

Supplemental material for “**The phylogenetic association between salt tolerance and heavy metal hyperaccumulation in angiosperms**”

Camile Moray¹, Eric W. Goolsby², Lindell Bromham¹

¹ Macroevolution and Macroecology Group, Division of Evolution, Ecology and Genetics, Research School of Biology, Australian National University, Canberra, Australia

² Odum School of Ecology Interdisciplinary Toxicology Program, University of Georgia, Athens, USA

Contents:

Supplementary methods: Extraction of non-monophyletic family subtrees

Table S1: Angiosperm families with halophytes and hyperaccumulators

Table S2: Angiosperm species known as both halophytes and hyperaccumulators

Figure S1: Phylogeny of angiosperm families with halophytes and hyperaccumulators

Figure S2: Phylogenies for the sample of seven angiosperm families analyzed

Extraction of non-monophyletic family subtrees

We generated a phylogeny for each of the target families (see Methods) by extracting all tips corresponding to each family from a published angiosperm phylogeny (Smith et al. 2011). However, for some families, not all tips were monophyletic in the published angiosperm phylogeny (Smith et al. 2011). For these families we extracted all tips associated with the family, excluding a small number of tips that were either nested within clades of other families or tips from other families that were nested within the clade of the target family. Here we list details on each non-monophyletic family subtree, referring to specific tip numbers associated with the original published phylogeny. For the Asteraceae subtree, we excluded one Asteraceae tip that was nested within the Campanulaceae clade (tip number 10079). For Brassicaceae we excluded five tips that were in the Capparaceae clade (42135, 42136, 42145, 42168, 42171). For Fabaceae, we excluded one Fabaceae tip that was in the Connaraceae clade (34282) removed one Apocynaceae tip (30884). For Euphorbiaceae we excluded four Peraceae tips that were nested in the Euphorbiaceae clade (36371:36374). For Phyllanthaceae we removed two tips from Picrodendraceae (36318, 36319) and one from Putranjivaceae (36312).

Table S1: List of angiosperm families with halophytes and hyperaccumulators. Family size represents the mean estimated number of species in each family according to the APG III website (Stevens 2001). The multi-tolerant spp column lists the number of species in each family that appear on both the list of halophytes and the list of hyperaccumulators.

Order	Family	Family size	Halophytes	Hyperaccumulators	Multi-tolerant spp
Alismatales	Alismataceae	88	3	0	0
-	Aponogetonaceae	43	2	0	0
-	Araceae	4759	8	4	2
-	Butomaceae	1	1	0	0
-	Cymodoceaceae	16	15	0	0
-	Hydrocharitaceae	116	22	0	0
-	Juncaginaceae	15	7	0	0
-	Posidoniaceae	9	3	0	0
-	Potamogetonaceae	102	6	1	0
-	Ruppiceae	6	2	0	0
-	Zosteraceae	14	17	0	0
Apiales	Apiaceae	3780	34	1	0
-	Araliaceae	1450	3	2	0
Arecales	Arecaceae	2361	37	0	0
Asparagales	Amaryllidaceae	1605	15	1	0
-	Asparagaceae	2480	24	1	0
-	Iridaceae	2025	10	5	2
-	Orchidaceae	22075	3	0	0
-	Xanthorrhoeaceae	900	3	0	0
Asterales	Argophyllaceae	21	0	2	0
-	Asteraceae	23600	275	84	9
-	Calyceraceae	60	1	0	0
-	Campanulaceae	2380	0	2	0
-	Goodeniaceae	430	6	0	0
-	Menyanthaceae	58	2	0	0
Brassicales	Bataceae	2	2	0	0
-	Brassicaceae	3710	40	92	3
-	Capparaceae	480	10	0	0
-	Cleomaceae	300	7	0	0
-	Resedaceae	75	5	1	0
-	Salvadoraceae	11	4	0	0
Buxales	Buxaceae	70	0	15	0
Caryophyllales	Aizoaceae	2035	46	2	2
-	Amaranthaceae	2275	508	11	7
-	Anacampserotaceae	32	1	0	0
-	Basellaceae	19	2	0	0
-	Cactaceae	1866	11	0	0
-	Caryophyllaceae	2200	27	10	0
-	Didiereaceae	16	2	0	0
-	Frankeniaceae	90	17	0	0
-	Gisekiaceae	5	1	0	0
-	Halophytaceae	1	1	0	0
-	Lophiocarpaceae	6	1	0	0
-	Molluginaceae	87	4	1	0
-	Nyctaginaceae	395	9	1	0
-	Phytolaccaceae	65	0	2	0
-	Plumbaginaceae	836	62	1	1
-	Polygonaceae	1110	41	7	1
-	Portulacaceae	70	12	0	0
-	Sarcobataceae	2	1	0	0
-	Simmondsiaceae	1	1	0	0
-	Stegnospermataceae	3	2	0	0
Caryophyllales	Talinaceae	27	1	1	0
-	Tamaricaceae	90	55	0	0

