Institute of Terrestrial Ecology

Centre for Ecology & Hydrology

Natural Environment Research Council

Introduction to Graphics in MINITAB Release 11

by

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Contents

1 Introduction

The graphics facilities of MINITAB have multiplied rapidly in recent releases. Those of us used to the old line-printer quality graphics will still find them under "character" graphics, but it is the high resolution graphics now available that form the focus of this short course.

Whilst MINITAB may lack the full versatility expected of dedicated graphics packages, such as Coreldraw or Harvard, it can now produce graphics of sufficient quality for talks and publications. Linked with the data manipulation and analysis features elsewhere within MINITAB, this creates a very powerful and practical package to use, and the Windows environment reduces the need to memorise commands for graph production. Do not , however, expect that MINITAB will be adequate for all of your graphics needs (in much that same way that it will not be adequate for all of your analysis needs) but we anticipate that it will cover the large majority of what you require.

Some of the data sets used in this course are contained within the appendices. These are

Puffin	data on beak length and depth of puffins from St. Kilda
Muntjac	data from Arnie Cooke on shrub damage and muntjac activity
Essex Skipper	data from Cor Zonneveld on abundance over time
MLC pigs	data on success rate and litter size from an AI programme
Toads	data from Arnie Cooke on toad road casualties over several years

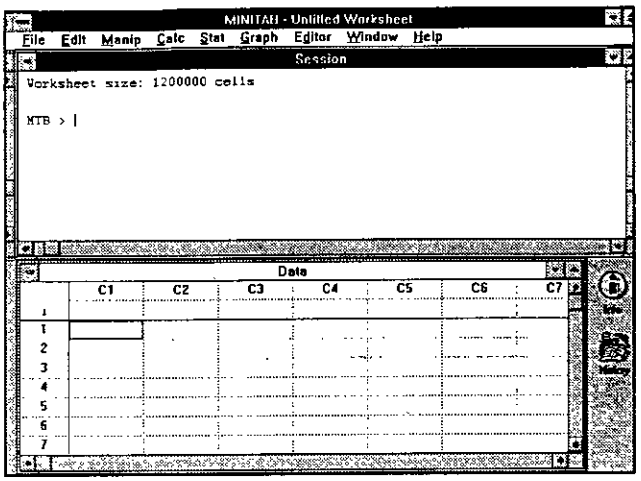
In addition, I have used some of Sarah Alexander's data from Hafren for some examples although these data are not included in the appendices.

There are slight differences between the Windows 3.X and Windows 95 versions of Minitab release 11. The original notes and examples for this course were based on release 10. Where changes between releases were only minor these have not been updated.

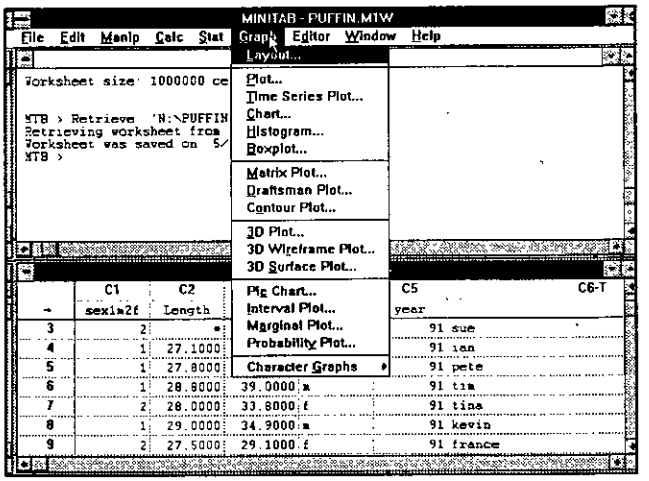
2 Minitab Graphics

2.1 The Menu System

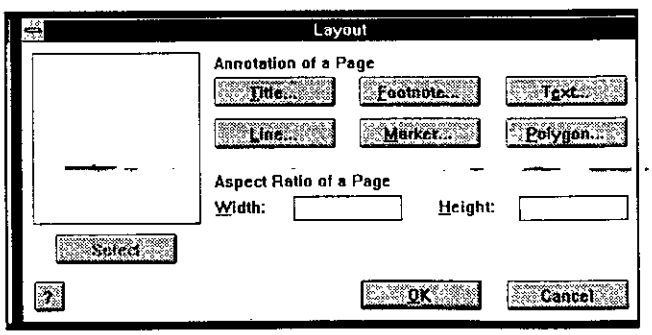
The following illustrates the opening screen from MINITAB Release 10. Access to the graphics facilities is via the sixth button along the top, i.e. click **Graph**



This menu offers a wide range of facilities for graphics (17 all told), which can be selected by further clicking.



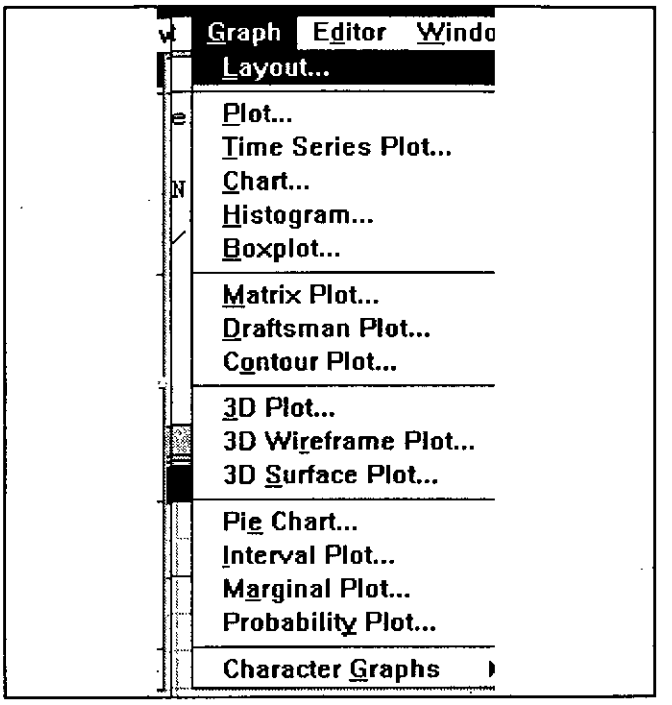
Clicking **Layout** displays a further menu. This is generally used to modify the whole graph window environment, for example, when producing multiple graphs per page, or changing the aspect ratio (shape) of a graphics page.



2.2 The Options

Under the graphics button are 18 options. These are:

```
Layout

Plot
Time Series Plot
Chart
Histogram
Boxplot

Matrix Plot
Draftsman Plot
Contour Plot

3D Plot
3D Wireframe Plot
3D Surface Plot

Pie Chart
Interval Plot
Marginal Plot
Probability Plot

Character Graphs
```



The majority of these, and some other graphics features are dealt with in the sections that follow.

2.3 Graph Elements And Their Options

There are some features that are common throughout the graph facilities of MINITAB. These will be dealt with here to avoid repetition under each graph type. These include

Lines. e.g. connecting lines, axes, tick marks, reference lines, legend boxes, borders etc. Options invariably exist to change colour (16 different colours are available; see below), line style (8 variants; see below) and line thickness (will normally have to be thicker to allow graphics to be converted for presentation use).

Available colours are:

0 white	**1** black	**2** red	**3** green
4 blue	**5** cyan	**6** magenta	**7** yellow
8 dark red	**9** dark green	**10** dark blue	**11** dark cyan
12 dark magenta	**13** dark yellow	**14** dark grey	**15** light grey

Available line types (styles):

0 null (invisible)	**1** solid	**2** dashes	**3** dots
4 dash 1-dot	**5** dash 2-dots	**6** dash 3-dots	**7** long dashes

Symbols. A range of symbols (30 in fact) are available, these can be modified in size, colour. They can be jittered (adjusted slightly by a random amount) so that overlapping points are visible.

Available symbols are detailed in the following box:

TYPE K

Changes the marker types, which you specify with an integer. The defaults for TYPE is 1 (circle). The marker types are as follows:

0 None	4 ✳	8 ⊕	12 ■	16 ◆	20 ▲	24 ▷	28 ▽
1 ○	5 · (dot)	9 ⊗	13 ⊡	17 ◇	21 △	25 ◁	29 ▼
2 +	6 ●	10 ⊙	14 ⊠	18 ⟡	22 ▷	26 ◀	30 ▽
3 ×	7 ⊙	11 □	15 ◇	19 △	23 ▶	27 ◁	

Shading (fill types). A range of 10 fill types/shadings are available, in a range of colours.

Fill types:

0 null (transparent)	**1** solid background	**2** right hatch foreground
3 left hatch foreground	**4** right & left hatch foreground	**5** horizontal hatch foreground
6 vertical hatch foreground	**7** horizontal & vertical hatch foreground	
8 grid foreground	**9** squares foreground	

On my printer, fill types are converted to grey scales on printing

Text. Axes labels, titles, legend details, tick mark labels, footnotes, free text etc. A range of fonts, colours, sizes are available. Text can be positioned at various angles.

Minimum and maximum values. Can be specified for most graph types, ditto intervals between tick marks etc.

Legend. Can be moved and modified etc.

Positioning. Graphs can be overlaid on top of one another, positioned as multiple graphs (frames) per page and edited.

Saving graphs. Graphs can be saved in three basic ways. These are

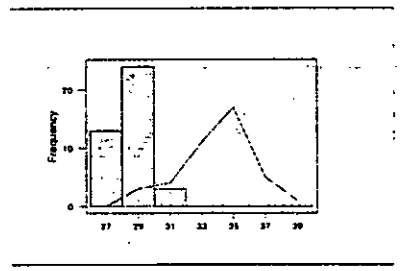
.....as Minitab Graphic files (.mgf files using **File - Save Window As)** which can be reopened into Minitab (using **File - Open Graph**) and edited, though it will not be possible to modify and rerun the graph by this method. It does not appear to be possible to edit release 10 .mgf files by release 11.

.....as encapsulated postscript files through **File - Print Window - Print to file.** A file name has to be supplied. Print setup may need to set for postscript through **File - Print setup - properties - postscript.** Files can then be imported into other packages.

.....copied and pasted into other applications (e.g. WordPerfect) via the clipboard (using **Edit - Copy Graph)**

Most of the graphics in these notes are captured by a separate package and inserted into WordPerfect. The one exception is the following graph which was saved as an encapsulated postscript file.

Compare it with that which appears under Multiple Graphs (section 20) for quality.

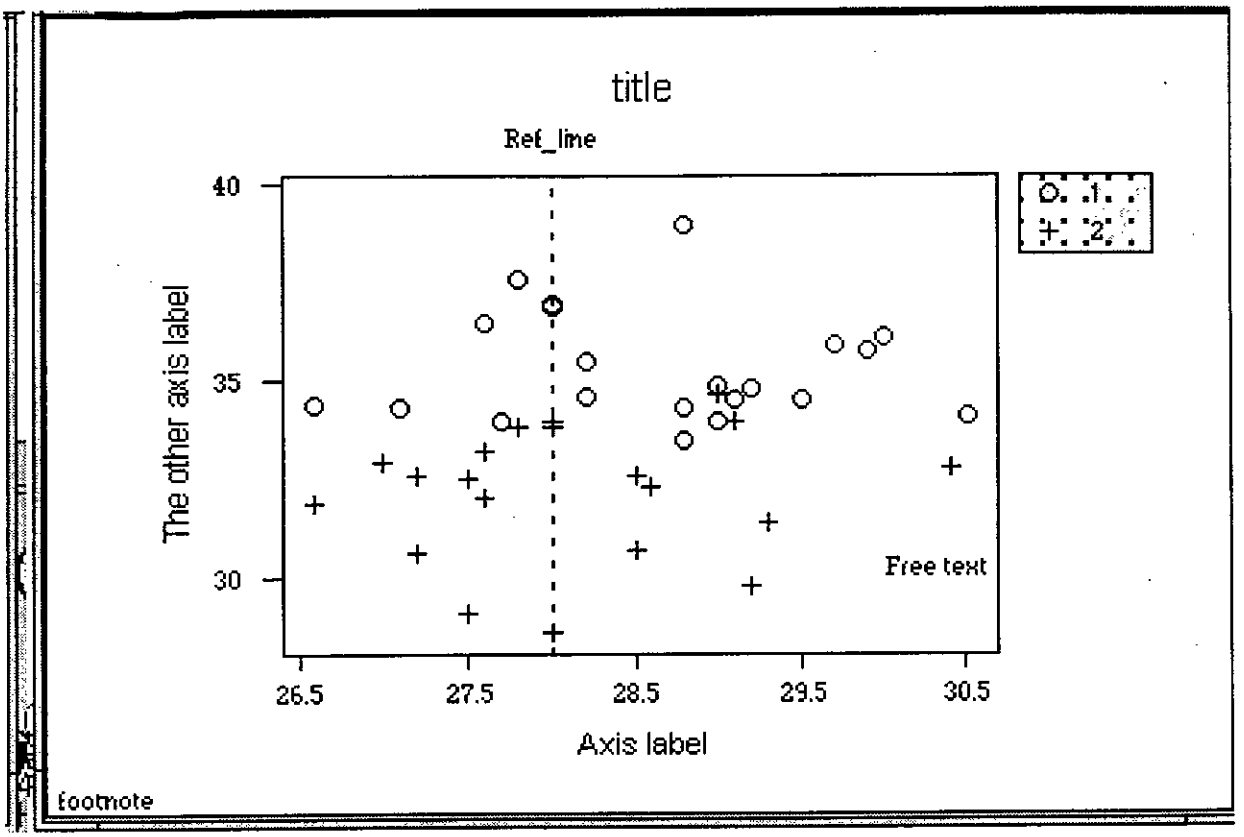


A sensible course of action is to save the Minitab commands that produced the graph as a text file. This can then be rerun at a later date.

Transposition Most of the graphs can be transposed so that the y- and x-axes are swapped.

2.4 Definitions

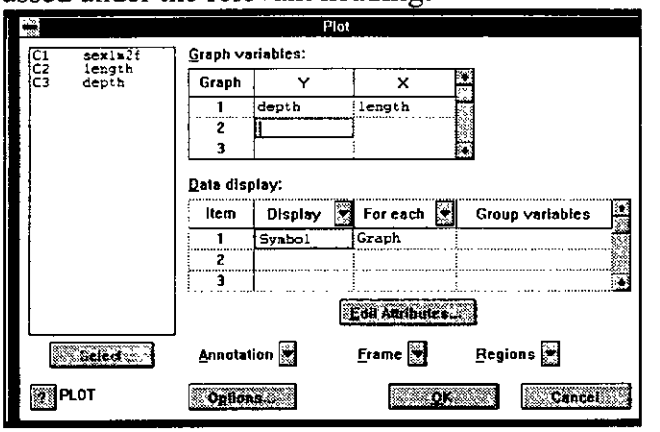
Some notation is needed to clarify matters. The following example shows a Figure region



sitting within a Page (in fact occupying the whole graphic page or window). The Data region is the area enclosed by axes (by default the central 60% of the Figure region). A title, footnote, axis labels, reference line and some free text have been added. The legend box has had its foreground, background and fill shading modified.

2.5 Common Features

There are a great deal of common elements to the menus for the various graphing facilities of Minitab. These are dealt with in outline below. Where there are substantial differences between different graph types, the differences are discussed under the relevant heading.



Graph variables

This details what is to be graphed; specifying which variables appear on which axes, and in some cases which are the categorical variables.

Data Display

This details in what form the data will be graphed. For instance, many of the graph types can be presented as symbols, connecting lines, solid areas below connecting lines, vertical lines from a reference line (e.g. the x-axis, or zero), bars, or LOWESS smoothed data. Data can be presented *in toto* or using an additional variable as a 'grouping' variable e.g. different symbols for different types.

Edit Attributes

This area allows you to change the appearance of the options chosen under Data Display. Symbols, lines, fill areas, line thickness, symbol size, colours etc.

Annotation

Title Allows creation of a title for an individual graph, size, colour, font etc.
Footnote Creation of footnote with options as above.
Text Text of various fonts, sizes and colour can be placed anywhere within the data area.
Data labels Labels individual data items within the graph.
Line Placing of line upon the graph
Marker Ditto marker
Polygon Ditto closed polygon

Frame

Axis Adding axis labels. Changing font size, colour, appearance and size of these. Changing type, thickness and colour of axis lines.
Tick Changing position, size, type, colour etc. of tick marks
Grid Sets a series of vertical or horizontal lines or a grid behind the graph
Reference Adds reference lines where appropriate
Min and Max Sets minimum and maximum values for x and/or y axes
Multiple graphs controls printing of multiple graphs

Regions

Figure Changes location of figure within page. Modify or remove figure frame.
Data Ditto but appearance of data region within figure region
Legend Size, appearance and location of legend window.

Options

Varies from graph facility to graph facility. This will be detailed under the separate graph options. These range from simple jitter to complex manipulation of the presented figure.

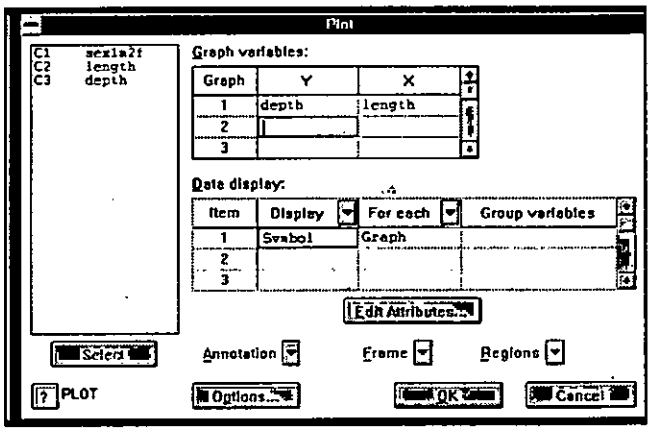
3 Plot

Choose **Graph - Plot**

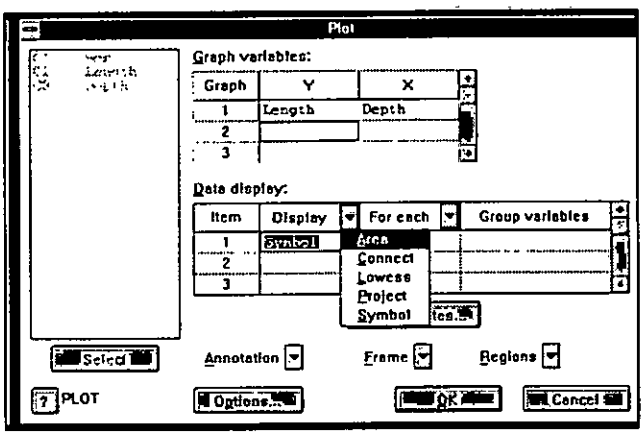
The plot command is the first in the graph menu. It has five basic variants; standard symbol plots (scatterplots), connecting points by lines, ditto but shading/filling the area below the line, connecting points to some known baseline (e.g. the x-axis) and LOWESS (locally weighted scatterplot smoothing) plots. Combination of the variants (e.g. lines plus symbols) are all available.

Examples of the default settings for these five types follow below.

The basic plot dialog box is like this

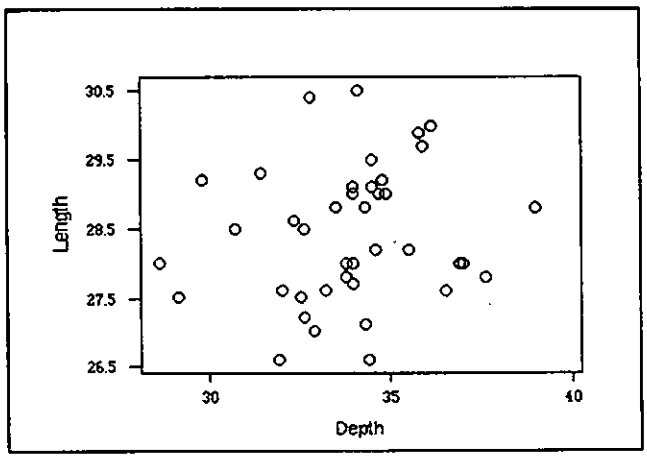


Under **Options** it is possible to jitter the data points and transpose the axes.

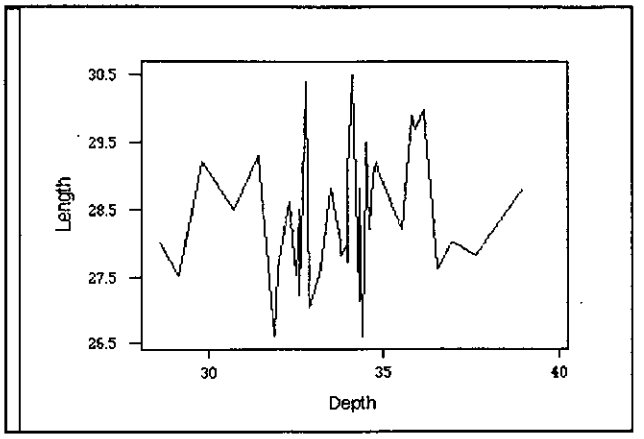


..Using the puffin data set we can click and select or double click on the variable list to specify y and x variables for the plot. Under display there are five optional presentations, each of which is displayed separately below.

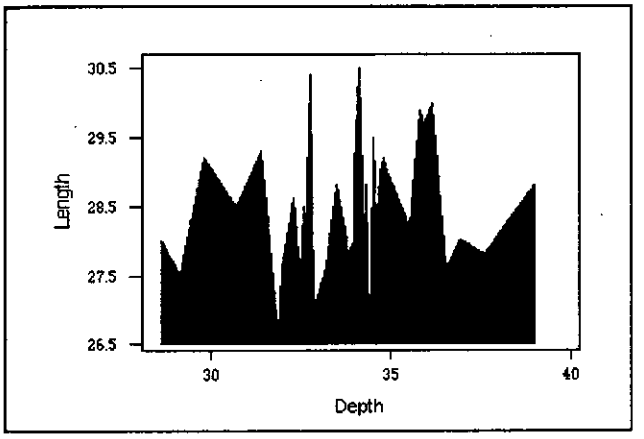
This is the default **Symbol** plot; black open circles and axes titles taken from column names. Minimum and maximum values are set automatically. If points overlap we can jitter them (in **Options**) by a random amount so that they are all visible .



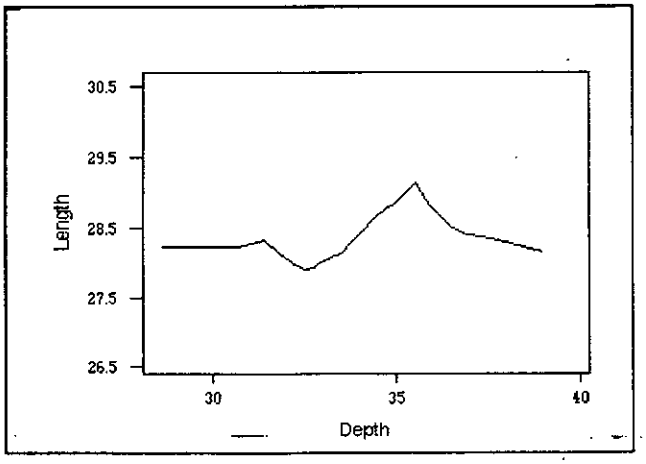
This is the default **Connect** option on the same set of data [although these data are not appropriate for such a presentation, this example is intended for illustration only].



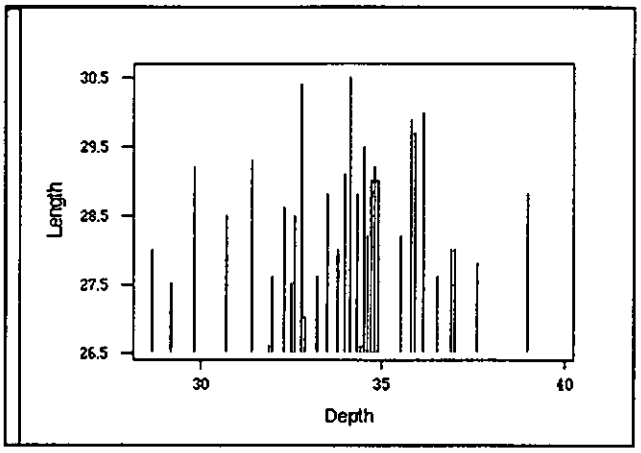
The default **Area** plot fills the area below the line.



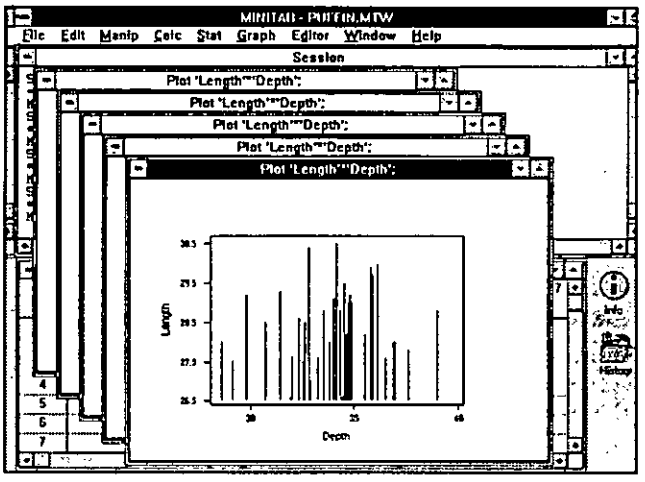
...and the default **Lowess** (locally weighted scatterplot smoothing) plot. This is effectively created by passing a moving window across the graph and calculating a smoothed value at the centre of the window as it passes. Options exist to change the extent of smoothing and the amount of data points in each window frame. This type of smoothing can be particularly useful in exploring patterns in data.



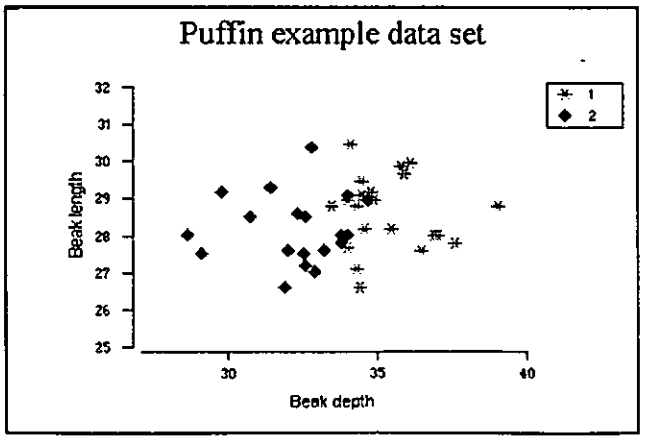
The **Project** plot connects points with the x-axis by default....



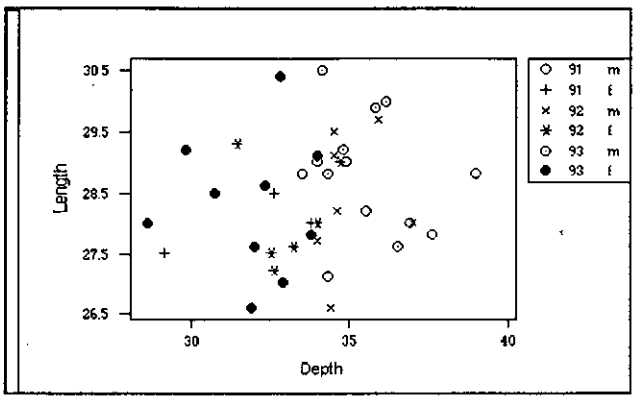
Having produced all these examples we get a busy window, with a new graph window produced for each. These cascade to a limit of 15 graphs at which point the user must close some or all of the graphs



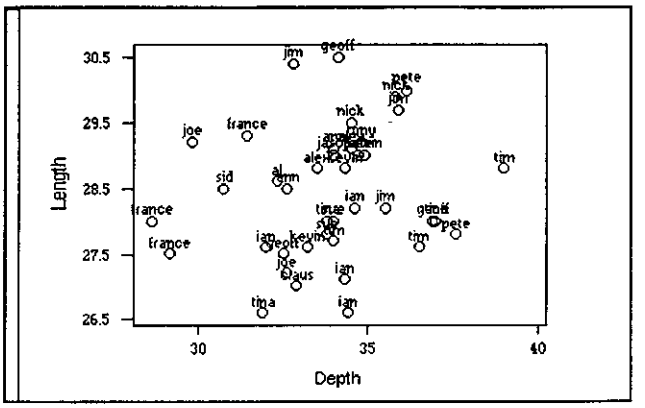
Data display is used to produce separate symbols per group. Grouping variables can be either numeric or alphabetic. In **Edit Attributes** these have been set to red asterisks size 1.5 for male and blue diamond size 1.5 for female. A legend is added by default when groups are used. This can be omitted or moved. Under **Annotation - Title** a title in Times New Roman of size 2 added. Under **Frame - axis**, axis titles have been added. Under **Frame - min and max** minima and maximas have been specified. The second x- and y- axes have been removed using **Regions - data - region edge type** set to none.



