Package 'photobiologyPlants'

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Type Package

Title Plant Photobiology Related Functions and Data

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Description Provides functions for quantifying visible (VIS) and ultraviolet (UV) radiation in relation to the photoreceptors Phytochromes, Cryptochromes, and UVR8 which are present in plants. It also includes data sets on the optical properties of plants.

License GPL (>= 2)

VignetteBuilder knitr

Depends R (>= 3.2.0), photobiology (>= 0.9.14), photobiologyWavebands (>= 0.4.2)

Suggests ggplot2 (>= 2.1.0), knitr (>= 1.13.0), ggspectra (>= 0.1.6)

LazyLoad yes

LazyData yes

ByteCompile true

Encoding UTF-8

URL http://www.r4photobiology.info/
https://bitbucket.org/aphalo/photobiologyplants

BugReports https://bitbucket.org/aphalo/photobiologyplants/issues

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`photobiologyPlants-package`

photobiologyPlants: Plant Photobiology Related Functions and Data

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Description

Provides functions for quantifying visible (VIS) and ultraviolet (UV) radiation in relation to the photoreceptors Phytochromes, Cryptochromes, and UVR8 which are present in plants. It also includes data sets on the optical properties of plants.

Details

Package 'photobiologyPlants' is part of a suite of packages for analysis and plotting of data relevant to photobiology (described at http://www.r4photobiology.info/). The current component package provides functions and data related to plant photoreceptors, light dependent reponses and optical properties of plants.

Acknowledgements

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Author(s)

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References

Aphalo, P. J., Albert, A., Björn, L. O., McLeod, A. R., Robson, T. M., Rosenqvist, E. (Eds.). (2012). Beyond the Visible: A handbook of best practice in plant UV photobiology (1st ed., p. xxx + 174). Helsinki: University of Helsinki, Department of Biosciences, Division of Plant Biology. ISBN 978-952-10-8363-1 (PDF), 978-952-10-8362-4 (paperback). Open access PDF download available at http://hdl.handle.net/10138/37558

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

Banerjee, R., Schleicher, E., Meier, S., Viana, R. M., Pokorny, R., Ahmad, M., ... Batschauer, A. (2007). The signaling state of Arabidopsis cryptochrome 2 contains flavin semiquinone. J Biol Chem, 282(20), 14916–14922. DOI 10.1074/jbc.M700616200

See Also

Package photobiology-package

Betula_ermanii.mspct *Spectral data for 'Betula ermanii' leaves*

Description

A dataset containing for wavelengths at a 1 nm interval in the range 350 to 1000 nm, tabulated values for total reflectance and total transmittance, for the upper and lower epidermis of leaves of different ages from 'Betula ermanii' trees growing in the forest in Japan.

The variables in each spectrum are as follows:

- w.length (nm)
- Rfr
- Tfr

Usage

```
Betula_ermanii.mspct
```

Format

`object_mspct` collection object with six `object_spct` member objects, each with 651 rows and 3 variables

Note

We thank H. M. Noda for allowing us to include these data in our package. We have included here only data for two leaves from one species (Solidago altissima) and for wavelengths shorter than 1000 nm, from the much larger original data set. The whole data set is publicly available and the data easy to read into R. The data included here where measured with a Li-Cor LI-1800 spectroradiometer equipped with a LI-1800-12 (Li-Cor) integrating sphere, and consequently are for total reflectance and total transmittance. Further details on methods are available through the JaLTER web site. If you use these data in a publication, please cite the original source as given under references and contact the original author.

References

Noda H. 'Reflectance and transmittance spectra of leaves and shoots of 22 vascular plant species and reflectance spectra of trunks and branches of 12 tree species in Japan' ERDP-2013-02.1.1 (http://db.cger.nies.go.jp/JaLTER/metacat/metacat/ERDP-2013-02.1.1/jalter-en)
JaLTER, Japan Long Term Ecological Research Network, http://www.jalter.org/

B_G *Calculate B:G photon ratio from spectral irradiance.*

Description

This function returns the blue:green photon ratio of a light source spectrum.