Order	Family	Family size	Halophytes	Hyperaccumulators	Multi-tolerant spp
Celastrales	Celastraceae	1400	9	1	0
Ceratophyllales	Ceratophyllaceae	6	1	0	0
Commelinales	Commelinaceae	652	4	3	0
-	Philydraceae	5	0	1	0
-	Pontederiaceae	33	3	1	1
Cornales	Loasaceae	265	1	0	0
Cucurbitales	Cucurbitaceae	960	14	0	0
Dilleniales	Dilleniaceae	355	1	0	0
Dipsacales	Caprifoliaceae	890	2	1	0
Ericales	Balsaminaceae	1001	0	1	0
-	Ebenaceae	548	4	0	0
-	Ericaceae	3995	1	1	0
-	Lecythidaceae	310	4	1	0
-	Primulaceae	2590	14	1	0
-	Sapotaceae	1100	2	2	0
-	Symplocaceae	320	0	2	0
-	Tetrameristaceae	5	1	0	0
-	Theaceae	328	0	1	0
Fabales	Fabaceae	19500	252	27	4
-	Polygalaceae	965	3	1	0
-	Surianaceae	8	1	0	0
Fagales	Betulaceae	145	1	1	0
-	Casuarinaceae	95	12	0	0
Gentianales	Apocynaceae	4555	44	2	1
-	Gentianaceae	1655	13	0	0
-	Loganiaceae	420	1	0	0
-	Rubiaceae	13150	15	12	0
-	Geraniaceae	805	1	0	0
Lamiales	Acanthaceae	4000	19	2	0
-	Bignoniaceae	800	9	0	0
-	Lamiaceae	7173	31	12	2
-	Linderniaceae	195	2	2	0
-	Oleaceae	615	0	1	0
-	Orobanchaceae	2060	17	7	0
-	Pedaliaceae	70	1	0	0
-	Phrymaceae	188	4	0	0
-	Plantaginaceae	1900	35	2	1
-	Scrophulariaceae	1800	14	1	0
-	Verbenaceae	918	15	3	0
Laurales	Hernandiaceae	55	2	0	0
-	Lauraceae	2500	2	0	0
Liliales	Colchicaceae	245	2	0	0
-	Liliaceae	610	2	0	0
Magnoliales	Annonaceae	2220	1	0	0
-	Myristicaceae	475	0	1	0
Malpighiales	Bonnetiaceae	35	1	0	0
-	Chrysobalanaceae	460	2	0	0
-	Clusiaceae	595	2	5	0
-	Dichapetalaceae	165	0	1	0
-	Elatinaceae	35	7	0	0
-	Euphorbiaceae	5735	43	37	3
-	Hypericaceae	560	1	0	0
-	Linaceae	300	4	0	0
-	Ochnaceae	495	0	3	0
-	Passifloraceae	935	0	5	0
-	Phyllanthaceae	1745	9	39	0
-	Putranjivaceae	210	1	0	0
-	Rhizophoraceae	149	19	0	0
Malpighiales	Salicaceae	1010	6	2	0
Malpighiales	Violaceae	800	1	4	0

