

# Package ‘PCPS’

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**Title** Principal Coordinates of Phylogenetic Structure

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**Description** Set of functions for analysis of Principal Coordinates of Phylogenetic Structure (PCPS).

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'FUN.GLM.R' 'FUN.GLS.marginal.R' 'FUN.GLS.sequential.R'  
'FUN.LME.marginal.R' 'FUN.LME.sequential.R' 'FUN.MANTEL.R'  
'FUN.RDA.R' 'check.formula.R' 'define.clade.R'  
'matrix.p.null.R' 'mutate.names.matrix.p.null.R'  
'organize.pcps.R' 'pcoa.sig.R' 'pcps.curve.R'  
'pcpc.curve.calc.R' 'plot.pcps.R' 'plot.pcpscurve.R'  
'print.pcoasig.R' 'print.pcps.R' 'print.pcpscurve.R'  
'print.pcpsig.R' 'print.summarypcoasig.R'  
'print.summarypcps.R' 'scores.pcps.R' 'select.pcpsmethod.R'  
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'summary.pcpscurve.R' 'wcmdscale.org.R'

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check.formula	<i>Internal function</i>
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**Description**

Internal function to check the validity of left hand side in a formula object.

**Usage**

```
check.formula(formula, vectornames)
```

**Arguments**

formula	An object of class <code>formula</code> .
vectornames	A vector with names to check the index.

**Value**

The index of left side of the formula in vectornames.

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define.clade	<i>Define clade</i>
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## Description

Function to define groups (clades) in a phylogenetic tree.

## Usage

```
define.clade(tree, threshold, time, method = c("threshold", "time"))
```

## Arguments

tree	Phylogenetic tree.
threshold	A threshold value to form the groups.
time	A cutting height (age) to form the groups.
method	Method to define the clades, "threshold" or "time".

## Details

In the method threshold the total length of phylogenetic tree is used as cutting factor. If threshold is near to zero the cutting is near the root, if threshold near to one cutting is near the tips.

The phylogenetic tree must contain the node labels for the function work. Use the [makeNodeLabel](#) for defining node labels in a flexible way.

## Value

clades	Tips and their clades.
height	The cutting height (age).

## Author(s)

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## See Also

[makeNodeLabel](#)

## Examples

```
require(ape)
tree<-makeNodeLabel(rcoal(10))
clades<-define.clade(tree, threshold = 0.8, method = "threshold")
clades
plot.phylo(tree, show.node.label = TRUE)
abline(v = clades$height)
```

matrix.p.null

*Auxiliar function to generate sets of null P matrix or null PCPS***Description**

Auxiliar function to generate sets of null P matrix or null PCPS used in [matrix.p.sig](#) or [pcps.sig](#). The result are long lists with permuted matrices.

**Usage**

```
matrix.p.null(
  comm,
  phylodist,
  runs = NULL,
  calcpcps = FALSE,
  method = "bray",
  squareroot = TRUE,
  adjpcps = FALSE,
  choices = NULL
)
```

**Arguments**

comm	Community data, with species as columns and sampling units as rows. This matrix can contain either presence/absence or abundance data.
phylodist	Matrix containing phylogenetic distances between species.
runs	Number of matrix will be generated (Default runs = NULL).
calcpcps	Logical argument (TRUE or FALSE) to specify if generate the PCPS (Default calcpcps = FALSE).
method	Dissimilarity index, as accepted by <a href="#">vegdist</a> (Default dist = "bray").
squareroot	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index (Default squareroot = TRUE).
adjpcps	Logical argument (TRUE or FALSE) to specify if return fitted PCPS (Default adjpcps = FALSE).
choices	Numeric vector to choose the PCPS to adjust (Default pcps.choices = NULL).

**Value**

call	The arguments used.
P.obs	Observed phylogeny-weighted species composition matrix.
pcps.obs	Observed principal coordinates of phylogenetic structure (PCPS).
permutation.site	A matrix with sequence of permutation for site shuffle null model, each permutation in one row.

permutation.taxa	A matrix with sequence of permutation for taxa shuffle null model, each permutation in one row.
P.null.site	A list with each permuted P matrix according with site shuffle null model.
P.null.taxa	A list with each permuted P matrix according with taxa shuffle null model.
pcps.null.site	A list with each permuted PCPS according with site shuffle null model.
pcps.null.taxa	A list with each permuted PCPS according with taxa shuffle null model.
pcps.null.taxa.adj	A list with each permuted PCPS (adjusted) according with taxa shuffle null model.

**Author(s)**

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**See Also**

[matrix.p](#), [pcps](#), [matrix.p.sig](#), [pcps.sig](#)

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matrix.p.sig	<i>Association between phylogeny-weighted species composition and environmental predictors</i>
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**Description**

Analyses to relate an environmental gradient to the phylogenetic assembly of species across a meta-community by means of phylogenetic fuzzy weighting.

