
P4

Python Palaeo Plotting Program

Version 0.1

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1 Introduction

P4 is a Python program used to display palaeo style data such as pollen, testate amoebae, or macrofossils. The program permits the rapid production of high-quality figures. The program produces plots such as those in figure 1 and figure 2. Additional annotations are possible within P4 but 'complex annotations' are often best added to the output via a separate drawing package outside of P4 such as Inkscape or CorelDraw for example. Svg files exported to Inkscape allow easy manipulation and final production. However, complete figures can be produced within P4. The program has not been built to do any complex statistics or even produce percentage data it purely plots the data the user provides. All features of example plots evident in figures 1 and 2 are editable in P4. One of the example figures (figure 1) is based on Ardkill Bog (ARD) testate amoebae data from Blundell et al. (2008) and the other (figure 2) is based on macrofossil data from Keighley Moor from Blundell and Holden (2015). This program manual primarily uses the testate amoebae data from ARD (Blundell et al., 2008) as an example of how to use the program. However, files required for the KM macrofossil plot are also supplied. Template files are also supplied so these can be filled with entries from scratch or the ARD/KM files can be edited to suit the users requirements. For the program to work these are required to be comma delimited csv files. However, to give added illustration as to how to fill out these files with data the two examples here from KM and ARD are also supplied as excel (.xlsx) files so colour and annotations can be added to allow the user to see more easily the details explained in this manual related to Parameter and Input files. All files supplied are listed below.

PROGRAM FILE

Program file - P4_v01.py

ARD FILES

Parameter file - ARD_Testate_Parameter.csv

Parameter file - ARD_Testate_Parameter.xlsx (for demo only)

Input file - ARD_Testate_Input.csv

Input file - ARD_Testate_Input.xlsx (for demo only)

Extra input file - ARD_Testate_Extra_Input.csv

Extra input file - ARD_Testate_Extra_Input.xlsx (for demo only)

Resultant figure (png) at 150 dpi - ARD_Testate_Plot_150_DPI.png

Resultant figure (png) at 600 dpi - ARD_Testate_Plot_600_DPI.png

KM FILES

Parameter file - KM_Macro_Parameter.csv

Parameter file - KM_Macro_Parameter.xlsx (for demo only)

Input file - KM_Macro_Input.csv

Input file - KM_Macro_Input.xlsx (for demo only)

Resultant figure (png) at 150 dpi - KM_Macro_Plot_150_DPI.png

Resultant figure (png) at 600 dpi - KM_Macro_Plot_600_DPI.png

TEMPLATE FILES

Parameter file - Template_Parameter.csv

Parameter file - Template_Parameter.xlsx (for demo only)

Input file - Template_Input.csv

Input file - Template_Input.xlsx (for demo only)

Extra input file - Template_Extra_Input.csv

Extra input file - Template_Extra_Input.xlsx (for demo only)

1.1 The basic building blocks of the program

The program is written in Python (version 3.7.6) and in a windows operating system is run from the ‘windows’ command terminal. The code can be viewed in any text viewer or ideally a Python Integrated Development Environment (IDE). The code has been tested successfully on computers running Windows 7 and 10. The code has also been tested using a computer running Mac and Linux systems and with a few changes works well. The code has been primarily tested primarily in Windows 7 and 10 with the authors data and some from other palaeoecologists but inevitably there will be some bugs that have not been captured. If reported to the author, he will do his best to fix any found. However, these should be minimal. The code is set up to receive two elements of information from the command line statement used when running the program in the command or terminal window. If the user wants to run it from within an IDE the code would need to be altered slightly. However, this only concerns people with a degree of Python programming experience and a wish to tailor or improve the code. These people will know how to run the code independent of the command line after examining the code and removing the argparse section. Here it is assumed that the reader has no knowledge of Python or even windows/linux/mac command line environment. The reader does not need to have any prior knowledge to use the program other than reading this manual.

1.1.1 Using Windows

Running the code from a ‘windows’ command terminal is how the program has been set up and is a simple operation once configured. This requires minimal time and is a one-off operation. To run via this route, either reinstall Python 3.7.6 (or more recent version) and make sure ‘add Python to PATH box’ is checked (figure 3). The PATH can be added manually later if need be and guides as to how to do that are available on-line. The simplest option is to reinstall Python and check the box. After installing the desired Python version, open a windows terminal by typing cmd into your search window (figure 4). Packages used by the program can be installed using pip by simply typing each of the following commands and waiting for the packages to install after each

command. This only needs to be carried out upon first using the program. Thereafter, the packages will be available.

```
pip install -U pip
pip install numpy
pip install pandas
pip install matplotlib
pip install argparse
```

To run the program via the command line after the above installs the user must change the directory to where the user has saved the program file (P4_v01.py) file using the cd command. For example, to go from C:\Users\Desktop to a directory you may have created at C:\Users\Desktop\Palaeo\P4 you would simply type cd C:\Users\Desktop\Palaeo\P4. Running the program involves a single command once navigated to the correct directory and the input of two pieces of information supplying the **location and name of the parameter file**. The **parameter** file will be explained later but it is essential to supply information related to the plot aesthetics and directions to other files (**INPUT and EXTRA files**) containing the palaeo data to be plotted and taxon specific aesthetics.

Command line statement to run the program

```
python P4_v01.py --input C:\Users\ARD_Testate_Parameter.csv
```

Here it can be seen that the command line statement is made up of the following.

- a) The word python followed by a single space.
- b) The name of the program 'P4_v01.py' and a further space.
- c) Two hyphens and the word 'input' followed by a single space.
- d) The route for the parameter file location followed by a single space.
- e) The file name for the parameter file with the .csv extension included.

Do not execute this command however until you have input file/files and parameter file configured, saved and correctly located.

1.1.2 Using Anaconda in Windows and Linux

Some users may well have Anaconda installed if you are a regular user of python for data science. A separate environment can be made and the packages installed like this instead if so in Windows and Linux. Here the exact versions of the packages are specified but this may not be necessary.

```
conda create -n P4 python=3.7 matplotlib==3.2.2 pandas==1.3.0 numpy==1.18.1
```

Here P4 is the name of the environment to be created (can be any name). The environment can then be activated by the following.

```
conda activate P4
```

After navigating to the location of the P4_v01.py file and the Parameter and Input files (see below for details) the command statement to run the program can then be as follows.

```
python P4_v01.py --input . ARD_Testate_Parameter.csv
```

1.1.3 Linux users

Linux users can use Anaconda as above or can use pip to install required packages. Firstly the user could make a new virtual environment using.

```
python3-m venv P4
```

Then activate the environment with the following.

```
. ./P4/bin/activate
```

Then install dependency packages with the following.

```
pip install -U pip  
pip install numpy==1.18.1 pandas matplotlib==3.2.2 argparse==1.1
```

The use the command line below to run the program.

```
python P4_v01.py --input . ARD_Testate_Parameter.csv
```

1.1.4 Mac users

- a) Install python3. For example, using a package manager like homebrew (<https://brew.sh>) or Macports (<https://www.macports.org/install.php>)
- b) Install pip3 using method as in a).
- c) Using pip3, install argparse, numpy, matplotlib, pandas similar to the windows version above but using pip3.
- d) The input for file location in the Parameter file see subsection 2.2 should be set to /Users/username/path_to_files.
- e) Use the command in the terminal similar to that listed above for windows with a few exceptions to activate the program but with the exceptions evident below.

Then use the following command to run the program.

```
python3 P4_v01.py --input . ARD_Testate_Parameter.csv
```

For those wishing to alter the code or get involved in Python programming the code can also be altered within any text editor but is perhaps best carried out in a dedicated IDE such as Spyder or VSCode. Within an IDE the experienced Python programmer is free to alter the code if they want to tailor it further to their requirements. Before the program is run the user needs

to understand that the program relies on two or potentially three csv files. A combination of one or two input file/files and a parameter file.

1) **Input file** (name must be supplied in the parameter file).

To provide the ‘palaeo data’ and the coding required for aesthetic attributes particular to each individual taxon to be displayed be it testate amoebae data, as in the ARD example file, or macrofossil data in the KM example file, or pollen, diatom or other palaeo data.

2) **Extra input file** (name if used must be supplied in the parameter file).

