

6 Acknowledgements

This project was funded under NCCE Contract No F80-32-06. The author is especially grateful for the enthusiasm, helpfulness and stimulating discussion from Heather Robertson, Peter Holmes and other English Nature Lowlands Team and Three Counties Team staff. In addition to the above, the author thanks Rue Ekins and Alison Macdonald for their time and interest in reading drafts and providing useful comments and discussion. The many landowners and occupiers involved are also thanked for their permission to carry out the surveys and their frequent active interest in the project.

7 References

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Appendix 1: Environmental variables used in analysis

Parts of variable names used in computer designations and in illustrations in this report are shown in **bold**.

1 Easting

National Grid three-figure easting, taken as a single figure for each site. All sites were either in 100km square "SO" or in "SP". "SP" grid references were given an extra 1 in the easting, i.e. SP 004 nnn becomes easting 1004.

2 Northing

National Grid three-figure northing. Since all sites were within the same 100km reference, there was no need for the adjustment carried out on "Easting".

3 Horse

Sites with horse grazing were given "1", others "0".

4 Cattle

Sites with cattle grazing were given "1", others "0". Since sites were either horse or cattle grazed, this variable is redundant for analysis and CANOCO was instructed to ignore it (because the same information is given by "Horse" alone).

5 Intensity

A subjective but quantified variable on a scale of 1 to 3. Grazing intensity was determined before data were gathered and referred to intensity in previous years in the few cases where it was known to have been changed in 1995. The intensity classes used were:

1 Light grazing

Although the site is grazed, the grazing level is such that the growth level is not reduced to the accepted figure of 2-5cm sward height at the end of the season. There may be litter build up and tussock formation. A farmer would consider that the land was stocked under capacity.

2 Moderate grazing

The site is grazed and the sward height is reduced as described above. Some localised damage to the sward may occur. A farmer would consider the land stocked at capacity without the need to resort to supplementary feeding.

- 3 **Heavy grazing**
- Sward damage occurs and supplementary feeding would be necessary at times to maintain stock on the land.
- 6 **Hay**
- Given "1" for hay cut, "0" for none.
- 7 **WinterRest**
- Sites reported to be rested from grazing in the winter were given "1", others "0".
- 8 **SummerRest**
- Sites reported to be rested from grazing in the summer were given "1", others "0".
- 9 **ManagementTime**
- Time in years for which the reported nature and intensity of management was known to have gone on for. To avoid spurious features from sites which had only been known for a few years but where management may have been the same for longer, all sites with the time given as more than ten years were truncated to "10".
- 10 **Height**
- Vegetation height in centimetres as estimated from the arithmetic mean of three dropped-disc measures in a square metre.
- 11 **HeightRange**
- Difference between the smallest and largest of the three dropped disc height estimates.
- 12 **Bare ground**
- The percentage of a quadrat occupied by bare ground.
- 13 **Litter**
- The percentage of a quadrat occupied by litter **judged to be remaining from the previous year's (ie 1994) growth.**
- 14 **Altitude**
- The median height above sea level in metres of a site, taken from the site cards.

15 **Area of MG5 grassland**

The total area in hectares of MG5 grassland reported from a whole site (i.e. one or a collection of contiguous fields) on the site cards.

The above variables were used as environmental variables or their influence on the data was removed as covariables. In addition, 19 nominal ("1" or "0" variables) covariables were established in order to form statistical blocks within which to constrain Monte Carlo permutation tests of one analysis. These were **Farm1** to **Farm19**, a quadrat only scoring "1" on the farm variable belonging to the site it came from.

Figure 1: Location of study sites within Worcestershire

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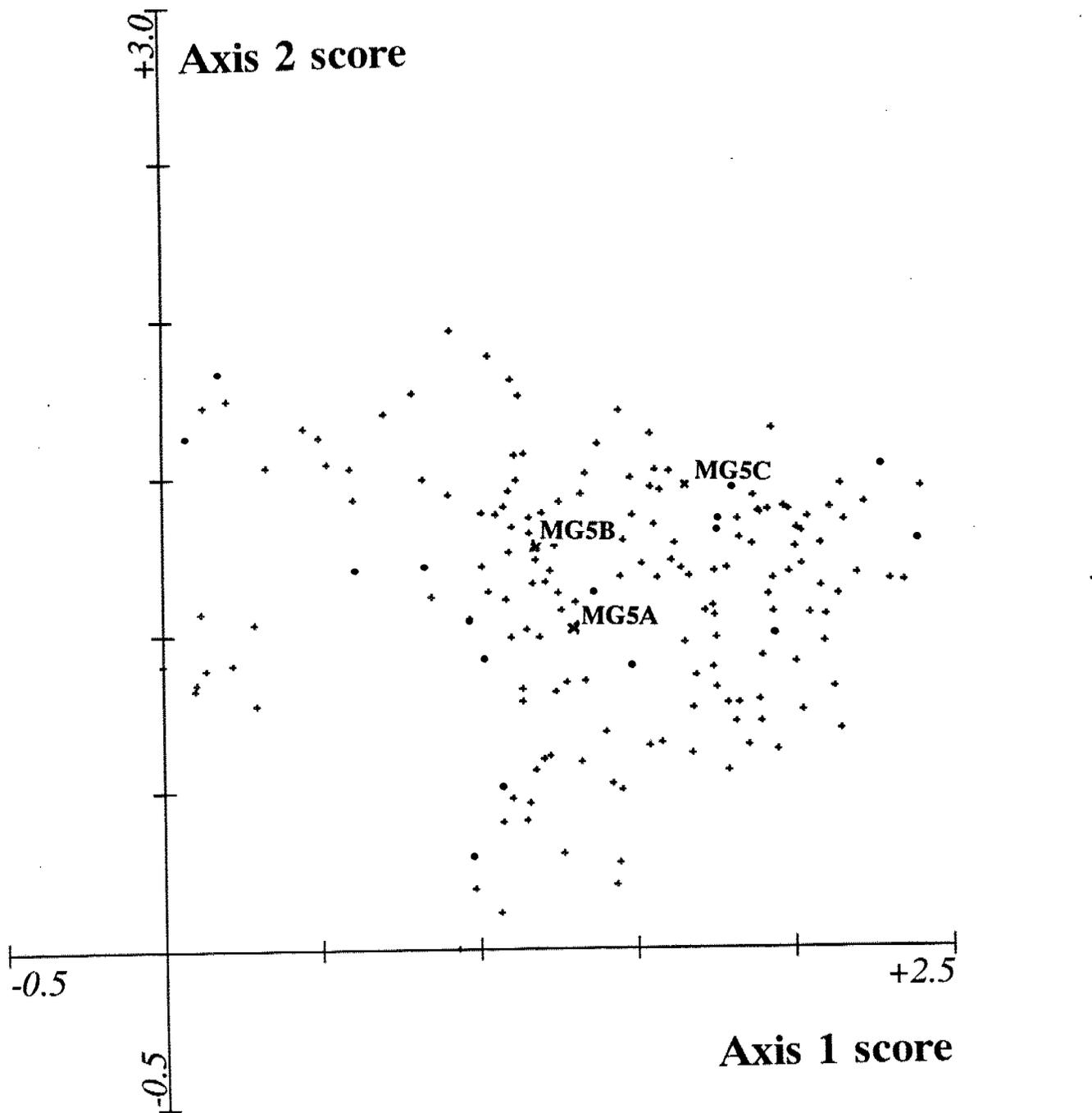
The effects of horse grazing on species-rich grasslands