**Usage**

```
matrix.p.sig(
  comm,
  phylodist,
  envir,
  checkdata = TRUE,
  FUN,
  runs = 999,
  parallel = NULL,
  newname = "pcps",
  ...
)
```

```
pcps.sig(
  comm,
  phylodist,
  envir,
```

```

    checkdata = TRUE,
    method = "bray",
    squareroot = TRUE,
    FUN,
    choices,
    runs = 999,
    parallel = NULL,
    newname = "pcps",
    ...
)

FUN.ADONIS(x, envir, method.p, sqrt.p = TRUE, formula, return.model = FALSE)

FUN.GLM(x, envir, formula, ..., return.model = FALSE)

FUN.GLS.marginal(x, envir, formula, ..., return.model = FALSE)

FUN.GLS.sequential(x, envir, formula, ..., return.model = FALSE)

FUN.LME.marginal(x, envir, formula, ..., return.model = FALSE)

FUN.LME.sequential(x, envir, formula, ..., return.model = FALSE)

FUN.MANTEL(
  x,
  envir,
  method.p,
  method.envir,
  sqrt.p = TRUE,
  ...,
  return.model = FALSE
)

FUN.RDA(x, envir, return.model = FALSE)

## S3 method for class 'pcpssig'
print(x, ...)

```

### Arguments

comm	Community data, with species as columns and sampling units as rows. This matrix can contain either presence/absence or abundance data. Alternatively comm can be an object of class <code>metacommunity.data</code> , an alternative way to set all data.frames/matrices. When you use the class <code>metacommunity.data</code> the arguments <code>phylodist</code> and <code>envir</code> must not be specified. See details.
phylodist	Matrix containing phylogenetic distances between species.
envir	A matrix or data.frame with environmental variables for each community, with variables as columns and sampling units as rows. See Details and Examples.

checkdata	Logical argument (TRUE or FALSE) to check if species sequence in the community data follows the same order as the one in the phyloDist matrix and if sampling units in the community data follows the same order as the one in the environmental data (Default checkdata = TRUE).
FUN	An object of class function to perform the analysis. See Details and Examples.
runs	Number of permutations for assessing significance.
parallel	Number of parallel processes or a predefined socket cluster done with parallel package. Tip: use detectCores() (Default parallel = NULL).
newname	New name to be replaced in object returned by <code>matrix.p.null</code> (Default newname = "pcps").
...	Other arguments passed to FUN function. See Details and Examples.
method	Dissimilarity index, as accepted by <code>vegdist</code> (Default dist = "bray").
squareroot	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index (Default squareroot = TRUE).
choices	Numeric vector to choose the PCPS used in analysis. See Details and Examples.
x	An object of class <code>pcpsig</code> or other object to apply the function passed by FUN. See Details.
method.p	Resemblance index between communities based on P matrix, as accepted by <code>vegdist</code> . Used in FUN.MANTEL, FUN.ADONIS, FUN.ADONIS2.global and FUN.ADONIS2.margin analysis. See Details and Examples.
sqrt.p	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity P matrix. Used in FUN.MANTEL, FUN.ADONIS, FUN.ADONIS2.global and FUN.ADONIS2.margin analysis. See Details and Examples (Default sqrt.p = TRUE).
formula	An object of class <code>formula</code> . Used in FUN.GLM, FUN.ADONIS, FUN.ADONIS2.global, FUN.ADONIS2.margin, FUN.GLS.marginal, FUN.GLS.sequential, FUN.LME.marginal and FUN.LME.sequential analysis. See Details and Examples.
return.model	Must not be specified. See Details.
method.envir	Resemblance index between communities based on environmental variables, as accepted by <code>vegdist</code> . Used in FUN.MANTEL analysis. See Details and Examples.

## Details

Each metacommunity is submitted to phylogenetic fuzzy weighting, generating a matrix that describing the phylogeny-weighted species composition of the communities (`matrix.p`). The function `matrix.p.sig` test directly the association this matrix with the environmental predictors. The pairwise dissimilarities are submitted to Mantel test (`mantel`) or ADONIS test (`adonis` or `adonis2`) to evaluate the influence of an environmental gradient on species dispersion across the communities. The function `pcps.sig` generates principal coordinates of phylogenetic structure (`pcps`) and use a single axis for run a generalized linear model (GLM, `glm`), linear model using generalized least squares (GLS, `gls`), linear mixed-effects models (LME, `lme`) or use set of axis for run a distance-based redundancy analysis (db-RDA, `rda`).

The sequence species show up in the community data matrix must be the same as they show up in the phylogenetic distance matrix and, similarly, the sequence of communities in the community data

matrix must be the same as that in the environmental data. The function `organize.pcps` organizes the data, placing the matrices of community, phylogenetic distance and environmental data in the same order. The function use of function `organize.pcps` is not required for run the functions, but is recommended. In this way the arguments `comm` and `phylo` can be specified them as normal arguments or by passing them with the object returned by the function `organize.pcps` using, in this case only the argument `comm`. Using the object returned by `organize.pcps`, the `comm` argument is used as an alternative way of entering to set all data.frames/matrices, and therefore the arguments `phylo` and `envir` must not be specified.

