

1 **Supplementary Materials for**

2 **Climate-driven patterns of global tree longevity**

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8 This file includes:

9 Supplementary Tables 1 to 2

10 Supplementary Figures 1 to 13

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12 **Supplementary Table 1| Mean annual precipitation (MAP) and mean annual temperature (MAT)**
13 **across clades and age groups.**

Clade	Age classification	MAP (mm)		MAT (°C)	
		Mean	SD	Mean	SD
Gymnosperm	Mature trees	859	517	4.77	6.68
	Old trees	799	624	4.13	5.98
	Ancient trees	753	600	4.44	5.41
Angiosperm	Old trees	1037	472	10.92	4.66
	Ancient trees	1003	427	10.26	5.76

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Supplementary Table 2| Species-level tree lifespan.

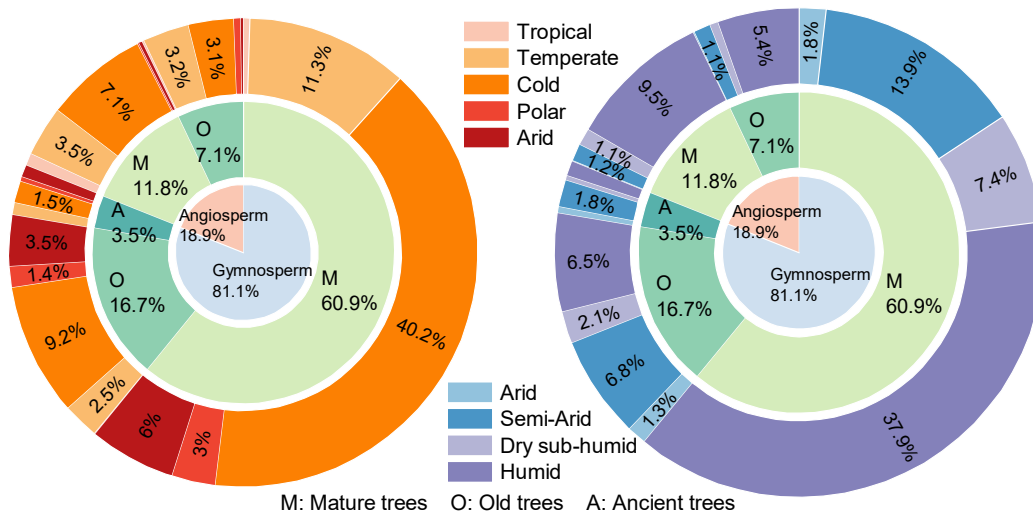
Abbreviations: NA, North America; SA, South America; AS, Asia; OC, Oceania; EU, Europe; AF, Africa.

Gymnosperms and angiosperms are represented by their initials.

No.	Species	Clade	Maximum age (year)	Lifespan (year)
1	<i>Sequoiadendron giganteum</i>	G	3205	2053
2	<i>Juniperus przewalskii</i>	G	3053	1809
3	<i>Pinus longaeva</i>	G	2984	1790
4	<i>Pinus aristata</i>	G	1665	1448
5	<i>Juniperus turkestanica</i>	G	1294	1275
6	<i>Fitzroya cupressoides</i>	G	1674	1245
7	<i>Juniperus spp.</i>	G	1437	1171
8	<i>Pinus sibirica</i>	G	1449	1157
9	<i>Taxodium distichum</i>	G	2098	1125
10	<i>Pinus balfouriana</i>	G	1230	1075
11	<i>Juniperus tibetica</i>	G	1306	1004
12	<i>Cedrus atlantica</i>	G	1024	942
13	<i>Pinus flexilis</i>	G	1596	918
14	<i>Juniperus occidentalis</i>	G	1300	903
15	<i>Athrotaxis selaginoides</i>	G	940	879
16	<i>Cryptomeria japonica</i>	G	1090	821
17	<i>Agathis australis</i>	G	1396	818
18	<i>Pinus heldreichii</i>	G	1075	812
19	<i>Juniperus osteosperma</i>	G	848	771
20	<i>Athrotaxis cupressoides</i>	G	946	768
21	<i>Fokienia hodginsii</i>	G	825	765
22	<i>Chamaecyparis nootkatensis</i>	G	800	759
23	<i>Taxodium mucronatum</i>	G	1032	750
24	<i>Juniperus excelsa</i>	G	915	750
25	<i>Juniperus scopulorum</i>	G	861	727
26	<i>Larix lyallii</i>	G	1011	715
27	<i>Pinus albicaulis</i>	G	983	710
28	<i>Pinus edulis</i>	G	1115	693
29	<i>Pseudotsuga menziesii</i>	G	1001	674
30	<i>Astrocedrus chilensis</i>	G	830	662
31	<i>Larix sibirica</i>	G	978	660
32	<i>Thuja occidentalis</i>	G	754	634
33	<i>Abies forestii</i>	G	660	628
34	<i>Libocedrus bidwillii</i>	G	720	613
35	<i>Picea smithiana</i>	G	720	612
36	<i>Tsuga dumosa</i>	G	1007	611
37	<i>Pinus mugo</i>	G	647	605
38	<i>Araucaria araucana</i>	G	766	599
39	<i>Larix decidua</i>	G	995	594

