Package 'flower'

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Description Flowering is an important life history trait of flowering plants. It has been mainly analyzed with respect to flowering onset and duration of flowering. This tools provide some functions to compute the temporal distribution of an flowering individual related to other population members. fCV() measures the temporal variation in flowering. RIind() measures the rank order of flowering for individual plants within a population. SI(), SI2(), SI3(), and SI4() calculate flowering synchrony with different methods.

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`flower-package` *Tools for characterizing flowering traits*

Description

Flowering is an important life history trait of flowering plants. It has been mainly analyzed with respect to flowering onset and duration of flowering. This tools provide some functions to compute the temporal distribution of an flowering individual related to other population members. fCV() measures the temporal variation in flowering. RIind() measures the rank order of flowering for individual plants within a population. SI(), SI2(), SI3(), and SI4() calculate flowering synchrony with different methods.

Details

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Version:	1.0
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Author(s)

WANG,Xie Maintainer: WANG,Xie <wangxiechangde@hotmail.com>

References

Michalski SG, Durka W. Synchronous Pulsed Flowering: Analysis of the Flowering Phenology in Juncus (Juncaceae). Annals of Botany 2007;100(6):1271-1285. doi:10.1093/aob/mcm206.

See Also

flower

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(1,0,0,1,1,0,1)
a5=c(0,0,1,1,1,0,1)
a6=c(0,0,0,1,1,1,1)
pop=c("pop1","pop1","pop1","pop2","pop2","pop2")
ind=c(1,2,3,1,2,3)
dd=rbind(a1,a2,a3,a4,a5,a6)
```

```
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
#the flowering synchrony index
R0=SI(dd,pop)
R0
R1=SI2_onepop(dd,as.matrix(ind))
R1
R2=SI2(dd,as.matrix(pop),as.matrix(ind))
R2
R3=SI3(dd,as.matrix(pop),as.matrix(ind))
R3
R4=SI4(dd,as.matrix(pop),as.matrix(ind))
R4
#the rank order of flowering
R5=RIind(dd,pop,ind)
R5
#the pulsed flowering phenology
R6=fCV(dd,pop)
R6
```

`fCV` *The coefficient of variation at population level*

Description

It used to quantify the pulsed flowering phenology on the population level. It has been used widely in mast seeding/mast flowering research to estimate the degree of annual variation in seed output within a population.

Usage

```
fCV(dd, pop)
```

Arguments

`dd`	Flowering data.
`pop`	ID of population.

Details

cv=sqrt((1/(n-1))*sum(xpt-mean(xpt))^2)/mean(xpt);(t=1:n)

Value

`cv`	measure of temporal variation in flowering
`n`	the number of days individual i was flowering
`x`	the total number of open flowers per day t and population p
`t`	flowering day

Note

nothing

Author(s)

WANG,XIE

References

[1]Silvertown JW. The evolutionary ecology of mast seeding in trees. Biological Journal of the Linnean Society. 1980;14:235~250. [2]Kelly D. The evolutionary ecology of mast seeding. Trends in Ecology & Evolution. 1994;9:465~470.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(0,0,0,1,1,0,1)
pop=c("pop1","pop1","pop2","pop2")
ind=c("1","2","1","2")
dd=rbind(a1,a2,a3,a4)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=fCV(dd,pop)
C
```

RIind *Flowering phenology index of Mahoro (2002) at individual level*

Description

It measures the rank order of flowering for individual plants within a population.

Usage

```
RIind(dd, pop, ind)
```

Arguments

dd	Flowering data
pop	group of Population
ind	ID of individual

Details

ri=sum(aij/bi);(j=1:p)

Value

i	individuals
j	time during the flowering from beginning to pike of flowering p
r	the rank of each individual
aij	flowers that had already open in the individual by the jth census day
bi	the total number of flowers opening in the individual during the season
xij	xij=aij/bi

Note

nothing

Author(s)

WANG,XIE

References

[1]Mahoro, S. (2002). Individual flowering schedule, fruit set, and flower and seed predation in Vaccinium hirtum Thunb. (Ericaceae). Can. J. Bot. 80: 82-92.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(0,0,0,1,1,0,1)
pop=c("pop1","pop1","pop2","pop2")
ind=c(1,2,1,2)
dd=rbind(a1,a2,a3,a4)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=RIind(dd,pop,ind)
C
```

RIpop *Flowering phenology index of Mahoro (2002) at poplulation level*

Description

Relative to the formula of Mahoro (2002),we suggested the reference object (b) calculated in a polulation was better than in a individua. It measures the rank order of flowering for individual plants within a population.

Usage

