Oikos

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Appendix 1

Table A1. Species, geographic location and references used in the meta-analysis for: (a) stomatal conductance (g_s, mmol·m^{-2}·s^{-1}), (b) percent loss of hydraulic conductivity (PLC) and (c) photochemical efficiency of photosystem II (F_v / F_m). Sign of effect summer-winter refers to the transition summer < winter (+), summer > winter (–) or summer = winter (=).

(a) Stomatal conductance (g_s)

Sites without summer drought

Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Acer pseudoplatanus	Oxfordshire, UK	Morecroft and Roberts 1999	–
Acer sacharum	Ashland, MO, USA	Loewenstein and Pallardy 1998	–
Calycanthus floridus	Trieste, Italy	Nardini and Salleo 2000	–
Carpinus betulus	Basel, Switzerland	Keel et al. 2007	–
Castanea sativa	Trieste, Italy	Nardini and Salleo 2000	–
Cercis siliquastrum	Trieste, Italy	Nardini and Salleo 2000	–
Corylus avellana	Trieste, Italy	Nardini and Salleo 2000	–
Fagus sylvatica	Basel, Switzerland	Keel et al. 2007	–
Fagus sylvatica f. purpurea	Kiel, Germany	Hacke and Sauter 1995	–
Juglans nigra	Ashland, MO, USA	Loewenstein and Pallardy 1998	–
Juglans regia	Trieste, Italy	Nardini and Salleo 2000	–
Malus domestica	Trieste, Italy	Nardini and Salleo 2000	–
Magnolia soulangeana	Trieste, Italy	Nardini and Salleo 2000	–
Quercus alba	Ashland, MO, USA	Loewenstein and Pallardy 1998	–

Quercus petraea	Basel, Switzerland	Keel et al. 2007	–
Quercus robur	Oxfordshire, UK	Morecroft and Roberts 1999	–
Quercus serrata	Nagoya, Japan	Hiyama et al. 2005	–
Evergreen angiosperms			
Aucuba japonica	Nagoya, Japan	Hiyama et al. 2005	+
Camellia japonica	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Castanopsis cuspidata	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Cleyera japonica	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Eurya japonica	Nagoya, Japan	Hiyama et al. 2005	+
Ilex pedunculosa	Nagoya, Japan	Hiyama et al. 2005	+
Ilex pedunculosa	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Ligustrum japonicum	Nagoya, Japan	Hiyama et al. 2005	+
Pachysandra terminalis	Hokkaido, Japan	Yoshie and Kawano 1986	–
Photinia glabra	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Quercus glauca	Kamigamo, Japan	Miyazawa and Kikuzwa 2005	–
Vaccinium bractearum	Nagoya, Japan	Hiyama et al. 2005	–
Conifers			
Picea abies	Lägeren, Switzerland	Falge et al. 1996	–
Picea glauca	British Columbia, Canada	Binder and Fielder 1996	–
Pinus sylvestris	Västoman, Sweden	Strand et al. 2002	–
Pinus sylvestris	Joensuu, Finland	Wang 1996	–
Pinus taeda	North Carolina, USA	Ellsworth 2000	–
Pinus taeda	North Carolina, USA	Murthy et al. 1997	–
Pinus taeda	Louisiana, USA	Tang et al. 2003	–

Sites with summer drought

Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Juglans regia	California, USA	Rosati et al. 2006	–

Prunus persica	Aguas de Moura, Portugal	Correia et al. 1997	–
Quercus douglasii	Sierra Nevada, CA, USA	Xu and Baldocchi 2003	–
Quercus faginea	Salamanca, Spain	Mediavilla et al. 2002	–
Quercus frainetto	Thessaloniki, Greece	Siam et al. 2008	–
Quercus ithaburensis	Thessaloniki, Greece	Siam et al. 2008	–
Quercus pubescens	Tuscany, Italy	Tognetti et al. 1998	–
Quercus pubescens	Thessaloniki, Greece	Siam et al. 2008	–
Quercus pubescens	Montpellier, France	Damesin and Rambal 1995	–
Sambucus nigra	Düsseldorf, Germany	Vogt and Lösch 1999	–
Sorbus aucuparia	Düsseldorf, Germany	Vogt and Lösch 1999	–
Evergreen angiosperms			
Arbutus unedo	Mallorca, Spain	Gulías et al. 2009	+
Arctostaphylos glandulosa	California, USA	Jacobsen et al. 2008	–
Boscia albitrunca	Oena Mine, South Africa	Wand et al. 1999	+
Ceanothus cuneatus	California, USA	Jacobsen et al. 2008	–
Ceanothus megacarpus	California, USA	Jacobsen et al. 2008	–
Ceanothus spinsus	California, USA	Jacobsen et al. 2008	–
Citisus albidus	Mallorca, Spain	Gulías et al. 2009	+
Citisus monspeliensis	Mallorca, Spain	Gulías et al. 2009	+
Citisus salvifolius	Mallorca, Spain	Gulías et al. 2009	+
Cneorum tricoccon	Mallorca, Spain	Gulías et al. 2009	–
Erica multiflora	Barcelona, Spain	Prieto et al. 2009	+
Erica multiflora	Barcelona, Spain	Llorens et al. 2003	+
Eucalyptus camaldulensis	Katanning, Australia	White et al. 2000	+
Eucalyptus leucoxylon	Katanning, Australia	White et al. 2000	+
Eucalyptus platypus	Katanning, Australia	White et al. 2000	+
Euclea pseudebenus	Oena Mine, South Africa	Wand et al. 1999	–
Globularia alypum	Barcelona, Spain	Prieto et al. 2009	+
Globularia alypum	Barcelona, Spain	Llorens et al. 2003	+
Hypericum balearicum	Mallorca, Spain	Gulías et al. 2009	–