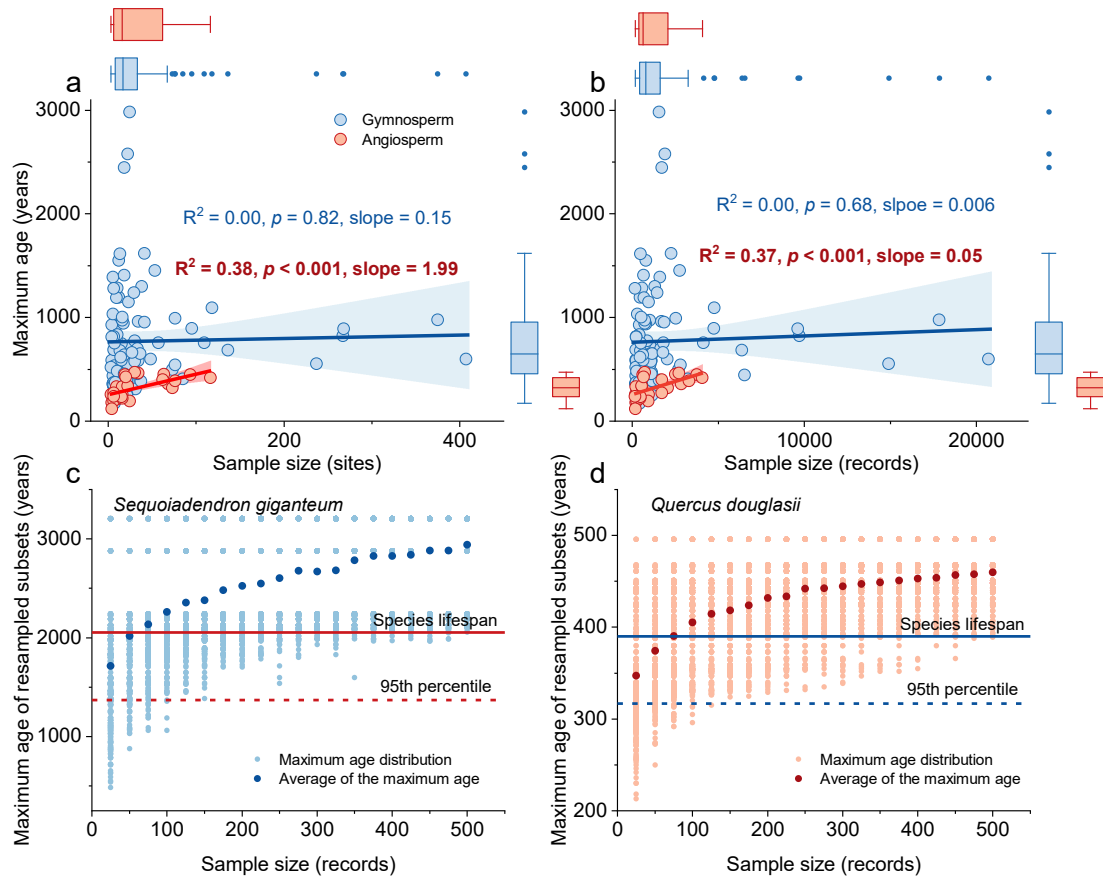
No.	Species	Clade	Maximum age (year)	Lifespan (year)
40	<i>Pinus nigra</i>	G	800	592
41	<i>Abies amabilis</i>	G	606	581
42	<i>Juniperus virginiana</i>	G	939	581
43	<i>Cedrus deodara</i>	G	712	574
44	<i>Pinus jeffreyi</i>	G	661	565
45	<i>Tsuga mertensiana</i>	G	745	565
46	<i>Pinus wallichiana</i>	G	689	554
47	<i>Larix spp.</i>	G	657	551
48	<i>Picea likiangensis</i>	G	589	546
49	<i>Cedrus libani</i>	G	619	535
50	<i>Pinus armandii</i>	G	634	530
51	<i>Picea engelmannii</i>	G	781	524
52	<i>Pinus ponderosa</i>	G	980	521
53	<i>Halocarpus biformis</i>	G	534	510
54	<i>Larix gmelinii</i>	G	631	510
55	<i>Pinus monophylla</i>	G	653	509
56	<i>Pinus strobus</i>	G	558	503
57	<i>Picea glehnii</i>	G	581	491
58	<i>Phyllocladus aspleniifolius</i>	G	653	482
59	<i>Pseudotsuga macrocarpa</i>	G	658	479
60	<i>Abies pinsapo</i>	G	483	468
61	<i>Picea schrenkiana</i>	G	555	465
62	<i>Picea sitchensis</i>	G	593	460
63	<i>Picea glauca</i>	G	968	450
64	<i>Pilgerodendron uviferum</i>	G	470	438
65	<i>Abies spectabilis</i>	G	578	430
66	<i>Tsuga canadensis</i>	G	554	423
67	<i>Pinus contorta</i>	G	519	418
68	<i>Pinus cembra</i>	G	525	414
69	<i>Pinus sylvestris</i>	G	612	412
70	<i>Pinus spp.</i>	G	720	404
71	<i>Pinus lambertiana</i>	G	435	400
72	<i>Pinus hartwegii</i>	G	364	357
73	<i>Pinus resinosa</i>	G	2006	353
74	<i>Calocedrus decurrens</i>	G	430	352
75	<i>Picea rubens</i>	G	424	351
76	<i>Picea mariana</i>	G	598	345
77	<i>Picea obovata</i>	G	457	345
78	<i>Abies lasiocarpa</i>	G	507	345
79	<i>Abies concolor</i>	G	373	342
80	<i>Phyllocladus trichomanoides</i>	G	374	334
81	<i>Larix laricina</i>	G	334	334
82	<i>Abies magnifica</i>	G	476	333