This file is used if more than one element is required on the same individual plot. For example if reconstructed testate water table depths were to be plotted, instead of a single entry of Mean Water Table depths alone the user may wish to plot error lines with for example a minimum and maximum error, and therefore have three lines (if a line plot was chosen) on the same individual plot as in the example in (figure 1).

3) **Parameter file** (Name can be altered). This name must be used as part of the command line statement to make the program run. (See text above). This file provides the instructions used to customise the more general aesthetics of the plot.

Information on how to configure the two possible input files is detailed in subsection 2.1 and the parameter file in subsection 2.2.

Once the input file/s and the parameter file have been configured and placed in the correct directories running the code via command line or within an IDE will momentarily (takes about 35 seconds for the example plot data provided for KM and ARD) lead to your plot being saved in both the directory and in the format (png, svg or pdf) specified by the user in the parameter file.

The output is plotted in portrait and needs to be rotated for easy inspection. On windows systems simply double click on the file in explorer and the image can be rotated in ‘Photos’ or whatever is the default viewing program. It is best to initially create a png of low dpi, perhaps 150, to reduce production time, that can easily be rotated for inspection until the user is satisfied with the plot. Once satisfied with the output it can be re-plotted as a higher dpi png (perhaps 600 or 800 dpi), or an svg or in pdf format ready for publication use. Adjustments to the data and/or parameters in any of the two or three csv files are needed until the plot is as the user requires. This involves altering any of the two or three possible input/parameter files, then re-saving and re-running the program to see if the changes have produced the desired plot. The program has many checks inbuilt to detect the most obvious user errors and will provide ‘helpful’ messages to help resolve the issue. This of course is an iterative process but after practice with the program the number of these steps and any encountered issues will reduce dramatically. Although the number of possible attributes that can be adjusted in the input and parameter files may appear daunting they are easily altered without the need of numerous windows, clicks or hunting for buttons etc. Many of the inputs required in the input files to control an individual plots’ appearance can simply be copy and pasted across different taxa. Completion of input and parameter files can be remarkably rapid

especially if those provided for the example figures at KM or ARD are used as a starting point and then simply modified. Once the user successfully completes a plot it is likely that many of the parameters and attributes will be similar for subsequent plots so the parameter/input files from the first plot can simply be edited.

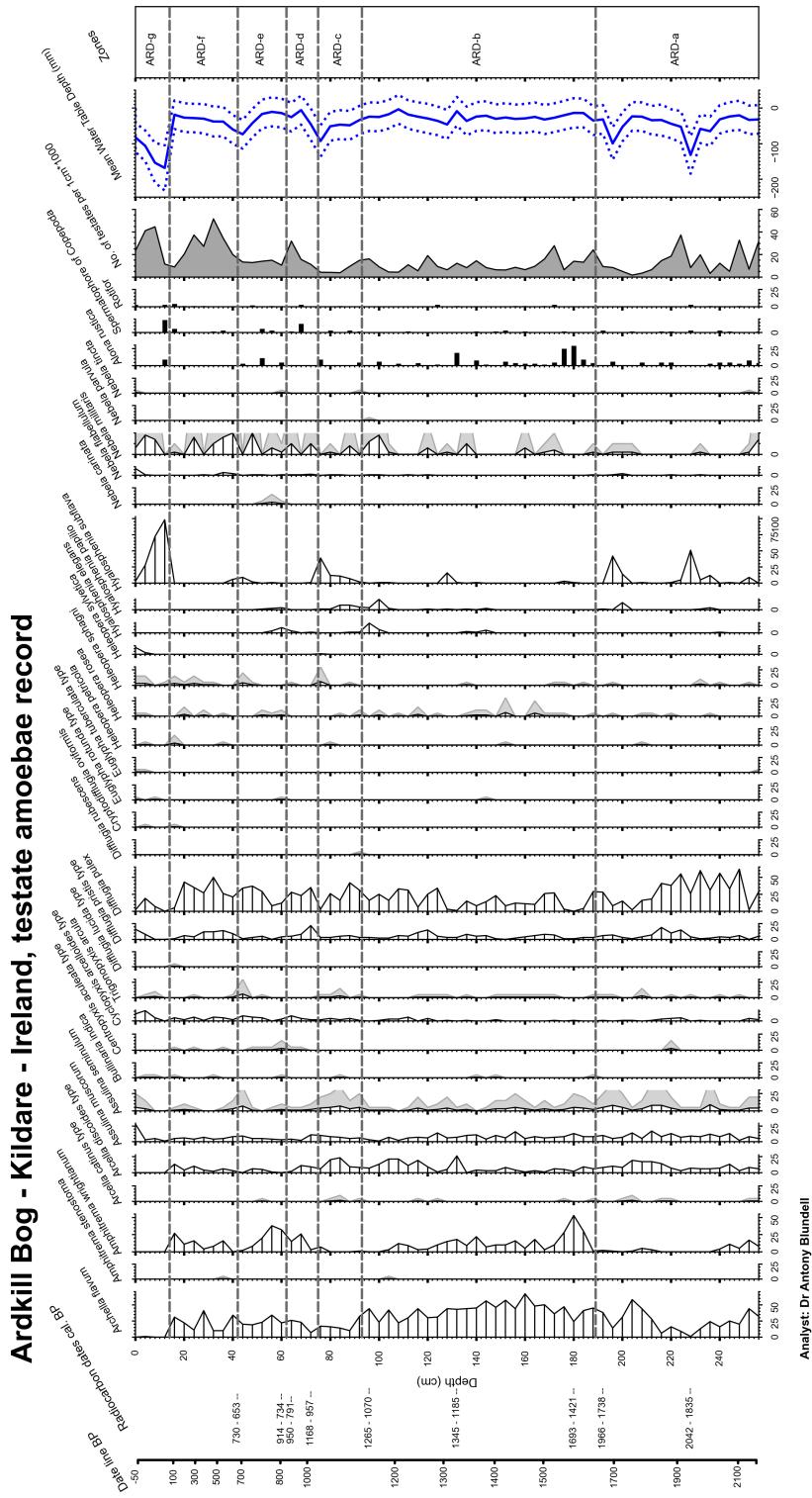


Figure 1: Example of F4 output for testate amoebae data from Ardkill Moss (ARD), Kildare, Ireland (modified from Blundell et al 2008).

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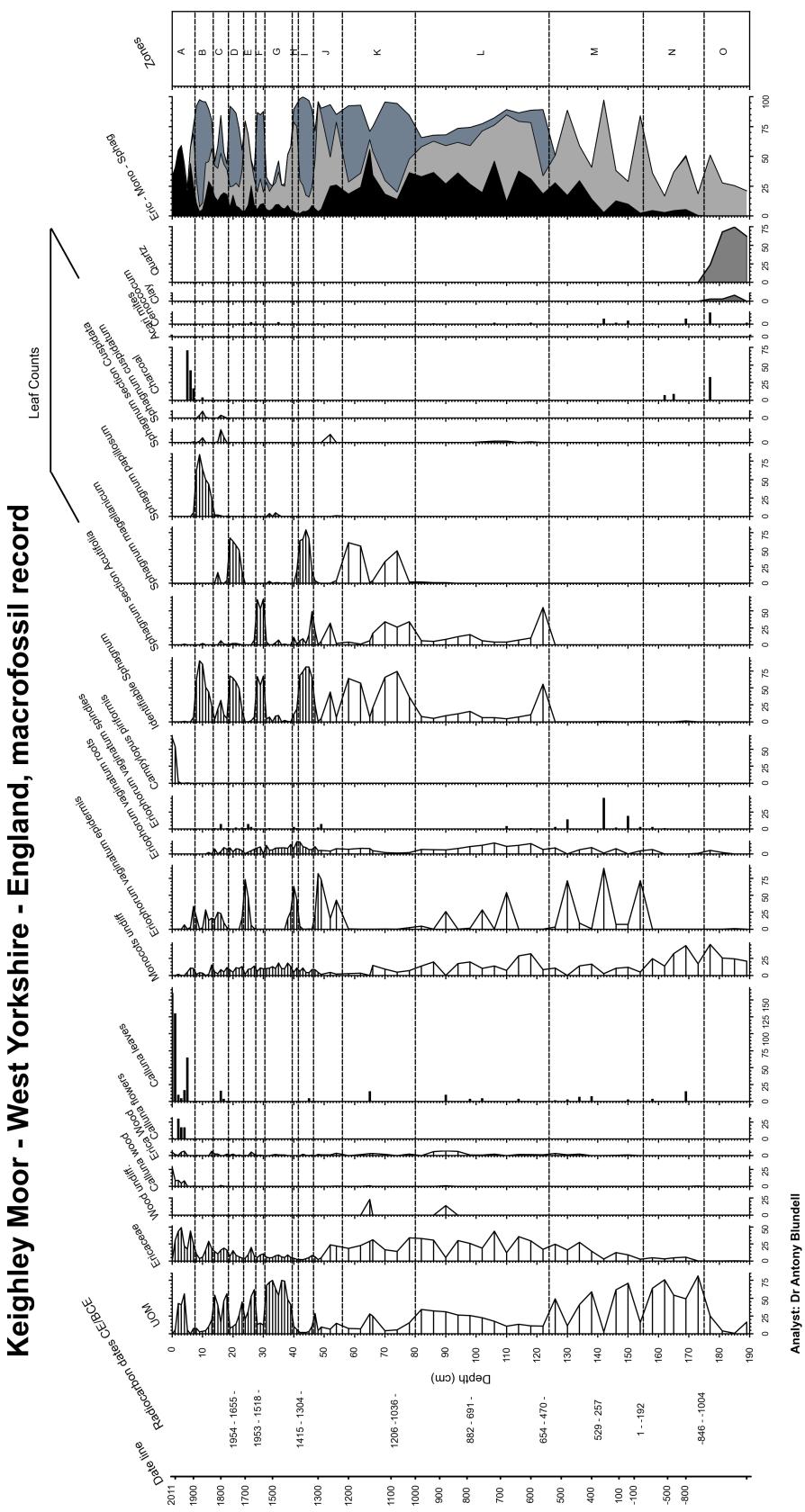


