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Appendix S1. Species for which mean vessel length data have been reported in the literature, including the environment in which they occur (temperate (temp), tropical or subtropical (trop/sub), arid or semi-arid (arid/semi), or a cultivated species or variety (cult)), habit (liana, shrub, or tree), and the sampled organ (stem or root). Data were originally collected from the following studies: Skene and Balodis (1968), Zimmermann and Jeje (1981), Zimmermann and Potter (1982), Newbanks et al. (1983), Aloni and Zimmermann (1984), Sperry et al. (1987), Ewers and Fisher (1989a,b), Cochard and Tyree (1990), Ewers et al. (1990), Middleton and Butterfield (1990), Gartner (1991), Sperry et al. (1991), Salleo et al. (1992), Sperry and Sullivan (1992), Sperry et al. (1994), Tognetti and Borghetti (1994), Hacke and Sauter (1995, 1996), Lipp and Nilsen (1997), Zotz et al. (1997), Kolb and Sperry (1999), Lo Gullo et al. (2000), Vander Willigen et al. (2000), Gorsuch and Oberbauer (2002), Vercambe et al. (2002), Cohen et al. (2003), McElrone et al. (2003), Kocacinar and Sage (2004), Sperry et al. (2005), Wheeler et al. (2005), Hacke et al. (2006), Jacobsen et al. (2007a), Kocacinar et al. (2008), Hacke et al. (2009), Lens et al. (2011), and Jacobsen and Pratt (2012). Data shown are only for samples less than 15 mm in diameter. The source references for data are provided for each species. For species for which multiple sources reported vessel length data, values represent an across sample and study mean. Mean vessel lengths for most species have been recalculated from published data as described in the Methods. Species for which mean vessel lengths have been calculated or recalculated are indicated with a "Y" in the final column and these numbers may therefore be slightly different than those reported in the original reference.

Species	Environment	Habit	Organ	Mean vessel length (m)	Maximum vessel length (m)	Mean vessel diameter (μm)	Reference(s)	Vessel length recalculated for present study (Y/N)
Acacia greggii	arid/semi	shrub	stem	0.0476			Kocacinar and Sage, 2004	Y
Acer glabrum v. diffusum	temp	tree	stem	0.0189			Lens et al., 2011	N
Acer glabrum v. glabrum	temp	tree	stem	0.0197			Lens et al., 2011	N
Acer grandidentatum	temp	tree	stem	0.0320		25.45	Hacke et al., 2006; Lens et al., 2011	N
Acer negundo	temp	shrub	stem	0.0333		35.19	Sperry et al., 2005; Lens et al., 2011	N
Acer platanoides	temp	tree	stem	0.0237			Lens et al., 2011	N
Acer pseudoplatanus	temp	tree	stem	0.0220			Lens et al., 2011	N
Acer rubrum	temp	tree	stem	0.0312	0.14	45.33	Zimmermann and Jeje, 1981; Zimmermann and Potter, 1982; Aloni and Zimmermann, 1984	Y