Malosma laurina	California, USA	Jacobsen et al. 2008	–
Olea europaea	Mallorca, Spain	Gulías et al. 2009	+
Olea europaea	Sfax, Tunisia	Ben Ahmed et al. 2007	+
Phillyrea latifolia	Tarragona, Spain	Ogaya and Peñuelas 2003	+
Phillyrea latifolia	Mallorca, Spain	Gulías et al. 2009	–
Pistacia lentiscus	Mallorca, Spain	Gulías et al. 2009	+
Pistacia lentiscus	Mallorca, Spain	Flexas et al. 2001	+
Quercus berberidifolia	California, USA	Jacobsen et al. 2008	–
Quercus coccifera	Mallorca, Spain	Gulías et al. 2009	+
Quercus coccifera	Teruel, Spain	Baquedano and Castillo 2007	+
Quercus ilex	Mallorca, Spain	Gulías et al. 2009	+
Quercus ilex	Tarragona, Spain	Ogaya and Peñuelas 2003	+
Quercus ilex	Teruel, Spain	Baquedano and Castillo 2007	–
Quercus suber	Santiago do Cacém, Portugal	Oliveira et al. 1992	–
Rhamnus alaternus	Mallorca, Spain	Gulías et al. 2009	+
Rhamnus ludovici-salvatoris	Mallorca, Spain	Gulías et al. 2009	–
Schotia afra	Oena Mine, South Africa	Wand et al. 1999	–
Tamarix usneoides	Oena Mine, South Africa	Wand et al. 1999	–
Conifers			
Juniperus phoenicea	Teruel, Spain	Baquedano and Castillo 2007	–
Juniperus thurifera	Guadalajara, Spain	Gimeno et al. 2012	+
Pinus canariensis	Tenerife, Spain	Peters et al. 2008	+
Pinus halepensis	Barcelona, Spain	Prieto et al. 2009	+
Pinus halepensis	Hebron, Israel	Maseyk et al. 2008	+
Pinus halepensis	Teruel, Spain	Baquedano and Castillo 2007	+
Pinus palustris	Georgia, USA	Addington et al. 2004	+
Pinus pinea	Northern Plateau, Spain	Pardos et al. 2010	+

(b) Percent loss of hydraulic conductivity (PLC)

Sites without summer drought			
Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Acer saccharum	Vermont, USA	Sperry et al. 1988	+
Alnus crispa	Alaska, USA	Sperry et al. 1994	+
Betula cordifolia	Vermont, USA	Sperry 1993	+
Betula occidentalis	Utah, USA	Sperry et al. 1994	+
Betula papyrifera var humilis	Alaska, USA	Sperry et al. 1994	+
Fagus grandifolia	Vermont, USA	Sperry 1993	=
Fagus sylvatica	Abetone, Italy	Magnani and Borghetti 1995	–
Fagus sylvatica	Nancy, France	Cochard et al. 2001	+
Fraxinus excelsior	Nancy, France	Cochard et al. 1997	+
Juglans regia	Clermont-Ferrand, France	Améglio et al. 2002	+
Populus balsamifera	Alaska, USA	Sperry et al. 1994	+
Populus tremuloides	Utah and Alaska, USA	Sperry et al. 1994	+
Prunus persica	Clermont-Ferrand, France	Améglio et al. 2002	+
Quercus gambelii	Utah, USA	Sperry et al. 1994	+
Sambucus nigra	Düsseldorf, Germany	Vogt 2001	+
Sorbus aucuparia	Düsseldorf, Germany	Vogt 2001	+
Evergreen angiosperms			
Laurus nobilis	Trieste, Italy	Gascó et al. 2007	+
Quercus ilex	Venice, Italy	Nardini et al. 2000	+
Rhododendron atawbiense	Oregon and North Carolina	Cordero and Nilsen 2002	+
Rhododendron maximum	Oregon and North Carolina	Cordero and Nilsen 2002	+
Conifers			
Abies balsamea	Vermont, USA	Sperry 1993	+
Abies lasiocarpa	Utah, USA	Sperry et al. 1994	+

Juniperus communis	Central Alps, Austria	Mayr et al. 2006	+
Picea abies	Central Alps, Austria	Mayr et al. 2006	+
Picea abies	Central Alps, Austria	Mayr et al. 2003	+
Picea glauca	Alaska, USA	Sperry et al. 1994	+
Picea rubens	Vermont, USA	Sperry 1993	+
Pinus albicaulis	Montana, USA	Sparks and Black 2000	+
Pinus cembra	Central Alps, Austria	Mayr et al. 2003	+
Pinus cembra	Central Alps, Austria	Mayr et al. 2006	+
Pinus contorta	Idaho, USA	Sparks et al. 2001	+
Pinus contorta	Idaho, USA	Sparks and Black 2000	+
Pinus mugo	Central Alps, Austria	Mayr et al. 2006	+

Sites with summer drought

Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Alnus cordata	Firence,Italy	Tognetti and Borghetti 1994	+
Quercus afares	Montpellier, France	Cavender-Bares et al. 2005	+
Quercus faginea	Montpellier, France	Cavender-Bares et al. 2005	+
Quercus pubescens	Tuscany, Italy	Tognetti et al. 1998	–
Evergreen angiosperms			
Quercus ilex	Montpellier, France	Cavender-Bares et al. 2005	–
Quercus ilex	Sicily, Italy	Nardini et al. 2000	+
Quercus ilex	Tuscany, Italy	Tognetti et al. 1998	–
Quercus suber	Montpellier, France	Cavender-Bares et al. 2005	+
Rhododendron macrophyllum	Oregon and North Carolina, USA	Cordero and Nilsen 2002	+
Conifers			
Abies grandis	Washingon, USA	McCulloh et al. 2011	+
Pseudotsuga menziesii	Washingon, USA	McCulloh et al. 2011	+
Thuja plicata	Washingon, USA	McCulloh et al. 2011	+
Tsuga heterophylla	Washingon, USA	McCulloh et al. 2011	+

(c) Photochemical efficiency of photosystem II (F_v / F_m)

