

# **Online Material**

**Table A.** Heritabilities, and genetic and phenotypic correlations between annual rings including standard errors from the multiple-trait analysis. (a) Earlywood density (ED). Heritabilities  $h^2$  along the emboldened diagonal, genetic correlations ( $r_A$ ) above the diagonal and phenotypic correlations ( $r_P$ ) below. Blue figures indicate  $r_P/r_A > 0.86$ , green  $r_P/r_A = 0.61-0.85$ , red  $r_P/r_A = 0.40-0.60$  and black  $r_P/r_A < 0.40$ . (b) Latewood density (LD). Heritabilities  $h^2$  along the emboldened diagonal, genetic correlations ( $r_A$ ) above the diagonal and phenotypic correlations ( $r_P$ ) below. Blue indicates  $r_P/r_A > 0.86$ , green  $r_P/r_A = 0.61-0.86$ , red  $r_P/r_A = 0.40-0.60$  and black  $r_P/r_A < 0.40$ . (c) Latewood density (LD). Heritabilities  $h^2$  along the emboldened diagonal, banded genetic correlations ( $r_A$ ) above the diagonal and phenotypic correlations ( $r_P$ ) below the diagonal. (d) Genetic correlations ( $r_A$ ) from the multiple-trait correlation analysis between earlywood and latewood density (ED and LD, respectively) in the ten annual rings. Blue indicates  $r_A > 0.85$ , green  $r_A = 0.61-0.85$ , red  $r_A = 0.40-0.60$  and black  $r_A < 0.40$ . (e) Phenotypic correlations ( $r_P$ ) from the multiple-trait correlation analysis between earlywood and latewood density (ED and LD, respectively) in the ten annual rings. Blue indicates  $r_P > 0.50$ , green  $r_P = 0.41-0.50$ , red  $r_P = 0.30-0.40$  and black  $r_P < 0.30$ .

(a)

Ring number from pith	ED									
	12	13	14	15	16	17	18	19	20	21
12	<b>0.083 ± 0.040</b>	0.91 ± 0.053	0.85 ± 0.081	0.79 ± 0.11	0.86 ± 0.10	0.69 ± 0.15	0.62 ± 0.15	0.81 ± 0.12	0.47 ± 0.19	0.63 ± 0.19
13	0.76 ± 0.016	<b>0.14 ± 0.051</b>	0.96 ± 0.046	0.83 ± 0.098	0.89 ± 0.11	0.78 ± 0.12	0.73 ± 0.13	0.88 ± 0.10	0.59 ± 0.16	0.67 ± 0.18
14	0.66 ± 0.023	0.70 ± 0.020	<b>0.21 ± 0.066</b>	0.924 ± 0.070	1.05 ± 0.053	0.93 ± 0.093	0.89 ± 0.079	1.01 ± 0.53	0.62 ± 0.16	0.83 ± 0.13
15	0.61 ± 0.026	0.66 ± 0.022	0.64 ± 0.024	<b>0.16 ± 0.054</b>	1.10 ± 0.060	0.94 ± 0.074	0.88 ± 0.089	0.96 ± 0.086	0.70 ± 0.14	0.74 ± 0.17
ED 16	0.50 ± 0.029	0.38 ± 0.033	0.54 ± 0.028	0.54 ± 0.028	<b>0.18 ± 0.057</b>	0.88 ± 0.12	0.77 ± 0.12	0.95 ± 0.064	0.55 ± 0.21	0.84 ± 0.13
17	0.55 ± 0.026	0.56 ± 0.025	0.49 ± 0.029	0.62 ± 0.023	0.42 ± 0.029	<b>0.25 ± 0.066</b>	1.07 ± 0.043	1.04 ± 0.058	0.93 ± 0.063	1.11 ± 0.097
18	0.55 ± 0.027	0.54 ± 0.026	0.57 ± 0.026	0.58 ± 0.025	0.61 ± 0.022	0.65 ± 0.019	<b>0.26 ± 0.068</b>	1.00 ± 0.041	0.91 ± 0.074	1.00 ± 0.070
19	0.53 ± 0.026	0.53 ± 0.026	0.55 ± 0.026	0.53 ± 0.026	0.68 ± 0.018	0.62 ± 0.020	0.73 ± 0.015	<b>0.24 ± 0.064</b>	0.82 ± 0.12	0.92 ± 0.094
20	0.39 ± 0.032	0.53 ± 0.026	0.40 ± 0.032	0.54 ± 0.026	0.16 ± 0.035	0.69 ± 0.017	0.56 ± 0.023	0.49 ± 0.025	<b>0.27 ± 0.069</b>	0.85 ± 0.12
21	0.35 ± 0.033	0.40 ± 0.031	0.43 ± 0.031	0.39 ± 0.032	0.50 ± 0.026	0.36 ± 0.030	0.58 ± 0.022	0.58 ± 0.021	0.38 ± 0.028	<b>0.20 ± 0.057</b>