The significance is obtained via two null models, one that shuffles sites across the environmental gradient and another that shuffles terminal tips (taxa) across the phylogenetic tree. The first null model (site shuffle) shuffles the site position across the environmental gradient and rerun the same model, generating a null F value (or r value in Mantel test). The second null model (taxa shuffle), shuffles terminal tips across the phylogenetic tree and generates a null matrix containing phylogeny-weighted species composition and rerun the same model, generating another null F value. In the `pcps.sig` function are generate set of null PCPS and each null PCPS (or set of PCPS in RDA) is submitted to a procrustean adjustment (see `procrustes`), and the fitted values between observed PCPS and null PCPS is obtained. The adjusted null PCPS is used to rerun the model, generating another null F value. The observed F value (or r value) is compared independently with both null sets of F values (or r value) to generate a probability value of the original F value being generated merely by chance according to each null model.

### The argument FUN

The type of analysis performed by this function is specified using the argument `FUN`. The current version of package includes ten predefined function, however additional small functions can be easy specify. All this function uses the environmental variables to analyze the association between phylogeny-weighted species composition and environmental predictors. For matrix P analysis, in `matrix.p.sig` function, the predefined functions available are `FUN.MANTEL`, `FUN.ADONIS`, `FUN.ADONIS2.global` and `FUN.ADONIS2.margin`. For PCPS analysis, in `pcps.sig` function, the predefined functions available are `FUN.GLM`, `FUN.RDA`, `FUN.GLS.marginal`, `FUN.GLS.sequential`, `FUN.LME.marginal` and `FUN.LME.sequential`. The significance for each null model is performed as described here, NOT using p value of basic functions.

### FUN.MANTEL

Mantel test that can be used in matrix P analysis. The arguments `method.p` and `sqrt.p` are specified for determine resemblance index between communities based on P matrix. The argument `method.envir` is specified to determine resemblance index between communities based on environmental variables. The significance is assess using r value, see more in `mantel`.

### FUN.ADONIS

Multivariate analysis of variance that can be used in matrix P analysis. The arguments `method.p` and `sqrt.p` are specified for determine resemblance index between communities based on P matrix. The argument `formula` is specified, where the left hand side gives the resemblance data, right hand side gives the variables. The resemblance data is internally named `p.dist`, thus formula is an expression of the form `p.dist ~ model` (see Examples). The significance is assess using overall F value, see more in `adonis`.

### FUN.ADONIS2.global and FUN.ADONIS2.margin

Multivariate analysis of variance that can be used in matrix P analysis. The arguments `method.p` and `sqrt.p` are specified for determine resemblance index between communities based on P matrix. The argument `formula` is specified, where the left hand side gives the resemblance data, right hand side



gives the variables. The resemblance data is internally named *p.dist*, thus formula is an expression of the form *p.dist ~ model* (see Examples). The significance is assessed using F value and the difference between function is due to the argument *by* in `adonis2`. The function `FUN.ADONIS2.global` use as default *by = NULL* to assess the overall significance of all terms together whereas the function `FUN.ADONIS2.margin` use as default *by = margin* to assess the marginal effects of the terms and return F and p value for each term. See more in `adonis2`.

The function `adonis2` evaluate the formula argument in the global environment, however CRAN do not allow assignments to the global environment. As a temporary workaround, copy and run the lines below to make the functions `FUN.ADONIS2.global` and `FUN.ADONIS2.margin` available.

```
FUN.ADONIS2.global <- function(x, envir, method.p, formula, sqrt.p = TRUE, return.model = FALSE){
  p.dist <- vegan::vegdist(x, method = method.p)
  if(sqrt.p){
    p.dist <- sqrt(p.dist)
  }
  assign("p.dist", p.dist, envir = globalenv())
  mod.obs <- vegan::adonis2(formula, data = data.frame(envir), permutations = 0, by = NULL, parallel = NULL)
  rm(p.dist, envir = globalenv())
  statistic.obs <- mod.obs$F[1]
  if(return.model){
    res <- list()
    res$mod.obs <- mod.obs
    res$statistic.obs <- statistic.obs
  } else{
    res <- statistic.obs
  }
  return(res)
}

FUN.ADONIS2.margin <- function(x, envir, method.p, formula, sqrt.p = TRUE, return.model = FALSE){
  p.dist <- vegan::vegdist(x, method = method.p)
  if(sqrt.p){
    p.dist <- sqrt(p.dist)
  }
  assign("p.dist", p.dist, envir = globalenv())
  mod.obs <- vegan::adonis2(formula, data = data.frame(envir), permutations = 2, by = "margin", parallel = NULL)
  rm(p.dist, envir = globalenv())
  nf <- length(mod.obs$F)-2
  statistic.obs <- mod.obs$F[seq_len(nf)]
  if(return.model){
    res <- list()
    res$mod.obs <- mod.obs
    res$statistic.obs <- statistic.obs
  } else{
    res <- statistic.obs
  }
  return(res)
}
```

}

**FUN.GLM**

Generalized linear models that can be used in PCPS analysis. The argument *formula* is specified, where the left hand side gives the PCPS used, right hand side gives the variables. The PCPS are internally named sequentially *pcps.1*, *pcps.2*, *pcps.3* and so on. Thus, formula is an expression of the form *pcps.1 ~ model* (see Examples). The type of environmental variables are extracted directly from *envir* argument, thus variables of class `factor` can be already specified in *envir data.frame* or through *formula* argument. The significance is assess using overall F value, see more in [glm](#).

**FUN.RDA**

Redundancy analysis that can be used in PCPS analysis. The RDA analysis is performed using all PCPS specified with choices argument and all environmental variables specified by *envir* argument. The significance is assess using overall F value, see more in [rda](#).