Figure 2: Example of P4 output for macrofossil data from Keighley Moor (KM) in West Yorkshire, England (modified from Blundell and Holden 2015).

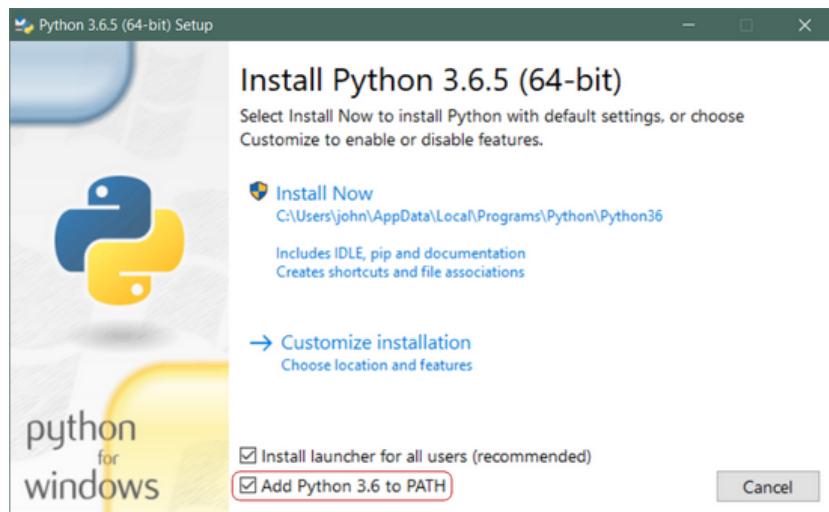


Figure 3: Adding Python to PATH when downloading Python. This figure is just for purposes of illustrating the need to check the Python to PATH box. The program was written in Python version 3.7.6 so it is recommended to use 3.7.6 or above.

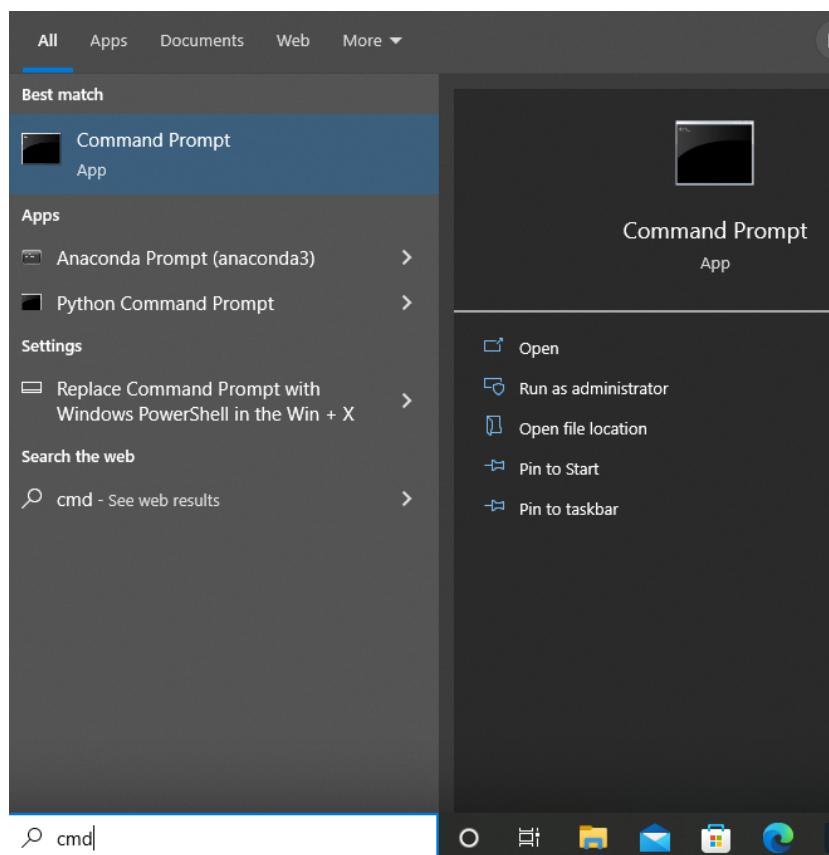


Figure 4: Obtaining command line from search in windows using cmd.

2 Input and Parameter files

2.1 The Input file\s

A blank template is provided for both the main input file (and the Extra input file if required). This can be filled out with the users data and specifications, or the user can modify one of the supplied input files from the KM or ARD examples. The template is called Template_Input.csv and the input file from the examples are ARD_Testate_Input.csv and KM_Macro_Input.csv demonstrating how the csv is configured for these two sites' testate and macrofossil data. Editing of these files is best carried out in either Excel or an Open Office equivalent such as Calc. These files can be edited in a text editor but it is much less convenient. Always save edited files as the same format supplied, as a comma delimited csv file with the csv extension.

ARD testate input file (ARD_Testate_Input.csv) is used here to show how to configure the input file. A screen shot of the layout is evident in figure 5. The figure has reduced number of taxa from the actual csv file and figure displayed in (figure 1) so as to enable display in this manual. The file not only contains the palaeo data (usually abundance of taxa) but also the depths, space for the codes the program employs for defining each graph style and colour and so forth, and some limited information related to configuring zones (if required). Close attention is required as to how the file is laid out and how users should modify it for their own data input. It is easiest to start with the ARD or KM example and modify it.

The first column is Depth. This heading 'Depth' needs to be retained and not altered. The name can be changed for display purposes for the plot in the parameter file if required. The final column is always 'Zones' and must be retained whether zones are required or not. Columns in-between are for the taxa abundances or whatever it is the user is plotting. These are names that will be displayed in the figure for different taxa (The order they come in is the order in which they are plotted). The names supplied here are the names that will appear on the plot so editing them is carried out here in the input file. **If extra space is required for more taxa simply insert a new column/columns between the Depth and Zones columns and add a new name in the initial cell in row 1.** The program does have a limit of 60 taxa/plots per figure. After 60 the figure is getting hard to read anyway and is better split in to two figures for clarity.

The program does not carry out statistical analyses or create percentages, however up to two 'stack' percentage plots can be calculated (see Percentage plot sections below). Numbers in the input file are the numbers that will be displayed. Testate amoebae data for example is often given as percentages so these would be worked out and then added to the input file as percentages. The example file for ARD has a mix (figure 5) of percentage and absolute count data.

