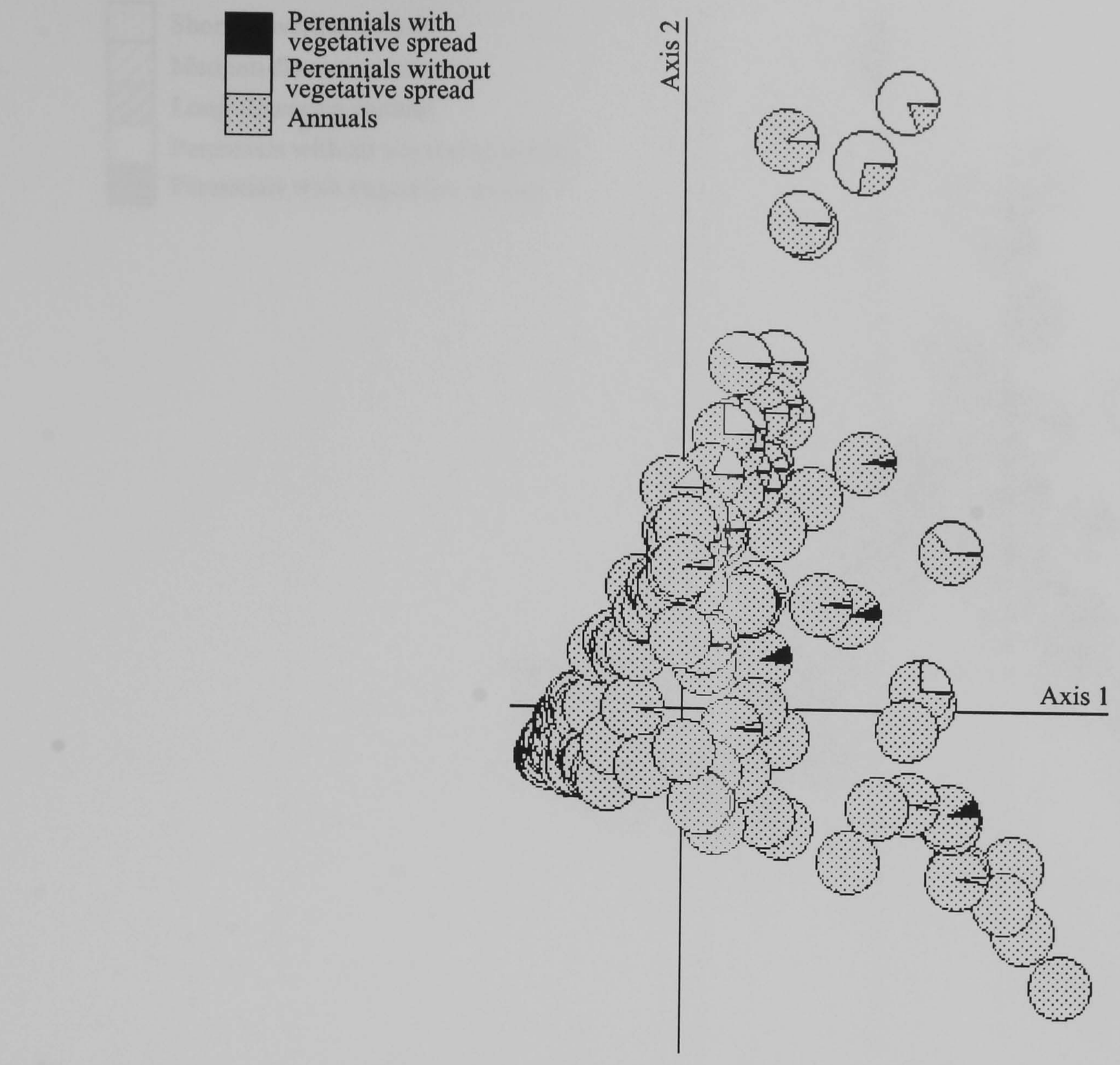


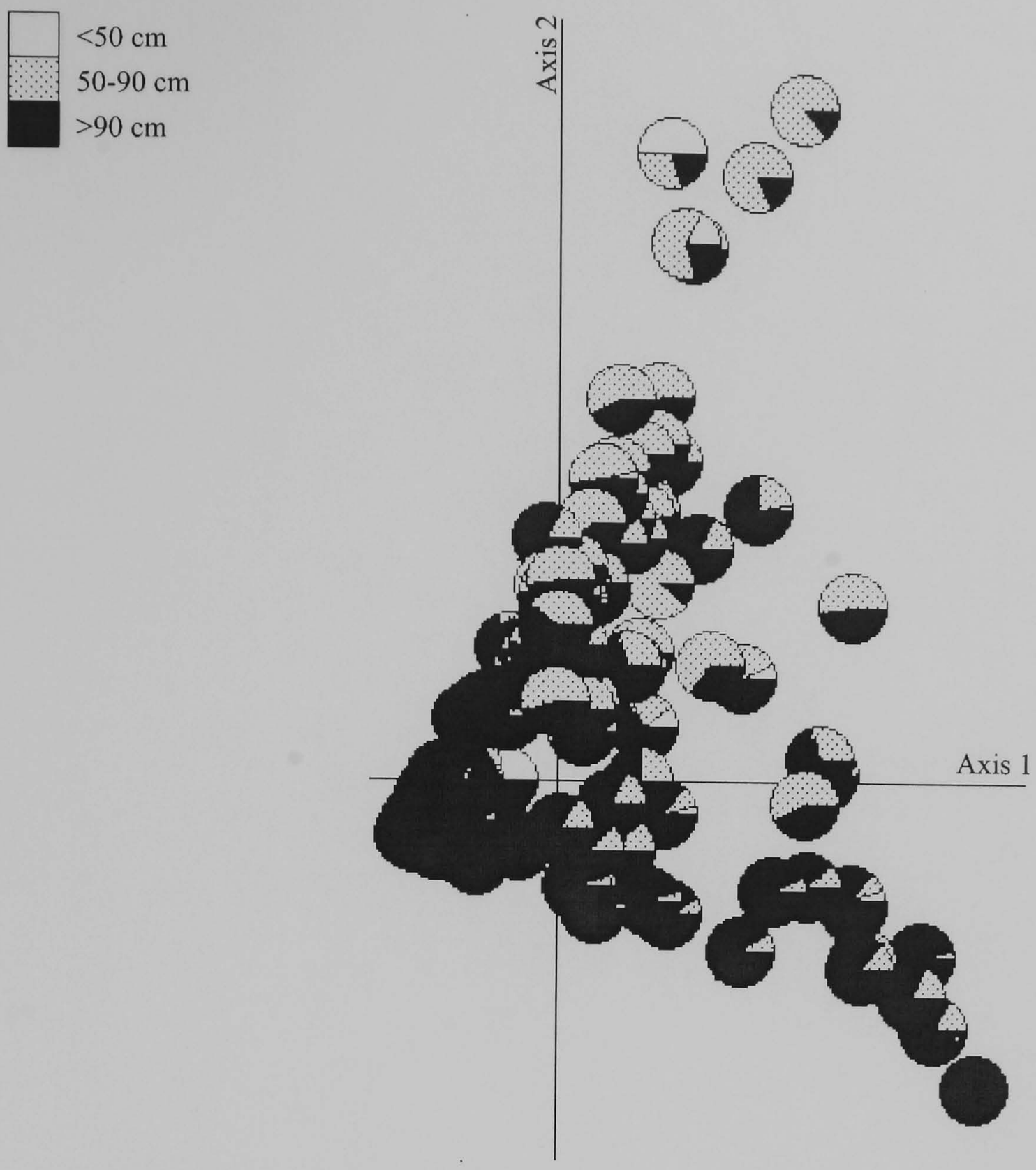
Fig. 6.6. Correspondence analysis plot of a. all glume wheat samples, b. glume wheat glume base samples and c. expanded section around origin of glume base plot, showing vegetative spread

a.

b.

Fig. 6.7. Correspondence analysis plot of a. glume wheat glume base samples and b. expanded section around origin, showing vegetative spread (perennials) and length of the flowering period (annuals)

a.



b.

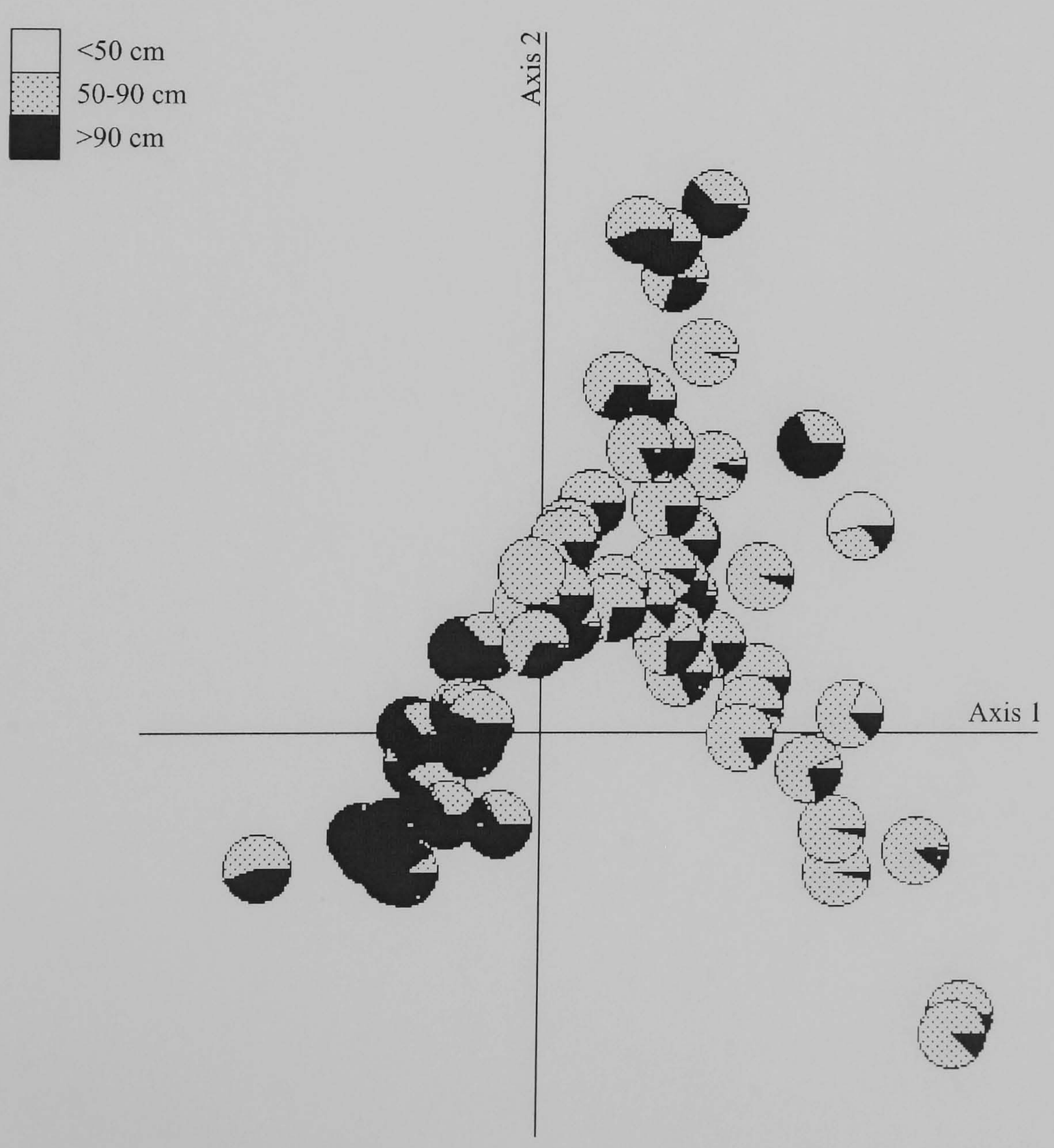
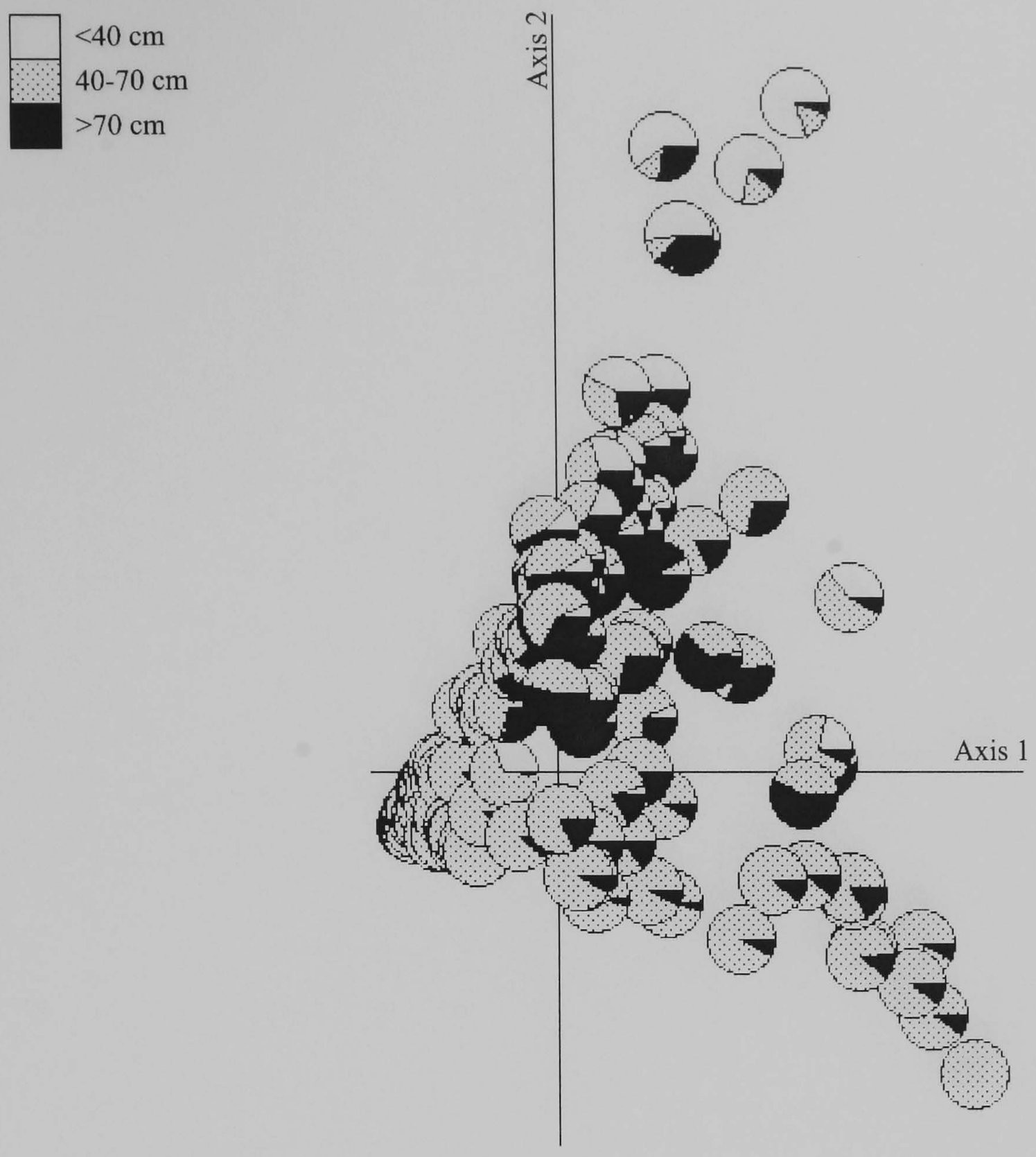


Fig. 6.8. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing canopy height

a.



b.

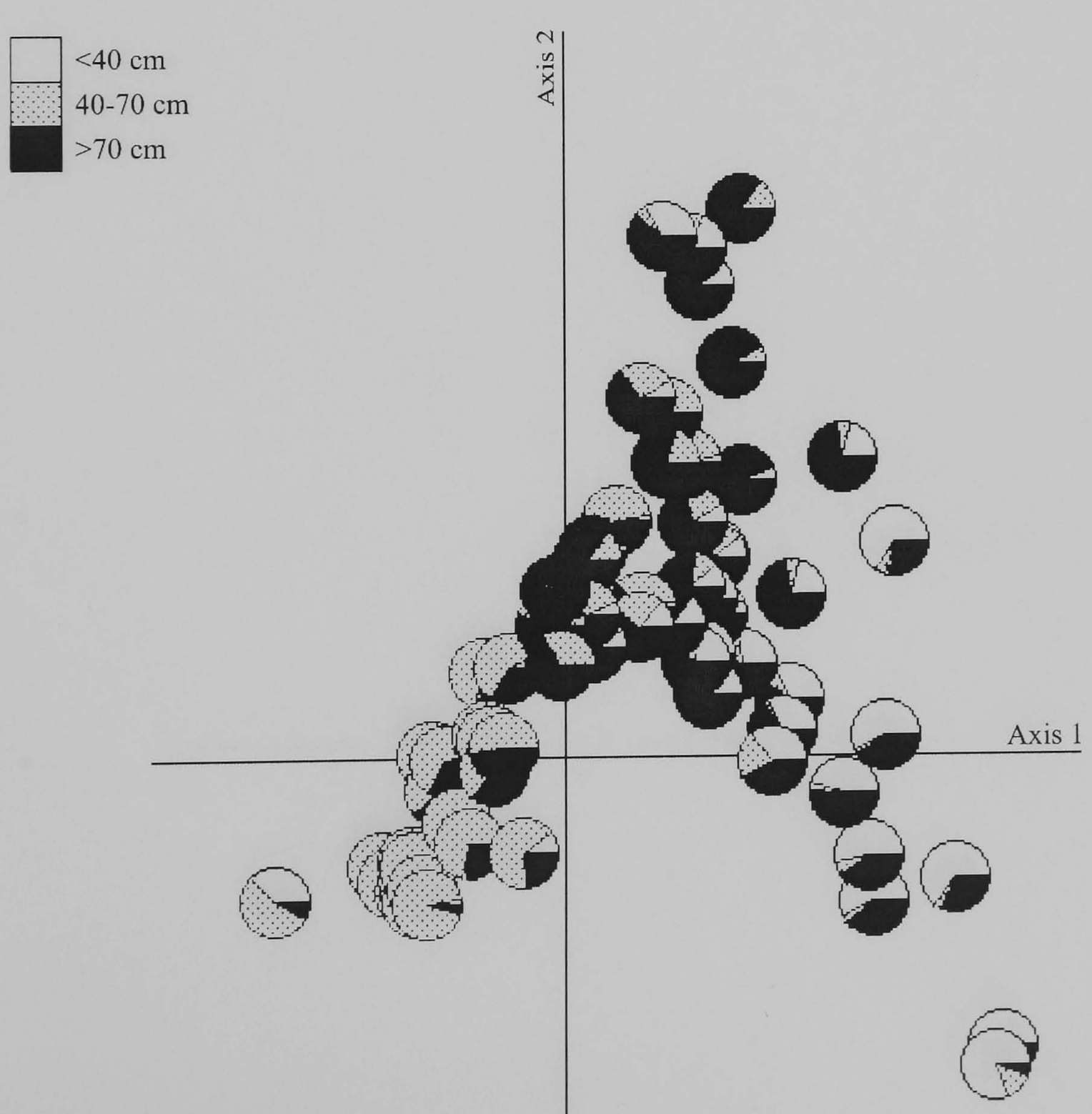


Fig. 6.9. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing canopy diameter

a.

b.

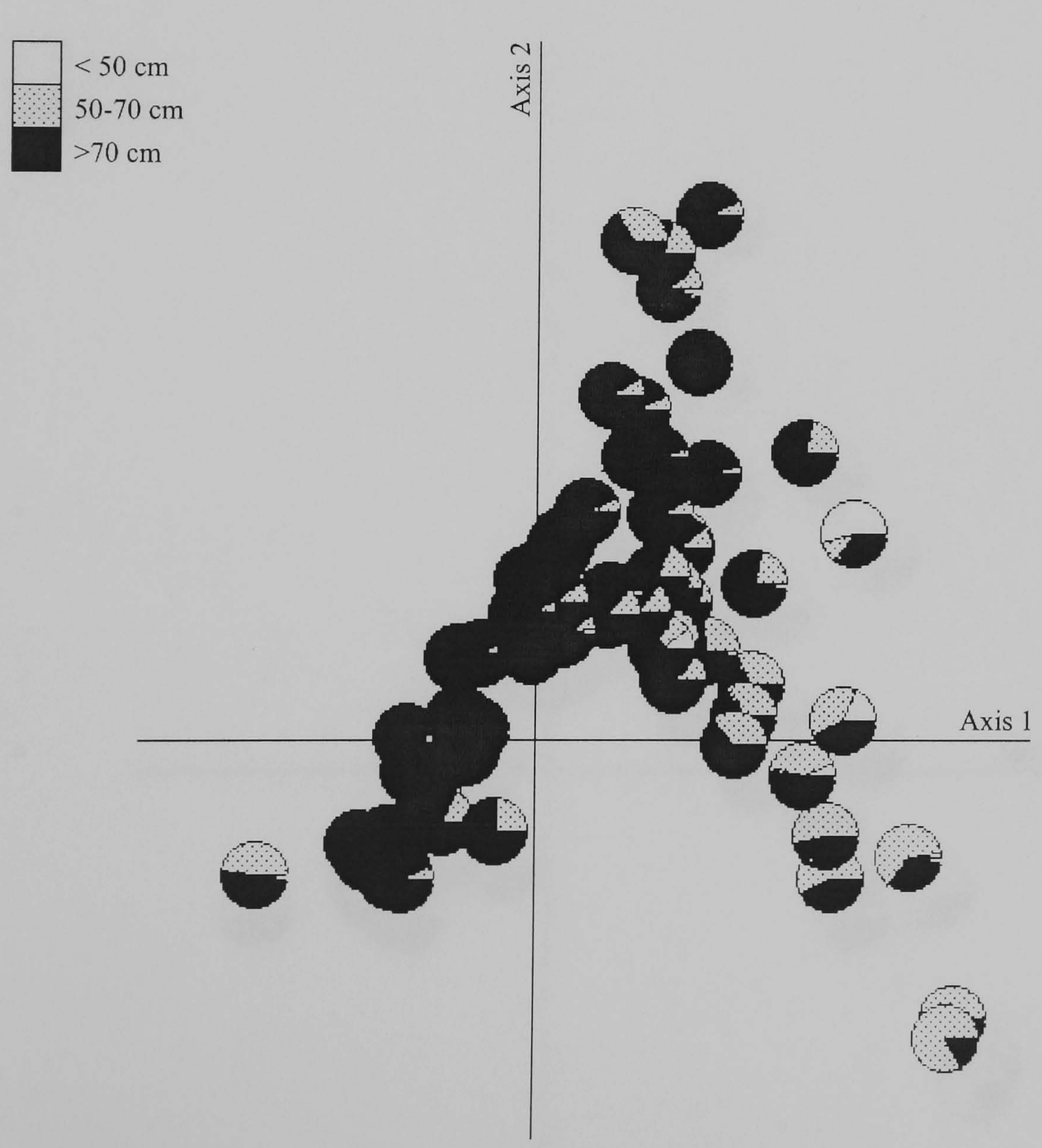


Fig. 6.10. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing mean canopy dimension

