

Supporting Information

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Fig. S1. The maximum-likelihood gene tree for three genes (*18S*, *atpB*, and *rbcL*) with identical topology to the tree shown in Fig 1A. Note that studies focused on the root of the land plants, including outgroups, place the root along the liverwort branch (Marchantia+Haplomitrium; “bryophytes” paraphyletic).

Table S1. List of taxa included in the phylogenetic analysis

Taxon	18S	<i>atpB</i>	<i>rbcl</i>
<i>Bryophyta</i>			
Anthoceros	X80984	D43695	D43695
Haplomitrium	U18504	AF313555	U87071
Marchantia	X75521	X04465	X04465
Polytrichum	X80982	AF313556	U87087
Sphagnum	Y11370	AF313557	L13485
<i>Lycopodiophyta</i>			
Huperzia	AF313567	U93819	Y07934
Isoetes	AF313577	AF313544	L11054
Selaginella	AF313575	AF313554	AJ010854
<i>Monilophyta</i>			
Angiopteris	D85301	AF313546	X58429
Blechnum	AF313570	U93838	U05909
Botrychium	AF313566	U93825	L13474
Cyathea	AF313574	AF313553	AF313585
Danaea	AF313561	AF313543	AF313578
Dicksonia	U18624	U93829	U05919
Equisetum	AF313576	AF313541	AF313579
Equisetum2	AF313562	AF313542	AF313580
Gleichenia	AF313572	AF313550	AF313584
Hymenophyllum	AF313559	AF313538	AF275645
Lygodium	AB001538	AF313549	L13479
Marattia	AF313564	AF313540	AF313581
Marsilea	AF313573	AF313551	L13480
Ophioglossum	AF313565	U93826	AF313582
Osmunda	AF313560	AF313539	D14882
Phanerosorus	AF313571	AF313548	AF313583
Plagiogyria	AF313568	AF313547	U05643
Psilotum	X81963	U93822	L11059
Pteridium	AF313569	U93835	U05939
Salvinia	X90413	AF313552	U05649
Tmesipteris	AF313563	AF313545	U30836
<i>Acrogymnospermae</i>			
Gymno_Araucaria	D38240	EF490503	EF490510
Gymno_Cycas	D85297	AF313558	L12674
Gymno_Ephedra	D38242	AF239779	D10732
Gymno_Ginkgo	D16448	AJ235481	D10733
Gymno_Gnetum	U42416	AF187060	U72819
Gymno_Juniperus	D38243	AY664834	AY988260
Gymno_Pinus	D38245	D17510	X58134
Gymno_Podocarpus	D38473	AF469661	AF462414
Gymno_Sciadopitys	D85292	AF239792	L25753
Gymno_Taxus	EF017310	AJ235619	AF456388
Gymno_Torreyia	D38249	AY664832	AY664858
Gymno_Welwitschia	AF207059	AJ235645	AY296573
<i>Angiospermae</i>			
Acorales_Acorus	AF197584	AJ235381	AY298815
Alismatales_Petrosavia	AF206987	AF209649	AF206806
Alismatales_Spathiphyllum	AF207023	AJ235606	AJ235807
Amborella	U42497	D89556	L12628
Apiales_Griselinia	AF206922	AF209595	L11225
Apiales_Pittosporum	L28142	AJ235561	L11202
Aquifoliales_Gonocaryum	AF206919	AJ235483	AJ235779
Aquifoliales_Ilex	AF206938	AJ235502	X98735
Arecales_Calamus	AF168828	AF233081	M81810
Arecales_Phoenix	AF206991	AF209652	M81814
Asparagales_Behnia	AF206864	AF209542	AF206740
Asparagales_Borya	AF206872	AF209543	AF206741
Asterales_Campanula	U42510	AJ235423	DQ356118
Asterales_Helianthus	AF107577	AJ236205	L13929
Austrobaileyales_Austrobaileya	U42503	AJ235403	L12632
Austrobaileyales_Schisandra	L75842	AJ235599	L12665
Berberidopsidales_Aextoxicon	AF206839	AJ235384	X83986

Table S1. Cont.

