

Interaction between xylem rays and vessel elements

Supplementary Material

Table S1. Measurements of vessel tangential dimension within secondary xylem of Norway maple. Values are expressed in micrometers (μm). AD – tangential dimension of a vessel neighboring with a ray, measured in location of ray largest width. DI – tangential dimension of a vessel measured in a distance of 40-45 μm from the end of a ray. Measurements no. 1–140 were taken from tree with a DBH of 48 cm, and 141–420 were taken from trees with a DBH of 8 cm

No.	AD	DI	No.	AD	DI	No.	AD	DI	No.	AD	DI
1	51.22	57.23	106	33.40	47.83	211	42.11	51.82	316	43.90	54.72
2	47.43	56.52	107	34.22	49.43	212	52.18	68.06	317	48.82	53.79
3	27.48	32.42	108	56.13	66.77	213	50.60	53.02	318	43.28	56.14
4	53.59	61.47	109	26.74	38.86	214	48.64	68.01	319	43.28	50.80
5	56.52	65.42	110	47.64	52.39	215	48.02	59.88	320	45.32	52.72
6	58.32	61.46	111	46.44	57.73	216	43.58	49.06	321	32.81	35.58
7	42.93	72.61	112	42.80	58.42	217	41.92	55.35	322	49.30	62.50
8	69.10	74.62	113	43.71	49.65	218	48.43	63.05	323	46.08	53.22
9	48.62	54.02	114	48.63	56.95	219	47.27	57.82	324	41.13	53.57
10	47.05	57.40	115	57.36	67.00	220	41.58	51.24	325	40.52	59.53
11	52.37	63.85	116	40.14	48.93	221	48.14	60.09	326	41.32	48.44
12	59.14	73.51	117	36.60	56.83	222	44.53	59.58	327	29.05	37.16
13	73.21	77.97	118	38.96	49.29	223	47.85	50.35	328	46.45	47.64
14	34.32	45.30	119	59.76	72.58	224	48.42	56.46	329	39.23	47.63
15	42.51	61.71	120	30.25	43.87	225	42.17	47.45	330	44.07	50.40
16	46.25	68.58	121	32.22	51.19	226	24.53	53.08	331	39.13	48.65
17	52.08	61.17	122	49.01	66.61	227	36.86	45.51	332	49.21	60.90
18	52.18	56.13	123	55.74	76.68	228	46.65	52.05	333	46.25	53.16
19	47.47	70.43	124	47.66	60.92	229	42.89	52.20	334	48.82	63.84
20	49.42	51.44	125	47.63	59.93	230	58.55	59.69	335	42.29	47.25
21	60.14	68.38	126	51.27	63.61	231	53.98	65.53	336	41.31	47.06
22	36.11	52.18	127	37.76	42.1	232	37.96	51.48	337	48.22	54.36
23	50.20	62.28	128	39.33	50.61	233	41.71	50.13	338	34.60	50.00
24	55.08	60.50	129	43.48	63.31	234	62.85	80.83	339	46.25	58.39
25	53.59	62.25	130	49.01	64.74	235	42.39	47.46	340	54.25	60.28
26	58.12	61.27	131	55.73	67.99	236	53.77	60.13	341	57.54	69.59
27	49.83	60.34	132	58.01	67.69	237	53.36	59.70	342	49.61	64.63
28	44.81	61.68	133	48.70	64.47	238	39.53	52.18	343	42.70	56.33
29	47.83	60.29	134	59.32	66.25	239	38.37	53.79	344	42.70	52.78
30	35.18	42.36	135	36.38	43.96	240	41.90	48.16	345	43.69	51.04
31	16.45	37.82	136	32.81	48.44	241	39.33	46.64	346	45.85	50.99
32	51.41	54.96	137	44.47	51.78	242	44.87	50.99	347	39.58	52.38
33	26.19	41.96	138	53.62	57.48	243	42.91	50.21	348	47.63	51.98
34	57.51	67.58	139	46.66	52.19	244	27.71	35.71	349	43.80	55.57
35	52.98	60.47	140	46.46	50.82	245	28.43	34.78	350	43.11	59.49
36	66.04	71.99	141	35.61	46.48	246	47.08	50.72	351	27.48	39.33
37	48.72	64.43	142	37.21	42.50	247	47.83	53.36	352	35.58	42.69
38	29.11	44.48	143	52.44	60.08	248	55.34	58.12	353	38.54	46.44
39	47.13	51.63	144	52.04	58.70	249	50.60	68.58	354	42.50	50.90
40	28.84	44.01	145	54.39	65.04	250	43.08	51.64	355	46.47	58.11
41	57.99	65.63	146	47.88	55.15	251	52.57	57.51	356	49.22	62.92
42	56.33	65.78	147	39.96	60.11	252	49.43	57.45	357	51.02	58.31
43	53.63	60.28	148	48.04	53.81	253	43.53	48.88	358	39.94	54.05
44	48.62	57.75	149	45.67	57.12	254	51.19	56.54	359	43.28	60.67
45	32.83	40.14	150	50.41	52.82	255	46.84	53.96	360	43.28	52.77
46	40.38	66.21	151	37.15	44.29	256	49.01	56.35	361	30.05	46.25
47	50.84	61.21	152	49.61	59.29	257	49.85	60.32	362	42.11	50.10
48	53.21	57.72	153	53.40	60.05	258	49.65	60.67	363	49.21	66.11