Sites without summer drought

Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Acer pensylvanicum	Harvard Forest, MA, USA	Lee et al. 2012	–
Acer rubrum	Harvard Forest, MA, USA	Lee et al. 2003	–
Acer saccharum	Harvard Forest, MA, USA	Lee et al. 2004	–
Betula populifolia	Harvard Forest, MA, USA	Lee et al. 2013	–
Buchanania latifolia	Junnan, China	Zhang et al. 2007	–
Castanea dentata	Harvard Forest, MA, USA	Lee et al. 2014	–
Cornus alternifolia	Harvard Forest, MA, USA	Lee et al. 2005	–
Fagus grandifolia	Harvard Forest, MA, USA	Lee et al. 2015	–
Fraxinus americana	Harvard Forest, MA, USA	Lee et al. 2006	–
Hamelia virginiana	Harvard Forest, MA, USA	Lee et al. 2016	–
Ilex verticillata	Harvard Forest, MA, USA	Lee et al. 2017	–
Populus grandidentata	Harvard Forest, MA, USA	Lee et al. 2018	–
Populus tremuloides	Harvard Forest, MA, USA	Lee et al. 2019	–
Prunus serotina	Harvard Forest, MA, USA	Lee et al. 2007	–
Quercus robur	Frankfurt, Germany	Brüggemann et al. 2009	–
Quercus rubra	Harvard Forest, MA, USA	Lee et al. 2008	–
Symplocos racemosa	Junnan, China	Zhang et al. 2007	–
Vaccinium corymbosum	Harvard Forest, MA, USA	Lee et al. 2009	–
Viburnum alnifolium	Harvard Forest, MA, USA	Lee et al. 2010	–
Viburnum cassinoides	Harvard Forest, MA, USA	Lee et al. 2011	–
Evergreen angiosperms			
Cyclobalanopsis helferiana	Junnan, China	Zhang et al. 2007	=
Quercus ilex	Frankfurt, Germany	Brüggemann et al. 2009	–
Rhododendron catawblense	Iowa, USA	Wang et al. 2009	–
Rhododendron ferrugineum	Innsbruck, Austria	Neuner and Pramsohler 2006	–

Rhododendron ponticum	Iowa, USA	Wang et al. 2009	–
Conifers			
Abies lasiocarpa	Colorado, USA	Zarter et al. 2006	–
Picea abies	Tyrolian Central Alps	Stecher et al. 1999	–
Picea abies	Paris, France	Berveiller et al. 2007	–
Picea engelmannii	Colorado, USA	Zarter et al. 2006	–
Picea morrisonicola	Tatachia, Taiwan	Weng et al. 2005	–
Pinus armandi	Guandaushi, Taiwan	Weng et al. 2006	–
Pinus cembra	Innsbruck, Austria	Neuner and Pramsohler 2006	–
Pinus cembra	Tyrolian Central Alps	Stecher et al. 1999	–
Pinus contorta	Colorado, USA	Zarter et al. 2006	–
Pinus ponderosa	Colorado, USA	Zarter et al. 2006	–
Pinus sylvestris	Paris, France	Berveiller et al. 2007	–
Pinus sylvestris	Hyytiälä, Finland	Porcar-Castell et al. 2008	–
Pinus taiwanensis	Tatachia and Guandaushi, Taiwan	Weng et al. 2009	–
Pseudotsuga menziesii	Colorado, USA	Zarter et al. 2006	–
Taxus baccata	Poznan, Poland	Robakowski and Wyka 2009	–

Sites with summer drought

Species	Geographic location	Reference	Sign of effect summer–winter
Deciduous angiosperms			
Quercus afares	Montpellier, France	Cavender-Bares et al. 2005	–
Quercus faginea	Montpellier, France	Cavender-Bares et al. 2005	=
Quercus frainetto	Thessaloniki, Greece	Siam et al. 2008	–
Quercus ithaburensis	Thessaloniki, Greece	Siam et al. 2008	–
Quercus lobata	California, USA	Mahall et al. 2009	–
Quercus pubescens	Montpellier, France	Damesin and Rambal 1995	–
Quercus pubescens	Thessaloniki, Greece	Siam et al. 2008	–
Evergreen angiosperms			
Arbutus andrachne	Patras, Greece	Karavatas and Manetas 1999	–

Arbutus unedo	Patras, Greece	Karavatas and Manetas 1999	–
Arctostaphylos uva-ursi	Guadalajara, Spain	Valladares et al. 2008	+
Erica multiflora	Barcelona, Spain	Prieto et al. 2009	–
Erica multiflora	Barcelona, Spain	Llorens et al. 2003	+
Globularia alypum	Barcelona, Spain	Prieto et al. 2009	–
Globularia alypum	Barcelona, Spain	Llorens et al. 2003	–
Ilex aquifolium	Madrid, Spain	Valladares et al. 2005	–
Myrtus communis	Huelva, Spain	Ain-Lhout et al. 2004	–
Nerium oleander	Patras, Greece	Karavatas and Manetas 1999	–
Notofagus dombeyi	Pichiquillaipe, Chile	Zúñiga et al. 2006	+
Notofagus nitida	Pichiquillaipe, Chile	Zúñiga et al. 2006	–
Phillyrea latifolia	Tarragona, Spain	Ogaya and Peñuelas 2003	–
Phillyrea latifolia	Patras, Greece	Karavatas and Manetas 1999	–
Pistacia lentiscus	Huelva, Spain	Ain-Lhout et al. 2004	+
Pistacia lentiscus	Patras, Greece	Karavatas and Manetas 1999	–
Quercus coccifera	Teruel, Spain	Baquedano and Castillo 2007	–
Quercus ilex	Montpellier, France	Cavender-Bares et al. 2005	+
Quercus ilex	Tarragona, Spain	Ogaya and Peñuelas 2003	–
Quercus ilex	Teruel, Spain	Baquedano and Castillo 2007	–
Quercus ilex	Guadalajara, Spain	Valladares et al. 2008	–
Quercus suber	Montpellier, France	Cavender-Bares et al. 2005	+
Conifers			
Abies balsamea	St. Paul, MN, USA	Verhoeven et al. 2009	–
Juniperus phoenicea	Huelva, Spain	Ain-Lhout et al. 2004	+
Juniperus phoenicea	Teruel, Spain	Baquedano and Castillo 2007	–
Pinus halepensis	Barcelona, Spain	Prieto et al. 2009	–
Pinus halepensis	Teruel, Spain	Baquedano and Castillo 2007	–
Pinus pinea	Northern Plateau, Spain	Pardos et al. 2010	–
Pinus strobus	St. Paul, MN, USA	Verhoeven et al. 2009	–