**FUN.GLS.marginal and FUN.GLS.sequential**

Linear model using generalized least squares that can be used in PCPS analysis. The argument *formula* is specified, where the left hand side gives the PCPS used, right hand side gives the variables. The PCPS are internally named sequentially *pcps.1*, *pcps.2*, *pcps.3* and so on. Thus, formula is an expression of the form *pcps.1 ~ model* (see Examples). The type of environmental variables are extracted directly from *envir* argument, thus variables of class `factor` can be already specified in *envir data.frame* or through *formula* argument. The significance is assess using F value and the difference between function is due to the argument *type* in [anova.gls](#). The function *FUN.GLS.marginal* use as default *type = marginal* to assess the marginal significance of all terms whereas the function *FUN.GSL.sequential* use as default *type = sequential* to assess the sequential effects of the terms. Those functons return all F values calculcd by [anova.gls](#), including the intercept if it is in the model. Additional arguments as *correlation* can be passed by ... argument. See more in [glS](#) and [anova.gls](#).

**FUN.LME.marginal and FUN.LME.sequential**

Linear mixed-effects models that can be used in PCPS analysis. The argument *formula* is specified, where the left hand side gives the PCPS used, right hand side gives the variables. The PCPS are internally named sequentially *pcps.1*, *pcps.2*, *pcps.3* and so on. Thus, formula is an expression of the form *pcps.1 ~ model* (see Examples). The type of environmental variables are extracted directly from *envir* argument, thus variables of class `factor` can be already specified in *envir data.frame* or through *formula* argument. The significance is assess using F value and the difference between function is due to the argument *type* in [anova.lme](#). The function *FUN.LME.marginal* use as default *type = marginal* to assess the marginal significance of all terms whereas the function *FUN.LME.sequential* use as default *type = sequential* to assess the sequential effects of the terms. Those functons return all F values calculcd by [anova.lme](#), including the intercept if it is in the model. Additional arguments as *correlation* and *random* can be passed by ... argument. See more in [lme](#) and [anova.lme](#).

**Additional function**

The functions *matrix.p.sig* and *pcps.sig* only perform permutation following null models and apply the functions in all permuted matrices. Additional functions can be easy specify and passed via *FUN* argument. A skeleton of this function is slowed below. In this function the argument *x* will be always the matrix P or one matrix with PCPS choose, when additional arguments as *envir* will specify statistical analysis performed in matrix P ou PCPS. This function must return the observed

statistical in addition the *return.model* argument must not be specified because it specify the return options used for observed and null statistics.

```
FUN.X <- function(x, envir, ..., return.model = FALSE){
  mod.obs <- # Function to perform analysis using x, envir and any additional argument
  statistic.obs <- # Extract only the numeric values of observed statistical
  # Next lines are mandatory
  if(return.model){
    res <- list()
    res$mod.obs <- mod.obs
    res$statistic.obs <- statistic.obs
  } else{
    res <- statistic.obs
  }
  return(res)
}
```

### Value

call	The arguments used.
P.obs	Phylogeny-weighted species composition matrix.
PCPS.obs	The principal coordinates of phylogenetic structure (PCPS)
model	The observed model returned by FUN, an object of class glm, gls, lme, rda, adonis, adonis2 or mantel to predefined function.
fun	The funtion used.
statistic.null.site	A matrix with null statistic for site shuffle null model.
statistic.null.taxa	A matrix with null statistic for taxa shuffle null model.
obs.statistic	Observed statistic, F value or r value to predefined function.
p.site.shuffle	The p value for the site shuffle null model.
p.taxa.shuffle	The p value for the taxa shuffle null model.

### Note

**IMPORTANT:** The sequence of species in the community data matrix **MUST** be the same as that in the phylogenetic distance matrix and, similarly, the sequence of communities in the community data matrix **MUST** be the same as that in the environmental data. See details and [organize.pcps](#).

### Author(s)

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### References

- Duarte, L.S. (2011). Phylogenetic habitat filtering influences forest nucleation in grasslands. *Oikos*, 120, 208:215.
- Duarte, L.S. (2016). Dissecting phylogenetic fuzzy weighting: theory and application in metacommunity phylogenetics. *Methods in Ecology and Evolution*, 7(8), 937:946.

**See Also**

[matrix.p](#), [pcps](#), [procrustes](#), [glm](#), [rda](#), [adonis](#), [adonis2](#), [mantel](#)