(b)

Ring number from pith	LD									
	12	13	14	15	16	17	18	19	20	21
12	<b>0.22 ± 0.066</b>	0.94 ± 0.062	1.01 ± 0.072	0.53 ± 0.22	0.90 ± 0.10	0.76 ± 0.14	0.73 ± 0.14	0.75 ± 0.14	0.76 ± 0.13	0.76 ± 0.14
13	0.74 ± 0.017	<b>0.20 ± 0.062</b>	0.96 ± 0.049	0.84 ± 0.10	0.94 ± 0.056	0.88 ± 0.063	0.89 ± 0.065	0.87 ± 0.069	0.90 ± 0.059	0.89 ± 0.066
14	0.70 ± 0.020	0.75 ± 0.017	<b>0.24 ± 0.070</b>	0.91 ± 0.065	0.97 ± 0.042	0.75 ± 0.11	0.84 ± 0.077	0.77 ± 0.10	0.72 ± 0.11	0.81 ± 0.093
15	0.63 ± 0.024	0.66 ± 0.022	0.74 ± 0.018	<b>0.18 ± 0.060</b>	1.00 ± 0.041	0.83 ± 0.094	0.82 ± 0.094	0.80 ± 0.11	0.80 ± 0.10	0.83 ± 0.099
LD 16	0.68 ± 0.020	0.73 ± 0.017	0.74 ± 0.017	0.74 ± 0.017	<b>0.12 ± 0.046</b>	0.88 ± 0.064	0.88 ± 0.058	0.82 ± 0.083	0.86 ± 0.071	0.89 ± 0.066
17	0.60 ± 0.024	0.78 ± 0.014	0.61 ± 0.025	0.67 ± 0.021	0.72 ± 0.018	<b>0.11 ± 0.042</b>	0.99 ± 0.019	1.01 ± 0.012	0.98 ± 0.023	1.00 ± 0.027
18	0.64 ± 0.022	0.71 ± 0.018	0.74 ± 0.018	0.67 ± 0.021	0.75 ± 0.016	0.77 ± 0.014	<b>0.15 ± 0.0491</b>	1.00 ± 0.012	0.97 ± 0.020	0.99 ± 0.023
19	0.60 ± 0.023	0.73 ± 0.017	0.67 ± 0.021	0.64 ± 0.022	0.70 ± 0.0185	0.82 ± 0.012	0.83 ± 0.011	<b>0.11 ± 0.041</b>	0.98 ± 0.015	0.99 ± 0.021
20	0.60 ± 0.024	0.71 ± 0.018	0.69 ± 0.020	0.64 ± 0.022	0.69 ± 0.019	0.76 ± 0.015	0.84 ± 0.010	0.86 ± 0.009	<b>0.15 ± 0.048</b>	0.98 ± 0.019
21	0.60 ± 0.024	0.68 ± 0.020	0.68 ± 0.021	0.62 ± 0.023	0.69 ± 0.019	0.71 ± 0.017	0.77 ± 0.014	0.80 ± 0.012	0.83 ± 0.010	<b>0.096 ± 0.039</b>

(c)