Table A2. Results from the analyses of covariance (ANCOVA) for stomatal conductance (g_s), percent loss of hydraulic conductivity (PLC) and photochemical efficiency of photosystem II (F_v / F_m) at sites without summer drought and with summer drought. Explanatory variables included temperature (T) and functional type of temperate woody species (FT: deciduous angiosperm, evergreen angiosperm and conifer) and the interaction among them. The adjusted R^2 value and significance of the model (p-value) are indicated for each model

g_s		DF	Sum Sq	Mean Sq	F-value	p-value
Without summer drought	T	1	688.95	688.95	50.26	< 0.0001
R^2 = 0.55; p < 0.0001	FT	2	56.98	28.49	2.08	0.13
	T × FT	2	524.85	262.42	19.15	< 0.0001
With summer drought	T	1	57.67	57.67	4.61	0.034
R^2 = 0.36; p < 0.0001	FT	2	503.66	251.83	20.15	< 0.0001
	T × FT	2	284.67	142.34	11.39	< 0.0001
PLC						
Without summer drought	T	1	52.96	52.96	16.87	0.0001
R^2 = 0.47; p < 0.0001	FT	2	136.44	68.22	21.73	< 0.0001
	T × FT	2	4.76	2.38	0.76	0.47
With summer drought	T	1	8.13	8.13	3.55	0.07
R^2 = 0.57; p = 0.003	FT	2	45.08	22.54	9.84	0.001
	T × FT	2	6.94	3.47	1.51	0.24
F_v / F_m						
Without summer drought	T	1	4.09	4.09	108.75	< 0.0001
R^2 = 0.74; p < 0.0001	FT	2	3.49	1.75	46.38	< 0.0001
	T × FT	2	1.20	0.60	15.96	< 0.0001
With summer drought	T	1	0.59	0.59	27.45	< 0.0001
R^2 = 0.74; pe < 0.0001	FT	2	1.83	0.91	42.84	< 0.0001
	T × FT	2	1.53	0.77	35.90	< 0.0001

Table A3. Results from the analyses of covariance (ANCOVA) for stomatal conductance (g_s), percent loss of hydraulic conductivity (PLC) and photochemical efficiency of photosystem II (F_v / F_m) at sites without summer drought and with summer drought. Explanatory variables included VPD (kPa) and functional type of temperate woody species (FT: deciduous angiosperm, evergreen angiosperm and conifer) and the interaction among them. The adjusted R^2 value and significance of the model (p-value) are indicated for each model

g_s		DF	Sum Sq	Mean Sq	F-value	p-value
Without summer drought	VPD	1	393.5	393.5	21.68	< 0.0001
R^2 = 0.41; p < 0.0001	FT	2	11.54	5.77	0.32	0.73
	VPD × FT	2	527.51	286.26	15.77	< 0.0001
With summer drought	VPD	1	6.01	6.01	0.45	0.5
R^2 = 0.32; p < 0.0001	FT	2	559.51	279.7	21.15	< 0.0001
	VPD × FT	2	203.51	101.75	7.69	0.0007
PLC						
Without summer drought	VPD	1	42.53	42.54	11.99	0.0009
R^2 = 0.40; p < 0.0001	FT	2	123.82	61.91	17.45	< 0.0001
	VPD × FT	2	3.29	1.65	0.46	0.63
With summer drought	VPD	1	8.55	8.55	3.73	0.07
R^2 = 0.46; p = 0.003	FT	2	43.75	21.87	9.54	0.001
	VPD × FT	2	7.83	3.92	1.71	0.21
F_v / F_m						
Without summer drought	VPD	1	2.66	2.66	41.44	< 0.0001
R^2 = 0.56; p < 0.0001	FT	2	3.32	1.66	25.9	< 0.0001
	VPD × FT	2	0.83	0.41	6.52	0.002
With summer drought	VPD	1	0.51	0.51	14.97	< 0.0001
R^2 = 0.58; p < 0.0001	FT	2	1.69	0.85	24.72	< 0.0001
	VPD × FT	2	0.99	0.49	14.35	< 0.0001

Table A4. Mean maximum conduit diameter (μm) of each of the case study species based on data averaged across studied sites in the published literature

Species	Mean maximum conduit diameter (μm)	References
Q. ilex	170 ± 20.8	Corcuera et al. 2004a, Micco et al. 2008, Albuixech et al. 2012
Q. faginea	270 ± 90	Corcuera et al. 2004b, Albuixech et al. 2012
P. nigra	47.0 ± 26.0	Froux et al. 2002, Esteban et al. 2011
J. thurifera	20.1 ± 1.9	DeSoto et al. 2011, Olano et al. 2012