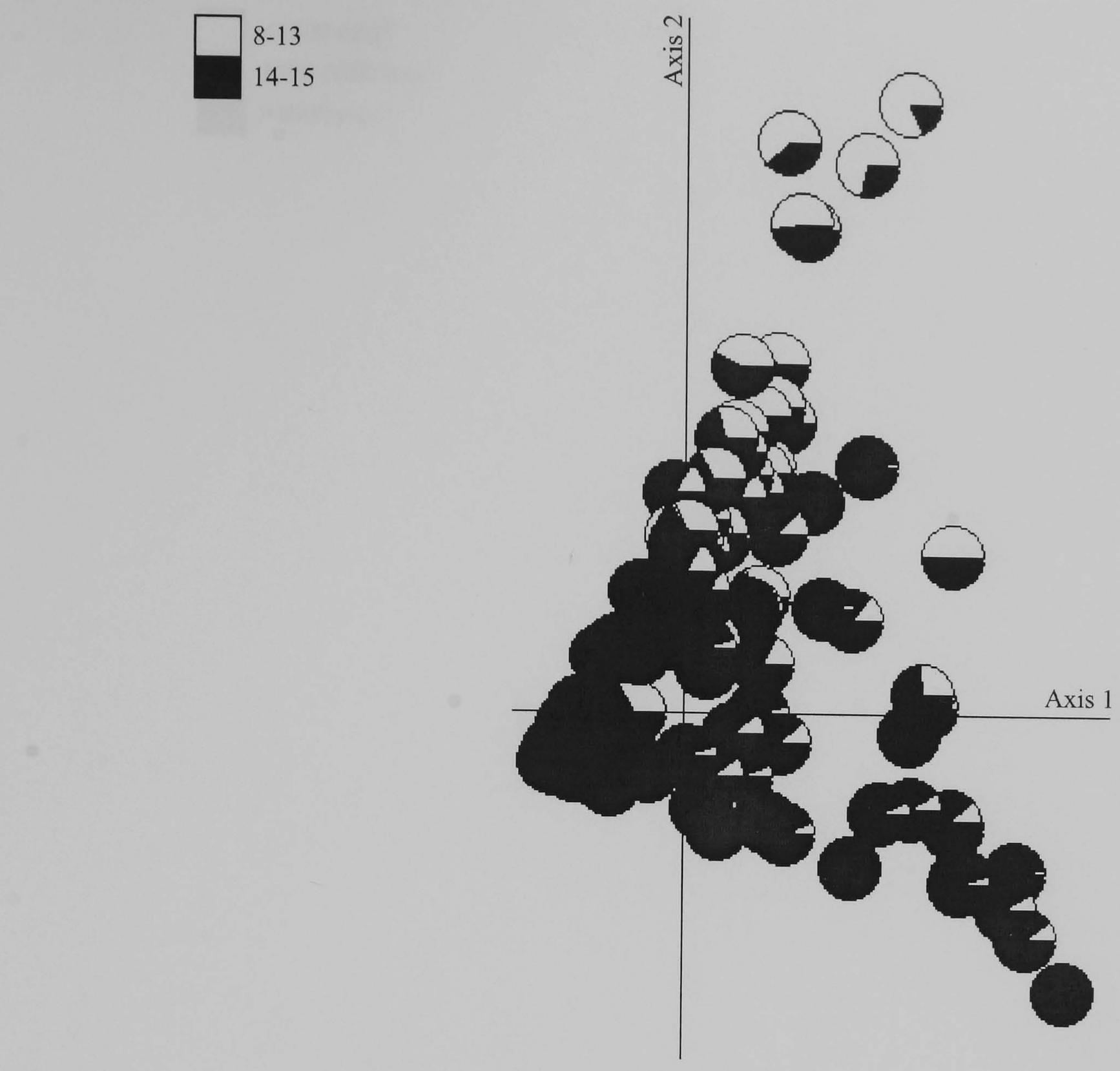
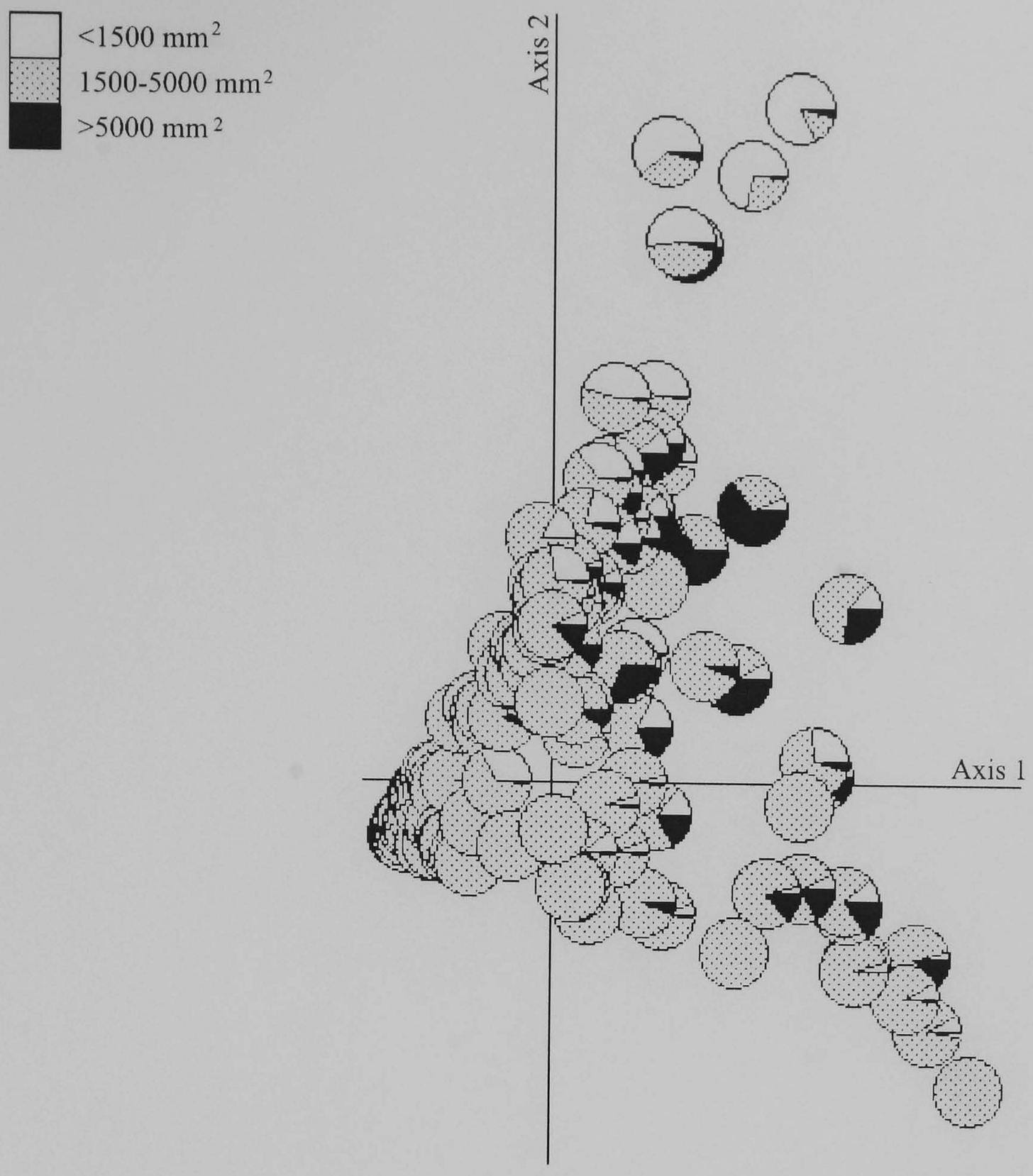


Fig. 6.11. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing the weed size index

a.



b.

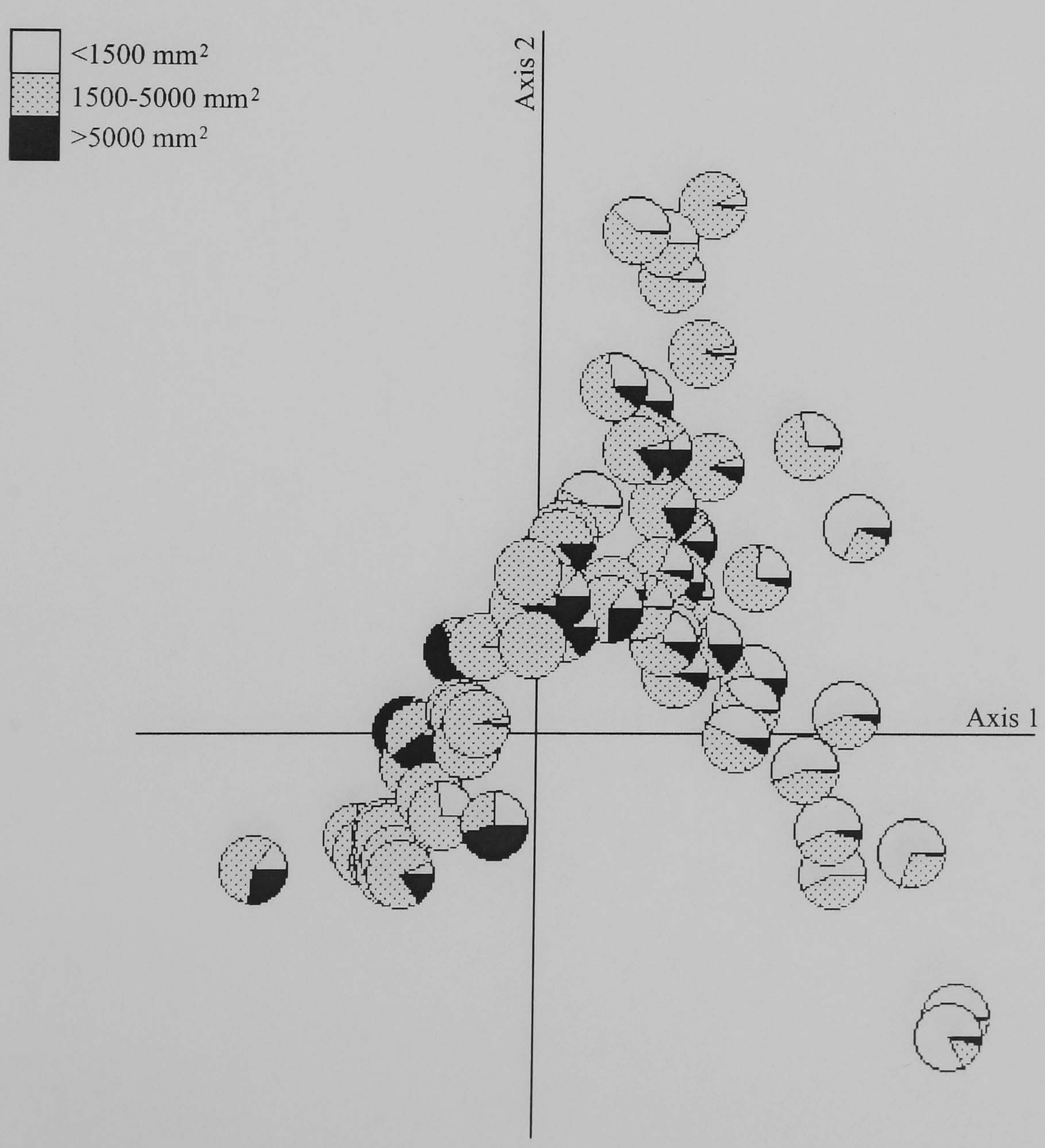


Fig. 6.12. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing leaf area per node

a.

b.

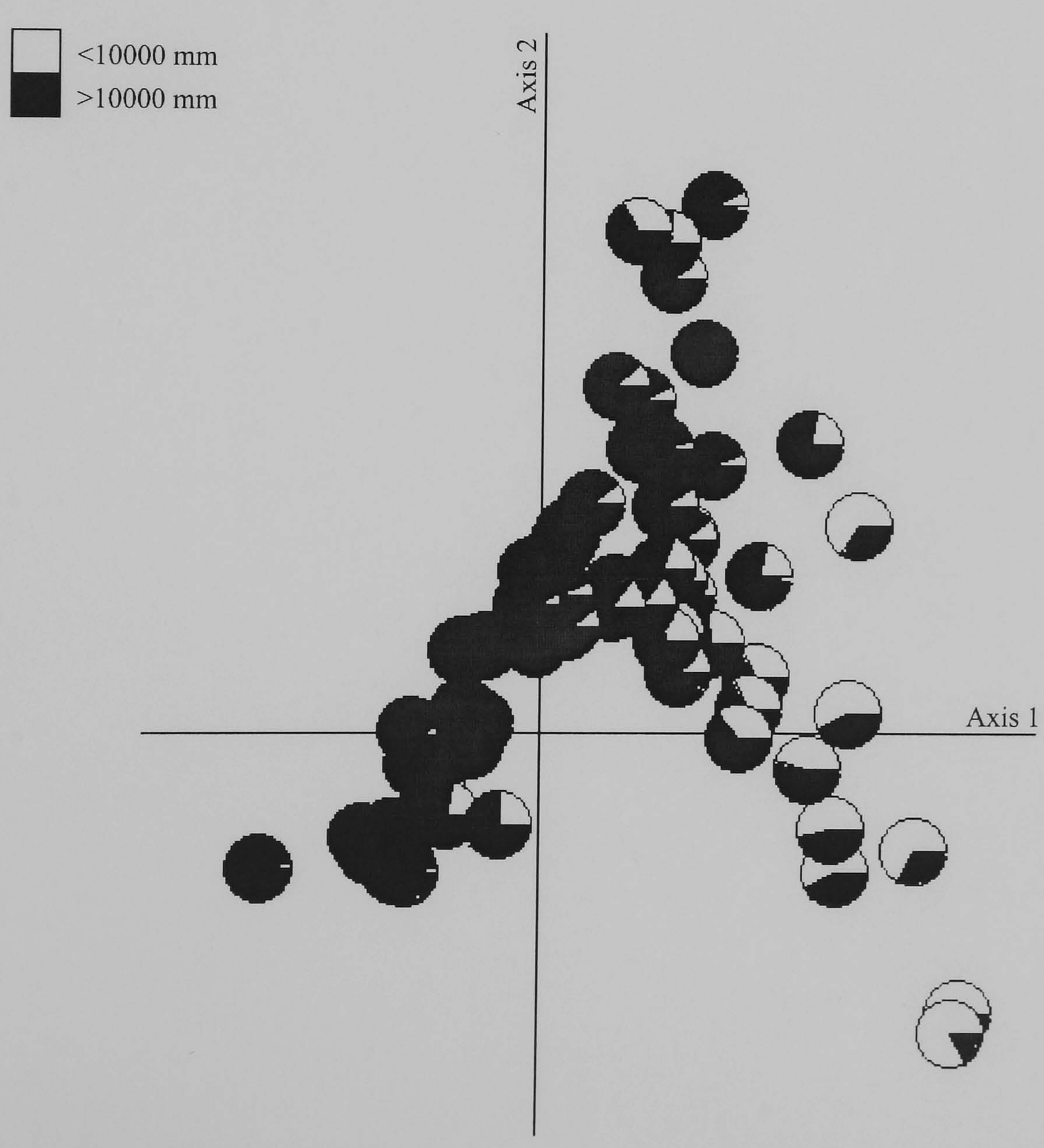


Fig. 6.13. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing leaf area per node:thickness

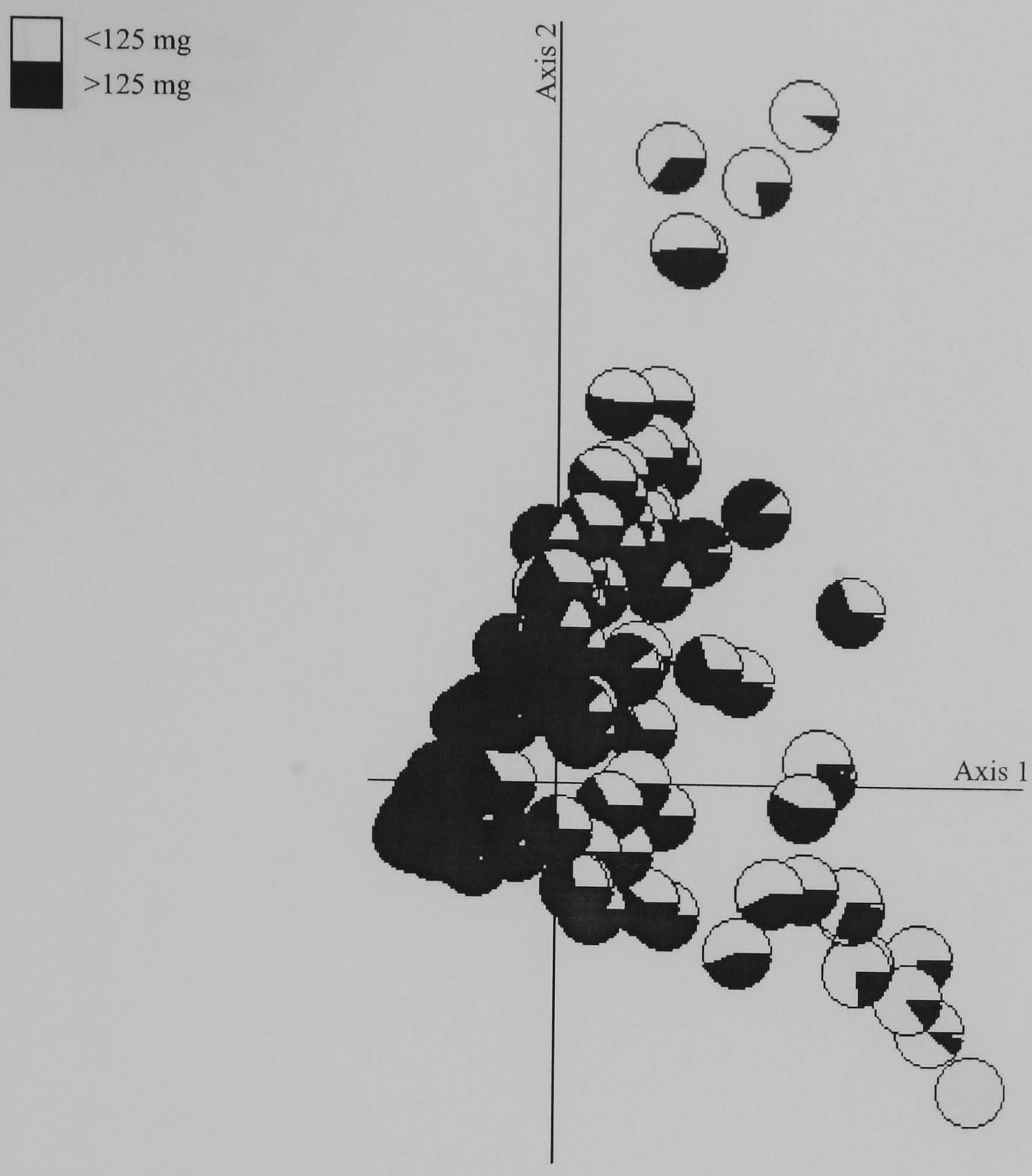
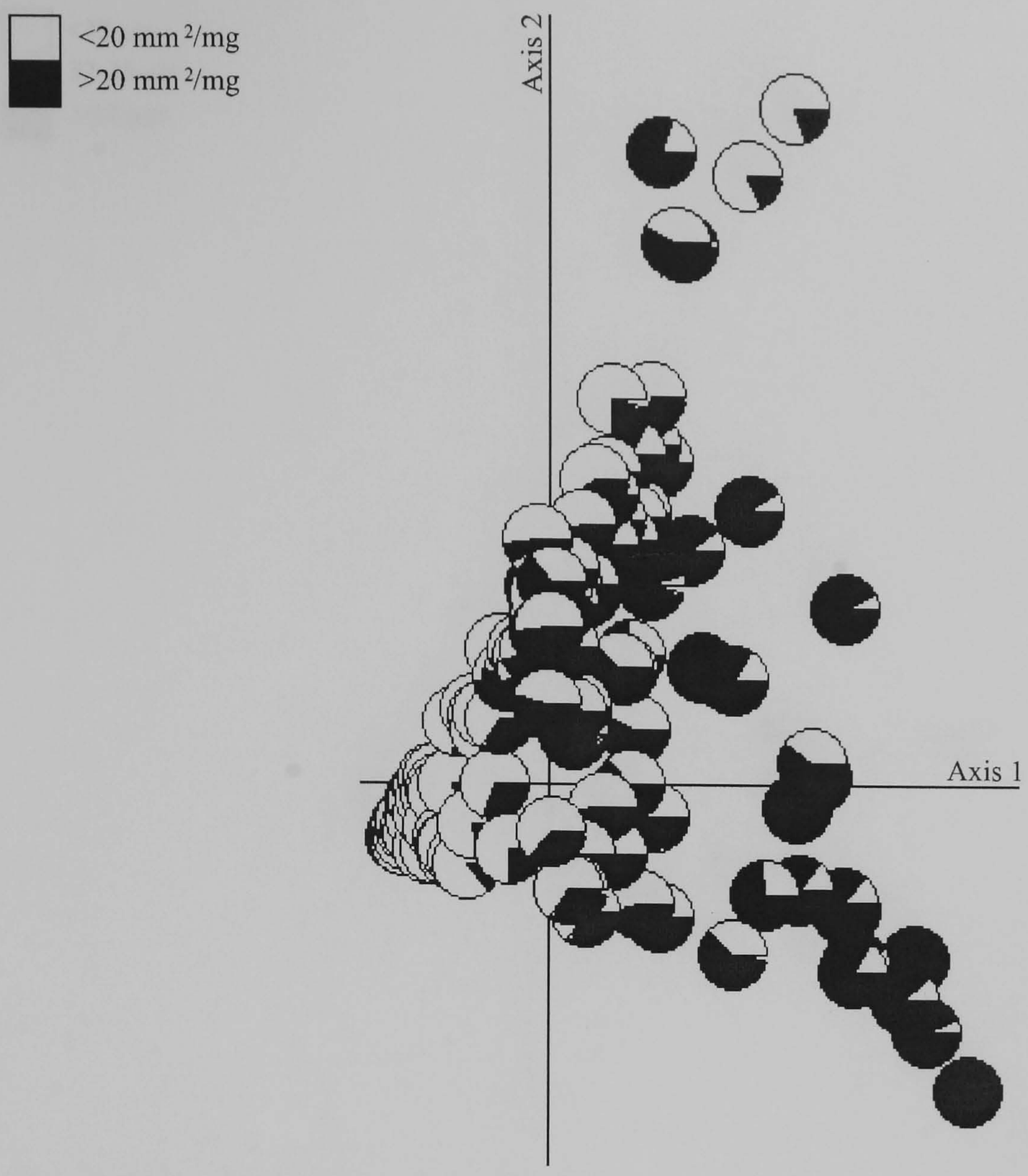


Fig. 6.14. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing leaf weight per node

a.



b.

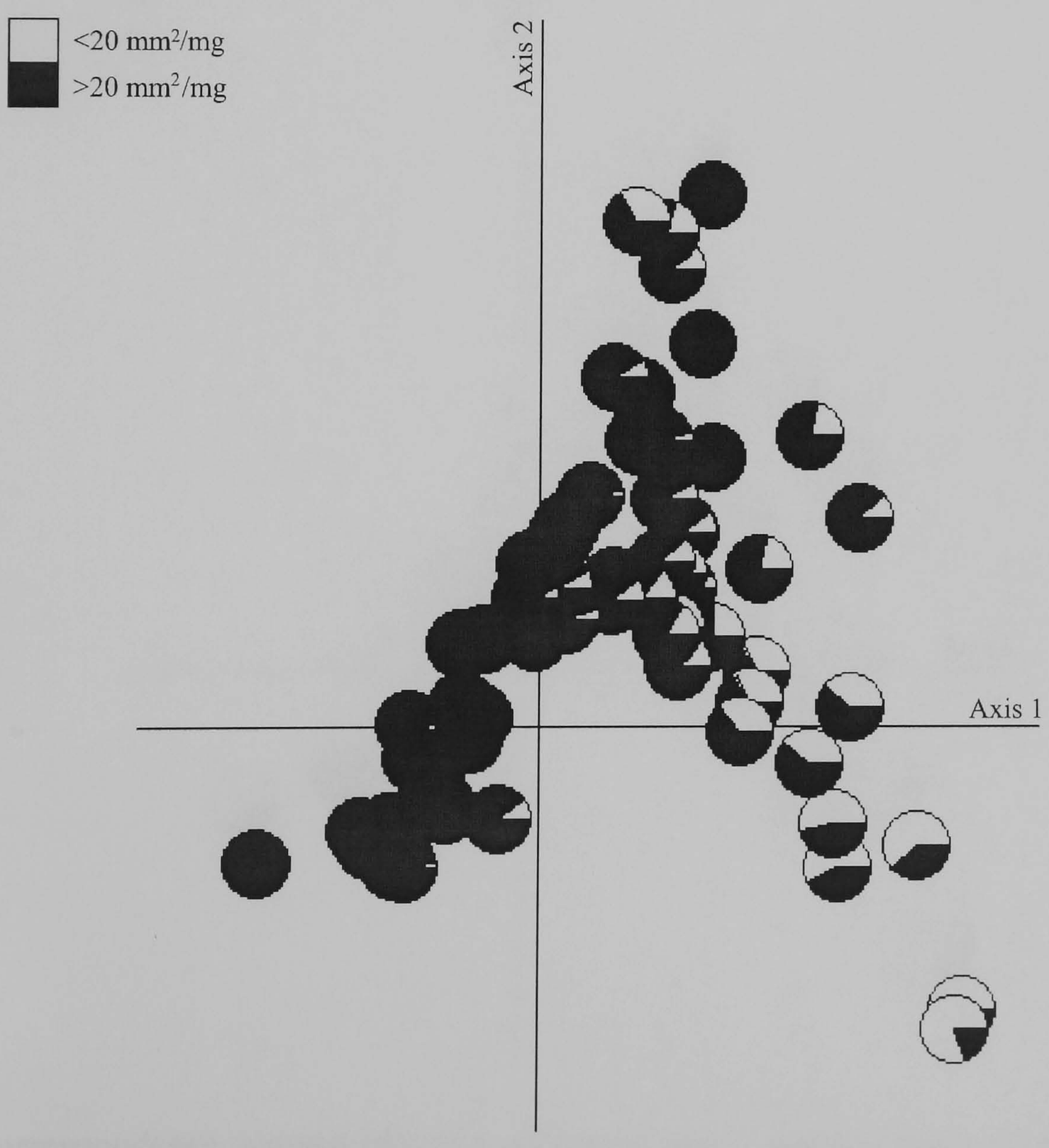
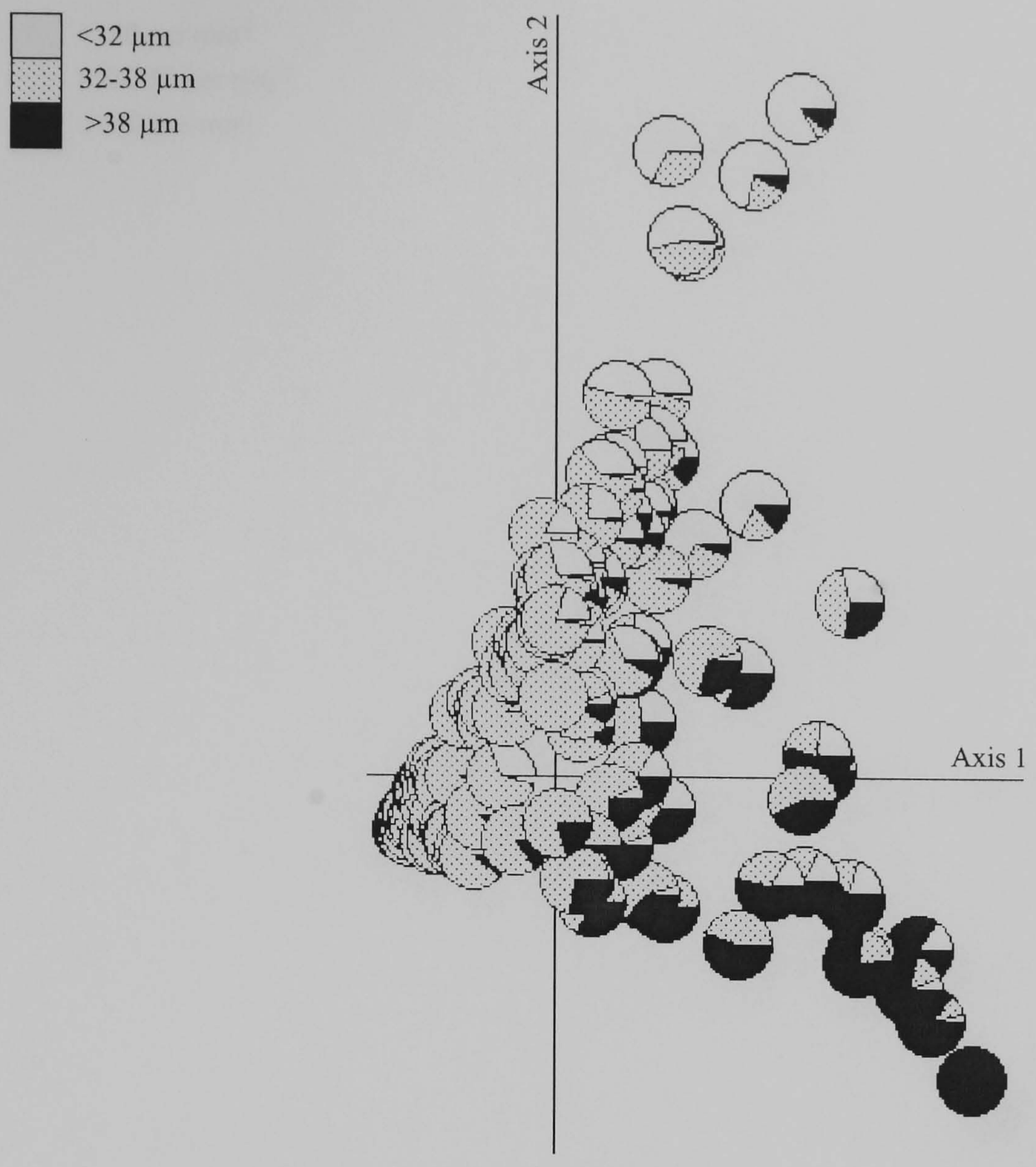


Fig. 6.15. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing specific leaf area

a.



b.