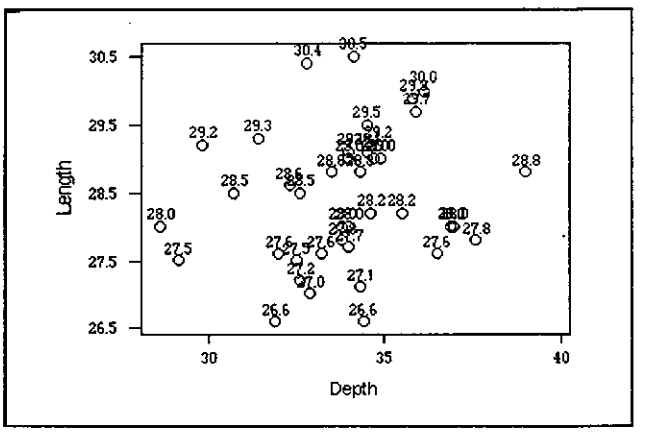
Differentiating by a single group variable can be extended to differentiating by more than one categorical variable. In this example groups are based on both sex and year. The default symbol for the fifth group is a dot (.). This is particular difficult to see at default size, particularly after photocopying when it can get confused with other specks. We recommend you use an alternative symbol.



Individual data points can be labelled with the values in an alphabetic or numerical column using the **Annotation - data labels** option.



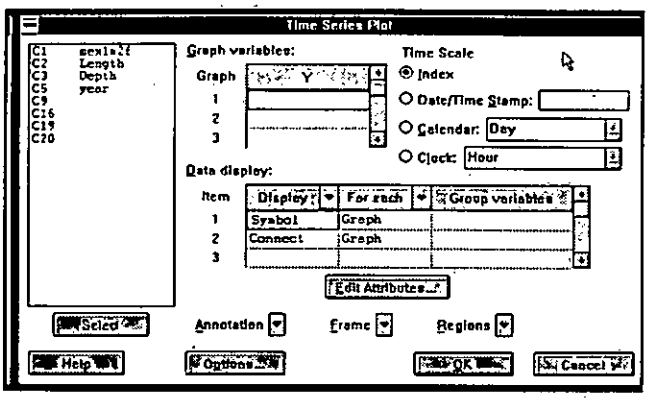
And can be labelled by the y-values themselves.



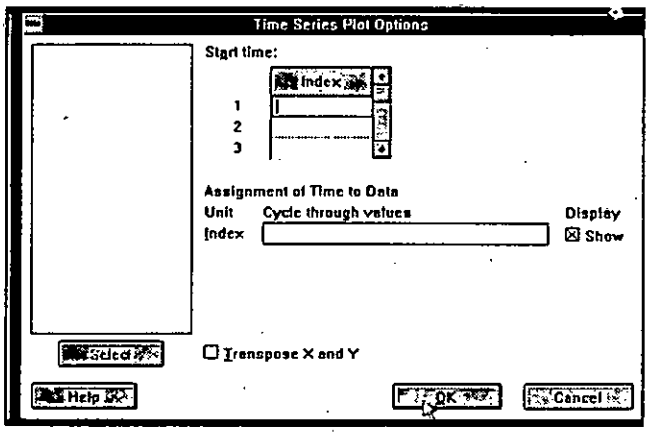
4 Time Series Plots

Choose **Graph - Time Series Plot**

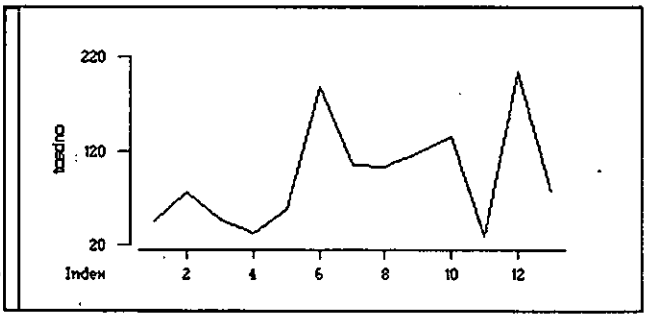
Here is the opening dialog box for a time series plot.



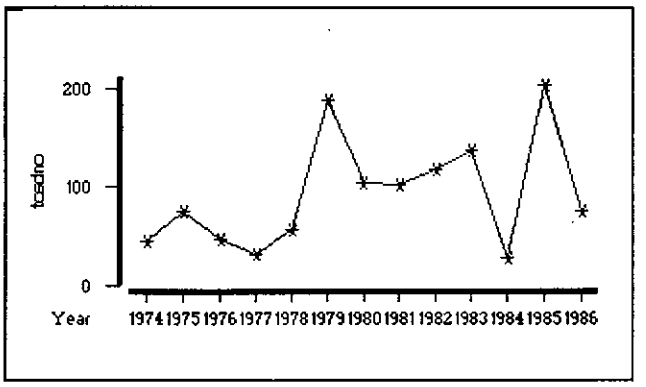
Under **Options** it is possible to specify start index values and transpose the axes.



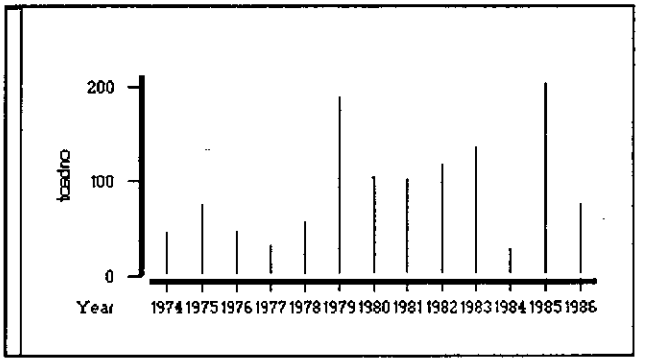
Time series are often better displayed as long plots, shown here the number of dead toads (road casualties) recorded in successive years.



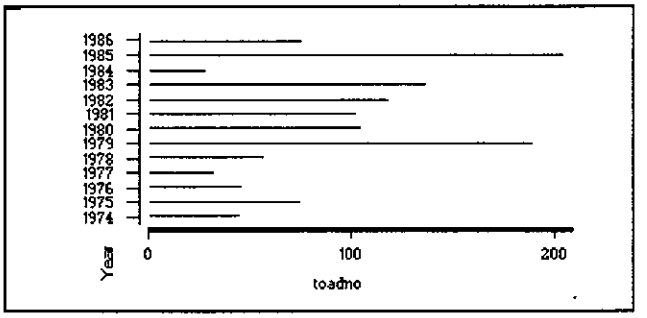
This graph has set the ymin value, trebled the line thicknesses of the axes, specified year as the unit of time with a start of 1974, and including a symbol. Time series plots can be indexed by time units ranging from a second up to a year.



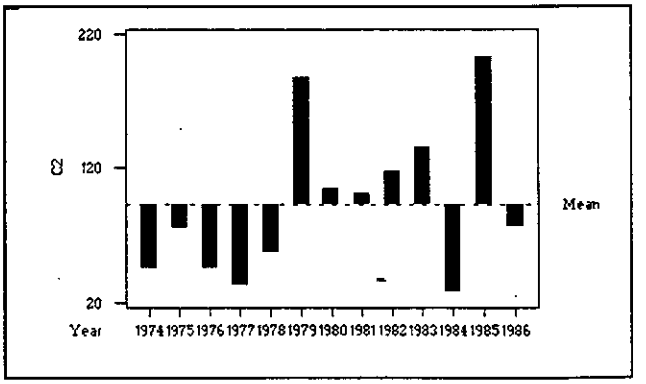
This graph is identical except that the time series is presented as a projection from the x-axis.



And as with all plots, the axes can be reversed (transposed).



This example shows the toad data time series. Individual years are displayed as connecting (thickened) lines from a base value (93.3). A reference line has been added. This feature of a baseline is available in many of the graph types.

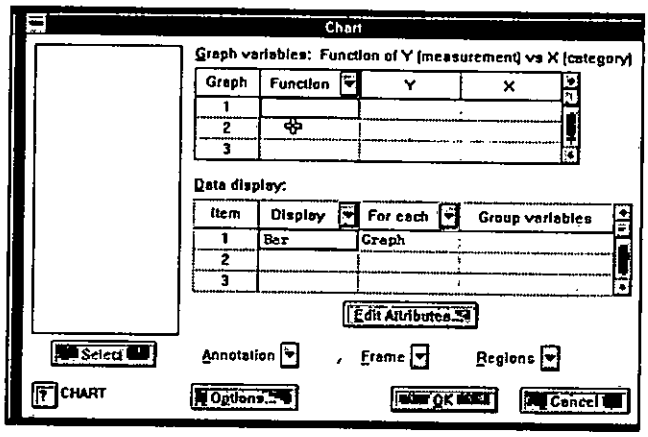


5 Chart

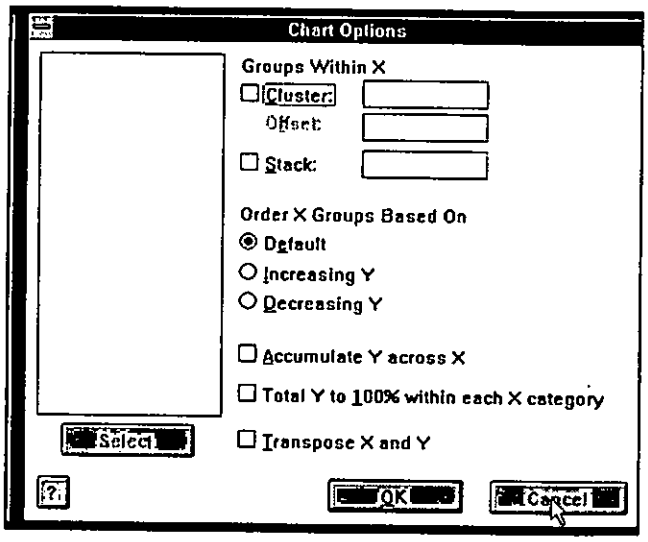
Choose **Graph - Chart**

Can represent histograms (frequency data) or some summary representation for each grouping variable. There are 10 possible summary measures. These are Count (number of values), N (number of non-missing values), Nmissing (number of missing values), Sum, Mean, Stdev (standard deviation), Median, Minimum, Maximum, SSQ (sums of squares).

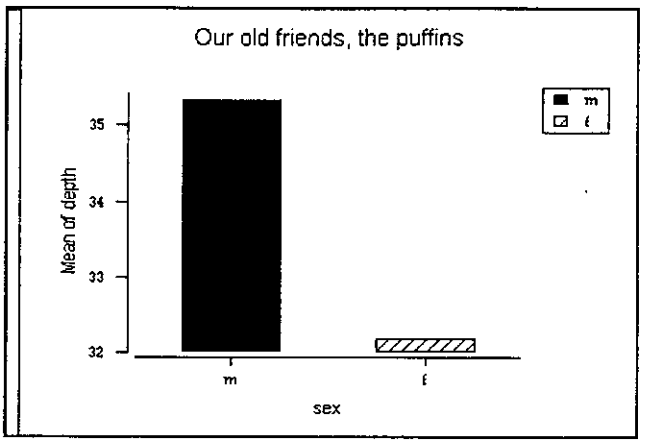
The opening dialog box



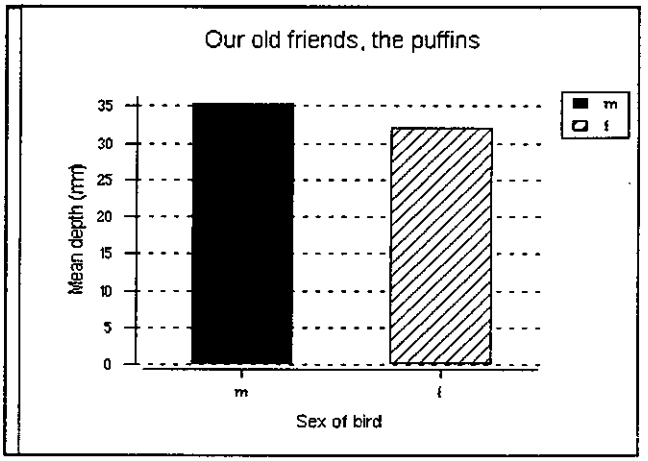
the **Options** dialog box



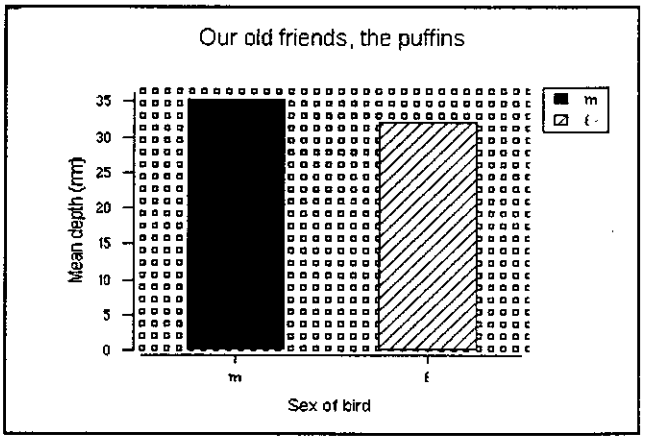
This example tabulates the mean depth separately from the two sexes.



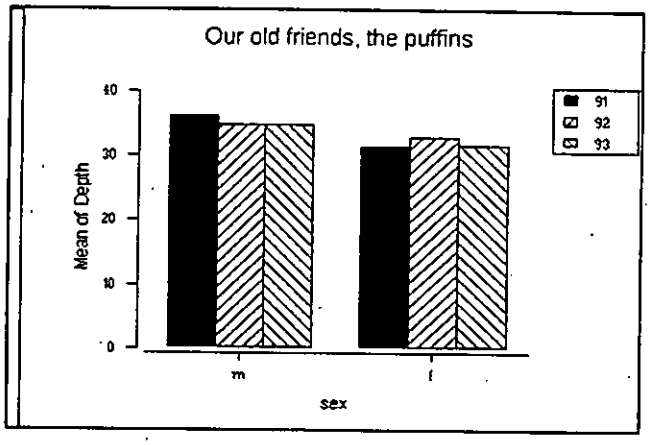
This chart is basically the same, although a grid, title, axis labels have been added and the minimum y-value set to zero.



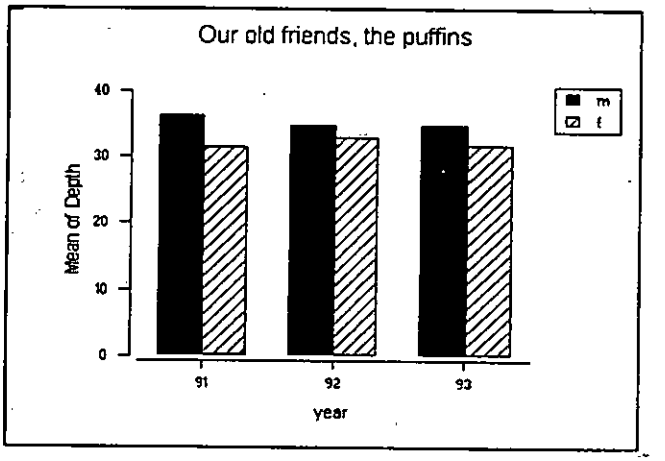
Rather over the top, this fills the area of the data region. In a similar way the figure region and legend region can also be filled or coloured.



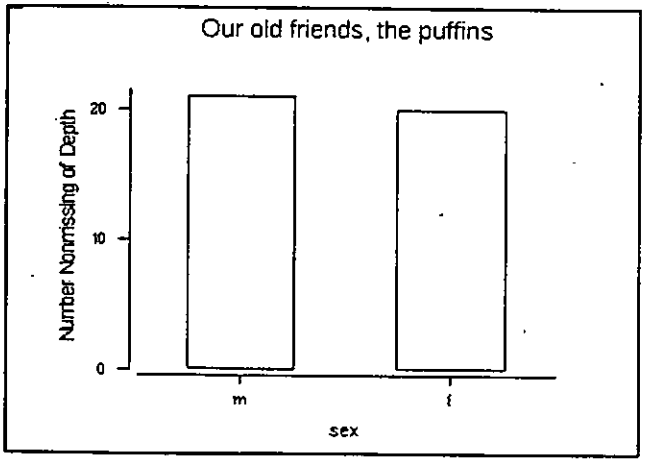
Under **Options**, charts can be clustered, for example here by year of record. Frequencies can be adjusted so that stacks or clusters each sum to 100%.



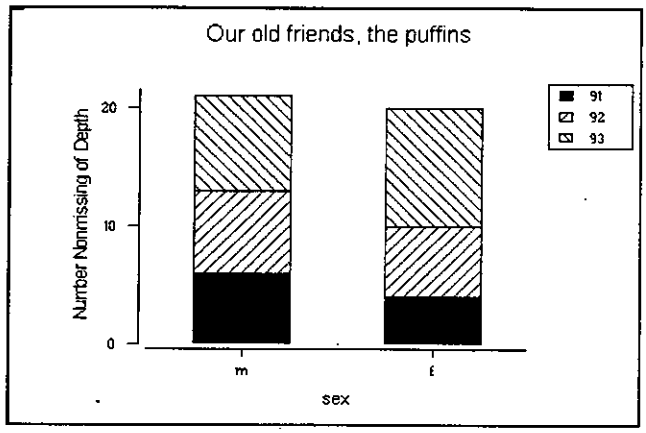
And this is basically the same but grouped by year and clustered by sex.



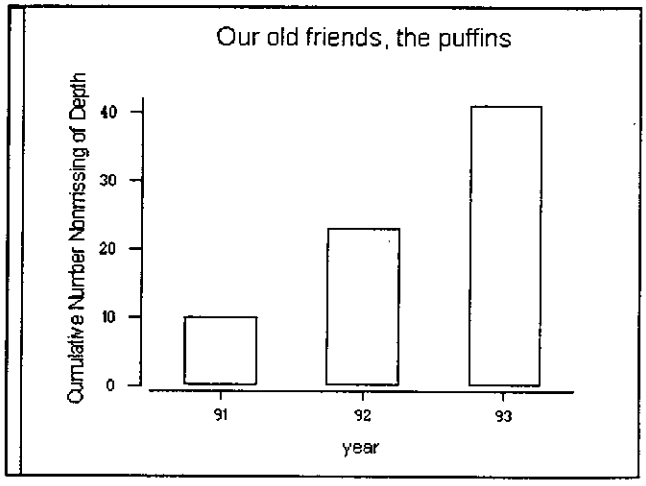
As mentioned earlier, other variables can be summarised in addition to just mean values. This chart shows the default settings when presenting the number of non-missing values for the two sex-classes.



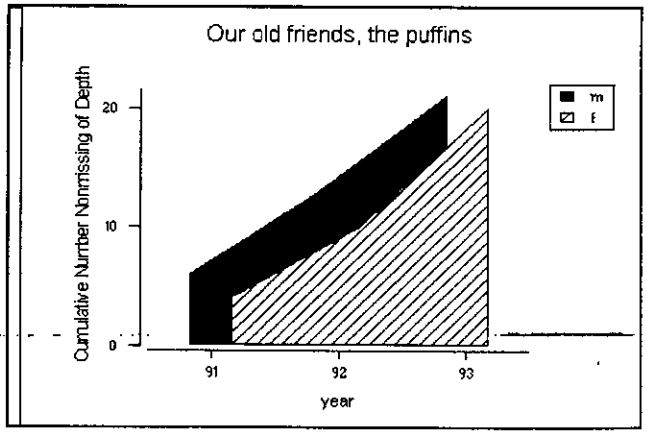
Also under **Options** is the ability to stack bars, for example grouping by sex and stacking by year the number of non-missing values.



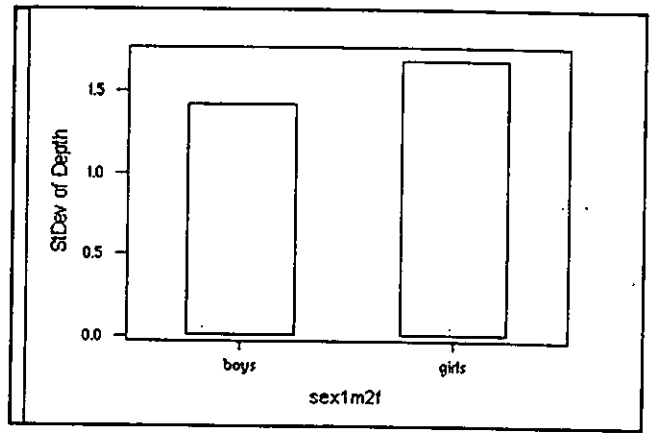
And data can be presented in cumulative form.



Or even in cumulative form per sex, and presented as a filled area.



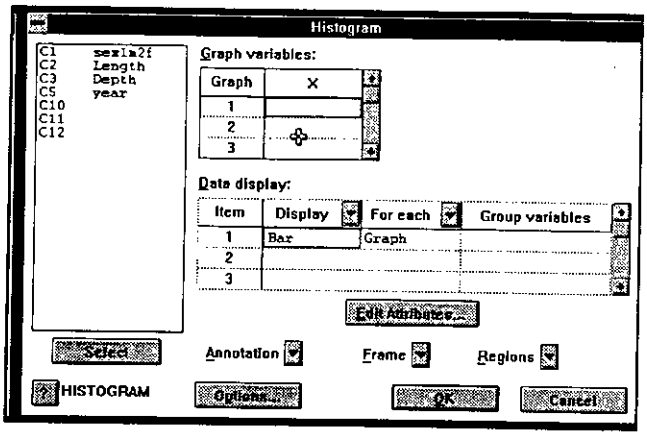
We don't have to use an alphabetic column to label our graphs; we can specify under **Frame - Tick** what we want our tick labels to be (as shown here).



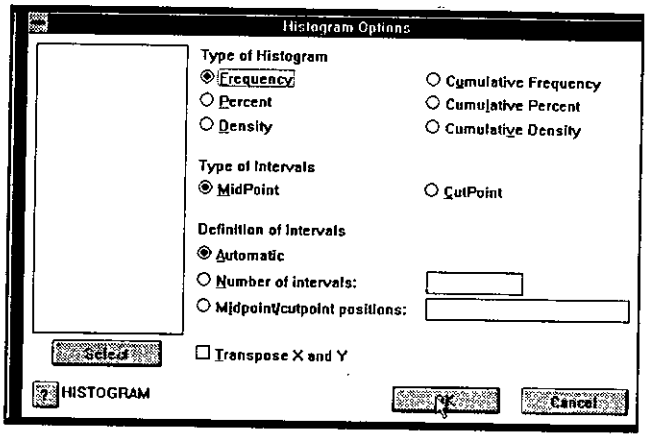
6 Histogram

Choose **Graph - Histogram**

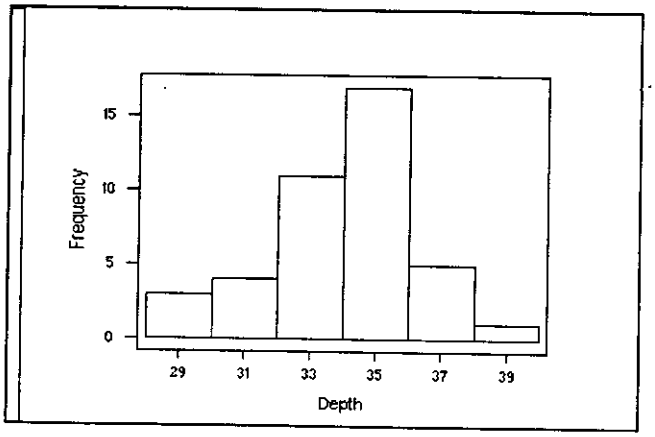
The opening dialog box



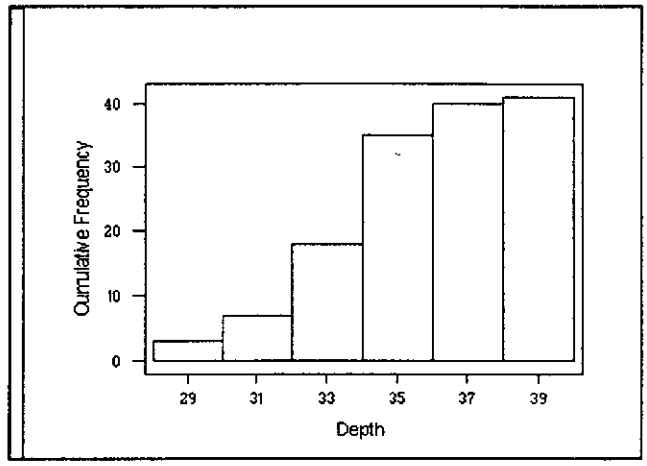
and the **Options** box



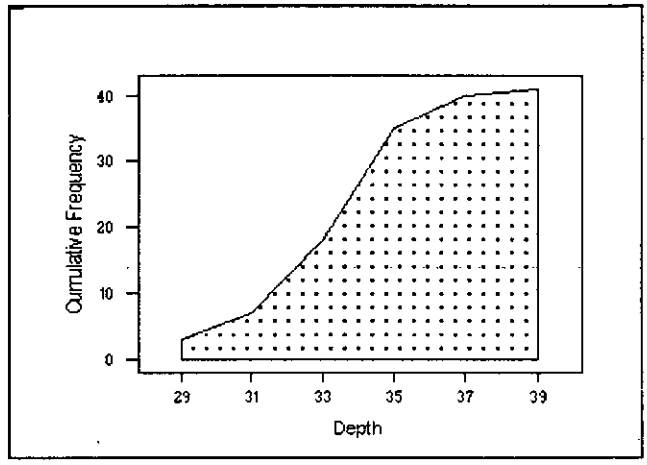
Presents basic histograms of recorded variables, here for puffin beak depth



Bars can be changed in width. Histograms can be presented as densities, i.e. summing to 1, or as cumulative total (as here).



Data can also be presented as cumulative frequency represented by a filled area rather than by bars.

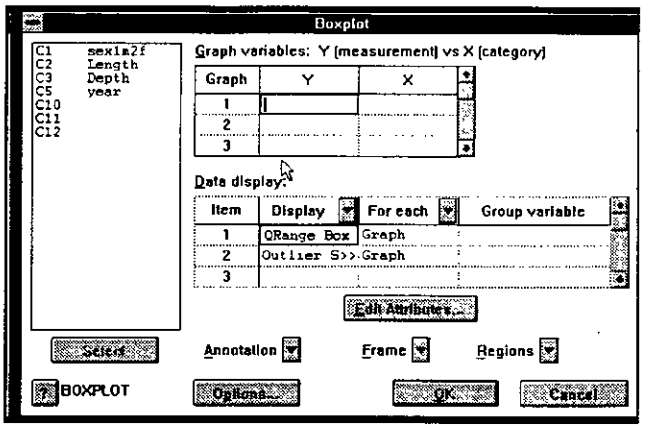


7 Boxplot

Choose **Graph - Boxplot**

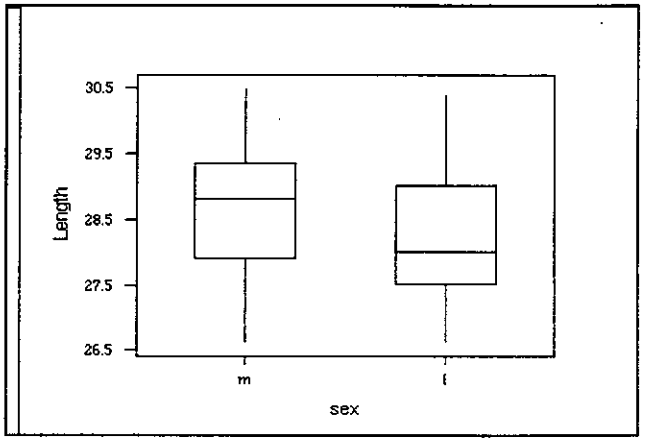
As well as representing the usual box-and-whisker plot based on interquartile range with symbols for outliers, this function can also represent confidence intervals, absolute range and display actual data values.

