

# Package ‘Bchron’

January 2, 2012

**Type** Package

**Title** Bayesian chronologies via compound Poisson-Gamma processes.

**Version** 3.1.4

**Date** 2010-11-1

**Depends** hrcrde, coda, svDialogs

**Author** Andrew Parnell

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**Description** This package takes dating information to produce joint chronological reconstructions for age-depth data. The package allows for: radiocarbon and non-radiocarbon depths, thickness errors, outlying dates, multiple calibration curves, and event prediction. It also produces some pretty pictures, and writes all output to files to allow for further analysis (eg palaeoclimate reconstruction). There is a menu system for users, as well as a command line interface for advanced and/or batch processing. This version contains an update to produce better plots of proxy data via the function Bchronproxyplot. **\*\*\*IMPORTANT NOTE\*\*\*** This version fixes a serious bug which was present in versions 3.1.1 and 3.1.2. You should have noticed this bug anyway when you ran the Bchronconvergecheck function.

**License** GPL (>= 2)

**LazyLoad** yes

**Repository** CRAN

**Date/Publication** 2010-11-03 07:32:45

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Bchron-package	<i>Compound Poisson-Gamma chronologies for radiocarbon and non-radiocarbon dates.</i>
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## Description

Runs MCMC and predictive distributions for the monotonic piece-wise linear compound Poisson Gamma process. Before a run of the Bchron model can commence, the file structures must be in the correct format. Included in the package is an example set of data from Glendalough, Ireland. All other cores must be in a similar format for the routines to work. The latest version of Bchron also contains a function ([Bchronproxyplot](#)) for plotting proxy data with age uncertainty.

\*\*\*IMPORTANT NOTE\*\*\* This version fixes a serious bug which was present in versions 3.1.1 and 3.1.2. You should have noticed this bug anyway when you ran the Bchronconvergecheck function.

## Details

Package:	Bchron
Type:	Package
Version:	3.0
Date:	2009-11-27
License:	GPL (>2)
LazyLoad:	yes

Bchron will run on windows, mac or linux systems, though installation instructions are slightly different for each. Instructions for completing installation are as follows:

1. Create a directory on your hard drive called Bchron.

2. Now navigate to the R directory and find the Bchron sub-directory within. On windows this will be C:\program files\R\R-XXXXXX\library\BChron\ where XXXXXX is the version number of R. On other platforms, this directory can be found by typing `.libPaths()` at the R command prompt.

3. In this directory, there there should be three subdirectories called Input, Output, and CalCurve. Copy these to the Bchron directory you created in step 1.

Everything is now set up.

Example full model run (with Glendalough.dat):

1. At the command prompt in R, type `library(Bchron)`
2. Type `Bchronmenu()` and choose option 1.
3. Locate your Bchron directory, and select `IntCal04.bch` as your calibration curve and `Glendalough.dat` as your input file. All other options can be left as default.
4. Now choose option 2 to calibrate the radiocarbon dates.
5. Choose option 3 and 'short' to do a short run of the Bchron model.
6. Choose option 4 to run the prediction stage and create a plot of the data.

Once a satisfactory short run has been obtained, a long run should be undertaken. The long run will take much longer than the short run, but will only be required once.

Example event prediction stage (with `GlendaloughEventDepthsAlnus.txt`)

1. Follow the steps above, and now choose option 5 for event prediction.
2. Type `Alnus` as the name of the event.
3. Check the output directory for `GlendaloughEventAgesAlnus.txt` which will contain 95% HDR age intervals for the depths of interest.

Other cores can be created in a spirit similar to that found in the `Glendalough.dat` file. This example input file has 5 radiocarbon dates and a non-radiocarbon date for the top of the core. The columns are tab delimited and represent the lab code of the sample, the radiocarbon age, the sample standard error, the depth (in cm) at which it was found, the thickness of the sample in cm. If the thickness is unknown, zero is acceptable. The next two columns contain the probabilities of being an outlier. The first probability identifies censored outliers as proposed by Christen (1994), the second indicates the probability an outlier is ignored completely by the Bchron model. The final column indicates whether this date is a radiocarbon date (type 1), a uniformly distributed date (type 2), or a normally distributed date (type 3). For uniform dates, the standard deviation value is taken to be the distance to the upper and lower limits. Type 3 dates are permitted to be outliers, with probabilities as given. Type 2 dates are not allowed to be outliers; the outlier probabilities for these dates are ignored.