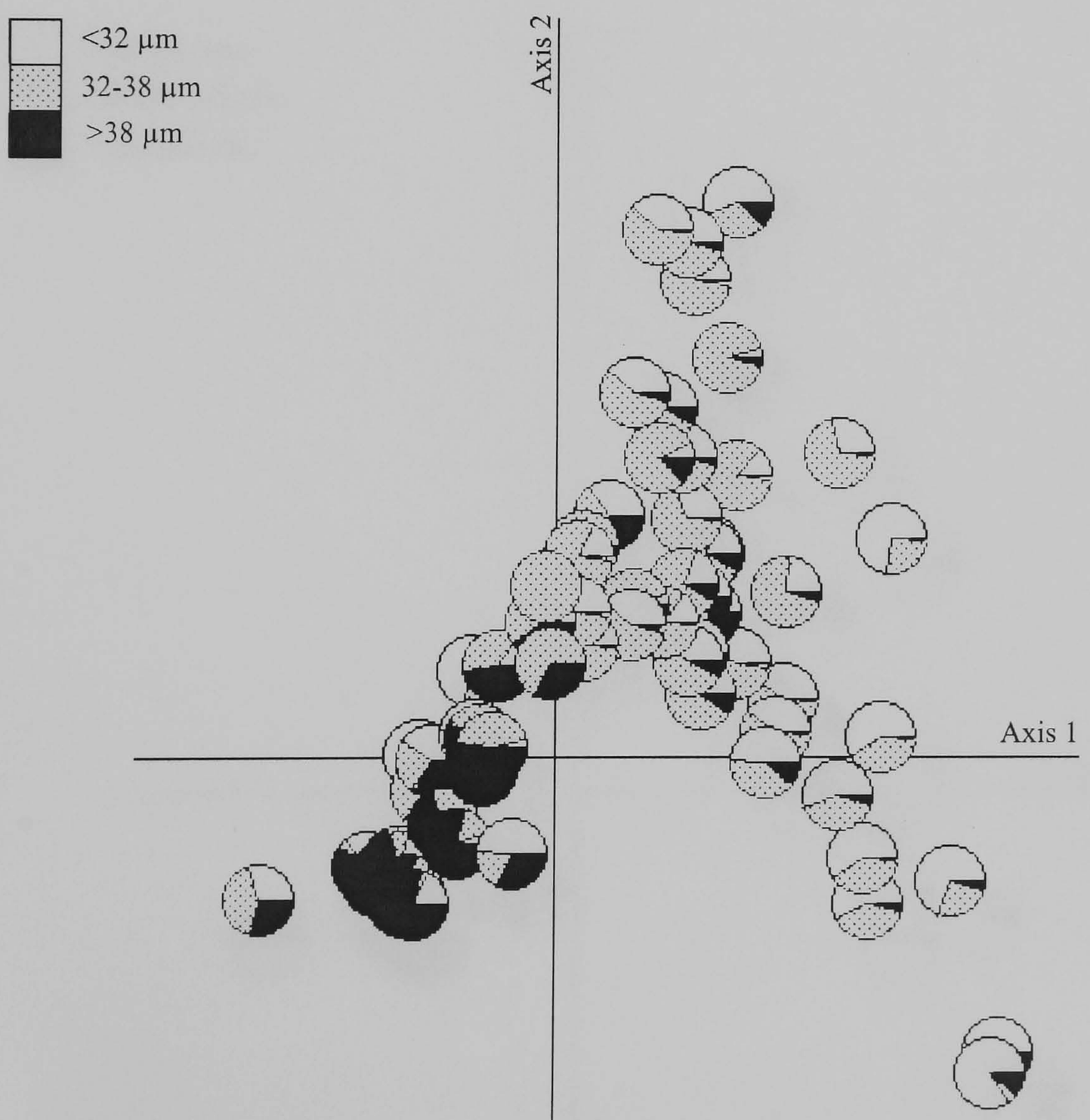
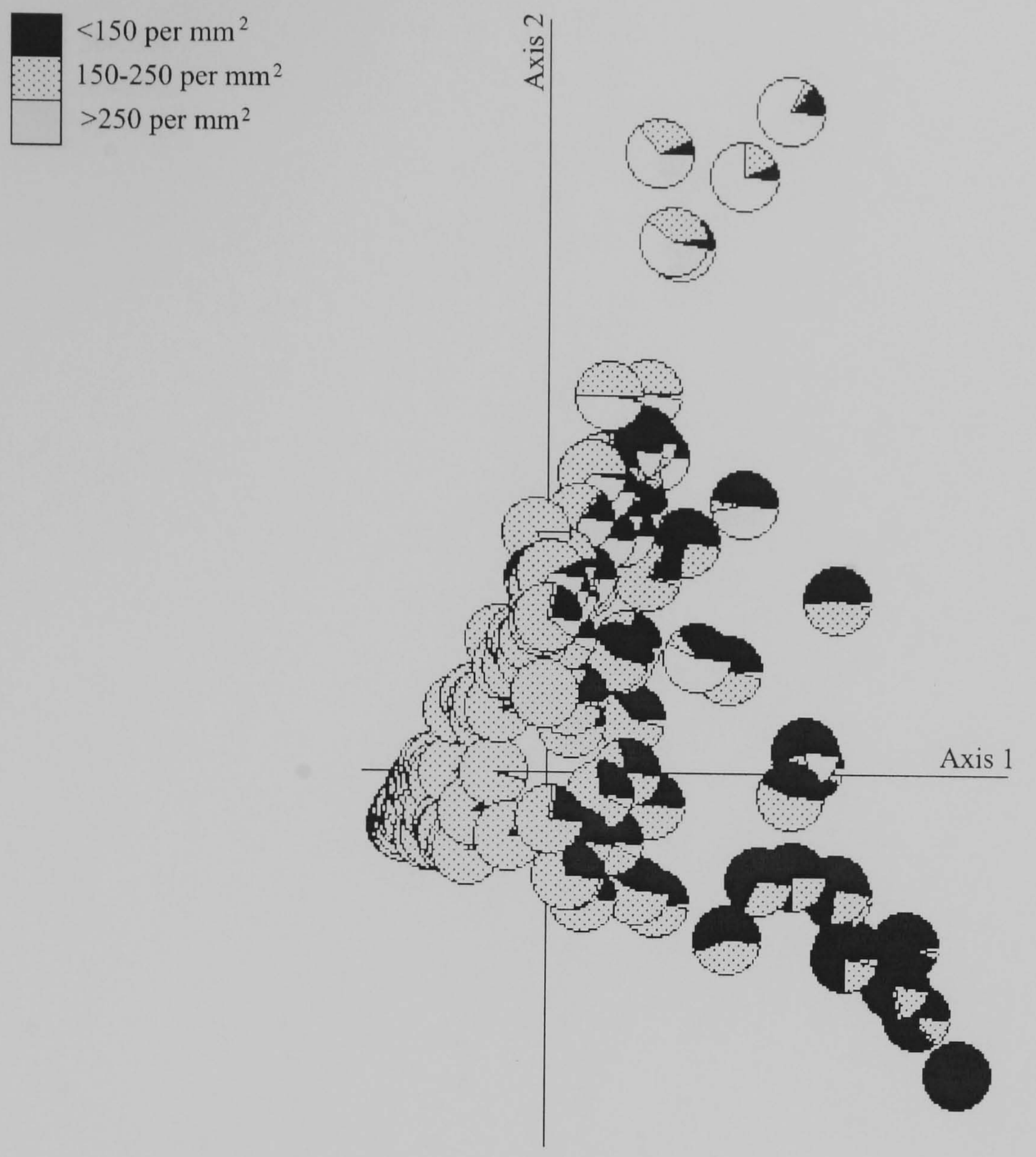


Fig. 6.16. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing guard cell length (a measure of stomatal size)

a.



b.

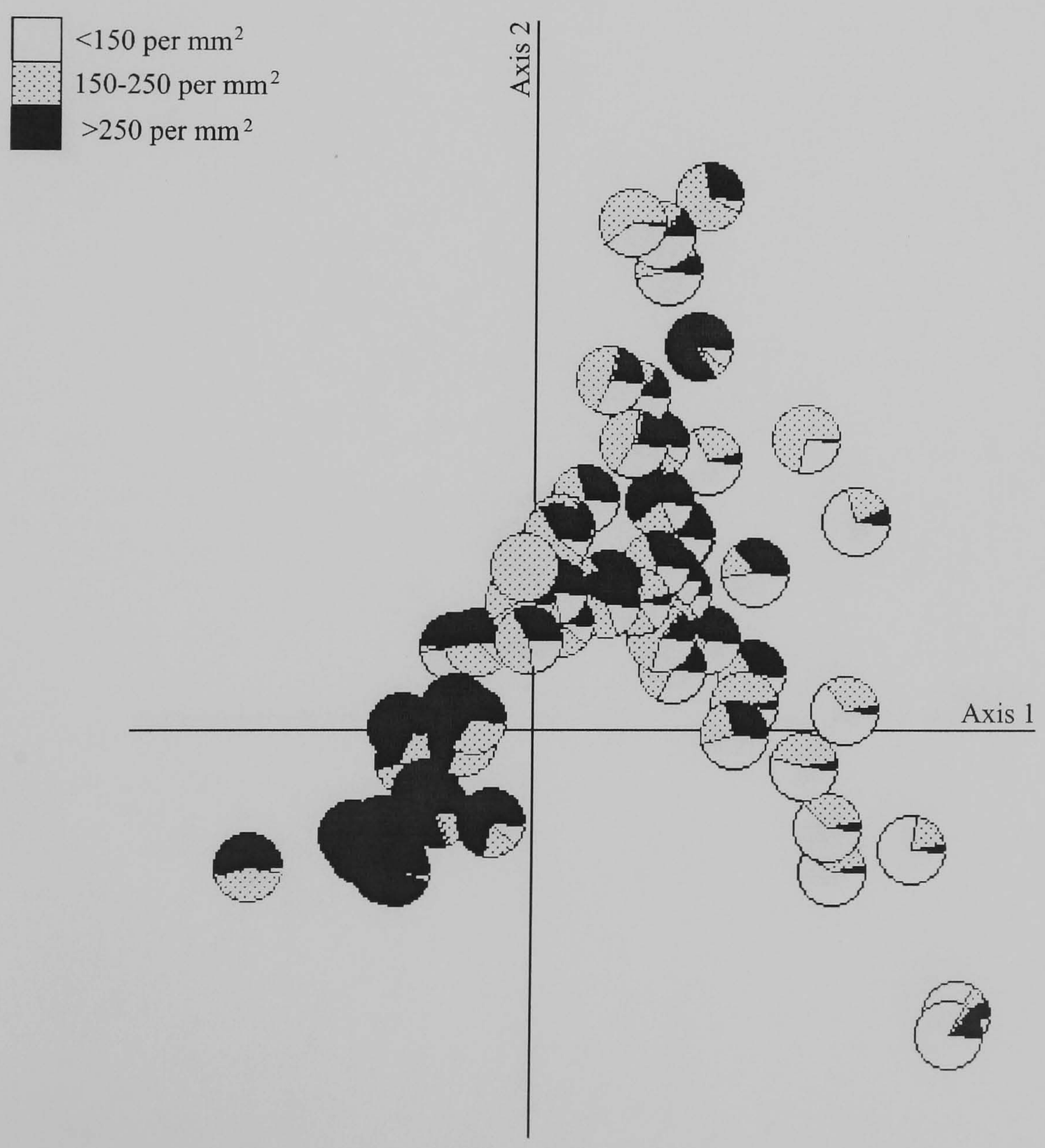
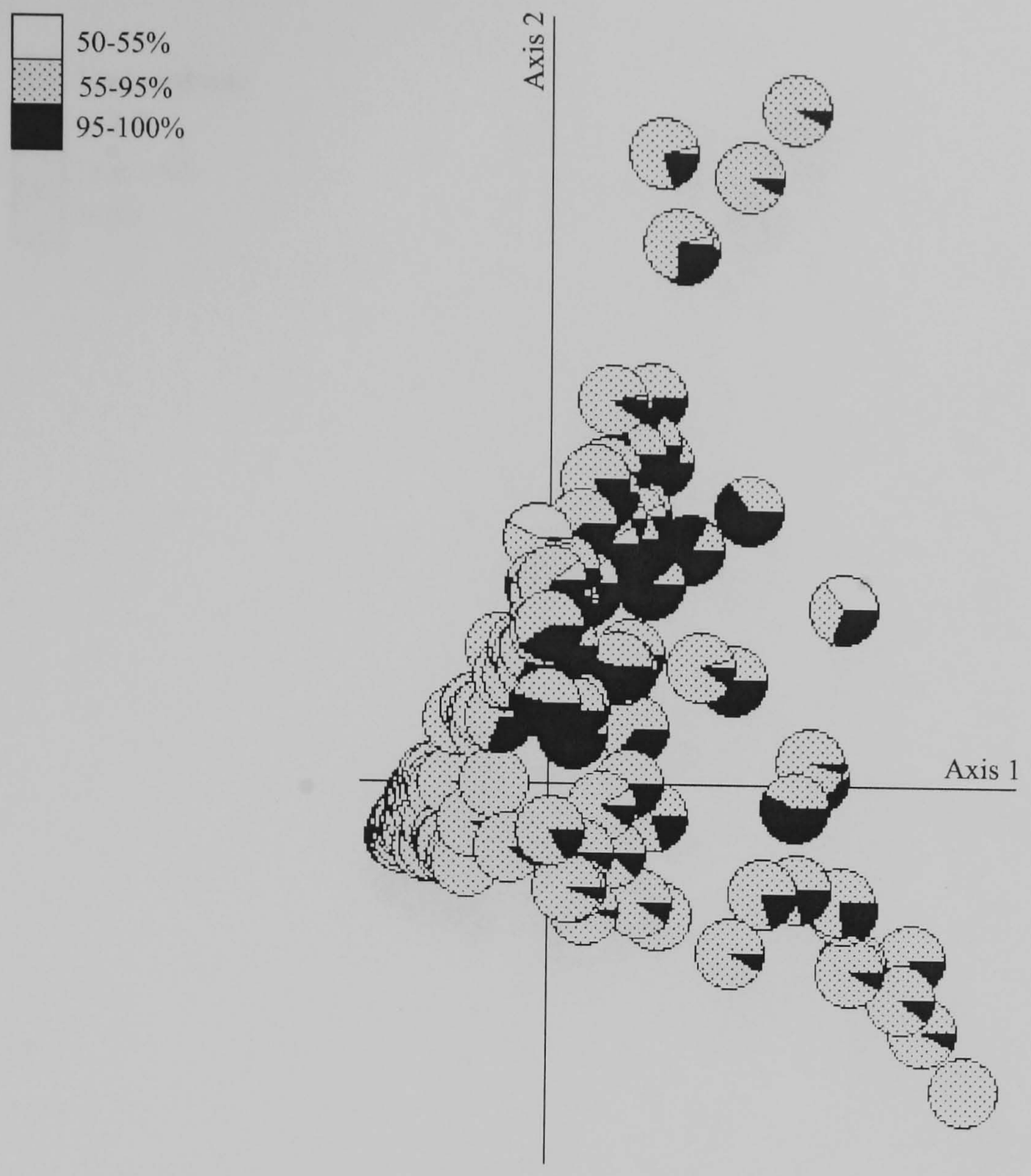


Fig. 6.17. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing stomatal density

a.



b.

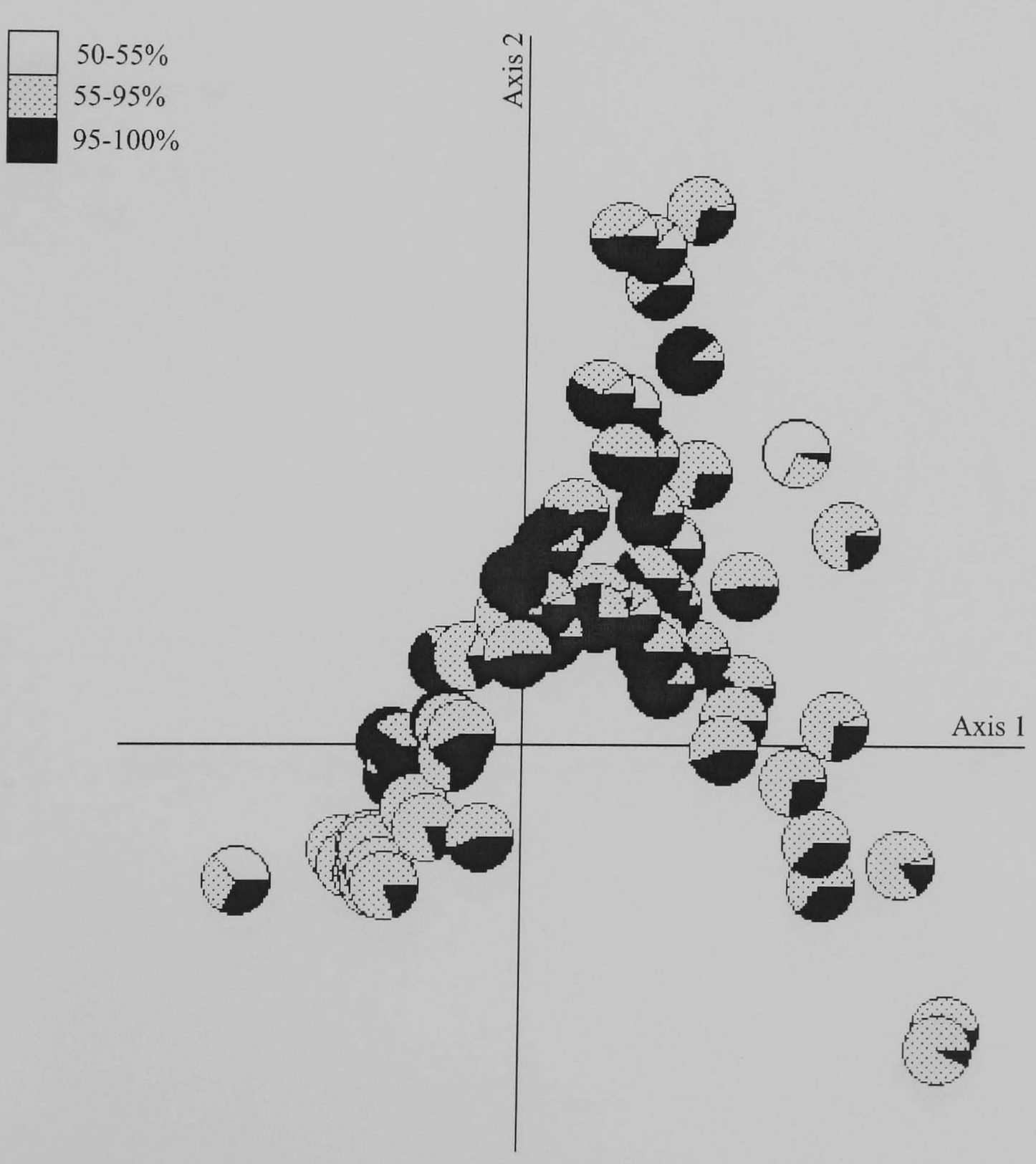
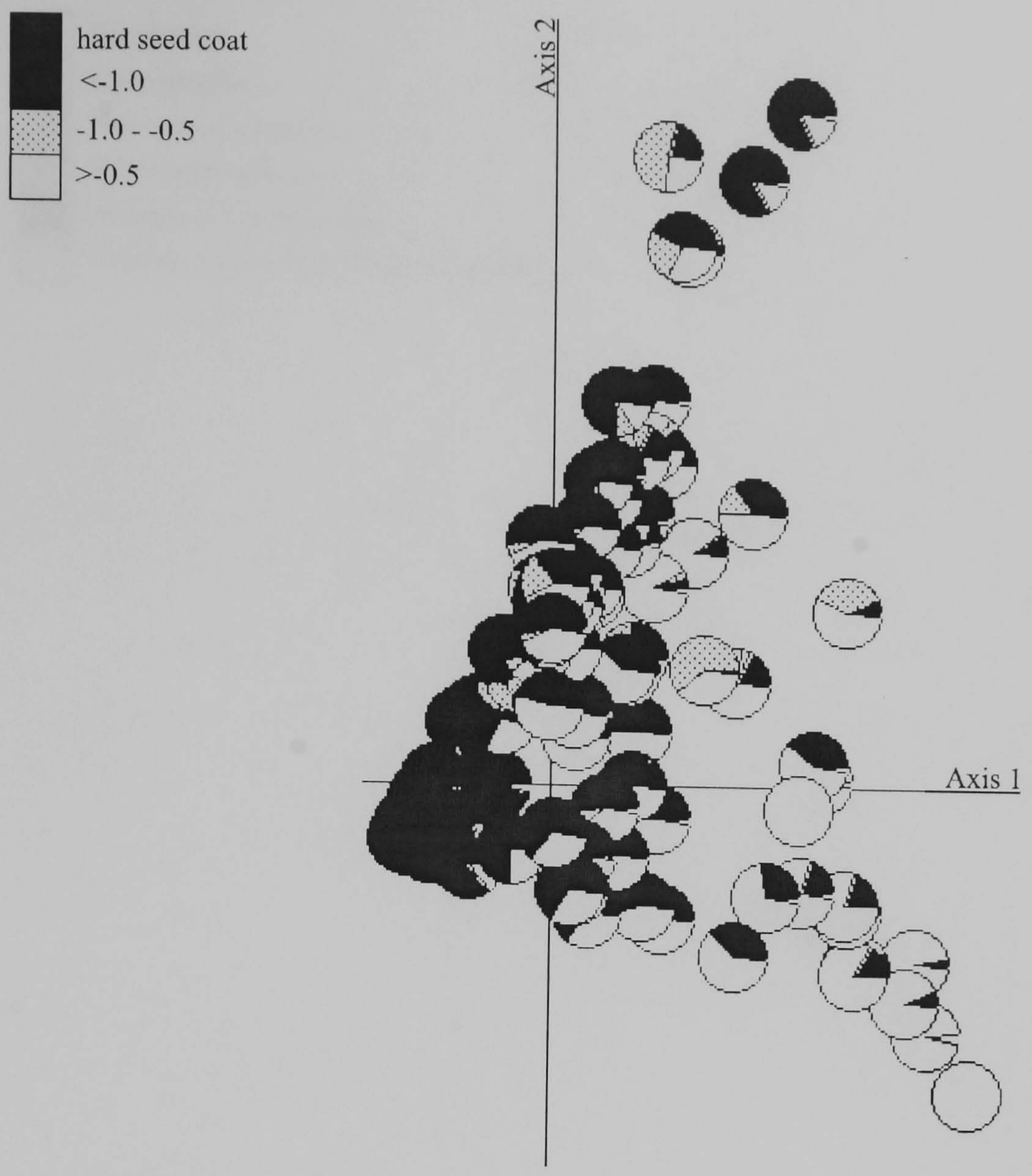


Fig. 6.18. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing the percentage of stomata on the leaf surface with the most stomata (stomatal distribution)

a.



b.