In figure 5 there is also 'No of testates per cm³' and 'Mean Water Table Depth' displayed, the latter from a transfer function. These can be seen in the final figure from the full input file in figure 1. The former is an example of when the

large numbers involved would have led to a graph much larger than those of the taxa data (if all scaled proportionately) hence the data is expressed as number of testates *1000 to bring about a similar scale to the taxa. A percentage range is normally 0 - 100 but if count data is likely to far exceed this, for example over 300 it is recommended to create a number x*10 or x*100. This is so the individual graphs can scale proportionately to each other without one graph occupying the entire plotting space. However, both 'No of testates per cm³', and 'Mean Water Table Depth' have been displayed using the Non Standard Scaling (NSC) capability of the program. This is designed for unusual non taxa like data that is to be plotted on very different scales to those of the taxa plots. There are options to display up to five of these type of plots with the taxa plots and may include things like for example, pH or conductivity or anything operating on an unusual scale compared to the majority of the other plots. How to nominate these and set accompanying scales is explained in subsection 2.2.

2.1.1 The input file setup

The input file is set out in a specific way and **rules must be adhered to** for the program to work successfully. The first row contains the 'Depth' label and then the names of taxa the user wants to plot. The final column has the label 'Zones' (figure 5). Often palaeo plots are split into zones of differing assemblages. This column is there to allow a 'Zone' column to be plotted at the end of the entire figure. The zone depths and names are provided in the parameter file (see subsection 2.2). The final column must always be named 'Zones' so adding extra taxa columns is carried out by inserting columns between the Depth and Zones columns in the template files or by modifying space between these columns in the ARD or KM example files. The 'Zones' heading text can be altered in the parameter file to whatever name the user requires. Whether zones are displayed as part of the figure can also be specified in the parameter file. The 2nd to 39th row of the input file contains number codes to inform the program of the various taxon specific aesthetic attributes the user requires such as graph type and various colours. The number codes and their possible entries are listed below. Not all entries are required depending on the graph type selected for the individual taxon. It is easiest to make all entries 0 (zero) to start with and then alter them from there. If many taxa require the same aesthetics then entries can of course be copied across very quickly (often most colours will be black for example or code 1). The graph types (line or scatter etc) that require an entry for the particular attributes listed below are listed next to the attribute title. For example 'Depth Bar Colour' is needed for Graph types 1, 2, 5.

Please see areas of the input file that should not be altered in red (figure 5). Areas in green are there to be edited. If no entry is required leave as 0. The xlsx versions of the various input files supplied show colour coding of grey, areas to not be altered and green where entries can be altered.

Attributes

Graph Type - Required for all taxa/data to be plotted

- 1 = Bar plot
- 2 = Line plot with depth bars and fill colour
- 3 = Line plot
- 4 = Shadow plot (line plot with area below filled in)
- 5 = Line and marker plot
- 6 = Scatter plot (markers only)
- 7 = Option for creating a summary percentage plot (see Percentage plot 1 and 2 below)

Depth Bar Colour - Graphs 1 and 2

Colour of the bars in graph types 1 and 2. Colour codes are listed once here but the same colour codes are used throughout all attributes. For those interested in Python programming these can easily be added to by the user within the program code in the **colour function**. If altered the col_max variable will need to be altered to the new number. So if one more colour is added col_max will change from 23 to 24. col_max is a variable used in user input error checking. Please note American spelling is used here for many instructions within the program such as 'gray' for grey. Colour codes are as follows.

- 1 = black
- 2 = gray
- 3 = dim gray (darker than dark gray)
- 4 = dark grey
- 5 = slate gray
- 6 = light gray
- 7 = red
- 8 = dark red
- 9 = orange red
- 10 = coral
- 11 = green
- 12 = dark green
- 13 = olive
- 14 = light green
- 15 = blue
- 16 = dark blue
- 17 = light blue
- 18 = cyan

19 = yellow
20 = brown
21 = magenta
22 = orange
23 = white

Depth Bar width - Graph 1

Bar width values of 0.5 to 2 are generally appropriate.

Depth Bar width - Graphs 2

Bar width values of 0.5 to 2 are generally appropriate.

Line Style - Graphs 2, 3, 4 and 5

Defines line style for plots with lines (not bars). Line style codes are listed here once and are the same for all line styles throughout the program.

1 = solid
2 = dotted
3 = dashed
4 = dashdot

Line Colour - Graphs 2, 3, 4 and 5

Define line colour. See colour codes above.

Fill Colour - Graphs 2 and 4

Define fill colour. See colour codes above.

Fill Colour Transparency - Graphs 2 and 4

Define fill transparency from 0 - 1. 0 is totally transparent and 1 no transparency.

Line width - Graphs 2, 3, 4 and 5

Define line width. Between 0.5 and 2 is typical.

Marker Type - Graphs 5 and 6

Define marker type. Codes are as follows.

1 = circle
2 = cross
3 = upward facing triangle
4 = downward facing triangle
5 = diamond
6 = asterisk

Marker Size - Graphs 5 and 6

Marker size. Typically between 1 - 5 is big enough.

Marker Face Colour - Graphs 5 and 6

Central colour of marker. See codes above.

Marker Edge Colour - Graphs 5 and 6

Outside colour of marker. See colour codes above.

Marker Edge Width - Graphs 5 and 6

Width of edge line round marker. Typically 0.5 to 1 is sufficient.

Taxon Title Text Colour

Colour for individual taxon title text. See colour codes.

Taxon Title Text Bold

Taxon title text bold or not bold 1 or 0.

Plot Vertical Spine Width

Width of main spine on individual plot. Typically 0.5 to 2 is sufficient

Plot Vertical Spine Style

Style of line used for spine for individual plot. See line style codes above.

Plot Vertical Spine Colour

Colour of line used for spine for individual plot. See colour codes above.

Plot Left Spine Width, Plot Left Spine Style, Plot Left Spine Colour, Plot Right Spine Width, Plot Right Spine Style, Plot Right Spine Colour

These are all as for vertical spine above.

X Tick Major Colour

Colour of major ticks on what is typically the depth axis. See colour codes above. Unlike all other attributes, this and X Tick Minor Colour, Y Tick Major Colour and Y Tick Minor Colour are available for the zones plot column if it has been specified in the parameter file. As seen in Figure 5 these entries have been altered to values of 1, indicating black, for the input example for ARD_Testate_Input.csv .

X Tick Minor Colour

Colour of minor ticks on what is typically the depth axis. See colour codes above.

Y Tick Major Colour

Colour of major ticks on what is typically the taxon abundance axis. See colour codes above.

Y Tick Minor Colour

Colour of minor ticks on what is typically the taxon abundance axis. See colour codes above.

Exaggeration multiplier

If exaggeration is required on the taxon plot add the multiplier required. To exaggerate the plot by 5 times add a 5 etc. Leave as 0 if no exaggeration required. See exaggeration applied on the ARD plot in figure 1.

Exaggeration graph type

Exaggeration is only allowed on graph types 2, 3 and 4 and the graph type used for the exaggeration can be either graph type 3 (line) or graph type 4 (line with fill below or just fill). If not required leave as 0.

Exaggeration fill colour

Colour used for the fill of the exaggeration if graph type 4 has been specified as the exaggeration graph type. See colour codes above or leave as 0.

Exaggeration fill transparency

Define fill transparency from 0 - 1. 0 is totally transparent and 1 is no transparency. If not required leave as 0.

Exaggeration line colour

Define line colour for exaggeration. See colour codes above. If not required leave as 0.

Exaggeration line width

Define exaggeration line width. Between 0.5 and 2 is typical. If not required leave as 0.

Exaggeration line style

Define exaggeration line style. See line style codes above. Leave as 0 if not required.

Percentage plot 1

Here groups are nominated to be included in a percentage summary stack graph. The user should code the taxa to be grouped together using numbers. For an example see entries for KM in the KM_Macro_Input.csv file. Taxa within the Ericaceae, Monocots and *Sphagnum* groups have been entered as 1, 2 and 3. These are plotted as a stack graph (See figure 2). These groups can also be made into new percentages based on the total of all the groups provided if required. This needs to be specified in the parameter file which is explained in subsection 2.2. In the input file a new column must be inserted and called whatever you like for the Percentage summary plot and the attributes in rows 2 to 27 filled in correctly. The number of groups is presently limited to five. The numbers 1-5 for groupings need to be employed. So if there are 3 groupings use numbers 1-3 to group them as in the example KM file.