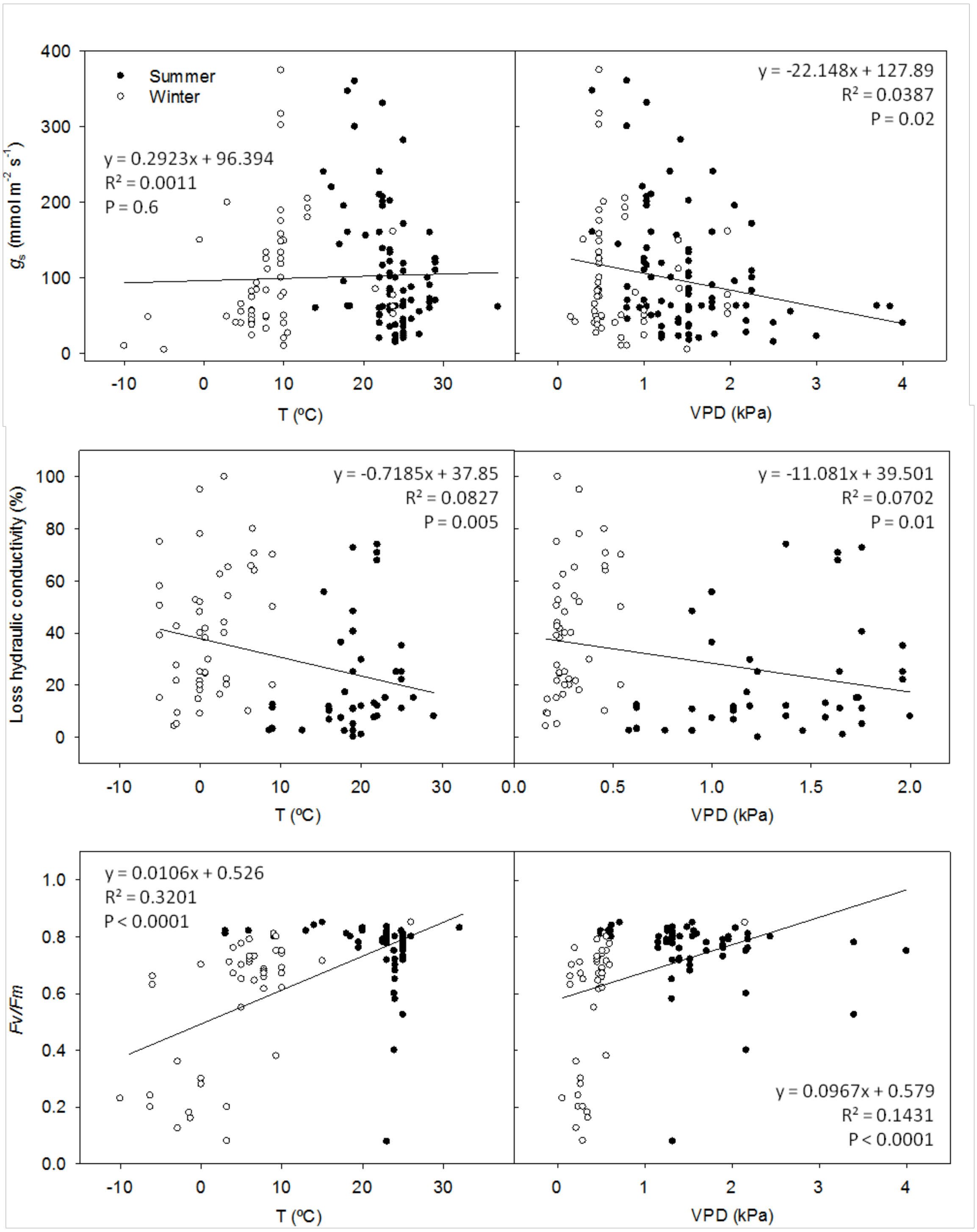

Figure A1. Linear regressions relating the physiological variables: stomatal conductance (g_s), percent loss of hydraulic conductivity (PLC) and photochemical efficiency of photosystem II (F_v / F_m) as a function of temperature (T, ºC) and vapor pressure deficit (VPD, kPa). Data for summer months are represented by open circles and that for winter months by closed circles.

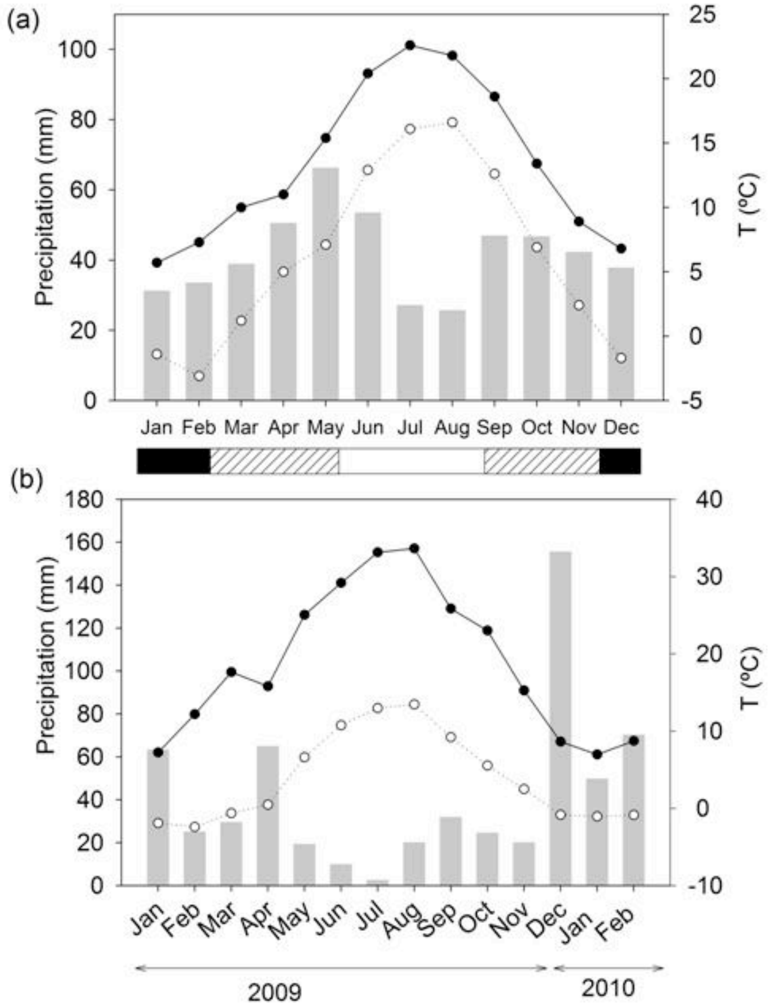

Figure A2. (a) Climatic diagram of the meteorological station closest to the study site at Molina de Aragón, Spain (40º50'40''N, 1º53'07''W, 1063 m a.s.l.) for the period 1951–2007. Filled and dashed portions of the horizontal lower bar indicate the periods with certain and possible frost, respectively. (b) Meteorological data for 2009 and winter 2010 from the installed meteorological station at the study site. Vertical bars represent mean monthly precipitation, and the mean maximum and minimum temperatures are represented by continuous and dotted line, respectively.