No.	Species	Clade	Maximum age (year)	Lifespan (year)
83	<i>Pinus merkusii</i>	G	378	329
84	<i>Pinus strobiformis</i>	G	407	323
85	<i>Pinus brutia</i>	G	317	313
86	<i>Picea abies</i>	G	891	308
87	<i>Pinus palustris</i>	G	424	306
88	<i>Pinus cembroides</i>	G	389	306
89	<i>Pinus roxburghii</i>	G	326	303
90	<i>Abies alba</i>	G	423	294
91	<i>Pinus rigida</i>	G	397	283
92	<i>Pinus banksiana</i>	G	327	264
93	<i>Pinus echinata</i>	G	314	261
94	<i>Pinus massoniana</i>	G	256	225
95	<i>Chamaecyparis thyoides</i>	G	254	212
96	<i>Pinus kesiya</i>	G	285	169
97	<i>Callitris intratropica</i>	G	188	159
98	<i>Lagarostrobos franklinii</i>	A	1774	1263
99	<i>Liriodendron tulipifera</i>	A	473	418
100	<i>Quercus petraea</i>	A	449	400
101	<i>Nothofagus pumilio</i>	A	453	392
102	<i>Quercus douglasii</i>	A	496	390
103	<i>Quercus prinus</i>	A	426	371
104	<i>Quercus alba</i>	A	432	340
105	<i>Tectona grandis</i>	A	391	319
106	<i>Quercus robur</i>	A	449	319
107	<i>Quercus stellata</i>	A	374	313
108	<i>Quercus spp.</i>	A	518	312
109	<i>Carya ovata</i>	A	347	300
110	<i>Quercus macrocarpa</i>	A	400	282
111	<i>Populus deltoides</i>	A	368	264
112	<i>Fagus sylvatica</i>	A	407	259
113	<i>Nothofagus solandri</i>	A	350	257
114	<i>Cedrela odorata</i>	A	258	252
115	<i>Juglans australis</i>	A	317	234
116	<i>Cedrela angustifolia</i>	A	254	227
117	<i>Quercus rubra</i>	A	227	215
118	<i>Centrolobium microchaete</i>	A	213	203
119	<i>Quercus velutina</i>	A	259	199
120	<i>Toona ciliata</i>	A	311	189
121	<i>Populus tremuloides</i>	A	254	187
122	<i>Cedrela fissilis</i>	A	179	177
123	<i>Acer saccharum</i>	A	199	158
124	<i>Fraxinus nigra</i>	A	198	151
125	<i>Quercus coccinea</i>	A	120	113



Supplementary Fig. 1 | Proportion of tree longevity by age group and biomes.

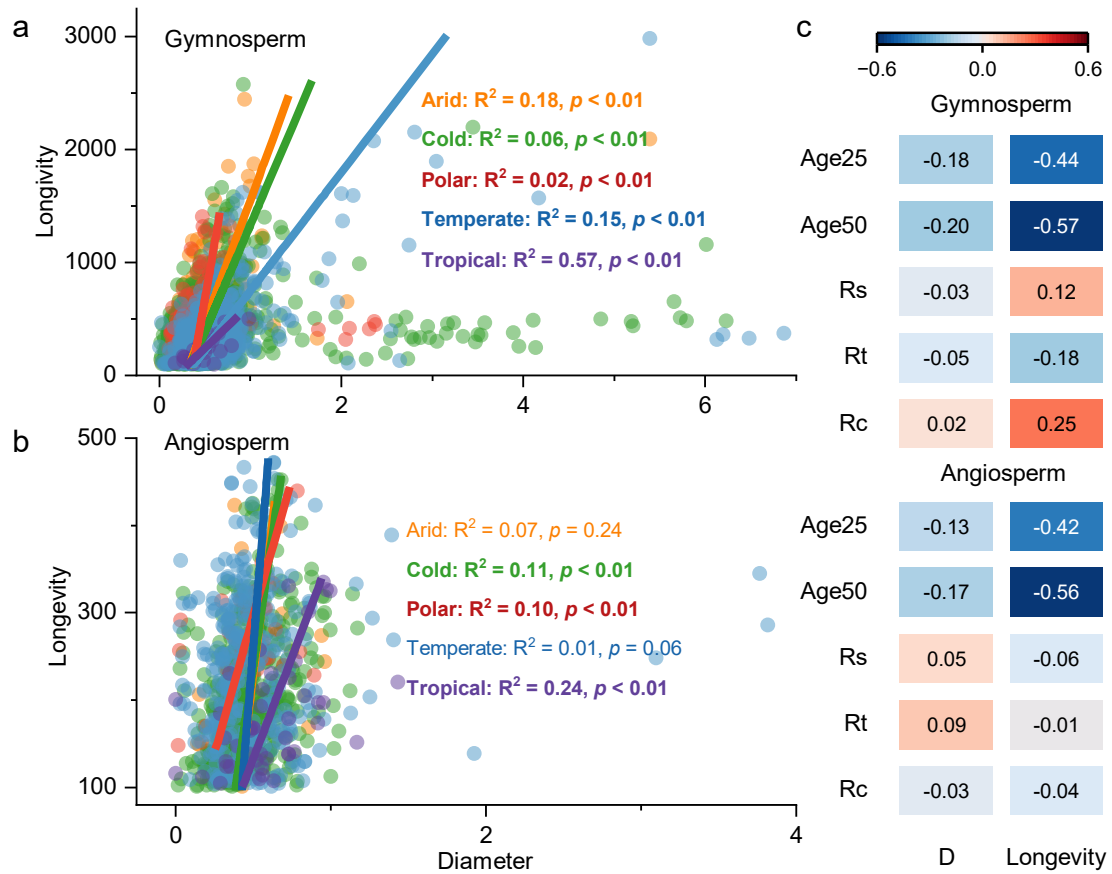
Abbreviations: M, mature; O, old; A, ancient trees.