Figure 2: DCA analysis of Worcestershire data: quadrats in relation to NVC data

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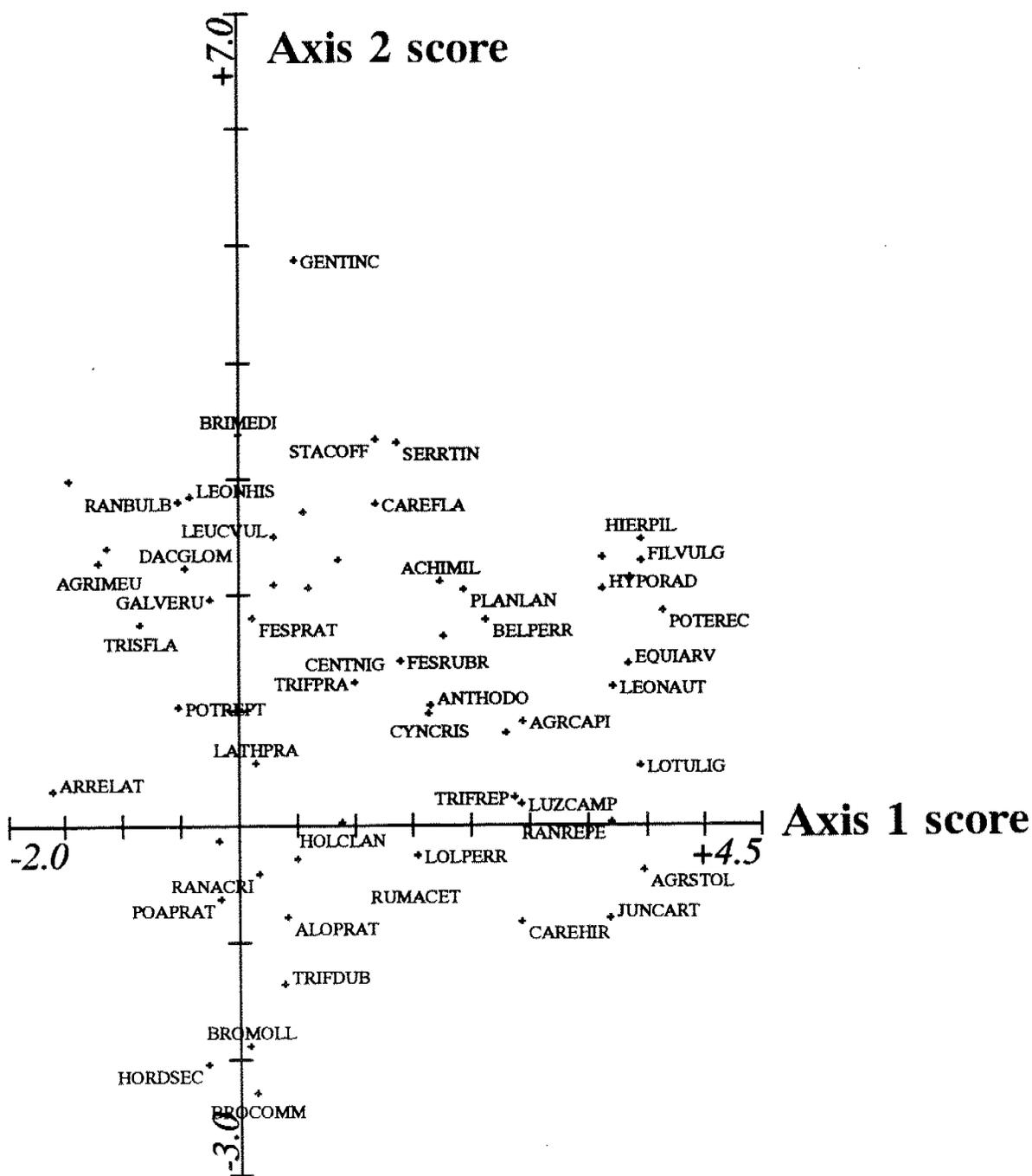
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Figure 3: DCA analysis of Worcestershire data: positions of species on the first two ordination axes

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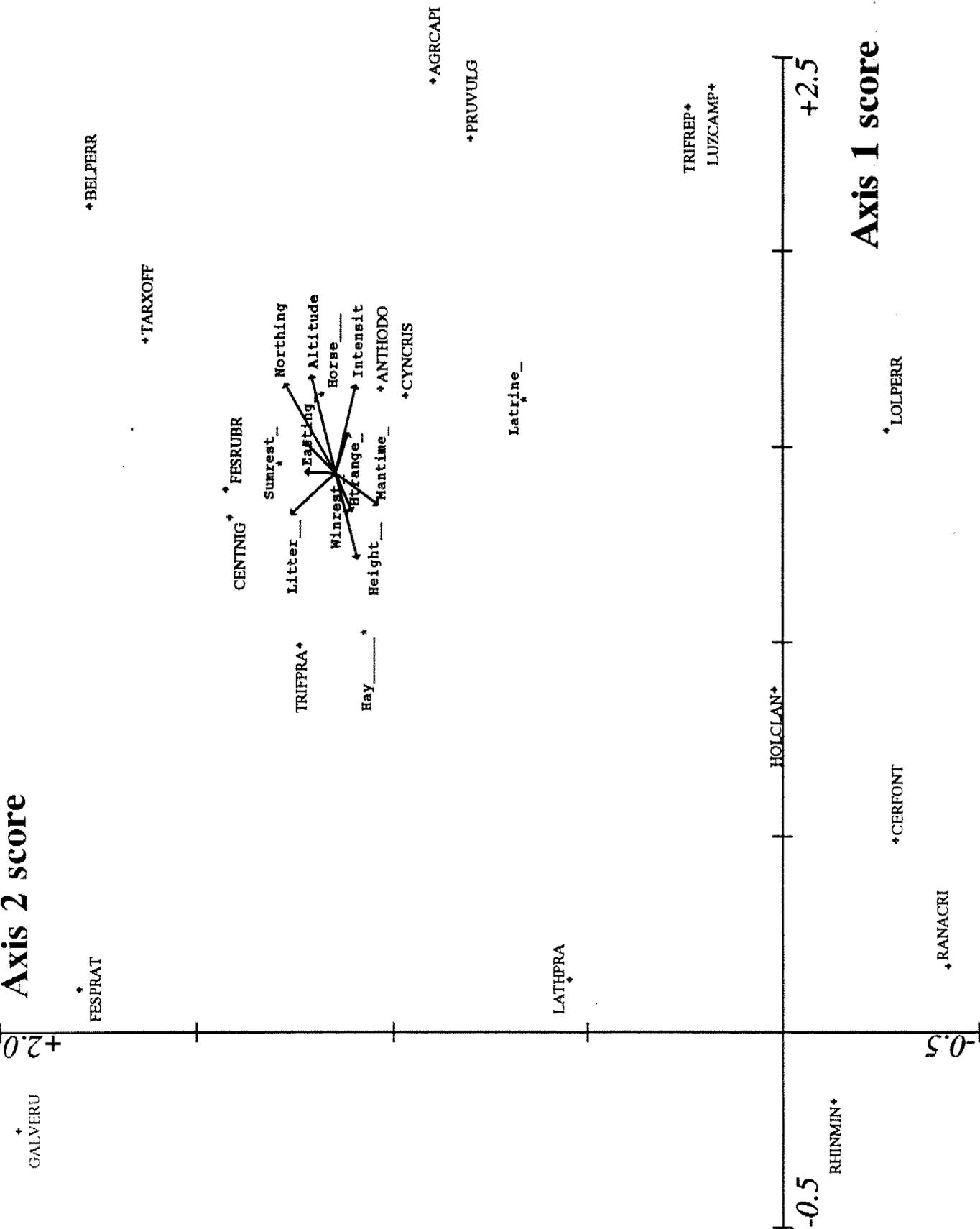
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Figure 4: DCA analysis of Worcestershire data: environmental variables superimposed on the first two ordination axes
Variable names follow Appendix 1