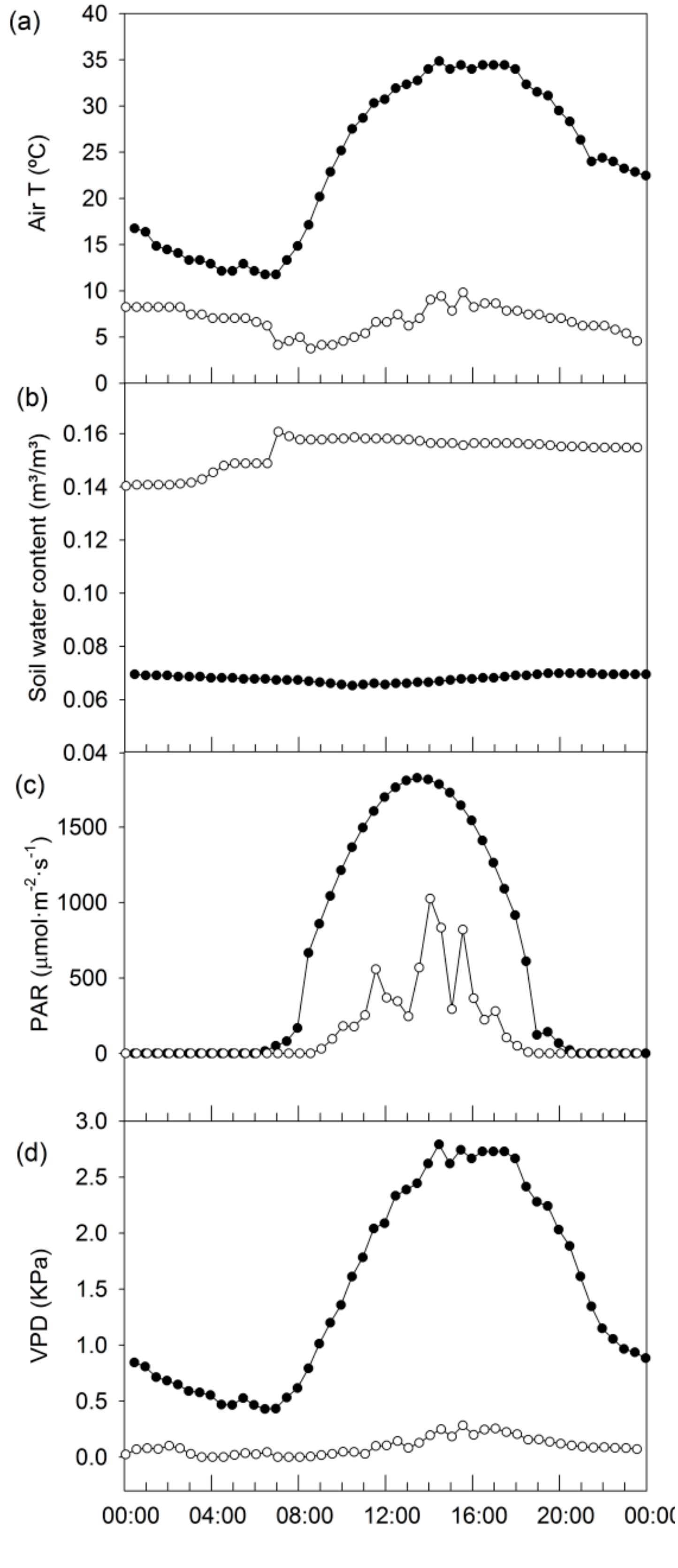

Figure A3. Diurnal changes in (a) air temperatura (ºC), (b) soil water content (m^3 m^{-3}), (c) photosyntetically active radiation (PAR, $\mu mol \cdot m^{-2} \cdot s^{-1}$) and (d) vapor pressure deficit (VPD, kPa) during a typical day during summer (closed symbols) and winter (open symbols) in Alto Tajo Natural Park (central Spain).

References cited in the Appendix

Addington, R. N. et al. 2004. Stomatal sensitivity to vapor pressure deficit and its relationship to hydraulic conductance in *Pinus palustris*. – Tree Physiol. 24: 561–569.

Ain-Lhout, F. et al. 2004. Seasonal differences in photochemical efficiency and chlorophyll and carotenoid contents in six Mediterranean shrub species under field conditions. – Photosynthetica 42: 399–407.

Albuixech Marti, J. et al. 2012. Seasonal dynamics of secondary growth and xylem anatomy in two coexisting Mediterranean Quercus. – For. Syst. 21: 9.

Améglio, T. et al. 2002. Winter embolism, mechanisms of xylem hydraulic conductivity recovery and springtime growth patterns in walnut and peach trees. – Tree Physiol. 22: 1211–1220.

Baquedano, F. J. and Castillo, F. J. 2007. Drought tolerance in the Mediterranean species *Quercus coccifera, Quercus ilex, Pinus halepensis*, and *Juniperus phoenicea*. – Photosynthetica 45: 229–238.

Ben Ahmed, C. et al. 2007. Effects of water deficit on olive trees cv. Chemlali under field conditions in arid region in Tunisia. – Sci. Hortic. 113: 267–277.

Binder, W. D. and Fielder, P. 1996. Seasonal changes in chlorophyll fluorescence of white spruce seedlings from different latitudes in relation to gas exchange and winter storability. – New For. 11: 207–232.

Brüggemann, W. et al. 2009. Photosynthesis studies on European evergreen and deciduous oaks grown under Central European climate conditions: II. Photoinhibitory and light-independent violaxanthin deepoxidation and downregulation of photosystem II in evergreen, winter-acclimated European *Quercus* taxa. – Trees 23: 1091–1100.

Cavender-Bares, J. et al. 2005. Summer and winter sensitivity of leaves and xylem to minimum freezing temperatures: a comparison of co-occurring Mediterranean oaks that differ in leaf lifespan. – New Phytol. 168: 597–612.

Cochard, H. et al. 1997. Developmental control of xylem hydraulic resistances and vulnerability to embolism in *Fraxinus excelsior* L: impacts on water relations. – J. Exp. Bot. 48: 655–663.

Cochard, H. et al. 2001. Mechanisms of xylem recovery from winter embolism in *Fagus sylvatica*. – Tree Physiol. 21: 27–33.

Corcuera, L. et al. 2004a. Effects of a severe drought on *Quercus ilex* radial growth and xylem anatomy. – Trees-Str. Funct. 18: 83–92.

Corcuera, L. et al. 2004b. Effects of a severe drought on growth and wood anatomical properties of *Quercus faginea*. – Iawa J. 25: 185–204.

Cordero, R. A. and Nilsen, E. T. 2002. Effects of summer drought and winter freezing on stem hydraulic conductivity of *Rhododendron* species from contrasting climates. – Tree Physiol. 22: 919–928.

Correia, M. J. et al. 1997. Diurnal change in the relationship between stomatal conductance and abscisic acid in the xylem sap of field-grown peach trees. – J. Exp. Bot. 48: 1727–1736.

Damesin, C. and Rambal, S. 1995. Field-study of leaf photosynthetic performance by a mediterranean deciduous oak tree (*Quercus pubescens*) during a severe summer drought. – New Phytol. 131: 159–167.

DeSoto, L. et al. 2011. Intra-annual patterns of tracheid size in the Mediterranean tree *Juniperus thurifera* as an indicator of seasonal water stress. – Can. J. For. Res. 41: 1280–1294.

Ellsworth, D. S. 2000. Seasonal CO_2 assimilation and stomatal limitations in a *Pinus taeda* canopy. – Tree Physiol. 20: 435–445.

Esteban, L. G. et al. 2012. Influence of region of provenance and climate factors on wood anatomical traits of *Pinus nigra* Arn. subsp *salzmannii*. – Eur. J. For. Res. 131: 633-645.