Supplementary Fig. 2 | Relationships between the sample size and maximum age.

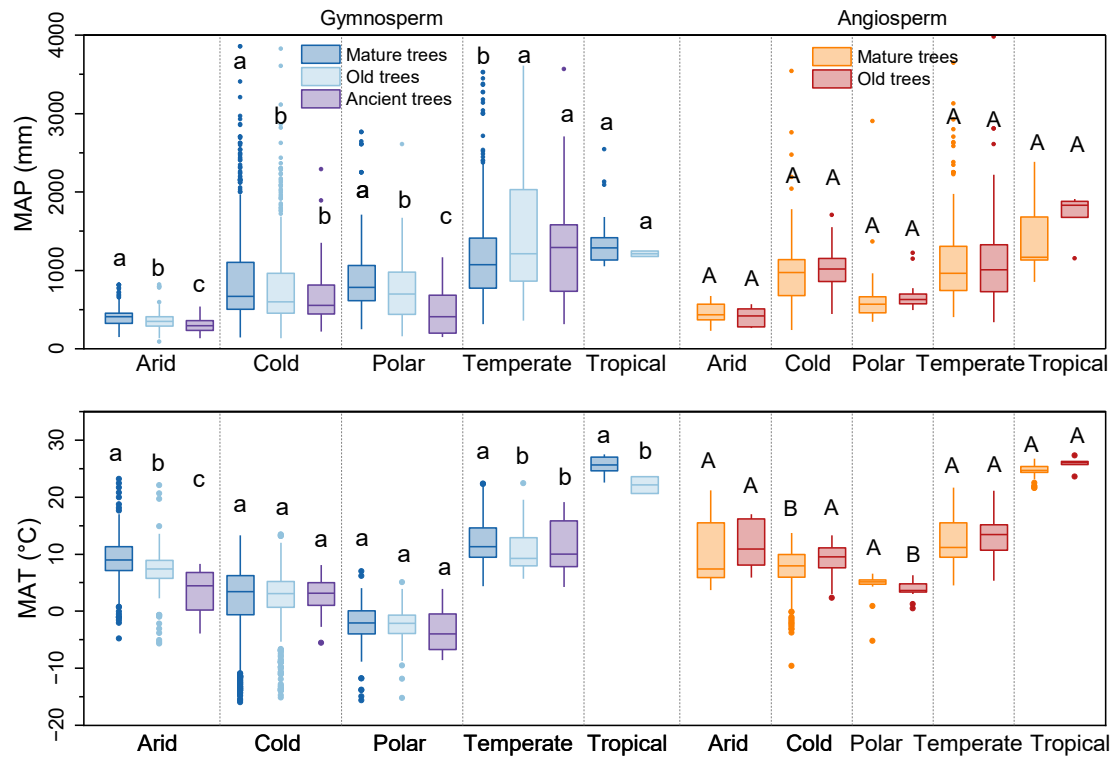
a-b Linear relationship between sample size (tree-ring sites and records) and site-specific maximum age.

c-d The maximum age distribution of sampled subsets for one gymnosperm species (*Sequoiadendron giganteum*) and one angiosperm species (*Quercus douglasii*). Light and dark dots represent the maximum age distribution and the mean maximum age at each sample size, respectively. The horizontal dashed and solid lines denote the 95th and 99th percentiles (i.e., species lifespan) of the true age, respectively.