Percentage plot 2

Here there is the option to have a second percentage summary stack graph. See instructions for Percentage plot 1 above.

Once your data and codings have been added the input file should be saved with a name and in a folder of the users choice as a **comma delimited csv file**. Please note this program does try to give the user warnings if the data you have added has an obvious error but not every eventuality will be accounted for in the error checking procedures. If a problem occurs without a useful error message re-trace preparation steps. If there is an error that has not been picked up by the program always keep an original template (the one provided with the program) so inputs can be restarted from a robust base. Data entry for the input and parameter files is quite simplistic so no great problem should be encountered once the user has read this manual.

2.1.2 The 'Extra' input file

Graph types 3, 5 and 6 (line, line and marker, and scatter) can have more than one plot as demonstrated in figure 1 for the Mean Water Table Depth (mm) plot. To do this a further file is required that is essentially a repeat of the input file. For the ARD data ARD_Testate_Extra_Input.csv is used (figure 6). For extra plots to be drawn the same taxon name (contained in main input file) must be contained within the Extra files taxa name. For example the ARD_Testate_Extra_Input.csv file for the ARD data the additional two lines to be plotted on the Mean Water Table Depth (mm) plot are called Mean Water Table Depth (mm) 1 and Mean Water Table Depth (mm) 2. The ARD_Testate_Extra_Input.csv file contains the same first two columns as the main input file followed by the additional data for the extra plots. The attributes can be altered as for the main input file. This additional csv input file can be called anything (here it is called ARD_Testate_Extra_Input.csv) but the name needs to be nominated in the parameter file. If this functionality is not required the entry in the parameter file 'Extra input file name' (see below) should be 'none'. Otherwise add the name such as ARD_Testate_Extra_Input.csv. This additional file should be saved in the same location as the main input file that is nominated in the parameter file (see below).

2.2 The Parameter file

This file contains all the more general non taxon specific user defined parameters that can be altered to change the appearance of the plot. Part of the parameter file for the ARD example data used here (ARD_Testate_Parameter.csv) is shown in figure 7. Column A (first column) is used by the program to locate the different parameters and Column C (third column) provides description and instruction to the user for each parameter. Only Column B should be edited by the user. **Do not change column A or C** or the program may not function correctly. The xlsx version of parameter files supplied show areas of grey that are not to be altered and areas of green where entries can be changed. These files are for illustration only all as all input and parameter files must be saved as csv files. Columns can be more easily read when opened in Excel or Open Office Calc if the column widths are expanded, and column text is centred for Column B. The file can of course be edited in notepad, wordpad, or any text editor but it is easier to follow in either Excel or the Open Office equivalent. Parameters are arranged in 15 logical groups separated by empty rows. Parameters followed by double ** are essential and must have entries or

the program will ask for them and close. The notes in column C are relatively self-explanatory but further explanation is provided below. The parameter file can be saved with any name as long as it is a comma delimited csv file with the .csv extension and can be placed in any location. The parameter file name and the route to it are required in the command statement in the windows command window to run the program (subsection 1.1).

2.2.1 PARAMETER GROUPINGS

Group 1 Files / Directories

Directory**

Provide the location route of the input file containing the main palaeo data. See the example in the example parameter files for ARD/KM here. **Make sure the levels of the route are separated with backslashes.**

C:\Users\

****This is where the main and extra (if required) input files with palaeo data are to be located and where your completed plot will be sent.****

Input file name**

Add the input file name with .csv extension.

Extra input file name**

Add the additional file name with .csv extension used for supplying data for multiple lines on plots. If no additional extra input file is required 'none' should be entered.

Output file name**

Add file name for the output image. Do not supply extension as that is dictated by the **Save_as** choice detailed below. The output is saved in the location specified in the **Directory** location supplied above.

Save as**

Select the required file type for output figure. Can be png, pdf or svg. Once the user is happy with the plot all available formats can be requested at once by simply separating each entry with a comma as such png, svg,pdf and all will be saved with the same output name. It is not recommended to do this when simply building the plot as the extra saving procedures make the iteration much longer in duration.

Png dpi

State the dpi resolution if png is selected above. For example, 150 for low, 300 for medium, or possibly 600 or higher for high resolution. This number can remain whether using png or not.

	Individual plot parameter titles	Do not change DEPTH title and zeros	Taxon plot parameter values to alter (See text)	Do not change Zones title or zeros
1	Graph 1 title			
2	Graph 1 Depth			
3	Depth Bar colour - Graphs 1,2			
4	Depth Bar width - Graphs 1			
5	Depth Bar width - Graphs 2			
6	Line Style - Graphs 1, 4, 5			
7	Line Colour - Graphs 1, 2, 4, 5			
8	Fill Colour - Graphs 1, 2, 4, 5			
9	Fill Colour Transparency - Graphs 2, 4			
10	Line width - Graphs 2, 3, 5			
11	Marker type - Graphs 5, 6			
12	Marker size - Graphs 5, 6			
13	Marker face colour - Graphs 5, 6			
14	Marker edge colour - Graphs 5, 6			
15	Marker edge width - Graphs 5, 6			
16	Marker edge style - Graphs 5, 6			
17	Text colour - Text Colour			
18	Text Title Text Bold			
19	Plot Vertex Spine Width			
20	Plot Vertex Spine Colour			
21	Plot Edge Spine Width			
22	Plot Edge Spine Colour			
23	Plot Edge Spine Colour			
24	Plot Right Spine Colour			
25	Plot Right Spine Style			
26	Plot Right Spine Colour			
27	X Tick Major Colour			
28	X Tick Minor Colour			
29	Y Tick Major Colour			
30	Y Tick Minor Colour			
31	Euclidean algorithm			
32	Euclidean algorithm - Graph 3 or 4			
33	Euclidean algorithm colour - Eu-style Graph 4			
34	Euclidean algorithm transparency - Eu-style Graph 4			
35	Euclidean algorithm colour - Ex-style Graphs 1-4			
36	Euclidean algorithm transparency - Ex-style Graphs 1-4			
37	Percentages plot 1			
38	Percentages plot 2			
39	DATA			
40	DATA			
41	DATA			
42	DATA			
43	DATA			
44	DATA			
45	DATA			
46	DATA			
47	DATA			
48	DATA			
49	DATA			
50	DATA			
51	DATA			
52	DATA			
53	DATA			
54	DATA			
55	DATA			
56	DATA			
57	DATA			
58	DATA			
59	DATA			
60	DATA			

Figure 5: A simplified version of ARD.Testate.Input.csv from Ardkill Bog (Blundell et al., 2008). Vastly reduced number of taxa are shown here to aid display but the full extent can be seen in the ARD.Testate.Input.csv file. Areas encased in green boxes are editable whereas those within red boxes should not be edited.

A	B	C	D	E
	DEPTH	Mean Water Table Depth (mm) 1	Mean Water Table Depth (mm) 2	Zones
1	0	3	3	0
2 Graph Type	0	0	0	0
3 Depth Bar Colour - Graphs 1, 2	0	0	0	0
4 Depth Bar width - Graphs 1	0	0	0	0
5 Depth Bar width - Graphs 2	0	0	0	0
6 Line Style - Graphs 2, 3, 4, 5	0	2	2	0
7 Line Colour - Graphs 2, 3, 4, 5	0	15	15	0
8 Fill Colour- Graphs 2,4	0	0	0	0
9 Fill Colour Transparency - Graphs 2,4	0	0	0	0
10 Line width - Graphs 2, 3, 4, 5	0	1	1	0
11 Marker Type - Graphs 5, 6	0	0	0	0
12 Marker Size - Graphs 5, 6	0	0	0	0
13 Marker Face Colour - Graphs 5, 6	0	0	0	0
14 Marker Edge Colour - Graphs 5, 6	0	0	0	0
15 Marker Edge Width - Graphs 5, 6	0	0	0	0
16 Taxon Title Text Colour	0	1	1	0
17 Taxon Title Text Bold	0	0	0	0
18 Plot Vertical Spine Width	0	0.5	0.5	0
19 Plot Vertical Spine Style	0	1	1	0
20 Plot Vertical Spine Colour	0	1	1	0
21 Plot Left Spine Width	0	0.5	0.5	0
22 Plot Left Spine Style	0	1	1	0
23 Plot Left Spine Colour	0	1	1	0
24 Plot Right Spine Width	0	0.5	0.5	0
25 Plot Right Spine Style	0	1	1	0
26 Plot Right Spine Colour	0	1	1	0
27 X Tick Major Colour	0	1	1	1
28 X Tick Minor Colour	0	1	1	1
29 Y Tick Major Colour	0	1	1	1
30 Y Tick Minor Colour	0	1	1	1
31 Exaggeration multiplier	0	0	0	0
32 Exaggeration graph type - Graph 3 or 4	0	0	0	0
33 Exaggeration fill colour - Ex style Graph 4	0	0	0	0
34 Exaggeration fill transparency - Ex style Graphs 4	0	0	0	0
35 Exaggeration line colour - Ex style Graphs 3,4	0	0	0	0
36 Exaggeration line width - Ex style Graphs 3,4	0	0	0	0
37 Exaggeration line style - Ex style Graphs 3,4	0	0	0	0
38 Percentage plot 1	0	0	0	0
39 Percentage plot 2	0	0	0	0
40 DATA	0	-123.2	-41.76	100
41 DATA	4	-149.4	-62.84	100
42 DATA	8	-209.48	-97.7	100