Acer saccharum	temp	tree	stem	0.0330			Zimmermann and Jeje, 1981; Lens et al., 2011	Y/N

Adenostoma fasciculatum	arid/semi	shrub	stem	0.0895	0.29	24.13	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Adenostoma sparsifolium	arid/semi	shrub	stem		0.48	27.61	Jacobsen et al., 2007a	
Alnus cordata	temp	tree	stem	0.0344	0.12	48.00	Tognetti and Borghetti, 1994	Y
Alnus crispa	temp	tree	stem	0.0095		19.00	Sperry et al., 1994	Y
Alnus incana	temp	tree	stem	0.0097		22.00	Sperry et al., 1994	Y
Ambrosia dumosa	arid/semi	shrub	stem	0.0910		28.54	Hacke et al., 2009	N
Amelanchier alnifolia	temp	shrub	stem	0.0555			Wheeler et al., 2005	N
Amelanchier utahensis	temp	shrub	stem	0.0284			Wheeler et al., 2005	N
Anemopaegma puberulum	trop/sub	liana	stem	0.2600	1.15	50.00	Ewers et al., 1990	N
Annona glabra	trop/sub	tree	stem	0.0554	0.52	64.60	Zotz et al., 1997	Y
Antigonon leptopus	trop/sub	liana	stem		0.86	27.00	Ewers et al., 1990	
Arctostaphylos glandulosa	arid/semi	shrub	stem	0.0507		26.23	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Arctostaphylos glauca	arid/semi	shrub	stem		0.30	26.60	Jacobsen et al., 2007a	
Arctostaphylos patula	arid/semi	shrub	stem	0.0786		24.69	Hacke et al., 2006	Y
Argyreia nervosa	trop/sub	liana	stem	0.5700	1.31	64.00	Ewers et al., 1990	N
Aristolochia gigantea	trop/sub	liana	stem		1.71	23.00	Ewers et al., 1990	
Aristolochia maxima	trop/sub	liana	stem		1.89	116.00	Ewers et al., 1990	
Aristolochia veraguensis	trop/sub	liana	stem		2.60	108.00	Ewers et al., 1990	
Arrabidaea corallina	trop/sub	liana	stem	0.6900	2.18	32.00	Ewers et al., 1990	N
Arrabidaea podopogon	trop/sub	liana	stem	0.6100	1.61	29.50	Ewers et al., 1990	N
Artaboytrys hexapetalus	trop/sub	liana	stem	0.0500	0.27	34.00	Ewers et al., 1990	N
Artemisia californica	arid/semi	shrub	stem	0.1011		29.09	Hacke et al., 2009	Y
Artemisia tridentata	arid/semi	shrub	stem	0.0265	0.10	24.00	Kolb and Sperry, 1999	Y
Artemisia tridentata	arid/semi	shrub	root	0.0859		39.00	Kolb and Sperry, 1999	Y
Atriplex acanthocarpa	arid/semi	shrub	stem	0.0294			Kocacinar and Sage, 2004	Y
Atriplex canescens	arid/semi	shrub	stem	0.0292		24.74	Kocacinar and Sage, 2004; Hacke et al., 2009	Y
Atriplex polycarpa	arid/semi	shrub	stem	0.0149			Kocacinar and Sage, 2004	Y
Atriplex semibaccata	arid/semi	shrub	stem	0.0246			Kocacinar and Sage, 2004	Y
Barringtonia racemosa	trop/sub	tree	stem	0.1391		30.00	Vander Willigen et al., 2000	Y
Bauhinia aculeata	trop/sub	shrub	stem	0.0419	0.41	29.00	Ewers and Fisher, 1989a; Ewers et al., 1990	Y/N
Bauhinia blakeana	trop/sub	tree	stem	0.2300	0.81	52.00	Ewers et al., 1990	N