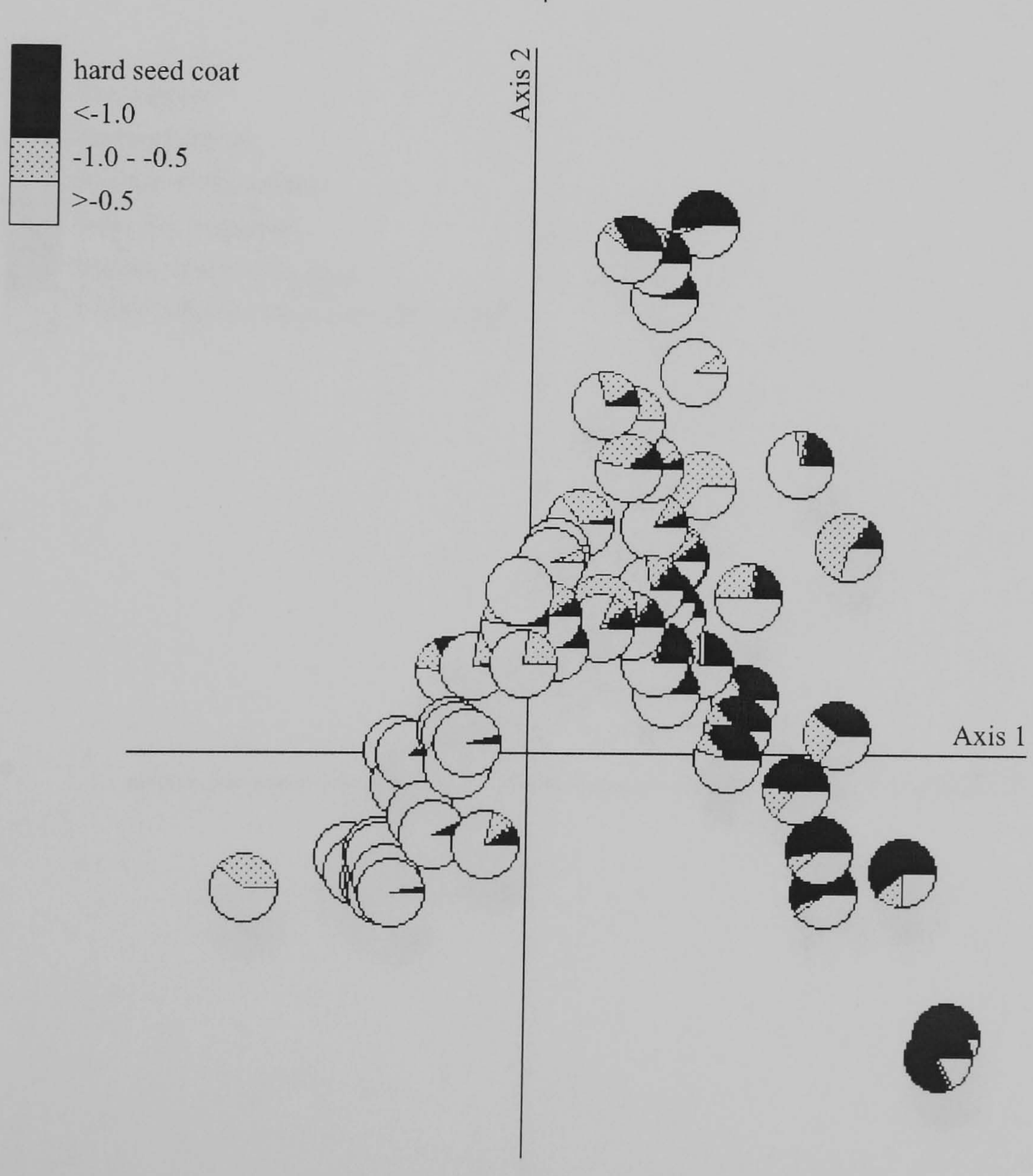
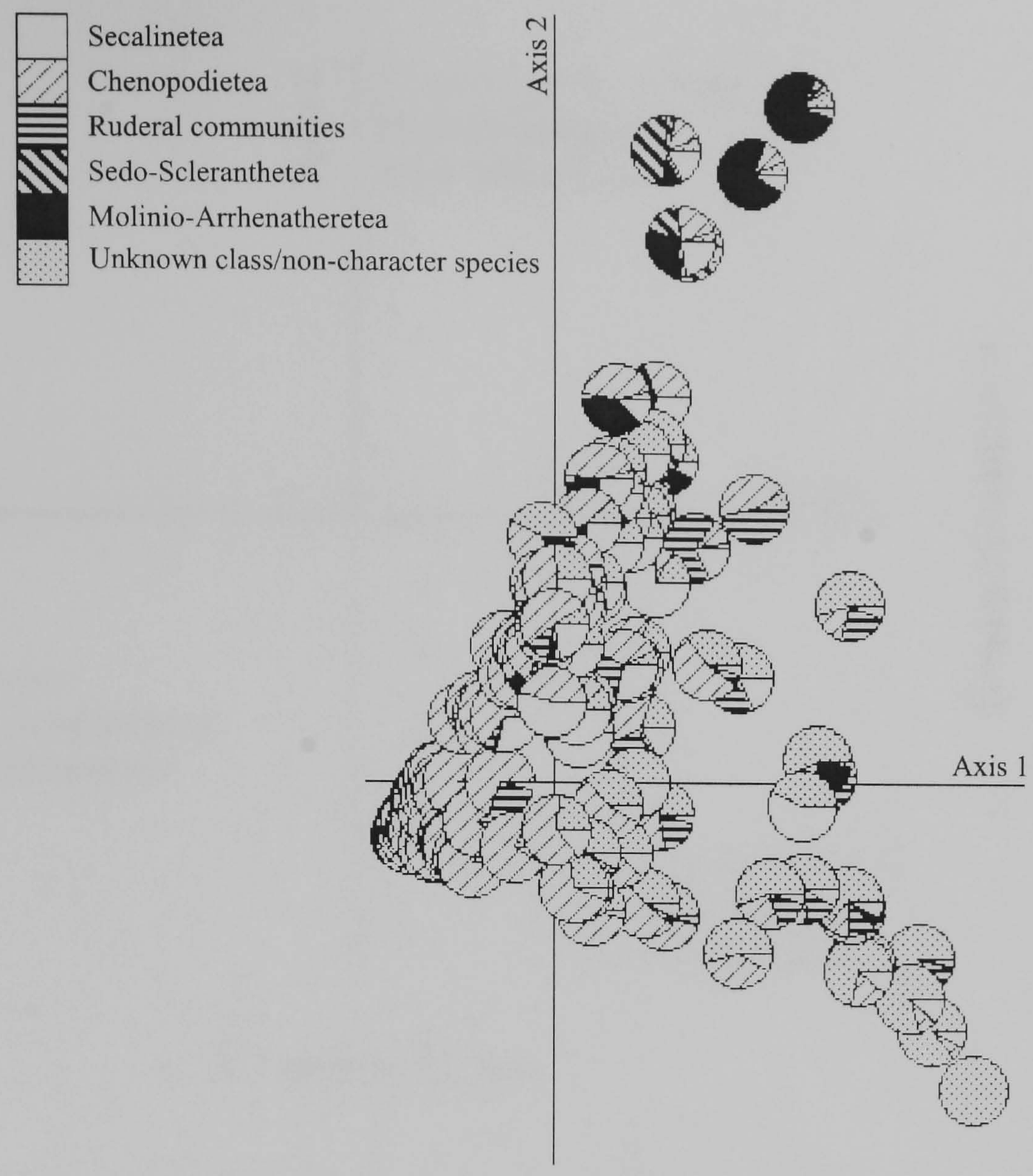


Fig. 6.19. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing the seed longevity index (inversely related to seed persistence)

a.



b.

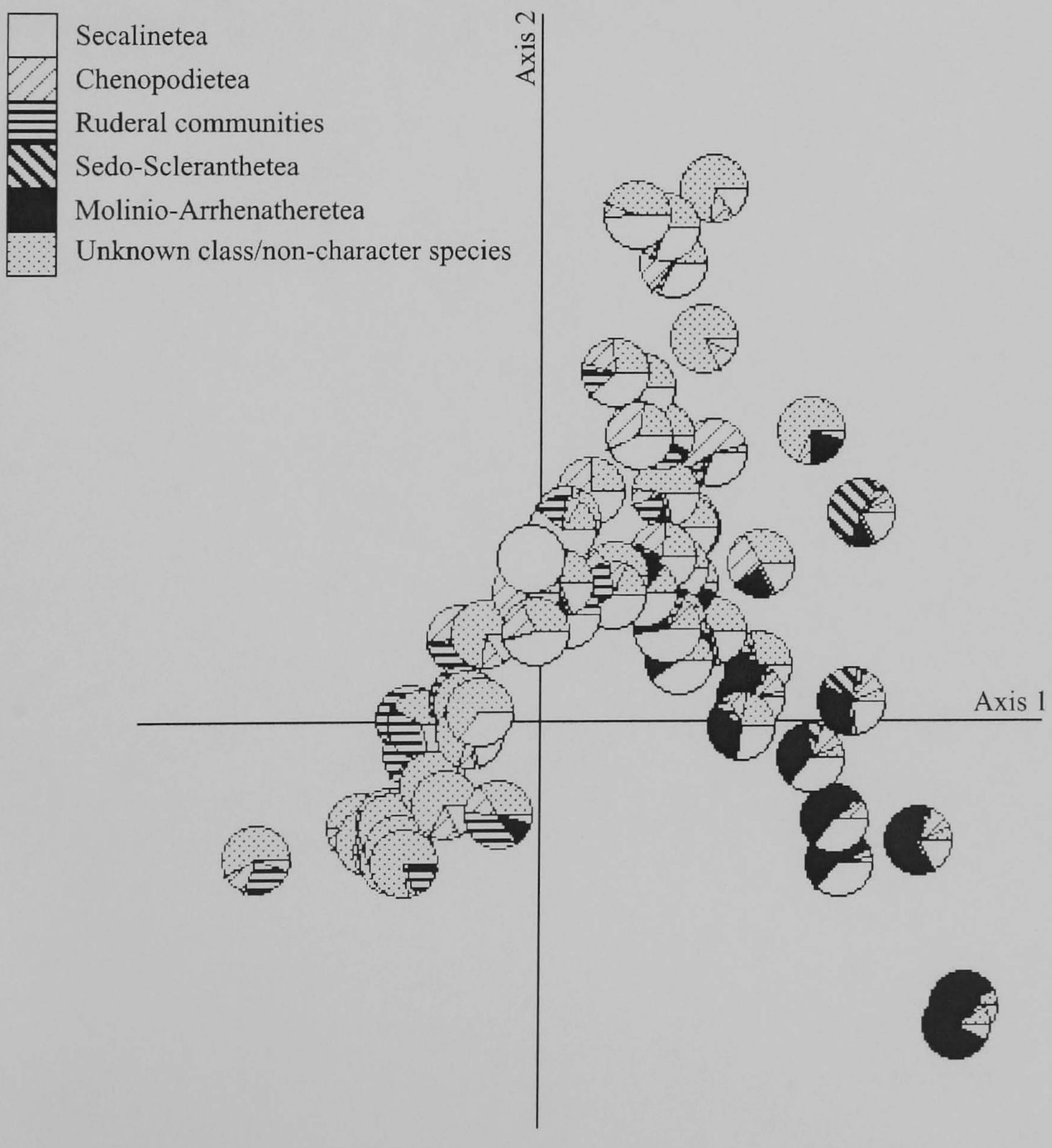


Fig. 6.20. Correspondence analysis plot of a. all glume wheat samples and b. glume wheat glume base samples, showing phytosociological class

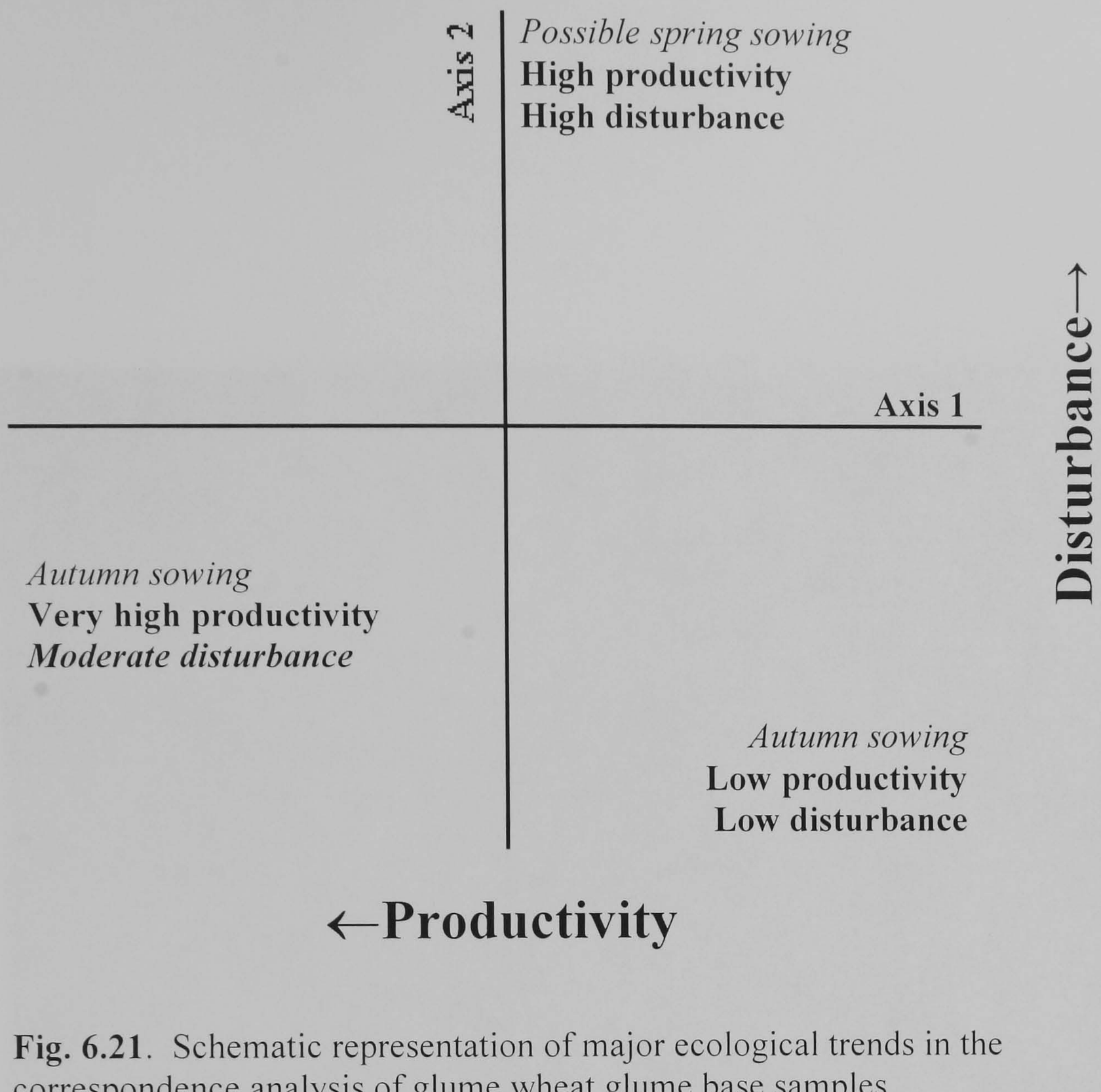


Fig. 6.21. Schematic representation of major ecological trends in the correspondence analysis of glume wheat glume base samples

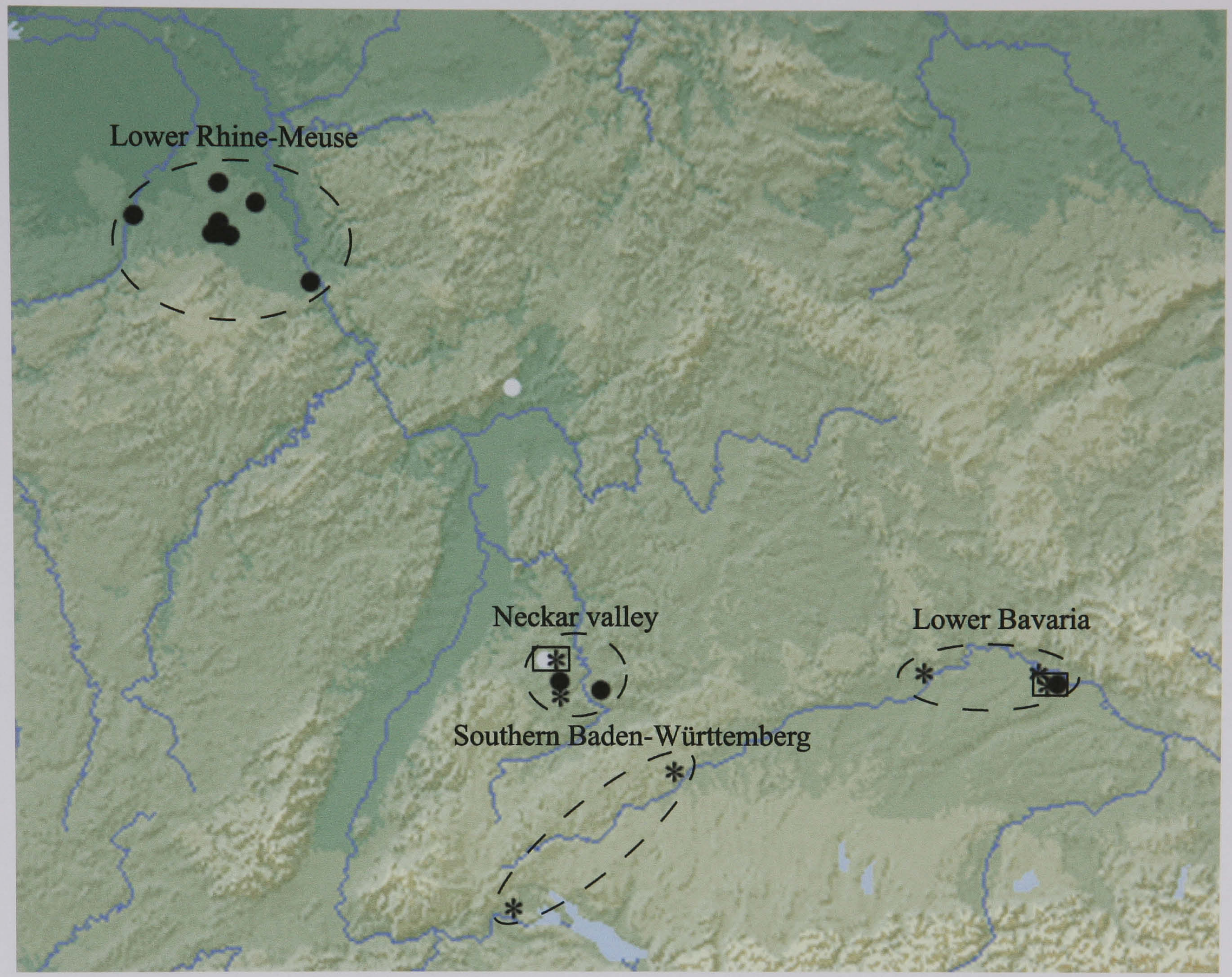


Fig. 6.22. Map showing the sites included in the correspondence analysis of glume wheat glume base samples and their crop growing conditions (©1988-1998 Microsoft and/or its suppliers); white circles = low productivity/low disturbance, black circles = very high productivity/moderate disturbance, asterisks = high productivity/high disturbance. Rectangles enclose sites with two symbols each, indicating a range of growing conditions (Vaihingen in the Neckar valley, Meindling in Lower Bavaria

Tables

Table 1.1. The major chronological periods included in the project (overall structure and ^{14}C dating follows Lüning 1996: Fig. 1; other sources are Keefer 1993: 171; Kooijmans 1993: Fig. 9; Whittle 1996a: Fig. 6.3; Preuss 1998: Supplement 1). Subdivions of periods are listed by region in rough chronological order. Abbreviations are as follows: LBK = Linearbandkeramik, SBK = Stichbandkeramik, TRB = Trichterbecherkultur

Major periods	*Early Neolithic*	*Middle Neolithic*	*Later Neolithic*			*Bronze Age*
			Jungneolithikum	*Spätneolithikum*	*Endneolithikum*	
^{14}C cal. B.C.	*5500-5000*	*5000-4400*	*4400-3500*	*3500-2800*	*2500-2200*	*2200-750*
N France, Belgium	Rubané récent	Cerny/Blicquy	Chasséen	Seine-Oise-Marne	Corded Ware Bell Beaker	Early Bronze, Middle Bronze, Late Bronze /Urnfield
Lower Rhine-Meuse basin	LBK	Rössen	Michelsberg			
Southern Germany, Switzerland		Hinkelstein, Großgartach, Rössen/Lengyel/SBK/ Oberlauterbach, Bischheim	Aichbühl, Michelsberg/Cortalloid, Schussenried, Altheim, Pfyn-Cortalloid	Horgen/Cham/Wartberg		
Central Germany, Bohemia, Southern Poland		SBK	Late Lengyel, TRB	Bernburg, Baden, Globular Amphora		
Austria, Hungary, Slovakia, Moravia		Lengyel	Late Lengyel	Baden		

Table 1.2. Experimental, historical and ethnographic data on cereal yields and archaeological estimates of crop and cultivated area requirements; *note run of bad years in 1920s at Woburn omitted; ** = yield data reported as 10-year averages

Source	Reference	Crop husbandry	Area yield kg/ha	Seed-yield ratio	Estimated kg/person	Estimated no./house	Estimated ha/household
Experimental data - shifting cultivation							
Draved experiment	Steensberg 1979		very poor	±no return			
Butser experiment	Reynolds 1977		1600 year 1, 1400 year 2, 900 year 3				
Wackershofen and Forchtenberg experiments	Rösch 2000; Rösch *et al.* 2002		up to 2500 and 4000 (year 1), minimal-zero yield in later years	>20:1			
Experimental data - continuous cereals at Woburn 1877-1920 (Russell and Voelcker 1936)*							
		wheat , no manure	480-1630 (ave 820)				
		wheat , manured	840-2750 (ave1640)				
		barley , no manure	114-1950 (ave 930)				
		barley , manured	1100-3560 (ave 2150)				
Experimental data - continuous barley at Rothamsted 1852-1962 (Rothamsted Experimental Station 1970)**							
		no manure	450-1500 (ave 928)				
		manured	1880-3510 (ave 2960)				
Experimental data – wheat/bare fallow at Rothamsted 1852-1964 (Rothamsted Experimental Station 1970)**							
		no manure	800-2380 (ave 1410)				
		manured	1870-3550 (ave 2840)				

Table 1.2, continued

Source	Reference	Crop husbandry	Area yield kg/ha	Seed-yield ratio	Estimated kg/person	Estimated no./house	Estimated ha/household
Experimental data - row-sown cereals grown for 15 years at Little Butser (Reynolds 1992)							
		no manure, 3x hoeing during crop growth	emmer: 360-3030 (ave 1650); spelt: 670-2610 (ave 1490)	ca. 30:1			
		as above, emmer rotated with broad beans	780-3110 (ave 2080)	ca. 30:1			
Historical data on shifting cultivation							
Forest farming in Canada	Schott 1936		1500-3400 in first year				
Shifting cultivation in Finland	Soininen 1959			20-50:1, up to 100:1			
Historical data - extensive cereal cultivation							
Medieval Europe (esp 800-1150 AD)	Henning 1994		450-550	2.5-3:1			
Historical data from central Europe (Medieval period, 18th cy)	Lüning 1979/1980 (see also Tegtmeier 1993: 5)		900	3:1	250	6	ca. 2.5, or 3.75 with bare fallow
Statistisch-Topographisches Bureau for 1850-1905	Gregg 1988		ca. 800 (range 650-1050)	ca. 4:1	up to 200 for male adult (55-65% of diet)	4-8	1.6-3.2
Ethnographic data - intensive cereal cultivation							
Asturias, NW Spain	P. Halstead, field notes	manuring, hand weeding	(800-) 1700-1900				

Table 1.2, continued

Source	Reference	Crop husbandry	Area yield kg/ha	Seed-yield ratio	Estimated kg/person	Estimated no./house	Estimated ha/household
Other estimates for prehistoric cereal cultivation							
	Halstead 1981a, 1987	(intensive cultivation)	800-1000				
	Bakels 1982		800		(65% or 80% of diet)	6-10	ca. 1.5-3
	Milisauskas and Kruk 1989b		500		200 (ca. 80% of diet)	5	2
	Billamboz *et al.* 1992		600, 800		100, 150 or 200 (50% - 100% diet)	5	ca. 1-2
	Jacomet *et al.* 1989: 90-91		600	5:1	ca. 150 (65% diet)	5-6	ca. 1.5-2
	Gross *et al.* 1990		650	5:1	ca. 100 (52% of diet)	5	1
	Halstead 1995	(intensive cultivation)	1000		300	5	ca. 2-3

Table 1.3. Estimates of the cultivated area for a household of five (requiring 1500 kg cereals per annum), assuming negligible deduction for seed corn. The requirement of 300 kg per person per year is based on the assumption that wheat provides the bulk (ca. 80%+) of the diet, allowing 2500 kcal per person per day given that 1 kg wheat provides ca. 3000 kcal (Gregg 1988: Table 1, 73).