**Examples**

```
## Not run:
data(flona)

# MANTEL
res <- matrix.p.sig(flona$community,flona$phylo, FUN = FUN.MANTEL, method.p = "bray",
  method.envir = "euclidean", envir = flona$environment[, 2, drop = FALSE], runs = 99)
res

# ADONIS
res <- matrix.p.sig(flona$community,flona$phylo, FUN = FUN.ADONIS, method.p = "bray",
  formula = p.dist~temp, envir = flona$environment[, 2, drop = FALSE], runs = 99)
res

# ADONIS2
res <- matrix.p.sig(flona$community,flona$phylo, FUN = FUN.ADONIS2.global,
  envir = flona$environment, formula = p.dist~temp+alt,
  method.p = "bray", runs = 99)
res
res <- matrix.p.sig(flona$community,flona$phylo, FUN = FUN.ADONIS2.margin,
  envir = flona$environment, formula = p.dist~temp+alt,
  method.p = "bray", runs = 99)
res

# GLM
res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.GLM, method = "bray",
  formula = pcps.1~temp, envir = flona$environment, choices = 1, runs = 99)
res
summary.lm(res$model)

# RDA
res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.RDA, envir = flona$environment,
  choices = 1:2, runs = 99)
res

# GLS
res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.GLS.marginal,
  formula = pcps.1~temp, envir = flona$environment, choices = 1, runs = 99)
res
anova(res$model, type = "marginal")

res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.GLS.marginal,
  formula = pcps.1~temp, envir = flona$environment,
  correlation = nlme::corCAR1(form = ~1:39), choices = 1, runs = 99)
res
anova(res$model, type = "marginal")
```

```

# LME
res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.LME.marginal, formula = pcps.1~alt,
  envir = flona$environment, random = ~1|temp, choices = 1, runs = 99)
res
anova(res$model, type = "marginal")

res <- pcps.sig(flona$community, flona$phylo, FUN = FUN.LME.sequential, formula = pcps.1~alt,
  envir = flona$environment, random = ~1|temp, choices = 1, runs = 99)
res
anova(res$model, type = "sequential")

## End(Not run)

```

---

mutate.names.matrix.p.null

*Internal function*


---

### Description

Internal function to perform replacement names in object returned by [matrix.p.null](#).

### Usage

```
mutate.names.matrix.p.null(x, replacement, newname)
```

### Arguments

x	An object returned by <a href="#">matrix.p.null</a> .
replacement	A replacement name to matched in object returned by <a href="#">matrix.p.null</a> .
newname	New name to be replaced in object returned by <a href="#">matrix.p.null</a> .

---

organize.pcps

*Function for organize data for Package PCPS*


---

### Description

Package **PCPS** requires that the species and community sequence in the data.frame or matrix must be the same for all data.frame/matrices. This function use the function [organize.syncsa](#) to organize the data.

### Usage

```
organize.pcps(comm, phylodist = NULL, envir = NULL, check.comm = TRUE, ...)
```

**Arguments**

comm	Community data, with species as columns and sampling units as rows.
phylodist	Matrix containing phylogenetic distance between species. Must be a complete matrix (not a half diagonal matrix). This matrix can be larger than community data (more species) as long as it has at least all species that are in community data (Default phylodist = NULL).
envir	Environmental variables for each community, with variables as columns and sampling units as rows (Default envir = NULL).
check.comm	Logical argument (TRUE or FALSE) to remove sampling units and species with total sums equal or less than zero (Default check.comm = TRUE).
...	Other parameters for the organize.syncsa function.

**Details**

The function, as well as `organize.syncsa`, organizes the data for the functions of the package PCPS, placing the matrices of community, phylogenetic distance and environmental variables in the same order.

Essentially this function is the same as function `organize.syncsa`. This use as reference the community data for organize all data.frame or matrices in the same order that the sampling units names and species names found in community data set. For this all data sets entered must be correctly named, with rows and columns named. The matrices phylodist and envir can be larger than community data (more species and/or more sampling units) as long as it has at least all species and/or sampling units that are in community data. The function organizes the data despite the absence of one of the data.frames or matrices, provided that the community data had been entered. Unspecified data will appear as NULL. All arguments this function will be passed to `organize.syncsa`, see more details in `organize.syncsa`.

**Value**

A object of class `metacommunity.data` (also of the class `list`) with all result returned by `organize.syncsa`. Featured for:

call	The arguments used.
community	Community data.
phylodist	Phylogenetic distance.
environmental	Environmental variables.

**Author(s)**

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>

**See Also**

[organize.syncsa](#)

**Examples**

```
data(ADRS)
organize.pcps(ADRS$community, phylodist = ADRS$phylo)
```

pcoa.sig

*Significant dimensions in principal coordinate analysis***Description**

Function for determine the number of significant dimensions in principal coordinate analysis (PCoA).

**Usage**

```
pcoa.sig(
  data,
  method = "gower",
  squareroot = FALSE,
  axis = 6,
  n.start = NULL,
  by = 1,
  iterations = 1000,
  parallel = NULL
)

## S3 method for class 'pcoasig'
print(x, ...)

## S3 method for class 'summarypcoasig'
print(x, ...)

## S3 method for class 'pcoasig'
summary(object, choices = c(1, 2), ...)
```

**Arguments**

data	Community data matrix.
method	Method for dissimilarity index, as accepted by <a href="#">vegdist</a> (Default method = "gower").
squareroot	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index (Default squareroot = FALSE).
axis	Maximum number of ordination principal axes to be monitored (Default axis = 6).
n.start	Initial sample size. If n.start = NULL initial sample size is equal to total sample size (Default n.start = NULL).
by	Sampling unit is added at each sampling step (Default by = 1).

iterations	Number of permutations to assess significance (Default iterations = 1000).
parallel	Number of parallel processes or a predefined socket cluster done with parallel package. Tip: use detectCores() (Default parallel = NULL).
x	An object of class pcoasig.
...	Other parameters for the respective functions.
object	An object of class pcoasig.
choices	Axes for re-scaling. Choices must have length equal to two (Default choices = c(1, 2)).