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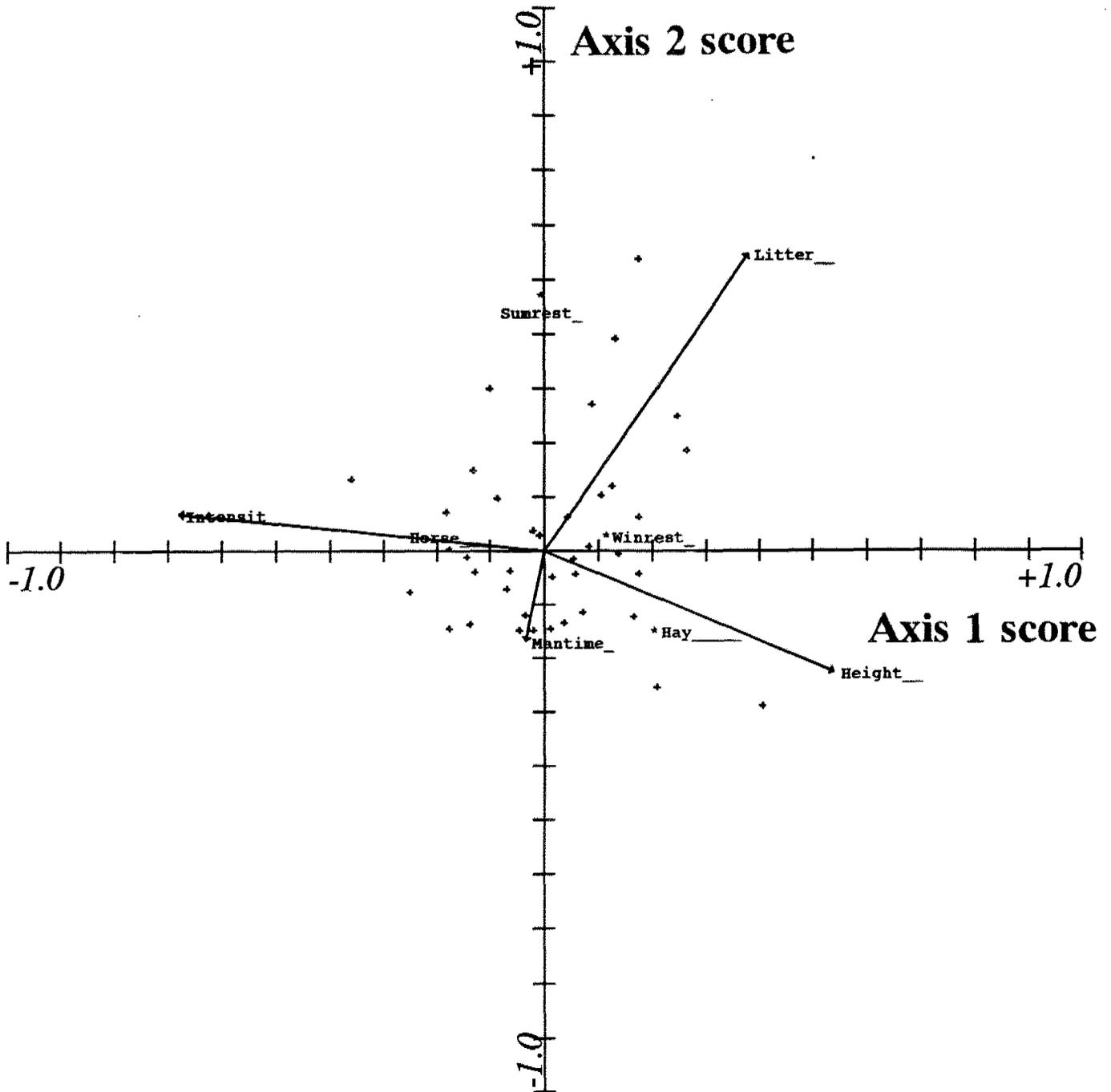
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Figure 5: Canonical correspondence analysis of the Worcestershire data: significant environmental variables in relation to species positions on the first two DCCA axes
Variable names follow Appendix 1: species are shown as crosses

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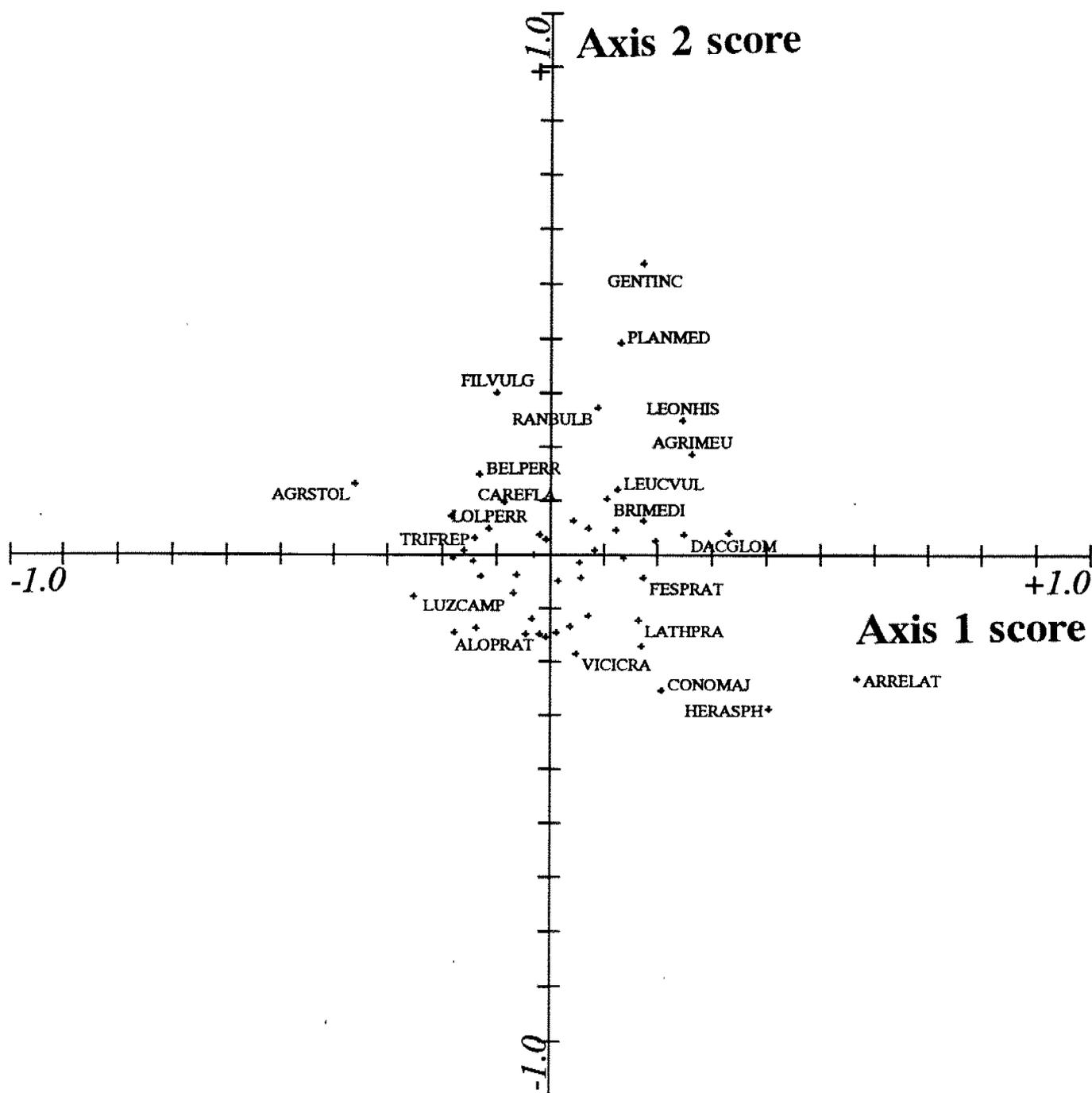
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Figure 6: Canonical correspondence analysis of the Worcestershire data: main species labelled on their positions as in Figure 5.
Variable names follow Appendix 1