Figure 6: View of EXTRA.csv file allowing extra lines to be plotted on Mean water table depth (mm) plot

Only edit this area of the parameter file. Explanations as to the meaning of each parameter are given in column C. Do not alter anything in column A or C only Column B is to be altered with user preferences. There are many more parameters, this is just the upper screen shot of the ARD Parameter file.

Figure 7: Screen shot of the parameter file showing some of the parameter names used by the program in column A, the parts the user should change in column B and explanations/directions for the individual parameters in column C. Parameters are grouped in to 15 logical groupings. Only alter entries in column B.

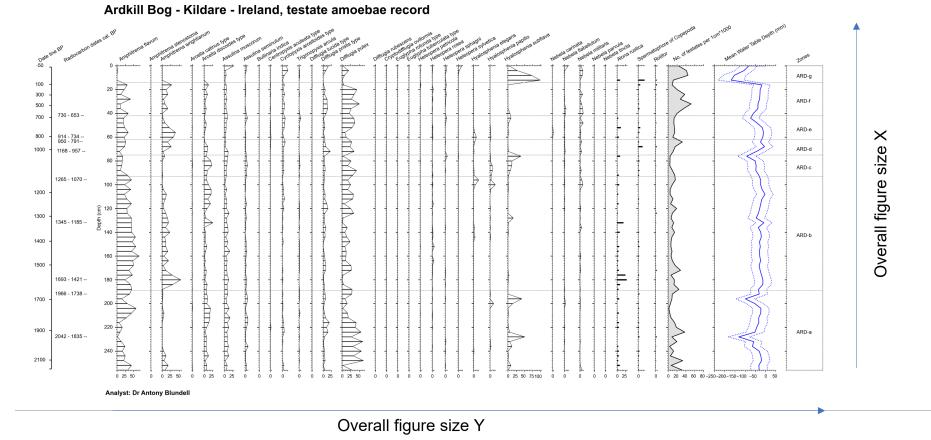


Figure 8: Arrows showing overall size in X and Y.

Group 2 Overall size

Overall figure size X**

Overall X size of figure in centimetres. The plot is formed in portrait, so X here refers to the depth axis side of the figure dimension (figure 8).

Overall figure size Y**

Overall Y size of figure in centimetres. The plot is formed in portrait, so the Y here refers to the length of the figure from the initial depth axis to the zone part of the figure if specified (figure 8).

Group 3 Overall font

Font style**

Choose the font style for the entire figure. Possible options include those below. These must be entered in lower case as below. Do not leave spaces after the entry.

arial, calibri, dejavu sans, times new roman

Group 4 Overall title

Overall title text

Supply the text required for the overall title.

Overall title text on/off**

Whether a title is displayed or not. An entry of 'on' or 'off' is required.

Overall title Y position

Position of start of title in 'page units' not 'data units'. 0 is far left on visible page, 1 far right. See example parameter files.

Overall title X position

Position of start of title in page units, not data units. 0 is lowest position on

visible page , 1 highest.

Overall title font size

Font size for overall title text.

Overall title rotation

Rotation in degrees for overall title text. Usually would be 90 degrees.

Overall title gap

Adjusts gap between main title (if specified) and the taxa plots. Adjust between 0 and 0.5.

Overall title text colour

Supply the text colour required for the overall title. See colour codes.

Overall title text bold on/off

Title text bold or not bold. An entry of 'on' or 'off' is required.

Group 5 Footer title

Footer text

Supply the text required for the footer title.

Footer text on/off**

Whether a footer title is displayed or not an entry of 'off' will stop the footer title being plotted, 'on' will permit display.

Footer Y position

Position of start of footer in 'page units' not data units. 0 is far left on visible page, 1 far right.

Footer X position

Position of the start of the footer. Number is in page not data units. 0 is lowest position on visible page and 1 is the highest on the visible page.

Footer font size

Font size for footer title text.

Footer rotation

Rotation in degrees for footer title text. Usually 90 degrees.

Footer text colour

Supply the text colour required for the footer title. See colour codes.

Footer text bold on/off

Footer text bold or not bold. An entry of 'on' or 'off' is required.

Group 6 X title parameters

X title text**

Enter text for the X title. This, as the plot is produced in portrait, is the 'depth' axis in the example plot.

X title font size**

Font size for X title text.

X title rotation**

Rotation in degrees for X title text.

X title text colour**

Colour of X title text. .

X title text bold on/off**

X title text bold or not bold. An entry of 'on' or 'off' is required.

Group 7 X axis parameters

X limit top**

Upper limit of X axis (depth) often 0 cm indicating the surface.

X limit base**

Lower limit of X axis (depth), deepest depth.

X major interval**

Major X tick interval unit (the depth axis, plots are plotted in portrait).

X minor interval

Minor X tick interval unit (the depth axis, plots are plotted in portrait).

X minor ticks on/off**

If 'ON' minor ticks for X (depth) axis are visible. An entry of 'on' or 'off' is required.

X ticks depth axis only**

If this option is OFF depth major and/or minor marks (depending on whether minor have been selected above) are displayed on all axes not just the first plot. An entry of 'on' or 'off' is required.

X major tick length**

Length of major tick marks.

X minor tick length

Length of minor tick marks.

X major tick width

Width of major tick marks.

X minor tick width

Width of minor tick marks.

X label font size

Font size of X axis tick labels.

X label rotation**

Rotation of X label (normally 90 degrees as plot made in portrait). The X labels will typically be numbers relating to for example cm depth.

X label colour**

Colour of X labels. See colour codes.

Group 8 Y axis titles**Y title font size****

Font size for Y title text.

Y title rotation**

Rotation of Y titles in degrees. The Y titles are the names of each taxon.

Group 9 Y axis ticks and labels**Y major tick interval****

Y axis major tick interval (interval applied to all taxon graphs, unless is non standard scaling).

Y minor tick interval

Y axis minor tick interval (interval applied to all taxon graphs, unless is non standard scaling).

Y minor ticks on/off**

If 'on' minor ticks on Y axis are visible. An entry of 'on' or 'off' is required.

Y ticks both ends of plot on/off**

If this is 'on' the program plots taxon abundance axis ticks at both ends of the plot. An entry of 'on' or 'off' is required.

Y major tick length**

Length of Y axis major tick marks.

Y minor tick length

Length of Y axis minor tick marks.

Y major tick width**

Width of Y axis major tick marks.

Y minor tick width

Width of Y axis minor tick marks.

Y label font size**

Font size of Y axis tick labels.

Y label rotation**

Rotation of Y labels (normally 90 degrees).

Y label gap**

Gap between Y axis titles and plots. Between 0.1 and 0.5 is usually sufficient.

Space between plots**

Space between each plot. Between 0.05 and 0.4 is normally sufficient.

Group 10 Zone depths, labels, title, appearance**Zones on/off****

Zones included in plot or not. An entry of 'on' or 'off' is required.

Zone depths

Enter zone depth boundaries separated by commas only. See example in examples parameter files.

Zone labels

Zone labels separated by commas only. See example in example parameter files. If the number of zone depths is not one less than the number of names a warning will be issued and the program stopped.

Zone title

Enter the zone title required.

Zone title font size

Zone title font size.