### Details

At each iteration step a bootstrap sample is subjected to PCoA ordination, the scores are submitted to a procrustean adjustment, and the correlation between observed and bootstrap ordination scores is computed. It compares such correlations to the same parameter generated in a parallel bootstrapped ordination of randomly permuted data. The number of axes in bootstrap or null PCoA with eigenvectors corresponding to positive eigenvalues may be smaller than the number of axes monitored, in this case, axes with values equal to 0 are created. The number of iterations with original values for each axis is shown in `n.permut.bootstrap` and `n.permut.null`.

The function `scores.pcoasig` re-scales the correlation values for `biplot` graphics.

### Value

value	The eigenvalues, relative eigenvalues and cumulative relative eigenvalues..
vectors	The principal coordinates.
correlations	Correlations between axis and original data.
mean.cor.null	Mean correlations, for axis, between null and reference scores.
mean.cor.bootstrap	Mean correlations, for axis, between bootstrap and reference scores.
n.permut.bootstrap	Number of iterations for each axis in bootstrap step.
n.permut.null	Number of iterations for each axis in null step.
probabilities	Probabilities for each axis.

### Note

#### Principal Component Analysis (PCA)

You can use the same function to determine the number of significant dimensions in principal component analysis (PCA). For this, standardize each variable for zero mean and uni variance (function `decostand` and `method standardize`) and use euclidean distance as dissimilarity index.

#### Interpretation

If the higher dimension is significant, then all lower dimensions will also be significant.

### Author(s)

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>



## References

Pillar, V.D. (1999). The bootstrapped ordination reexamined. *Journal of Vegetation Science* 10, 895-902.

## See Also

[pcoa](#), [procrustes](#)

## Examples

```
## Not run:
data(flona)
res<-pcoa.sig(flona$community, method = "bray", squareroot = TRUE, axis = 6, iterations = 100)
res
summary(res)$scores

## End(Not run)
```

---

pcps

*Principal Coordinates of Phylogenetic Structure*

---

## Description

Function to generate Principal Coordinates of Phylogenetic Structure (PCPS).

## Usage

```
pcps(
  comm,
  phylodist,
  checkdata = TRUE,
  method = "bray",
  squareroot = TRUE,
  correlations = TRUE
)

## S3 method for class 'pcps'
plot(
  x,
  groups = NULL,
  choices = c(1, 2),
  display = "text",
  showlabel = TRUE,
  ...
)
```

```
## S3 method for class 'pcps'
print(x, ...)

## S3 method for class 'summarypcps'
print(x, ...)

scores.pcps(x, choices = c(1, 2), ...)

## S3 method for class 'pcps'
summary(object, choices = c(1, 2), ...)
```

### Arguments

comm	Community data, with species as columns and sampling units as rows. This matrix can contain either presence/absence or abundance data. Alternatively comm can be an object of class <code>metacommunity.data</code> , an alternative way to set all data.frames/matrices. When you use the class <code>metacommunity.data</code> the argument <code>phylodist</code> must not be specified. See details.
phylodist	Matrix containing phylogenetic distances between species.
checkdata	Logical argument (TRUE or FALSE) to check if species sequence in the community data follows the same order as the one in the phylodist matrix (Default <code>checkdata = TRUE</code> ).
method	Dissimilarity index, as accepted by <code>vegdist</code> (Default <code>dist="bray"</code> ).
squareroot	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index (Default <code>squareroot = TRUE</code> ).
correlations	Logical argument (TRUE or FALSE) to specify if are calculated the correlations between each PCPS and each species in matrix P (Default <code>correlations = TRUE</code> ).
x	An object of class <code>pcps</code> .
groups	Factor giving the groups (Clades) for each species (Default <code>groups = NULL</code> ).
choices	Axes for re-scaling. Choices must have length equal to two (Default <code>choices = c(1, 2)</code> ).
display	Display text or points for the sampling units, partial match to "text" or "points" (Default <code>display = "text"</code> ).
showlabel	Label the groups by their names in the centroid of the object.
...	Other parameters for the respective functions.
object	An object of class <code>pcps</code> .

### Details

The function obtains a matrix containing phylogeny-weighted species composition (`matrix.p`) and is submitted to principal coordinates analysis (PCoA). This method generates the principal coordinates of phylogenetic structure (PCPS) (Duarte, 2011).

The sequence species show up in the community data matrix must be the same as they show up in the phylogenetic distance matrix. The function `organize.pcps` organizes the data, placing the matrices of community and phylogenetic distance in the same order. The use of `organize.pcps`

is not required for run this function, but is recommended. In this way the arguments `comm` and `phylo` can be specified them as normal arguments or by passing them with the object returned by the function `organize.pcps` using, in this case only the argument `comm`. Using the object returned by `organize.pcps`, the `comm` argument is used as an alternative way of entering to set all `data.frames/matrices`, and therefore the `phylo` argument must not be specified.

The function `summary` or the function `scores.pcps` re-scales the correlation values for obtain the scores for `biplot` graphics. The function `plot` draws a simple biplot and represent clades as "spider" graphs (see `ordispider`).