Order	Family	Family size	Halophytes	Hyperaccumulators	Multi-tolerant spp
Malvales	Cistaceae	175	1	1	0
-	Malvaceae	4225	56	8	2
-	Neuradaceae	10	1	0	0
-	Thymelaeaceae	891	3	1	0
Myrtales	Combretaceae	500	12	0	0
-	Lythraceae	620	23	2	1
-	Melastomataceae	5005	1	3	0
-	Myrtaceae	4620	51	12	0
-	Onagraceae	656	6	0	0
-	Vochysiaceae	190	0	4	0
Nymphaeales	Nymphaeaceae	58	3	0	0
Oxalidales	Cunoniaceae	280	0	1	0
-	Oxalidaceae	770	2	1	0
Pandanales	Pandanaceae	885	11	0	0
-	Velloziaceae	240	0	1	0
Picramniales	Picramniaceae	49	1	0	0
Piperales	Piperaceae	3615	1	0	0
-	Saururaceae	6	1	1	0
Poales	Bromeliaceae	1770	2	0	0
-	Cyperaceae	5430	124	8	1
-	Flagellariaceae	4	1	0	0
-	Juncaceae	430	22	1	0
-	Poaceae	11160	345	29	14
-	Restionaceae	500	2	0	0
-	Typhaceae	25	11	0	0
Proteales	Nelumbonaceae	2	1	0	0
-	Proteaceae	1600	0	2	0
Ranunculales	Menispermaceae	442	3	0	0
-	Papaveraceae	760	3	2	0
-	Ranunculaceae	2525	18	1	0
Rosales	Elaeagnaceae	45	3	0	0
-	Moraceae	1125	7	0	0
-	Rhamnaceae	925	6	0	0
-	Rosaceae	2520	10	1	0
-	Ulmaceae	35	1	0	0
-	Urticaceae	2625	0	1	0
Santalales	Olacaceae	57	1	0	0
-	Santalaceae	990	3	0	0
Sapindales	Anacardiaceae	873	7	0	0
-	Meliaceae	615	6	0	0
-	Nitrariaceae	16	8	0	0
-	Rutaceae	2070	5	0	0
-	Sapindaceae	1630	3	1	0
-	Simaroubaceae	110	1	0	0
Saxifragales	Crassulaceae	1370	2	6	0
-	Cynomoriaceae	2	1	0	0
-	Haloragaceae	145	0	1	0
Solanales	Convolvulaceae	1625	22	5	1
-	Hydroleaceae	12	1	0	0
-	Solanaceae	2460	42	2	1
Unplaced	Boraginaceae	2755	37	2	0
Vitales	Vitaceae	850	4	0	0
Zingiberales	Zingiberaceae	1208	1	0	0
Zygophyllales	Zygophyllaceae	285	30	1	1

Table S2: Angiosperm species identified as both halophytes and hyperaccumulators. Species names follow The Plant List (2010) taxonomy, and order and family taxonomy follows APG III (2009).

Order	Family	Species
Alismatales	Araceae	<i>Pistia stratiotes</i>
-	-	<i>Spirodela polyrrhiza</i>
Asparagales	Iridaceae	<i>Iris ensata</i>
-	-	<i>Iris lactea</i>
Asterales	Asteraceae	<i>Ageratum conyzoides</i>
-	-	<i>Centaurea virgata</i>
-	-	<i>Cirsium arvense</i>
-	-	<i>Dittrichia viscosa</i>
-	-	<i>Erigeron canadensis</i>
-	-	<i>Lactuca orientalis</i>
-	-	<i>Sonchus arvensis</i>
-	-	<i>Sonchus asper</i>
-	-	<i>Taraxacum mongolicum</i>
Brassicales	Brassicaceae	<i>Alyssum pateri</i>
-	-	<i>Brassica juncea</i>
-	-	<i>Raphanus raphanistrum</i>
Caryophyllales	Aizoaceae	<i>Mesembryanthemum crystallinum</i>
-	-	<i>Sesuvium portulacastrum</i>
-	Amaranthaceae	<i>Amaranthus hybridus</i>
-	-	<i>Arthrocnemum macrostachyum</i>
-	-	<i>Atriplex confertifolia</i>
-	-	<i>Atriplex halimus</i>
-	-	<i>Beta vulgaris</i>
-	-	<i>Salsola kali</i>
-	-	<i>Salsola soda</i>
-	Plumbaginaceae	<i>Armeria maritima</i>
-	Polygonaceae	<i>Polygonum aviculare</i>
Commelinales	Pontederiaceae	<i>Eichhornia crassipes</i>
Fabales	Fabaceae	<i>Aeschynomene indica</i>
-	-	<i>Melilotus officinalis</i>
-	-	<i>Prosopis laevigata</i>
-	-	<i>Tephrosia villosa</i>
Gentianales	Apocynaceae	<i>Hemidesmus indicus</i>
Lamiales	Lamiaceae	<i>Clerodendrum infortunatum</i>
-	-	<i>Ocimum tenuiflorum</i>
-	Plantaginaceae	<i>Plantago asiatica</i>
Malpighiales	Euphorbiaceae	<i>Croton bonplandianus</i>
-	-	<i>Euphorbia hirta</i>
-	-	<i>Euphorbia macroclada</i>
Malvales	Malvaceae	<i>Alcea rosea</i>
-	-	<i>Sida rhombifolia</i>
Myrtales	Lythraceae	<i>Trapa natans</i>
Poales	Cyperaceae	<i>Schoenoplectus americanus</i>
-	Poaceae	<i>Agrostis stolonifera</i>
-	-	<i>Chrysopogon zizanioides</i>
-	-	<i>Cynodon dactylon</i>
-	-	<i>Dactyloctenium aegyptium</i>
-	-	<i>Desmostachya bipinnata</i>
-	-	<i>Dichanthium annulatum</i>
-	-	<i>Echinochloa stagnina</i>
-	-	<i>Eleusine indica</i>
-	-	<i>Festuca arundinacea</i>
-	-	<i>Festuca ovina</i>
-	-	<i>Imperata cylindrica</i>
-	-	<i>Melinis repens</i>