Zone title rotation

Zone title rotation. 120 degrees in one of the example parameter files.

Zone title colour

Colour of zone title text. See colour codes.

Zone title bold ON/OFF

Zone title in bold or not. An entry of ON or OFF is required.

Zone labels on/off

Zone labels visible or not. An entry of 'on' or 'off' is required.

Zone label font size

Zone label font size.

Zone label rotation

Zone label rotation in degrees. 90 degrees in example parameter files.

Zone label position

Distance from edge of zone boundary of plot in 'data units'.

Zone label colour

Colour of zone labels. See colour codes.

Zone label bold on/off

Zone labels in bold. An entry of 'on' or 'off' is required.

Zone line style

Zone line styles. Add linestyle code for each zone line separated by comma only. See line style coding above and example parameter file.

Zone line width

Width of zone lines. Add line width for each zone line separated by comma only. See example parameter file.

Zone line col list

Colour of zone lines. Add line colour for each zone line separated by comma only. See example parameter file and colour codes.

Zone boundary line left on/off

Zone boundary line left. An entry of 'on' or 'off' is required.

Zone boundary line right on/off

Zone boundary line right. An entry of 'on' or 'off' is required.

Zone boundary line top on/off

Zone boundary line top.

Zone boundary line bottom on/off

Zone boundary line bottom. An entry of 'on' or 'off' is required.

Zone boundary line style

Zone boundary box line style. See line style coding.

Zone boundary line colour

Colour of boundary box zone lines. See colour codes.

Zone boundary line width

Width of zone boundary box zone lines.

Zone X major tick colour

Colour of depth major tick marks for zones if X ticks depth axis only parameter is 'off'.

Zone X minor tick colour

Colour of depth minor tick marks for zones if X ticks depth axis only parameter is 'off' and minor ticks are specified.

Group 11 Radiocarbon titles, depths, labels and appearance

RC ages on/off**

If listed makes RC dates visible or not. An entry of 'on' or 'off' is required.

RC age title on/off

RC title visible or not. An entry of 'on' or 'off' is required.

RC age title

Provide title text for RC dates.

RC age title depth position

Provide depth at which title is to be displayed. Use minus number if is required above the 0 cm position.

RC age title offset position

Specify offset (figure 9) from first plot in data units (RC dates are plotted to side of first taxon plotted next to depth axis). Therefore, likely to be minus number as to side of first taxon plot. See examples in example parameter files.

RC age title font size

Font size of RC title text.

RC age title colour

Colour of RC title text. See colour codes.

RC age title bold on/off

RC title text bold or not bold. An entry of 'on' or 'off' is required.

RC age title rotation

RC title text rotation in degrees.

RC age labels

Provide RC age labels separating each with comma only.

RC age label font size

Font size of RC label text.

RC age labels colour

Colour of RC title text. See colour codes.

RC age labels bold on/off

RC label text bold or not bold. An entry of 'on' or 'off' is required.

RC age labels rotation

RC label text rotation in degrees.

RC age depth label positions

RC depth locations separated by commas only.

Ardkill Bog - Kil

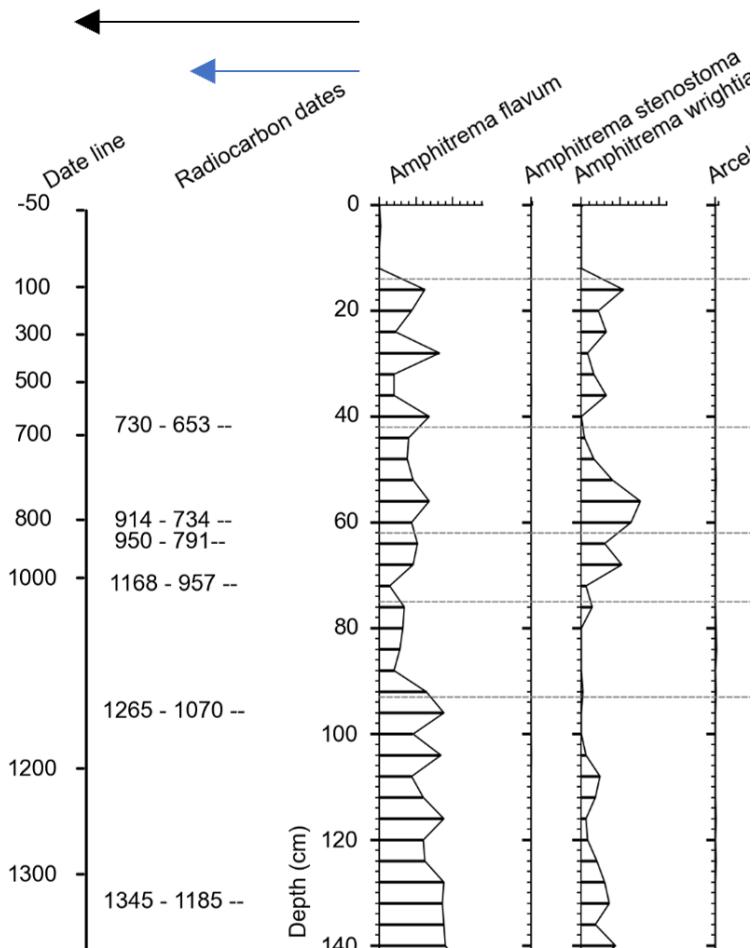


Figure 9: Arrows show minus offset from first plot for both RC and INT dates. Units are data units of the first plot. Offsets are required for the titles, labels and for the INT date line if required.

RC age label position offset

Offset from first plot in data units (RC dates are plotted to side of first taxon plotted next to depth axis, see figure 9). Will be minus number. See example in example parameter files.

Group 12 Interpolated dates title, depths, labels, appearance**INT ages on/off****

If listed makes INT dates and line visible or not. An entry of 'on' or 'off' is required.

INT age title on/off

RC title visible or not. An entry of 'on' or 'off' is required

INT age title

Provide title text for INT dates.

INT age title depth position

Provide depth at which title is to be displayed. Use minus number if is required above the 0 cm position.

INT age title offset position

Specify offset from first plot in data units (RC dates are plotted to side of first taxon plotted next to depth axis). Therefore, likely to be minus number as to side of first taxon plot (figure 9). See example in example parameter files.

INT age title font size

Font size of INT title text.

INT age title colour

Colour of INT title text. See colour codes.

INT age title bold on/off

INT title text bold or not bold. An entry of 'on' or 'off' is required.

INT age title rotation

INT title text rotation in degrees.

INT age labels

Provide INT age labels separating each with commas only.

INT age label font size

Font size of INT label text.

INT age labels colour

Colour of INT title text. See colour codes.

INT age labels bold on/off

INT label text bold or not bold. An entry of 'on' or 'off' is required.

INT age labels rotation

INT label text rotation in degrees.

INT age depth label positions

INT depth locations seperated by commas only.

INT age label position offset

Offset from first plot in data units (INT dates are plotted to side of first taxon plotted next to depth axis). Will be minus number. See examples in example parameter files.

INT lines offset

Offset of date line from first plot in data units (INT date line is plotted to side of first taxon plotted next to depth axis). Will be minus number (figure 9). See example in example parameter files.

INT upper most depth age

Up-most depth of the first INT date to be used at the surface.

INT lines width

Date line line width

INT lines colour

Date line colour. See colour codes.

INT depth lines length

Length of tick lines. This uses data units and is based on the data units in the first plot (abundance for Archella flavum or UOM in either example provided).

INT lines width correction

If tick lines do not meet main line exactly can use correction here to adjust. If no correction needed add 0. This uses data units so if the plot is based around depth as in the examples provided these will be the units.

INT lines length correction

If the main vertical line does not meet main line exactly can use correction here to adjust. If no correction needed add 0.

Group 13 Grouping annotations**Grouping annotation 1 on/off****

Display grouping annotation or not. An entry of 'on' or 'off' is required.

Grouping annotation 1 start

Supply the taxon (y axis plot title) from where the annotation should start from, *Sphagnum* section *Acutifolia* in figure 10 (see examples in example parameter files).