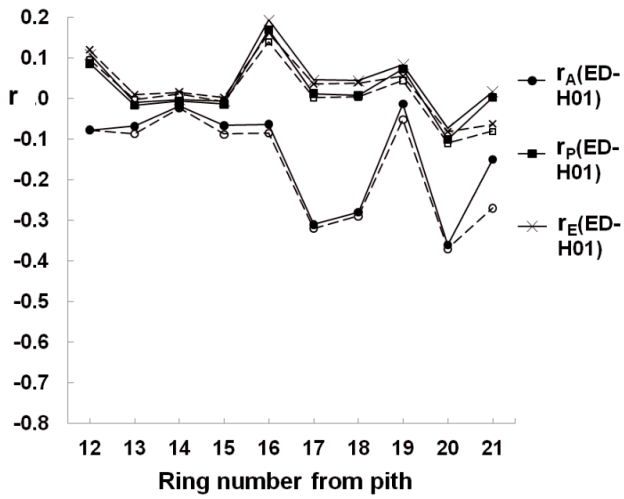
Ring number from pith	LD									
	12	13	14	15	16	17	18	19	20	21
12	<b>0.22 ± 0.066</b>	0.97 ± 0.019	0.93 ± 0.031	0.93 ± 0.035	0.93	0.89 ± 0.049	0.89	0.86 ± 0.063	0.86	0.86
13	0.74 ± 0.017	<b>0.20 ± 0.062</b>	0.97	0.93	0.93	0.93	0.89	0.89	0.86	0.86
14	0.70 ± 0.020	0.75 ± 0.017	<b>0.24 ± 0.070</b>	0.97	0.93	0.93	0.93	0.89	0.89	0.86
15	0.63 ± 0.024	0.66 ± 0.022	0.74 ± 0.018	<b>0.18 ± 0.060</b>	0.97	0.93	0.93	0.93	0.89	0.89
LD 16	0.68 ± 0.020	0.73 ± 0.017	0.74 ± 0.017	0.74 ± 0.017	<b>0.12 ± 0.0464</b>	0.97	0.93	0.93	0.93	0.89
17	0.60 ± 0.024	0.78 ± 0.014	0.61 ± 0.025	0.67 ± 0.021	0.72 ± 0.018	<b>0.11 ± 0.042</b>	0.97	0.93	0.93	0.93
18	0.64 ± 0.022	0.71 ± 0.018	0.74 ± 0.018	0.67 ± 0.021	0.75 ± 0.016	0.77 ± 0.014	<b>0.15 ± 0.049</b>	0.97	0.93	0.93
19	0.60 ± 0.023	0.73 ± 0.017	0.67 ± 0.021	0.64 ± 0.022	0.70 ± 0.018	0.82 ± 0.012	0.83 ± 0.011	<b>0.11 ± 0.041</b>	0.97	0.93
20	0.60 ± 0.024	0.71 ± 0.018	0.69 ± 0.020	0.64 ± 0.022	0.69 ± 0.019	0.76 ± 0.015	0.84 ± 0.010	0.86 ± 0.009	<b>0.15 ± 0.048</b>	0.97
21	0.60 ± 0.024	0.68 ± 0.020	0.68 ± 0.021	0.62 ± 0.023	0.69 ± 0.019	0.71 ± 0.017	0.77 ± 0.014	0.83 ± 0.010	0.83 ± 0.010	<b>0.096 ± 0.039</b>

(d)

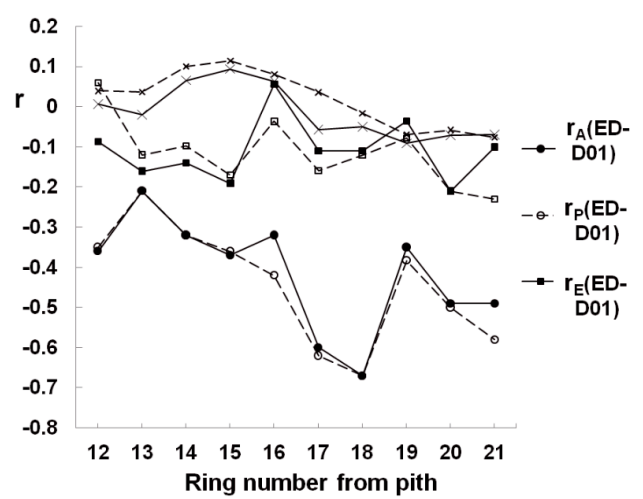
Ring number from pith	ED									
	12	13	14	15	16	17	18	19	20	21
12	1.04 ± 0.085	0.78 ± 0.12	0.76 ± 0.13	0.39 ± 0.21	0.72 ± 0.14	0.40 ± 0.19	0.43 ± 0.18	0.40 ± 0.19	0.42 ± 0.18	0.46 ± 0.19
13	0.89 ± 0.12	0.76 ± 0.12	0.66 ± 0.15	0.43 ± 0.21	0.72 ± 0.14	0.46 ± 0.18	0.47 ± 0.17	0.47 ± 0.18	0.50 ± 0.17	0.48 ± 0.18
14	1.03 ± 0.10	0.90 ± 0.091	0.86 ± 0.081	0.61 ± 0.17	0.80 ± 0.11	0.46 ± 0.18	0.55 ± 0.16	0.51 ± 0.17	0.48 ± 0.17	0.53 ± 0.17
15	0.83 ± 0.15	0.80 ± 0.13	0.86 ± 0.11	0.78 ± 0.12	0.96 ± 0.080	0.53 ± 0.17	0.55 ± 0.17	0.49 ± 0.18	0.54 ± 0.17	0.54 ± 0.18
<b>LD</b> 16	0.93 ± 0.16	0.87 ± 0.15	1.00 ± 0.080	0.84 ± 0.13	0.91 ± 0.085	0.50 ± 0.20	0.63 ± 0.16	0.52 ± 0.19	0.55 ± 0.18	0.59 ± 0.18
17	1.06 ± 0.13	0.96 ± 0.098	0.90 ± 0.13	0.84 ± 0.13	0.94 ± 0.094	0.83 ± 0.10	0.94 ± 0.094	0.90 ± 0.095	0.92 ± 0.095	0.95 ± 0.097
18	1.05 ± 0.13	0.96 ± 0.090	0.88 ± 0.10	0.90 ± 0.11	0.98 ± 0.069	0.82 ± 0.10	0.86 ± 0.083	0.88 ± 0.085	0.89 ± 0.081	0.91 ± 0.087
19	0.96 ± 0.13	0.90 ± 0.12	0.91 ± 0.098	0.82 ± 0.14	0.91 ± 0.097	0.63 ± 0.16	0.74 ± 0.13	0.72 ± 0.14	0.72 ± 0.14	0.78 ± 0.13
20	0.73 ± 0.20	0.84 ± 0.11	0.62 ± 0.18	0.71 ± 0.16	0.82 ± 0.13	0.86 ± 0.089	0.89 ± 0.090	0.89 ± 0.080	0.93 ± 0.065	0.95 ± 0.078
21	1.10 ± 0.16	1.00 ± 0.12	0.91 ± 0.12	0.79 ± 0.17	0.94 ± 0.11	0.80 ± 0.14	0.91 ± 0.11	0.87 ± 0.12	0.88 ± 0.11	0.89 ± 0.10