Usage

```
B_G(spct, std = "Sellaro", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of blue and green should be used, defaults to "Sellaro"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the B:G photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
B_G(sun.spct)
```

CRY2.mspct *CRY2 Absorbance spectra.*

Description

A dataset containing the wavelengths at an arbitrary nm interval. Tabulated values for the in vitro absorbance spectrum of CRY2. The data were digitized from Figure 1.B, curve "dark adapted sample", and curve "irradiated with blue light (450 nm, 50 umol m-2 s-1) during 30 min" in Banerjee et al. (2007).

Format

A `filter.mspct` with two member `filter.spct` objects each with 100 or 200 rows and 2 numeric variables, `w.length` and `A`

Details

The variables of the member spectra are as follows:

- w.length (nm)
- A (spectral absorbance)

References

Banerjee, R., Schleicher, E., Meier, S., Viana, R. M., Pokorny, R., Ahmad, M., ... Batschauer, A. (2007). The signaling state of Arabidopsis cryptochrome 2 contains flavin semiquinone. J Biol Chem, 282(20), 14916–14922. doi:10.1074/jbc.M700616200

McCree_photosynthesis.mspct *McCree's action spectra for whole-leaf photosynthesis.*

Description

The 'classical' action spectra of K. J. McCree (1972) for Amaranthus edulis Speg. var. UCD 1966 and Avena sativa L. var. Coronado are included in this data set. Response is net CO2 uptake measured of leaf sections. Light source was a xenon-arc lamp fitted with a monochromator. Irradiance was in the range 10 to 15 W m$^-2$.

Format

A `response_mspct` object with two member `response_spct` objects each with 200 rows and 2 numeric variables, `w.length` and `s.e.response`.

Note

Digitised from bitmap of from the original publicatiom.

References

McCree, K. J. (1972) Significance of Enhancement for Calculations Based on the Action Spectrum for Photosynthesis. Plant Physiology, 49, 704-706. Fig. 1, AMARANTH

Pfr_Ptot *Calculate phytochrome photoequilibrium*

Description

A method implemented for objects of different classes.

Usage

```
Pfr_Ptot(x, ...)

## Default S3 method:
Pfr_Ptot(x, ...)

## S3 method for class 'numeric'
Pfr_Ptot(x, spct.out = length(x) > 20, ...)

## S3 method for class 'source_spct'
Pfr_Ptot(x, ...)
```

Arguments

x	an R object
...	not used
spct.out	logical Flag indicating if the returned object should be of class response_spct instead of numeric.

Value

If x is numeric, giving wavelengths (nm), a vector of numeric values giving the unitless photon ratio at each wavelength or a generic_spct object with the wavelength values sorted in ascending order and the corresponding Pfr_Ptot values in column s.q.response.

If x is a source_spct object, a single numeric value giving the unitless photon ratio

Methods (by class)

- `default`: Default for generic function
- `numeric`: Specialization for numeric
- `source_spct`: Specialization for source_spct
  Calculate phytochrome photoequilibrium from spectral (photon) irradiance

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

`Pfr_Ptot_R_FR` *Pr:Ptot ratio (photoequilibrium) from R:FR photon ratio.*

Description

Calculation of Pfr:Ptot ratio for Type I Phytochrome from red:far-red photon ratio. "Exact" only for dichromatic irradiation, only approximate for R:FR ratio calculated from a broadband light source.

Usage

```
Pfr_Ptot_R_FR(R.FR)
```

Arguments

`R.FR`	R:FR a single value or a vector of photon ratio (unitless) values

Value

a single value or a vector of numeric values giving the Pr:Ptot unitless ratio

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

See Also

`q_ratio`

Examples

```
Pfr_Ptot_R_FR(1.15)
Pfr_Ptot_R_FR(0.10)
Pfr_Ptot_R_FR(c(0.1,1.15,5.0,20.0))
```

`phytochrome.spct` *Tabulated data for Phytochrome Sigma*

Description

A dataset containing the wavelengths at a 1 nm interval. Tabulated values for Sigma R and Sigma FR for Type I Phytochrome as compiled by Mancinelli (1994).

The variables are as follows:

- wavelength (nm)
- Sigma.R (quantum effectiveness)
- Sigma.FR (quantum effectiveness)

Format

A generic.spct object with 49 rows and 3 variables

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

`Phy_reaction_rates` *Phytochrome reaction rates*

Description

Rate constants k1 Pr -> Pfr; k2 Pfr -> Pr; photoconversion rate nu = k1 + k2 for Type I Phytochrome.