Interaction between xylem rays and vessel elements

No.	AD	DI	No.	AD	DI	No.	AD	DI	No.	AD	DI
49	48.23	70.78	154	44.53	46.90	259	39.72	52.89	364	52.37	69.20
50	45.17	59.77	155	39.94	51.14	260	44.27	50.72	365	42.49	56.35
51	46.67	53.90	156	56.13	59.93	261	44.87	53.37	366	52.17	57.31
52	44.58	47.06	157	50.20	65.42	262	51.01	53.57	367	49.22	59.10
53	58.89	75.89	158	40.73	59.83	263	47.63	51.46	368	48.02	65.44
54	64.46	72.73	159	61.46	79.08	264	33.96	42.34	369	68.65	78.80
55	71.94	82.63	160	60.87	75.89	265	38.16	41.52	370	37.65	52.80
56	72.37	83.05	161	39.25	46.68	266	41.12	49.41	371	37.35	51.78
57	41.72	46.06	162	41.46	46.73	267	42.70	43.50	372	52.17	60.53
58	45.45	49.80	163	38.39	51.64	268	87.95	99.47	373	70.18	82.03
59	42.93	51.48	164	41.50	47.85	269	44.16	52.42	374	50.80	58.70
60	55.14	60.28	165	47.27	53.61	270	35.91	47.14	375	43.11	58.50
61	48.09	55.14	166	30.87	44.86	271	39.74	43.17	376	47.56	57.00
62	46.90	62.06	167	41.53	52.44	272	45.68	59.55	377	48.40	56.38
63	40.92	51.19	168	55.18	62.81	273	36.56	45.66	378	74.78	94.67
64	41.51	45.69	169	39.58	45.20	274	37.74	40.87	379	38.54	46.45
65	46.46	51.38	170	35.21	50.40	275	46.46	50.48	380	37.15	50.44
66	45.12	56.96	171	38.75	45.09	276	41.53	50.46	381	43.08	52.77
67	91.30	105.94	172	49.46	54.42	277	54.14	57.35	382	54.15	63.91
68	81.72	94.49	173	49.44	56.86	278	27.44	33.68	383	34.49	51.00
69	51.40	57.36	174	41.32	51.38	279	58.87	65.83	384	46.51	54.56
70	41.51	56.13	175	46.85	51.13	280	37.45	45.00	385	35.18	50.03
71	49.60	64.03	176	50.60	58.50	281	50.60	57.91	386	36.03	52.97
72	43.28	46.94	177	55.22	62.02	282	53.57	62.15	387	51.82	70.60
73	91.32	104.75	178	21.80	30.25	283	41.91	48.56	388	58.53	65.22
74	84.68	94.26	179	42.89	62.86	284	44.67	52.97	389	50.40	59.77
75	51.56	58.74	180	45.88	54.02	285	40.20	52.57	390	60.08	70.79
76	52.98	56.01	181	48.03	58.72	286	43.75	50.34	391	47.43	60.08
77	59.30	65.22	182	49.88	57.53	287	45.28	52.78	392	38.95	48.24
78	49.05	51.98	183	36.96	47.84	288	44.87	52.57	393	41.54	57.31