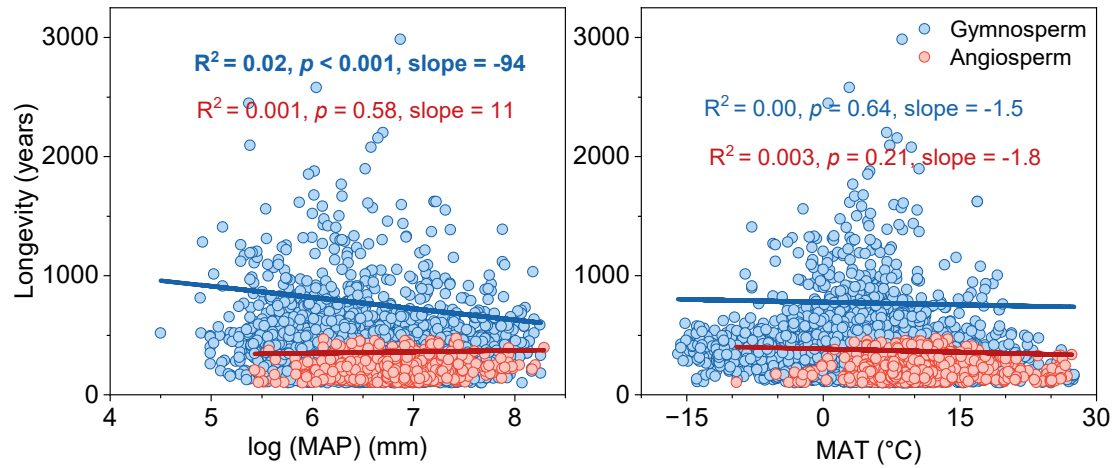
Supplementary Fig. 3 | Relationships between the diameter and longevity across clade and biome, and Spearman rank correlations between diameter, longevity and tree-ring based growth traits.

Abbreviations: D, diameter; Age25, juvenile growth rate at 25 years of age; Age50, juvenile growth rate at 50 years of age; Rt, resistance; Rc, recovery; Rs, resilience. Only statistically significant correlations ($p < 0.05$) are displayed.



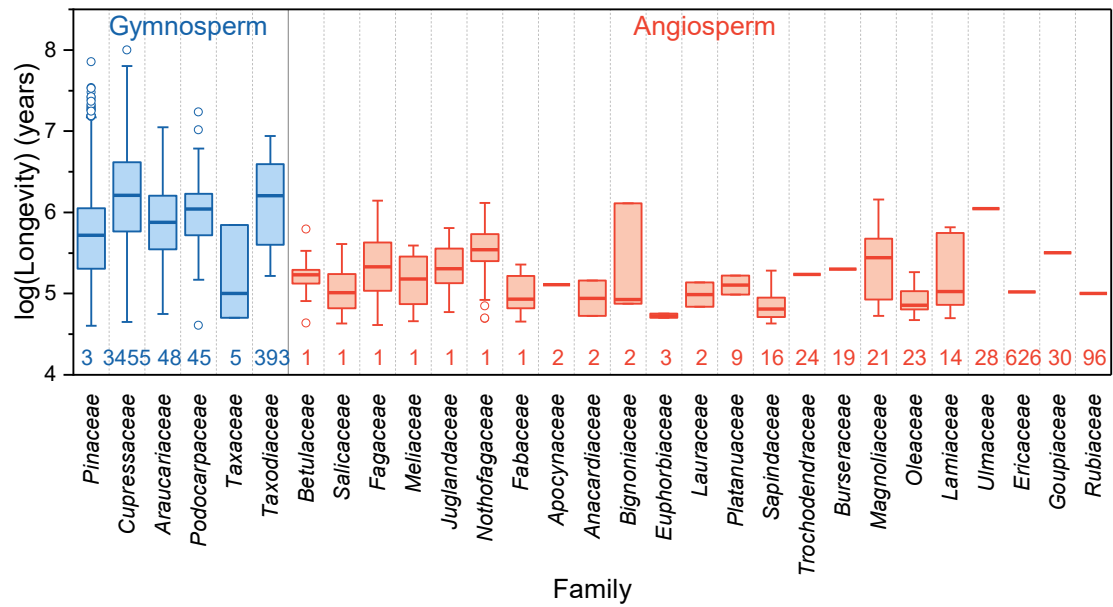
Supplementary Fig. 4 | Climate variables for age groups across clade and biome.

Boxplots display the 25th percentiles, median and 75th percentiles and outliers. Statistically significant differences among age groups are indicated by different letters (Tukey's HSD tests, $p < 0.05$).



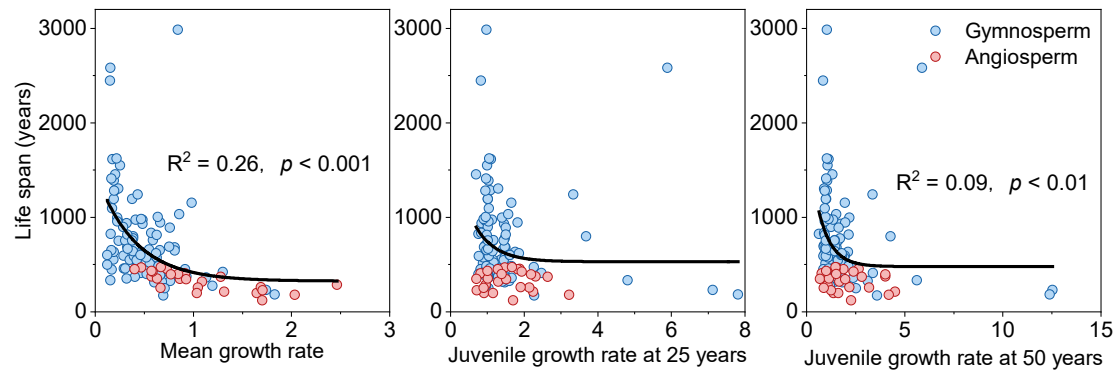
Supplementary Fig. 5 | Relationships between mean annual precipitation (MAP), mean annual temperature (MAT) and tree longevity.