Usage

```
Phy_reaction_rates(w.length, s.irrad, unit.in = "energy",
  check.spectrum = TRUE, use.cached.mult = FALSE)
```

Arguments

w.length	numeric array of wavelength (nm)
s.irrad	numeric array of spectral (energy) irradiances (W m-2 nm-1) or (mol s-1 m-2)
unit.in	character string with allowed values "energy", and "photon", or its alias "quantum"
check.spectrum	logical indicating whether to sanity check input data, default is TRUE
use.cached.mult	logical indicating whether multiplier values should be cached between calls

Value

a list of three numeric values giving the photoconversion rate (nu) and reaction rates (k1, k2).

References

Hayward, P. M. (1984) Determination of phytochrome parameters from radiation measurements. In Techniques in Photomorphogenesis, H. Smith and M. G. Holmes (eds). Academic Press, London, pp. 159-173. ISBN 0-12-652990-6.

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

See Also

photon_ratio and energy_ratio

Examples

```
library(photobiology)
trimmed.sun.spct <- trim_wl(sun.spct, range = c(300, 770))
with(trimmed.sun.spct, Phy_reaction_rates(w.length, s.e.irrad))
```

Phy_Sigma *Phytochrome Sigma as a function of wavelength*

Description

Phytochrome Sigma as a function of wavelength, calculated by interpolatio from data for Type I Phytochrome as compiled by Mancinelli (1994).

Usage

```
Phy_Sigma(w.length)
```

Arguments

w.length	numeric array of wavelength (nm)

Value

a numeric array with values for Sigma

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

See Also

Pfr_Ptot and Pfr_Ptot_R_FR

Examples

```
with(sun.data, Phy_Sigma(w.length))
```

Phy_Sigma_FR *Pfr Sigma as a function of wavelength*

Description

Pfr Sigma as a function of wavelength, calculated by interpolatio from data for Type I Phytochrome as compiled by Mancinelli (xxxx).

Usage

```
Phy_Sigma_FR(w.length, use.cached.mult = FALSE)
```

Arguments

w.length	numeric array of wavelength (nm)
use.cached.mult	logical ignored

Value

a numeric array with values for Sigma

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

See Also

Phy_Sigma, Pfr_Ptot and Pfr_Ptot_R_FR

Examples

```
with(sun.spct, Phy_Sigma_FR(w.length))
with(sun.spct, Phy_Sigma_FR(w.length, TRUE))
```

Phy_Sigma_R *Pr Sigma as a function of wavelength*

Description

Pr Sigma as a function of wavelength, calculated by interpolatio from data for Type I Phytochrome as compiled by Mancinelli (1994).

Usage

```
Phy_Sigma_R(w.length, use.cached.mult = FALSE)
```

Arguments

w.length	numeric array of wavelength (nm)
use.cached.mult	logical ignored

Value

a numeric array with values for Sigma

References

Mancinelli, A.L. (1994) The physiology of phytochrome action. In Photomorphogenesis in plants, 2nd edition. R.E. Kendrick and G.H.M. Kronenberg, eds. Kluwer Academic Publishers, Dordrecht, pp. 211-269. ISBN 978-0-7923-2551-2 (print), 978-94-011-1884-2 (on-line). DOI 10.1007/978-94-011-1884-2_10

See Also

Phy_Sigma, Pfr_Ptot and Pfr_Ptot_R_FR

Examples

```
with(sun.data, Phy_Sigma_R(w.length))
with(sun.data, Phy_Sigma_R(w.length, TRUE))
```

R_FR *Calculate R:FR photon ratio from spectral irradiance.*

Description

This function returns the red:far-red photon ratio of a light source spectrum.

Usage

```
R_FR(spct, std = "Smith10", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of red and far-red should be used, defaults to "Smith"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the R:FR photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
R_FR(sun.spct)
```

`Solidago_altissima.mspct` *Spectral optical data for 'Solidago altissima' leaves*

Description

A dataset containing for wavelengths at a 1 nm interval in the range 350 to 1000 nm, tabulated values for total reflectance and total transmittance, for the upper and lower epidermis of one leaf from the upper part of a shoot and another one from the lower part.