The opening dialog box

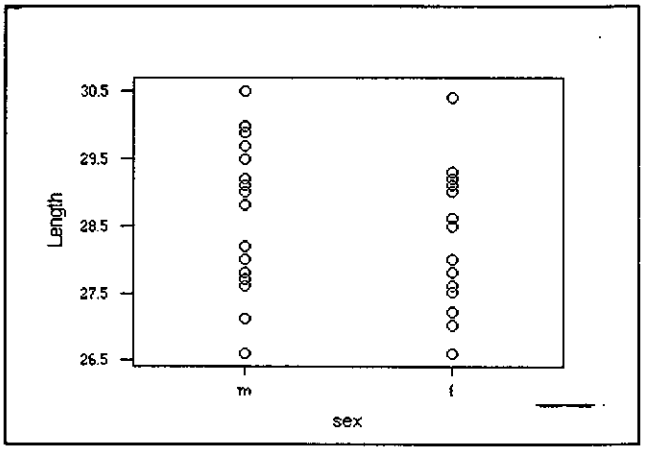


The **Options** box allows the axes to be transposed

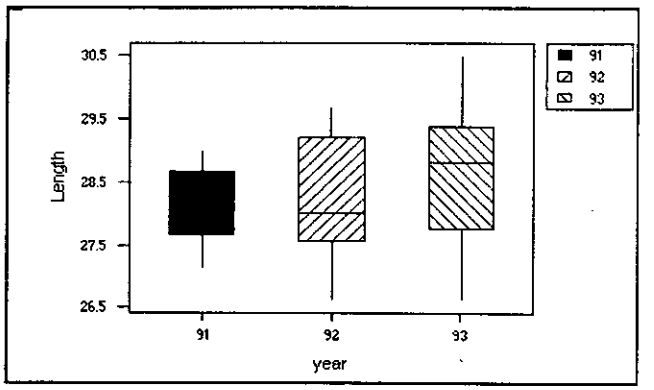
Puffin data for length, summarised by sex



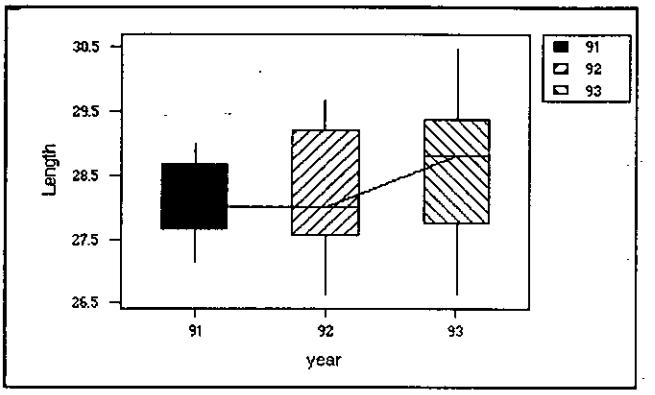
Presented as individual values



Length data grouped by year



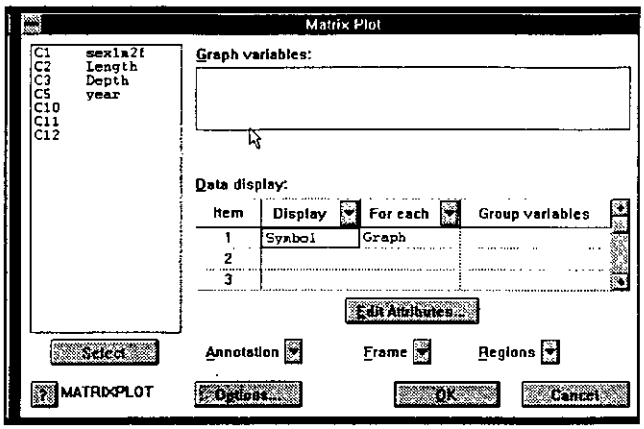
and as before but with medians connected



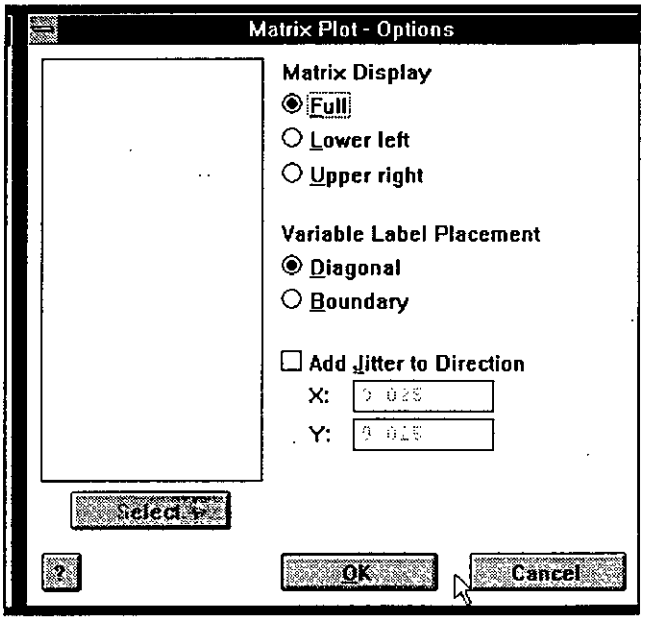
8 Matrix Plot

Choose **Graph - Matrix Plot**

The dialog box

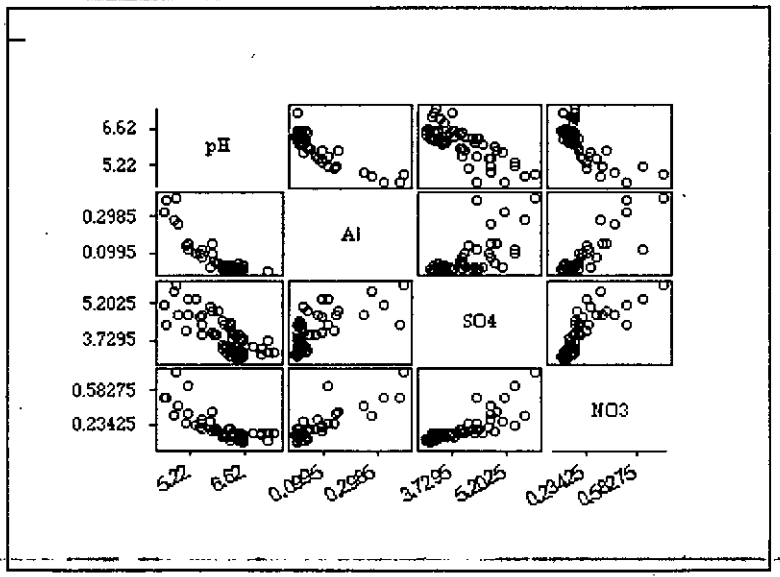


The **Options** box

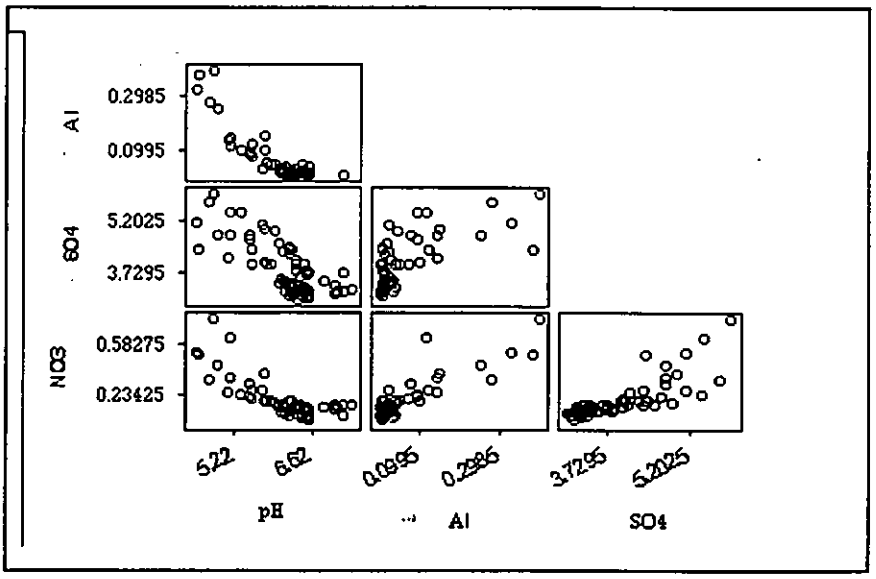


Presents a scatterplot of variables against one another, here using some of Sarah's data from Hafren.

Up to 20 variables may be used (Although these will probably be impossible to see because of their small size).

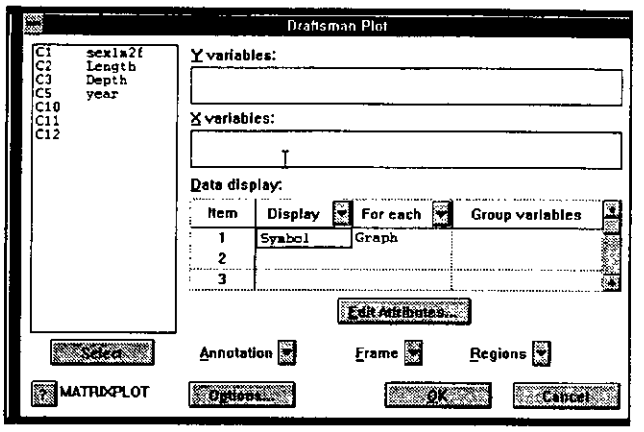


This can be modified to just produce the upper triangular plot, or lower (as here) with labels moved to the boundary.



9 Draftsman Plot

Choose **Graph - Draftsman Plot**



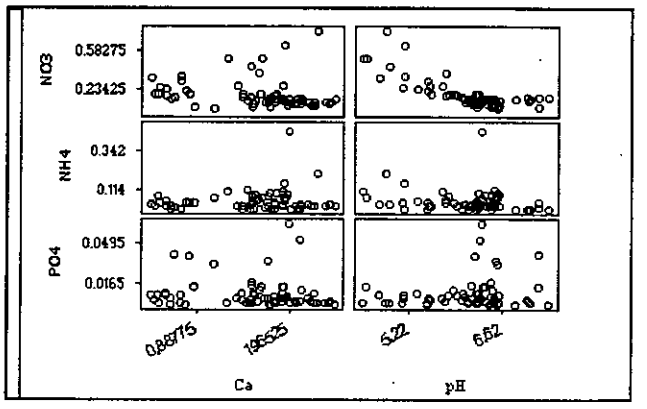
Produces an array of plots

The opening dialog box.

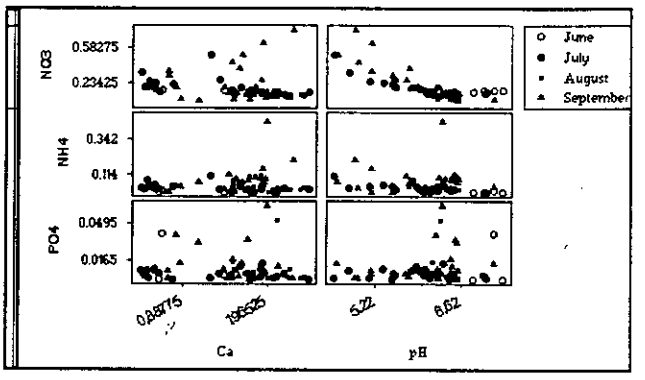
The **Options** box allows jittering.

With this option we can produce summaries in tabular format to our own specification. This example again uses some of Sarah's data from Hafren.

Up to 20 variables can be plotted in each direction.



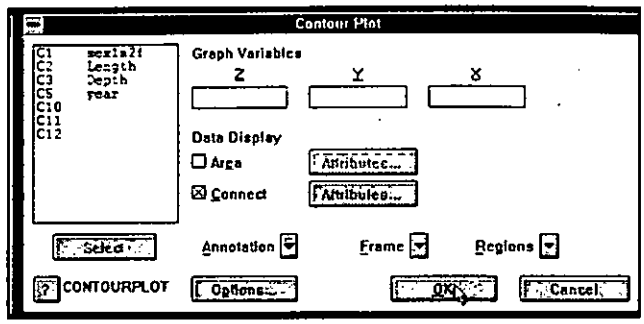
In both matrix and draftsmans plots, groups can be represented by different symbols; in this case a different symbol for each month of collection.



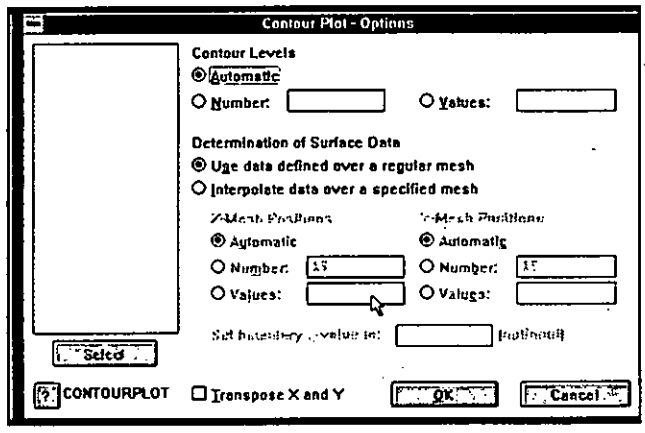
10 Contour Plot

Choose **Graph - Contour Plot**

The opening dialog box

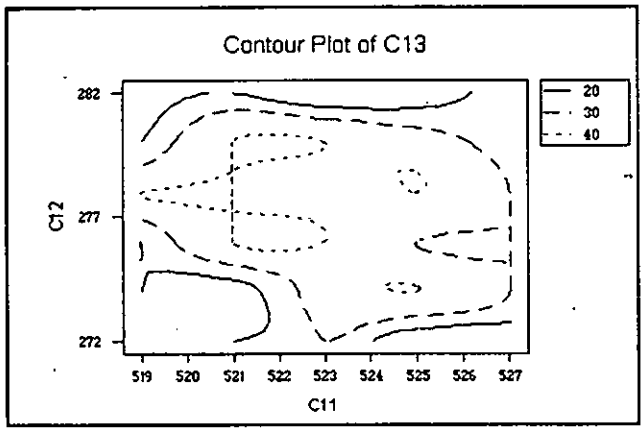


The **Options** dialog box

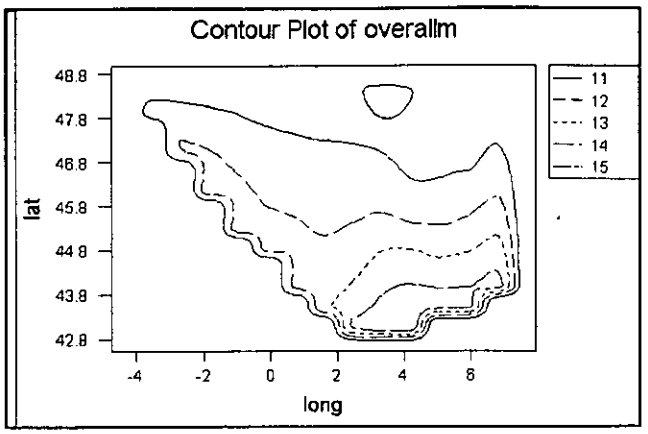


For given x, y and z coordinates this option will produce a contour plot.

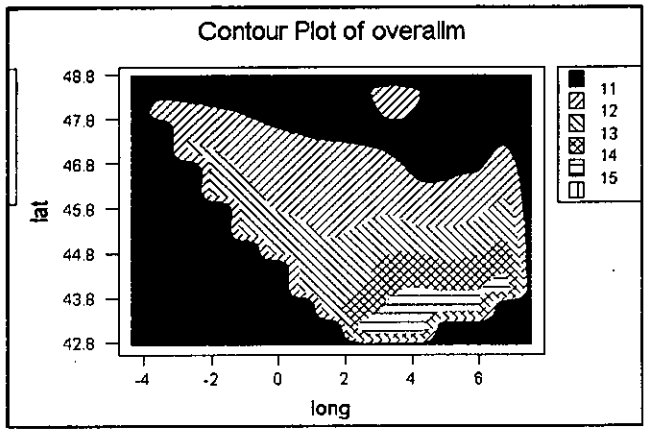
This rather crude picture derives from hastily abstracted tetrad altitudes in Huntingdonshire. Monks Wood is located to the high ground towards the top of the graph, with the fens and the Ouse valley shown in the top right and lower right areas respectively!



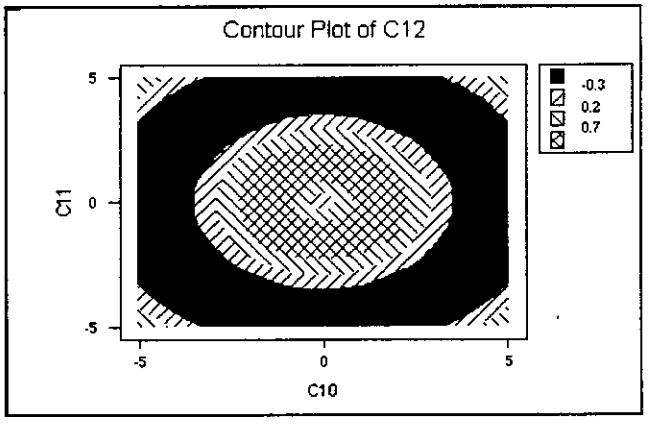
A better example is this contour map of annual mean French temperatures; Mediterranean bottom right.



or as contour shaded areas.



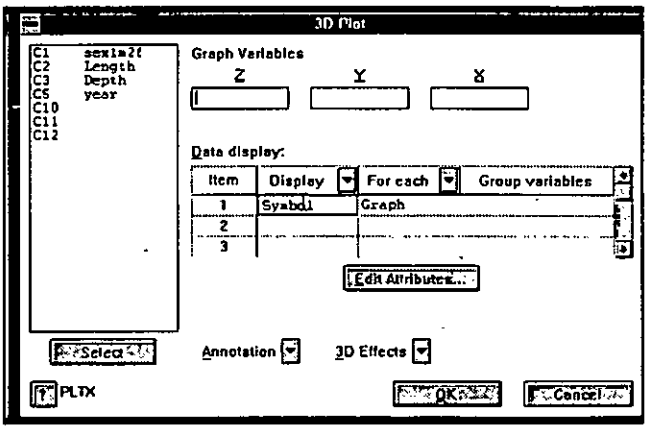
A better example is provided by a contour of the 'cowboy hat' function. We can specify the number of contour lines, the value of actual contours and the resolution of these. Data may be either from a regular or irregular mesh.



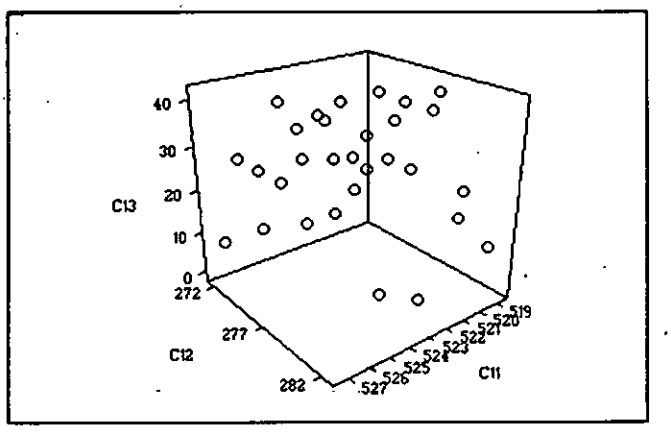
11 3D Plot

Choose **Graph - 3D Plot**

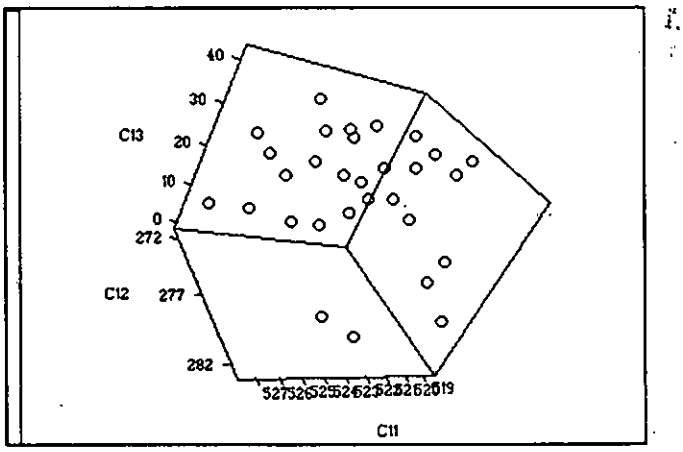
We have little experience with these as yet, and are unconvinced about their ease with which they convey information. This is the opening dialog box.



This graph shows the Huntingdon altitudes referred to above.



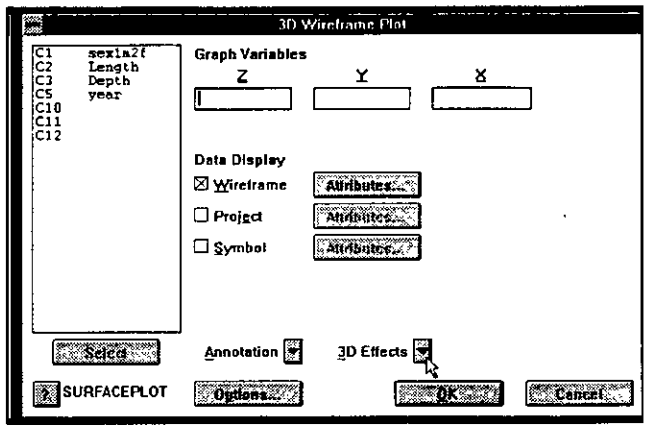
This can be rotated and presented from many different angles.



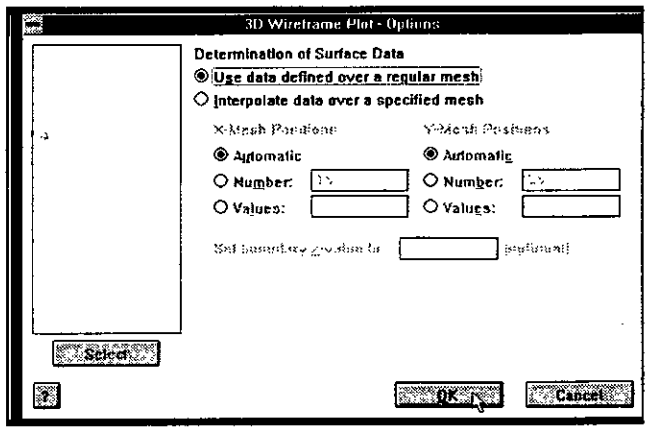
12 3D Wireframe Plot

Choose **Graph - 3D Wireframe Plot**

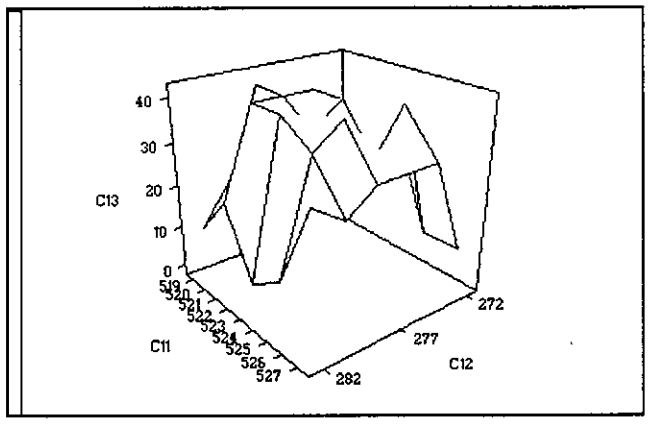
The opening dialog box



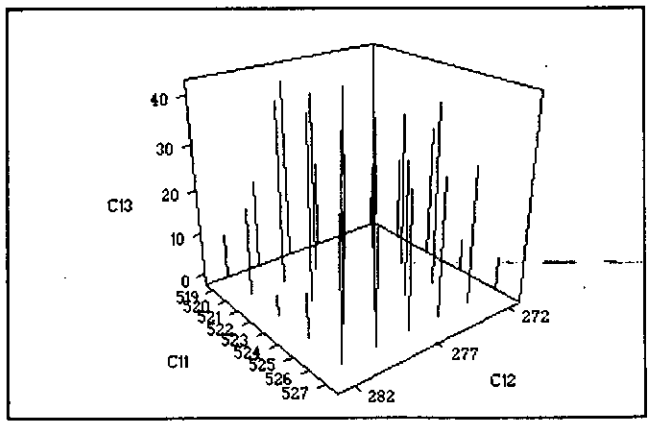
The **Options** box



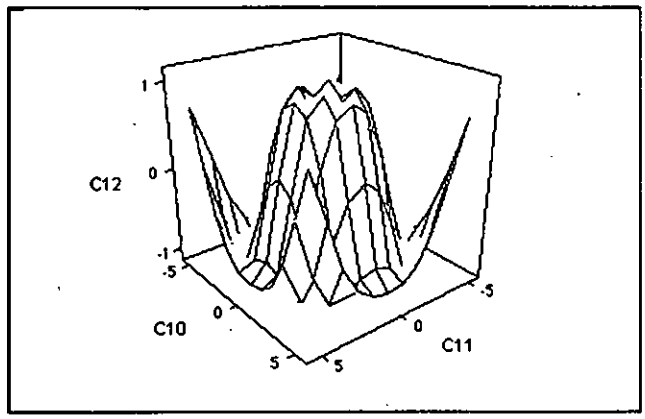
A wireframe plot produced on the Huntingdon data. Again our experience with this type of graph is limited.



Data can be presented as wireframes, projections (as here), symbols (as for 3D plots) or any combination of these.



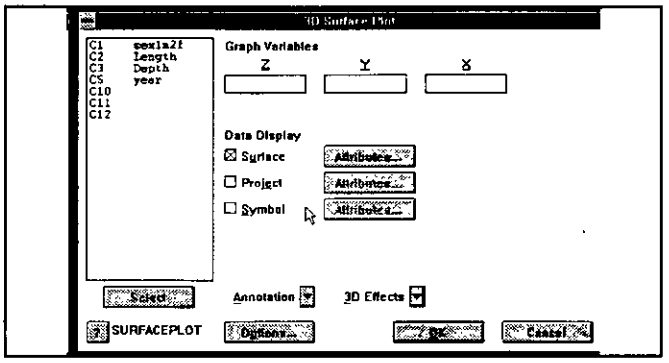
A wireframe of the 'cowboy hat' looks like this.



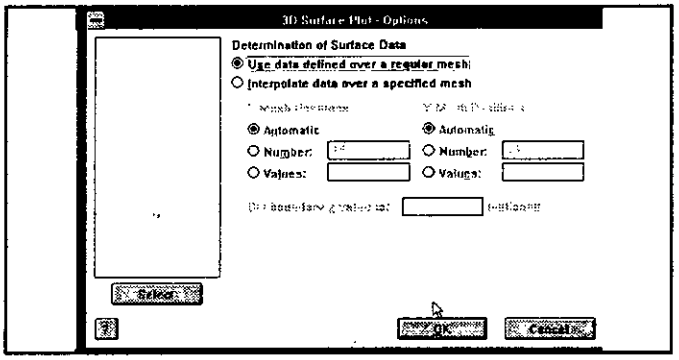
13 3D Surface Plot

Choose **Graph - 3D Surface Plot**

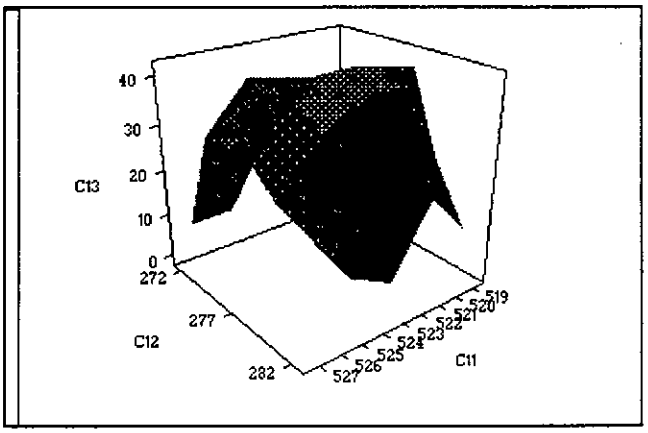
The opening dialog



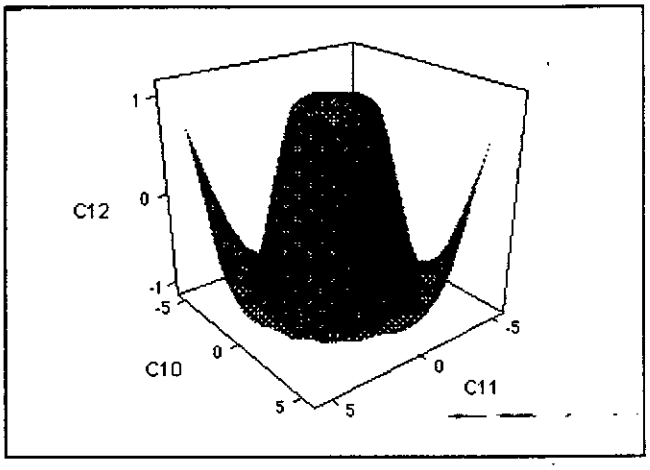
The **Options** box



The classic surface plot, here showing the drop from Monks Wood, down into the fens (just like the Llanberis pass really).