### Author(s)

Andrew Parnell <Andrew.Parnell@ucd.ie>

### References

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

### See Also

See [Bchronmenu](#) for examples.

---

Bchroncalibrate      *Radiocarbon calibration of Bchron data*

---

### Description

Runs standard radiocarbon calibration of determinations.

### Usage

```
Bchroncalibrate(Bchrondata, iterations = 5e+05, burnin = 50000, thinby = 45, howmany = 50000, defaults =
```

### Arguments

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
iterations	Number of MCMC iterations required. Default is 500,000.
burnin	Number of discarded burn-in iterations. Default is 50,000.
thinby	Step size of iterations to thin out. Default is to take every 45th iteration.
howmany	Number of iterations before R reports back and updates the screen. Default is 50000
defaults	If true, runs Bchroncalibrate without any warnings and overwrites previous runs. If FALSE (default) will prompt user before continuing.

### Details

This function run simple radiocarbon calibration of each of the determinations individually without any chronology constraint. The results here should be directly comparable with those obtained from, eg Oxcal, Bcal, Calib, etc.

### Value

No specific value is returned but two files are created in the output directory, giving the raw radiocarbon calibrated age iterations (corenameTrueDates.txt) and a summary of the 2.5

### Author(s)

Andrew Parnell <Andrew.Parnell@ucd.ie>

### References

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

### See Also

See [Bchronload](#) and [Bchronmenu](#) for examples.

---

Bchroncheck	<i>Checking of Bchron data objects</i>
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---

**Description**

A quick check to make sure that the Bchron data object will run in [Bchroncalibrate](#) and [BchronMCMC](#).

**Usage**

```
Bchroncheck(Bchrondata)
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
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**Details**

Checks the Bchron data object for inconsistencies. If the object passes all these tests, it *should* run correctly in all areas of the Bchron system.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronload](#) and [Bchronmenu](#) for examples.

---

Bchronconvergecheck	<i>MCMC convergence checking of Bchron output</i>
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**Description**

Allows convergence checking of both [BchronMCMC](#) and [Bchroncalibrate](#) output. Uses the Geweke convergence diagnostic from the coda package.

**Usage**

```
Bchronconvergecheck(Bchrondata, dates = FALSE)
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
dates	if true, checks the individually calibrated dates for convergence. Otherwise checks the parameter set from a run of <a href="#">BchronMCMC</a> .

**Details**

Uses the package coda Geweke diagnostic to perform a convergence check on a single MCMC chain. Note that this is not the only method of convergence checking. Also provides some context for how well the model appears to have converged.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronload](#) and [Bchronmenu](#) for examples.

---

Bchroncreatecalcurve    *Create Bchron-style radiocarbon calibration curve*

---

**Description**

Allows the user to create calibration curves for use with Bchron.

**Usage**

```
Bchroncreatecalcurve()
```

**Details**

This function will turn a standard .14c file (as given by the international radiocarbon calibration group) into a .bch file as used by Bchron. Bchron uses a specific, yearly-interpolated version of the calibration curves to speed up computation. Bchron comes with northern-hemisphere, southern-hemisphere, and marine reservoir calibration curves, but users can create their own calibration files in the .14c format if they wish. This function will translate that calibration curve into the Bchron .bch format.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

## References

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

## See Also

See [Bchronload](#) and [Bchronmenu](#) for examples.

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Bchronload	<i>Command-line based loading of Bchron input files for a Bchron run.</i>
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## Description

A quick command line function to create a Bchron data object from various inputs. Note that all text strings must be given in inverted commas (apart from TRUE/FALSE).