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The effects of horse grazing on species-rich grasslands

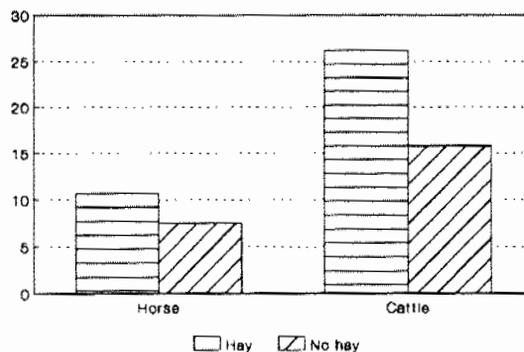
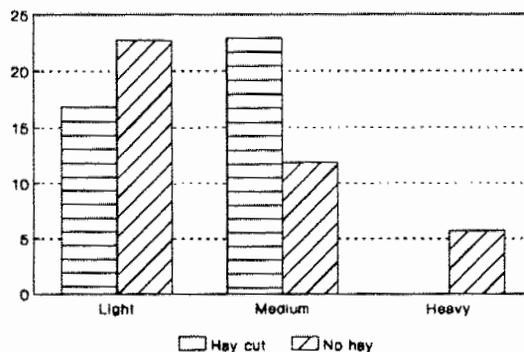
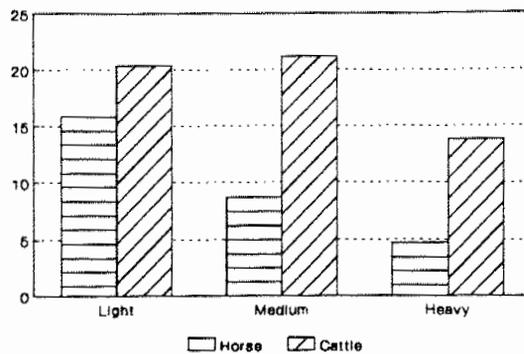
Figure 7: The effects of grazing species, intensity and hay cut on sward height

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Sward height



Y-axes are mean heights (cm)

The effects of horse grazing on species-rich grasslands

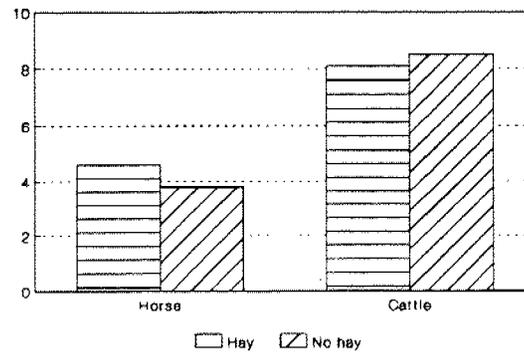
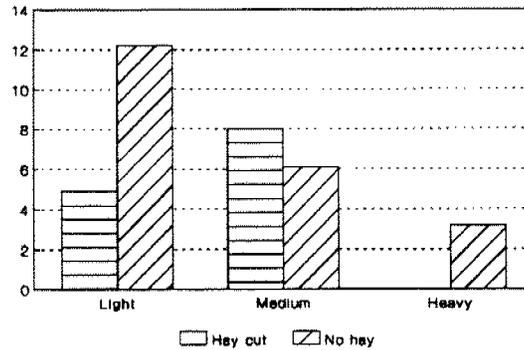
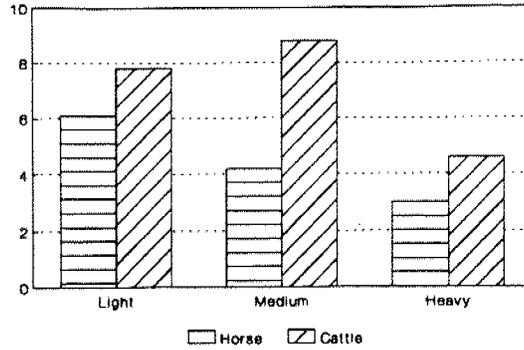
Figure 8: The effects of grazing species, intensity and hay cut on height range within a 1m square

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Height range



Y-axes are average ranges per quadrat in cm

The effects of horse grazing on species-rich grasslands

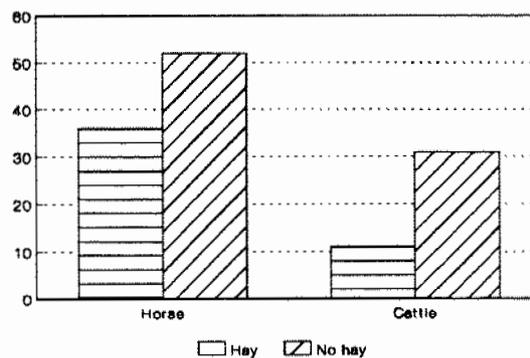
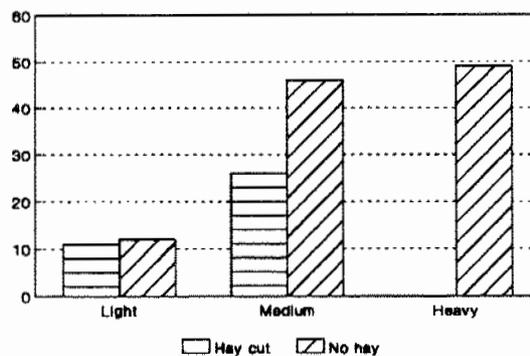
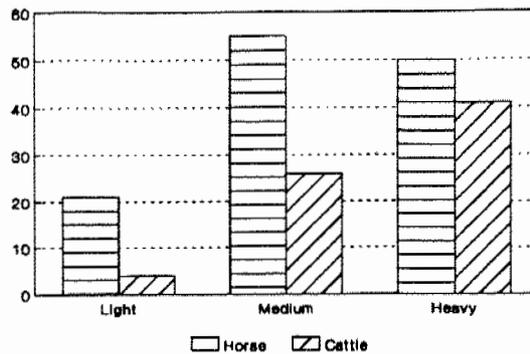
Figure 9: The effects of grazing species, intensity and hay cut on the ten species CANOCO associates most strongly with heavily grazed short swards.