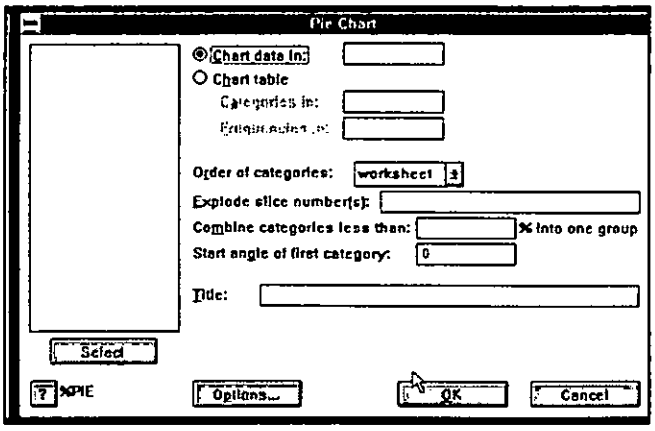
And the same graph type for the 'cowboy hat' (p.s. it looks better in colour).



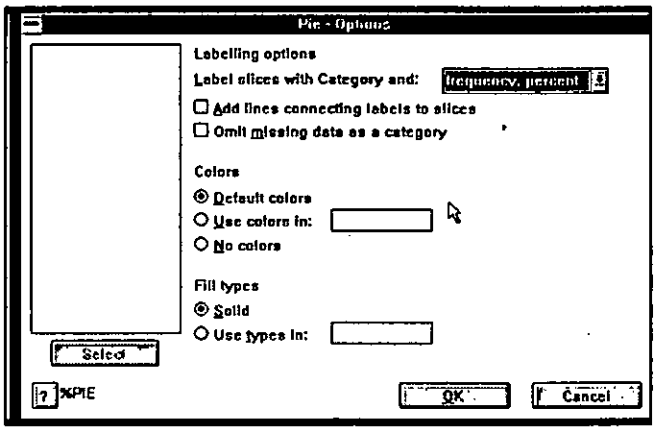
14 Pie Chart

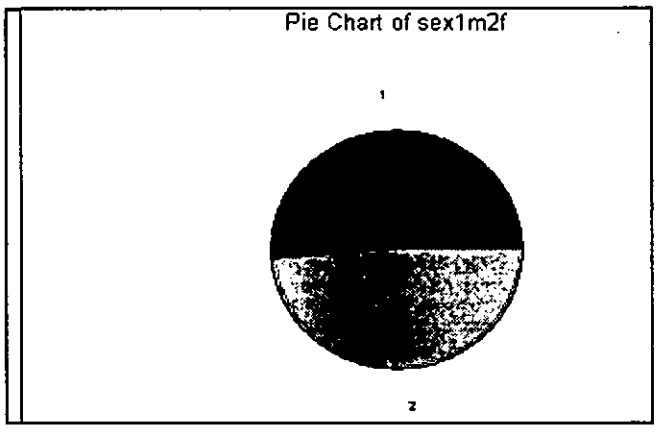
Choose **Graph - Pie Chart**

Tim dislikes pies, especially 3D ones. This facility is available through a %Macro and hence is notably slower than other graphic facilities.

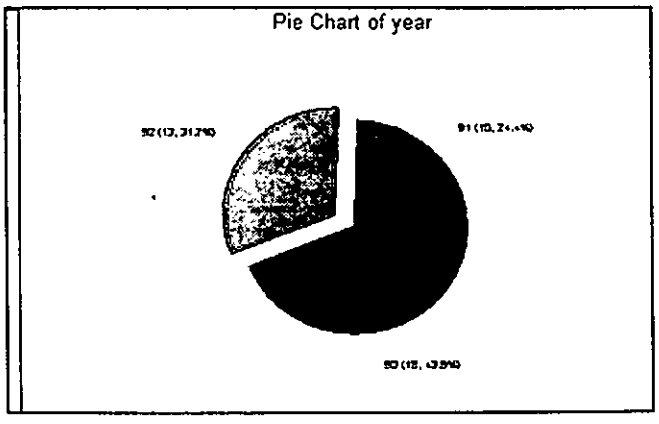


The **Options** box





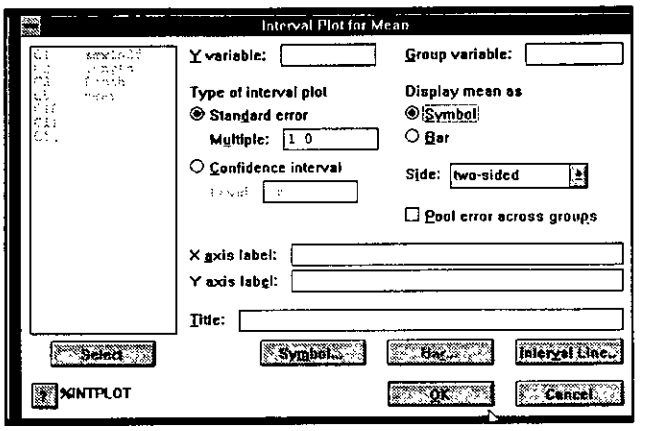
Options exist to explode a portion of the pie (as here), change colours, starting angle, combination of small categories etc.



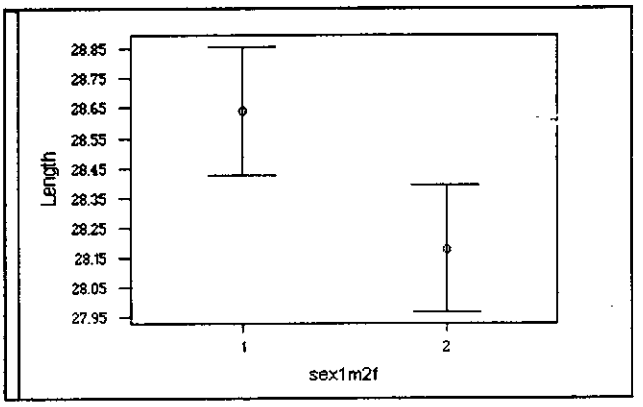
15 Interval Plot

Choose **Graph - Interval Plot**

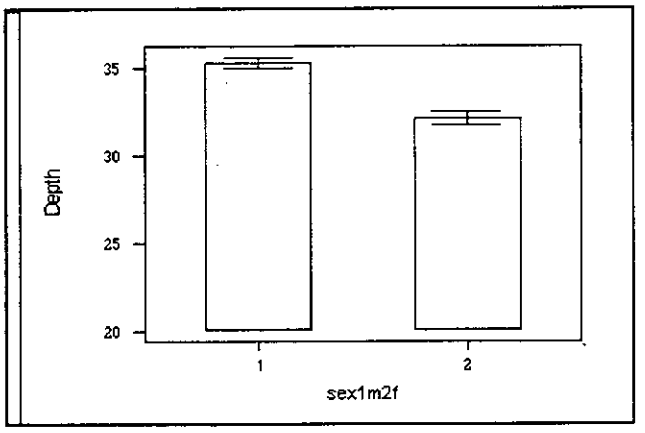
Another %Macro



Here showing the mean±s.e for some data. In this form, it is disappointing to report that it is not possible to vary min and max values. Multiples of a s.e. and confidence intervals can also be displayed by these bars. These can be modified to be above, below, or both sides (as here) of the mean. S.e.'s can also be estimated pooled across groups, rather than calculated from an individual group.

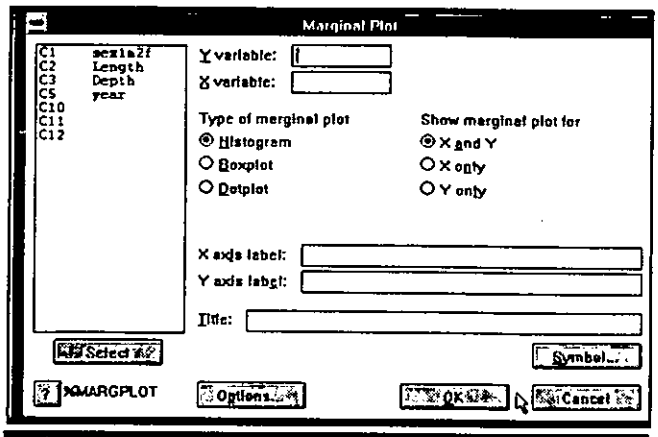


It is possible to set the y minimum when presenting the results as a bar!

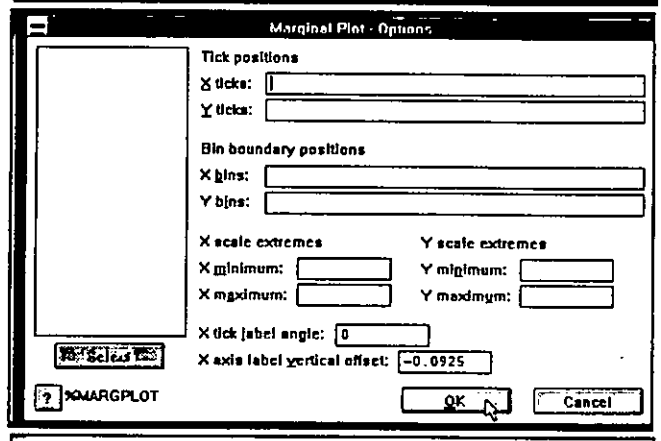


16 Marginal Plot

Choose **Graph - Marginal Plot**

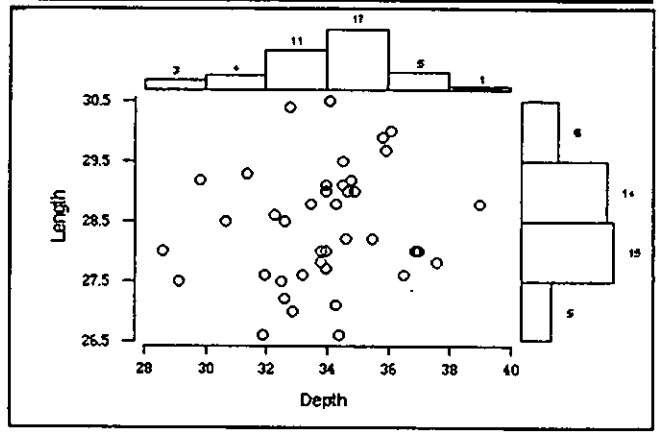


The **Options** box

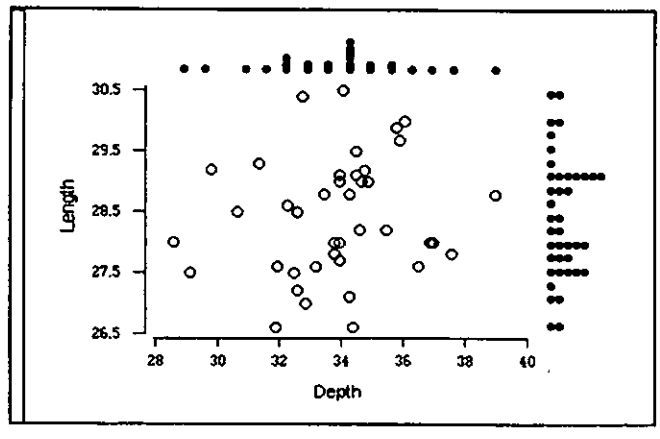


This very useful plot plots two variables, and on the margins produces a histogram....

The bar width on the margins can be modified.

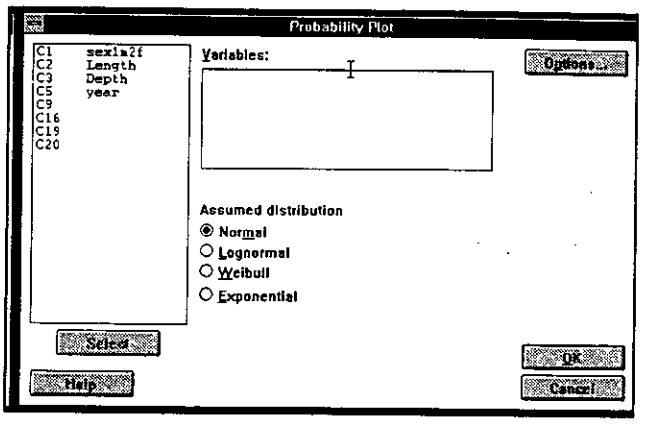


The marginal plot can be a dotplot of the variable on that axis.



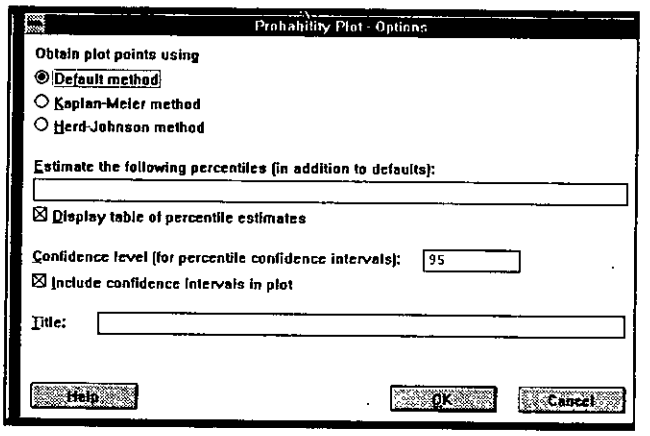
17 Probability Plot

Choose **Graph - Probability Plot**

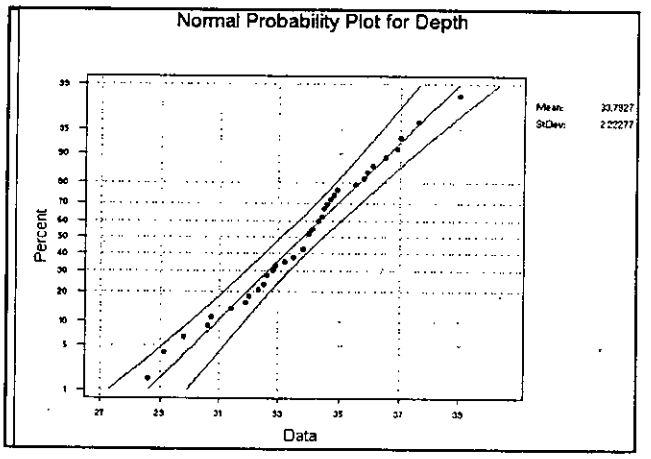


Tests whether the data from a variable can be considered to derive from one of four probability distributions

i) Normal
ii) Weibull
iii) Lognormal
iv) Exponential



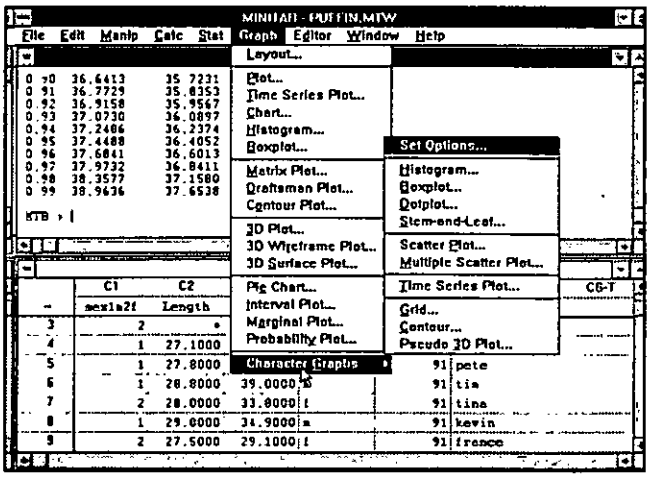
The options box



An example of the Normal probability plot complete with confidence intervals. Release 10 used to carry an indication of significance!

18 Character Graphs

It is not our intention to dwell on these line-printer graphics, but a few are summarised in the following pages



Histogram

```
MTB > Histogram 'Depth'.

Character Histogram



Histogram of Depth   N = 41

Midpoint    Count
      29        2  **
      30        1  *
      31        3  ***
      32        3  ***
      33        6  ******
      34       11  ***********
      35        6  ******
      36        4  ****
      37        3  ***
      38        1  *
      39        1  *
```

Boxplot

```
MTB > BoxPlot 'Depth';
SUBC>   By 'sex1m2f'.
```

Character Boxplot

```
sex1m2f

                                        ---------
1                                   ----I +     I--------       *
                                        ---------

                        --------------
2           ------------I       +     I------
                        --------------

+-------+---------+---------+---------+---------+------Depth
        28.0      30.0      32.0      34.0      36.0      38.0
```

Dotplot

```
MTB > DotPlot 'Depth';
SUBC>   By 'sex1m2f'.
```

Character Dotplot

```
 sex1m2f                                    ..
1                                  . :.::..  .... . :  .      .

+-------+---------+---------+---------+---------+-------Depth

 sex1m2f                       .
 2         .   .   .   ..  .  : .:...  ::   .                  .

+---------+---------+---------+---------+---------+-------Depth

      28.0      30.0      32.0      34.0      36.0      38.0
```

Stem-and-Leaf Plot

```
MTB > Stem-and-Leaf 'Depth'.

Character Stem-and-Leaf Display


Stem-and-leaf of Depth     N  = 41
Leaf Unit = 0.10


    1   28 6
    3   29 18
    5   30 67
    7   31 49
   14   32 0356689
   18   33 2588
  (14)  34 00001334556789
    9   35 589
    6   36 159
    3   37 06
    1   38
    1   39 0
```

Scatterplot

```
MTB > Plot 'Length' 'Depth';
SUBC>   Symbol 'x'.


Character Plot

Length-
      -                                  x
      -                              x
  30.0+                                      xx
      -                                      x
      -                    x                 x
      -           x                        2  x2x
      -                                 x    x                        x
  28.5+                  x        xx
      -                                      x     x
      -     x                              2x                 2   x
      -        x               x  x  x     x               x
      -                           x
  27.0+                             x       x
      -                     x               x
      -
      -
   +---------+---------+---------+---------+---------+------Depth

         28.0       30.0       32.0       34.0       36.0       38.0
         N* = 1
```

Multiple Plot
MTB > MPlot 'Depth' 'year' 'Length' 'year'.

Character Multiple Plot

```
     -    A
     -
     -    A
     -    A                          A                          A
36.0+                               A                          2
     -    2
     -    A                          7                          5
     -    A                          A                          2
     -    A                          2                          2
32.0+                                                          3
     -                               A
     -    A                                                     4
     -                               3                          4
     -    4                          2                          7
28.0+     4                          5                          4
     -    2                          2                          B
     -                               B                          B
       --------+---------+---------+---------+---------+---------
            91.20     91.60     92.00     92.40     92.80
   N* = 1
   A = Depth vs. year        B = Length vs. year
```

Time Series Plot (using toad data)
MTB > TSPlot 'number'

Character Time Series Plot

```
number  -
        -                          2
        -              6
     180+
        -
        -
        -
        -                        0
     120+                      9
        -                  7 8
        -
        -
        -    2                           3
      60+            5
        -  1   3
        -        4
        -                        1
         +---------+---------+---------+
         0         5        10        15
```

Pseudo Contour Plot (using Huntingdon data)

```
MTB > TPlot C12 C11 C13.
```

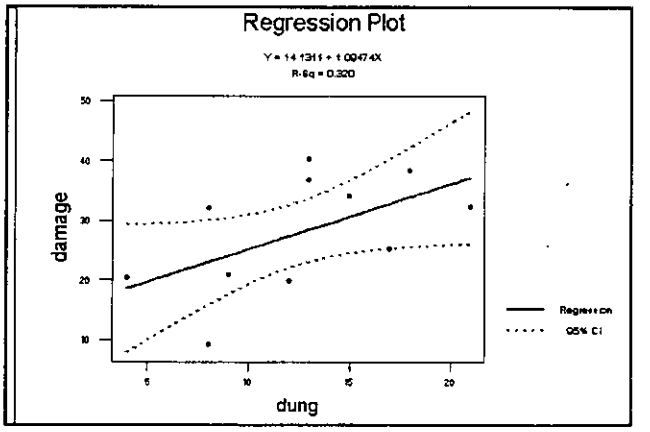
Character TPlot

```
C12
      -   0            .            0            0            /
      -
      -
  280.0+   .            X            X            /            .
      -
      -
      -   X            X            /            X            /
      -
  276.5+
      -   .            X            X            /            /
      -
      -
      -   .            0            /            X            /
  273.0+
      -   0            .            /            0            0
      -
      -
        --+---------+---------+---------+---------+---------+----C11
         519.0     520.5     522.0     523.5     525.0     526.5

        '0' <  15.0791 < '.' <  26.7000 < '/' <  38.3209 < 'X'
```

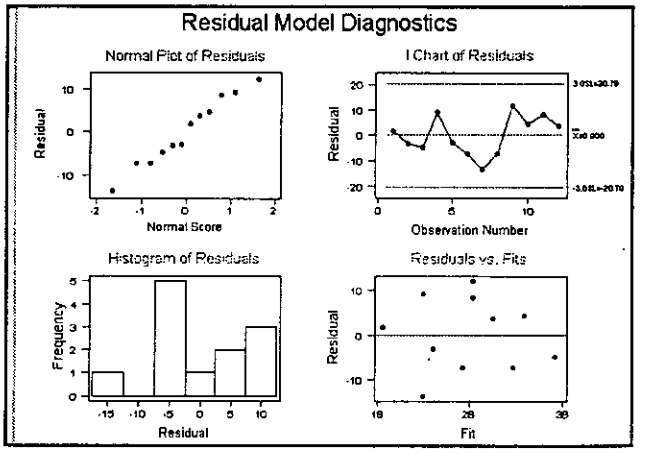
19 Regression and ANOVA plots

Found under the **Stat** menu rather than the graph menu these are still very useful high resolution graphical facilities

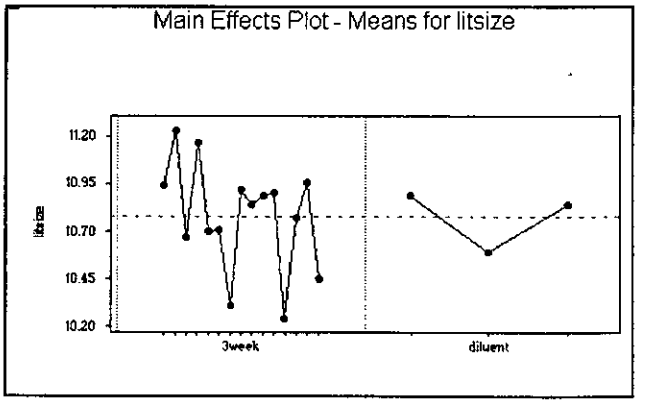
This is the fitted line plot from regression



and this is the diagnostic plot from regression (an identical facility exists for ANOVA diagnostics)

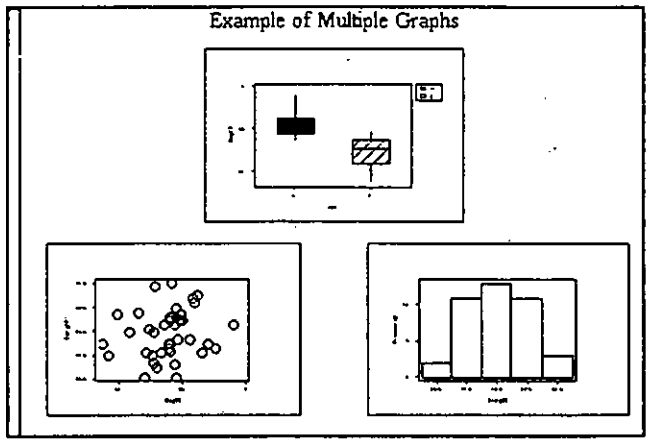


Under ANOVA is the main effect plot facility



20 Multiple Graphs

Example of multiple graph showing plot, histogram and boxplot together.

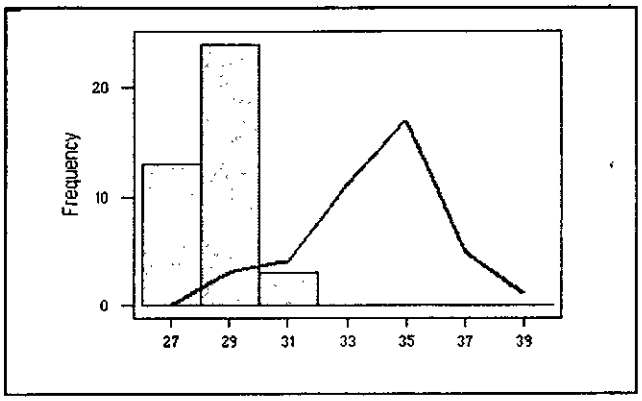


These are achieved by starting **Layout** then issuing various graph commands, each with complimentary **Region - Figure** positions and completing with **Graph - Endlayout**.