Falge, E. et al. 1996. A model of the gas exchange response of *Picea abies* to habitat conditions. – Trees-Str. Funct. 10: 277–287.

Flexas, J. et al. 2001. Seasonal patterns and control of gas exchange in local populations of the Mediterranean evergreen shrub *Pistacia lentiscus* L. – Acta Oecol. 22: 33–43.

Froux, F. et al. 2002. Xylem hydraulic efficiency versus vulnerability in seedlings of four contrasting Mediterranean tree species (*Cedrus atlantica*, *Cupressus sempervirens, Pinus halepensis* and *Pinus nigra*). – Ann. For. Sci. 59: 409–418.

Gascó, A. et al. 2007. Seasonal changes in the ion-mediated increase of xylem hydraulic conductivity in stems of three evergreens: any functional role? – Physiol. Plant. 129: 597–606.

Gimeno, T. E. et al. 2012. Enhanced growth of *Juniperus thurifera* under a warmer climate is explained by a positive carbon gain under cold and drought. – Tree Physiol. 32: 326–336.

Gulías, J. et al. 2009. Seasonal and inter-annual variations of gas exchange in thirteen woody species along a climatic gradient in the Mediterranean island of Mallorca. – Flora 204: 169–181.

Hacke, U. and Sauter, J. J. 1995. Vulnerability of xylem to embolism in relation to leaf water potential and stomatal conductance in *Fagus sylvatica f. purpurea* and *Populus balsamifera*. – J. Exp. Bot. 46: 1177–1183.

Hiyama, T. et al. 2005. Seasonal variation in stomatal conductance and physiological factors observed in a secondary warm-temperate forest. – Ecol. Res. 20: 333–346.

Jacobsen, A. L. et al. 2008. Comparative community physiology: nonconvergence in water relations among three semi-arid shrub communities. – New Phytol. 180: 100–113.

Karavatas, S. and Manetas, Y. 1999. Seasonal patterns of photosystem II photochemical efficiency in evergreen sclerophylls and drought semi-deciduous shrubs under Mediterranean field conditions. – Photosynthetica 36: 41–49.

Keel, S. G. et al. 2007. Stomatal conductance in mature deciduous forest trees exposed to elevated CO_2. – Trees-Str. Funct. 21: 151–159.

Lee, D. W. et al. 2003. Pigment dynamics and autumn leaf senescence in a New England deciduous forest, eastern USA. – Ecol. Res. 18: 677–694.

Llorens, L. et al. 2003. Ecophysiological responses of two Mediterranean shrubs, *Erica multiflora* and *Globularia alypum,* to experimentally drier and warmer conditions. - Physiol. Plant.

119: 231–243.

Loewenstein, N. J. and Pallardy, S. G. 1998. Drought tolerance, xylem sap abscisic acid and stomatal conductance during soil drying: a comparison of young plants of four temperate deciduous angiosperms. – Tree Physiol. 18: 421–430.

Magnani, F. and Borghetti, M. 1995. Interpretation of seasonal changes of xylem embolism and plant hydraulic resistance in *Fagus sylvatica*. – Plant Cell Environ. 18: 689–696.

Mahall, B. E. et al. 2009. A comparative study of oak (*Quercus*, Fagaceae) seedling physiology during summer drought in southern California. – Am. J. Bot. 96: 751–761.

Maseyk, K. S. et al. 2008. Physiology–phenology interactions in a productive semi-arid pine forest. – New Phytol. 178: 603–616.

Mayr, S. 2003. Winter at the alpine timberline. Why does embolism occur in Norway spruce but not in stone pine? – Plant Physiol. 131: 780–792.

Mayr, S. et al. 2006. Frost drought in conifers at the alpine timberline: xylem dysfunction and adaptations. – Ecology 87: 3175–3185.

McCulloh, K. A. et al. 2011. An annual pattern of native embolism in upper branches of four tall conifer species. – Am. J. Bot. 98: 1007–1015.

Mediavilla, S. et al. 2002. Stomatal and mesophyll limitations to photosynthesis in one evergreen and one deciduous Mediterranean oak species. – Photosynthetica 40: 553–559.

Micco, V. et al. 2008. Wood anatomy and hydraulic architecture of stems and twigs of some Mediterranean trees and shrubs along a mesic–xeric gradient. – Trees 22: 643–655.

Miyazawa, Y. and Kikuzawa, K. 2005. Winter photosynthesis by saplings of evergreen broad-leaved trees in a deciduous temperate forest. – New Phytol. 165: 857–866.

Morecroft, M. D. and Roberts, J. M. 1999. Photosynthesis and stomatal conductance of mature canopy oak (*Quercus robur*) and sycamore (*Acer pseudoplatanus*) trees throughout the growing season. – Funct. Ecol. 13: 332–342.

Murthy, R. et al. 1997. Seasonal trends of light-saturated net photosynthesis and stomatal conductance of loblolly pine trees grown in contrasting environments of nutrition, water and carbon dioxide. – Plant Cell Environ. 20: 558–568.

Nardini, A. and Salleo, S. 2000. Limitation of stomatal conductance by hydraulic traits: sensing or preventing xylem cavitation? – Trees 15: 14–24.

Nardini, A. et al. 2000. Different responses to drought and freeze stress of *Quercus ilex* L. growing along a latitudinal gradient. – Plant Ecol. 148: 139–147.

Neuner, G. and Pramsohler, M. 2006. Freezing and high temperature thresholds of photosystem 2 compared to ice nucleation, frost and heat damage in evergreen subalpine plants. – Physiol. Plant. 126: 196–204.

Ogaya, R. and Peñuelas, J. 2003. Comparative seasonal gas exchange and chlorophyll fluorescence of two dominant woody species in a holm oak forest. – Flora 198: 132–141.

Olano, J. M. et al. 2012. Quantitative tracheid anatomy reveals a complex environmental control of wood structure in continental Mediterranean climate. – Int. J. Plant Sci. 173: 137–149.

Oliveira, G. et al. 1992. Water relations of cork-oak (*Quercus suber* L) under natural conditions. – Vegetatio 100: 199–208.

Pardos, M. et al. 2010. Seasonal changes in the physiological activity of regeneration under a natural light gradient in a *Pinus pinea* regular stand. – For. Syst. 19: 367–380.