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"Short" species from CANOCO



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

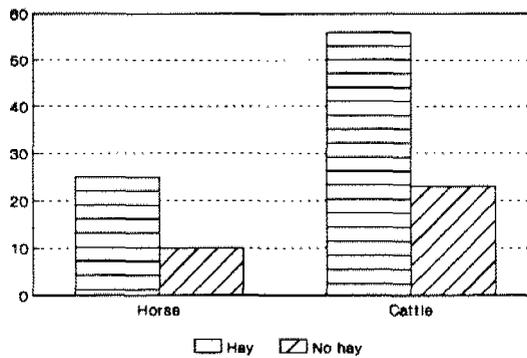
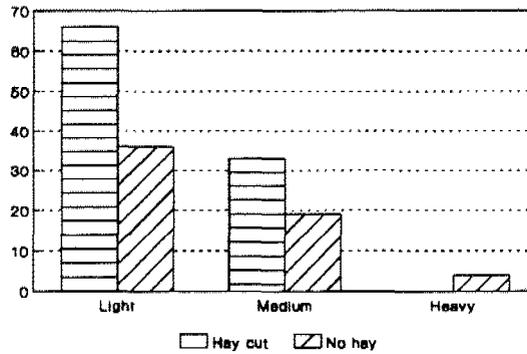
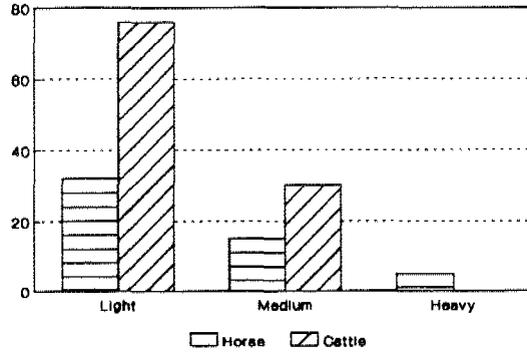
Figure 10: The effects of grazing species, intensity and hay cut on the ten species CANOCO associates most strongly with lightly grazed tall swards.

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"Tall" species from CANOCO



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

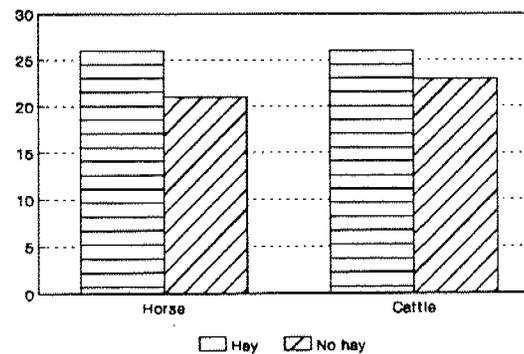
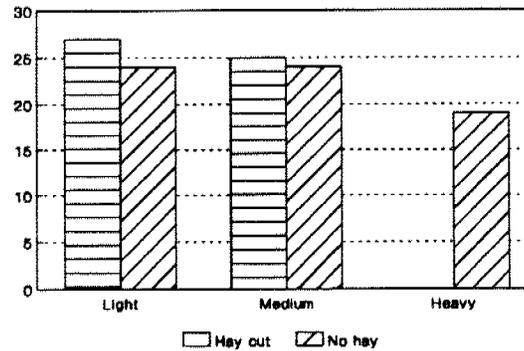
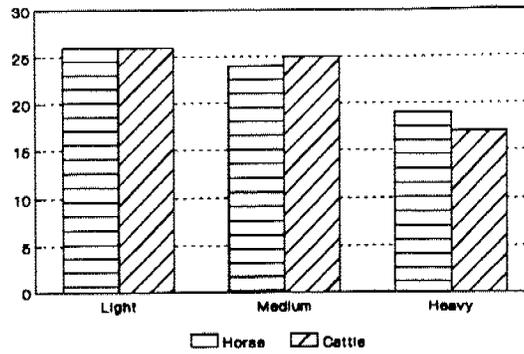
Figure 11: The effects of grazing species, intensity and hay cut on species richness

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Species richness



Y-axes are total numbers of species per square metre

The effects of horse grazing on species-rich grasslands

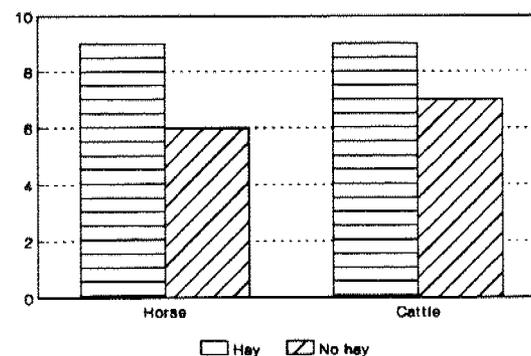
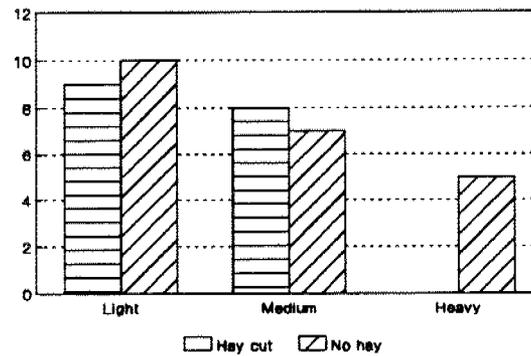
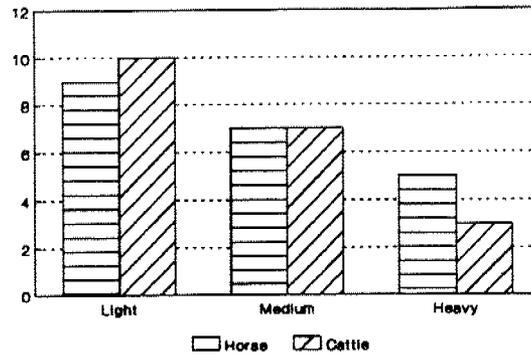
Figure 12: The effects of grazing species, intensity and hay cut on the number of mesotrophic indicator species