79	59.74	73.53	184	44.52	53.56	289	38.35	50.80	394	42.10	52.57
80	41.91	57.73	185	41.50	57.72	290	37.37	53.20	395	37.55	48.12
81	44.70	52.75	186	50.40	59.30	291	48.46	58.35	396	47.27	57.52
82	42.29	54.94	187	54.55	65.52	292	44.66	59.49	397	41.21	48.46
83	50.99	57.91	188	53.27	57.44	293	45.50	52.81	398	42.29	52.17
84	47.69	60.32	189	37.55	53.16	294	52.87	58.64	399	41.33	47.04
85	41.38	55.97	190	41.83	58.32	295	51.81	61.49	400	42.81	51.10
86	40.12	58.91	191	35.64	46.28	296	45.79	57.74	401	40.91	50.40
87	46.62	76.57	192	32.44	49.41	297	46.89	53.64	402	41.51	53.36
88	47.23	71.16	193	32.82	48.62	298	49.61	54.75	403	38.94	45.66
89	43.11	56.32	194	36.57	47.86	299	53.16	58.72	404	38.93	50.99
90	44.47	50.6	195	37.46	45.10	300	42.03	56.19	405	39.73	51.99
91	45.14	54.45	196	44.72	57.36	301	51.38	59.09	406	46.54	51.49
92	43.16	55.93	197	53.61	72.61	302	47.05	50.63	407	41.52	46.51
93	54.74	65.02	198	33.61	42.10	303	34.39	41.53	408	51.01	60.71
94	41.43	53.59	199	26.68	46.48	304	49.61	58.70	409	43.33	49.82
95	46.59	53.44	200	54.94	61.11	305	40.31	53.56	410	39.54	49.03
96	70.21	72.34	201	33.80	41.91	306	54.55	60.08	411	41.51	50.22
97	69.85	78.8	202	38.55	44.66	307	51.36	59.09	412	38.74	54.95
98	65.30	79.85	203	22.54	41.52	308	35.84	43.35	413	43.29	50.42
99	70.95	88.35	204	40.32	48.42	309	26.88	41.71	414	46.44	52.18
100	46.05	54.75	205	41.00	43.09	310	47.25	57.33	415	46.25	66.41
101	53.22	71.21	206	42.69	50.60	311	45.65	64.52	416	41.77	55.88
102	48.08	57.51	207	37.57	49.03	312	34.19	43.11	417	52.77	59.88
103	34.00	47.07	208	40.18	44.29	313	31.64	44.66	418	46.05	59.50
104	41.90	62.31	209	44.67	52.97	314	40.75	53.96	419	40.37	53.17
105	54.97	66.86	210	33.78	48.24	315	39.93	50.11	420	54.74	63.07

Table S2. Measurements of ray width within secondary xylem of pedunculate oak, with a distinction between earlywood and latewood. Values are expressed in micrometers (μm). CE – measurement taken near the center of the vessel. DI – measurement taken at a distance from the vessel (closer to the trunk pith)