Area yield (kg/ha)	*Cultivatea area (ha)*
400	3.75
500	3.00
600	2.50
700	2.14
800	1.88
900	1.67
1000	1.50
1100	1.36
1200	1.25
1300	1.15
1400	1.07
1500	1.00
1600	0.94
1700	0.88
1800	0.83

Table 1.4. The relationship of the four major crop husbandry models to the three variables of permanence, intensity and seasonality

Models	*Permanence*		
Shifting cultivation	Transient plots	*Intensity*	
Extensive ard cultivation	Fixed plots	Extensive	*Seasonality*
Floodplain cultivation		Intensive	Spring sowing
Intensive garden cultivation			Autumn or spring sowing

Table 2.1. The archaeobotanical reports available for neolithic-bronze age sites in the study area; EN = Early Neolithic, MN = Middle Neolithic; LN = Later Neolithic, BA = Bronze Age

Reference	*Site(s)*	*Period*	*Country*
Bakels 1978	various	EN	Germany, The Netherlands
Bakels 1979	various	EN	The Netherlands
Bakels 1982/3	Fort Harrouard	BA	France
Bakels 1983/4	various	BA	Germany
Bakels 1984	various	various	France
Bakels 1986a	Hienheim "Im Fuchsloch"	EN-MN	Germany
Bakels 1986b	Hienheim/Donau	LN, BA	Germany
Bakels 1986c	Frauenhofen	EN-MN	Austria
Bakels 1991a	Maastricht-Randwijck	MN	The Netherlands
Bakels 1992a	Overhespen, Wange	EN	Belgium
Bakels 1992b	Meindling	EN	Germany
Bakels 1993	Siebenborn "Vor Tonguich"	EN	Germany
Bakels 1995a	Bucy-le-Long	EN	France
Bakels 1995b	Berry-au-Bac	EN	France
Bakels 1999a	various	various	France
Bakels 1999b	Schwanfeld	LN	Germany
Bakels and Rouselle 1985	various	EN-MN	Belgium, The Netherlands
Bakels *et al*. 1993	Maastricht-Randwijck	MN	The Netherlands
Bakels unpublished	Ratzerdorf	EN	Austria
Baudais *et al*. 1997	Clairvaux station III	LN	France
Baumann and Schultze-Motel 1968	various	EN	Germany
Behre 1982	Harkenbleck, Wiesens	BA	Germany
Behre 1988	Toos-Waldi	BA	Switzerland
Bertsch 1929	various	EN	Germany
Bertsch 1941	Heilbronn	EN-MN	Germany
Bertsch and Bertsch 1949	various	EN-MN	Germany
Blankenhorn and Hopf 1982	Federsee sites	LN	Germany
Bocquet *et al*. 1986	Charavines "Les baigneurs"	LN	France
Bocquet *et al*. 1987	Charavines "Les baigneurs"	LN	France
Bogaard unpublished	Vaihingen/Enz	EN	Germany
Bollinger and Jacomet-Engel 1981	Twann	LN	Switzerland
Brombacher 1997	Lake Biel sites	LN	Switzerland
Brombacher 2000	Lake Biel sites	LN	Switzerland
Brombacher and Jacomet 1997	Lake Zurich sites	LN-BA	Switzerland
Cheben and Hajnalová 1997	various	EN-LN	Slovakia
Clemens *et al*. 1994	Zeltingen-Rachtig	various	Germany
Dietsch 1996	Bercy	LN	France
Feigenwinter unpublished	Uerschausen-Horn	BA	Switzerland
Fredskild 1978	Thaygen-Weier	LN	Switzerland
Gizbert 1960	various	various	Poland
Gizbert 1971	various	various	Poland
Gluza 1971	Mogila 62	MN	Poland
Gluza 1983	Mogila 62	MN	Poland
Gluza *et al*. 1988	various	LN	Poland
Gregg 1989	Ulm-Eggingen	EN	Germany
Gyulai 1991	Balatonmagyarod-Hidvegpuszta	BA	Hungary
Gyulai 1999a	Rakospalota-Ujmajor	EN	Hungary
Gyulai 1999b	various	BA	Hungary

Table 2.1, continued

Reference	*Site(s)*	*Period*	*Country*
Hajnalová 1975	various	various	Slovakia
Hajnalová 1983	Sturovo/Nove Zamky	EN	Slovakia
Hajnalová 1986	Svodin	MN-LN	Slovakia
Hajnalová 1988	Blatné	EN	Slovakia
Hajnalová 1989	various	various	Slovakia
Hajnalová 1990	Sitno	BA	Slovakia
Hajnalová 1993	various	various	Slovakia
Hajnalová 1994	various	various	Slovakia
Hajnalová 1999	various	MN-LN	Slovakia
Hartyanyi 1982	Tiszaalpár	BA	Hungary
Hartyanyi and Novaki 1975	various	various	Hungary
Heim 1979	Bosse de l'Tombe, Givry	MN	France
Heim 1988	Crisnée	EN	Belgium
Heim and Jadin 1998	various	EN	Belgium
Hinton 1995	Ergolding-Fischergasse	LN	Germany
Hinton 1999	Galgenberg	LN	Germany
Hofmann 1953	Vösendorf/Mödling	EN	Austria
Hopf 1957	Lietfeld	LN	Germany
Hopf 1962	Riekhofen	LN	Germany
Hopf 1963	Eitzum/Wolfenbüttel, Helmstedt	EN	Germany
Hopf 1968	Ehrenstein	LN	Germany
Hopf 1969	Säckingen	BA	Germany
Hopf 1975a	Entzheim	LN	France
Hopf 1975b	Butzbach, Degerfeld	EN	Germany
Hopf 1977	Schlößlesfeld	LN	Germany
Hopf 1981	Schernau	MN	Germany
Hopf 1985	Ouroux-Marnay	BA	France
Hopf 1987	Geispolsheim	LN	France
Hopf 1989	Quellberg bei Weingarten/Baden	EN	Germany
Hopf 1992	Sengkofen „Pfatterbreite"	LN	Germany
Hopf and Blankenhorn 1987	various	various	Germany
Hummel 1968	Hundisburg/Haldensleben	EN	Germany
Jacomet 1986a	Cham-St. Andreas	LN	Switzerland
Jacomet 1986b	AKAD-Seehofstrasse, Pressehaus	LN	Switzerland
Jacomet 1990	Sipplingen	LN	Germany
Jacomet and Karg 1996	Zug-Sumpf	BA	Switzerland
Jacomet and Karg unpublished	Zug-Sumpf	BA	Switzerland
Jacomet and Wagner 1987	Zug-Vorstadt 26	LN	Switzerland
Jacomet *et al.* 1989	Lake Zurich sites	LN-BA	Switzerland
Jacomet *et al.* unpublished	Rekingen-Bierkeller	BA	Switzerland
Jacomet *et al.* unpublished	various	LN-BA	Switzerland
Jacomet-Engel 1980	Pressehaus-Ringier	LN	Switzerland
Jacquat 1989	Hauterive-Champréveyres	BA	Switzerland
Jacquat and Bauer 1993	Zug-Sumpf	BA	Switzerland
Jacquat and Hafner 1996	Hünenberg-Chämleten	LN	Switzerland
Jacquet *et al.* 1998	Lyon-Vaise	BA	France
Jørgensen 1975	Thayngen-Weier	LN	Switzerland
Karg 1988	Uhingen-Römerstrasse 91	BA	Germany
Karg 1989	Treffensbuch	BA	Germany

Table 2.1, continued

Reference	*Site(s)*	*Period*	*Country*
Karg 1990	Allensbach-Strandbad	LN	Germany
Klichowska 1961	various	various	Poland
Klichowska 1967	various	various	Poland
Klichowska 1968	Wroclaw	BA	Poland
Klichowska 1970	Radziejow Kujawski	LN	Poland
Klichowska 1971	Bruszczewo	BA	Poland
Klichowska 1972	various	various	Poland
Klichowska 1975	various	EN-LN	Poland
Klichowska 1976	various	EN-BA	Poland
Knörzer 1967b	various	EN	Germany
Knörzer 1968	various	EN	Germany
Knörzer 1971a	Langweiler/Jülich	MN	Germany
Knörzer 1971b	various	EN-MN	Germany
Knörzer 1972	Langweiler 3and 6/Jülich	EN, BA	Germany
Knörzer 1973	Langweiler 2/Jülich	EN	Germany
Knörzer 1974	Bedburg-Garsdorf/Bergheim	EN	Germany
Knörzer 1977	Langweiler 9/Jülich	EN	Germany
Knörzer 1979b	Broichweiden, Kr. Aachen	EN	Germany
Knörzer 1980a	Bergheim-Zieverich	EN	Germany
Knörzer 1980b	Wanlo/Wickerath	EN	Germany
Knörzer 1988	Langweiler 8/Jülich	EN	Germany
Knörzer 1992	Blumenberg	BA	Germany
Knörzer 1995	Erkelenz/Kückhoven	EN	Germany
Knörzer 1997	various	EN-LN	Germany
Knörzer 1998	Erkelenz/Kückhoven	EN	Germany
Kohler-Schneider 1999	Stillfried	BA	Austria
König 1990	Wehlen	EN	Germany
Kreuz 1990	various	EN	Austria, Germany
Kreuz 1997	Harheim	EN, BA	Germany
Kroll 1997	Greding	BA	Germany
Kühn 1960	various	various	Czech Republic, Slovakia
Kühn 1978	Slapanice	BA	Czech Republic
Kühn 1981a	Slapanice	BA	Czech Republic
Kühn 1981b	various	various	Czech Republic, Slovakia
Kulczycka-Leciejewiczowa 1973	Trzebiesławice/Sandomierz	EN	Poland
Küster 1985	Hochdorf	LN	Germany
Küster 1988	Burkheim	BA	Germany
Küster 1989	Ergolding-Fischergasse	LN	Germany
Küster 1990	Moorenweis	LN	Germany
Küster 1991a	Künzig-Unternberg	MN	Germany
Küster 1991b	Langenbach-Niederhummel	EN	Germany
Küster 1992a	Freising	BA	Germany
Küster 1992b	Freising	BA	Germany
Küster 1992c	Gaimersheim	MN	Germany
Küster 1992d	Murr	EN	Germany
Küster 1992e	Manching	various	Germany
Küster 1994	Dresden-Cotta, Zwenkau	EN	Germany
Küster 1995b	various	various	Germany
Küster 1997	Eching-Viecht	BA	Germany

Table 2.1, continued

Reference	*Site(s)*	*Period*	*Country*
Lies 1948	Westeregeln/Straßfurt	EN	Germany
Litynska 1986	Site 7, Las Stocki	neo	Poland
Litynska 1990	Iwanowice-Klin	MN	Poland
Lundström-Baudais 1978	Brise-Lames	LN	Switzerland
Lundström-Baudais 1986	Clairvaux station III	LN	France
Lundström-Baudais 1991	Charavines "Les baigneurs"	LN	France
Lundström-Baudais 1993a	Clairvaux station II	LN	France
Lundström-Baudais 1993b	Motte-aux-Magnins	LN	France
Maier 1988	Ödenahlen	LN	Germany
Maier 1991	Hornstaad-Hörnle	LN	Germany
Maier 1995	Ödenahlen	LN	Germany
Maier 1996	Hornstaad-Hörnle	LN	Germany
Maier 1999	Hornstaad-Hörnle	LN	Germany
Maier unpublished	Alleshausen-Grundwiesen	LN	Germany
Maier unpublished	Hornstaad-Hörnle	LN	Germany
Marinval 1993	various	EN-LN	France
Marinval 1995	Gurgy (Les Plantes-du-Monts)	MN	France
Mattes 1957	various	EN	Germany
Meier-Arendt 1966	various	EN	Germany
Meyer and Willerding 1961	Göttingen-Kleiner Hagen	EN	Germany
Mötefindt 1914	various	various	Germany
Natho 1957	Burgliebenau	neo	Germany
Neef 1985	Gittrup	BA	Germany
Neef 1990	Pestenacker	LN	Germany
Netolitzky 1936	Köln-Lindenthal	EN	Germany
Nevizansky 1980	Kamenin	LN	Slovakia
Nötzold 1982a	various	various	Germany
Nötzold 1982b	various	various	Germany
Opravil 1989	Velesovicich	BA	Czech Republic
Pétrequin 1974	Gonvillars	EN	France
Pétrequin *et al.* 1985	Planches-pres-Arbois	BA	France
Piening 1979	various	MN-LN	Germany
Piening 1981	Twann	LN	Switzerland
Piening 1982a	various	various	Germany
Piening 1982b	Ilsfeld	MN	Germany
Piening 1986a	Aldingen	LN	Germany
Piening 1986b	Grossachsenheim	LN	Germany
Piening 1988a	Stuttgart-Mühlhausen	various	Germany
Piening 1988b	Freiburg-Geisingen	LN	Germany
Piening 1989	Bietigheim-Bissingen	EN	Germany
Piening 1992	Aldingen	LN	Germany
Piening 1998	Ditzingen	EN-MN	Germany
Riehl unpublished	Wangen	LN	Germany
Robinson and Rasmussen 1989	Thaygen-Weier	LN	Switzerland
Rösch 1984	Siedlung Forschner	BA	Germany
Rösch 1985	Hornstaad-Hörnle	LN	Germany
Rösch 1990a	Hornstaad-Hörnle V	LN	Germany
Rösch 1990b	Wallhausen, Dingelsdorf	LN	Germany
Rösch 1990c	Hegne-Galgenacker	LN	Germany
Rösch 1992	Stuttgart-Mühlhausen	EN	Germany

Table 2.1, continued

Reference	*Site(s)*	*Period*	*Country*
Rösch 1993a	Unteruhldingen-Stollenwiesen	BA	Germany
Rösch 1993b	Wiesloch-Weinäcker	BA	Germany
Rösch 1995a	Vaihingen/Enz	EN	Germany
Rösch 1995b	Knittlingen	BA	Germany
Rösch 1996a	Hagnau-Burg	BA	Germany
Rösch 1998b	Vaihingen/Enz	EN	Germany
Rösch unpublished	Stuttgart-Mühlhausen	EN	Germany
Rösch unpublished	Wiesloch-Weinäcker	BA	Germany
Rothmaler and Natho 1957	various	EN	Germany
Rouselle 1984	Saint-Lambert	EN	Belgium
Schiemann 1954	Ur-Fulerum	MN	Germany
Schlichtherle 1983	Yverdon, Av. des Sports	LN	Switzerland
Schlichtherle and Maier 1993	Alleshausen-Grundwiesen	LN	Germany
Schmidt 1983	Attersee	LN	Austria
Schneider 1991	Stillfried	BA	Austria
Schneider 1994	Schletz	EN	Austria
Schneider and Raunjak 1994	Oberleiser Berg	BA	Austria
Schultze-Motel 1980	Eisleben, Kr. Wanzleben	EN	Belgium
Stahlhofen 1981	„am Probsthorn" in Haldensleben I	LN	Germany
Stika 1991	various	EN	Germany
Stika 1996	Heilbronn-Klingenberg	EN, LN	Germany
Stika unpublished	Heilbronn-Klingenberg	LN	Germany
Stika unpublished	Kirchheim-Benzenzimmern, Eierplätze V	BA	Germany
Stika unpublished	Korntal-Münchingen	BA	Germany
Szafer 1958	Ojcow/Krakow	EN	Poland
Tempir 1966	various	various	Czech Republic, Slovakia
Tempir 1968	various	various	Czech Republic
Tempir 1969	various	various	Slovakia
Tempir 1971	Bylany/Kutná Hora	EN	Czech Republic
Tempir 1973	various	various	Czech Republic
Tempir and Vodak 1959	various	various	Czech Republic, Slovakia
Uenze 1956	various	EN	Germany
Zeist and Boekschoten-van Helsdingen 1991	Niederwil	LN	Switzerland
Villaret-von Rochow 1967	Seeberg, Burgäschisee-Süd	LN	Switzerland
Wasylikowa 1989	Pleszów	EN-MN	Poland
Wasylikowa *et al.* 1985	Pleszów	EN-MN	Poland
Werneck 1949	Eggendorf am Walde	EN	Austria
Werneck 1961	various	various	Austria
Wiethold 1996	Borg, Kr. Merzig-Wadern	BA	Germany
Wiethold 1998	various	various	France
Willerding 1965	Rosdorf/Göttingen	EN	Germany
Willerding 1969	various	various	Germany
Willerding 1980	various	EN	Germany
Willerding 1985	Esbeck	EN	Germany
Willerding 1988a	Rössing	EN	Germany
Willerding 1992	Großenrode	MN	Germany
Zibulski unpublished	Cham-Oberwil	BA	Switzerland

Table 2.2. Decisions on how to treat distinct species sometimes occurring in amalgamated categories

Original categories used	*No. of occurrences*	*% of occurrences*
(a). Separate species identifications only used		
Chenopodium ficifolium	6	16
Chenopodium polyspermum	31	82
Chenopodium ficifolium/polyspermum	1	2
Galium aparine	50	31
Galium spurium	107	66
Galium aparine/spurium	5	3
Polygonum lapathifolium	44	39
Polygonum persicaria	61	55
Polygonum persicaria/lapathifolium	7	6
Silene nutans	4	14
Silene vulgaris	15	54
Silene dioica	4	14
Silene nutans/vulgaris	4	14
Silene vulgaris/dioica	1	4
Vicia hirsuta	37	63
Vicia tetrasperma	8	13
Vicia hirsuta/tetrasperma	14	24
(b). All identifications treated as the amalgamated category		
Atriplex patula	2	40
Atriples prostrata	1	20
Atriplex patula/prostrata	2	40
Galium mollugo	1	14
Galium verum	1	14
Galium mollugo/verum	5	72
Luzula campestris	1	25
Luzula multiflora	1	25
Luzula campestris/multiflora	2	50
Trifolium arvense	3	50
Trifolium campestre	2	33
Trifolium arvense/campestre	1	17
Viola arvensis	2	40
Viola tricolor	2	40
Viola arvensis/tricolor	1	20
(c). All identifications treated as definitely identified species		
Chenopodium glaucum	3	75
Chenopodium glaucum/rubrum	1	25
Knautia arvensis	3	75
Knautia arvensis/dipsacifolia	1	25
Papaver rhoeas	3	43
Papaver rhoeas/dubium	3	43
Papaver rhoeas/dubium/hybridum	1	14
Trifolium pratense	4	80
Trifolium badium/pratense	1	20

Table 2.3. The standardised archaeobotanical wild/weed taxa selected and their frequency in selected samples

Standardised archaeobotanical taxa	*No. of samples*	*Occurrence in at least three neolithic or three bronze age samples*
Agrostemma githago	8	
Anagallis arvensis	3	yes
Aphanes arvensis	6	
Arenaria serpyllifolia	3	yes
Atriplex patula/prostrata	11	
Brassica rapa	12	
Bromus arvensis/hordeaceus/secalinus	222	
Bromus sterilis/tectorum	74	
Camelina sativa	5	
Chenopodium album group	273	
Chenopodium ficifolium	6	
Chenopodium glaucum	4	yes
Chenopodium hybridum	11	
Chenopodium polyspermum	31	
Descurainia sophia	10	
Digitaria ischaemum	5	
Echinochloa crus-galli	65	
Eleocharis palustris group	5	
Erigeron acer	3	yes
Fallopia convolvulus	264	
Fallopia dumetorum	5	
Festuca rubra	4	yes
Galeopsis angustifolia/ladanum/segetum	15	
Galeopsis bifida/speciosa/tetrahit	7	
Galium aparine	49	
Galium mollugo group/verum group	7	
Galium spurium	108	
Hyoscyamus niger	5	
Knautia arvensis	4	yes
Lapsana communis	133	
Lolium perenne	4	yes
Luzula campestris/multiflora	4	yes
Malva sylvestris	3	yes
Medicago lupulina	7	
Moerhingia trinervia	4	yes
Nepeta cataria	5	
Papaver rhoeas	7	
Phleum pratense	112	
Plantago lanceolata	20	
Plantago major	10	
Poa annua	19	
Poa pratensis group/trivialis	20	
Polygonum aviculare group	27	
Polygonum hydropiper	6	
Polygonum lapathifolium	42	

Table 2.3, continued

Standardised archaeobotanical taxa	*No. of samples*	*Occurrence in at least three neolithic or three bronze age samples*
Polygonum minus	4	yes
Polygonum persicaria	60	
Prunella vulgaris	10	
Ranunculus repens	4	yes
Rumex acetosella	42	
Rumex conglomeratus/sanguineus	29	
Rumex crispus/obtusifolius	11	
Rumex acetosa/thyrsiflorus	8	
Sambucus ebulus	12	
Scleranthus annuus	6	
Setaria pumila	17	
Setaria verticillata/viridis	66	
Silene dioica	4	yes
Silene gallica	4	yes
Silene latifolia	6	
Silene vulgaris	15	
Sisymbrium officinale	3	yes
Solanum nigrum	86	
Sonchus asper	8	
Spergula arvensis	3	yes
Stachys sylvatica	3	yes
Stellaria graminea/palustris	7	
Stellaria media	7	
Thlaspi arvense	3	yes
Trifolium arvense/campestre	6	
Trifolium montanum	4	yes
Trifolium pratense	5	
Trifolium repens	10	
Urtica dioica	4	yes
Urtica urens	6	
Valerianella dentata	33	
Veronica arvensis	5	
Vicia hirsuta	36	
Vicia tetrasperma	9	
Viola arvensis/tricolor	5	

Table 2.4. The species included in the selected wild/weed taxa and requiring FIBS data; * = species selected from species groups in Tutin *et al*. (1964-1993)

Selected archaeobotanical taxa	*Species requiring FIBS data*	*Subspecies targeted*
Agrostemma githago	Agrostemma githago L.	
Anagallis arvensis	Anagallis arvensis L.	
Aphanes arvensis	Aphanes arvensis L.	
Arenaria serpyllifolia	Arenaria serpyllifolia L.	
Atriplex patula/prostrata	Atriplex patula L.	
	Atriplex prostrata (Boucher) ex DC.	
Brassica rapa	Brassica rapa L.	
Bromus arvensis/hordeaceus/secalinus	Bromus arvensis L.	
	Bromus hordeaceus L.	hordeaceus
	Bromus secalinus L.	
Bromus sterilis/tectorum	Bromus sterilis L.	
	Bromus tectorum L.	
Camelina sativa	Camelina sativa (L.) Crantz	
Chenopodium album group	Chenopodium album L.*	
Chenopodium ficifolium	Chenopodium ficifolium Sm.	
Chenopodium glaucum	Chenopodium glaucum L.	
Chenopodium hybridum	Chenopodium hybridum L.	
Chenopodium polyspermum	Chenopodium polyspermum L.	
Descurainia sophia	Descurainia sophia (L.) Webb ex Prantl	
Digitaria ischaemum	Digitaria ischaemum (Schreber) Muhl.	
Echinochloa crus-galli	Echinochloa crus-galli (L.) Beauv.	
Erigeron acer	Erigeron acer L.	
Fallopia convolvulus	Fallopia convolvulus (L.) A. Löve	
Fallopia dumetorum	Fallopia dumetorum (L.) J. Holub	
Festuca rubra	Festuca rubra L.	rubra
Galeopsis angustifolia/ladanum/segetum	Galeopsis angustifolia Ehrh. ex Hoffm.	
	Galeopsis ladanum L.	
	Galeopsis segetum Necker	
Galeopsis bifida/speciosa/tetrahit	Galeopsis bifida Boenn.	
	Galeopsis speciosa Miller	
	Galeopsis tetrahit L.	
Galium aparine	Galium aparine L.	
Galium mollugo group/verum group	Galium mollugo L.*	
	Galium verum L.*	
Galium spurium	Galium spurium L.	
Hyoscyamus niger	Hyoscyamus niger L.	
Knautia arvensis	Knautia arvensis (L.) Coulter	
Lapsana communis	Lapsana communis L.	communis
Lolium perenne	Lolium perenne L.	
Luzula campestris/multiflora	Luzula campestris (L.) DC.	
	Luzula multiflora (Retz.) Lej.	
Malva sylvestris	Malva sylvestris L.	
Medicago lupulina	Medicago lupulina L.	
Moerhingia trinervia	Moerhingia trinervia (L.) Clairv.	
Nepeta cataria	Nepeta cataria L.	
Papaver rhoeas	Papaver rhoeas L.	
Phleum pratense	Phleum pratense L.	bertolonii
	Phleum pratense L.	pratense
Plantago lanceolata	Plantago lanceolata L.	
Plantago major	Plantago major L.	major