## Usage

```
Bchronload(name, fullname = NULL, path = NULL, outdepths=NULL, calibName = "IntCal09", extractdate = -0.
```

## Arguments

name	A text string containing the name of the .dat file used.
fullname	A text string giving the full name of the core (used for plotting purposes). Defaults to name.
path	The path to the Bchron directory. Defaults to c:/Bchron (windows) or ~/Bchron (unix).
outdepths	A collection of depths at which chronological ages will be calculated. Default is top dated depth to bottom dated depth, length 200.
calibName	The name of the calibration curve .bch file used. Defaults to the Northern Hemisphere 2009 internationally agreed calibration curve.
extractdate	The extracted date of the core in thousands of years before present. Defaults to the year 2000 (= -0.05 k cal years BP).
check	If true, performs <a href="#">Bchronconvergecheck</a> on the given data files.
full	If true, also loads in chronologies, calibrated dates, etc, for further analysis. This may take a bit of extra time as some of these files are large.

## Details

Useful for batch processing of calibration runs, this function allows the user to load in and create a Bchrondata object which can then be used in all the other Bchron functions.

**Value**

Returns a list object with the following components:

name	The name of the .dat file
fullname	The full name of the core
version	The version number of Bchron
path	The path to the Bchron directory
calibcurvefile	The path to the calibration curve
c14file	The path to the .14c file of the calibration curve
inputfile	The path to the input file of dates and depths
calibdatesfile	The path to the file of calibrated radiocarbon date samples
calibrangesfile	The path to the file of calibrated radiocarbon date ranges
parsfile	The path to the file of Bchron parameter output
chronsfile	The path to the file containing the sample chronologies
outlierfile	The path to the file containing the outlier date summaries
rangesfile	The path to the file containing the chronology summary ranges
extractdate	The date of core extraction
bigcalsize	The length of the .bch calibration curve
lowcal	The youngest age of the given calibration curve
highcal	The eldest age of the given calibration curve
input	The table of input data (dates, depths, thicknesses etc)
outdepths	A collection of depths at which the chronological age is required
calibdates	(if full=TRUE, a matrix of sample calibrated dates
calibranges	if full=TRUE, a matrix of calibrated date ranges
pars	if full=TRUE, a matrix of Bchron parameter output
chrons	if full=TRUE, a matrix of sample chronologies
outlier	if full=TRUE, a matrix of outlier date summaries
ranges	if full=TRUE, a matrix of chronology summaries

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronmenu](#) for examples.

## Examples

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B
# myrun <- Bchronload("Glendalough")
# Bchroncalibrate(myrun)
# BchronMCMC(myrun)
# Bchronpredict(myrun)
# Bchronplot(myrun)
```

---

BchronMCMC

*Run the Bchron*

---

## Description

Runs the compound Poisson-Gamma model for radiocarbon and non-radiocarbon dates

## Usage

```
BchronMCMC(Bchrondata, iterations = 1e+05, burnin = 10000, thinby = 8, howmany = 2000, defaults = FALSE,
```

## Arguments

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
iterations	Number of MCMC iterations required. Default is 100,000.
burnin	Number of discarded burn-in iterations. Default is 10,000.
thinby	Step size of iterations to thin out. Default is to take every 8th iteration.
howmany	Number of iterations before R reports back and updates the screen. Default is 2000.
defaults	If TRUE, runs BchronMCMC without any warnings and overwrites previous runs. If FALSE (default) will prompt user before continuing.
testrun	if TRUE, tries a very short run to test that BchronMCMC works.

## Details

The Bchron MCMC function fits a compound Poisson-Gamma distribution to the increments between the dated levels. This involves a stochastic linear interpolation where the age gaps are  $\text{Gamma}(2, \beta)$  distributed, and the depth gaps are  $\text{Exponential}(\lambda)$ . Radiocarbon and non-radiocarbon dates (including outliers) are updated within the function also by MCMC.

## Value

Creates a parameter output file (corenamepars.txt) in the output directory containing outlier estimates, parameter values, and other details required. This information can be turned into chronology samples by calling [Bchronpredict](#).

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronmenu](#) for examples.

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B  
# myrun <- Bchronload("Glendalough")  
# Bchroncalibrate(myrun)  
# BchronMCMC(myrun)  
# Bchronpredict(myrun)  
# Bchronplot(myrun)
```

---

Bchronmenu

*Walkthrough menu system for the Bchron package*

---

**Description**

A walkthrough menu system for the Bchron package. Gives users the ability to load in data, run the Bchron MCMC model, run predictions and plots, and look at event ages.