No.	Earlywood		Latewood		No.	Earlywood		Latewood	
	CE	DI	CE	DI		CE	DI	CE	DI
1	9.35	17.24	4.43	18.06	51	5.21	13.16	16.57	26.07
2	4.16	19.48	7.68	18.59	52	5.20	17.15	10.52	14.23
3	5.06	9.61	9.78	13.77	53	8.19	8.62	6.75	15.73
4	11.69	12.34	7.93	17.83	54	6.24	10.51	8.76	12.99
5	2.27	9.35	13.12	20.27	55	6.75	18.92	11.30	18.58
6	3.90	11.29	9.68	23.53	56	6.65	21.27	9.44	13.54
7	7.79	14.95	12.13	21.69	57	7.68	15.39	9.74	13.79
8	9.55	15.38	10.40	15.85	58	7.50	13.79	12.48	11.46
9	5.75	16.49	7.97	20.13	59	8.83	14.32	9.48	11.44
10	6.17	15.19	11.71	19.00	60	9.09	13.38	10.92	14.68
11	7.66	21.03	11.96	13.52	61	8.59	14.29	7.14	16.05
12	5.65	16.62	7.82	17.07	62	8.48	14.32	11.71	16.00
13	7.79	21.81	12.21	15.64	63	11.56	21.19	7.19	11.97
14	6.62	13.15	6.49	17.93	64	6.49	17.82	9.49	16.29
15	5.45	10.81	9.08	13.94	65	8.10	32.33	9.87	15.63
16	7.40	16.36	5.66	10.23	66	7.40	19.28	7.01	17.17
17	8.18	20.52	8.78	13.17	67	4.58	12.32	4.00	11.62
18	9.16	17.40	8.31	13.36	68	7.68	21.55	6.63	19.87
19	10.03	31.51	10.71	12.76	69	5.65	33.77	7.22	10.05
20	12.47	17.18	7.40	13.24	70	8.57	31.81	8.75	14.83
21	14.12	26.20	9.63	16.36	71	7.54	19.28	10.27	14.56
22	4.74	18.44	9.61	13.28	72	16.76	18.11	9.11	11.67
23	10.45	33.77	5.53	11.82	73	10.40	18.80	11.13	14.55
24	4.68	15.84	13.40	18.56	74	10.36	12.73	8.31	17.16
25	9.09	11.91	15.32	22.73	75	6.54	26.33	10.26	16.56
26	8.67	17.40	20.80	20.76	76	7.22	17.28	9.61	16.23
27	5.07	7.92	10.69	14.60	77	12.96	23.05	10.06	18.05
28	4.68	19.67	22.21	29.61	78	5.55	22.76	9.36	13.50
29	10.33	31.36	21.84	21.17	79	5.98	13.25	7.41	16.23
30	12.47	32.73	12.35	23.13	80	5.88	19.46	6.15	14.43
31	6.91	44.28	15.50	16.38	81	7.41	19.09	11.40	16.56
32	7.42	19.91	9.84	17.54	82	5.45	16.41	8.47	12.57
33	6.75	8.38	5.01	8.28	83	14.44	20.62	7.01	13.64
34	9.35	15.45	12.76	19.00	84	6.23	22.53	9.94	18.60
35	4.10	11.43	12.37	19.91	85	12.24	22.09	7.42	13.75
36	6.06	17.94	10.40	14.55	86	10.52	23.36	14.42	16.12
37	4.48	17.02	11.43	21.95	87	8.78	15.22	11.53	16.62
38	6.23	12.66	9.48	21.30	88	14.14	16.51	11.02	12.60
39	2.47	16.63	7.31	14.03	89	6.43	16.29	10.07	15.92
40	5.25	20.51	16.75	30.26	90	9.24	23.68	6.75	14.40
41	2.86	9.24	7.53	20.91	91	6.62	17.14	13.65	17.29
42	4.29	9.37	16.36	24.42	92	14.65	25.19	12.78	10.46
43	7.02	8.96	14.81	17.92	93	5.66	12.62	7.81	10.57
44	3.13	11.94	12.99	18.83	94	8.19	15.85	10.40	20.13
45	4.42	11.96	11.04	20.40	95	8.32	17.27	10.94	14.29
46	4.11	11.93	11.03	21.83	96	10.65	15.41	7.58	12.71
47	4.89	14.06	13.25	19.20	97	5.58	15.19	8.38	21.33
48	7.02	28.98	12.88	25.34	98	7.80	16.58	14.04	22.37
49	2.52	17.43	9.93	13.00	99	7.06	17.38	10.39	16.28
50	2.34	15.98	9.12	14.06	100	10.62	27.47	8.79	11.33