(e)

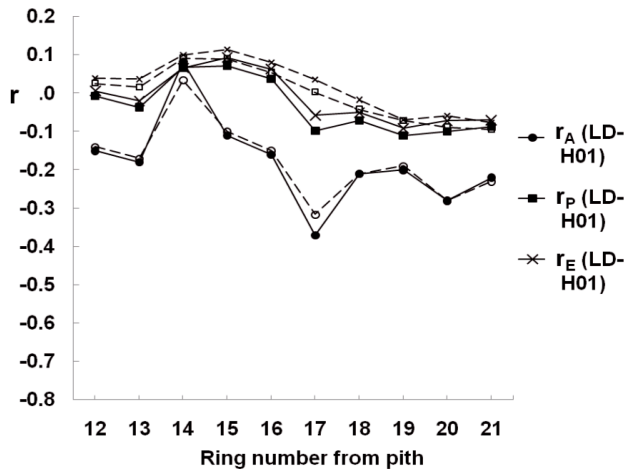
Ring number from pith	ED									
	12	13	14	15	16	17	18	19	20	21
12	0.52 ± 0.027	0.52 ± 0.028	0.45 ± 0.034	0.38 ± 0.036	0.46 ± 0.032	0.43 ± 0.033	0.42 ± 0.034	0.39 ± 0.034	0.39 ± 0.034	0.37 ± 0.034
13	0.49 ± 0.029	0.62 ± 0.022	0.45 ± 0.032	0.38 ± 0.034	0.43 ± 0.032	0.50 ± 0.029	0.41 ± 0.032	0.45 ± 0.030	0.46 ± 0.030	0.43 ± 0.031
14	0.50 ± 0.030	0.55 ± 0.028	0.63 ± 0.024	0.45 ± 0.033	0.48 ± 0.031	0.41 ± 0.034	0.48 ± 0.031	0.44 ± 0.032	0.49 ± 0.031	0.47 ± 0.031
15	0.46 ± 0.032	0.49 ± 0.030	0.46 ± 0.032	0.55 ± 0.026	0.50 ± 0.029	0.47 ± 0.031	0.43 ± 0.032	0.45 ± 0.031	0.49 ± 0.030	0.46 ± 0.031
<b>LD</b> 16	0.36 ± 0.034	0.30 ± 0.035	0.49 ± 0.030	0.44 ± 0.031	0.58 ± 0.023	0.27 ± 0.034	0.39 ± 0.031	0.31 ± 0.033	0.31 ± 0.033	0.37 ± 0.031
17	0.34 ± 0.033	0.46 ± 0.029	0.26 ± 0.036	0.41 ± 0.032	0.42 ± 0.029	0.55 ± 0.023	0.37 ± 0.030	0.45 ± 0.027	0.39 ± 0.029	0.39 ± 0.029
18	0.37 ± 0.032	0.41 ± 0.031	0.41 ± 0.032	0.36 ± 0.033	0.46 ± 0.028	0.47 ± 0.027	0.50 ± 0.026	0.49 ± 0.026	0.49 ± 0.026	0.43 ± 0.028
19	0.38 ± 0.031	0.36 ± 0.031	0.43 ± 0.031	0.41 ± 0.031	0.49 ± 0.027	0.38 ± 0.029	0.45 ± 0.027	0.47 ± 0.026	0.45 ± 0.026	0.44 ± 0.027
20	0.30 ± 0.034	0.44 ± 0.029	0.19 ± 0.038	0.31 ± 0.034	0.28 ± 0.033	0.52 ± 0.025	0.35 ± 0.031	0.47 ± 0.026	0.51 ± 0.025	0.42 ± 0.028
21	0.28 ± 0.035	0.27 ± 0.034	0.31 ± 0.035	0.24 ± 0.036	0.33 ± 0.032	0.24 ± 0.033	0.36 ± 0.030	0.32 ± 0.030	0.37 ± 0.029	0.40 ± 0.026