**Usage**

```
Bchronmenu()
```

**Details**

The Bchron menu system first creates a Bchrondata object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. Using the menu system bypasses the need to create these objects. This function is essentially a shell for calling [Bchronload](#), [Bchroncalibrate](#), [BchronMCMC](#), [Bchronpredict](#) and [Bchronplot](#).

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronload](#), [Bchroncalibrate](#), [BchronMCMC](#), [Bchronpredict](#), [Bchronplot](#), [Bchronpredictevent](#), [Bchronplotevent](#).

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B
# myrun <- Bchronload("Glendalough")
# Bchroncalibrate(myrun)
# BchronMCMC(myrun)
# Bchronpredict(myrun)
# Bchronplot(myrun)
```

---

Bchronplot	<i>Produce Bchron chronology plots</i>
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---

**Description**

Produces plots of chronologies and radiocarbon dates

**Usage**

```
Bchronplot(Bchrondata, plot = TRUE, dates = TRUE, datelabels = FALSE, chrons = TRUE, dateselect = NULL, I
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
plot	If true, will create a new plot, if false, will overlay on top of existing plot
dates	If true, will plot the individually calibrated dates.
datelabels	If true, will plot the date labels to the left of the individually calibrated dates.
chrons	If true, will plot the chronology.
dateselect	A vector or sequence giving the dates which are to be plotted. Useful for ignoring the dates of boundaries, or when many dates overlap.
limits	A vector of length 4 with dimensions as c(lowestdepth,oldestage,highestdepth,youngestage).
dateheight	The height of the date densities relative to the depth scale.
chronwidth	The desired probability range of the plotted chronology. Default is 0.95 of 95
datecolour	The colour of the radiocarbon dates as plotted.
chroncolour	The colour of the chronology.
outcolour	The colour of outlying dates.
transp	The degree of transparency of the chronology.
outprob	The threshold over which dates are considered outliers and coloured accordingly. Default is 0.2.

<code>legendloc</code>	The location of the legend. Can be given as any of "topleft", "top", etc, or <code>locator(1)</code> to position the legend manually.
<code>leghoriz</code>	If true, creates a horizontal rather than vertical legend.
<code>...</code>	Other arguments, such as width, height, of the plot created.

**Details**

The options allow for a wide variety of possible plotting scenarios, including black and white plots, overlaid densities, outlier identification, etc, etc.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

See [Bchronmenu](#) for examples.

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B
# myrun <- Bchronload("Glendalough")
# Bchroncalibrate(myrun)
# BchronMCMC(myrun)
# Bchronpredict(myrun)
# Bchronplot(myrun)
```

---

`Bchronplotevent`

*Histogram of the probability distribution for an event in a core.*

---

**Description**

Provides a histogram and summary of the probability distribution for a given depth, slice, or event in a core.

**Usage**

```
Bchronplotevent(Bchrondata, depth = NULL, slice = NULL, event = NULL, eventname = NULL, nbreaks = 30, his
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
depth	One of the output depths (in cm) in the core (see <a href="#">Bchronload</a> for more information on output depths).
slice	A slice number for one of the depths in the core.
event	An event name. Must have an associated corenameeventdepthseventname.txt file associated with it.
eventname	The full name of the event (eg "Alnus rise").
nbreaks	The number of breaks for the histogram.
histcolour	The colour of the histogram.
...	Other arguments, such as the width and height of the plot.

**Details**

This function can be used to identify the age of a certain part of the core according to the chronology model. It does not necessarily have to be an age that has a radiocarbon (or non-radiocarbon) date. Where an event name is given, a file should be created giving the depths at which the event occurred. See [Bchronpredictevent](#) for more information.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

[Bchronpredictevent](#)

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B
# myrun <- Bchronload("Glendalough")
# Bchroncalibrate(myrun)
# BchronMCMC(myrun)
# Bchronpredictevent(myrun,event="Alnus")
# Bchronplotevent(myrun,event="Alnus",eventname="Alnus rise")
```

Bchronpredict

*Predict ages for given depths in a Bchron core*

---

**Description**

Performs stochastic Poisson-Gamma linear interpolation on the output of a run of the [BchronMCMC](#).

**Usage**

```
Bchronpredict(Bchrondata, numchron = 10000, defaults = FALSE)
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
numchron	The number of chronologies required. Default is 10,000.
defaults	If true, runs Bchronpredict without any warnings and overwrites previous runs. If FALSE (default) will prompt user before continuing.