The session commands to create the above plot are shown below. Graphs are assigned to the page using a co-ordinate system which ranges from 0 to 1 in both x and y directions. In this example the lower graphs are set between y=0.05 and y=0.45, and the upper between y=0.55 and y=0.95. Left hand graphs are between x=0.05 and x=0.45, right hand graphs between x=0.55 and x=0.95, centre graph between x=0.3 and x=0.7.

```
MTB > Layout;
SUBC>  Title "Example of Multiple Graphs";
SUBC>    TFont 1.
* NOTE  * Beginning LAYOUT mode.
      Type ENDLAYOUT to end mode.
MTB > Plot 'Length'*'Depth';
SUBC>  Symbol;
SUBC>  Figure 0.05 0.45 0.05 0.45.
* NOTE * N missing = 1
MTB > Histogram 'Length';
SUBC>  MidPoint;
SUBC>  Bar;
SUBC>  Figure 0.55 0.95 0.05 0.45.
* NOTE * N missing = 1
MTB > Boxplot 'Depth'*'sex';
SUBC>  Box 'sex';
SUBC>  Symbol;
SUBC>    Outlier;
SUBC>  Figure 0.3 0.7 0.5 0.9.
MTB > EndLayout.
* NOTE  * Ending LAYOUT mode.
```

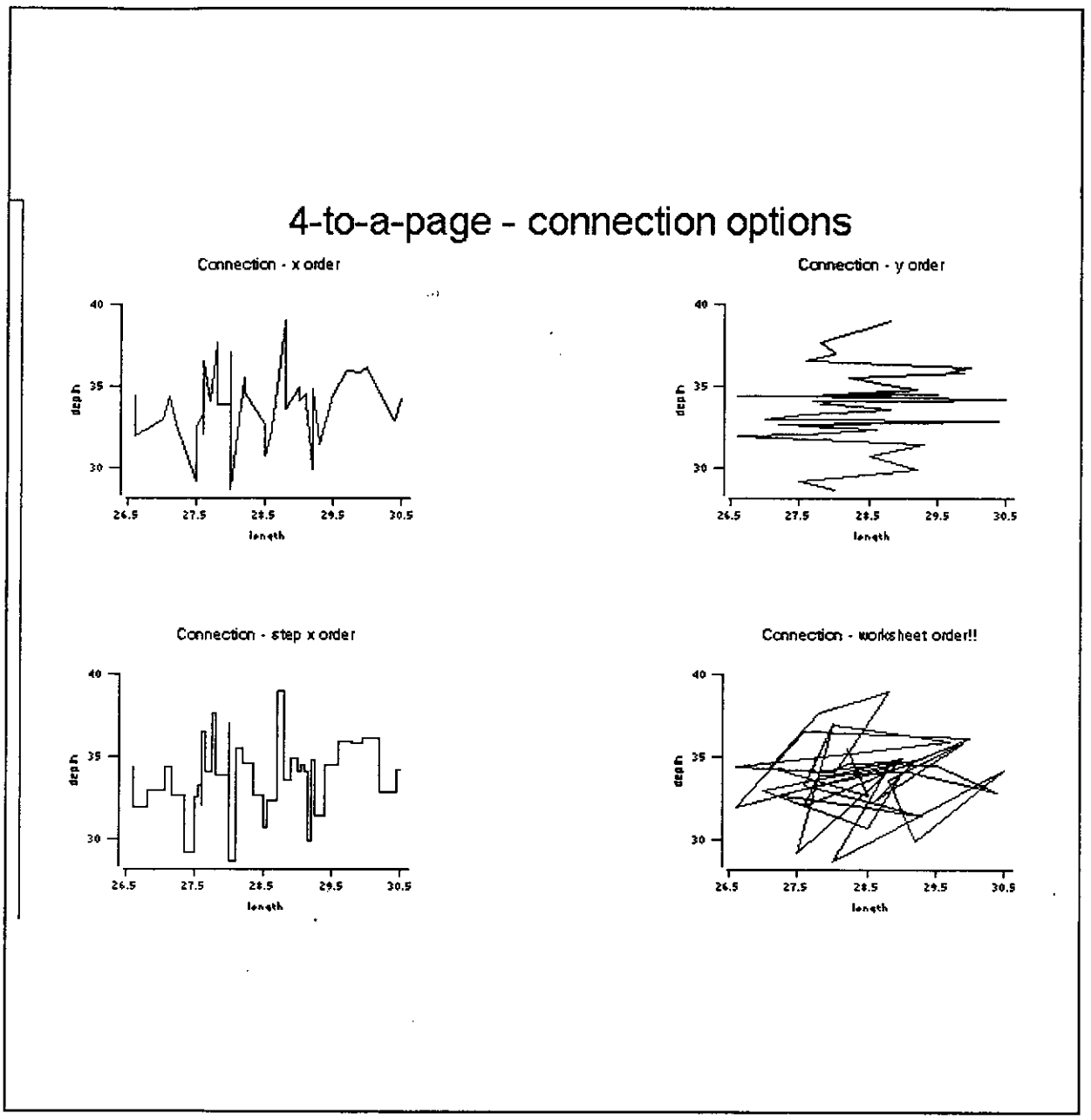
Frame - Multiple Graphs can be used to place graphs on top of one another or to ensure that multiple graphs have some or all of the axes at a common scale.
Example of overlay, depth and length by histogram, one as a bar, the other as a connecting line.



The following Minitab commands produce four graphs to a page and demonstrate the **connect** options in **plot**.

```
Layout;
 Title "4-to-a-page - connection options".
Plot 'Depth'*'Length';
 Connect;
 Title "Connection - x order";
 Figure 0.0 0.45 0.5 0.95;
 Data;
  EType 0;
 Axis 1;
  Label "length";
 Axis 2;
  Label "depth".
Plot 'Depth'*'Length';
 Connect;
  Order 2;
 Title "Connection - y order";
 Figure 0.55 1 0.5 0.95;
 Data;
  EType 0;
 Axis 1;
  Label "length";
 Axis 2;
  Label "depth".
Plot 'Depth'*'Length';
 Connect;
  Step 0;
 Title "Connection - step x order";
 Figure 0 0.45 0 0.45;
 Data;
  EType 0;
 Axis 1;
  Label "length";
 Axis 2;
  Label "depth".
Plot 'Depth'*'Length';
 Connect;
  Order 0;
 Title "Connection - worksheet order!!";
 Figure 0.55 1 0 0.45;
 Data;
  EType 0;
 Axis 1;
  Label "length";
 Axis 2;
  Label "depth".
EndLayout.
```

Here is the result showing the various **Connect** options in **Plot**. Top left; connecting in order of increasing x value. Bottom left; ditto but in step fashion. Top right; in order of increasing y values. Bottom right; in order of the worksheet!!!



21 Macros and Saving Commands

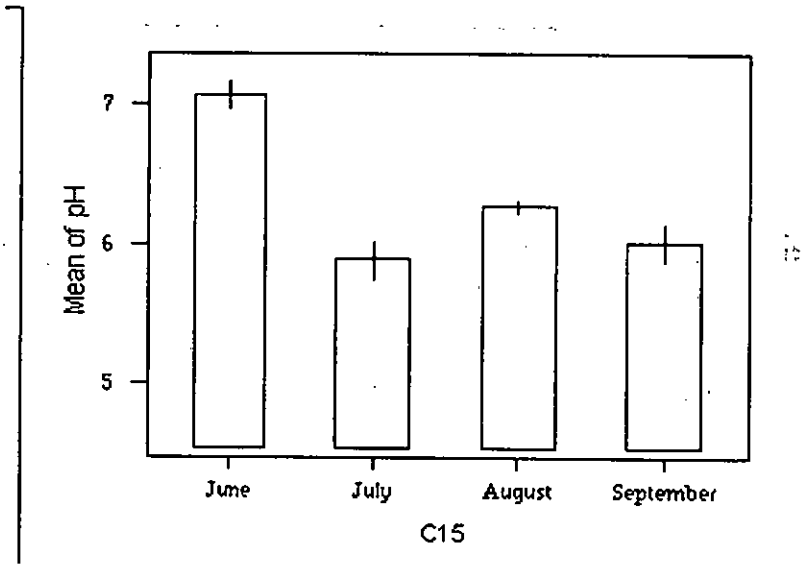
Commands to produce graphs can be complex; as shown in the example for multiple graphs above. It is wise to save the commands that produce a graph in a preferred format. This can then be used again; either by pasting into the session window and editing, or by modifying them to produce macros.

Graph commands are best saved from the history window, either directly using **File - Save Window**, or by pasting into an appropriate file.

Using session commands it will be possible for the user to create macros similar in complexity to those that create the regression diagnostic plots shown earlier.

The following fairly limited macro (which needs development) was created to allow standard error bars to be added to bar charts created using **Chart** (which has more flexibility than **Interval Plot**). An example of the output is shown adjacent

```
unstack ck20 into c21-c24;
subs c14.
let k1=mean(c21)
let k2=mean(c22)
let k3=mean(c23)
let k4=mean(C24)
let k5=stdev(c21)/sqrt(n(c21))
let k6=stdev(c22)/sqrt(n(c22))
let k7=stdev(c23)/sqrt(n(c23))
let k8=stdev(c24)/sqrt(n(c24))
let k9=k1-k5
let k10=k2-k6
let k11=k3-k7
let k12=k4-k8
let k13=k1+k5
let k14=k2+k6
let k15=k3+k7
let k16=k4+k8
let k17=min(ck20)
let k18=max(ck20)
Chart Mean(ck20) * C15;
 Bar;
 Line 1 k9 1 k13;
 Line 2 k10 2 k14;
 Line 3 k11 3 k15;
 Line 4 k12 4 k16;
 Minimum 2 k17;
 Maximum 2 k18.
```

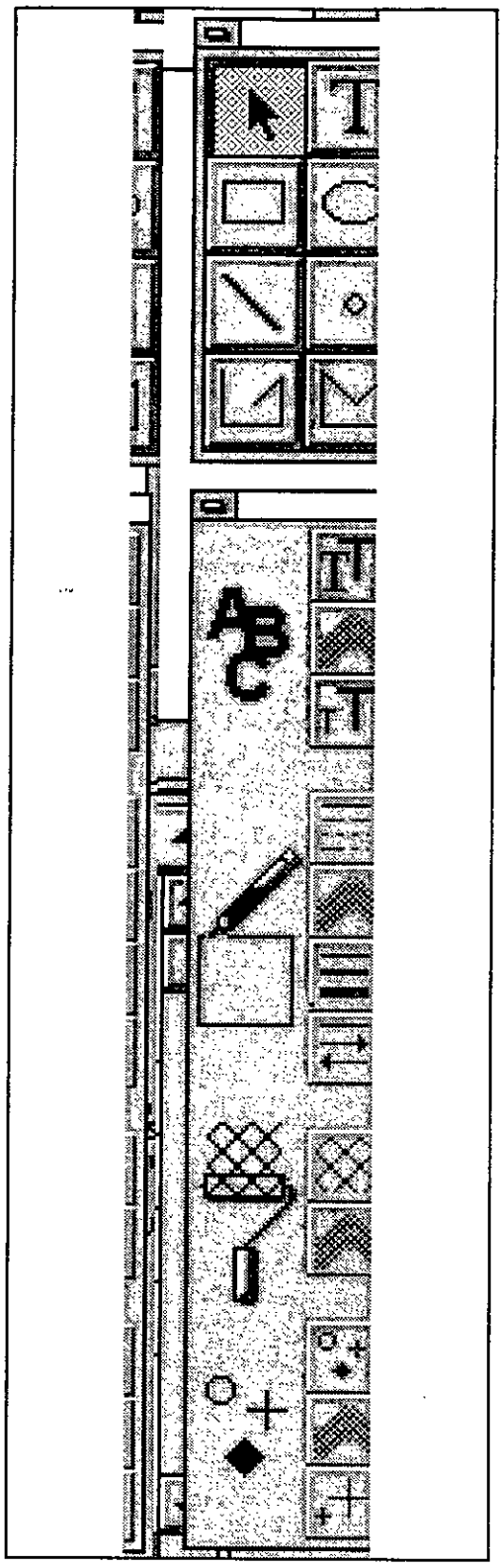


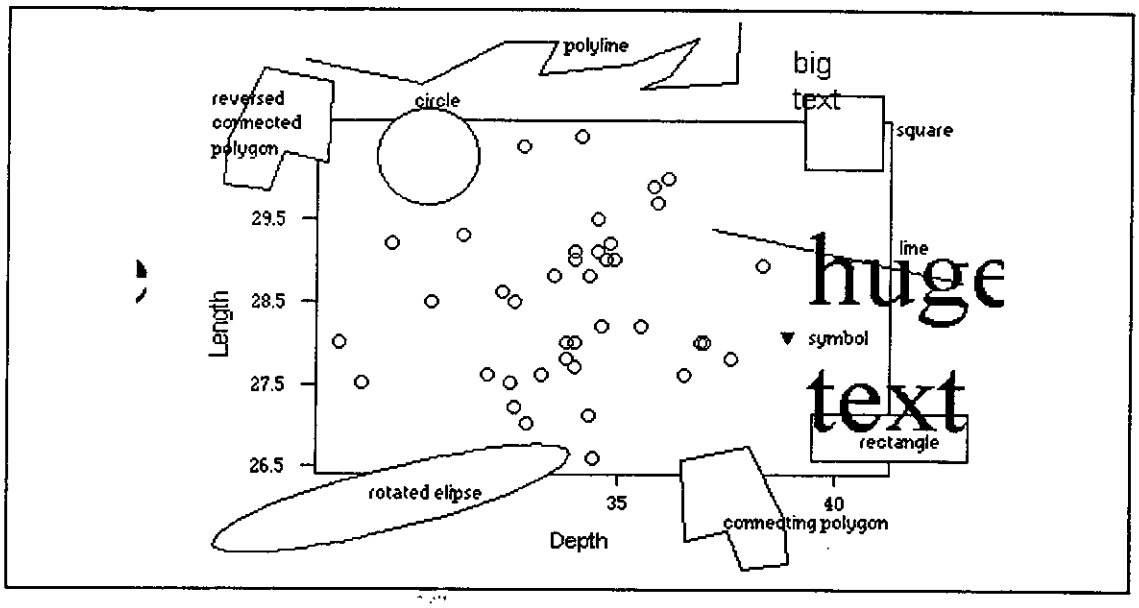
22 Editing Graphs

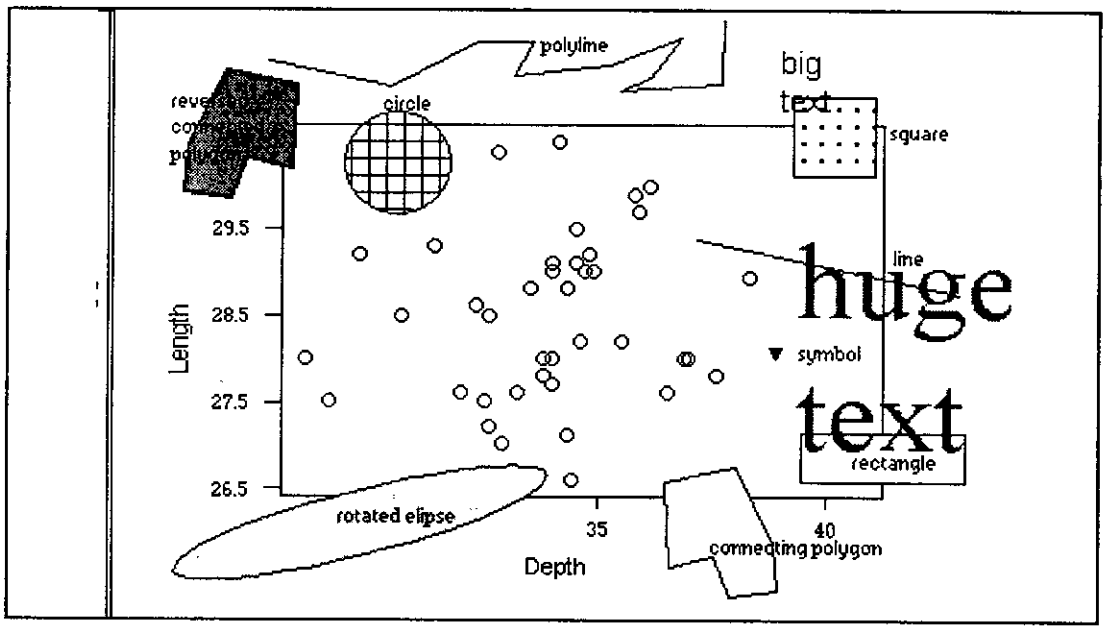
Choose **Editor - Edit**
(or double click in graphic area)

Under the Minitab editor there exists some fairly complex facilities for editing graphs. There are two palettes associated with editor (the tool palette and the attribute palette). The former allows you to select items, draw lines, write text, create polylines (connecting lines), polygons (enclosed figure defined by points), drawing circles, ellipses, rectangles, squares and adding symbols. Once done these can all be duplicated, modified in size, colour, appearance etc. Shapes can be rotated or reversed etc.

On the adjacent figure we see the tool palette above the attribute palette. The upper specifies the type of editing; the lower selects options (colour, size etc) within that type.





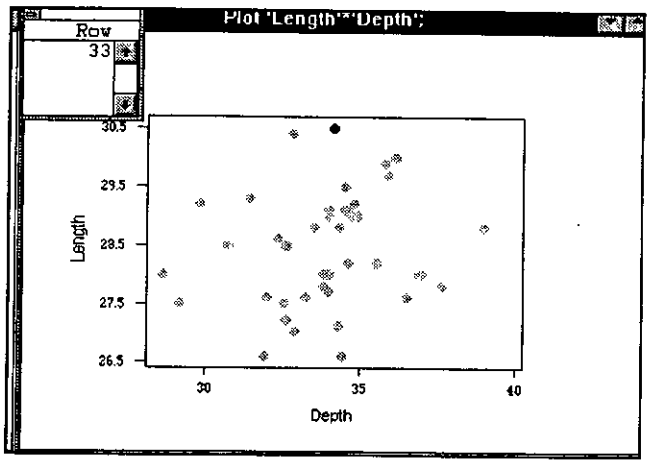


The upper figure displays the extremes of editing, whilst the lower shows the addition of colour and shading.

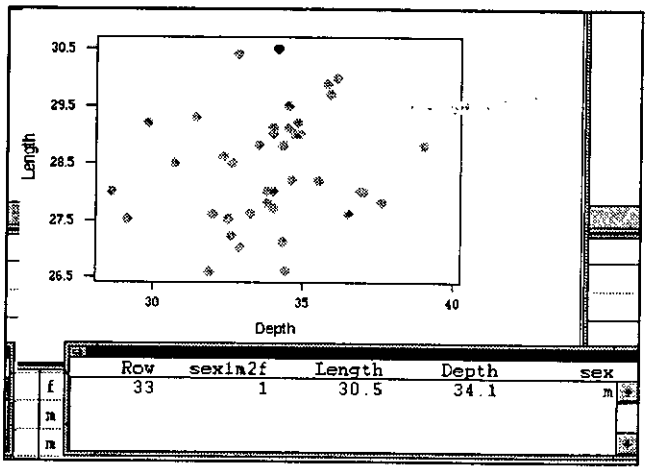
23 Brushing (is good for you)

Choose **Editor - Brush**

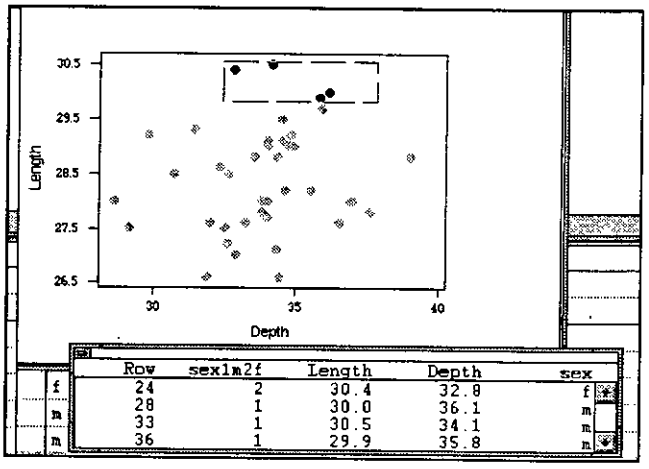
Initial suggestions are that brushing is going to be a very useful diagnostic when familiarity is achieved. Points on graphs can be identified as the row numbers that exist in the worksheet.

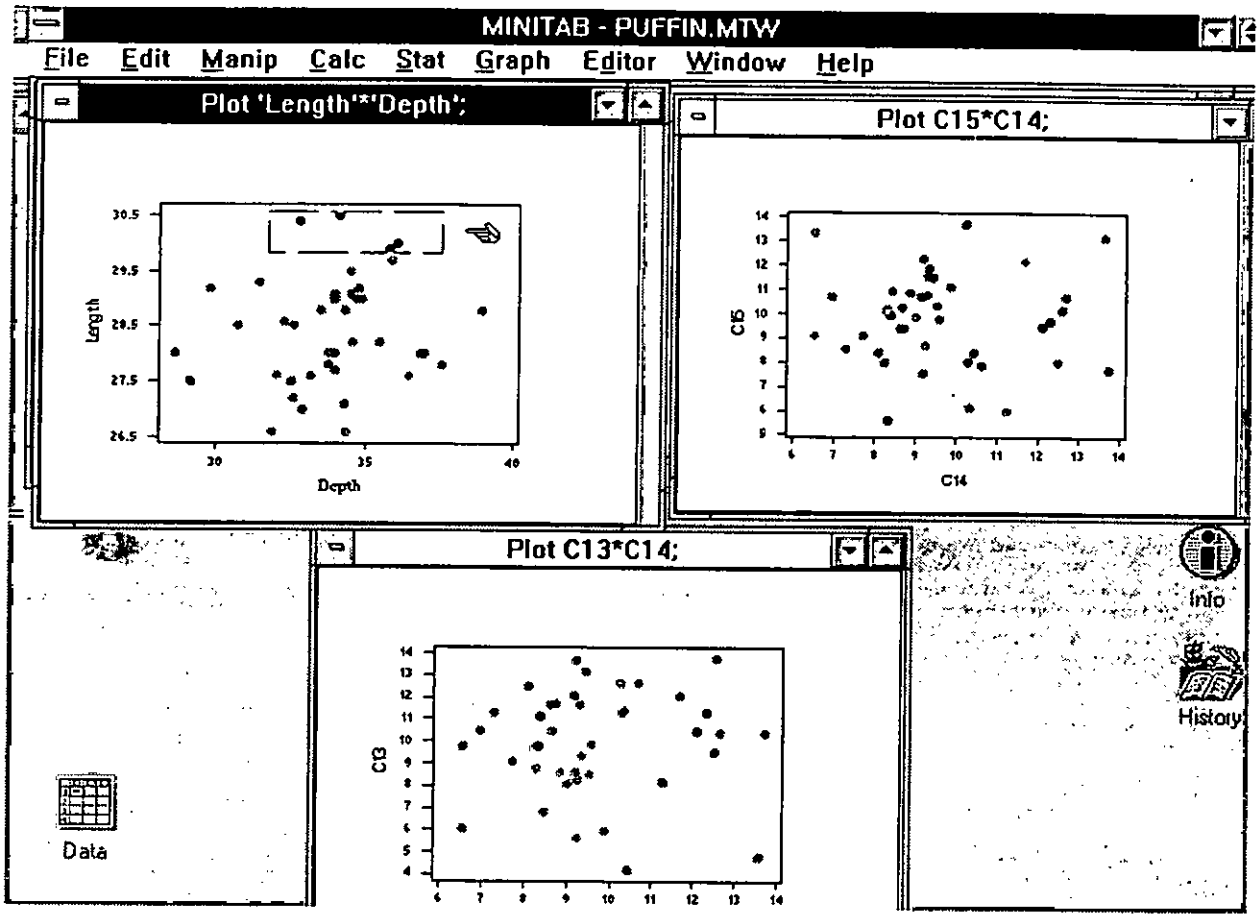


Identification can be increased to display chosen variables (from **Editor - Set ID variables).**



and all points within regions can be identified.





When several graphs are visible at one time, then brushed points are highlighted on all of these. (unfortunately brushed points are less obvious on photocopies of monochrome output!).

Brushed points are highlighted in the data window. With release 11 comes the opportunity to create a column indicator variable in the worksheet based on points brushed graphically, i.e. to identify points within a certain portion of the graph. To use this facility use **Editor - Brush - Create Indicator Variable** and fill in the dialogue box. Options exist to run a series of commands each time the brushed set changes.

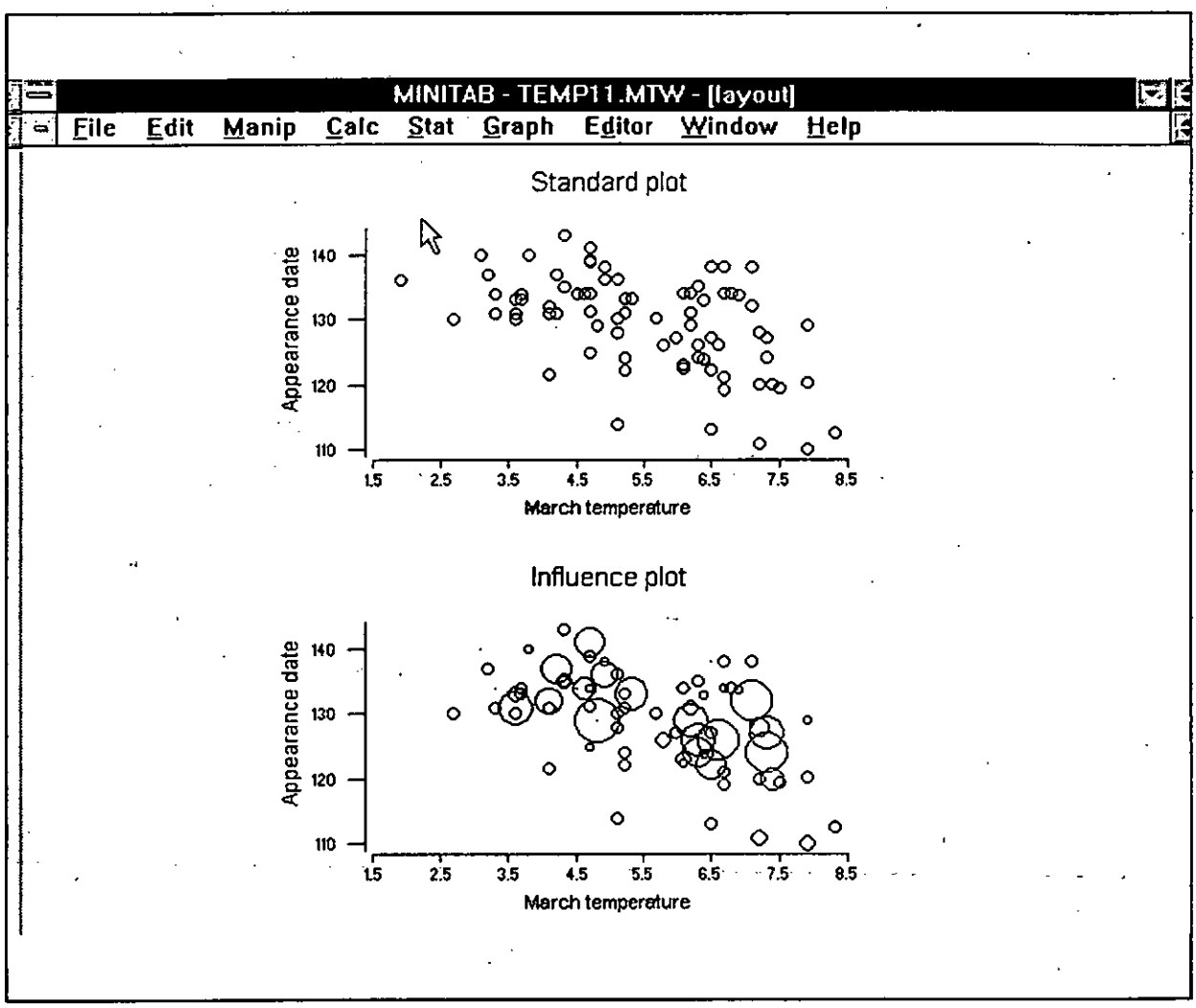
24 Some Further Examples

During earlier presentations of this course a number of questions from the audience suggested the need to include examples of some more complex graphs

24.1 Influence Plots

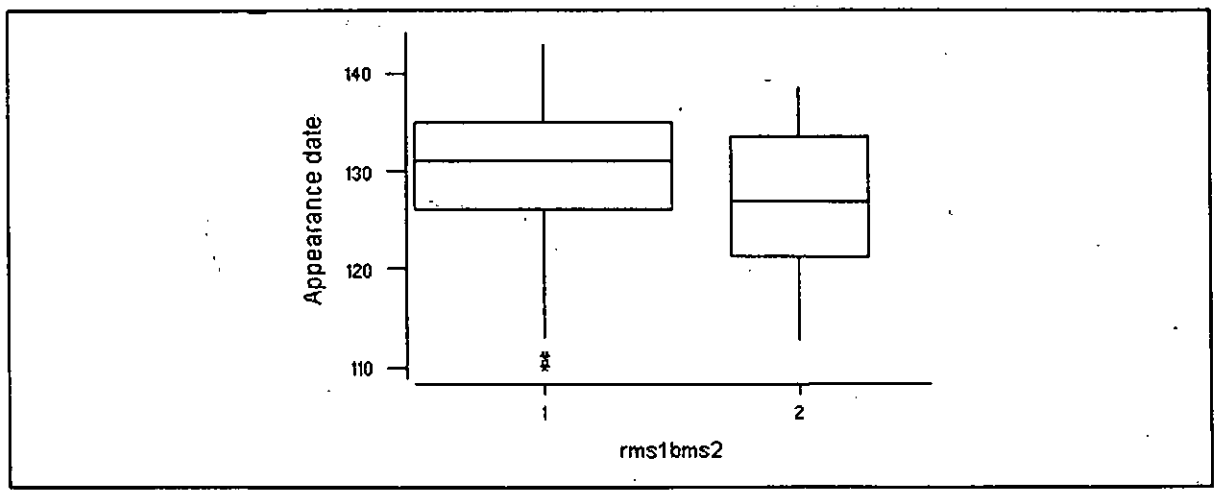
These can be achieved by changing the **Plot - For each** to point, and then changing **Size** under **Edit attributes** to a variable indicating symbol size. The following example shows an influence plot where symbol size is set proportional to the number of values contributing to each data point.

```
layout
Plot 'otip1'*'martemp';
  Symbol;
    Type 1;
    Size C9;
  Title "Influence plot";
  Figure 0.15 0.85 0.0 0.5;
  Data;
    EType 0;
  Axis 1;
    Label "March temperature";
  Axis 2;
    Label "Appearance date".
Plot 'otip1'*'martemp';
  Symbol;
    Type 1;
  Title "Standard plot";
  Figure 0.15 0.85 0.5 1;
  Data;
    EType 0;
  Axis 1;
    Label "March temperature";
  Axis 2;
    Label "Appearance date".
endlayout
```



24.2 Influence Boxplots

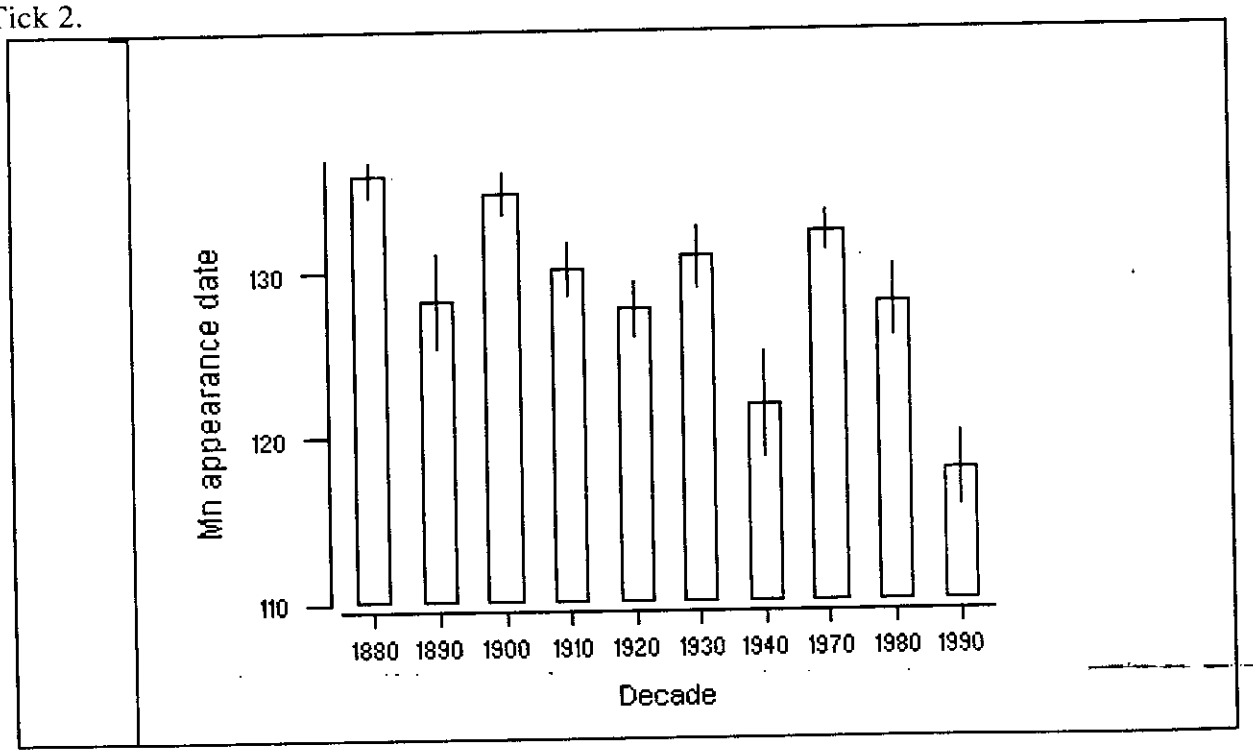
'Fat' Boxplots can be easily created by using the **Options** facility and setting boxplot width proportional to sample size.