### Value

<code>P</code>	Phylogeny-weighted species composition matrix.
<code>values</code>	The eigenvalues, relative eigenvalues and cumulative relative eigenvalues.
<code>vectors</code>	The principal coordinates of phylogenetic structure (PCPS).
<code>correlations</code>	Correlations between a PCPS axis and phylogenetically weighted species abundances or frequencies.
<code>scores</code>	Scores for biplot graphics.

### Note

**IMPORTANT:** The sequence species show up in the community data matrix **MUST** be the same as they show up in the phylogenetic distance matrix. See details and `organize.pcps`.

### Author(s)

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>

### References

Duarte, L.S. (2011). Phylogenetic habitat filtering influences forest nucleation in grasslands. *Oikos*, 120, 208:215.

### See Also

`matrix.p`, `wcmdscale`, `ordispider`, `ordilabel`

### Examples

```
data(ADRS)
res<-pcps(ADRS$community, ADRS$phylo)
res
summary(res)
summary(res, choices = c(1, 2))$scores
plot(res, display = "text", groups = c(rep("Clade-A", 2), rep("Clade-B", 4)))
```

---

pcps.curve

*Curve of phylogenetic signal at metacommunity level*


---

## Description

The function estimate the phylogenetic signal at metacommunity level and draws a representation curve.

## Usage

```
pcps.curve(
  comm,
  phylodist,
  trait,
  checkdata = TRUE,
  method = "bray",
  squareroot = TRUE,
  ranks = TRUE,
  null.model.ts = FALSE,
  null.model.bm = FALSE,
  tree,
  runs = 99,
  progressbar = FALSE,
  parallel = NULL
)

pcpc.curve.calc(values, vectors, mt)

## S3 method for class 'pcpscurve'
plot(
  x,
  draw.model = c("none", "ts", "bm"),
  type = "b",
  probs = c(0.025, 0.975),
  col = "black",
  model.col = "black",
  ...
)

## S3 method for class 'pcpscurve'
print(x, ...)

## S3 method for class 'pcpscurve'
summary(object, probs = c(0.025, 0.975), ...)
```

**Arguments**

comm	Community data, with species as columns and sampling units as rows. This matrix can contain either presence/absence or abundance data. Alternatively comm can be an object of class <code>metacommunity.data</code> , an alternative way to set all data.frames/matrices. When you use the class <code>metacommunity.data</code> the arguments <code>trait</code> and <code>phylo</code> must not be specified. See details.
phylo	Matrix containing phylogenetic distances between species.
trait	Matrix data of species described by traits, with traits as columns and species as rows.
checkdata	Logical argument (TRUE or FALSE) to check if species sequence in the community data follows the same order as the one in the trait and in the phylo matrices (Default <code>checkdata = TRUE</code> ).
method	Dissimilarity index, as accepted by <code>vegdist</code> (Default <code>dist = "bray"</code> ).
squareroot	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index (Default <code>squareroot = TRUE</code> ).
ranks	Logical argument (TRUE or FALSE) to specify if ordinal variables are convert to ranks (Default <code>ranks = TRUE</code> ).
null.model.ts	Logical argument (TRUE or FALSE) to specify if use null model that shuffles terminal tips across the phylogenetic tree to generate null curves. See details (Default <code>null.model.ts = FALSE</code> ).
null.model.bm	Logical argument (TRUE or FALSE) to specify if use null model that simulate trait evolving under Brownian motion to generate null curves. See details (Default <code>null.model.bm = FALSE</code> ).
tree	Phylogenetic tree, as phylo object.
runs	Number of randomizations.
progressbar	Logical argument (TRUE or FALSE) to specify if display a progress bar on the R console (Default <code>progressbar = FALSE</code> ).
parallel	Number of parallel processes or a predefined socket cluster done with parallel package. Tip: use <code>detectCores()</code> (Default <code>parallel = NULL</code> ).
values	The eigenvalues, relative eigenvalues and cumulative relative eigenvalues returned by <code>pcps</code> .
vectors	The principal coordinates of phylogenetic structure returned by <code>pcps</code> .
mt	Matrix containing trait average at community level for one trait.
x	An object of class <code>pcpscurve</code> .
draw.model	Type of null model to draw; none (none), taxa shuffle (ts), brownian motion model (bm).
type	Type of the plot to be drawn (Default <code>type = "b"</code> ).
probs	Numeric vector of probabilities used by <code>quantile</code> . (Default <code>probs = c(0.025, 0.975)</code> ).
col	Plot color.
model.col	Color of lines of null models.
...	Further graphical parameters for points.
object	An object of class <code>pcpscurve</code> .

## Details

The sequence species show up in the community data matrix must be the same as they show up in the phylogenetic distance matrix and in traits matrix. The function `organize.pcps` organizes the data, placing the matrices of community and phylogenetic distance and trait in the same order. The function use of function `organize.pcps` is not required for run the functions, but is recommended. In this way the arguments `comm` and `phylodist` can be specified them as normal arguments or by passing them with the object returned by the function `organize.pcps` using, in this case only the argument `comm`. Using the object returned by `organize.pcps`, the `comm` argument is used as an alternative way of entering to set all data.frames/matrices, and therefore the arguments `phylodist` and `trait` must not be specified.