**Details**

Must be run after a [BchronMCMC](#) run to turn parameter estimates into sample chronologies.

**Value**

Produces files corenamechrons.txt and corenameranges.txt in the output directory which contain sample chronologies and estimated ranges for each of the output depths.

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

[Bchronpredictevent](#)

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B  
# myrun <- Bchronload("Glendalough")  
# Bchroncalibrate(myrun)  
# BchronMCMC(myrun)  
# Bchronpredict(myrun)  
# Bchronplot(myrun)
```

---

Bchronpredictevent      *Predict ages of events in a core*

---

### Description

Estimates and plots the ages of specific depths, slices or events in a Bchron core. Useful for event identification.

### Usage

```
Bchronpredictevent(Bchrondata, event = "Event", numchron = 10000)
```

### Arguments

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
event	An event name. Must have an associated corenameeventdepthseventname.txt file associated with it.
numchron	The number of chronologies required. Default is 10,000.

### Details

For each event, the user will need to create a file of the desired depths intervals for which the ages are required. These depths are to be put the files in the input directory in a file named CorenameEvent-DepthsEventname.txt where Corename is the name of the core and Eventname is the name of the event (eg GlendaloughEventDepthsUlmusDecline.txt). The format of the file should look like the following: 261 265 267 269 271 282 This formulation allows for uncertainty in the depths at which the event occurred.

### Value

A file CorenameEventAgesEventName.txt will be created in the output directory giving extra information on the ages of the event.

### Author(s)

Andrew Parnell <Andrew.Parnell@ucd.ie>

### References

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

### See Also

[Bchronplotevent](#)

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B
# myrun <- Bchronload("Glendalough")
# Bchroncalibrate(myrun)
# BchronMCMC(myrun)
# Bchronpredictevent(myrun,event="Alnus")
# Bchronplotevent(myrun,event="Alnus",eventname="Alnus rise")
```

---

Bchronproxypplot

*Plot proxy data with associated chronological uncertainties*


---

**Description**

Function produces plots of a proxy data time series, with associated error bands to indicate chronological uncertainty.

**Usage**

```
Bchronproxypplot(Bchrondata, proxy, title = NULL, xlabel = "Age (k cal yrs BP)", ylabel = "Proxy", num = 1
```

**Arguments**

Bchrondata	A Bchron data object with fields for the the input and output files, the name of the core being used, the details of the calibration curve, and details of the model run required. See <a href="#">Bchronload</a> and <a href="#">Bchronmenu</a> for more details.
proxy	A vector of proxy observations of the same length as the number of output depths in the core. See <a href="#">Bchronload</a> for more information on the output depths.
title	A text string giving the title for the plot.
xlabel	A text string giving the x-axis label for the plot
ylabel	A text string giving the y-axis label for the plot
num	The number of sample chronologies to plot, default set at 1000
col	The colour of the lines drawn
meancol	The colour of the line drawn to represent the mean chronology
transp	The degree of transparency of individual chronology lines drawn
...	Other arguments, such as the width and height of the plot

**Details**

The plots produces show a number of sample proxy series based on different chronological samples (the number of these is controlled by num).

**Author(s)**

Andrew Parnell <Andrew.Parnell@ucd.ie>

**References**

Haslett and Parnell (2008, JRSSC, 57:399-418) and Parnell et al (2008, QSR, 27(19-20):1872-1885)

**See Also**

[Bchronplotevent](#)

**Examples**

```
# For the example data, the following should run (when the files are placed in the default directory in windows; c:/B  
# myrun <- Bchronload("Glendalough")  
# x <- sin(seq(0,pi,length=150))  
# Bchronproxyplot(myrun,x)
```

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