24.3 Error Bars

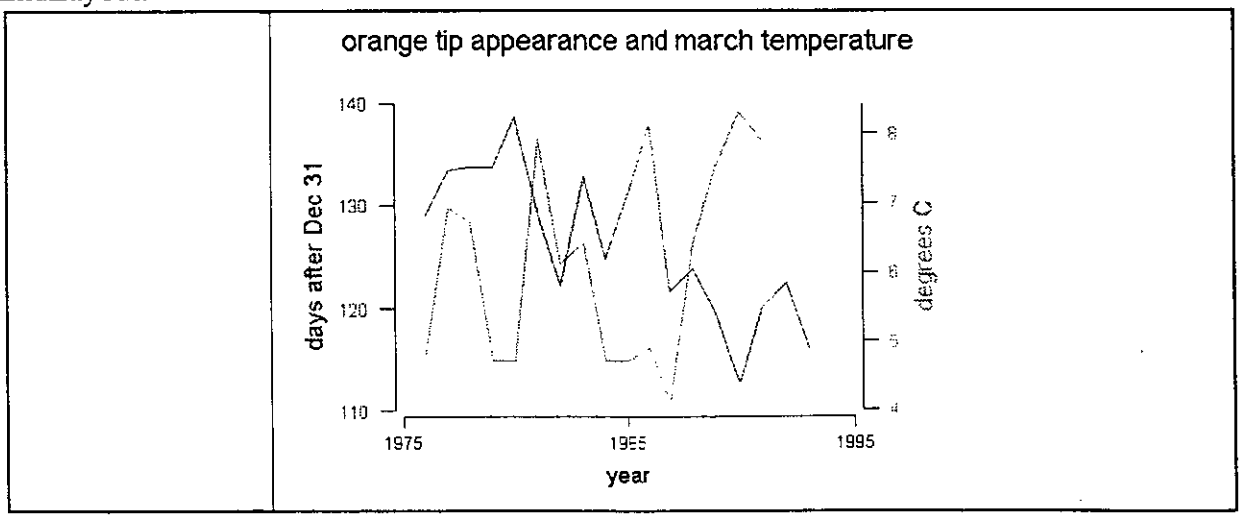
Possibly one of the big failings of Minitab graphics. Influence plot is limited in its options. The macro shown earlier can be used but is less flexible. The following example assumes that means, mean-se and mean+se are available in three columns and then combines a 'bar' with two projections.

```
Chart Mean( mn ) * 'decd';
 Bar;
 Project 'decd';
  Type 1;
  Base 'mnminus';
 Project 'decd';
  Type 1;
  Base 'mnplus';
 Data;
  EType 0;
 NoLegend;
 Minimum 2 110;
 Axis 1;
  Label "Decade";
 Axis 2;
  Label "Mn appearance date";
 Tick 1;
  Labels "1880" "1890" "1900" "1910" "1920" "1930" "1940" "1970" "1980" &
   "1990";
 Tick 2.
```



24.4 Two Different y-scales

```
Layout.
Plot c401*c402;
  connect;
type 1;
colour 2;
title "orange tip appearance and march temperature";
Data;
   EType 0;
  Axis 1;
label "year";
   Axis 2;
label "days after Dec 31";
tcolour 2;
tick 2;
tcolour 2.
Plot c403*c404;
connect;
type 1;
colour 3;
Data;
   EType 0;
Axis 1;
label " ";
   Axis 2;
side 2;
label "degrees C";
tcolour 3;
  Side 2;
  Tick 1;
  Tick 2;
   Side 2;
tcolour 3.
EndLayout.
```

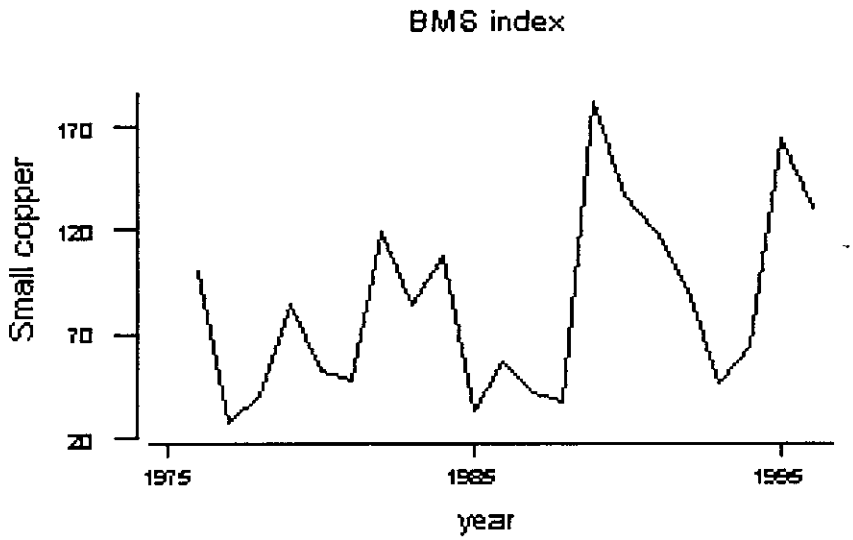


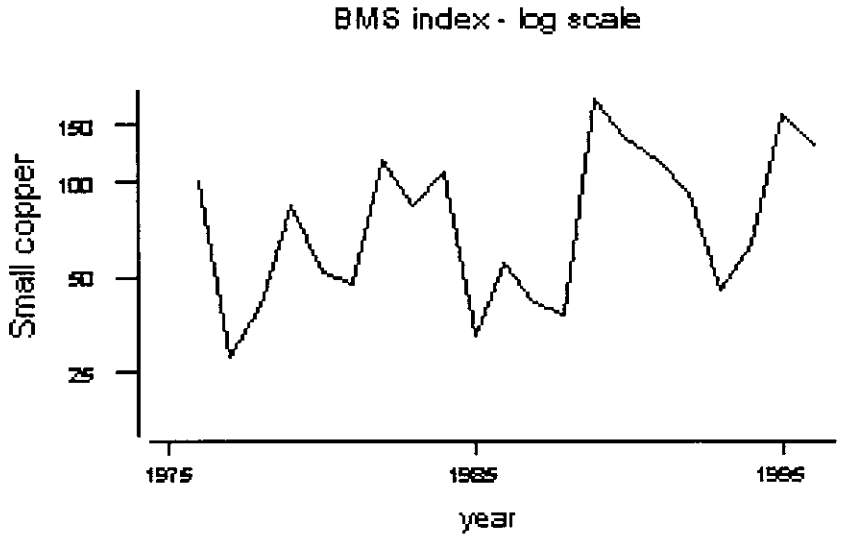
24.5 Logscale On Axis

This example uses the Butterfly monitoring scheme results where the collated index has traditionally been log(10) transformed.

```
Layout;
  Title "Example of log scale".
Plot 'Small Co'*'yr';
  Connect;
  Title "BMS index";
  Figure 0.2 0.8 0.5 0.95;
  Data;
    EType 0;
  Axis 1;
    Label "year";
  Axis 2;
    Label "Small copper".
Plot c45*'yr';
  Connect;
  Title "BMS index - log scale";
  Figure 0.2 0.8 0 0.45;
  Data;
    EType 0;
  Minimum 2 1.2;
  Axis 1;
    Label "year";
  Axis 2;
    Label "Small copper";
  Tick 1;
  Tick 2 1.4 1.7 2 2.18 2.3;
    Labels "25" "50" "100" "150" "200".
EndLayout.
```

Example of log scale





Minitab 11 - some comments on differences in graphics

At the time of writing we have had Minitab release 11 at Monks Wood only for a short while and the manuals arrived only a week before this course! Hence we may be at a disadvantage to those of you who have more experience of the differences between releases 10 and 11.

The use of date-time variables in graphs has not been explored here, but potentially they can be used in all graphs.

Differences to probability plots enable the testing against four probability distributions, although the test of significance appears to have disappeared.

Some improvements to graph brushing mean that indicator variables can be automatically created in your worksheet.

The default symbol in **Plot** is now a solid circle rather than an open one

The default is not to have a frame around a figure

Release 10 Minitab graphics (.mgf) files do not appear to be editable by release 11

Appendix 1

The following set of data will be familiar to those attending the Introductory MINITAB course.

```
# Puffin beak measurements, St Kilda
# C1 - Sex (1 = male, 2 = female)  C2 - Length (mm)  C3 - Depth (mm)
1 28.2 35.5
2 28.5 32.6
2  *   30.6
1 27.1 34.3
1 27.8 37.6
1 28.8 39.0
2 28.0 33.8
1 29.0 34.9
2 27.5 29.1
1 28.0 36.9
1 29.7 35.9
1 26.6 34.4
2 28.0 34.0
1 28.2 34.6
2 29.0 34.7
1 27.7 34.0
1 28.0 37.0
2 27.6 33.2
2 29.3 31.4
2 27.5 32.5
2 27.2 32.6
1 29.1 34.5
1 29.5 34.5
2 30.4 32.8
2 29.1 34.0
2 27.8 33.8
2 27.6 32.0
1 30.0 36.1
1 27.6 36.5
2 26.6 31.9
1 28.8 34.3
2 28.0 28.6
1 30.5 34.1
2 29.2 29.8
1 28.8 33.5
1 29.9 35.8
2 28.6 32.3
1 29.2 34.8
2 27.0 32.9
2 28.5 30.7
1 29.0 34.0
```

Appendix 2

#Arnie Cooke's Muntjac data
c1 damage to shrubs
c2 standardised dung count
20.3 4
20.8 9
32.3 21
32.1 8
20.9 9
19.9 12
9.2 8
25.3 17
40.4 13
38.3 18
36.8 13
34.2 15

Appendix 3

#cor zonneveld's essex skipper data
c1 day number
c2 essex skipper count
1 20
4 38
6 51
8 105
10 114
12 81
17 45
19 51
22 33
25 23
27 20
28 22
30 19
32 7
34 5
37 7
38 7
41 2
43 1
46 2
48 1

Appendix 4

#MLC pig ai results
c1 % successful fertilisations
c2 Average litter size of ditto
c3 diluent type 1,2,3
c4 sequential 3-weekly period

69.2	10.98	1	1
66.2	11.17	1	2
66.5	10.96	1	3
73.4	11.01	1	4
79.7	10.89	1	5
81.3	10.60	1	6
84.5	10.52	1	7
80.1	11.18	1	8
81.9	11.04	1	9
80.0	10.83	1	10
81.9	11.01	1	11
77.3	10.48	1	12
79.6	11.14	1	13
74.0	11.27	1	14
77.7	10.21	1	15
*	*	2	1
73.9	11.79	2	2
75.2	10.26	2	3
76.0	10.79	2	4
71.2	10.28	2	5
71.8	10.93	2	6
76.6	9.86	2	7
80.2	10.75	2	8
73.9	10.59	2	9
77.4	10.70	2	10
79.6	10.63	2	11
70.9	10.05	2	12
84.6	10.59	2	13
74.5	10.69	2	14
75.6	10.36	2	15
76.2	10.91	3	1
75.2	10.73	3	2
75.3	10.79	3	3
75.6	11.71	3	4
72.1	10.92	3	5
71.0	10.60	3	6
73.0	10.56	3	7
79.4	10.83	3	8
73.7	10.89	3	9
74.1	11.12	3	10
80.5	11.07	3	11
84.1	10.20	3	12
77.5	10.59	3	13
69.6	10.90	3	14
74.4	10.79	3	15

Appendix 5

#Arnie Cooke's toad counts
c1 year
c2 toad counts
1974 45
1975 75
1976 46
1977 32
1978 57
1979 189
1980 105
1981 102
1982 118
1983 136
1984 28
1985 204
1986 76

Some example graphs

The graphs on the following pages are intended to give you some examples of graphics within Minitab. These are a selection from real graphs produced over the last six months. They are **not** described in detail, but give examples of

mixing lines and symbols(2)

clustered bar charts

stacked bar charts

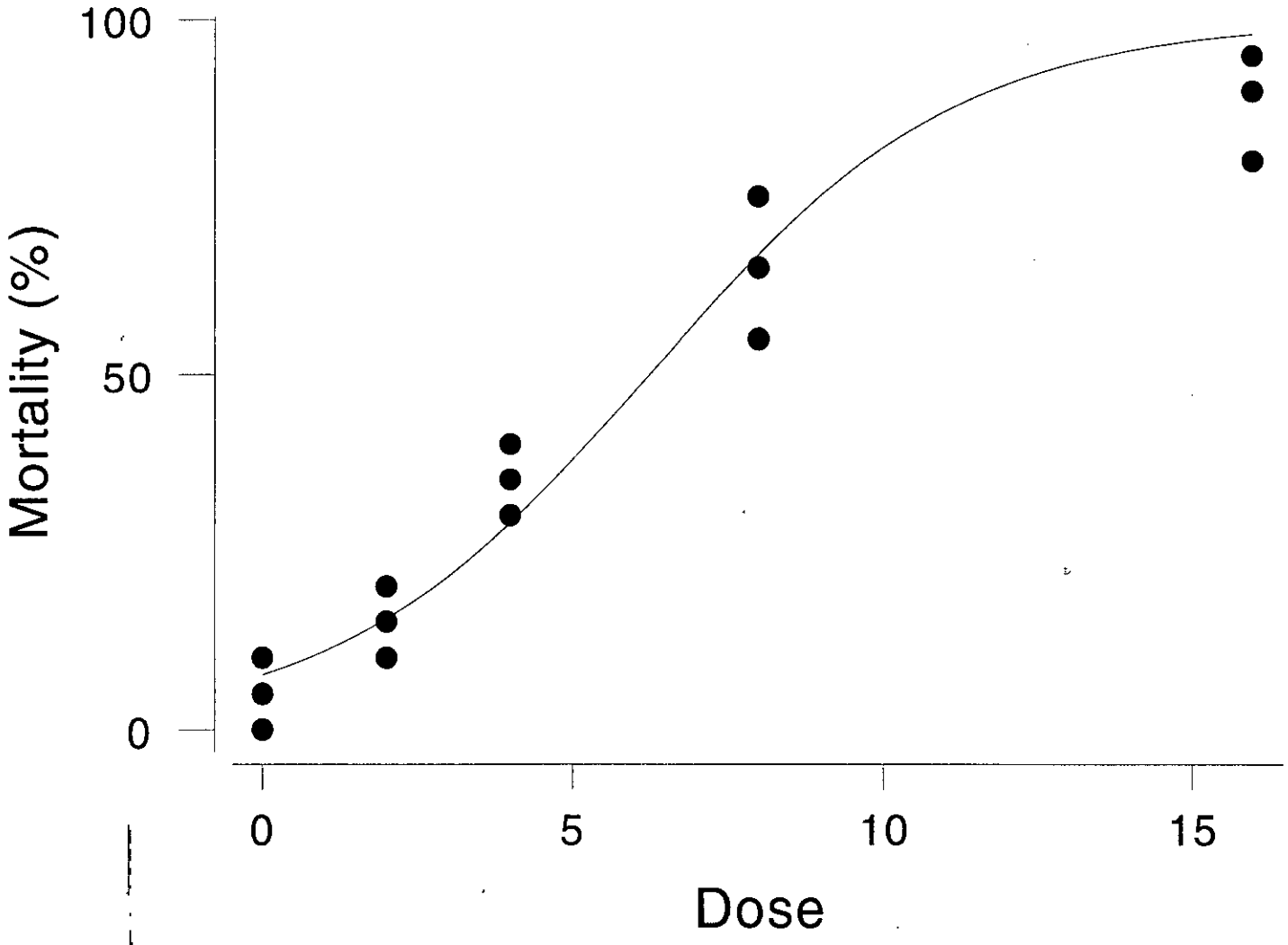
differential symbols and LOWESS smoothing

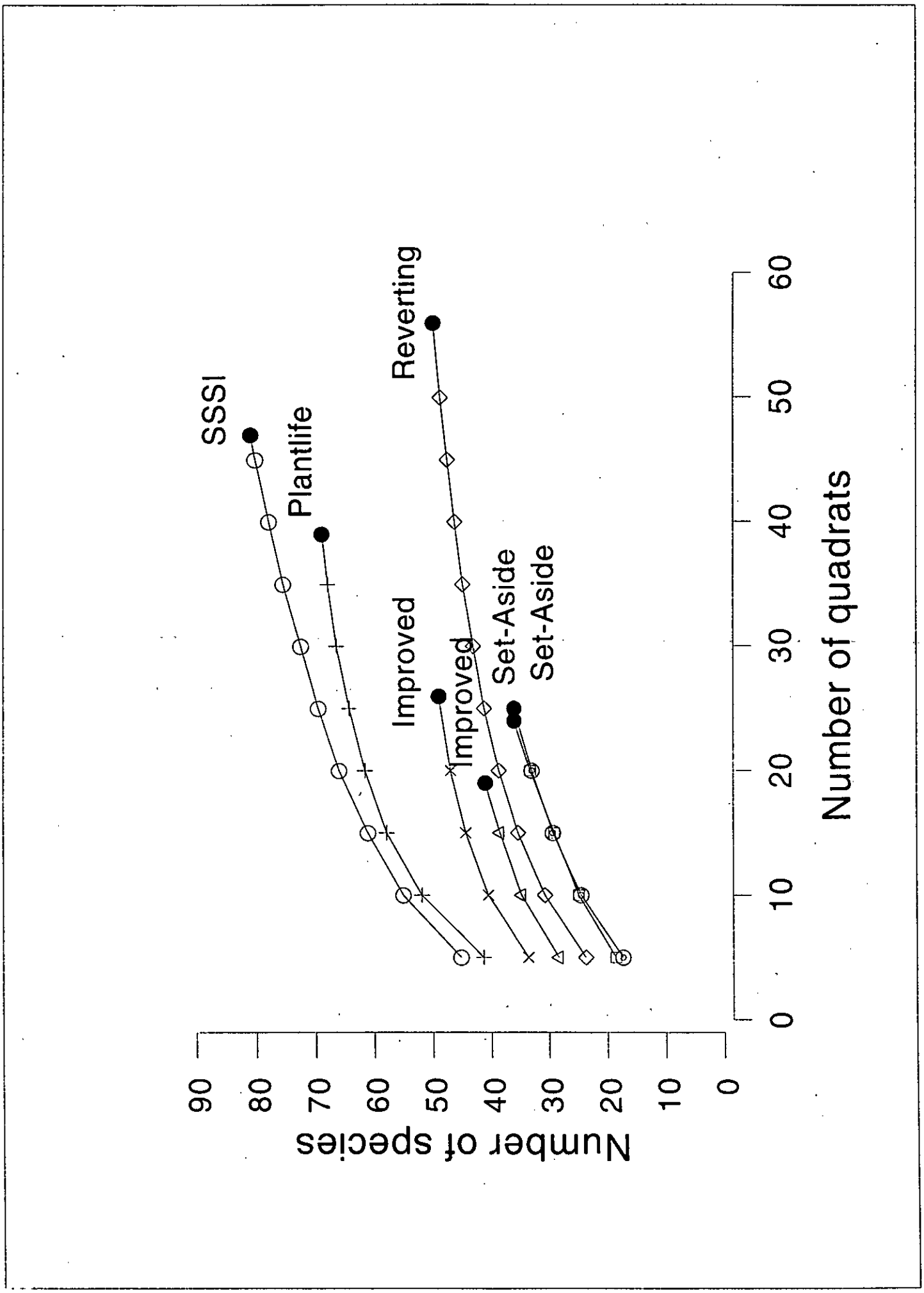
graphic symbols(2)

biplots with labelling(2)

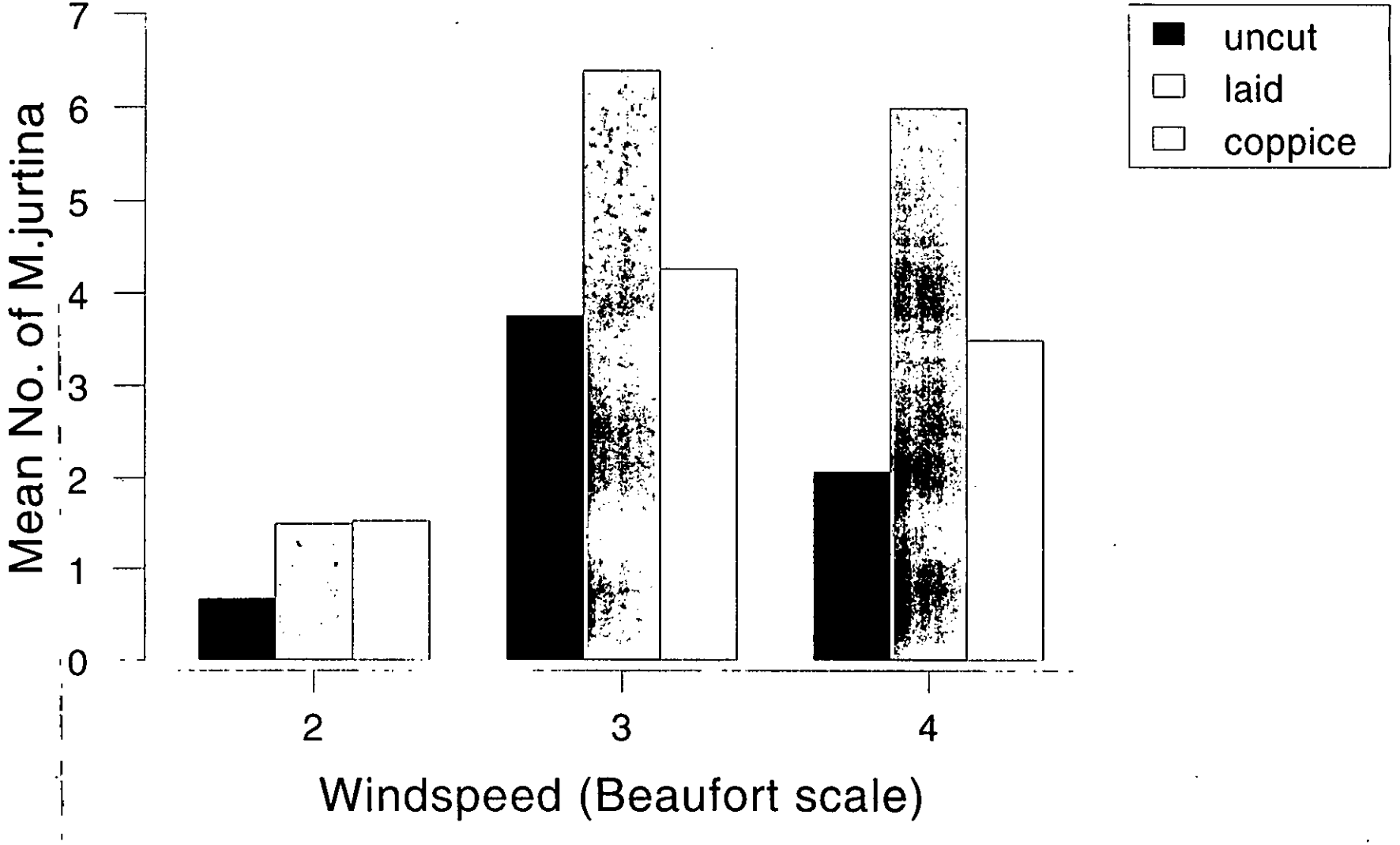
ordination plots(2)

multiple frames of ordination, bar charts, biplots, symbol+connect+LOWESS, histograms, and plots