```
RIpop(dd, pop, ind)
```

Arguments

dd	Flowering data.
pop	Group of Population.
ind	ID of individual.

Details

ri=sum(aij/bi);(j=1:p)

Value

i	individuals
j	time during the flowering from beginning to pike of flowering p
r	the rank of each individual
aij	flowers that had already open in the individual by the jth census day
bi	the total number of flowers opening in the individual during the season
xij	xij=aij/bi

Note

nothing

Author(s)

WANG,XIE

References

[1]Mahoro, S. (2002). Individual flowering schedule, fruit set, and flower and seed predation in Vaccinium hirtum Thunb. (Ericaceae). Can. J. Bot. 80: 82-92.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(0,0,0,1,1,0,1)
pop=c("pop1","pop1","pop2","pop2")
ind=c(1,2,1,2)
dd=rbind(a1,a2,a3,a4)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=RIpop(dd,pop,ind)
C
```

SI *Flowering synchrony index of Albert et al.(2001)*

Description

Flowering synchrony was calculated considering all pairs of plants or poluplation.

Usage

```
SI(dd, pop)
```

Arguments

dd	Flowering data.
pop	Research scale, such as Population, individual, inflorescence, single flowers.

Details

si=(1/(n-1))*sum(aij/bij)

Value

m	number of record days
n	number of group levels
f	names of group levels
aij	number of days on which j and i individuals are simultaneously flowering
bij	number of days on which at least one of them (j and/or i) is flowering
si	synchrony index,this index ranges from 0 (no synchrony) to 1 (flowering overlap is complete)

Note

nothing

Author(s)

WANG,XIE

References

[1]Albert MJ, Escudero A, Iriondo JM. Female reproductive success of narrow endemic Erodium paularense in contrasting microhabitats. Ecology.2001,82,1734~1747.

[2]Augspurger CK. Reproductive synchrony of a tropical shrub: experimental studies on effects of pollinators and seed predators on Hybanthus prunifolius (Violaceae),Ecology.1981,62,775~788.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(0,0,0,1,1,0,1)
pop=c("pop1","pop1","pop2","pop2")
dd=rbind(a1,a2,a3,a4)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=SI(dd,pop)
C
```

SI2 *Flowering synchrony index of Augspurger (1983)*

Description

It measures the extent of overlapping in the flowering periods among pairs of individuals in a population.

Usage

```
SI2(dd, pop, ind)
```

Arguments

dd	Flowering data.
pop	Research scale, such as Population, individual, inflorescence, single flowers.
ind	ID ofindividual or inflorescence.

Details

si=(1/(n-1))*(1/fi)sum(ej);(j=1:n)

Value

n	The number of individuals in the population.
fi	The number of days individual i was flowering.
ej	The number of days that individuals i and j are flowering synchronously, with j != i.
bij	Number of days on which at least one of them (j and/or i) is flowering.
si	Synchrony index,from 0 (total lack of synchrony) to 1 (perfect synchrony).

Note

SI2 has been criticized for its dependence on flowering duration because the factor 1/fi increases the level of synchrony when flowering duration decreases.

Author(s)

WANG,XIE

References

[1]Augspurger, C. K. (1983). Phenology, flowering synchrony and fruit set of six neotropical shrubs. Biotropica 15: 257~267.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(1,0,0,1,1,0,1)
a5=c(0,0,1,1,1,0,1)
a6=c(0,0,0,1,1,1,1)
pop=c("pop1","pop1","pop1","pop2","pop2","pop2")
ind=c(1,2,3,1,2,3)
dd=rbind(a1,a2,a3,a4,a5,a6)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=SI2(dd,as.matrix(pop),as.matrix(ind))
C
```

SI2_onepop *Flowering synchrony index of Augspurger (1983) in a polulation*

Description

It measures the extent of overlapping in the flowering periods among pairs of individuals in a population.

Usage

```
SI2_onepop(dd, ind)
```

Arguments

dd	Flowering data
ind	ID of individual or inflorescence.