Bauhinia corymbosa	trop/sub	liana	stem	0.1000	1.13	23.00	Ewers et al., 1990	N
Bauhinia fossoglensis	trop/sub	liana	stem	0.1602	0.80	41.00	Ewers and Fisher, 1989a; Ewers et al., 1990	Y/N
Bauhinia galpinii	trop/sub	shrub	stem	0.0864	0.54	40.33	Ewers and Fisher, 1989a; Ewers et al., 1990	Y/N
Bauhinia purpurea	trop/sub	tree	stem	0.1272	0.60	38.25	Ewers and Fisher, 1989a; Ewers et al., 1990	Y/N
Bauhinia vahlii	trop/sub	liana	stem	0.2667	1.03	39.67	Ewers et al., 1990	N
Bauhinia variegata	trop/sub	tree	stem	0.1100	1.01	48.00	Ewers et al., 1990	N
Betula occidentalis	temp	tree	stem	0.0326		27.00	Sperry and Sullivan, 1992; Sperry et al., 1994	Y
Betula papyrifera	temp	tree	stem	0.0185		34.00	Sperry et al., 1994	Y
Bougainvillea spectabilis	trop/sub	liana	stem		0.38	27.00	Ewers et al., 1990	
Calligonum aphyllum	arid/semi	shrub	stem	0.0328			Kocacinar and Sage, 2004	Y
Camarostaphylis diversifolia	arid/semi	shrub	stem		0.27	21.93	Jacobsen et al., 2007a	
Carya glabra	temp	tree	stem	0.3312		70.38	Hacke et al., 2006	Y
Ceanothus crassifolius	arid/semi	shrub	stem	0.0423	0.66	25.45	Hacke et al., 2006; Jacobsen et al., 2007a	Y
Ceanothus cuneatus	arid/semi	shrub	stem	0.0538	0.23	22.12	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Ceanothus leucodermis	arid/semi	shrub	stem		0.45	25.62	Jacobsen et al., 2007a	
Ceanothus megacarpus	arid/semi	shrub	stem	0.0670	0.47	26.05	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Ceanothus oliganthus	arid/semi	shrub	stem	0.0566	0.62	26.19	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Ceanothus spinosus	arid/semi	shrub	stem	0.0555	0.30	26.84	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Ceanothus velutinus	temp	shrub	stem	0.0583		29.21	Hacke et al., 2006	Y
Cercocarpus betuloides	arid/semi	shrub	stem		1.04	33.94	Jacobsen et al., 2007a	
Cercocarpus ledifolius	temp	shrub	stem	0.0189			Wheeler et al., 2005	N
Cercocarpus montanus	temp	shrub	stem	0.0394			Wheeler et al., 2005	N
Cinnamomum camphora	trop/sub	tree	stem	0.1184		19.50	Vander Willigen et al., 2000	Y
Coleogyne ramosissima	arid/semi	shrub	stem	0.0587		18.60	Hacke et al., 2009	Y
Combretum paniculatum	trop/sub	liana	stem		1.85	49.00	Ewers et al., 1990	
Dalbergia brownei	trop/sub	liana	stem	0.1200	0.55	48.00	Ewers et al., 1990	N
Derris scandens	trop/sub	liana	stem	0.3700	1.50	14.00	Ewers et al., 1990	N
Eriogonum cinereum	arid/semi	shrub	stem	0.0870		32.06	Hacke et al.,	Y

							2009	
Fagus sylvatica f. purpurea	temp	tree	stem	0.0681	0.29	23.40	Hacke and Sauter, 1995	Y
Flaveria brownii	arid/semi	shrub	stem	0.0239		22.70	Kocacinar et al., 2008	Y
Flaveria chloraefolia	arid/semi	shrub	stem	0.0194		27.30	Kocacinar et al., 2008	Y