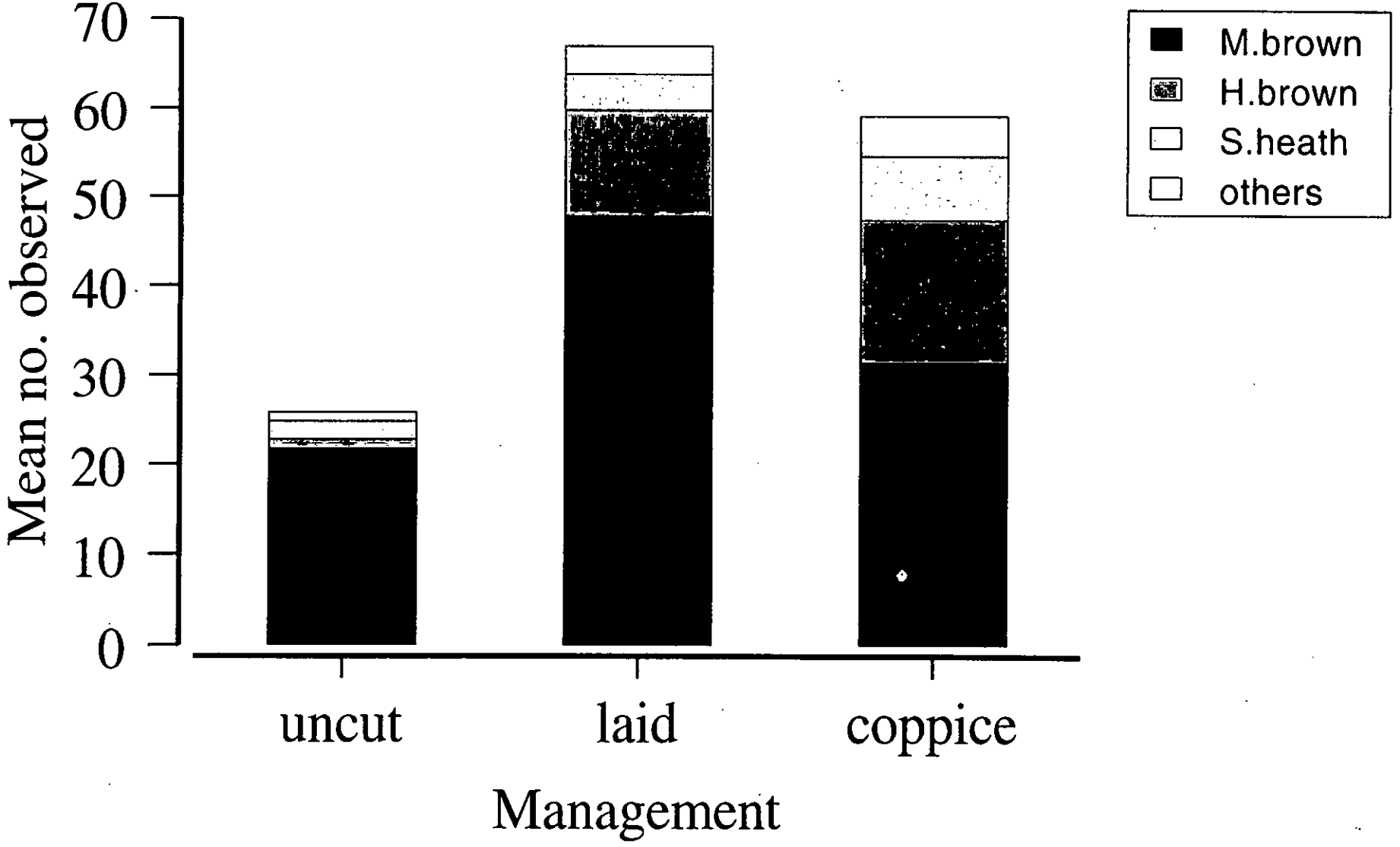

100
50
0
Mortality (%)
0
5
10
15
Dose


Number of species
0
10
20
30
40
50
60
70
80
90
Number of quadrats
0
10
20
30
40
50
60
SSSI
Plantlife
Reverting
Improved
Improved
Set-Aside
Set-Aside

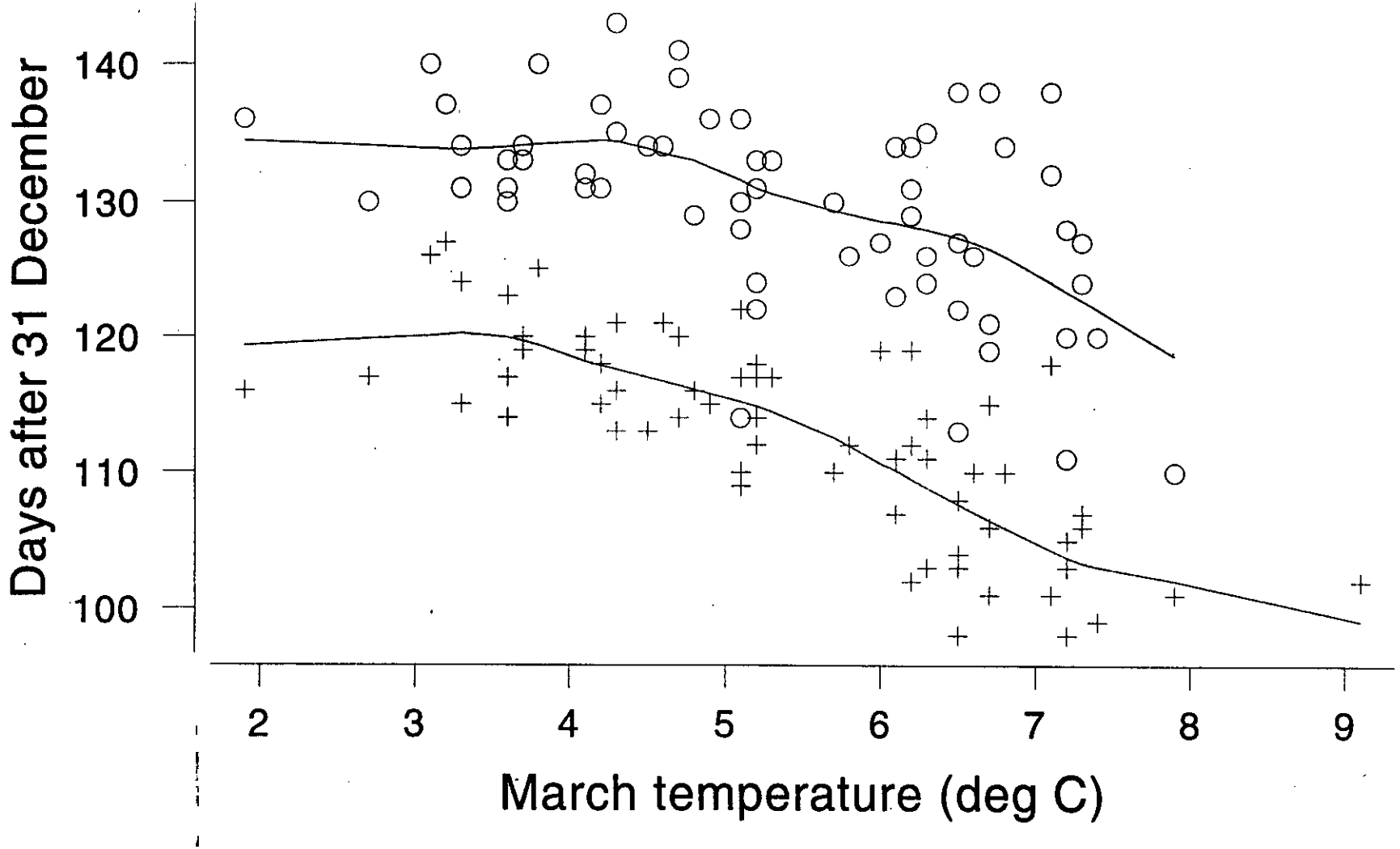
Dover, Sparks & Greatorex-Davies. Figure 4. (DSG4.mgf)

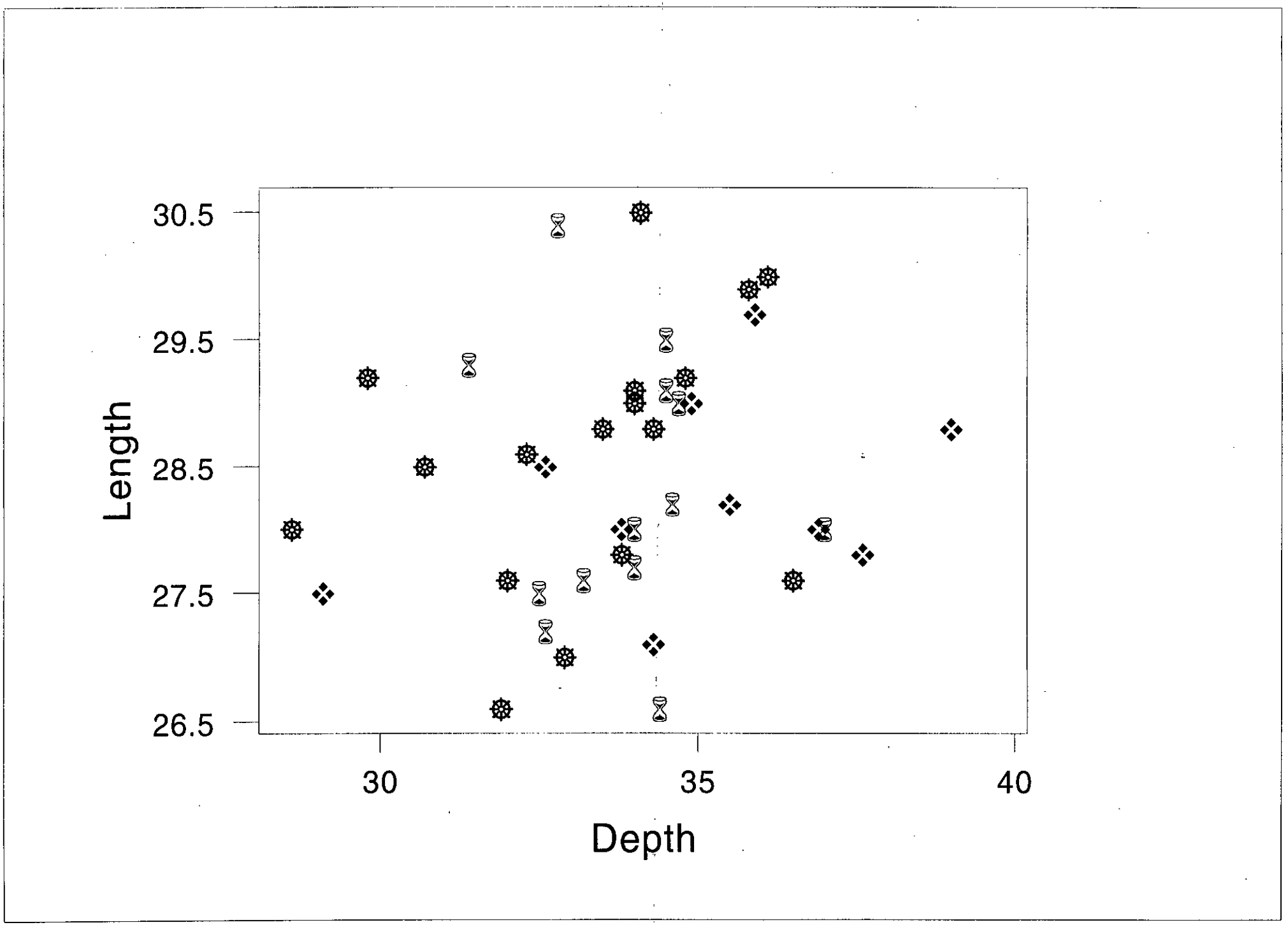


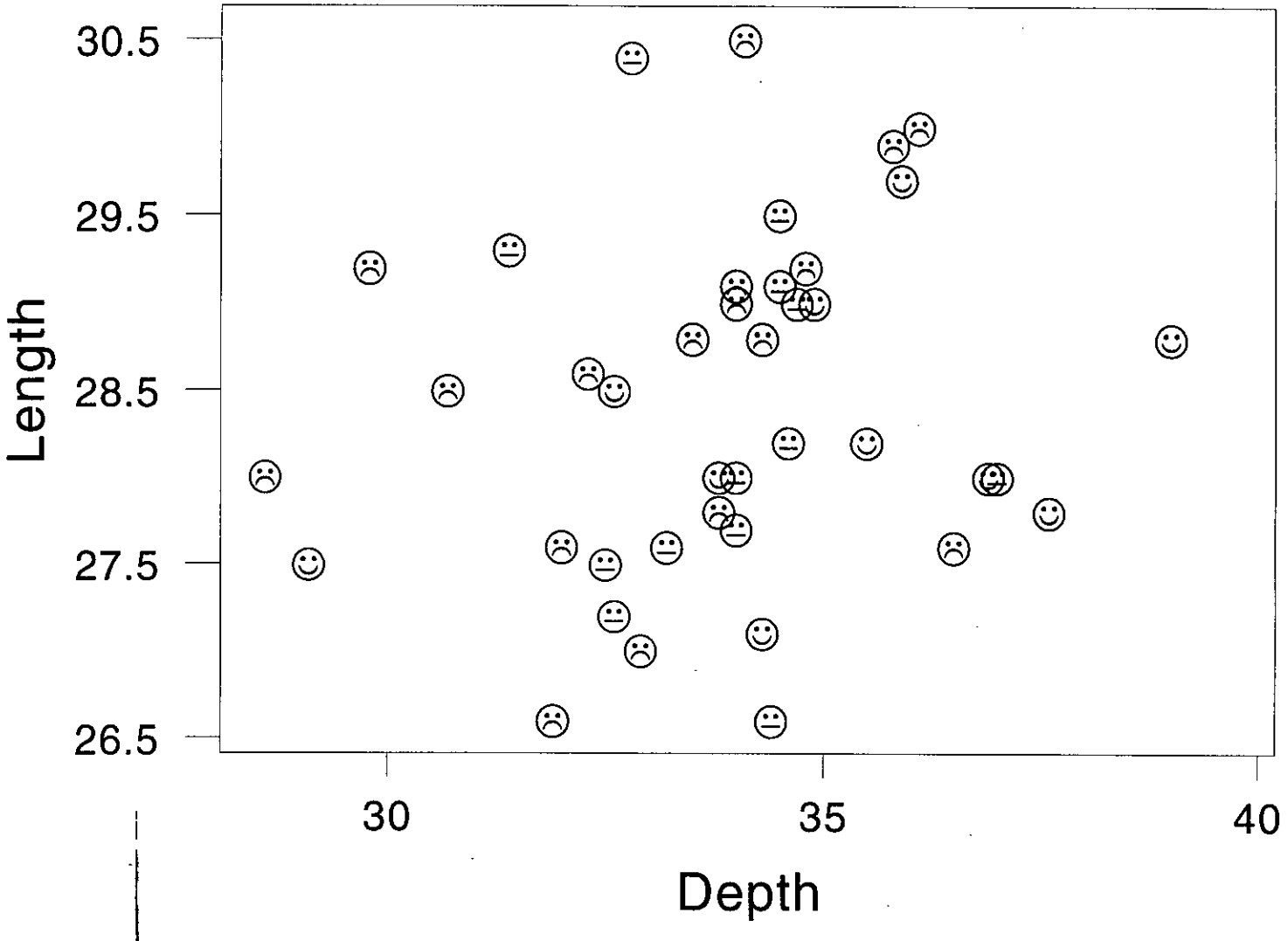
Butterfly Species



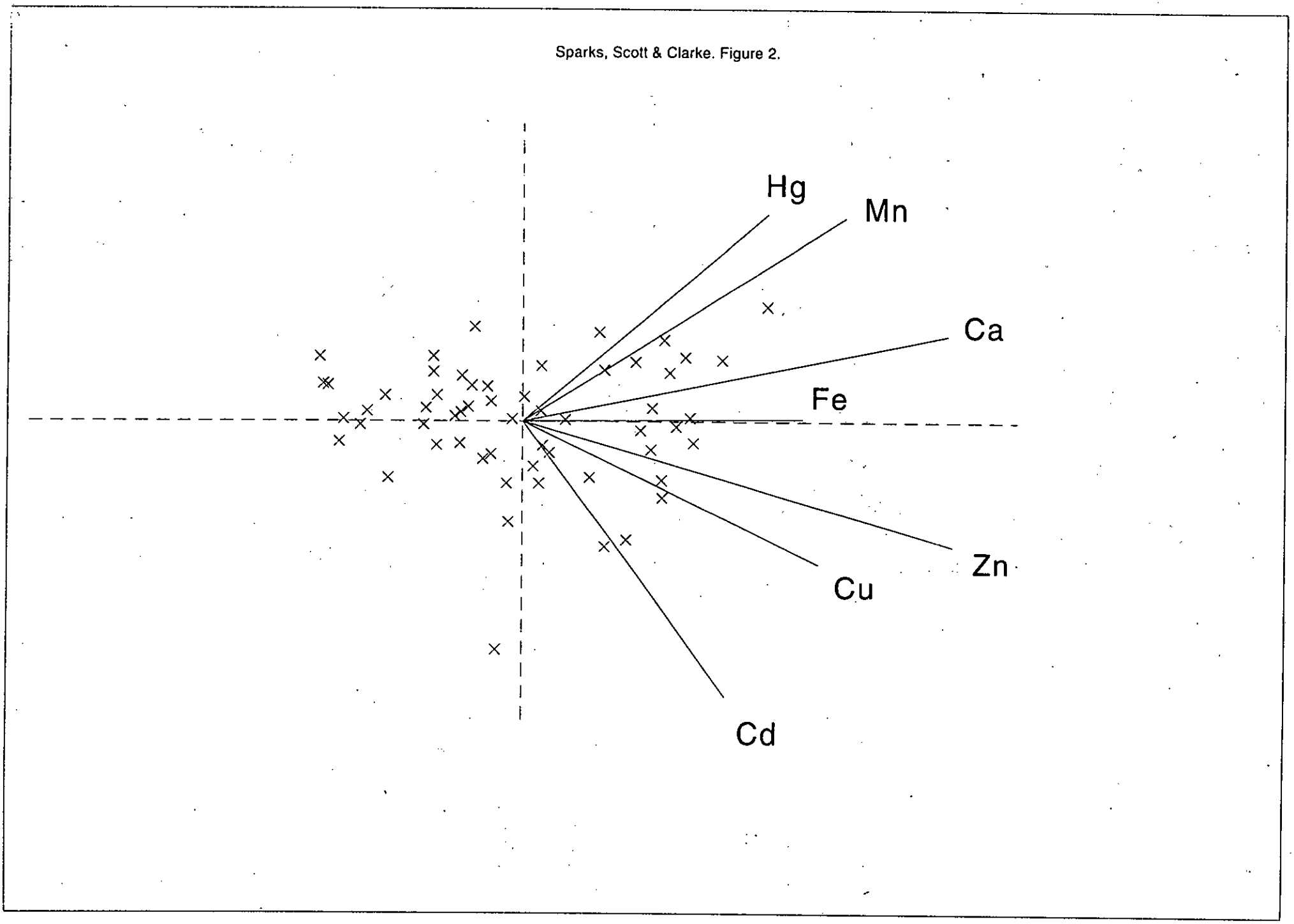
Mean first appearance (England & Wales)
(Garlic mustard flowers (+) and orange tip butterfly(o))



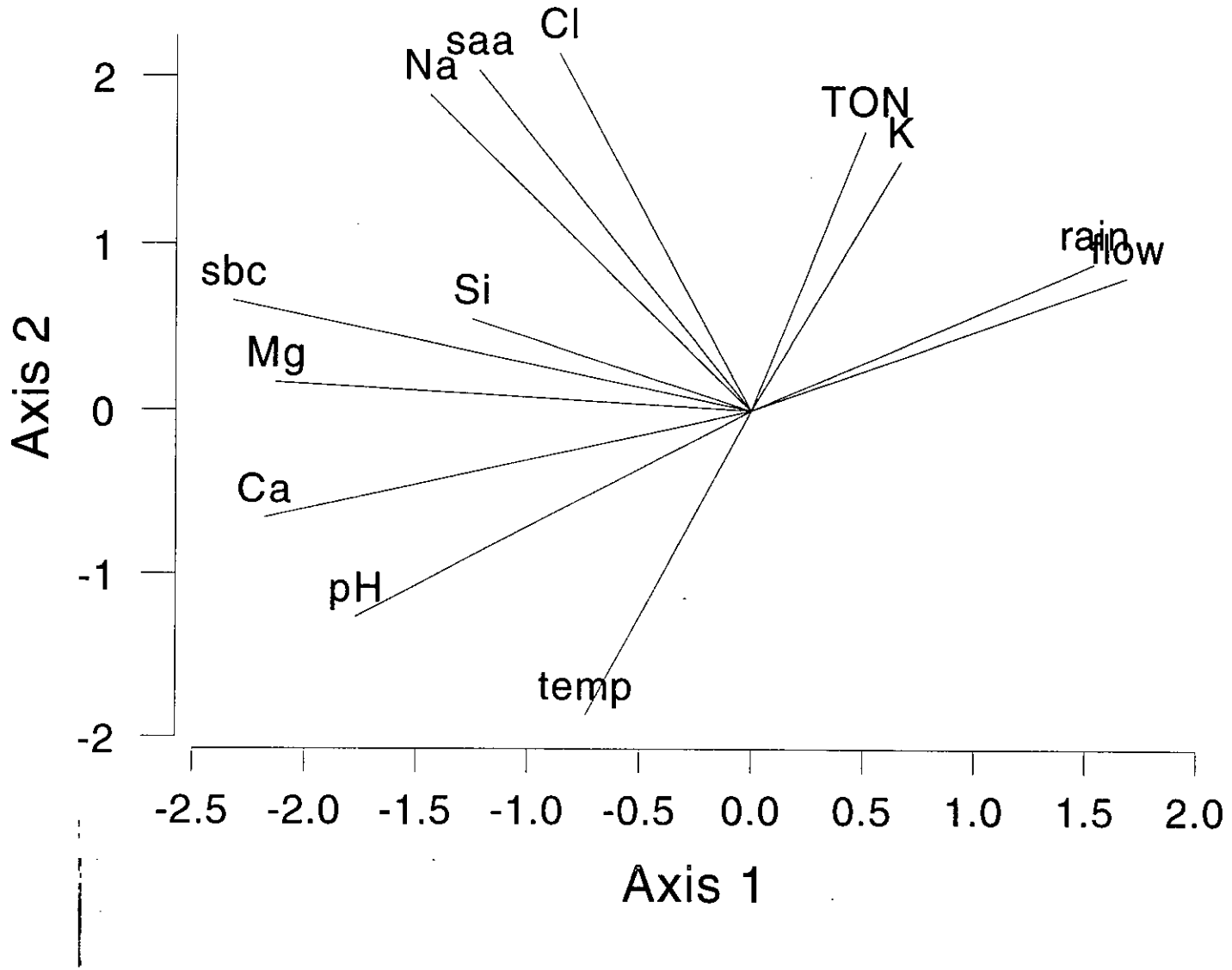

30.5
29.5
28.5
27.5
26.5
Length
30
35
40
Depth


30.5
29.5
28.5
27.5
26.5
Length
30
35
40
Depth

Sparks, Scott & Clarke. Figure 2.



Cyff. All years. 11 variables+temp/rain



Sparks, Scott & Clarke. Figure 4.

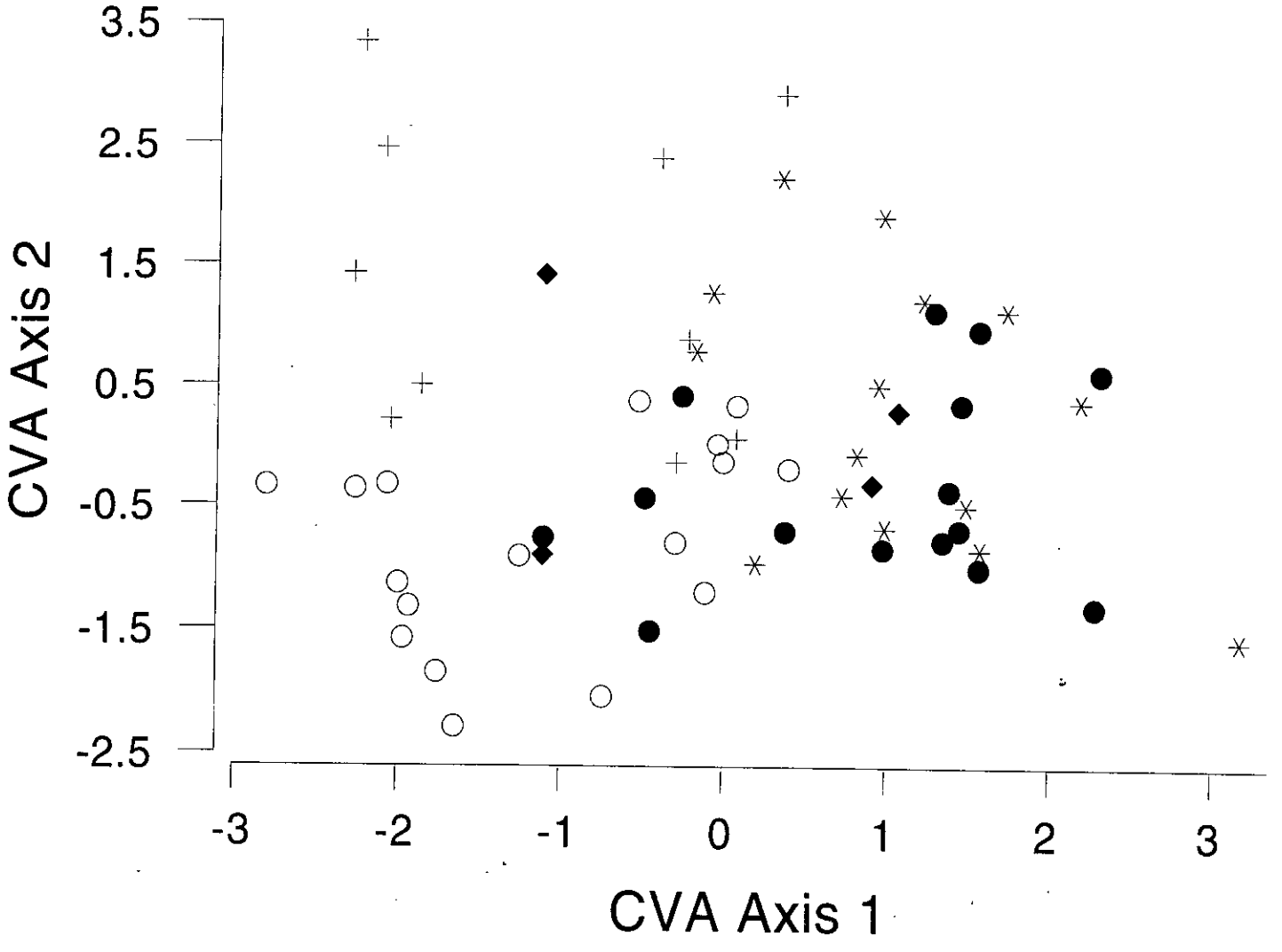
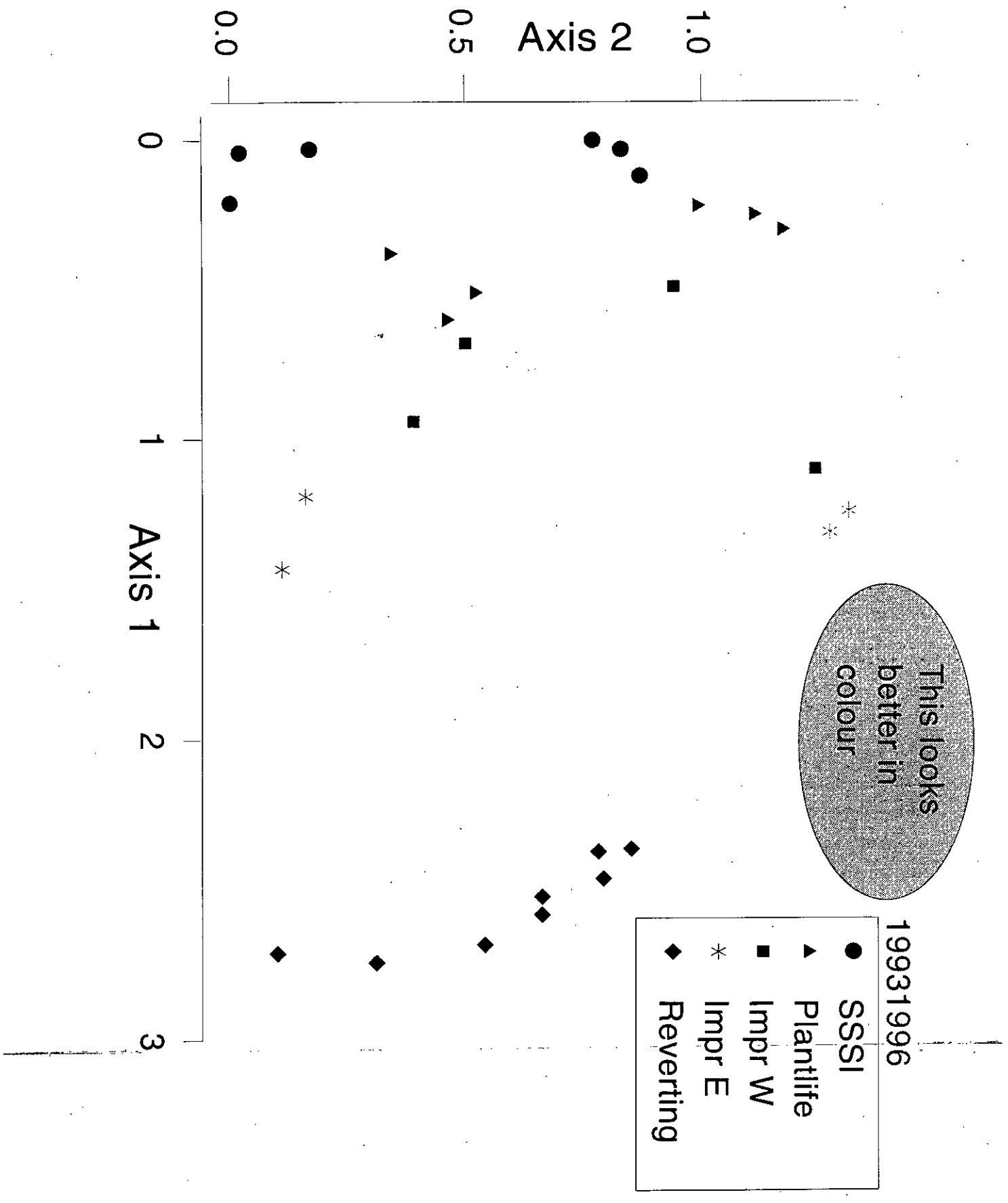
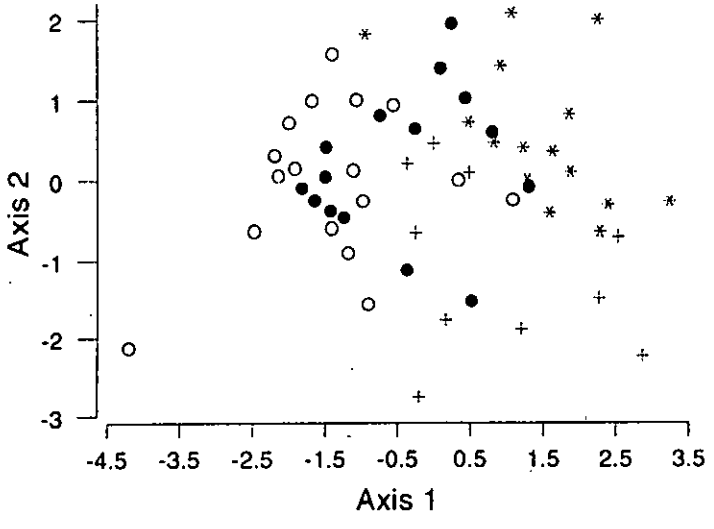


FIGURE 3.1 R. RAY GRASSLANDS: DECORANA plot based upon transect mean values for vegetation composition in 1993 and 1996.