Grouping annotation 1 title

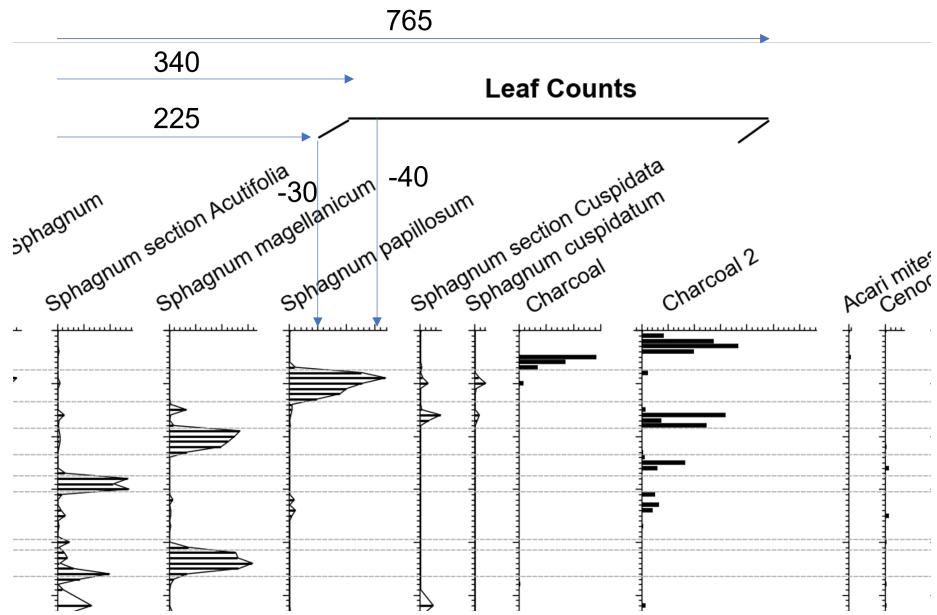


Figure 10: Arrows show dimensions required to draw the group annotation seen in figure 2. The numbers are contained in the parameter file for KM macrofossils and are based on dimensions from *Sphagnum* section *Acutifolia* as nominated in example above.

Supply text for the title of the group annotation.

Grouping annotation 1 title font size

Font size for the text title.

Grouping annotation 1 title bold on/off

Text bold or not bold. An entry of 'on' or 'off' is required.

Grouping annotation 1 title colour

Text colour. See colour codes.

Grouping annotation 1 line colour

Grouping annotation line colour. See colour codes.

Grouping annotation 1 line width

Grouping annotation line width.

Grouping annotation 1 line start x

Offset from nominated start taxon on x axis (depth axis, see figure 10).

Grouping annotation 1 line start y

Offset from nominated start taxon on y axis (abundance axis, see figure 10, example value 280).

Grouping annotation 1 line end x

Offset for end of group annotation from nominated start taxon on x axis

(depth axis, see figure 10, example value -40).

Grouping annotation 1 line end y

Offset for end of group annotation from nominated start taxon on y axis (abundance axis, see figure 10, example value 680).

Grouping annotation 1 tag end x

Offset of end of tag end if required on x axis (see figure 10, example value -35) .

Grouping annotation 1 tag end y

Offset of end of tag end if required on y axis (see figure 10, example value 245).

Grouping annotation 1 tag correction

Grouping annotation vertical correction in data units. If this grouping is being used this must be filled in. The tag part of the annotation occasionally does not meet the horizontal line. If this needs to be corrected it can be done so here using data units. If no correction needed add 0.

Grouping annotation 1 line correction

Grouping annotation horizontal correction in data units. If this grouping is being used this must be filled in. The horizontal part of the annotation occasionally does not meet the tag lines. If this needs to be corrected it can be done so here using data units. If no correction needed add 0.

There are 10 options for including grouping annotations in the parameter file. Groups 2 - 10 annotation attributes are a repeat of Grouping 1 above.

Group 14 Non standard scaling (NSC) 1 - 5, ticks, min and max limits

If taxa data provided is percentage, it is likely to be within 0 - 100 range. However, if also plotting pH for example the range may be from 3.5 to 5. Non std scaling (NSC) elements are for this purpose. Here nominate the exact name of the measure used in the input file and it will be selected to be treated differently to the other taxa data. This is necessary as the plots need to be scaled against each other which posses no problem if they are operating in similar ranges. There are 5 possible places for accommodating data with unusual scaling. These are NSC 1 - 5. Options listed below are available for all 5 but will be listed here just for NSC 1. Please see the example for the ARD_Testate_Parameter.csv file. Elements here are the 'Mean Water Table Depth (mm)' and 'No. of testates per 1cm*1000'. If, as in this example, NSC entries 3 - 5 are not being used then an entry of 'none' is required. If using only two NSC options use NSC entries for NSC 1 and NSC 2. Do not use for example NSC 3, 4 or 5. Clearly if using 4 NSC options use NSC 1 - 4.

NSC 1**

State data name from input file that needs unusual scale. If not in use enter 'none'.

NSC 1 Y major tick interval

Major tick interval for Y axis for NSC 1.

NSC 1 Y minor tick interval

Minor tick interval for Y axis for NSC 1.

NSC 1 Y min

Minimum value on Y axis.

NSC 1 Y max

Maximum value on Y axis.

NSC 1 spine on/off

Is spine required on Y axis. An entry of 'on' or 'off' is required.

NSC 1 size

Width of plot compared to maximum width of other non NSC data. Expressed as percentile so 1 is 100 percent and 1.5 is 150 percent.

NSC spine start 1

Spine to start at 0 or minimum value. An entry of 0 or 'mini' is required.

Group 15 Percentage Stack Plots

If percentage stack plots are required information regarding codes for aesthetics are entered here. At present there is the option for two percentage stack plots although this could be expanded at a later date if it was required. These stack plots are each able to have up to five groups. The example in figure 2 displays three groups Ericaeae, Monocots and *Sphagnum*, shortened to Eric - Mono - Sphag in the title. These groups were specified in the input file KM_Macro_Input.csv and the aesthetic attributes listed below are in the KM_Macro_Parameter.csv file for this example. These can simply be grouped and plotted or they can be grouped and a new percentage of each individual group based on the sum of all groups calculated and that can be plotted instead. These plots by default are plotted at a set size. This can be altered with the Percentage stack plot size attribute (see below).

Percentage stack plot 1 on/off**

Specify if stack plot required or not. Entry of 'on' or 'off'.

Percentage stack plot 1 title

Add the title to be displayed above the percentage stack plot.

Percentage stack plot calculation 1

Is a recalculation of percentage based on the sum of the groups supplied required? A 'yes' or 'no' entry is required.

Percentage stack plot size 1

Supply factor to size plot. Initially use 1. If plot is too small an entry of 1.2 will make it 20% larger or if too large an entry of 0.9 will make it 10% smaller.

Percentage stack plot colours 1

Supply colours for your groups based on colour codes detailed in subsection 2.1. Separate each code with a comma (See example in KM parameter file).

Percentage stack plot line width 1

Provide line width for lines separating groups in stack plot. If no lines required leave blank.

Percentage stack plot line colour 1

Supply a single colour code for the lines between the groups in the stack plot. See colour codes. If no lines required leave blank.

These are simply repeated for Percentage Stack Plot 2 if two are required.

3 General procedure checklist

- Place program file in desired location.
- Fill out template parameter file or modify one of the example parameter files with desired preferences as directed in the manual and save as csv.
- Fill out template input file or modify one of the example input file/s with desired preferences (as directed by manual) and palaeo data.
- If required fill out template Extra Input file or modify example from ARD with desired preferences (as directed by manual) and palaeo data.
- Place Input file/files and parameter file in desired locations (simplest if all in same location).
- Execute command line statement to run program.
- Fix any issues highlighted by the inbuilt user error checks that will provide messages pointing towards the problem.
- Examine plot and change input/parameter files to make desired changes and re-save.
- Execute command line statement to run program and repeat editing of the input/parameter files until desired plot is achieved.
- If requiring png once satisfied with the plot save as a high dpi plot (eg 600) or alternatively save as svg or pdf.
- Remember to cite the DOI if you use the program for creating plots for publications.

4 References

- Blundell, A., Charman, D.J., Barber, K.B. 2008. Multi-proxy late Holocene records from Ireland: towards a regional palaeoclimate curve. *Journal of Quaternary Science* 23, 59-71.

- Blundell, A., Holden, J., A. 2015. Using palaeoecology to support blanket peatland management. Ecological Indicators 49, 110-120.