Table 2.4, continued

Selected archaeobotanical taxa	*Species requiring FIBS data*	*Subspecies targeted*
Poa annua	Poa annua L.	
Poa pratensis group/trivialis	Poa angustifolia L.	
	Poa pratensis L.	
	Poa subcaerulea Sm.	
	Poa trivialis L.	
Polygonum aviculare group	Polygonum arenastrum Boreau	
	Polygonum aviculare L.	
	Polygonum rurivagum Jordan ex Boreau	
Polygonum hydropiper	Polygonum hydropiper L.	
Polygonum lapathifolium	Polygonum lapathifolium L.	
Polygonum minus	Polygonum minus Hudson	
Polygonum persicaria	Polygonum persicaria L.	
Prunella vulgaris	Prunella vulgaris L.	
Ranunculus repens	Ranunculus repens L.	
Rumex acetosa/thyrsiflorus	Rumex acetosa L.	
	Rumex thyrsiflorus Fingerh.	
Rumex acetosella	Rumex acetosella L.	
Rumex conglomeratus/sanguineus	Rumex conglomeratus Murray	
	Rumex sanguineus L.	
Rumex crispus/obtusifolius	Rumex crispus L.	
	Rumex obtusifolius L.	
Sambucus ebulus	Sambucus ebulus L.	
Scleranthus annuus	Scleranthus annuus L.	
Setaria pumila	Setaria pumila (Poiret) Schultes	
Setaria verticillata/viridis	Setaria verticillata (L.) Beauv.	
	Setaria viridis (L.) Beauv.	
Silene dioica	Silene dioica (L.) Clairv.	
Silene gallica	Silene gallica L.	
Silene latifolia	Silene latifolia Poiret	
Silene vulgaris	Silene vulgaris (Moench) Garcke	vulgaris
Sisymbrium officinale	Sisymbrium officinale (L.) Scop.	
Solanum nigrum	Solanum nigrum L.	
Sonchus asper	Sonchus asper (L.) Hill	
Spergula arvensis	Spergula arvensis L.	
Stachys sylvatica	Stachys sylvatica L.	
Stellaria graminea/palustris	Stellaria graminea L.	
	Stellaria palustris Retz.	
Stellaria media	Stellaria media L.	
Thlaspi arvense	Thlaspi arvense L.	
Trifolium arvense/campestre	Trifolium arvense L.	
	Trifolium campestre Schreber	
Trifolium montanum	Trifolium montanum L.	
Trifolium pratense	Trifolium pratense L.	
Trifolium repens	Trifolium repens L.	
Urtica dioica	Urtica dioica	
Urtica urens	Urtica urens L.	
Valerianella dentata	Valerianella dentata (L.) Pollich	
Veronica arvensis	Veronica arvensis L.	
Vicia hirsuta	Vicia hirsuta DC.	
Vicia tetrasperma	Vicia tetrasperma (L.) Schreber	
Viola arvensis/tricolor	Viola arvensis Murray	
	Viola tricolor L.	tricolor

Table 2.5. Archaeological sites with selected (weed-rich) archaeobotanical samples in the study area

Sites		Samples	
Location	**Reference(s)**	**No.**	**Sample date**
Belgium - Hainaut			
Aubechies	Bakels and Rouselle 1985	2	EN (LBK)
Czech Republic - southern Moravia			
Malenovice	Tempir 1968	1	BA (Urnfield)
France - Aisne valley			
Villeneuve-St-Germain	Bakels 1984	1	MN (Villeneuve-St-Germain)
France - Burgundy			
Vergigny	Wiethold 1998	1	BA (Bronze final)
Germany - Lower Bavaria			
Aiterhofen	Bakels 1983/4	2	EN (LBK)
Altdorf	Bakels 1983/4	1	EN (LBK)
Enkingen	Kreuz 1990	1	EN (LBK)
Freising	Küster 1992a, b	1	BA (EBA)
Galgenberg	Hinton 1999	1	LN (Altheim)
Greding	Kroll 1997	1	BA (Urnfield)
Hienheim/Donau	Bakels 1978, 1986b	1	EN (LBK)
Künzing-Bruck	Küster 1995b	2	BA (EBA)
Langenisarhofen	Bakels 1983/4	1	BA (MBA)
Meindling	Bakels 1992b	11	EN (LBK)
Niederpöring-Leitensiedlung	Küster 1995b	1	BA (Urnfield)
Osterhofen-Schmiedorf	Küster 1995b	1	MN (SBK/Oberlauterbach)
Schernau	Hopf 1981	1	MN (Bischheim)
Sengkofen „Pfatterbreite"	Hopf 1992	1	LN (Michelsberg)
Straubing-Oeberau	Küster 1995b	1	BA (Urnfield)
Germany - Lower Saxony			
Lietfeld	Hopf 1957	1	LN (Bernburg)
Göttingen-Kleiner Hagen	Meyer and Willerding 1961; Willerding 1969	1	EN (LBK)
Harkenbleck	Behre 1982	1	BA (LBA)
Germany - Mosel valley			
Siebenborn "Vor Tonguich"	Bakels 1993	3	EN (LBK)
Germany - Neckar valley			
Aldingen	Piening 1986a, 1992	1	LN (Schwieberdingen)
Ditzingen	Piening 1998	4	EN (LBK) (/MN (Rössen))
Endersbach	Piening 1979, 1982a	2	MN (Großgartach)
Freiburg-Geisingen	Piening 1988b	2	LN (Schussenried)
Grossachsenheim	Piening 1986b	2	LN (Schussenried)
Heilbronn-Klingenberg	Stika 1996, unpublished	4	EN (LBK), LN (Michelsberg)
Hochdorf	Küster 1985	29	LN (Schussenried)
Knittlingen	Rösch 1995b	4	BA (Urnfield)

Table 2.5, continued

Sites		Samples	
Location	**Reference(s)**	**No.**	**Sample date**
Stuttgart-Mühlhausen	Rösch 1992, unpublished	1	EN (LBK)
Korntal-Münchingen	Stika unpublished	1	BA (Urnfield)
Uhingen-Römerstrasse 91	Karg 1988	1	BA (MBA)
Vaihingen/Enz	Rösch 1995a, 1998b; Bogaard unpublished	58	EN (LBK)
Germany - Saarland			
Borg, Kr. Merzig-Wadern	Wiethold 1996	1	BA (MBA)
Germany - Southern Baden-Württemberg			
Hilzingen, Kr. Konstanz	Stika 1991	6	EN (LBK)
Ehrenstein	Hopf 1968	9	LN (Schussenried)
Hornstaad-Hörnle	Maier 1991, 1996, 1999, unpublished	3	LN (Hornstaad)
Ulm-Eggingen	Gregg 1989	15	EN (LBK)
Germany - South Hessen			
Bruchenbrücken	Kreuz 1990	4	EN (LBK)
Germany - Upper Rhine			
Burkheim	Küster 1988	1	BA (Urnfield)
Germany and The Netherlands - Lower Rhine-Meuse			
Aldenhoven 1	Knörzer 1997	2	MN (Rössen)
Aldenhoven/Jülich	Knörzer 1967b, 1971a, 1971b	1	EN (LBK)
Bedburg-Garsdorf/Bergheim	Knörzer 1974	4	EN (LBK)
Beek/S-Limburg	Bakels 1978, 1979; Bakels and Rouselle 1985	5	EN (LBK)
Erkelenz/Kückhoven	Knörzer 1995, 1998	2	EN (LBK)
Geleen (Haesselderveld)	Bakels 1979; Bakels and Rouselle 1985	2	EN (LBK)
Gittrup	Neef 1985	2	BA
Hambach 260	Knörzer 1997	1	MN (Großgartach)
Inden I	Knörzer 1971b, 1997	7	MN (Rössen)
Inden III	Knörzer 1971b, 1997	1	MN (Rössen)
Köln/Mengenich	Knörzer 1967b, 1968, 1971b	1	EN (LBK)
Lamersdorf/Düren	Knörzer 1967b, 1968, 1971b	4	EN (LBK)
Langweiler 16	Knörzer 1997	2	EN (LBK)
Langweiler 2/Jülich	Knörzer 1973	1	EN (LBK)
Langweiler 3/Jülich	Knörzer 1972	1	EN (LBK)
Langweiler 3+6/Jülich	Knörzer 1972	3	BA (Urnfield)
Langweiler 6/Jülich	Knörzer 1972	1	EN (LBK)
Langweiler 8/Jülich	Knörzer 1988	22	EN (LBK)
Langweiler 9/Jülich	Knörzer 1977	5	EN (LBK)
Langweiler/Jülich	Knörzer 1971a, b	2	MN (Rössen)
Laurenzberg 7	Knörzer 1997	9	EN (LBK)

Table 2.5, continued

Sites		Samples	
Location	**Reference(s)**	**No.**	**Sample date**
Laurenzberg 8	Knörzer 1997	4	EN (LBK)
Maastricht-Randwijck	Bakels 1991a; Bakels *et al.* 1993	4	MN (Rössen)
Meckenheim/Bonn	Knörzer 1967b, 1968, 1971b	2	EN (LBK)
Rödingen/Jülich	Knörzer 1967b	2	EN (LBK)
Wanlo/Wickerath	Knörzer 1980b	3	EN (LBK)
Hungary – Hungarian Plain			
Arotkö-Dongohalom	Hartyanyi and Novaki 1975	1	BA (MBA)
Mende-Leanyvar	Hartyanyi and Novaki 1975	1	BA (MBA)
Pecs-Nagyarpad	Hartyanyi and Novaki 1975	1	BA (MBA)
Poland - Krakow region			
Iwanowice-Klin	Litynska 1990	1	MN (Lengyel)
Mogila 62	Gluza 1971, 1983; Gluza *et al.* 1988	2	MN (Lengyel)
Slovakia - southern Slovakia			
Blatné	Hajnalová 1988, 1989	2	EN (LBK)
Kamenin	Nevizansky 1980; Hajnalová 1989	1	LN (Baden)
Sturovo/Nove Zamky	Hajnalová 1975, 1983	1	EN (LBK)
Svodin	Hajnalová 1986	4	MN (Lengyel), LN (Baden)
Zemplinske Kopcany	Hajnalová 1989	1	BA (EBA)
Switzerland - Bern region			
Münchenwiler (Im Loch 1)	Jacomet *et al.* unpublished	2	BA (LBA)
Switzerland – North-central Switzerland			
Cham-Oberwil	Zibulski unpublished	1	BA (MBA)
Kleiner Hafner	Jacomet *et al.* 1989, unpublished; Brombacher and Jacomet 1997	1	LN (Cortalloid)
Kanalisationssanierung Seefeld	Brombacher and Jacomet 1997; Jacomet *et al.* unpublished	2	LN (Horgen, Corded Ware)
Mozartstrasse	Jacomet *et al.* 1989, unpublished; Brombacher and Jacomet 1997	1	LN (Pfyn)
Mythenschloss	Jacomet *et al.* 1989, unpublished; Brombacher and Jacomet 1997	1	LN (Corded Ware)
Uerschausen-Horn	Feigenwinter unpublished	9	BA (LBA)
Zug-Sumpf	Jacomet and Karg 1996, unpublished	5	BA (LBA)

Table 2.6. Numbers of samples and sites with available archaeobotanical data compared with the final numbers selected

	Early-Middle Neolithic *(5500 - 4400 B.C.)*	**Later Neolithic** *(4400 - 2300 B.C.)*	**Bronze Age** *(2300 - 750 B.C.)*	**Totals**
Samples				
available	4900	2500	700	8100
weed-rich (from discrete contexts)	217	55	44	316
Sites				
available	200	100	100	400
with weed-rich samples	51	13	24	85

Table 2.7. The functional attributes used and their possible ecological significance

Functional attribute	*Ecological attribute for which measurement is a surrogate*	*Relationship to habitat conditions*	*References*
(a) Attributes relating to the duration and quality of the growth period			
Maximum canopy height and diameter	Maximum plant size, the product of growth rate and period of growth	Positively correlated with potential productivity and negatively with disturbance of habitat	Grime 1979
Maximum leaf weight and area per node	Maximum nodal unit of foliar growth	Positively correlated with potential productivity of habitat	Grime 1979; Givnish 1987; Bogaard *et al.* 1998
Leaf area per node/leaf thickness	Plant growth rate	Positively correlated with potential productivity of habitat	Jackson 1967; Dale 1982; Givnish 1987; G. Jones *et al.* 2000
Mean specific leaf area (leaf area/dry leaf weight)	Plant growth rate	Positively correlated with potential productivity of habitat	Reich *et al.* 1992; Reich 1993; van Arendonk and Poorter 1994
Mean leaf dry matter content (dry leaf weight/fresh leaf weight)	Dry matter investment in leaves and (inversely) plant growth rate	Negatively correlated with potential productivity of habitat	Garnier and Laurent 1994; Ryser 1996
(b) Attributes relating to seasonality and/or the ability to regenerate rapidly following disturbance			
Life history of annuals (summer or winter annual)	Season of growth	Winter annuals associated with autumn sowing and summer annuals with spring sowing	Ellenberg 1950
Germination time	Beginning of life cycle	Autumn-germination associated with autumn sowing and spring-germination with spring sowing	Ellenberg 1950
Estimated epidermal cell endopolyploidy	Indication of cool-season growth	Positively correlated with autumn sowing	Grime *et al.* 1988; Melaragno *et al.* 1993
Onset of the flowering period	Timing of life cycle	Late onset of flowering associated with spring sowing	Grime *et al.* 1988; Sans and Masalles 1995
Length of flowering period	Duration of life cycle and therefore potential to regenerate from seed	Positively associated with spring sowing and disturbance	Grime *et al.* 1988; Sans and Masalles 1995
Vegetative spread (horizontal or vertical root system)	Ability of perennials to regenerate vegetatively from root fragments	Horizontal root system positively associated with disturbance	Håkansson 1982; Mortimer 1990
(c) Attributes relating to water use			
Mean stomatal size	Capacity to restrict transpirational water loss	Positively correlated with moist, productive conditions and negatively with droughted conditions	Salisbury 1927; Carpenter and Smith 1975; Donselman and Flint 1982
Mean stomatal density	Capacity to restrict transpirational water loss	Negatively correlated with moist, productive conditions (given the negative relationship between size and density) and positively with droughted conditions	(as above)
Epidermal cell size	Capacity to minimise loss of turgor	Negatively correlated with droughted conditions	Cutler *et al.* 1977

Table 2.7, continued

Functional attribute	*Ecological attribute for which measurement is a surrogate*	*Relationship to habitat conditions*	*References*
Epidermal cell wall undulation	Provides structural support in conditions of high turgor	Positively correlated with moist conditions	Linsbauer 1930; Watson 1942
Root diameter at 10 cm depth (a surrogate for root length)	Ability to exploit subsoil water	Positively correlated with droughted conditions	Parker 1968
(d) Attribute relating to shade tolerance			
Stomatal distribution (amphistomatous or not)	Ability to maximise CO_2 uptake per unit area of leaf and therefore potential to exploit unshaded habitats	Amphistomatous species unable to regenerate after disturbance in shade cast by crop	Peat and Fitter 1994; G. Jones *et al.* 2000
(e) Miscellaneous attribute			
Presence of a persistent seed bank	Capacity to regenerate from a persistent seed bank in the soil	Positively associated with interannual instability of habitat conditions	Thompson and Grime 1979; Bekker *et al.* 1998

Table 2.8. Flowering onset/length classes

Classes	**Flowering onset**	**Flowering duration**
Short-flowering with *early* – intermediate onset	*January – June*	1 – 3 months
Late-flowering (and so of short – medium duration)	*July*	1 – 5 months
Long-flowering (and so with early – intermediate onset)	*January – June*	>5 months
Medium flowering duration with intermediate onset	*April – June*	4 – 5 months

Table 2.9. Summary of collections and functional attribute data for each species

	No. collections by source				No. collections providing functional attribute data		
Species	*Atlantic/continental*	*Mediterranean*	*Grown on*	*total*	*Plant*	*Leaf*	*Tap root*
Agrostemma githago L.	4			4	4	4	3
Anagallis arvensis L.	4	13		17	16	10	6
Aphanes arvensis L.	4	3		7	6	5	2
Arenaria serpyllifolia L.	4			4	4	4	3
Atriplex patula L.	9	6		15	10	13	5
Atriplex prostrata (Boucher) ex DC.	7			7	3	7	3
Brassica rapa L.	3			3	3	3	3
Bromus arvensis L.	1		2	3	3	3	-
Bromus hordeaceus L.	6			6	5	5	-
Bromus secalinus L.	2		1	3	3	3	-
Bromus sterilis L.	9			9	6	8	-
Bromus tectorum L.			2	2	2	2	-
Camelina sativa (L.) Crantz	2		1	3	3	3	3
Chenopodium album L.	9			9	4	7	3
Chenopodium ficifolium Sm.	5			5	3	5	3
Chenopodium glaucum L.	1		1	2	2	2	2
Chenopodium hybridum L.	5			5	5	5	5
Chenopodium polyspermum L.	4			4	3	3	2
Descurainia sophia (L.) Webb ex Prantl	3			3	3	3	3
Digitaria ischaemum (Schreber) Muhl.			2	2	2	2	-
Echinochloa crus-galli (L.) Beauv.	3	3		6	4	6	-
Erigeron acer L.	3			3	3	3	3
Fallopia convolvulus (L.) A. Löve	7			7	4	6	3
Fallopia dumetorum (L.) J. Holub				0	0	0	0
Festuca rubra L.	3	1		4	4	4	-

Table 2.9, continued

	No. collections by source				**No. collections providing attribute data**		
Species	*Atlantic/continental*	*Mediterranean*	*Grown on*	***total***	*Plant*	*Leaf*	*Tap root*
Galeopsis angustifolia Ehrh. ex Hoffm.	1			1	1	1	1
Galeopsis bifida Boenn.	3			3	1	2	1
Galeopsis ladanum L.				0	0	0	0
Galeopsis segetum Necker	1		1	2	2	2	2
Galeopsis speciosa Miller	1			1	1	1	1
Galeopsis tetrahit L.	4			4	4	4	4
Galium aparine L.	6	3		9	5	9	3
Galium mollugo L.	5			5	4	5	-
Galium spurium L.		8		8	8	2	4
Galium verum L.	4	4		8	5	8	-
Hyoscyamus niger L.	1		1	2	2	2	2
Knautia arvensis (L.) Coulter	3			3	3	3	3
Lapsana communis L.	9			9	6	8	6
Lolium perenne L.	4	8		12	10	8	-
Luzula campestris (L.) DC.	3			3	3	3	-
Luzula multiflora (Retz.) Lej.	3			3	3	3	-
Malva sylvestris L.	6			6	6	4	3
Medicago lupulina L.	8	7		15	13	10	7
Moerhingia trinervia (L.) Clairv.	3			3	3	3	3
Nepeta cataria L.	3			3	3	3	-
Papaver rhoeas L.	4	10		14	10	11	6
Phleum pratense L. subsp. bertolonii	3			3	3	3	-
Phleum pratense L. subsp. pratense	3			3	3	3	-
Plantago lanceolata L.	4			4	4	4	-
Plantago major L.	3			3	3	3	-
Poa annua L.	5			5	5	5	-

Table 2.9, continued

	No. collections by source				No. collections providing attribute data		
Species	*Atlantic/continental*	*Mediterranean*	*Grown on*	***total***	*Plant*	*Leaf*	*Tap root*
Poa pratensis L.	3			3	2	3	-
Poa angustifolia L.	1			1	1	1	-
Poa subcaerulea Sm.	1			1	1	1	-
Poa trivialis L.	8			8	5	8	-
Polygonum arenastrum Boreau	5			5	4	5	4
Polygonum aviculare L.	6			6	3	5	3
Polygonum rurivagum Jordan ex Boreau		9		9	9	9	4
Polygonum hydropiper L.	4			4	3	4	3
Polygonum lapathifolium L.	4			4	4	3	3
Polygonum minus Hudson				0	0	0	0
Polygonum persicaria L.	8			8	3	7	3
Prunella vulgaris L.	3			3	3	3	-
Ranunculus repens L.	8			8	6	8	-
Rumex acetosa L.	3			3	3	3	1
Rumex acetosella L.	7			7	3	6	-
Rumex conglomeratus Murray	3	2		5	4	5	4
Rumex crispus L.	6			6	5	4	6
Rumex obtusifolius L.	7			7	6	7	3
Rumex sanguineus L.	4			4	4	4	3
Rumex thyrsiflorus Fingerh.	1		2	3	3	3	3
Sambucus ebulus L.	1			1	1	1	-
Scleranthus annuus L.	3			3	3	3	2
Setaria pumila (Poiret) Schultes	2	1	1	4	3	3	-
Setaria verticillata (L.) Beauv.	1	2		3	3	3	-
Setaria viridis (L.) Beauv.	2	4		6	5	6	-
Silene dioica (L.) Clairv.	4			4	3	4	-

Table 2.9, continued

	No. collections by source				No. collections providing attribute data		
Species	*Atlantic/continental*	*Mediterranean*	*Grown on*	***total***	*Plant*	*Leaf*	*Tap root*
Silene gallica L.	1		1	2	2	2	2
Silene latifolia Poiret	4			4	4	3	2
Silene vulgaris (Moench) Garcke	6			6	3	5	-
Sisymbrium officinale (L.) Scop.	5	3		8	5	8	3
Solanum nigrum L.	5	6		11	8	8	4
Sonchus asper (L.) Hill	5	2		7	4	6	3
Spergula arvensis L.	5			5	3	4	2
Stachys sylvatica L.	3			3	3	3	-
Stellaria graminea L.	4			4	3	4	-
Stellaria palustris Retz.				0	0	0	0
Stellaria media L.	8			8	4	8	3
Thlaspi arvense L.	5			5	2	4	2
Trifolium arvense L.	5			5	4	5	4
Trifolium campestre Schreber	5	7		12	9	8	12
Trifolium montanum L.	1		2	3	3	3	3
Trifolium pratense L.	7	8		15	12	6	11
Trifolium repens L.	4	2		6	6	6	-
Urtica dioica	3			3	3	3	-
Urtica urens L.	5			5	3	5	3
Valerianella dentata (L.) Pollich	4		1	5	5	4	4
Veronica arvensis L.	13			13	9	12	9
Vicia hirsuta DC.	11			11	8	10	6
Vicia tetrasperma (L.) Schreber	9			9	7	8	6
Viola arvensis Murray	8			8	6	6	4
Viola tricolor L.	4		1	5	5	5	5

Table 2.10. Simplification of crop identification categories

Amalgamated category	*Contents*
Glume wheat grains	Grains of glume wheat species (einkorn/emmer/spelt)
Glume wheat glume bases	Glume bases of glume wheat species (einkorn/emmer/spelt)
Free-threshing cereal grains	Grains of free-threshing cereal species (naked, hulled or indeterminate barley/durum wheat/bread wheat)
Free-threshing cereal rachis	Rachis internodes of free-threshing cereal species (naked or hulled six-row barley, durum wheat/bread wheat)
Oat grains	Grains of oat
Oat floret bases	Floret bases of cultivated oat type
Indeterminate cereal grains	Grains of indeterminate cereal and/or wheat
Flax	Seeds of cultivated and/or indeteterminate flax
Millet	Seeds of all cultivated millet species (broomcorn/foxtail)
Opium poppy	Seeds of opium poppy
Pulses	Seeds of cultivated pulse species (pea/lentil/broad bean/bitter vetch)

Table 2.11. Classification system for archaeobotanical samples based on crop content

Category	*Grain:chaff ratio*
≥70% Glume wheat grain+glume bases	
Predominantly glume bases	Glume wheat grains:glume bases < 0.3
Possible spikelets	Glume wheat grains:glume bases 0.3 - 1.5
Predominantly grains	Glume wheat grains:glume bases >1.5
≥70% Free-threshing cereal grains+rachis internodes	
Predominantly rachis internodes	Free-threshing cereal grains:rachis <2
Possible ears/ear fragments	Free-threshing cereal grains:rachis 2 - 5
Predominantly grains	Free-threshing cereal grains:rachis >5
≥70% Millet seeds	
≥70% Flax seeds	
≥70% Pulse seeds	
Mixed or indeterminate crop types*	
Not properly quantified	
<50 crop items	

*these samples contain <70% of any one crop type or ≥70% indeterminate cereal grain

Table 2.12. Classification of wild/weed taxa into physical types (bfh=big free heavy, bfl = big free light, bhh = big headed heavy, sfh = small free heavy, sfl = small free light, shh = small headed heavy, shl = small headed light)

Original categories of wild/weed taxa	*Weed types*
Agrimonia eupatoria	bhh
Agropyron caninum	bfl
Agrostemma githago	bfh
Agrostis sp.	sfh
Ajuga sp.	sfh
Aphanes arvensis	sfh
Arenaria serpyllifolia	sfl
Artemisia vulgaris	sfl
Astragalus glycyphyllos	bfh
Atriplex patula/hastata	sfh
Atriplex patulum	sfh
Atriplex sp.	sfh
Brassica campestris	bfh
Bromus arv/sec/hord	bfh
Bromus arvensis	bfh
Bromus arvensis/hordeaceus	bfh
Bromus arvensis/secalinus	bfh
Bromus cf. arvensis	bfh
Bromus cf. arvensis/secalinus	bfh
Bromus cf. hordeaceus	bfh
Bromus cf. secalinus	bfh
Bromus cf. sterilis	sfl
Bromus cf. sterilis/tectorum	sfl
Bromus erectus	sfl
Bromus hordeaceus	bfh
Bromus secalinus	bfh
Bromus secalinus type	bfh
Bromus secalinus/hordeaceus	bfh
Bromus sterilis	sfl
Bromus sterilis type	sfl
Bromus sterilis/tectorum	sfl
Bromus tectorum	sfl
Bromus tectorum type	sfl
Camelina cf. sativa	sfh
Campanula sp.	sfl
Carex muricata	bfh
Carex spicata	bfh
cf. Echinochloa crus-galli	sfh