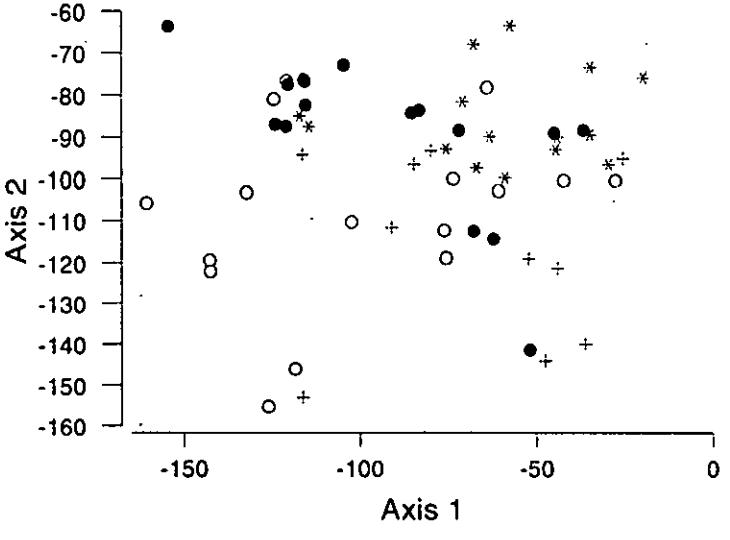


Sparks, Scott & Clarke. Figure 1.

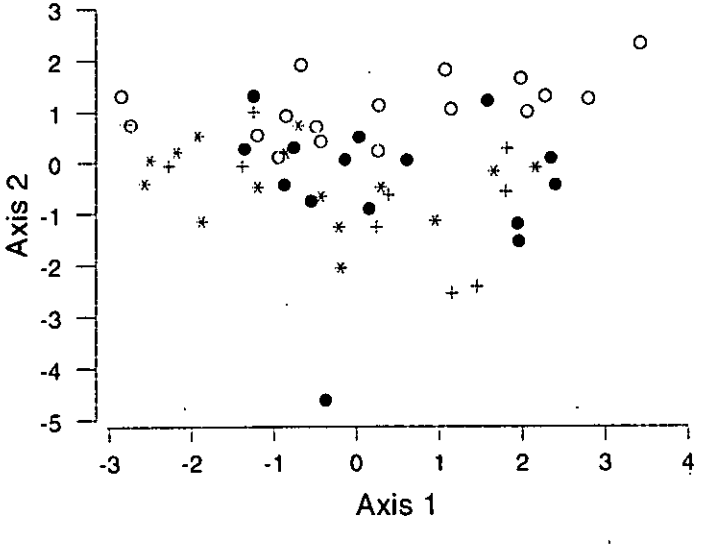
a)



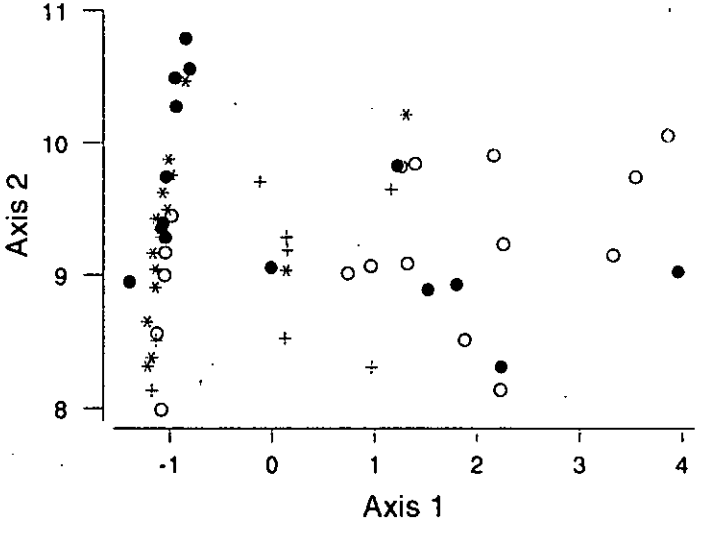
b)

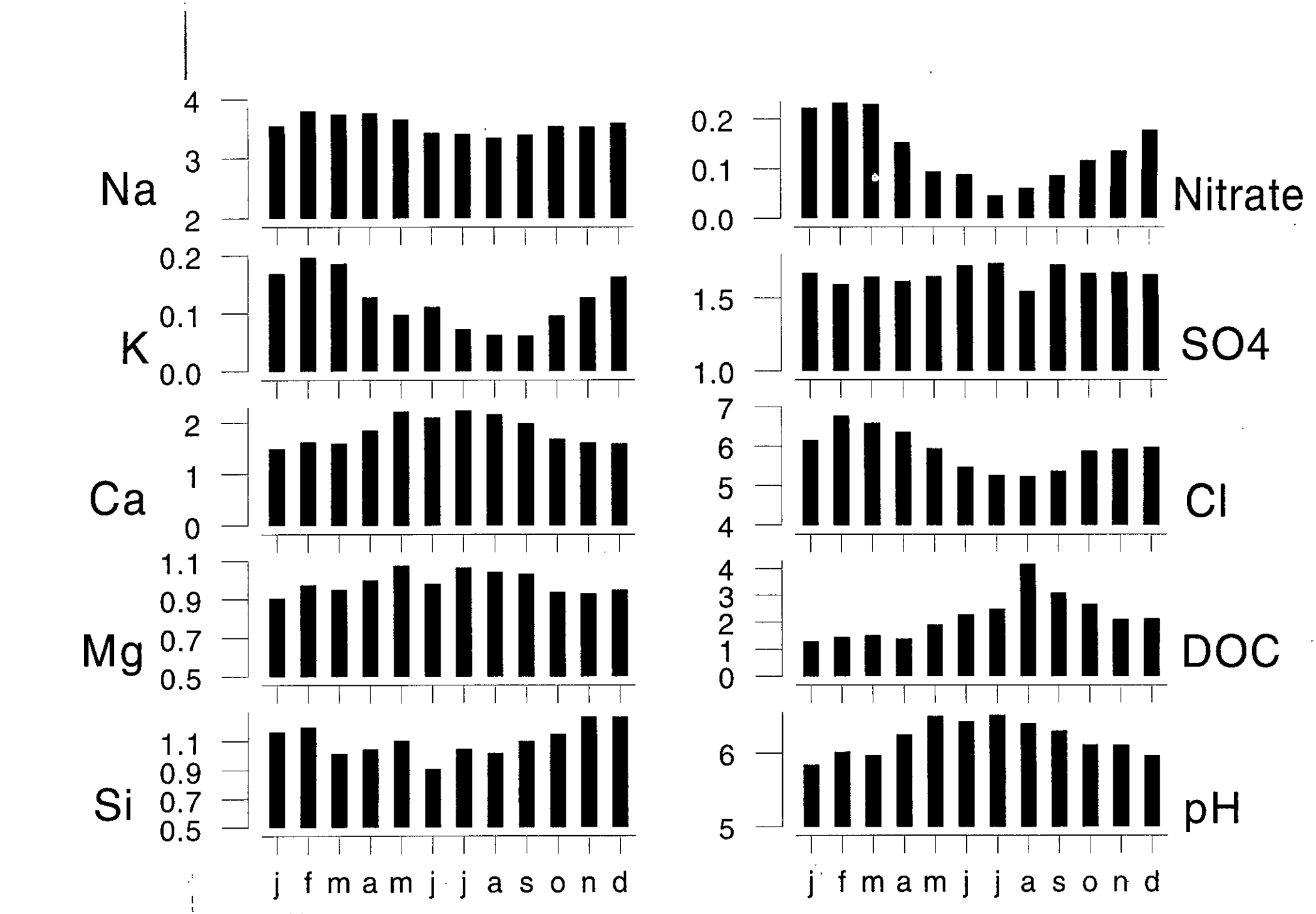


c)

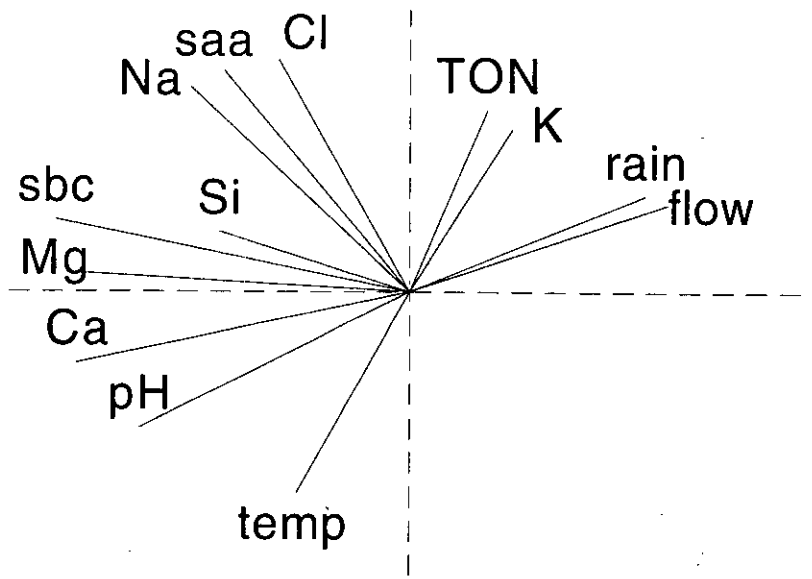


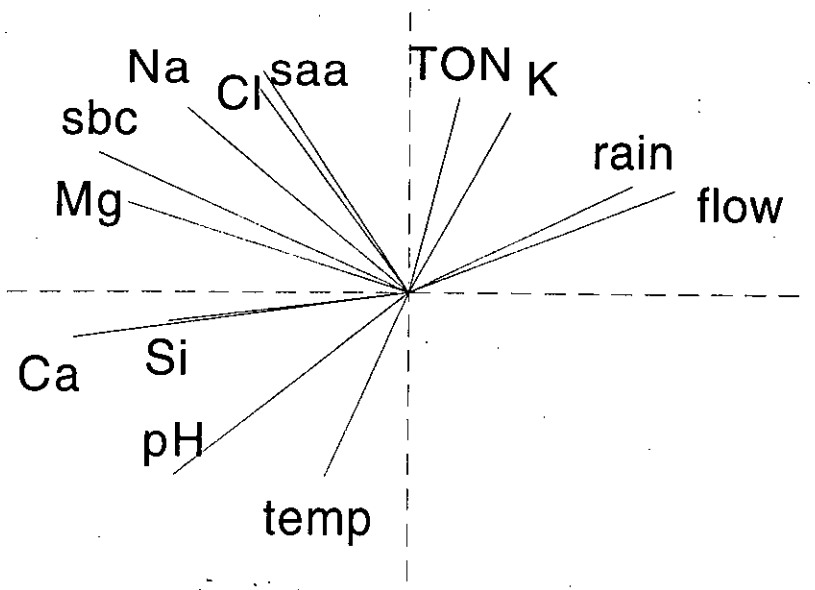
d)



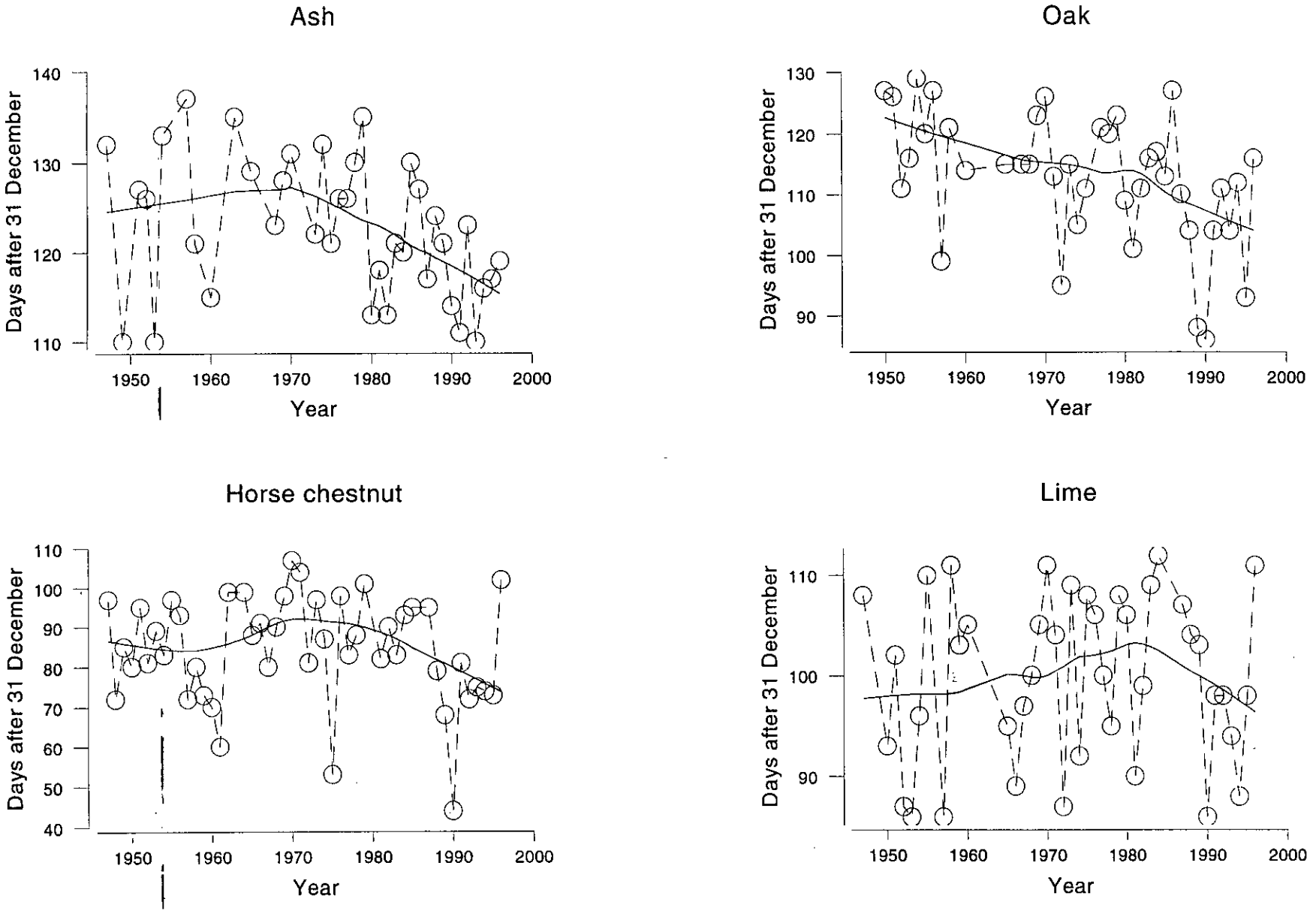


Cyff. Units (in legend?)

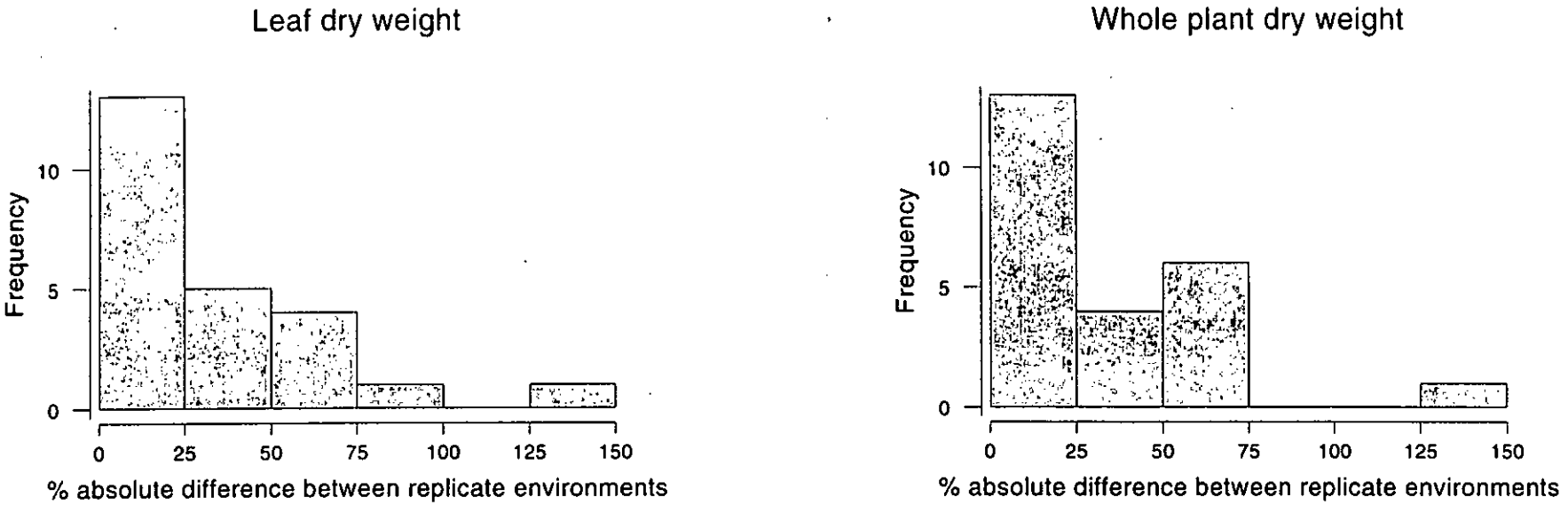

saa
Cl
Na
TON
K
rain
flow
sbc
Si
Mg
Ca
pH
temp


Na
Cl
saa
TON
K
sbc
rain
Mg
flow
Ca
Si
pH
temp

Sparks, Carey & Combes Figure 1



Sparks, Bailey & Elston. Figure 2.



Sparks and Yates Fig. 4.

Fig. 4a

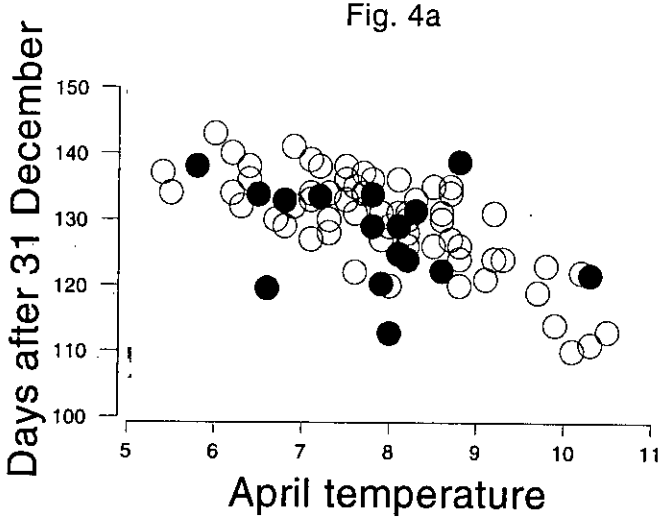


Fig. 4b

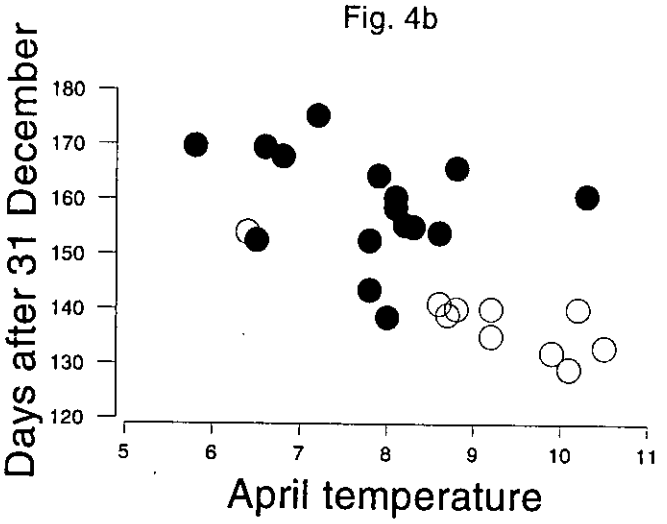


Fig. 4c

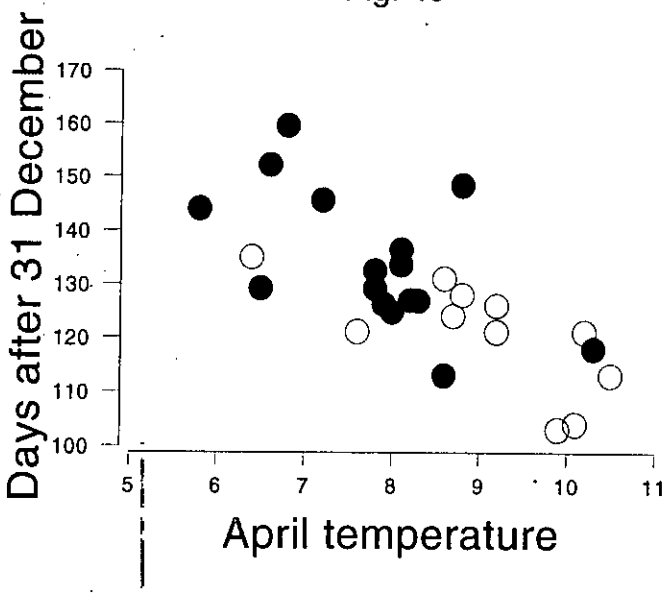
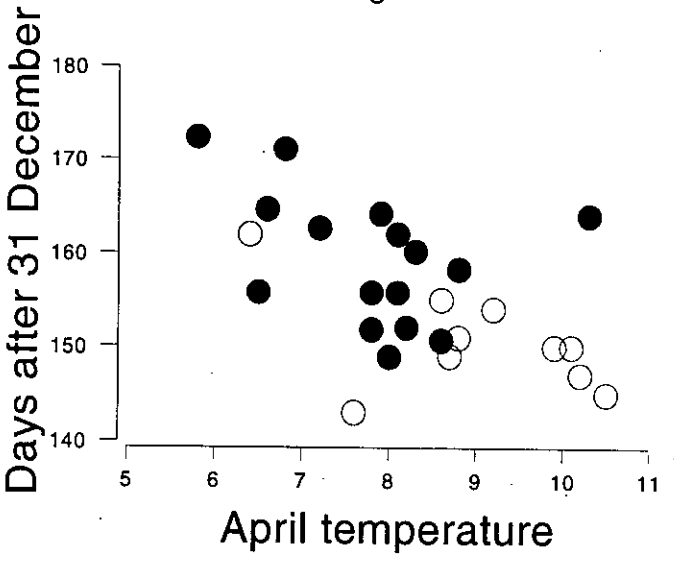


Fig. 4d



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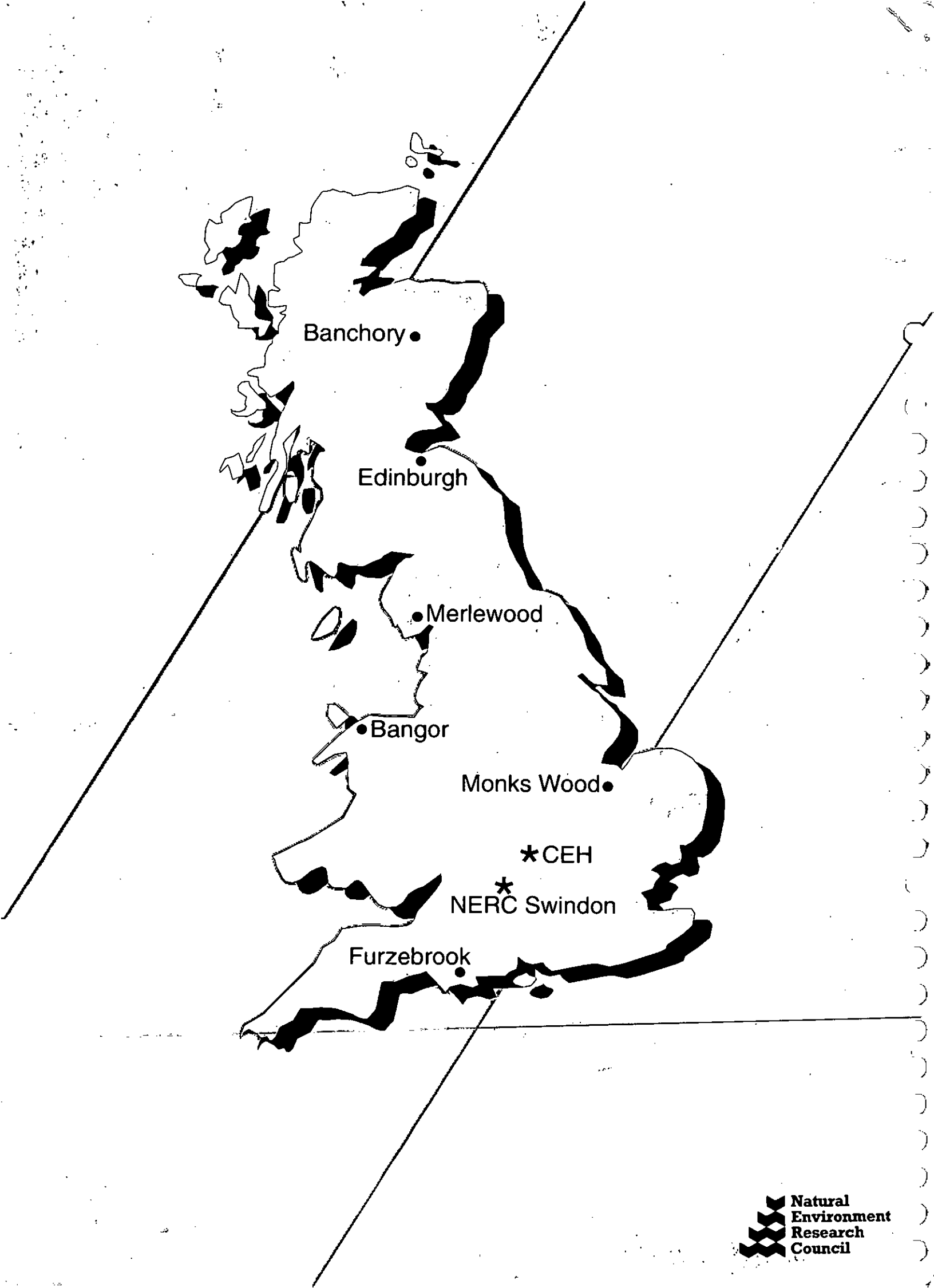
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