Flaveria pringlei	arid/semi	shrub	stem	0.0448		43.50	Kocacinar et al., 2008	Y
Flaveria robusta	arid/semi	shrub	stem	0.0416		29.90	Kocacinar et al., 2008	Y
Flaveria sonorensis	arid/semi	shrub	stem	0.0523		26.20	Kocacinar et al., 2008	Y
Flaveria vaginata	arid/semi	shrub	stem	0.0252		20.70	Kocacinar et al., 2008	Y
Fraxinus pennsylvanica	temp	tree	stem	0.2526		39.65	Hacke et al., 2006	Y
Garrya veatchii	arid/semi	shrub	stem		0.35	28.40	Jacobsen et al., 2007a	
Halimodendron halodendron	arid/semi	shrub	stem	0.0432			Kocacinar and Sage, 2004	Y
Haloxylon aphyllum	arid/semi	shrub	stem	0.0415			Kocacinar and Sage, 2004	Y
Hazardia squarrrosa	arid/semi	shrub	stem	0.0459		32.21	Hacke et al., 2009	Y
Heteromeles arbutifolia	arid/semi	shrub	stem		0.86	26.41	Jacobsen et al., 2007a	
Hippocratea volubilis	trop/sub	liana	stem	0.4021	1.60	77.67	Ewers and Fisher, 1989a, b; Ewers et al., 1990	Y/N
Hymenoclea salsola	arid/semi	shrub	stem	0.0587		28.65	Hacke et al., 2009	Y
Isomeris arborea	arid/semi	shrub	stem	0.0224		17.73	Hacke et al., 2009	Y
Larrea tridentata	arid/semi	shrub	stem	0.1177		34.01	Kocacinar and Sage, 2004; Hacke et al., 2006; Hacke et al., 2009	Y
Lepidospartum squamatum	arid/semi	shrub	stem	0.0684		33.50	Hacke et al., 2009	Y
Lotus scoparius	trop/sub	shrub	stem	0.0687		38.03	Hacke et al., 2009	Y
Macfadyena unguis-cati	trop/sub	liana	stem	0.4900	1.51	22.33	Ewers et al., 1990	N
Malosma laurina	arid/semi	shrub	stem	0.1524	0.92	55.35	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Malus domestica	cult	tree	stem	0.0730	0.59		Cohen et al., 2003	N
Mansoa allicea	trop/sub	liana	stem		0.84	22.00	Ewers et al., 1990	
Mascagnia psilophylla	trop/sub	liana	stem		1.11	29.00	Ewers et al., 1990	
Morus alba	temp	tree	stem	0.3714		57.73	Hacke et al., 2006	Y
Nitraria schoberi	arid/semi	shrub	stem	0.0389			Kocacinar and Sage, 2004	Y
Oxydendron arboreum	temp	tree	stem	0.1689		30.39	Hacke et al., 2006	Y
Oxytenia acerosa	arid/semi	shrub	stem	0.0482			Kocacinar and Sage, 2004	Y
Pachystima myrsinites	temp	shrub	stem	0.0364		16.89	Hacke et al., 2006	Y
Parthenocissus quinquefolia	temp	liana	stem	0.0959			McElrone et al., 2003	Y

Passiflora coccinea	trop/sub	liana	stem	0.1416	0.76	25.67	Ewers et al., 1989a; Ewers et al., 1990	Y/N
Peixotoa glabra	trop/sub	liana	stem	0.2300	1.49	27.50	Ewers et al., 1990	N
Pithecoctenium crucigerum	trop/sub	liana	stem	0.5927	2.66	49.33	Ewers et al., 1989a, b; Ewers et al., 1990	Y/N
Populus balsamifera	temp	tree	stem	0.0703	0.35	33.60	Hacke and Sauter, 1995, 1996	Y
Populus tremuloides	temp	tree	stem	0.0191	0.15	23.00	Zimmermann and Jeje, 1981; Sperry et al., 1991; Sperry and Sullivan, 1992; Sperry et al., 1994	Y