Table 2.12, continued

Original categories of wild/weed taxa	*Weed types*
cf. Hyoscyamus niger	sfh
cf. Phleum pratense	sfh
cf. Phleum sp.	sfh
cf. Scleranthus annuus	sfh
cf. Sherardia arvensis	sfh
Chenopodium album	sfh
Chenopodium cf. album	sfh
Chenopodium cf. ficifolium	sfh
Chenopodium cf. glaucum	sfh
Chenopodium cf. polyspermum	sfh
Chenopodium hybridum	bfh
Chenopodium polyspermum	sfh
Chenopodium sp.	sfh
Chenopodium/Atriplex	sfh
Chrysanthemum leucanthenum	shl
Circaea lutetiana	shh
Conium maculatum	sfl
Daucus carota	bfh
Descurainia sophia	sfh
Digitaria ischaemum	sfh
Echinochloa crus-galli	sfh
Echinochloa/Setaria	sfh
Erigeron acris	sfl
Erucastrum cf. nasturtiifolium	sfh
Festuca cf. rubra	shl
Galeopsis ladanum/segetum	bfh
Galeopsis segetum	bfh
Galeopsis tetrahit type	bfh
Galium aparine	bfh
Galium cf. aparine	bfh
Galium cf. spurium	sfh
Galium cruciata	bfh
Galium mollugo/verum	sfh
Galium palustre	sfh
Galium spurium	sfh
Hyoscyamus niger	sfh
Hypericum perforatum	sfl
Knautia arvensis	bfh
Knautia arvensis/dipsacifolia	bfh
Lamium amplexicaule	sfh

Table 2.12, continued

Original categories of wild/weed taxa	*Weed types*
Lapsana communis	sfh
Lathyrus/Vicia	bfh
Leontodon autumnalis	sfl
Linum catharticum	sfl
Lolium perenne	shl
Luzula campestris	sfh
Luzula cf. multiflora	sfh
Malva cf. sylvestris	shh
Malva sp.	shh
Malva sylvestris	shh
Matricaria chamomilla	sfl
Melandrium album	shh
Melandrium cf. rubrum	shh
Melandrium rubrum	shh
Moehringia trinervia	sfh
Myosotis arvensis	sfh
Myosoton aquaticum	sfh
Nepeta cataria	sfh
Origanum vulgare	sfl
Papaver rhoeas (group)	shl
Papaver rhoeas/dubium	shl
Pastinaca sativa	bfh
Phleum cf. nodosum	sfh
Phleum cf. pratense/nodosum	sfh
Phleum pratense	sfh
Phleum pratense/nodosum	sfh
Phleum sp.	sfh
Picris hierachoides (agg)	sfh
Pimpinella saxifraga	sfh
Plantago lanceolata	shh
Plantago major	shh
Plantago major cf. ssp. Intermedia	shh
Poa annua	sfh
Poa compressa/nemoralis/palustris	sfh
Poa non-annua type	sfh
Poa pratensis/trivialis	sfh
Poa sp.	sfh
Poa sp. non-annua	sfh
Poa trivialis	sfh
Poa/Phleum	sfh
Polygonum amphibium	bfh

Table 2.12, continued

Original categories of wild/weed taxa	*Weed types*
Polygonum aviculare	bfh
Polygonum calcatum	bfh
Polygonum cf. lapathifolium	bfh
Polygonum cf. persicaria	bfh
Polygonum cf. persicaria/lapathifolium	bfh
Polygonum convolvulus	bfh
Polygonum dumetorum	bfh
Polygonum lapathifolium	bfh
Polygonum minus	bfh
Polygonum persicaria	bfh
Polygonum persicaria/lapathifolium	bfh
Potentilla argentea	sfh
Prunella vulgaris	sfh
Ranunculus cf. repens	bfh
Ranunculus repens	bfh
Rumex acetosa	sfh
Rumex acetosa/obt/cri	sfh
Rumex acetosella	sfh
Rumex cf. crispus/obtusifolius	sfh
Rumex conglomeratus/sanguineus	sfh
Rumex crispus	sfh
Rumex crispus/obtusifolius	sfh
Rumex sanguineus	sfh
Rumex sp.	sfh
Rumex tenuifolius	sfh
Rumex thyrsiflorus	sfh
Sambucus ebulus	bhh
Saponaria officinalis	bfh
Setaria cf. viridis/verticillata	sfh
Setaria glauca	sfh
Setaria viridis	sfh
Setaria viridis/verticillata	sfh
Silene cf. vulgaris	shh
Silene cucubalus	shh
Silene nutans	shh
Silene nutans/vulgaris	shh
Silene sp.	shh
Silene vulgaris	shh
Silene vulgaris/Melandrium rubrum	shh
Sisymbrium officinale	sfh
Solanum cf. nigrum	sfh

Table 2.12, continued

Original categories of wild/weed taxa	*Weed types*
Solanum dulcamara/nigrum	sfh
Solanum nigrum	sfh
Solanum sp.	sfh
Sonchus asper	sfl
Stachys sylvatica	bfh
Stellaria media	sfh
Stipa sp.	bhh
Trifolium arvense type	sfh
Trifolium cf. arvense	sfh
Trifolium cf. dubium	sfh
Trifolium cf. pratense	sfh
Trifolium cf. repens	sfh
Trifolium pratense type	sfh
Trifolium repens	sfh
Trifolium sp.	sfh
Urtica dioica	sfh
Urtica urens	sfh
Valerianella cf. dentata	sfh
Valerianella dentata	sfh
Valerianella rimosa	bfh
Verbascum cf. nigrum	sfl
Verbascum sp.	sfl
Verbena officinalis	sfh
Veronica arvensis	sfh
Veronica cf. hederifolia	bfh
Vicia cf. hirsuta	bfh
Vicia hirsuta	bfh
Vicia hirsuta/tetrasperma	bfh
Vicia sp.	bfh
Vicia tetrasperma	bfh
Vicia/Lathyrus	bfh

Table 2.13. Outline of the Hambach Forest experiment from 1979-1984 showing weed surveys and soil disturbance measures

	1979	*1980*	*1981*	*1982*	*1983*	*1984*
Plots 1-10:						
Tillage prior to sowing	Hand weeding	Hand weeding	Rotavator	Rotavator	Rotavator/hoe	Rotavator
Weeding during crop growth	Hand weeding	Hand weeding	Hand weeding		Hand weeding/hoeing	Hand weeding/hoeing
Weed survey	Survey	Survey	Survey	Survey		Survey
Plots 11-20:						
Tillage prior to sowing		Ard	Ard	Ard/hoe	Rotavator/hoe	Rotavator
Weeding during crop growth					Hand weeding/hoeing	Hand weeding/hoeing
Weed survey	Survey	Survey	Survey	Survey		Survey
Plot 21:						
Preparation/tillage prior to sowing		Burning	Burning	Rotavator	Rotavator/hoe	Rotavator
Weeding during crop growth					Hand weeding/hoeing	Hand weeding/hoeing
Weed survey				Survey		Survey

Table 2.14. Conversion of the cover/abundance scale
used to record the Hambach weed surveys to a numerical scale

Cover/abundance scale	*Numerical scale*
v	1
r	2
+	3
I	4
II	5
III	6
IV	7

Table 2.15. Conversion of the cover/abundance scale
used in Hüppe and Hofmeister (1990: Table 1) to a numerical scale

Cover/abundance scale	*Numerical scale*
r	1
+	2
I	3
II	4
III	5
IV	6
V	7

Table 3.1. The number of weed associations (Germany study) or cultivated plots (Evvia study) reclassified with high or low probability by the discriminant functions based on quantitative and semi-quantitative data

	with high probability (≥0.90)	with low probability (<0.90)
Sowing regime (n=37)		
Quantitative data	35 (95%)	2 (5%)
Semi-quantitative data	25 (68%)	12 (32%)
Cultivation intensity (n=38)		
Quantitative data	31 (74%)	10 (26%)
Semi-quantitative data	30 (79%)	8 (21%)

Table 3.2. Classification of Asturias plots using the discriminant function for German weed associations from autumn- and spring-sown crops

	German associations	Classification of Asturias plots			
	% correctly reclassified	Autumn-sown		Spring-sown	
		no.	%	no.	%
Quantitative data	95	59	91	6	9
Semi-quantitative data	89	44	68	21	32

Table 3.3. Classification of Asturias cereal plots using the discriminant function for Evvia pulse fields and gardens

	Evvia plots	Classification of Asturias plots			
	% correctly reclassified	Garden		Field	
		no.	%	no.	%
Quantitative data	92	65	100	0	0
Semi-quantitative data	90	65	100	0	0

Table 3.4. Comparison of weed physical types (big free heavy and small free heavy) and flowering onset/length categories for weed species in the Germany study

	Early-intermediate/ short-flowering	Late-flowering	Long-flowering	Intermediate/medium-flowering
Big free heavy	8	2	1	10
Small free heavy	4	11	14	17

Table 3.5. Comparison of functional attribute values for taxa with big free heavy (BFH) and small free heavy (SFH) seeds, showing average values (ave) and standard deviations (sd); result of Mann-Whitney U-test given where $p<0.05$

		Germany			**Evvia**			**Asturias**		
		BFH	SFH	p	BFH	SFH	p	BFH	SFH	p
	n	*21*	*46*		*30*	*28*		*23*	*28*	
Functional attributes										
Maximum canopy height	ave	65	49		58	40	0.02	96	78	
	sd	33	30		30	18		35	55	
Maximum canopy diameter	ave	65	51		74	49	0.02	173	145	0.04
	sd	29	43		44	40		174	245	
Leaf area per node:thickness	ave	8278	6081		7538	4559		25161	26991	
	sd	9061	7738		8002	4069		39066	51528	
Specific leaf area	ave	22	27		23	26		24	29	
	sd	7	11		8	12		6	11	
Flowering period	ave	3.90	5.33	0.01	2.89	3.07		3.83	5.21	
	sd	1.09	2.23		0.83	0.78		1.30	3.27	
Stomatal distribution (% on one surface)	ave	68.48	70.82		70.25	69.04		75.46	70.15	
	sd	13.84	15.68		14.90	14.18		14.15	15.51	

Table 4.1. Classification of samples based on their crop type composition

a. Classification according to predominant crop type

Crop-based category	*No. of samples*
≥70% Glume wheat	167
≥70% Free-threshing cereal	7
≥70% Millet	1
≥70% Flax	1
≥70% Pulse	1
Mixed or indeterminate crop types*	75
Not properly quantified	12
<50 crop items	52

*these samples contain <70% of any one crop type or ≥70% indeterminate cereal grain

b. Classification according to contamination

Predominant crop type	**>90% one crop type** *(Uncontaminated)*	**70-90% one crop type**		**Total**
		Possibly contaminated (cereal samples contaminated mainly by indet. cereal grain)	*Definitely contaminated (all other contamination)*	
Glume wheat	124	30	13	167
Free-threshing cereal	2	2	3	7
Millet			1	1
Pulse			1	1
Flax			1	1

Table 4.2. The final crop processing classification of samples containing 'compatible' crop material and wild/weed seeds

	No. of samples		**Total**
	Uncomtaminated	*Possibly contaminated*	
Glume wheat samples			
glume base samples			
fine sieve by-products, high probability	80	16	96
fine sieve by-products, low probability	8	8	16
'spikelet' samples			
unsieved 'spikelets' (classified as fine sieve by-products, low probability)	3		3
unsieved 'spikelets' (classified as fine sieve products, low probability)	1	1	2
sieved 'spikelets' (classified as fine sieve products, high probability)	3		3
grain samples			
fine sieve products, high probability	6		6
fine sieve products, low probability	1		1
Free-threshing cereal samples			
unthreshed samples			
(classified as by-products or products, low probability)		2	2
grain samples			
fine sieve products, high probability	1		1

Table 4.3. Date and context details of samples suitable for ecological analysis (bibliographic references for each site are given in Table 2.5)

Site	*Sample code*	*Period*	*Context description*
Aiterhofen	ait84	EN (LBK)	level B20, pit 84
Aldingen	ali131	LN (Schwieberdingen)	pit 131
Altdorf	alt152/5	EN (LBK)	level 152/5, pit 1
Bedburg-Garsdorf/Bergheim	bed28	EN (LBK)	pit 28
Bedburg-Garsdorf/Bergheim	bed41	EN (LBK)	pit 41
Bedburg-Garsdorf/Bergheim	bed44	EN (LBK)	pit 44
Bruchenbrücken	bru283	EN (LBK)	pit 283
Bruchenbrücken	bru29	EN (LBK)	pit 29
Cham-Oberwil	cha2	BA (MBA)	pit 2 (samples 14-16 from upper/middle/lower pit 2 amalgamated)
Ditzingen	dit257	EN (LBK)	pit 257
Ditzingen	dit520	EN (LBK)	pit 520
Ditzingen	dit946	EN (LBK) (/MN (Rössen))	pit 946
Endersbach	end1982	MN (Großgartach)	pit (in Piening 1982a report)
Grossachsenheim	gro427	LN (Schussenried)	pit 427, layer 3
Harkenbleck	har1	BA (LBA)	associated with pot
Hienheim/Donau	hie1211/2	EN (LBK)	pit 1211, layer 2
Hilzingen, Kr. Konstanz	hil348e	EN (LBK)	pit 348e
Hilzingen, Kr. Konstanz	hil348f	EN (LBK)	pit 348f
Hilzingen, Kr. Konstanz	hil394	EN (LBK)	pit 394
Hilzingen, Kr. Konstanz	hil537	EN (LBK)	pit 537
Hochdorf	hoc186	LN (Schussenried)	pit 186, layer 1K

Table 4.3, continued

Site	*Sample code*	*Period*	*Context description*
Hochdorf	hoc315	LN (Schussenried)	pit 315, layer 2
Hochdorf	hoc326	LN (Schussenried)	pit 326
Hochdorf	hoc330	LN (Schussenried)	pit 330, layer 1
Hochdorf	hoc403	LN (Schussenried)	pit 403, layer 5
Hochdorf	hoc458-2	LN (Schussenried)	pit ("drying oven"), layer 3
Hochdorf	hoc458-3	LN (Schussenried)	pit ("drying oven"), layer 4 and 4a amalgamated
Hochdorf	hoc460	LN (Schussenried)	pit 460, layer A1
Hochdorf	hoc485	LN (Schussenried)	pit 485, layer 4
Hochdorf	hoc486	LN (Schussenried)	pit 486, layer A
Hochdorf	hoc592	LN (Schussenried)	pit 592, layer 3
Hornstaad-Hörnle	hor1	LN (Hornstaad)	burned destruction layer
Hornstaad-Hörnle	hor2	LN (Hornstaad)	burned destruction layer
Iwanowice-Klin	iwa231	MN (Lengyel)	pit 231
Kamenin	kam80	LN (Baden)	object 80 (pit?)
Lamersdorf/Düren	lamA	EN (LBK)	pit A
Langweiler 16	16lan352	EN (LBK)	pit 3/position 52
Langweiler 2/Jülich	2lan306	EN (LBK)	pit 306
Langweiler 3/Jülich	3lan7	EN (LBK)	dark layer in pit
Langweiler 8/Jülich	8lan1033	EN (LBK)	pit 1033/position 7, charred layers in pit
Langweiler 8/Jülich	8lan1482	EN (LBK)	pit 1432/position 11, charred layer in pit
Langweiler 8/Jülich	8lan2126	EN (LBK)	pit 2126/position 9, charred layer in pit
Langweiler 8/Jülich	8lan2146	EN (LBK)	pit 2146/position 4 and 11 amalgamated
Langweiler 8/Jülich	8lan2799-1	EN (LBK)	pit 2799/position 15, charred or brown layer in pit

Table 4.3, continued

Site	*Sample code*	*Period*	*Context description*
Langweiler 8/Jülich	8lan2799-2	EN (LBK)	pit 2799/second position 15, charred or brown layer in pit
Langweiler 8/Jülich	8lan3881	EN (LBK)	pit 3881, dark layer in pit
Langweiler 8/Jülich	8lan3911	EN (LBK)	pit 3911/position 14, charred layer in pit
Langweiler 8/Jülich	8lan52	EN (LBK)	pit 52/position 5, charred layer in pit
Langweiler 9/Jülich	9lan17	EN (LBK)	pit 1061/position 17 (layer III)
Langweiler 9/Jülich	9lan19	EN (LBK)	pit 1061/position 19 (layer IV)
Laurenzberg 7	7lau200	EN (LBK)	pit 200/position 6
Laurenzberg 7	7lau202	EN (LBK)	pit 200/position 5
Laurenzberg 7	7lau2022	EN (LBK)	pit 200/position 7
Laurenzberg 7	7lau372	EN (LBK)	pit 372
Laurenzberg 7	7lau430	EN (LBK)	pit 430/position 4
Laurenzberg 7	7lau713	EN (LBK)	pit 713/position 6
Laurenzberg 8	8lau136	EN (LBK)	pit 13/position 6
Maastricht-Randwijck	maa13-2	MN (Rössen)	pit 13, samples 62-3 amalgamated
Meckenheim/Bonn	mec24	EN (LBK)	pit 24
Meckenheim/Bonn	mec72	EN (LBK)	pit 72
Meindling	mei100-1	EN (LBK)	pit 100-1
Meindling	mei115-3	EN (LBK)	pit 115-3
Meindling	mei98	EN (LBK)	pit 98
Mythenschloss	myt001	LN (Corded Ware)	structure G
Straubing-Oeberau	str100	BA (Urnfield)	pit (sample 100)
Ulm-Eggingen	ulm122/29a	EN (LBK)	long pit (sample 122/29a)
Ulm-Eggingen	ulm123/1c	EN (LBK)	long pit (sample 123/1c)

Table 4.3, continued

Site	*Sample code*	*Period*	*Context description*
Ulm-Eggingen	ulm153/1	EN (LBK)	pit (sample 153/1)
Ulm-Eggingen	ulm24/16	EN (LBK)	pit (sample 24/16)
Ulm-Eggingen	ulm26/23	EN (LBK)	long pit associated with structure 18 (sample 26/23)
Ulm-Eggingen	ulm34/1	EN (LBK)	long pit associated with structure 20 (sample 34/1)
Vaihingen/Enz	vaih1	EN (LBK)	pit (level 1/surface 180060/feature 10/samples 97-98 amalgamated)
Vaihingen/Enz	vaih10	EN (LBK)	pit (level 1-2/surface 255040/feature 18/samples 640-641 amalgamated)
Vaihingen/Enz	vaih11	EN (LBK)	pit (level 1-2/surface 255050/feature 1/samples 645-646 amalgamated)
Vaihingen/Enz	vaih12	EN (LBK)	pit (level 1-2/surface 255050/feature 1/samples 695-698 amalgamated)
Vaihingen/Enz	vaih13	EN (LBK)	pit (level 1-2/surface 285100/feature 7/samples 720-721 amalgamated)
Vaihingen/Enz	vaih14	EN (LBK)	pit (level 1-2/surface 285070/feature 6/sample 857)
Vaihingen/Enz	vaih15	EN (LBK)	pit (level 1-2/surface 285060/feature 3/samples 893-897A amalgamated)
Vaihingen/Enz	vaih16	EN (LBK)	pit (level 1-2/surface 285050/feature 1/samples 925-927 amalgamated)
Vaihingen/Enz	vaih17	EN (LBK)	pit (level 1-2/surface 195050/feature 5/samples 1034-1037 amalgamated)
Vaihingen/Enz	vaih18	EN (LBK)	pit (level 1-2/surface 195070/feature 22/samples 1050-1052 amalgamated)
Vaihingen/Enz	vaih19	EN (LBK)	pit (level 5/surface 195080-90/feature 6/samples 1325-1327 amalgamated)
Vaihingen/Enz	vaih2	EN (LBK)	pit (level 1/surface 180070/feature 11/samples 117-121 amalgamated)
Vaihingen/Enz	vaih21	EN (LBK)	pit (level 1-2/surface 195040/feature 1/samples 1100-1104 amalgamated)
Vaihingen/Enz	vaih22	EN (LBK)	pit (level 1-2/surface 195040/feature 1/samples 1105-1109 amalgamated)
Vaihingen/Enz	vaih23	EN (LBK)	pit (level 1-2/surface 195040/feature 1/samples 1110-1112 amalgamated)
Vaihingen/Enz	vaih24	EN (LBK)	pit (level 1-2/surface 195040/feature 2/samples 1113-1116 amalgamated)
Vaihingen/Enz	vaih25	EN (LBK)	pit (level 1-2/surface 240080/feature 2/samples 1202-1204 amalgamated)
Vaihingen/Enz	vaih27	EN (LBK)	pit (level 1-2/surface 240050/feature 2/samples 1258-1260 amalgamated)
Vaihingen/Enz	vaih3	EN (LBK)	pit (level 1-2/surface 135060/feature 9/sample 224)

Table 4.3, continued

Site	*Sample code*	*Period*	*Context description*
Vaihingen/Enz	vaih30	EN (LBK)	pit (level 4-5/surface 195080-90/feature 27/sample 1294)
Vaihingen/Enz	vaih31	EN (LBK)	pit (level 1-2/surface 105040/feature 2/sample 1301)
Vaihingen/Enz	vaih32	EN (LBK)	pit (level 1-2/surface 105040/feature 2/samples 1322-1324 amalgamated)
Vaihingen/Enz	vaih33	EN (LBK)	pit (level 1-2/surface 270040/feature 2/sample 1344)
Vaihingen/Enz	vaih35	EN (LBK)	pit (level 1-2/surface 270040/feature 2/sample 1349)
Vaihingen/Enz	vaih36	EN (LBK)	pit (level 2-3/surface 270040/feature 13/samples 1451-1454 amalgamated)
Vaihingen/Enz	vaih37	EN (LBK)	pit (level 2-3/surface 270050/feature 15/samples 1455-1460 amalgamated)
Vaihingen/Enz	vaih38	EN (LBK)	pit (level 2-3/surface 270050/feature 16/samples 1469-1470 amalgamated)
Vaihingen/Enz	vaih39	EN (LBK)	pit (level 1-2/surface 300040/feature 2/samples 1488-1491 amalgamated)
Vaihingen/Enz	vaih4	EN (LBK)	pit (level 1-2/surface 135040/feature 14/samples 228-229 amalgamated)
Vaihingen/Enz	vaih41	EN (LBK)	pit (level 1-2/surface 210070/feature 16/samples 1599-1600 amalgamated)
Vaihingen/Enz	vaih44	EN (LBK)	pit (level 1-2/surface 210040/feature 12/samples 1741-1742 amalgamated)
Vaihingen/Enz	vaih45	EN (LBK)	pit (level 1-2/surface 315040/feature 1/samples 1919-1923 amalgamated)
Vaihingen/Enz	vaih46	EN (LBK)	pit (level 1-2/surface 345040/feature 1/sample 2068)
Vaihingen/Enz	vaih47	EN (LBK)	pit (level 1-2/surface 345040/feature 1/samples 2080-2082 amalgamated)
Vaihingen/Enz	vaih49	EN (LBK)	pit (level 1-2/surface 315960/feature 12/samples 2444-2445 amalgamated)
Vaihingen/Enz	vaih5	EN (LBK)	pit (level 1-2/surface 225050/feature 15/samples 364-366 amalgamated)
Vaihingen/Enz	vaih51	EN (LBK)	pit (level 1-2/surface 315980/feature 13/samples 2528-2533 amalgamated)
Vaihingen/Enz	vaih52	EN (LBK)	pit (level 1-2/surface 300960/feature 12/samples 2542-2545 amalgamated)
Vaihingen/Enz	vaih53	EN (LBK)	pit (level 1-2/surface 315000/feature 25/samples 2569-2571 amalgamated)
Vaihingen/Enz	vaih54	EN (LBK)	pit (level 6-7/surface 345900/feature 33/samples 2688-2690 amalgamated)
Vaihingen/Enz	vaih55	EN (LBK)	pit (level 1-2/surface 300970/feature 16/sample 2709)

Table 4.3, continued

Site	*Sample code*	*Period*	*Context description*
Vaihingen/Enz	vaih57	EN (LBK) but possible mixing with MN/Latène material	pit (level 1-2/surface 360940/feature 3/samples 2760-2764 amalgamated)
Vaihingen/Enz	vaih58	EN (LBK)	pit (level 1-2/surface 285980/feature 5/sample 2867)
Vaihingen/Enz	vaih59	EN (LBK)	pit (level 1-2/surface 285970/feature 9/samples 2868-2871 amalgamated)
Vaihingen/Enz	vaih6	EN (LBK)	pit (level 1-2/surface 225070/feature 1/sample 396)
Vaihingen/Enz	vaih60	EN (LBK)	pit (level 1-2/surface 270990/feature 1/samples 2923-2924 amalgamated)
Vaihingen/Enz	vaih61	EN (LBK)	pit (level 1-2/surface 255980-270980/feature 1/sample 2929)
Vaihingen/Enz	vaih62	EN (LBK)	pit (level 1-2/surface 225960/feature 1/sample 2973)
Vaihingen/Enz	vaih63	EN (LBK)	pit (level 1-2/surface 225980/feature 20/sample 2976)
Vaihingen/Enz	vaih64	EN (LBK)	pit (level 1-2/surface 225980/feature 20/samples 2979-2982 amalgamated)
Vaihingen/Enz	vaih65	EN (LBK)	pit (level 1-2/surface 225980/feature 4/samples 2987-2989 amalgamated)
Vaihingen/Enz	vaih66	EN (LBK)	pit (level 1-2/surface 225000/feature 9/samples 2994-2999 amalgamated)
Vaihingen/Enz	vaih67	EN (LBK)	pit (level 1-2/surface 225000/feature 4/sample 3009)
Vaihingen/Enz	vaih7	EN (LBK)	pit (level 1-2/surface 255120/feature 6/samples 467-470 amalgamated)
Vaihingen/Enz	vaih8	EN (LBK)	pit (level 1-2/surface 255050/feature 13/samples 616-619 amalgamated)
Vaihingen/Enz	vaih9	EN (LBK)	pit (level 1-2/surface 255060/feature 1/samples 630-635 amalgamated)
Wanlo/Wickerath	wan188	EN (LBK)	pit 188
Wanlo/Wickerath	wan202	EN (LBK)	pit 202, layer 3