Peters, J. et al. 2008. Influence of canopy position, needle age and season on the foliar gas exchange of *Pinus canariensis*. – Eur. J. For. Res. 127: 293–299.

Porcar-Castell, A. et al. 2008. Seasonal acclimation of photosystem II in *Pinus sylvestris*. I. Estimating the rate constants of sustained thermal energy dissipation and photochemistry. – Tree Physiol. 28: 1475–1482.

Prieto, P. et al. 2009. Effects of long-term experimental night-time warming and drought on photosynthesis, F_v/F_m and stomatal conductance in the dominant species of a Mediterranean shrubland. – Acta Physiol. Plant. 31: 729–739.

Robakowski, P. and Wyka, T. 2009. Winter photoinhibition in needles of *Taxus baccata* seedlings acclimated to different light levels. – Photosynthetica 47: 527–535.

Rosati, A. et al. 2006. Tree water status and gas exchange in walnut under drought, high temperature and vapour pressure deficit. – J. Hort. Sci. Biotechnol. 81: 415–420.

Siam, A. M. J. et al. 2008. Physiological and growth responses of three Mediterranean oak species to different water availability regimes. – J. Arid Environ. 72: 583–592.

Sparks, J. P. and Black, R. A. 2000. Winter hydraulic conductivity and xylem cavitation in coniferous trees from upper and lower treeline. – Arct Antarct. Alp. Res. 32: 397–403.

Sparks, J. et al. 2001. Water content, hydraulic conductivity, and ice formation in winter stems of *Pinus contorta* : a TDR case study. –Oecologia 127: 468–475.

Sperry, J. S. 1993. Winter xylem embolism and spring recovery in *Betula cordifolia, Fagus grandifolia, Abies balsamera* and *Picea rubens*. – In: Borghetti, J. et al. (eds), Water transport in plants under climatic stress. Cambridge Univ. Press, pp. 86–98.

Sperry, J. S. and Tyree, M. T. 1988. Mechanism of water stress-induced xylem embolism. – Plant Physiol. 88: 581–587.

Sperry, J. S. et al. 1994. Xylem embolism in ring-porous, diffuse-porous, and coniferous trees of northern Utah and interior Alaska. – Ecology 75: 1736–1752.

Stecher, G. et al. 1999. Effects of winter-stress on photosynthesis and antioxidants of exposed and shaded needles of *Picea abies* (L.) Karst. and *Pinus cembra* L. – Phyton-Ann. REI Bot. 39: 205–211.

Strand, M. et al. 2002. Impacts of seasonal air and soil temperatures on photosynthesis in Scots pine trees. – Tree Physiol. 22:839–847.

Tang, Z. M. et al. 2003. Seasonal photosynthesis and water relations of juvenile loblolly pine relative to stand density and canopy position. – Trees-Str. Funct. 17: 424–430.

Tognetti, R. and Borghetti, M. 1994. Formation and seasonal occurrence of xylem embolism in *Alnus cordata*. – Tree Physiol. 14: 241–250.

Tognetti, R. et al. 1998. Vulnerability of xylem to embolism in relation to plant hydraulic resistance in *Quercus pubescens* and *Quercus ilex* co-occurring in a Mediterranean coppice stand in central Italy. – New Phytol. 139: 437–447.

Valladares, F. et al. 2008. Is shade beneficial for mediterranean shrubs experiencing periods of extreme drought and late-winter frosts? – Ann. Bot. 102: 923–933.

Verhoeven, A. et al. 2009. Seasonal changes in abundance and phosphorylation status of photosynthetic proteins in eastern white pine and balsam fir. – Tree Physiol. 29: 361–374.

Vogt, U. K. 2001. Hydraulic vulnerability, vessel refilling, and seasonal courses of stem water potential of *Sorbus aucuparia* L. and *Sambucus nigra* L. – J. Exp. Bot. 52: 1527–1536.

Vogt, U. K. and Lösch, R. 1999. Stem water potential and leaf conductance: a comparison of *Sorbus aucuparia* and *Sambucus nigra*. – Phys. Chem. Earth Sci. 24: 121–123.

Wand, S. J. E. et al. 1999. A preliminary study of the responsiveness to seasonal atmospheric and rainfall patterns of wash woodland species in the arid Richtersveld. – Plant Ecol. 142: 149–160.

Wang, K. Y. 1996. Canopy CO_2 exchange of Scots pine and its seasonal variation after four-year exposure to elevated CO_2 and temperature. – Agric. For. Meteorol. 82: 1–27.

Wang, X. et al. 2009. Seasonal changes in photosynthesis, antioxidant systems and ELIP expression in a thermonastic and non-thermonastic *Rhododendron* species: a comparison of photoprotective strategies in overwintering plants. – Plant Sci. 177: 607–617.

Weng, J.-H. et al. 2005. Seasonal variations in photosynthesis of *Picea morrisonicola* growing in the subalpine region of subtropical Taiwan. – Tree Physiol. 25: 973–979.

Weng, J.-H. et al. 2006. Seasonal variation in photosystem II efficiency and photochemical reflectance index of evergreen trees and perennial grasses growing at low and high elevations in subtropical Taiwan. – Tree Physiol. 26: 1097–1104.

Weng, J.-H. et al. 2009. Relationships of photosynthetic capacity to PSII efficiency and to photochemical reflectance index of *Pinus taiwanensis* through different seasons at high and low elevations of sub-tropical Taiwan. – Trees-Str. Funct. 23: 347–356.

White, D. A. et al. 2000. Leaf water relations and stomatal behavior of four allopatric *Eucalyptus* species planted in Mediterranean southwestern Australia. – Tree Physiol. 20: 1157–1165.

Xu, L., and Baldocchi, D. D. 2003. Seasonal trends in photosynthetic parameters and stomatal conductance of blue oak (*Quercus douglasii*) under prolonged summer drought and high temperature. – Tree Physiol. 23: 865–877.

Yoshie, F. and Kawano, S. 1986. Seasonal changes in photosynthetic characteristics of *Pachysandra terminalis* (Buxaceae), an evergreen woodland chamaephyte, in the cool temperate regions of Japan. – Oecologia 71: 6–11.

Zarter, C. R. et al. 2006. Winter down-regulation of intrinsic photosynthetic capacity coupled with up-regulation of Elip-like proteins and persistent energy dissipation in a subalpine forest. – New Phytol. 172: 272–282.