Ref: E0505F12

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Number of indicator species



Y-axes are total numbers of species per square metre

The effects of horse grazing on species-rich grasslands

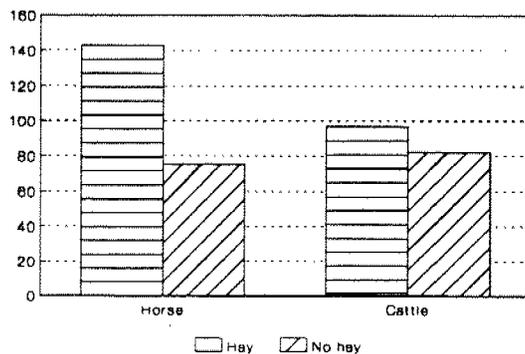
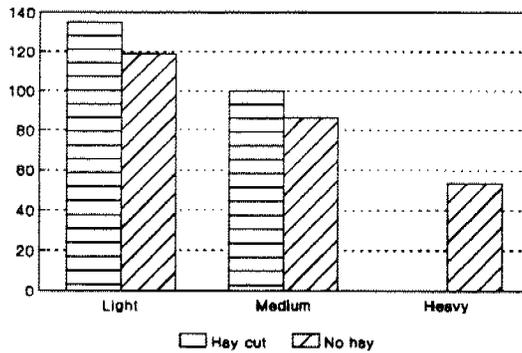
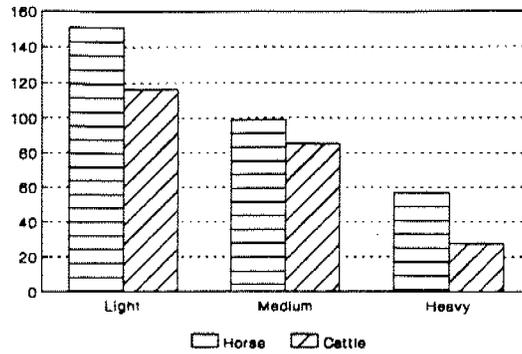
Figure 13: The effects of grazing species, intensity and hay cut on indicator species weighted by their abundance and indicator strength

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Weighted indicator species score



Y-axes are mean quadrat sums of
(score x cell count)

The effects of horse grazing on species-rich grasslands

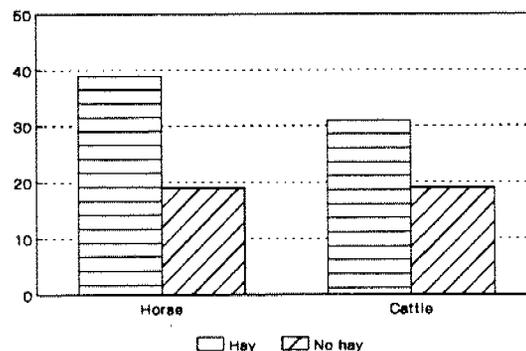
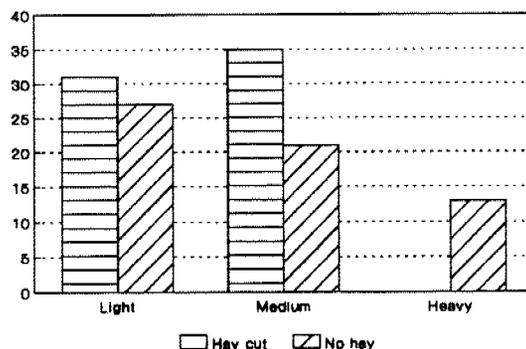
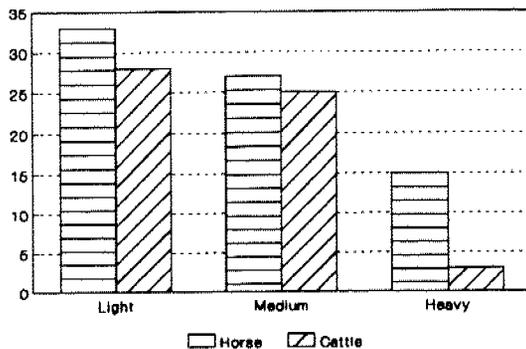
Figure 14: The effects of grazing species, intensity and hay cut on species associated with diverse (>22 species m⁻²) vegetation

Ref: E0505F14

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Species-rich associates



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

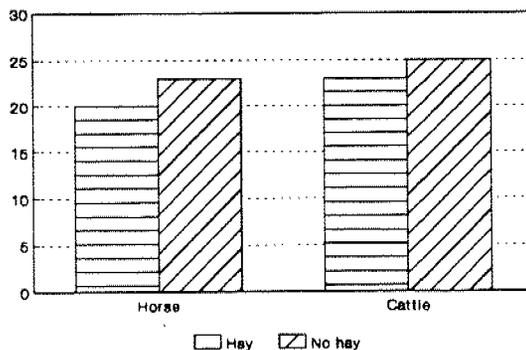
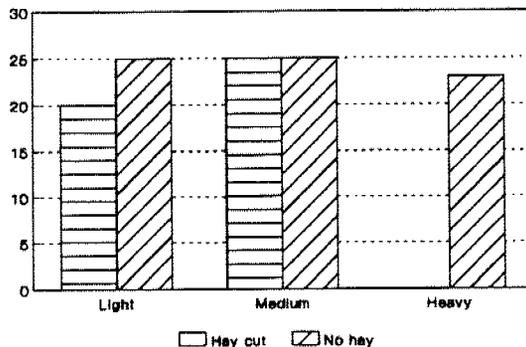
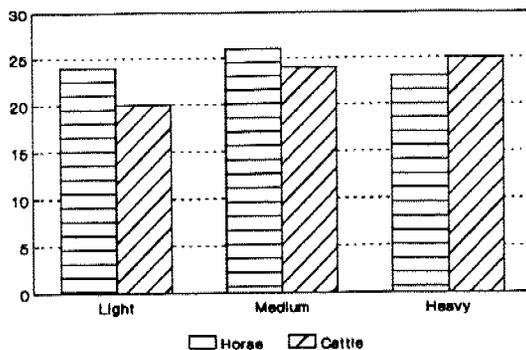
Figure 15: The effects of grazing species, intensity and hay cut on species associated with species poor (<14 m²) vegetation

Ref: E0505F15

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Species-poor associates



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

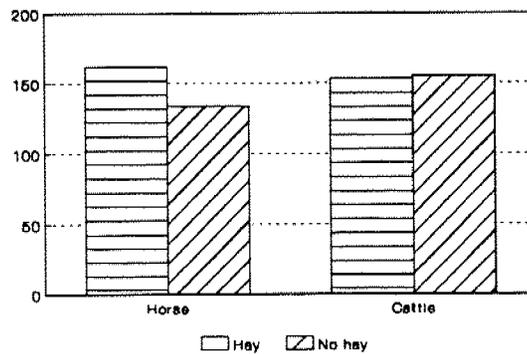
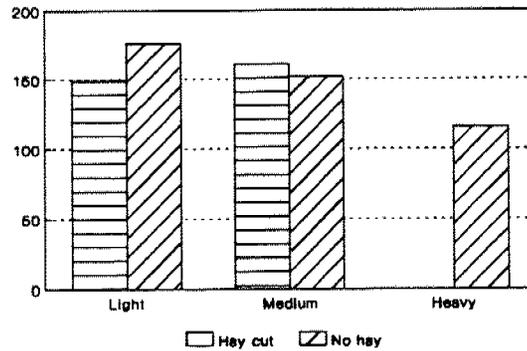
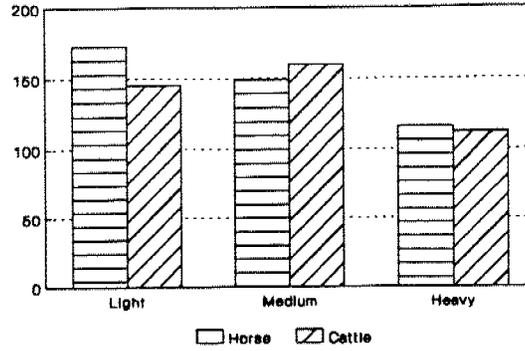
Figure 16: The effects of grazing species, intensity and hay cut on declining species