Prosopis glandulosa	arid/semi	shrub	stem	0.0560			Kocacinar and Sage, 2004	Y
Prunus ilicifolia	arid/semi	shrub	stem		0.22	26.78	Jacobsen et al., 2007a	
Prunus persica	cult	tree	root	0.1701	0.86	86.00	Vercambe et al., 2002	Y
Pueraria montana	temp	liana	stem	0.6955		149.48	Hacke et al., 2006	Y
Purshia tridentata	arid/semi	shrub	stem	0.0391			Wheeler et al., 2005	N
Pyrostegia venusta	trop/sub	liana	stem		1.53	39.00	Ewers et al., 1990	
Quercus agrifolia	arid/semi	shrub	stem		1.96	50.88	Jacobsen et al., 2007a	
Quercus alba	temp	tree	stem	0.1153			Cochard and Tyree, 1990	Y
Quercus berberidifolia	arid/semi	shrub	stem	0.1779	1.60	46.83	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Quercus gambelii	arid/semi	shrub	stem	0.1656		37.62	Sperry and Sullivan, 1992; Hacke et al., 2006	Y
Quercus prinus	temp	tree	stem	0.1571		48.37	Hacke et al., 2006	Y
Quercus rubra	temp	tree	stem	0.1159			Cochard and Tyree, 1990	Y
Quercus wislizenii	arid/semi	shrub	stem		1.45	38.14	Jacobsen et al., 2007a	
Rhamnus californica	arid/semi	shrub	stem		1.06	29.56	Jacobsen et al., 2007a	
Rhamnus crocea	arid/semi	shrub	stem		1.83	23.66	Jacobsen et al., 2007a	
Rhamnus ilicifolia	arid/semi	shrub	stem		1.23	26.15	Jacobsen et al., 2007a	
Rhododendron maximum	temp	shrub	stem	0.0246	0.16	21.50	Lipp and Nilsen, 1997	Y
Rhus integrifolia	arid/semi	shrub	stem		1.16	35.43	Jacobsen et al., 2007a	
Rhus ovata	arid/semi	shrub	stem	0.2216	1.40	42.26	Jacobsen et al., 2007a; Hacke et al., 2009	Y
Rhus trilobata	arid/semi	shrub	stem	0.0997	0.80	38.86	Hacke et al., 2006; Jacobsen et al., 2007a	Y
Salix exigua	temp	shrub	stem	0.0457		30.15	Sperry et al., 2005	Y
Salix pulchra	temp	shrub	stem	0.1081		24.00	Gorsuch and Oberbauer, 2002	Y

Salix viminalis	temp	shrub	stem	0.0526	0.16		Salleo et al., 1992	Y
Salvia leucophylla	arid/semi	shrub	stem	0.0814		38.47	Hacke et al., 2009	Y
Salvia mellifera	arid/semi	shrub	stem	0.0668		30.78	Hacke et al., 2009	Y
Sambucus cerulea	temp	shrub	stem	0.0449		37.59	Sperry et al., 2005	Y
Saritaea magnifica	trop/sub	liana	stem	0.1346	0.61	45.33	Ewers et al., 1989a, b; Ewers et al., 1990	Y/N
Serjania polyphylla	trop/sub	liana	stem	0.7500	1.58	25.00	Ewers et al., 1990	N
Sorbus scopulina	temp	tree	stem	0.0477			Wheeler et al., 2005	N
Spartium junceum	arid/semi	shrub	stem	0.0573			Gullo et al., 2000	Y
Stigmaphyllon ellipticum	trop/sub	liana	stem	0.3480	1.40	35.60	Ewers et al., 1989a, b; Ewers et al., 1990	Y/N
Stigmaphyllon periplocifolium	trop/sub	liana	stem		1.51	23.00	Ewers et al., 1990	
Tecomaria capensis	trop/sub	tree	stem	0.0506	0.15	12.70	Vander Willigen et al., 2000	Y
Thunbergia grandiflora	trop/sub	liana	stem		1.28	42.00	Ewers et al., 1990	