Table 4.4. Classification of 'potentially unmixed' cereal samples according to the lowest maximum wild/weed plant height per sample

Lowest max plant height (cm)	*No. of samples*
<40 cm	34
40-70 cm	33
>70 cm	63

Table 4.5. The classification of wild/weed taxa in the 'potentially unmixed' cereal samples according to general habitat groupings (Ellenberg *et al*. 1992); only those taxa selected for FIBS measurements are shown

Ellenberg group	*Standardised archaeobotanical taxa*
Bedrock/stone scree:	Galeopsis angustifolia/ladanum/segetum
Disturbed ground:	Agrostemma githago
	Atriplex patula/prostrata
	Bromus arvensis/hordeaceus/secalinus
	Bromus sterilis/tectorum
	Chenopodium album group
	Chenopodium ficifolium
	Chenopodium glaucum
	Chenopodium hybridum
	Chenopodium polyspermum
	Descurainia sophia
	Digitaria ischaemum
	Echinochloa crus-galli
	Fallopia convolvulus
	Galium aparine
	Galium spurium
	Hyoscyamus niger
	Lapsana communis
	Malva sylvestris
	Nepeta cataria
	Papaver rhoeas
	Plantago major
	Polygonum aviculare group
	Polygonum lapathifolium
	Polygonum minus
	Polygonum persicaria
	Rumex crispus/obtusifolius
	Sambucus ebulus
	Setaria pumila
	Setaria verticillata/viridis
	Silene latifolia
	Sisymbrium officinale
	Solanum nigrum
	Sonchus asper
	Stellaria media

Table 4.5, continued

Ellenberg group	*Standardised archaeobotanical taxa*
	Vicia hirsuta
	Vicia tetrasperma
Disturbed/grassland:	Rumex acetosa/thyrsiflorus
Disturbed/woodland:	Rumex conglomeratus/sanguineus
Grassland:	Festuca rubra
	Galium mollugo group/verum group
	Knautia arvensis
	Lolium perenne
	Luzula campestris/multiflora
	Phleum pratense
Grassland:	Plantago lanceolata
	Poa pratensis group/trivialis
	Prunella vulgaris
	Trifolium arvense/campestre
	Trifolium pratense
	Trifolium repens
	Valerianella dentata
	Veronica arvensis
Woodland:	Moehringia trinervia
	Stachys sylvatica
Indeterminate:	Arenaria serpyllifolia
	Camelina sativa
	Galeopsis bifida/speciosa/tetrahit
	Poa annua
	Ranunculus repens
	Rumex acetosella
	Silene dioica
	Silene vulgaris
	Urtica dioica
Not classified:	Brassica rapa

Table 4.6. Codes and full names of wild/weed taxa in correspondence analyses of archaeobotanical data

Codes	*Full names*
BROMAHS	Bromus arvensis/hordeaceus/secalinus
BRSTETEC	Bromus sterilis/tectorum
CHENALB	Chenopodium album group
CHENFIC	Chenopodium ficifolium
CHENPOL	Chenopodium polyspermum
ECHICRU	Echinochloa crus-galli
FALLCON	Fallopia convolvulus
GALESLA	Galeopsis angustifolia/ladanum/segetum
GALIAPA	Galium aparine
GALISPU	Galium spurium
HYOSNIG	Hyoscyamus niger
LAPSCOM	Lapsana communis
PAPARHO	Papaver rhoeas
PHLEPRA	Phleum pratense
PLANMAJ	Plantago major
POAANN	Poa annua
POAPRTR	Poa pratensis group/trivialis
POLYAVI	Polygonum aviculare group
POLYLAP	Polygonum lapathifolium
POLYPER	Polygonum persicaria
RANUREP	Ranunculus repens
RUMEACL	Rumex acetosella
RUMESACO	Rumex conglomeratus/sanguineus
RUMETHAC	Rumex acetosa/thyrsiflorus
SETAPUM	Setaria pumila
SETAVIVE	Setaria verticillata/viridis
SILEVUL	Silene vulgaris
SOLANIG	Solanum nigrum
SONCASP	Sonchus asper
TRIFREP	Trifolium repens
VALEDEN	Valerianella dentata
VICIHIR	Vicia hirsuta

Table 5.1. Woodland taxa in the archaeobotanical samples (see Table 4.3 for sample codes)

Sample code	bed28	hor2
Site	Bedburg-Garsdorf	Hornstaad-Hörnle
Period	Early Neolithic (LBK)	Later Neolithic (Hornstaad)
Woodland perennials		
Agropyron canina	x	
Circaea lutitiana		x
Stachys sylvatica	x	
Woodland annual		
Moehringia trinervia		x

Table 5.2. The classification of archaeobotanical samples (n=130) by the discriminant function extracted to distinguish weed associations from autumn- and spring-sown crops (Germany), showing samples classified with high probability (≥0.90) and low probability (<0.90)

Archaeobotanical samples		**Semi-quantitative analysis**				**Quantitative analysis**			
		Autumn-sown		*Spring-sown*		*Autumn-sown*		*Spring-sown*	
Cereal type	*Processing stage*	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability
Free-threshing	unthreshed	2						2	
Glume wheat	unsieved 'spikelets'	5				5			
Glume wheat	fine sieve by-products	83	4	18	7	86	19	6	1
Glume wheat	fine sieve products	7				7			
Glume wheat	sieved 'spikelets'	2	1			3			
Free-threshing	fine sieve product		1			1			

Table 5.3. The classification of archaeobotanical samples with *Chenopodium album* removed (n=74*) by the discriminant function extracted to distinguish weed associations from autumn- and spring-sown crops (Germany), showing samples classified with high probability (≥0.90) and low probability (<0.90)

Archaeobotanical samples		**Semi-quantitative analysis**				**Quantitative analysis**			
		Autumn-sown		*Spring-sown*		*Autumn-sown*		*Spring-sown*	
Cereal type	*Processing stage*	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability
Free-threshing	unthreshed	2						2	
Glume wheat	unsieved 'spikelets'	4				4			
Glume wheat	fine sieve by-products	50		6	2	51	1	5	1
Glume wheat	fine sieve products	6				6			
Glume wheat	sieved 'spikelets'	3				3			
Free-threshing	fine sieve product	1				1			

* the samples containing at least 30 seeds of wild/weed taxa after the removal of *C. album*

Table 5.4. The classification of archaeobotanical samples (n=130) by the discriminant function extracted to distinguish pulse fields and gardens (Evvia), showing samples classified with high probability (≥0.90) and low probability (<0.90)

Archaeobotanical samples		**Semi-quantitative analysis**				**Quantitative analysis**			
		Field		*Garden*		*Field*		*Garden*	
Cereal type	*Processing stage*	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability
Free-threshing	unthreshed samples			2				2	
Glume wheat	unsieved 'spikelets'			4	1			4	1
Glume wheat	fine sieve by-products	1	2	109		3	2	103	4
Glume wheat	fine sieve products		1	4	2			6	1
Glume wheat	sieved 'spikelets'			3				2	1
Free-threshing	fine sieve product			1				1	

Table 5.5. The classification of archaeobotanical samples with *Chenopodium album* removed (n=74*) by the discriminant function extracted to distinguish pulse fields and gardens (Evvia), showing samples classified with high probability (≥0.90) and low probability (<0.90)

Archaeobotanical samples		**Semi-quantitative analysis**				**Quantitative analysis**			
		Field		*Garden*		*Field*		*Garden*	
Cereal type	*Processing stage*	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability	with high probability	with low probability
Free-threshing	unthreshed samples			2				2	
Glume wheat	unsieved 'spikelets'			4				3	1
Glume wheat	fine sieve by-products	1	1	56		3	6	47	2
Glume wheat	fine sieve products		2	3	1			4	2
Glume wheat	sieved 'spikelets'			2	1			2	1
Free-threshing	fine sieve product			1				1	

* the samples containing at least 30 seeds of wild/weed taxa after the removal of *C. album*

Table 5.6. Cross-tabulation of the classification of archaeobotanical samples by the semi-quantitative discriminant analyses; high probability = ≥0.90, low probability = <0.90

		Autumn-sown		*Spring-sown*	
		high probability	low probability	high probability	low probability
Field	high probability	1			
	low probability	3			
Garden	high probability	93	5	18	7
	low probability	3			

Table 5.7. Combined classification of archaeobotanical samples by processing group

		Autumn field	*Autumn garden*	*Spring field*	*Spring garden*
Cereal type	*Processing stage*				
Free-threshing	unthreshed		2		
Glume wheat	unsieved 'spikelets'		5		
Glume wheat	fine sieve by-products	3	84		25
Glume wheat	fine sieve products	1	6		
Glume wheat	sieved 'spikelets'		3		
Free-threshing	fine sieve product		1		

Table 5.8. The relationship of husbandry regime to archaeological site and geographical region

Sites	*Autumn field*	*Autumn garden*	*Spring garden*	*Total*
Aiterhofen			1	1
Altdorf		1		1
Hienheim/Donau		1		1
Meindling		2	1	3
Straubing-Oeberau		1		1
Lower Bavaria (n=7)	***0***	***5***	***2***	
Harkenbleck (*Lower Saxony*)	1			1
Bruchenbrücken (*Mainz*)		2		2
Aldingen		1		1
Ditzingen		2	1	3
Endersbach		1		1
Erbedingen-Hochdorf		11		11
Grossachsenheim	1			1
Vaihingen		42	14	56
Neckar valley (n=73)	***1***	***57***	***15***	
Cham-Oberwil	1			1
MYT		1		1
North-central Switzerland (n=2)	***1***	***1***	***0***	
Iwanowice-Klin (*Poland - Krakow*)		1		1
Bedburg-Gamersdorf		3		3
Lamersdorf/Düren		1		1
Langweiler 16		1		1
Langweiler 2/Jülich			1	1
Langweiler 3+6/Jülich		1		1
Langweiler 8/Jülich		9	1	10
Langweiler 9/Jülich		2		2
Laurenzberg 7	1	5		6
Laurenzberg 8		1		1
Maastricht-Randwijck		1		1
Meckenheim/Bonn		2		2
Wanlo/Wickerath		2		2
Rhineland (n=33)	***3***	***28***	***2***	
Kamenin (*Slovakia - south*)		1		1
Hilzingen, Kr. Konstanz			4	4
Hornstaad-Hörnle IA - burnt layer		2		2
Ulm-Eggingen		4	2	6
Southern Baden-Württemberg (n=12)	***0***	***6***	***6***	
Total				***130***

Table 5.9. The relationship of husbandry regime to chronological period

Period	*Autumn field*	*Autumn garden*	*Spring garden*	*Total*
LBK	1	81	25	107
Middle Neolithic		4		4
Later Neolithic	1	15		16
Bronze Age	2	1		3

Table 6.1. The effect of crop processing on the functional attributes

Attribute	**Fine sieve products**	**Fine sieve by-products**	**Result**
Seasonality	*autumn*	*autumn and spring*	*Products conform to expected bias but by-products variable*
Life history	summer annuals	winter/summer annuals	
Germination time	autumn/spring	spring	
Flowering onset/length	early-intermediate/short	late and early-intermediate/short	
Endopolyploidy	high	low-high	
Disturbance			*No effect detected apart from (expected) association of products with short flowering*
Length of the flowering period	short	short-med-long	
Vegetative spread	(mostly annuals)	(mostly annuals)	
Fertility			*No obvious effect – slight effects consistently in the opposite direction to expected bias*
Canopy height	tall	variable	
Canopy diameter	medium	variable	
Mean canopy dimension	big	variable	
Weed size index	high	variable	
Leaf area per node	medium	variable	
Leaf weight per node	medium	variable	
SlA	high	low	
Water availability			*Trend in opposite direction to expected bias*
Stomatal size	big	small-medium	
Stomatal density	few	intermediate-many	
Shade			*No effect detected*
Amphistomaty	variable	variable	
Habitat stability		.	*Products and most by-products conform to expected bias*
Seed persistence	impersistent	mostly persistent	

Table 6.2. The relationship of chronological period to growing conditions (productivity and disturbance)

Period	*Low productivity low disturbance*	*High productivity high disturbance*	*Very high productivity moderate disturbance*	*Total*
LBK	x	x	x	55
Middle Neolithic			x	2
Later Neolithic			x	10

Table 6.3. Interpretation of observed ecological trends in terms of crop husbandry practices

Growing conditions	**Archaeological sites**	**Crop husbandry**		
		Tillage	*Weeding during crop growth*	*Manuring*
Low productivity and disturbance	Bruchenbrücken, Vaihingen (both LBK)	Relatively poor	Low level – none	Productivity not carefully maintained
High productivity and high disturbance	Aiterhofen, Ditzingen, Hienheim, Hilzingen, Meindling, Ulm-Eggingen, Vaihingen (all LBK)	Thorough (e.g. by hoe, or plough followed by hoe)	High level	Productivity maintained
Very high productivity and moderate disturbance	Endersback (MN), Hochdorf (LN), Meindling (LBK), Lower Rhine-Meuse sites (LBK-MN)	Adequate but less thorough than above	Low level	Productivity maintained

Table 7.1. Variability between regions in the LBK

	Lower Rhine-Meuse	*Neckar valley*	*Southern Baden-Württemberg*	*Lower Bavaria*	*References*
Crop spectra	No barley*	Barley	Barley	No barley	Küster 1995b: 83; Lüning 2000: 60
Faunal spectra	(High cattle?)	High pig & wild	High pig & wild	High pig & wild	Döhle 1993; Tresset and Vigne 2001
Sielmann zone	A	B	-	B	Sielmann 1972
Regional ceramic group	Rhine-Meuse group	South-west Bandkeramik group	South-west Bandkeramik group	Bavaria-Danube group	Lüning 1988; Strien 1990
Funerary practice	Tradition II	Tradition II	-	Tradition I	Jeunesse 1996

* but 2 rachis fragments preserved by waterlogging from the LBK well at Erkelenz/Kückhoven (Knörzer 1998)

Table 7.2. Variability between LBK Vaihingen and later neolithic Hochdorf

	Vaihingen	*Hochdorf*	*References*
Crop spectra	Einkorn/emmer as main crop	Naked barley and einkorn/emmer well attested	Küster 1985; Rösch 1995a, 1998b; Bogaard unpublished
Faunal spectra	Cattle-pig-sheep/goat; 16% wild	Cattle-pig-sheep/goat; 7% wild	Makovicz-Poliszot 1988; Arbogast 1998
House form	Longhouse	Smaller houses	Keefer 1988: 42-43; Krause 1998

Appendix

Appendix: Experiment measuring the 'winnowability' of weed seeds and glume wheat chaff

The purpose of this experiment was to determine 1. whether seed 'lightness' as a component of weed seed physical type (see 2.5.3) can be measured objectively and 2. the extent to which glume wheat glume material (spikelet forks, glume bases) can be removed by winnowing alone following spikelet pounding.

Methods

A 'seed buoyancy machine' designed by the Unit of Comparative Plant Ecology, University of Sheffield to measure the wind-dispersal potential of seeds was used to assess the 'winnowability' of glume wheat glume material and weed seeds. The machine measures the rate of fall (meters/second) of items through a 1.5 m-long tube (Askew *et al.* 1997). First, the potential of the seed buoyancy machine to distinguish between 'light' and 'heavy' seeds was determined by dropping five seeds of each 'light' and 'heavy' species from the Amorgos study (G. Jones 1983, 1984, 1987) through the tube. Second, the rate of fall of einkorn and emmer glume material in different states of fragmentation was measured using the seed buoyancy machine. The velocity of five specimens of each fragmentation type was measured for einkorn and emmer, and average velocities were calculated for each fragment type.

Results

As shown in Appendix Fig. 1, weed species classified as 'light' by G. Jones (1984) (i.e. those tending to be winnowed off in the Amorgos study) have velocities lower than 3.50 m/s, whereas weed species classified as 'heavy' by G. Jones (1984) (i.e. those that did not tend to be winnowed off in the Amorgos study) have velocities greater than 3.00 m/s. There is only a small degree of overlap (3.00 – 3.50 m/s) in the velocities of 'heavy' and 'light' seeds. It can be concluded, therefore, that seed lightness is susceptible to objective measurement using the seed buoyancy machine.

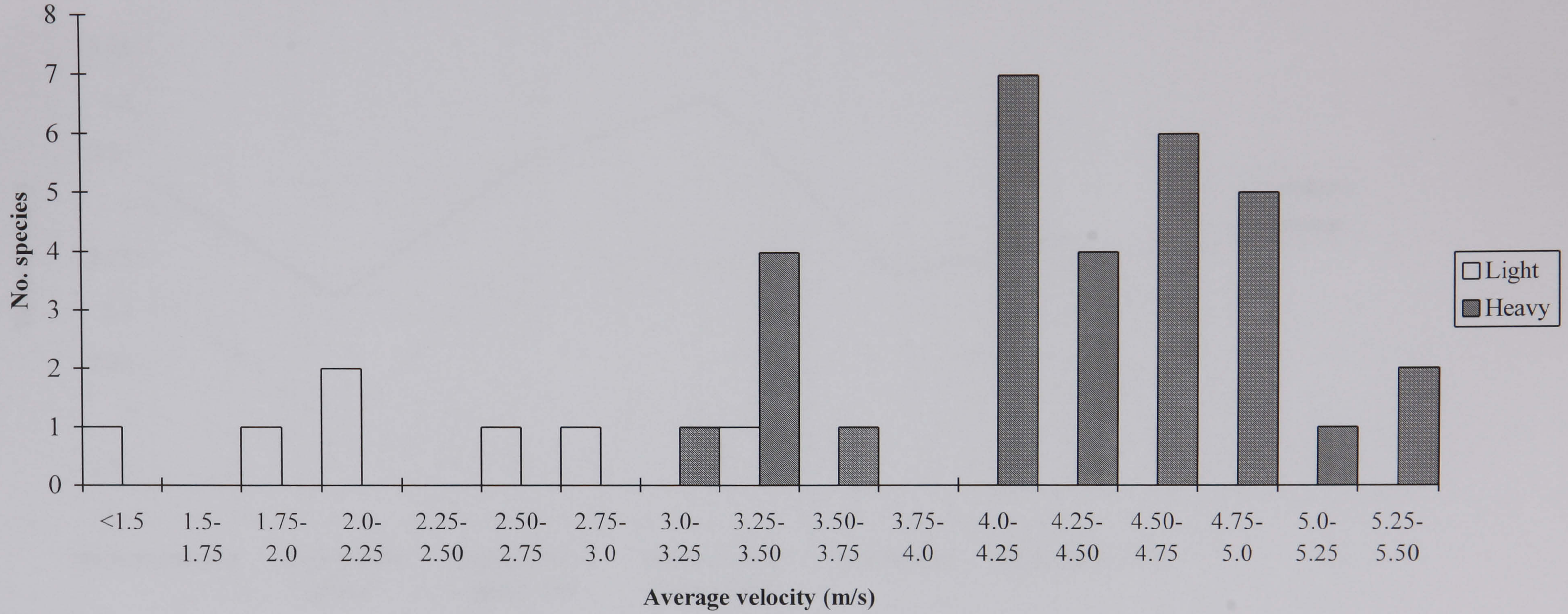
Appendix Fig. 2 shows the average velocities of einkorn and emmer glume material in different states of fragmentation, which clearly affects their velocity. For both einkorn and emmer, velocities are lowest for whole glumes (with the whole upper portion of the glume intact). For emmer, the highest velocity is reached by glumes with the upper half of the glume removed; for einkorn, spikelet forks (with all but the base of the glume removed) show the highest velocity. Removal of the lighter upper portions of the glume, therefore, tends to correspond with higher velocity. Furthermore, in all states of fragmentation except the spikelet

fork, emmer shows higher velocities than einkorn, presumably because of its more robust morphology.

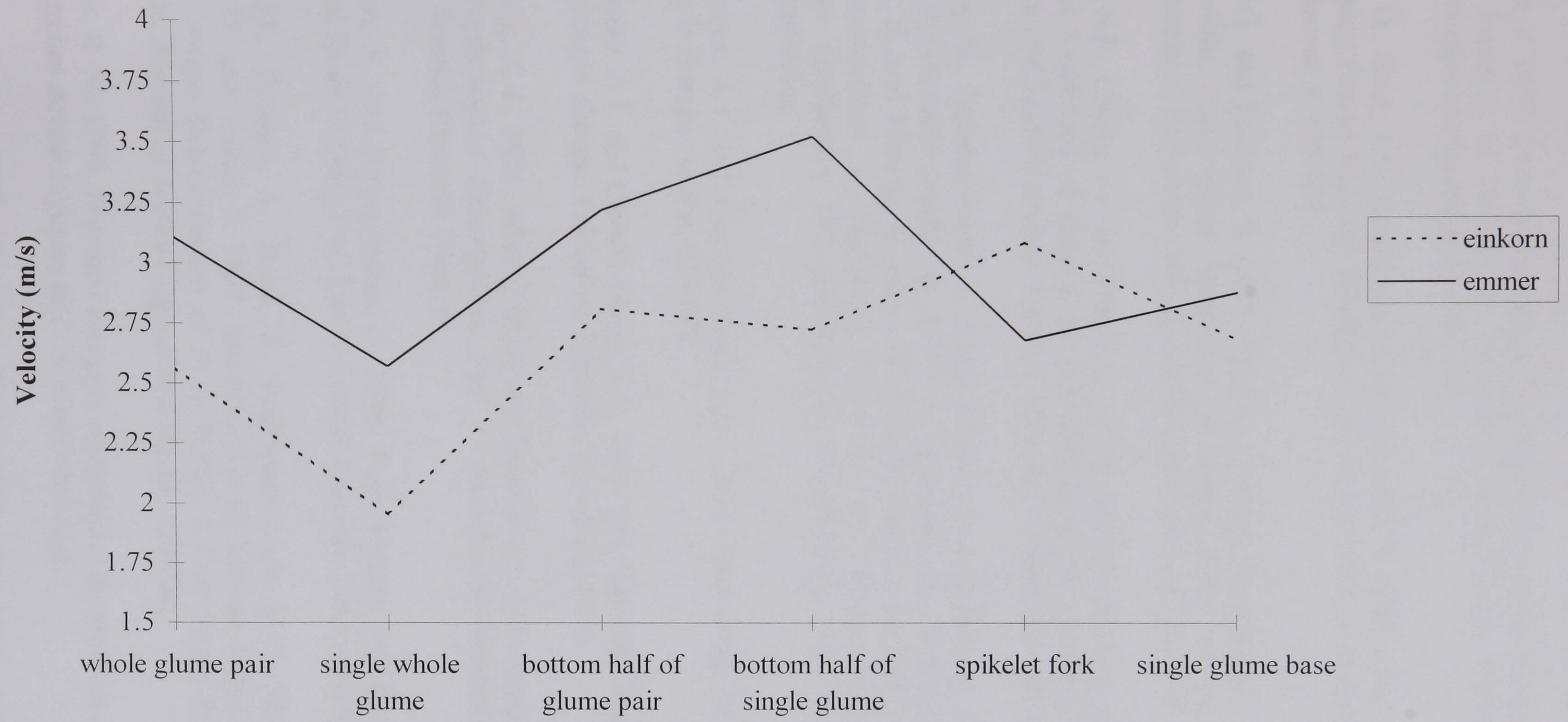
Comparison of the velocities of the glume material (Appendix Fig. 2) with the velocity ranges of 'heavy' and 'light' weed seeds in the Amorgos study (Appendix Fig. 1) suggests that einkorn glumes are potentially separated off by winnowing in most, if not all, states of fragmentation; the velocity of einkorn spikelet forks is ambiguous since it falls in the overlap region of 'heavy' and 'light' weed seeds (3.00 – 3.50 m/s). Emmer glumes appear to be separable by winnowing in at least two states of fragmentation (single whole glume, spikelet fork); all other states are ambiguous since they fall in the overlap region.

Discussion

These preliminary results suggest that samples dominated by einkorn and/or emmer glume bases could potentially represent the by-products of winnowing following spikelet pounding. Einkorn glume material in particular appears to be separable by winnowing alone, whereas the separation of emmer glume material by winnowing is less certain. For emmer, at least, another cleaning process such as fine sieving would probably be necessary in order to remove glume material in all states of fragmentation. If einkorn and emmer were grown as a 'maslin' crop, as often inferred for the LBK and other neolithic periods (e.g. Willerding 1980, 1983b; Knörzer 1997, 1998), it seems likely that any winnowing of pounded spikelets would be followed by fine sieving to remove all forms of glume material.



Appendix Fig. 1. The average velocities (m/s) of 'light'- and 'heavy'-seeded weed species from the Amorgos study



Appendix Fig. 2. The average velocities (m/s) of einkorn and emmer glume material in different states of fragmentation

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