Details

si=(1/(n-1))*(1/fi)sum(ej);(j=1:n)

Value

n	The number of individuals in the population.
fi	The number of days individual i was flowering.
ej	The number of days that individuals i and j are flowering synchronously, with j != i.
bij	Number of days on which at least one of them (j and/or i) is flowering.
si	Synchrony index,from 0 (total lack of synchrony) to 1 (perfect synchrony).

Note

SI2 has been criticized for its dependence on flowering duration because the factor 1/fi increases the level of synchrony when flowering duration decreases.

Author(s)

WANG,XIE

References

[1]Augspurger, C. K. (1983). Phenology, flowering synchrony and fruit set of six neotropical shrubs. Biotropica 15: 257~267.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(0,0,0,1,1,0,1)
ind=c("1","1","2","2")
dd=rbind(a1,a2,a3,a4)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=SI2_onepop(dd,ind)
C
```

SI3 *Among-individual synchrony index of Koenig et al. (2003)*

Description

The mean of all pairwise Pearson correlations coefficients (ri) of the numbers of open flowers per day (xti) of all individuals within a population.

Usage

```
SI3(dd, pop, ind)
```

Arguments

dd	Flowering data.
pop	ID of population.
ind	ID of individual.

Details

si3=mean(cor(xit))

Value

si3	Among-individual synchrony index of Koenig (2003).
ri	All pairwise Pearson correlations coefficients (ri) of xit.
xit	The numbers of open flowers per day.

Note

nothing

Author(s)

WANG,XIE

References

[1]Koenig WD, Kelly D, Sork VL, Duncan RP, Elkinton JS, Peltonen MS, Westfall RD. Dissecting components of population-level variation in seed production and the evolution of masting behavior. Oikos. 2003;102:581~591.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(1,0,0,1,1,0,1)
a5=c(0,0,1,1,1,0,1)
a6=c(0,0,0,1,1,1,1)
pop=c("pop1","pop1","pop1","pop2","pop2","pop2")
ind=c(1,2,3,1,2,3)
dd=rbind(a1,a2,a3,a4,a5,a6)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=SI3(dd,as.matrix(pop),as.matrix(ind))
C
```

SI4 *An alternative synchronization index of Marquis (1988)*

Description

SI4 thus facilitates comparison between species irrespective of flowering duration.

Usage

```
SI4(dd, pop, ind)
```

Arguments

dd	Flowering data.
pop	ID of population.
ind	ID of individual.

Details

si4=sum(xit/bit)*pt;bit=sum(xit);t=1:n

Value

si4	An alternative synchronization index of Marquis (1988).
xit	The numbers of open flowers per day.
bit	The total number of flowers of individual i during the whole flowering period.
pt	The proportion of all marked stems (inflorescence or individual) in bloom at day t.
t	Day.

Note

SI4 is a function of the numbers of open flowers per plant in contrast to Augspurger's measure SI2 which uses the mere information on whether a plant is flowering or not. SI4 accounts for full effects of variation in both the within-individual and the between-individual flowering patterns, and eventually includes the overlap of the individual flowering with the flowering of other individuals as an aspect of cross-fertilization (Bolmgren, 1998).

Author(s)

WANG,XIE

References

[1]Marquis RJ. Phenologcal variation in the Neotropical understory shrub Piper arieianum: causes and consequences. Ecology. 1988;69:1552~1565. [2]Bolmgren K. The use of synchronization measures in studies of plant reproduction phenology. Oikos. 1998;82:411~415.

See Also

nothing

Examples

```
a1=c(0,1,1,1,0,0,0)
a2=c(0,1,0,1,1,0,0)
a3=c(0,0,0,1,1,1,0)
a4=c(1,0,0,1,1,0,1)
a5=c(0,0,1,1,1,0,1)
a6=c(0,0,0,1,1,1,1)
pop=c("pop1","pop1","pop1","pop2","pop2","pop2")
ind=c(1,2,3,1,2,3)
dd=rbind(a1,a2,a3,a4,a5,a6)
colnames(dd)=c("D5/1","D5/2","D5/3","D5/4","D5/5","D5/6","D5/7")
C=SI4(dd,as.matrix(pop),as.matrix(ind))
C
```

Index