Taxon	18S	<i>atpB</i>	<i>rbcl</i>
Berberidopsidales_Berberidopsis	AF206866	AJ235409	AJ235773
Brassicales_Carica	U42514	AF035901	M95671
Brassicales_Cleome	U42511	AF209565	M95755
Buxales_Buxus	X16599	AF092110	DQ182333
Buxales_Pachysandra	AF094533	AF092111	AF093718
Campanulid_Berzelia	U42508	AF095731	L14391
Campanulid_Eremosyne	U42807	AJ236215	L47969
Campanulid_Escallonia	U42544	AJ235467	L11183
Canellales_Canella	AF206879	AJ235424	AJ131928
Canellales_Zygogynum	AF206865	AJ235408	L12633
Caryophyllales_Delosperma	AF206899	AJ235452	AJ235778
Caryophyllales_Rhabdodendron	AF207007	AJ235578	Z97649
Celastales_Lepuropetalon	L28141	AF209616	L11192
Celastales_Plagiopteron	AF206993	AJ235562	AJ235787
Ceratophyllum_Ceratophyllum	D85300	D89552	M77030
Chloranthales_Hedyosmum	AF206925	AJ235490	L12649
Chloranthales_Sarcandra	AF207012	AJ235593	L12663
Commelinales_Helmholtzia	U42074	AF168922	AY465691
Commelinales_Pontederia	AF168871	AF209657	L20128
Cornales_Cornus	X16602	AJ235444	L11216
Cornales_Hydrangea	U42781	AJ235497	L11187
Crossomitaes_Crossosoma	U42529	AF209571	L11179
Crossomitaes_Ixerba	AF084476	AF209606	AF084475
Cucurbitales_Coriaria	AF206891	AJ235443	L01897
Cucurbitales_Tetrameles	U41502	AF209689	AF206828
Dasypogonaceae_Dasypogon	AJ417898	AF168907	AF206758
Dilleniales_Dillenia	AY788163	AY788268	L01903
Dilleniales_Tetracera	AJ235982	AJ235622	AJ235796
Dioscorea_Dioscorea	AF069203	AJ235456	AY904802
Dipsacales_Scabiosa	AJ236006	AJ236207	AF156734
Dipsacales_Viburnum	AJ236007	AJ235640	AJ420869
Ericales_Phlox	AJ235996	AJ236221	AF206809
Ericales_Styrax	U43296	AJ235615	L12623
Fabales_Bauhinia	U42537	AF209540	AM234266
Fabales_Pisum	U43011	X03852	X03853
Fagales_Chrysolepis	AF206886	AF209563	AF206750
Fagales_Juglans	AF206943	AF209609	AF206785
Garryales_Aucuba	U42522	AJ235402	L11210
Garryales_Eucommia	L54066	AJ235469	L01917
Gentianales_Exacum	AJ236023	AJ236195	L11684
Gentianales_Mitchella	U42802	AF209630	Z68805
Geraniales_Greyia	U43151	AF209594	L11185
Geraniales_Pelargonium	AF206982	AF035911	L01919
Gunnerales_Gunnera	U43787	EU002162	EU002279
Gunnerales_Myrothamnus	AF094555	AF093386	AF060707
Icacinales_Icacina	AF206935	AF209603	AF206780
Lamiales_Cyrtandra	AJ236053	AJ236172	AF206757
Lamiales_Olea	L49289	AJ236163	AJ001766
Laurales_Calycanthus	U38318	AJ235422	L14291
Laurales_Sassafras	AF233091	AF209668	AF206790
Liliales_Bomarea	AF206871	AJ235413	Z77255
Liliales_Lilium	AF206952	AF209618	Z77295
Magnoliales_Knema	AF206946	AF209611	L12653
Magnoliales_Magnolia	AF206956	AJ235526	AY008934
Malpighiales_Linum	L24401	AJ235521	Z75681
Malpighiales_Populus	AF206999	AF209658	AF206812
Malvales_Bombax	U42507	AJ233051	AF022118
Malvales_Neurada	AF206970	AF209637	U06814
Myrtales_Clarkia	U67930	AF209564	L10896
Myrtales_Heteropyxis	AF206927	AF209597	AF206775
Nymphaeales_Barclaya	AF096692	AF209536	M77028
Nymphaeales_Cabomba	AF206878	AF187058	M77027

Table S1. Cont.