Toxicodendron diversilobum	arid/semi	liana	stem	0.0565	0.63		Gartner, 1991	Y
Toxicodendron diversilobum	arid/semi	shrub	stem	0.0782	0.63		Gartner, 1991	Y
Trichilia dregeana	trop/sub	tree	stem	0.0896	0.30	28.00	Vander Willigen et al., 2000	Y
Ulmus americana	temp	tree	stem	0.0320	0.12		Newbanks et al., 1983	Y
Umbellularia californica	arid/semi	shrub	stem		0.90	52.04	Jacobsen et al., 2007a	
Vitis labrusca/riparia	temp	liana	stem	0.4160	1.40		Sperry et al., 1987	Y
Vitis rotundifolia	trop/sub	liana	stem	0.3217	1.73	96.00	Ewers et al., 1989b; Ewers et al., 1990	Y/N
Vitis vinifera	cult	liana	stem	0.1503	0.90	69.18	Sperry et al., 2005; Wheeler et al., 2005; Jacobsen and Pratt, 2012	Y/N

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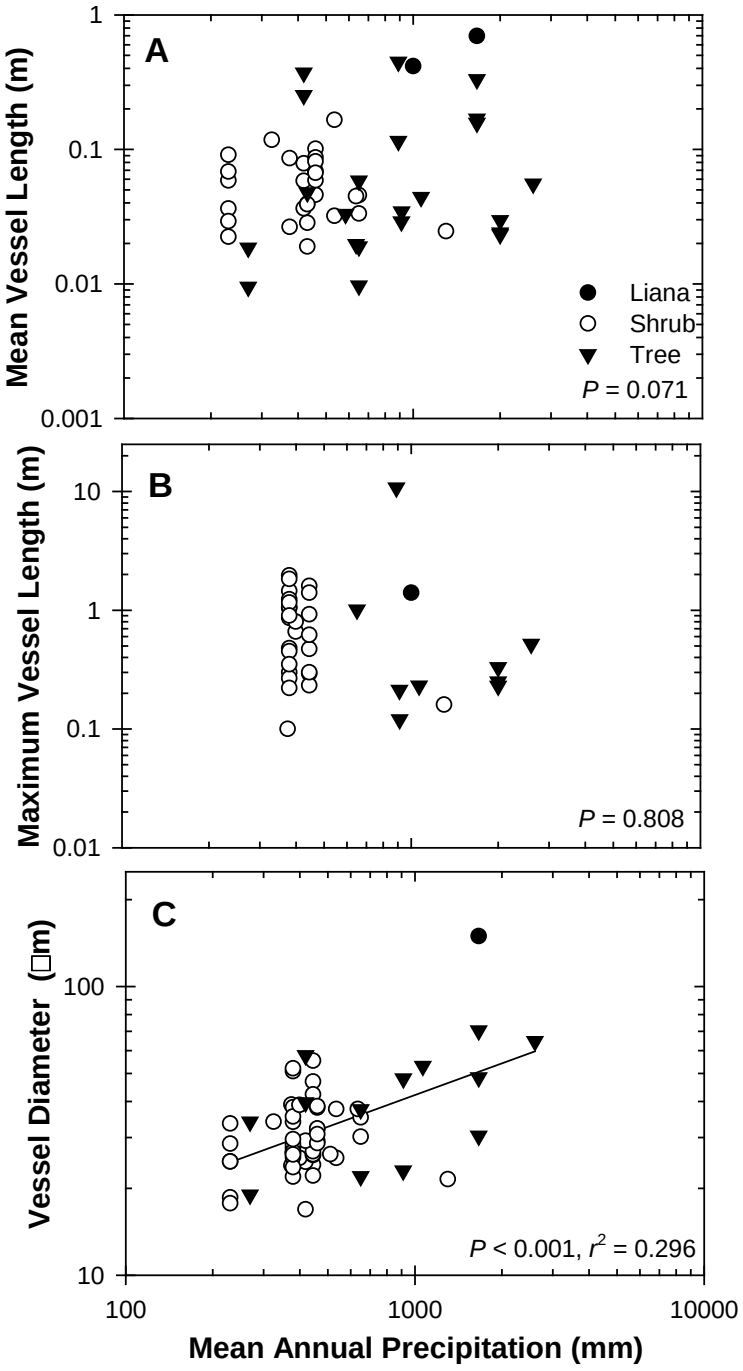
Appendix S2. Mean annual precipitation as a predictor for mean (A) and maximum (B) vessel length and mean vessel diameter (C). Mean annual precipitation did not predict either mean or maximum vessel length. However, this analysis should be viewed with caution because it is based on only the small percentage (40%) of sampled species that were measured from non-irrigated field grown plants. The majority of samples from the complete dataset (51.6%) were measured from plants grown in irrigated gardens or irrigated potted plants or were from plants for which no site information was provided (8.4%) and these data were excluded from this analysis. Additionally, excluding irrigated plants removed nearly all of the liana species from this analysis (only two were sampled from natural field sites) and thus it is heavily biased toward shrubs and trees which may not be representative of all woody species. Even with this limited data set, mean annual precipitation is predictive of mean vessel diameter.

For additional analyses (see the main text) species were lumped into general environmental categories based on what was reported in source studies (tropical/sub-tropical, temperate, or arid/semi-arid environments) and irrespective of whether they were irrigated. These analyses therefore assumed that species were broadly adapted to their native environment and not likely to be heavily influenced by irrigation. This may not be a valid assumption and it is clear that more broad sampling and careful reporting of source populations and sites will be necessary to fully address the question of whether precipitation or environment influence vessel length.


A
Mean Vessel Length (m)
1
0.1
0.01
0.001
Liana
Shrub
Tree
P = 0.071
B
Maximum Vessel Length (m)
10
1
0.1
0.01
P = 0.808
C
Vessel Diameter (□m)
100
10
P < 0.001, r2 = 0.296
100
1000
10000
Mean Annual Precipitation (mm)

26