Interaction between xylem rays and vessel elements

Table S3. Descriptive statistics of vessel tangential dimension in all analyzed Norway maple specimens. AD – tangential dimension of a vessel neighboring with a ray, measured in location of ray largest width, DI – tangential dimension of a vessel measured at a distance of 40–45 μm from the end of a ray, $n = 420$, SD – standard deviation, SE – standard error

	AD [μm]	DI [μm]
Mean	46.04	56.26
Minimum	16.45	30.25
Maximum	91.32	105.94
Median	45.58	54.75
SD	9.73	10.29
SE	0.47	0.50

Table S4. Descriptive statistics of vessel tangential dimension in Norway maple specimen with a DBH of 48 cm. AD – tangential dimension of a vessel neighboring with a ray, measured in location of ray largest width, DI – tangential dimension of a vessel measured at a distance of 40–45 μm from the end of a ray, $n = 140$, SD – standard deviation, SE – standard error

	AD [μm]	DI [μm]
Mean	49.20	60.26
Minimum	16.45	32.42
Maximum	91.32	105.94
Median	47.76	58.83
SD	11.90	12.14
SE	1.01	1.03

Table S5. Descriptive statistics of vessel tangential dimension in two Norway maple specimens with a DBH of 8 cm. AD – tangential dimension of a vessel neighboring with a ray, measured in location of ray largest width, DI – tangential dimension of a vessel measured at a distance of 40–45 μm from the end of a ray, $n = 280$, SD – standard deviation, SE – standard error

	AD [μm]	DI [μm]
Mean	44.46	54.26
Minimum	21.80	30.25
Maximum	87.95	99.47
Median	43.72	53.12
SD	8.01	8.57
SE	0.48	0.51

Table S6. Descriptive statistics of ray width in earlywood of pedunculate oak. CE – measurement taken near the center of the vessel, DI – measurement taken at a distance from the vessel (closer to the trunk pith), $n = 100$, SD – standard deviation, SE – standard error

	DI [μm]	CE [μm]
Mean	17.99	7.50
Minimum	7.92	2.27
Maximum	44.28	16.76
Median	17.08	7.14
SD	6.53	2.93
SE	0.65	0.29

Table S7. Descriptive statistics of ray width in latewood of pedunculate oak. CE – measurement taken near the center of the vessel, DI – measurement taken at a distance from the vessel (closer to the trunk pith), $n = 100$, SD – standard deviation, SE – standard error

	DI [μm]	CE [μm]
Mean	16.63	10.34
Minimum	8.28	4.00
Maximum	30.26	22.21
Median	16.18	9.90
SD	4.16	3.31
SE	0.42	0.33

Table S8. Results of the Shapiro-Wilk test assessing data normality for vessel tangential dimensions in Norway maple for the specimen with a DBH of 48 cm. A value of 0.0000 indicates that the p -value was <0.0001 in the Shapiro-Wilk test. $n = 140$. Test results are significant at $p < 0.01$. “Adjacent” refers to the tangential dimension of a vessel adjacent to a ray, measured at the location of maximum ray width. “Distance” refers to the tangential dimension of the same vessel measured 40–45 μm away from the end of the ray

Norway maple wood	Adjacent	Distance
W	0.946421	0.927356
p	0.0000	0.0001

Table S9. Results of the Shapiro-Wilk test assessing data normality for vessel tangential dimensions in Norway maple for two specimens with a DBH of 8 cm. A value of 0.0000 indicates that the p -value was <0.0001 in the Shapiro-Wilk test. $n = 280$. Test results are significant at $p < 0.01$. “Adjacent” refers to the tangential dimension of a vessel adjacent to a ray, measured at the location of maximum ray width. “Distance” refers to the tangential dimension of the same vessel measured 40–45 μm away from the end of the ray