Taxon	18S	<i>atpB</i>	<i>rbcl</i>
Oncothecaceae_Oncotheca	AF206976	AJ235549	AJ131950
Oxalidales_Averrhoa	AF206859	AJ235404	L14692
Oxalidales_Davidsonia	AF206897	AF209574	AF206759
Pandanales_Barbacenia	AF206861	AJ235406	AJ131946
Pandanales_Freycinetia	AF206915	AF209590	AF206770
Piperales_Aristolochia	AF206855	AJ235399	L12630
Piperales_Piper	AF206992	AJ235560	EF450311
Poales_Flagellaria	AF168845	AF209589	AF206769
Poales_Sparganium	L24419	AF209678	M91633
Proteales_Nelumbo	L75835	AF093387	M77032
Proteales_Placospermum	L75837	AF060391	AF093729
Proteales_Platanus	U42794	U86386	AY858644
Proteales_Roupala	AF094559	AF060416	AF093728
Ranunculales_Coptis	L75838	AF093393	AF093730
Ranunculales_Pteridophyllum	AF094560	U86400	U86631
Rosales_Humulus	AF206931	AF209599	U02729
Rosales_Morus	L24398	AJ235536	L01933
Sabiales_Meliosma	AF206961	AF209626	AF206793
Sabiales_Sabia	L75840	AF093395	AM183414
Santalales_Opilia	U42790	AJ235550	AJ131773
Santalales_Osyris	L24409	AF209641	L11196
Santalales_Schoepfia	AF207017	AF209671	L11205
Sapindales_Poncirus	AF206997	AJ238409	AJ235806
Sapindales_Schinus	AF207015	AF035914	U39270
Saxifrigales_Daphniphyllum	U42531	AF092118	L01901
Saxifrigales_Dudleya	U42526	AJ235461	L11182
Solanales_Hydrophyllum	AJ236019	AJ235498	L01927
Solanales_Nolana	AJ236017	AF209638	U08616
Trochodendrales_Tetracentron	U42814	AF093422	L12668
Trochodendrales_Trochodendron	AF094565	AF093423	L01958
Vitales_Leea	AF206951	AJ235520	AJ235783
Vitales_Vitis	AF207053	AJ235643	L01960
Zingiberales_Dimerocostus	AF168839	AF168909	AF243838
Zingiberales_Musa	U42083	AF168931	L05455

List of taxa included in the phylogenetic analysis with GenBank accession numbers, which were compiled from Soltis et al. (1) and Pyer et al. (2). In many cases, all three genes were not sampled for a particular taxon, and so sequences from closely related species of the same genus were used. The taxon labels are consistent with the labels shown in [Figs. S1, S2, S3, and S4](#).

1. Soltis PS, Soltis DE, Chase MW (1999) Angiosperm phylogeny inferred from multiple genes as a tool for comparative biology. *Nature* 402:402–404.
2. Pryer KM, et al. (2001) Horsetails and ferns are a monophyletic group and the closest living relatives to seed plants. *Nature* 409:618–622.

Table S2. Fossil information, minimum age estimates, and associated lognormal prior-probability distribution parameters for the clades calibrated in our divergence-time analysis of land plants