Ref: E0505F16

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Declining species



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

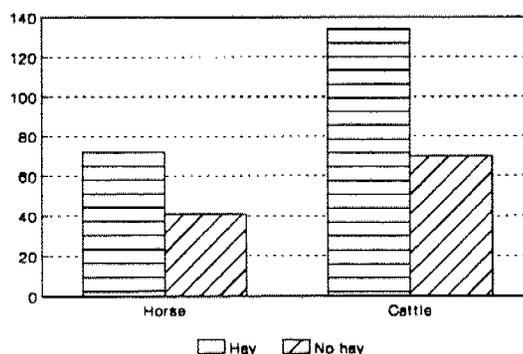
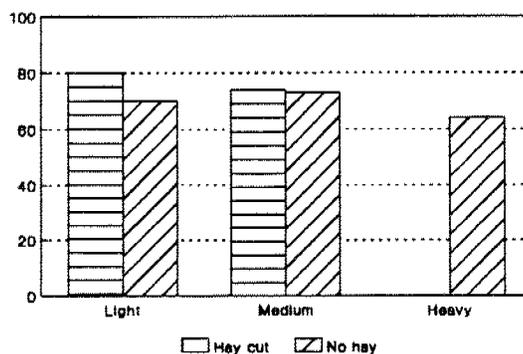
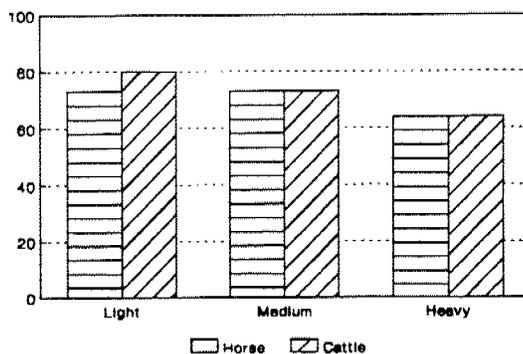
Figure 17: The effects of grazing species, intensity and hay cut on species with seedbank type 1

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Seedbank type 1



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

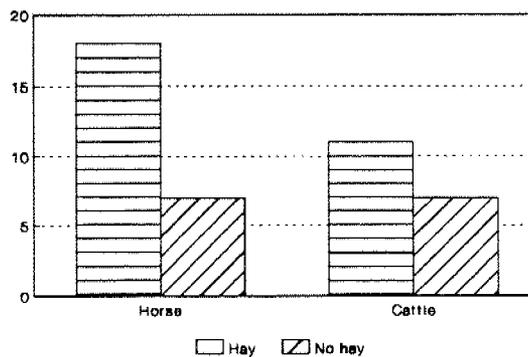
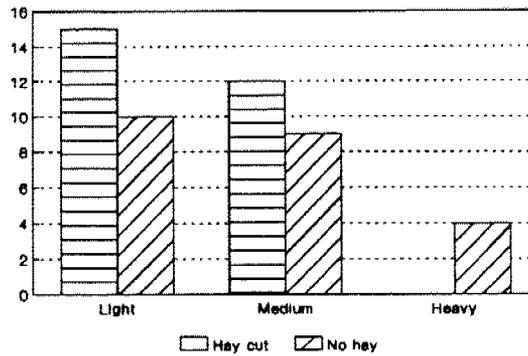
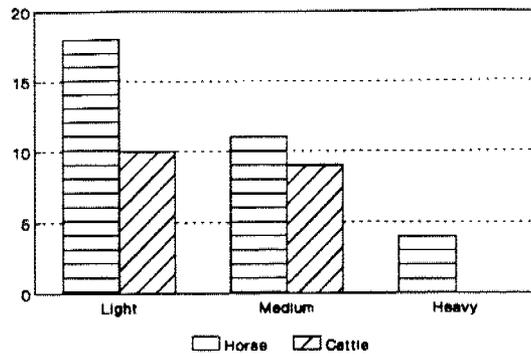
Figure 18: The effects of grazing species, intensity and hay cut on species with seedbank type 2

Ref: E0505F18

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Seedbank type 2



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

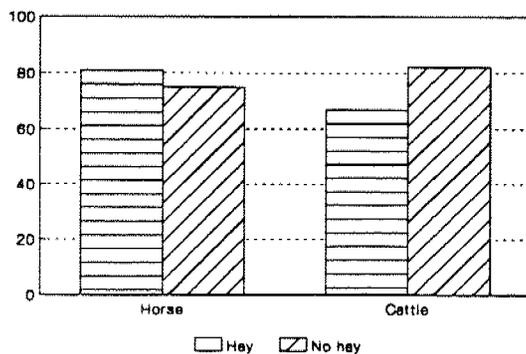
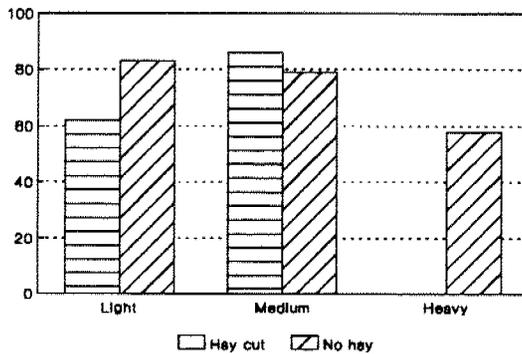
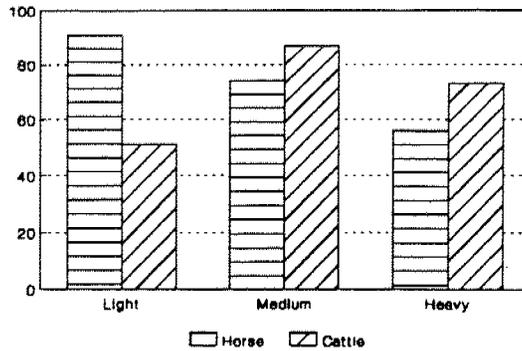
Figure 19: The effects of grazing species, intensity and hay cut on species with seedbank type 3

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Seedbank type 3



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The effects of horse grazing on species-rich grasslands