Norway maple wood	Adjacent	Distance
W	0.957413	0.932884
p	0.0000	0.0000

Table S10. Results of the Shapiro-Wilk test assessing data normality in the study of vessel tangential dimensions in Norway maple (for all analyzed trees). A value of 0.0000 indicates that the p -value was <0.00001 in the Shapiro-Wilk test. $n = 420$. Test results are significant at $p < 0.01$. “Adjacent” refers to the tangential dimension of a vessel adjacent to a ray, measured at the location of maximum ray width. “Distance” refers to the tangential dimension of the same vessel measured 40–45 μm away from the end of the ray

Norway maple wood	Adjacent	Distance
W	0.937364	0.927356
p	0.0000	0.0000

Table S11. Results of the Shapiro-Wilk test assessing data normality in the study of ray width in pedunculate oak. A value of 0.0000 indicates that the p -value was <0.00001 in the Shapiro-Wilk test. $n = 100$. Test results are significant at $p < 0.01$. "Center" refers to the ray width measured near the center of an adjacent vessel. "Distance" refers to the ray width measured farther away from the vessel (toward the trunk pith)

Pedunculate oak wood		Center	Distance
Earlywood	W	0.9631	0.9103
	p	0.0167	0.0000
Latewood	W	0.9267	0.9608
	p	0.0000	0.0046

Table S12. Results of the Wilcoxon matched-pairs test ($\alpha = 0.01$) performed for two groups of measurements from the vessel tangential dimension analysis (for all analyzed trees). Vessel tangential dimension within the secondary xylem of Norway maple was measured near the widest part of an adjacent ray, and at a distance from ray end. AD – measured at the location of ray's largest width, DI – measured at a distance of 40–45 μm from the end of a ray

Pair of variables	Valid N	T	Z	p value	p value (asym.)
AD vs. DI	420	0	17.758601	0.0001	<0.000001

Table S13. Results of the Wilcoxon matched-pairs test ($\alpha = 0.01$) performed for two groups of measurements from the vessel tangential dimension analysis for the specimen with a DBH of 48 cm. Vessel tangential dimension within the secondary xylem of Norway maple was measured near the widest part of an adjacent ray, and at a distance from ray end. AD – measured at the location of ray's largest width, DI – measured at a distance of 40–45 μm from the end of a ray

Pair of variables	Valid N	T	Z	p value	p value (asym.)
AD vs. DI	140	0	10.2641	0.0001	<0.000001

Table S14. Results of the Wilcoxon matched-pairs test ($\alpha = 0.01$) performed for two groups of measurements from the vessel tangential dimension analysis for specimens with a DBH of 8 cm. Vessel tangential dimension within the secondary xylem of Norway maple was measured near the widest part of an adjacent ray, and at a distance from ray end. AD – measured at the location of ray's largest width, DI – measured at a distance of 40–45 μm from the end of a ray

Pair of variables	Valid N	T	Z	p value	p value (asym.)
AD vs. DI	280	0	14.5039	0.0001	<0.000001

Table S15. Results of the Wilcoxon matched pairs-test ($\alpha = 0.01$) performed for two groups of measurements from the ray width analysis. Ray width within the secondary xylem of pedunculate oak was measured near the center of a neighboring vessel, and at a distance from the vessel, toward the trunk pith, for both earlywood and latewood datasets. EW-C – earlywood, measured near the vessel center, EW-D – earlywood, measured at a distance, LW-C – latewood, measured near the vessel center, LW-D – latewood, measured at a distance

Pair of variables	Valid N	T	Z	p value
EW-C vs. EW-D	100	0	8.680057	0.0001
LW-C vs. LW-D	100	17	8.621612	0.0001