The PCPS are used, in a sequential manner, as predictors in a linear regression to model the trait averages across the metacommunity. The curve is drawn as the percentage of cumulative eigenvalues in the abscissa and as the determination coefficient of regressions in the ordinate.

Two null models are available. The first one (ts), the null curves are generated shuffling terminal tips across the phylogenetic tree, generates a set of random PCPS and recalculates the curves. The second (bm), the null curves are generated with simulate traits evolving under Brownian motion model.

## Value

<code>curve.obs</code>	The cumulative PCPS eigenvalues and the coefficient of determination.
<code>curve.null.ts</code>	The cumulative PCPS eigenvalues and the coefficient of determination for each randomization using the taxa shuffle null model.
<code>curve.null.bm</code>	The cumulative PCPS eigenvalues and the coefficient of determination for each randomization using the Brownian motion null model.

## Note

**IMPORTANT:** The sequence of species in the community data matrix **MUST** be the same as that in the phylogenetic distance matrix and in traits matrix. See details and `organize.pcps`.

## Author(s)

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>

## References

Duarte, L.S. (2011). Phylogenetic habitat filtering influences forest nucleation in grasslands. *Oikos*, 120, 208:215.

## See Also

[matrix.p](#), [pcps](#)

**Examples**

```
## Not run:
data(flona)
res<-pcps.curve(flona$community, flona$phylo, flona$trait[,1,drop = FALSE],
               null.model.ts = TRUE, runs = 9)
res
summary(res)
plot(res, draw.model = "ts", type = "b", col = "red")

## End(Not run)
```

---

select.pcpsmethod	<i>Internal function</i>
-------------------	--------------------------

---

**Description**

Internal function to select a predefined method/function available in this package.

**Usage**

```
select.pcpsmethod(
  method = c("mantel", "adonis", "glm", "rda", "gls.marginal", "gls.sequential",
            "lme.marginal", "lme.sequential", "none")
)
```

**Arguments**

method	A predefined method/function available in PCPS package, partial match to "mantel", "adonis", "glm", "rda", "gls.marginal", "gls.sequential", "lme.marginal", "lme.sequential" and "none".
--------	---

---

self.belonging	<i>Degree of self belonging of species</i>
----------------	--

---

**Description**

Define the degree of self belonging of species.

**Usage**

```
self.belonging(dis, standardize = TRUE)
```

**Arguments**

<code>dis</code>	Matrix containing distance between species.
<code>standardize</code>	Logical argument (TRUE or FALSE) to specify if <code>dis</code> must be standardized in values into range 0 from 1 (Default <code>standardize = TRUE</code> ).

**Details**

For the calculation of self-belonging of a set of species the dissimilarities between the species are transformed into similarities and used to define degrees of belonging to fuzzy sets (Pillar et al. 2009; Pillar & Duarte 2010). Every species among all species specifies a fuzzy set in relation to all other species, with a certain degree of belonging. The self-belonging of a given species `i` expresses its degree of belonging to the root node of the phylogenetic/functional tree, conditioned to the similarities between `i` and all other internal nodes connecting it to the root.

**Value**

The self-belonging for each species.

**Author(s)**

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>

**References**

Pillar, V.D.; Duarte, L.d.S. (2010). A framework for metacommunity analysis of phylogenetic structure. *Ecology Letters*, 13, 587:596.

Pillar, V.D., Duarte, L.d.S., Sosinski, E.E. & Joner, F. (2009). Discriminating trait-convergence and trait-divergence assembly patterns in ecological community gradients. *Journal of Vegetation Science*, 20, 334:348.

**See Also**

[belonging](#)

**Examples**

```
data(ADRS)
self.belonging(ADRS$phylo)
```



---

`wcmdscale.org`*Internal function for organize the results of wcmdscale function*

---

**Description**

Internal function for organize the results of `wcmdscale` function. The function computes dissimilarity indices using the function `vegdist` and perform Principal Coordinates Analysis (PCoA) using the function `wcmdscale`. If data is of class `dist`, the function do not computes the dissimilarity indices.

**Usage**

```
wcmdscale.org(data, method, squareroot, eig, correlations, ...)
```

**Arguments**

<code>data</code>	Data matrix or dissimilarities of class <code>dist</code> .
<code>method</code>	Method for dissimilarity index, as accepted by <code>vegdist</code> .
<code>squareroot</code>	Logical argument (TRUE or FALSE) to specify if use square root of dissimilarity index.
<code>eig</code>	Logical argument (TRUE or FALSE) to indicates if eigenvalues are returned.
<code>correlations</code>	Logical argument (TRUE or FALSE) to indicates if correlations between axis and original data are returned.
<code>...</code>	Other arguments passed to <code>wcmdscale</code> function.

**Value**

<code>values</code>	The eigenvalues, relative eigenvalues and cumulative relative eigenvalues.
<code>vectors</code>	The principal coordinates.
<code>correlations</code>	Correlations between axis and original data.

**Author(s)**

Vanderlei Julio Debastiani <[vanderleidebastiani@yahoo.com.br](mailto:vanderleidebastiani@yahoo.com.br)>

**See Also**

[vegdist](#), [wcmdscale](#)

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