	Clade	Fossil	Fossil type	Ref.	Stem/Crown	Min. age	Mean (SD)
1	Tracheophyta	<i>Leclerquia</i> sp.	Plant	1	Stem	377.4	3.5 (0.5)
2	Marattiales	<i>Marattia</i> , <i>Angiopteris</i>	Spore	2,3	Crown	166.1	1.5 (0.5)
3	Cyatheales	<i>Cniopteris</i> , <i>Kylikipteris</i> , <i>Eboracia</i>	Plant	2	Crown	166.1	1.6 (0.5)
4	Euphyllophyta	Unnamed	Seeds	4	Crown	365	3.5 (0.5)
5	Acrogymnospermae	<i>Emporia lockardii</i>	Cones	5,6	Crown	290	2.4 (0.5)
6	Nymphaeales	<i>Scutifolium jordanicum</i>	Leaves	7	Crown	105.0	1.5 (0.5)
7	Laurales	Unnamed	Flower	8	Crown	108.8	2.1 (0.5)
8	Magnoliales	Unnamed	Flower	8	Stem	108.8	1.5 (0.5)
9	Chloranthales	<i>Hedyosmum</i> sp.	Flower	9	Crown	121.0	1.5 (0.5)
10	Canellales	Unnamed	Pollen	10	Stem	122.5	2.0 (0.5)
11	Pandanales	<i>Pandanus</i> sp.	Pollen	11,12	Crown	65.0	1.8 (0.5)
12	Arecales	<i>Dicolpopollis malesianus</i>	Pollen	13	Crown	65.0	1.8 (0.5)
13	Poales	<i>Restio</i> sp.	Pollen	12,14	Crown	68.1	1.8 (0.5)
14	Zingiberales	<i>Spirematospermum chandlerae</i>	Seeds	15	Crown	83.5	1.8 (0.5)
15	Proteales	<i>Platanocarpus brookensis</i>	Flower	16	Crown	108.8	1.5 (0.5)
16	Buxales	Unnamed	Fruit, flower	17	Stem	112.0	1.5 (0.5)
17	Gunnerales	<i>Retitricolpites microreticulatus</i>	Pollen	12	Crown	88.2	1.5 (0.5)
18	Saxifragales	<i>Divisestylus</i> sp.	Fruit, flower	18	Crown	89.3	1.5 (0.5)
19	Caryophyllales	Unnamed	Seeds	19	Crown	83.5	1.5 (0.5)
20	Dilleniales	<i>Dillenites</i> sp.	Seeds	19	Crown	51.9	1.5 (0.5)
21	Santanales	Unnamed	Seeds	19	Crown	51.9	1.5 (0.5)
22	Ericales	Unnamed	Flower	20	Crown	91.2	1.5 (0.5)
23	Cornales	Unnamed	Flower	21	Crown	85.8	1.5 (0.5)
24	Lamiales	<i>Fraxinus wilcoxiana</i>	Fruit	22	Crown	44.3	1.5 (0.5)
25	Solanales	<i>Cantisolanum daturoides</i>	Fruit	19	Crown	44.3	1.5 (0.5)
26	Aquifoliales	<i>Ilexpollenites</i> sp.	Pollen	12,23	Crown	85.0	1.5 (0.5)
27	Vitales	Unnamed	Seeds	19	Crown	57.9	1.5 (0.5)
28	Myrtales	<i>Esqueiria futabensis</i>	Flower	24	Crown	88.2	1.5 (0.5)
29	Sapindales	Unnamed	Fruit	25	Crown	65.0	1.5 (0.5)
30	Malvales	Unnamed	Pollen	26	Crown	69.7	1.5 (0.5)
31	Fabales	Unnamed	Fruit	27	Crown	59.9	1.5 (0.5)
32	Fagales	<i>Tenerina</i> sp.	Pollen	28	Stem	96.0	1.5 (0.5)

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Table S3. Divergence-time estimates (in Myr) for major clades of land plants as estimated partitioning for codon position

Clade	Coding analysis
Land plants	442 (401–514)
<i>Tracheophyta</i>	411 (392–442)
<i>Spermatophyta</i>	331 (306–363)
<i>Acrogymnospermae</i>	301 (294–313)
<i>Gnetophyta</i>	157 (103–218)
<i>Angiospermae</i>	231 (189–281)
<i>Magnoliidae</i>	166 (147–190)
<i>Monocotyledoneae</i>	145 (127–168)
<i>Eudicotyledoneae</i>	155 (137–176)

Dates within parentheses denote the 95% HPD.