Curves represent 95th quantile regression fits.



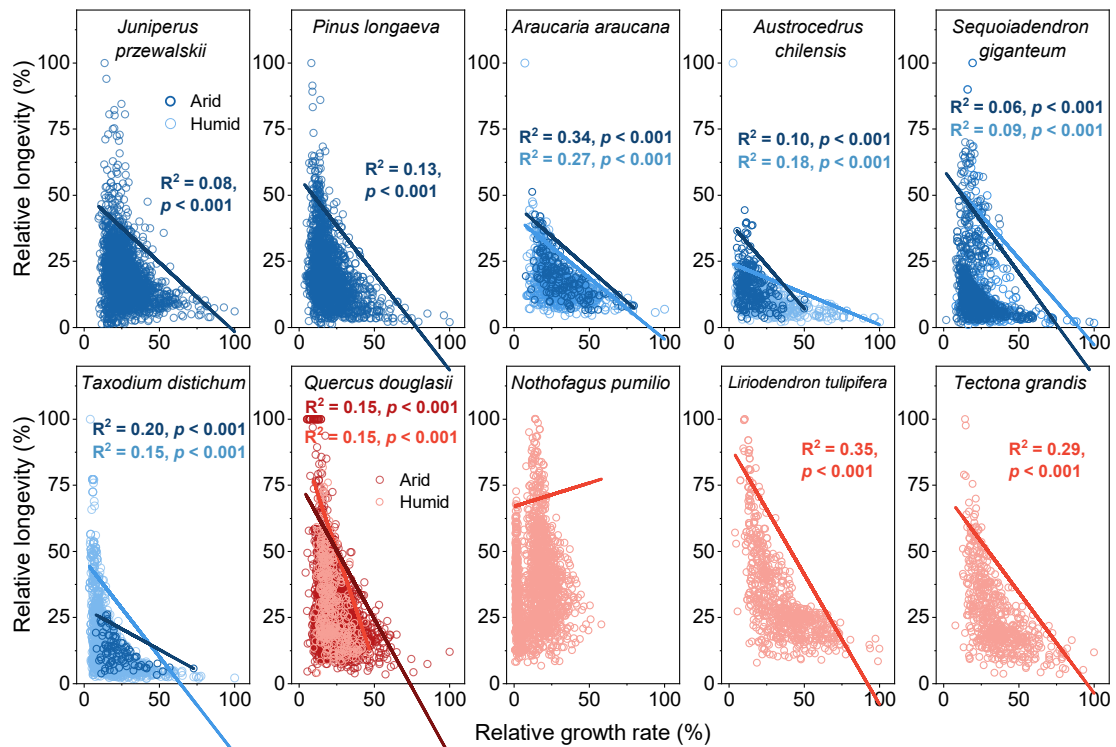
Supplementary Fig. 6 | Distribution of tree longevity across clades and family.

Boxplots display the 25th percentiles, median and 75th percentiles, with whiskers indicating 1.5 times the interquartile range and outliers. Letters at panel bottoms specify the number of tree-ring series.



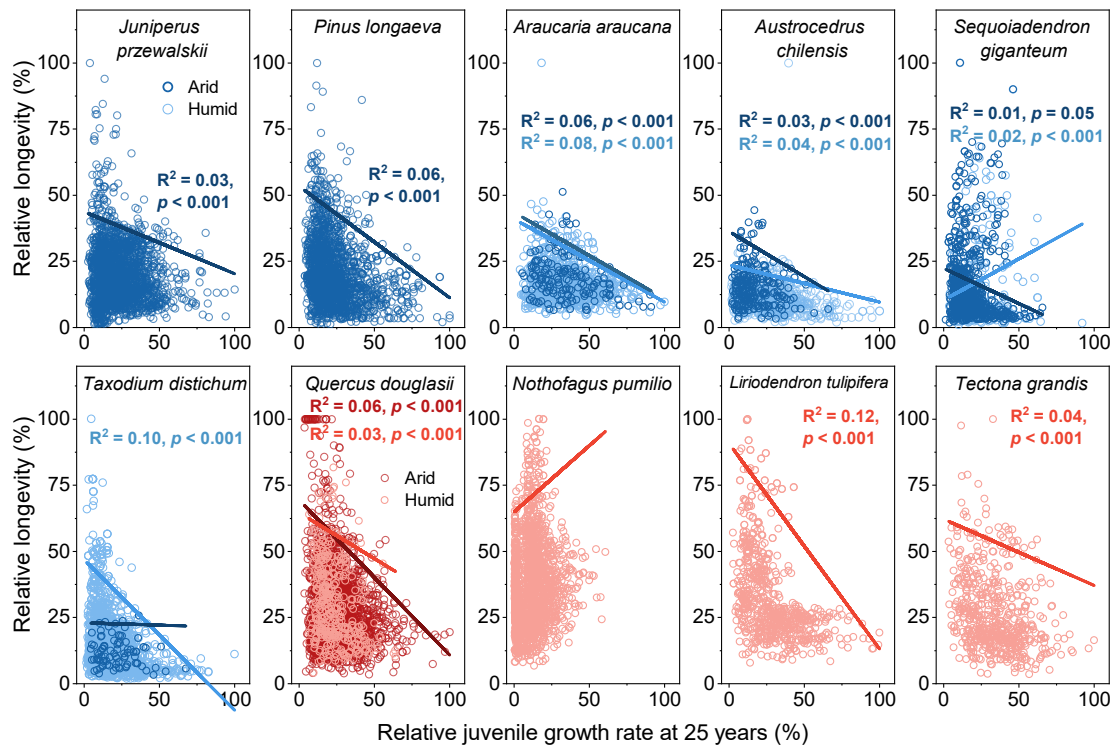
Supplementary Fig. 7 | Grow rate *versus* species-specific lifespan.