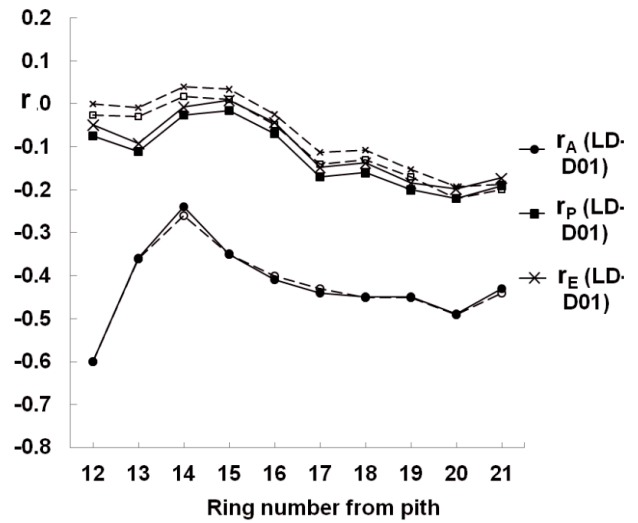
(a)



(b)

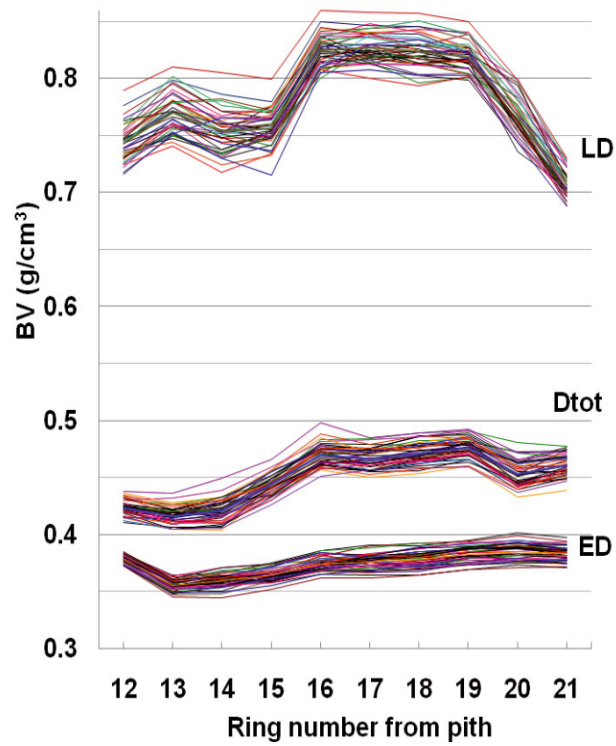


(c)



(d)

**Figure A.** Genetic, environmental and phenotypic correlations ( $r(A)$ ,  $r(E)$  and  $r(P)$ , respectively) between earlywood and latewood density (ED and LD), and tree height (H01) and stem diameter (D01). Solid line: no covariate, broken line: the width of the corresponding ring section used as a covariate.



**Figure B.** Changes in total breeding values (BV) of the 40 parents during the 10-year period in  $\text{g}\cdot\text{cm}^{-3}$ . Result from analysis with the width of the corresponding ring section the same year used as a covariate.