The variables in each spectrum are as follows:

- w.length (nm)
- Rfr
- Tfr

Usage

```
Solidago_altissima.mspct
```

Format

`object_mspct` collection object with four `object_spct` member objects, each with 651 rows and 3 variables

Note

We thank H. M. Noda for allowing us to include these data in our package. We have included here only data for two leaves from one species (Solidago altissima) and for wavelengths shorter than 1000 nm, from the much larger original data set. The whole data set is publicly available and the data easy to read into R. The data included here where measured with a Li-Cor LI-1800 spectroradiometer equipped with a LI-1800-12 (Li-Cor) integrating sphere, and consequently are for total reflectance and total transmittance. Further details on methods are available through the JaLTER web site. If you use these data in a publication, please cite the original source as given under references and contact the original author.

References

Noda H. 'Reflectance and transmittance spectra of leaves and shoots of 22 vascular plant species and reflectance spectra of trunks and branches of 12 tree species in Japan' ERDP-2013-02.1.1 (http://db.cger.nies.go.jp/JaLTER/metacat/metacat/ERDP-2013-02.1.1/jalter-en)
JaLTER, Japan Long Term Ecological Research Network, http://www.jalter.org/

UVA_PAR *Calculate UVA:PAR photon ratio from spectral irradiance.*

Description

This function returns the UVA:PAR photon ratio of a light source spectrum.

Usage

```
UVA_PAR(spct, std = "ISO", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of UVA should be used, defaults to "ISO"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the UVA:PAR photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
UVA_PAR(sun.spct)
```

UVA_UV *Calculate UVA:UV photon ratio from spectral irradiance.*

Description

This function returns the UVA:UV photon ratio of a light source spectrum.

Usage

```
UVA_UV(spct, std = "ISO", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of UVB and UV should be used, defaults to "ISO"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the UVA:UV photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
UVA_UV(sun.spct)
```

UVB_PAR *Calculate UVB:PAR photon ratio from spectral irradiance.*

Description

This function returns the UVB:PAR photon ratio of a light source spectrum.

Usage

```
UVB_PAR(spct, std = "ISO", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of UVB should be used, defaults to "ISO"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the UVB:UV photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
UVB_PAR(sun.spct)
```

UVB_UV *Calculate UVB:UV photon ratio from spectral irradiance.*

Description

This function returns the UVB:UV photon ratio of a light source spectrum.

Usage

```
UVB_UV(spct, std = "ISO", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

spct	an object of class "source.spct"
std	select which definition of UVB and UV should be used, defaults to "ISO"
use.cached.mult	logical indicating whether multiplier values should be cached between calls
use.hinges	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the UVB:UV photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
UVB_UV(sun.spct)
```

UVR8_Glasgow.spct *UVR8 absorbance spectrum*

Description

A dataset containing the wavelengths at an arbitrary nm interval. Tabulated values for the in vitro absorbance spectrum of UVR8.

Format

A `filter.spct` object with 100 rows and 2 numeric variables, `w.length` and `A`

Details

The variables are as follows:

- w.length (nm)
- A (spectral absorbance)

References

Christie, J. M., A. S. Arvai, K. J. Baxter, M. Heilmann, A. J. Pratt, A. O'Hara, S. M. Kelly, M. Hothorn, B. O. Smith, K. Hitomi, et al. (2012). "Plant UVR8 photoreceptor senses UV-B by tryptophan-mediated disruption of cross-dimer salt bridges." In: Science (New York, N.Y.) 335.6075, pp. 1492–1496. DOI: 10.1126/science.1218091. (Figure S3)

`UV_PAR` *Calculate UV:PAR photon ratio from spectral irradiance.*

Description

This function returns the UV:PAR photon ratio of a light source spectrum.

Usage

```
UV_PAR(spct, std = "ISO", use.cached.mult = FALSE, use.hinges = TRUE)
```

Arguments

`spct`	an object of class "source.spct"
`std`	select which definition of UV should be used, defaults to "ISO"
`use.cached.mult`	logical indicating whether multiplier values should be cached between calls
`use.hinges`	logical indicating whether to use hinges to reduce interpolation errors

Value

a single numeric nondimensional value giving the UV:PAR photon ratio, with name attribute set to the name of the wavebands, with "(q:q)" appended.

Examples

```
UV_PAR(sun.spct)
```

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