The estimated growth rate-lifespan relationship was fitted by negative exponential regressions.



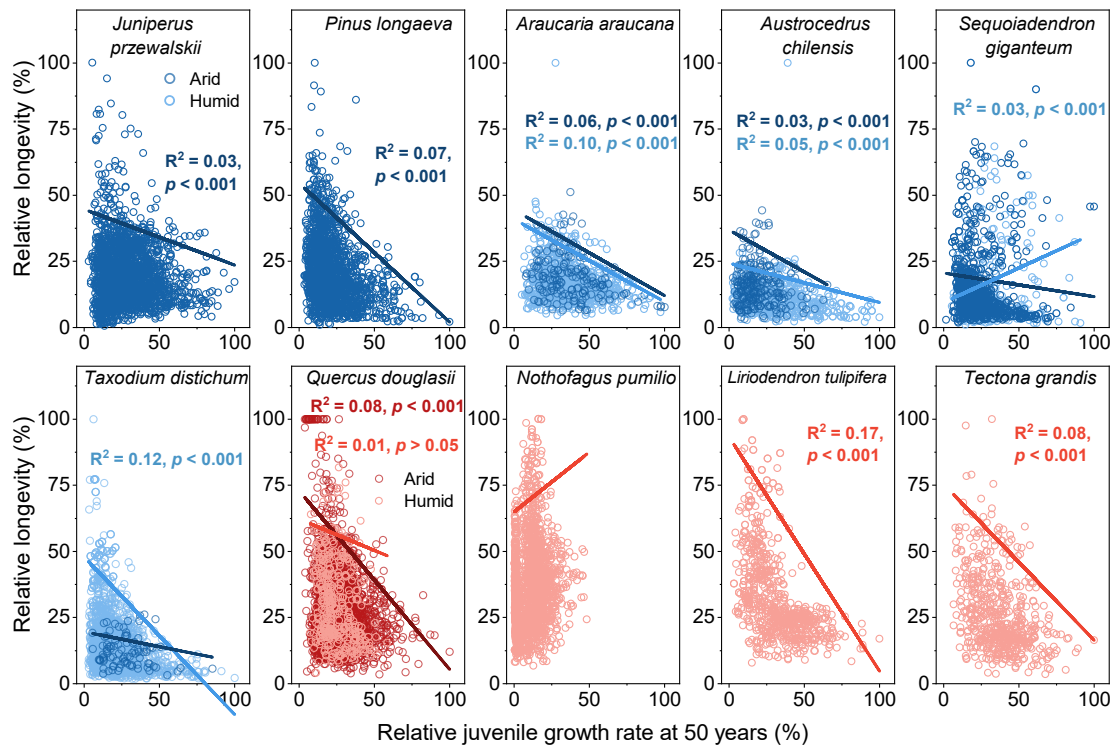
Supplementary Fig. 8 | Mean growth rate versus tree longevity in 10 long-living species by site moisture.

Blue and orange dots represent gymnosperms and angiosperms, respectively. Dark and light dots distinguish between arid and humid sites, respectively. The estimated growth rate-longevity relationship was fitted using 95th quantile regression.



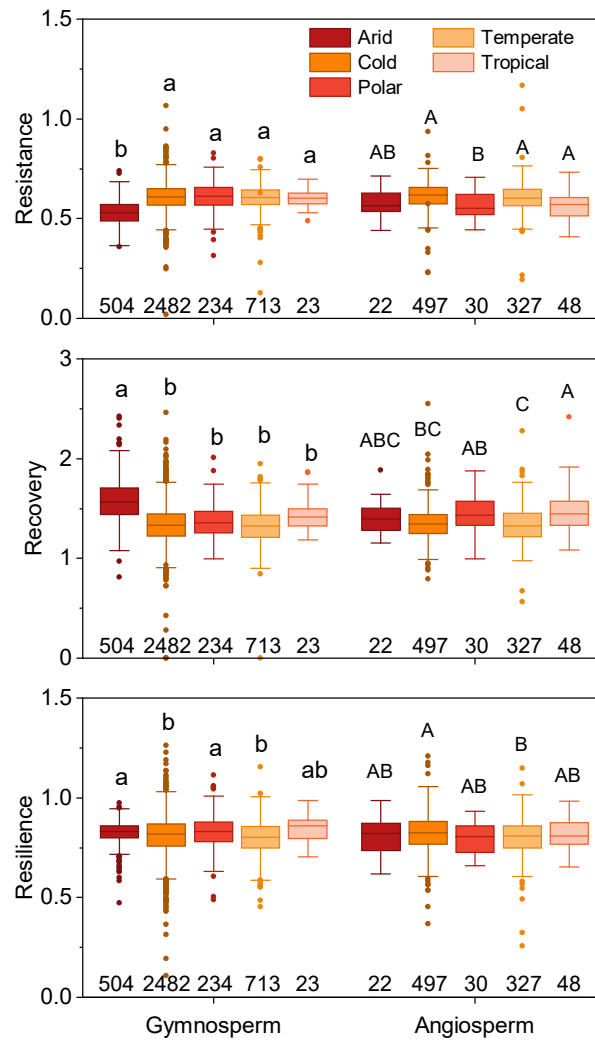
Supplementary Fig. 9 | Juvenile growth rate at 25 years of age versus tree longevity in 10 long-living species by site moisture.