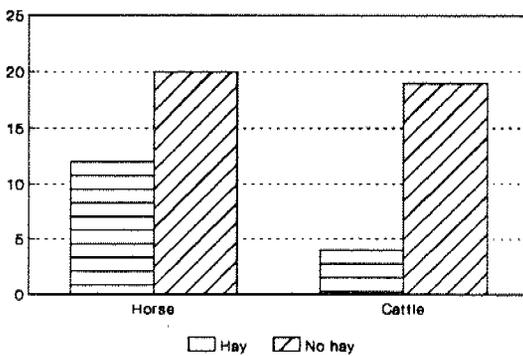
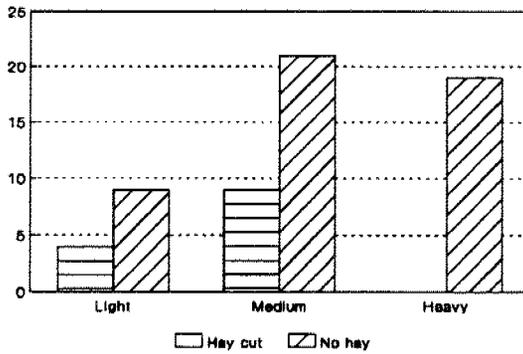
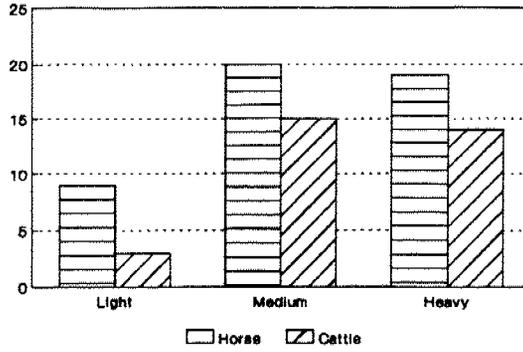
Figure 20: The effects of grazing species, intensity and hay cut on species with seedbank type 4

Ref: E0505F20

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Seedbank type 4



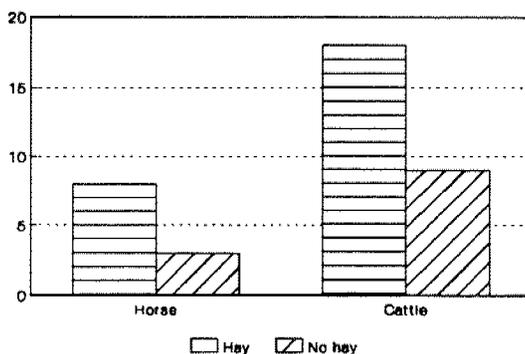
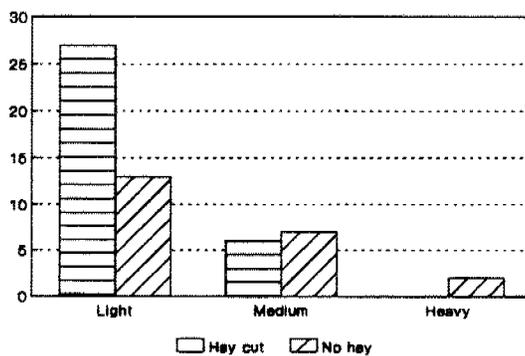
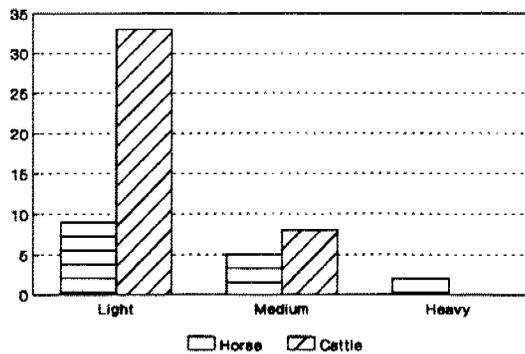
Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

Figure 21: The effects of grazing species, intensity and hay cut on Grime's "competitor" species.

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Competitors



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

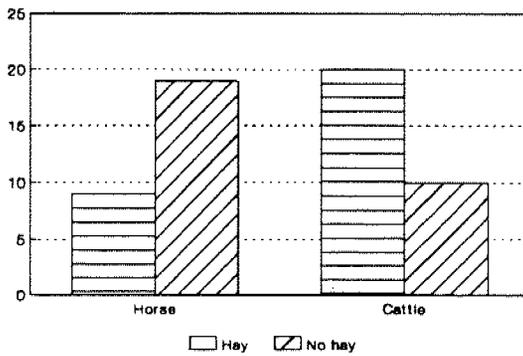
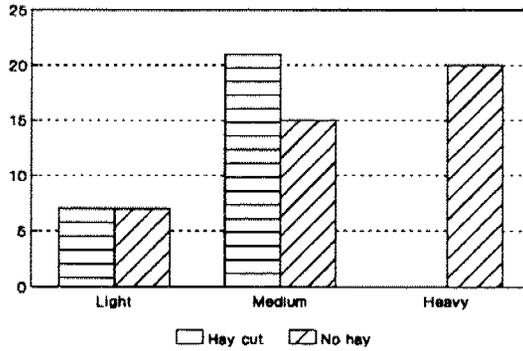
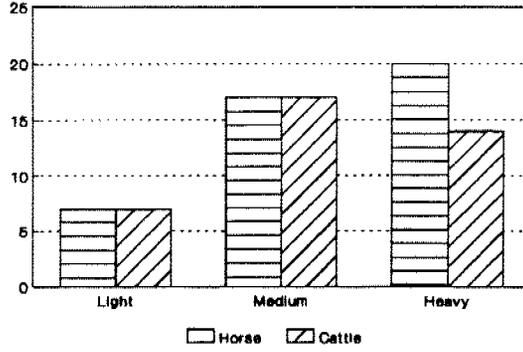
Figure 22: The effects of grazing species, intensity and hay cut on Grime's "ruderal" species.

Ref: E0505F22

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Ruderals



Y-axes are total numbers of cells occupied per square metre

The effects of horse grazing on species-rich grasslands

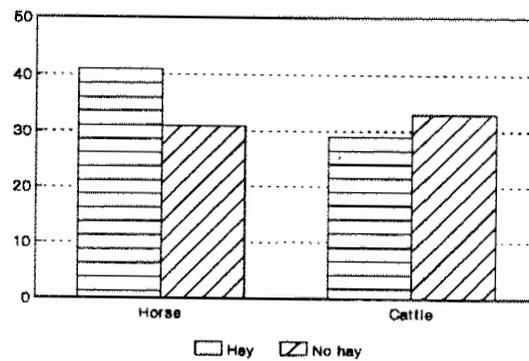
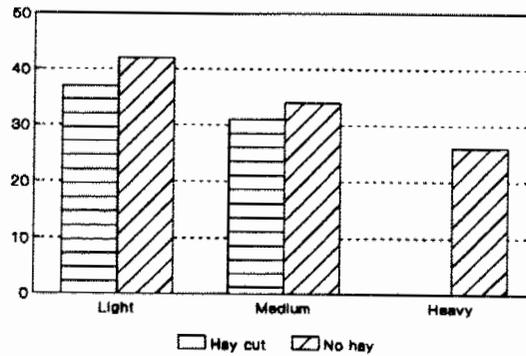
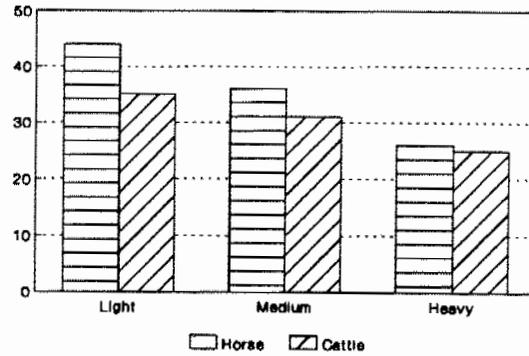
Figure 23: The effects of grazing species, intensity and hay cut on Grime's "stress-tolerator" species.

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Stress tolerators



Y-axes are total numbers of cells occupied per square metre