Blue and orange dots represent gymnosperms and angiosperms, respectively. Dark and light dots distinguish between arid and humid sites, respectively. The estimated growth rate-longevity relationship was fitted using 95th quantile regression.



Supplementary Fig. 10 | Juvenile growth rate at 50 years of age versus tree longevity in 10 long-living species by site moisture.

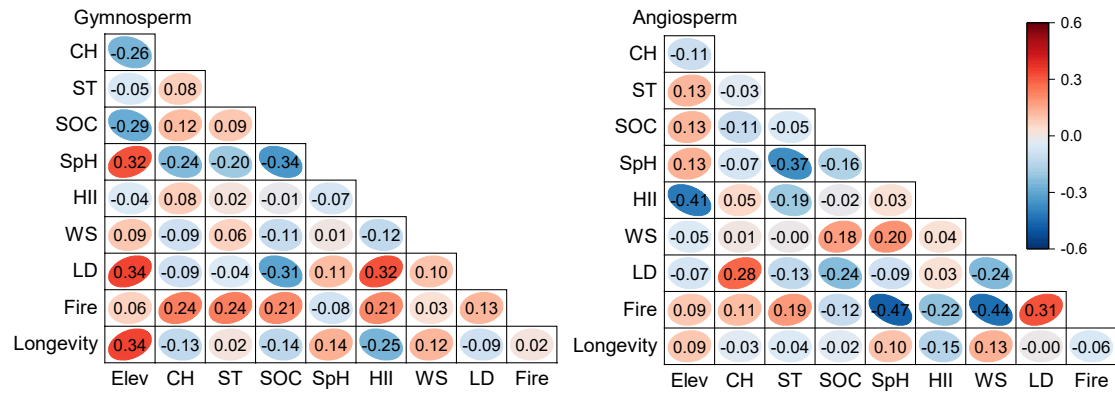
Blue and orange dots represent gymnosperms and angiosperms, respectively. Dark and light dots distinguish between arid and humid sites, respectively. The estimated growth rate-longevity relationship was fitted using 95th quantile regression.



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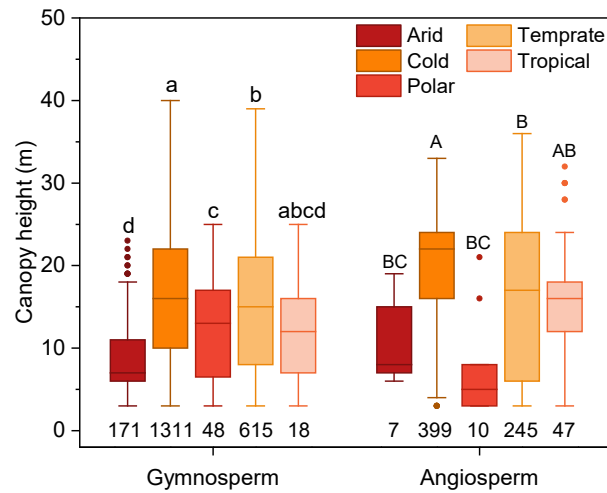
78 **Supplementary Fig. 11 | Tree resistance, recovery and resilience across clades and biomes.**

79 The boxes display the 25th percentiles, median and 75th percentiles, with whiskers indicating 1.5 times
80 the interquartile range and outliers. Statistically significant differences between biomes are shown with
81 different letters (Tukey's HSD tests, $p < 0.05$).



Supplementary Fig. 12 | Spearman correlations between tree longevity and environmental variables.

The color, shape and orientation of ellipses are mapped to coefficient values. Abbreviations: Elev, elevation; CH, canopy height; Soil properties: ST, topsoil texture; SOC, topsoil organic carbon; SpH, topsoil water pH; HII, human impact factor; WS, wind speed; LD, lightning density; Fire, number of forest fires. Only statistically significant correlation coefficients ($p < 0.05$) are displayed.



Supplementary Fig. 13 | Canopy height variation across clades and biomes.

The boxes display the 25th percentiles, median and 75th percentiles, with whiskers indicating 1.5 times the interquartile range and outliers. Statistically significant differences between biomes are shown with different letters (Tukey's HSD tests, $p < 0.05$).