Order	Family	Species
-	-	<i>Paspalum conjugatum</i>
-	-	<i>Spartina spartinae</i>
Solanales	Convolvulaceae	<i>Evolvulus alsinoides</i>
-	Solanaceae	<i>Solanum americanum</i>
Zygophyllales	Zygophyllaceae	<i>Zygophyllum fabago</i>

Figure S1: Phylogeny of angiosperm families containing 401 of the 411 families included in the analysis (see Methods) that are represented in a published phylogeny of angiosperms (Smith et al. 2011). 148 out of the 149 families with halophytes are marked in dark green, all 82 families with heavy metal hyperaccumulators are marked in dark purple, and the 21 families containing multi-tolerator species (able to tolerate salinity and hyperaccumulate heavy metals) are marked in dark blue. The family phylogeny is modified from Saslis-Lagoudakis et al. (2014).

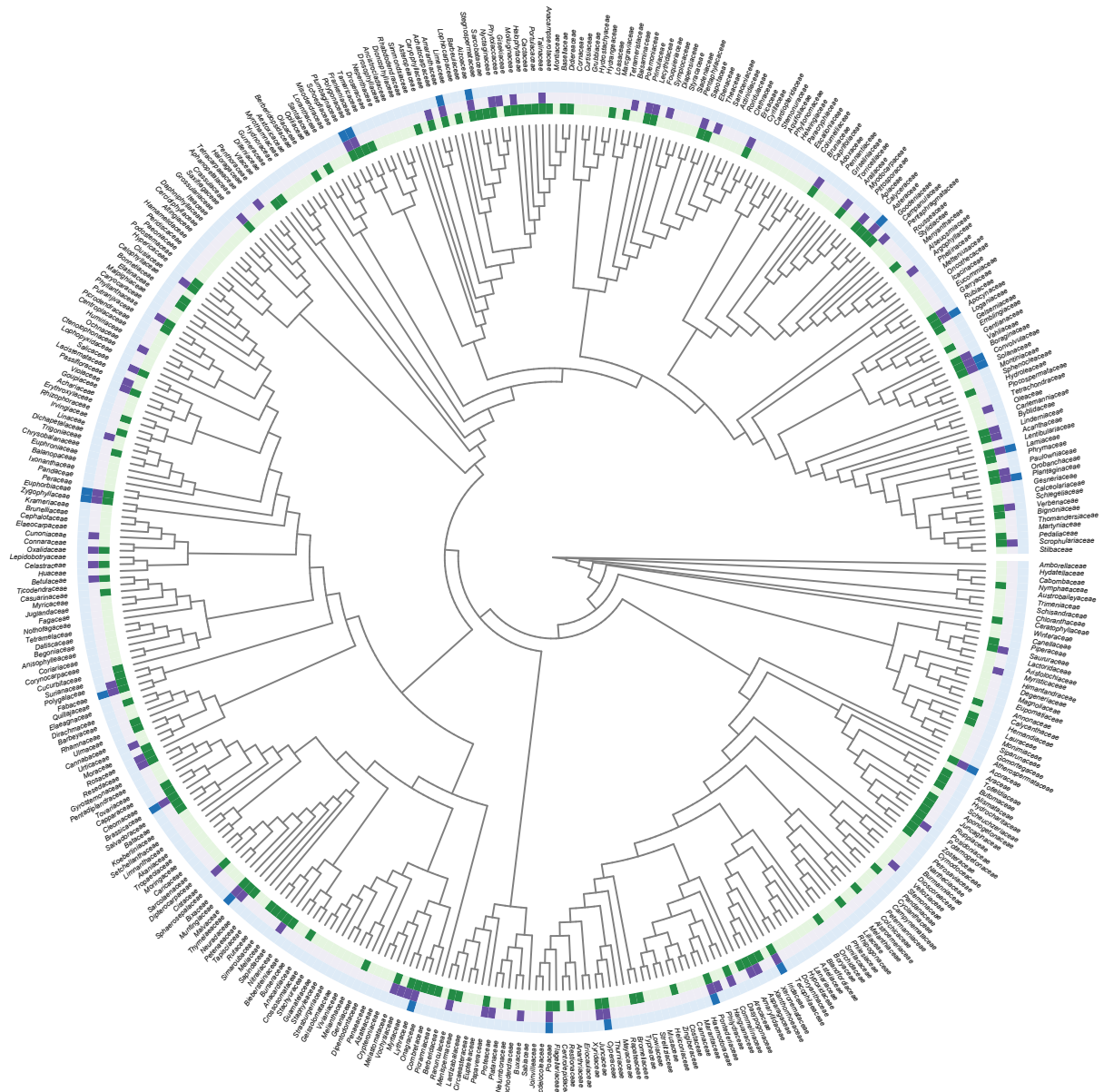
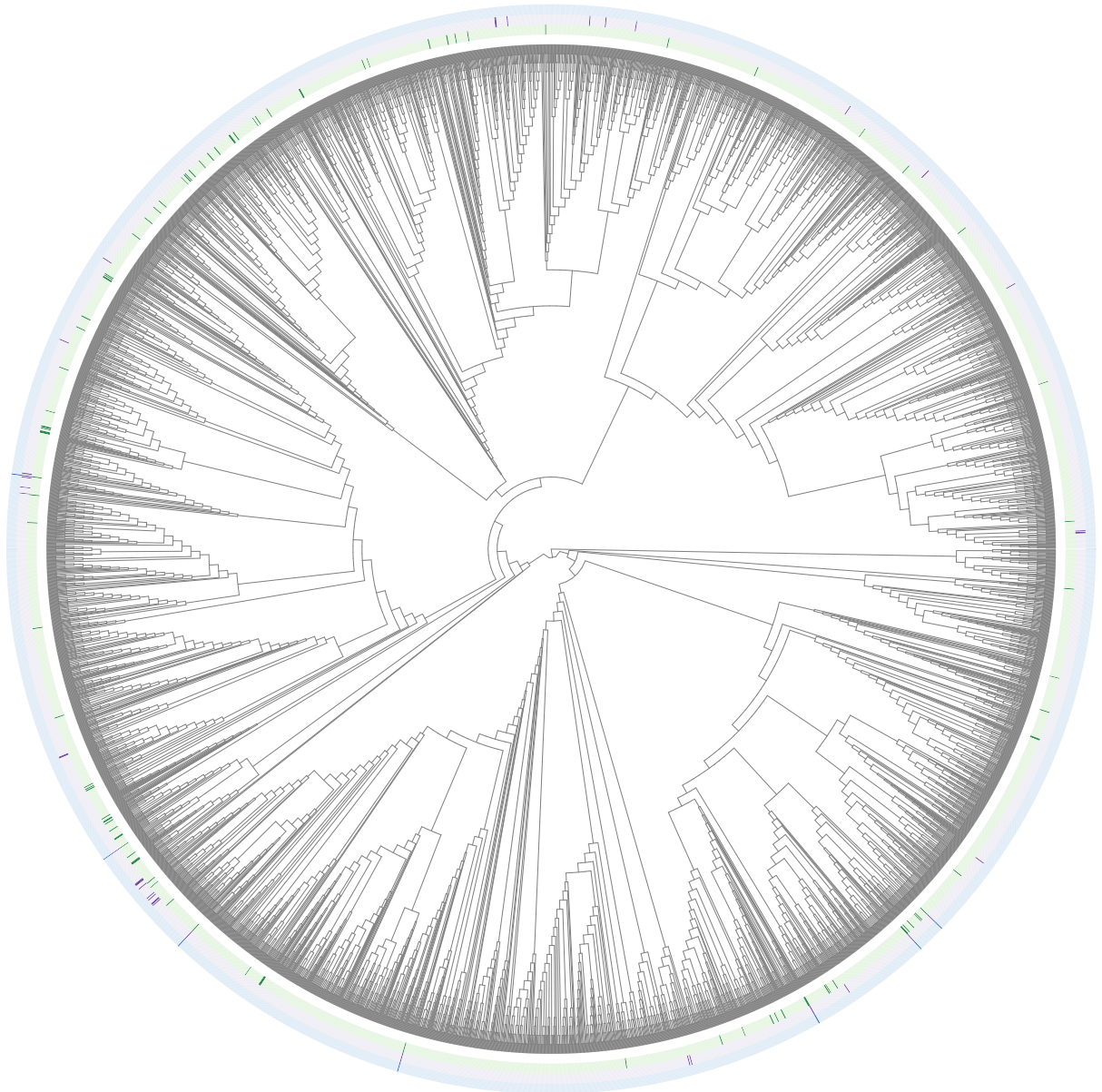
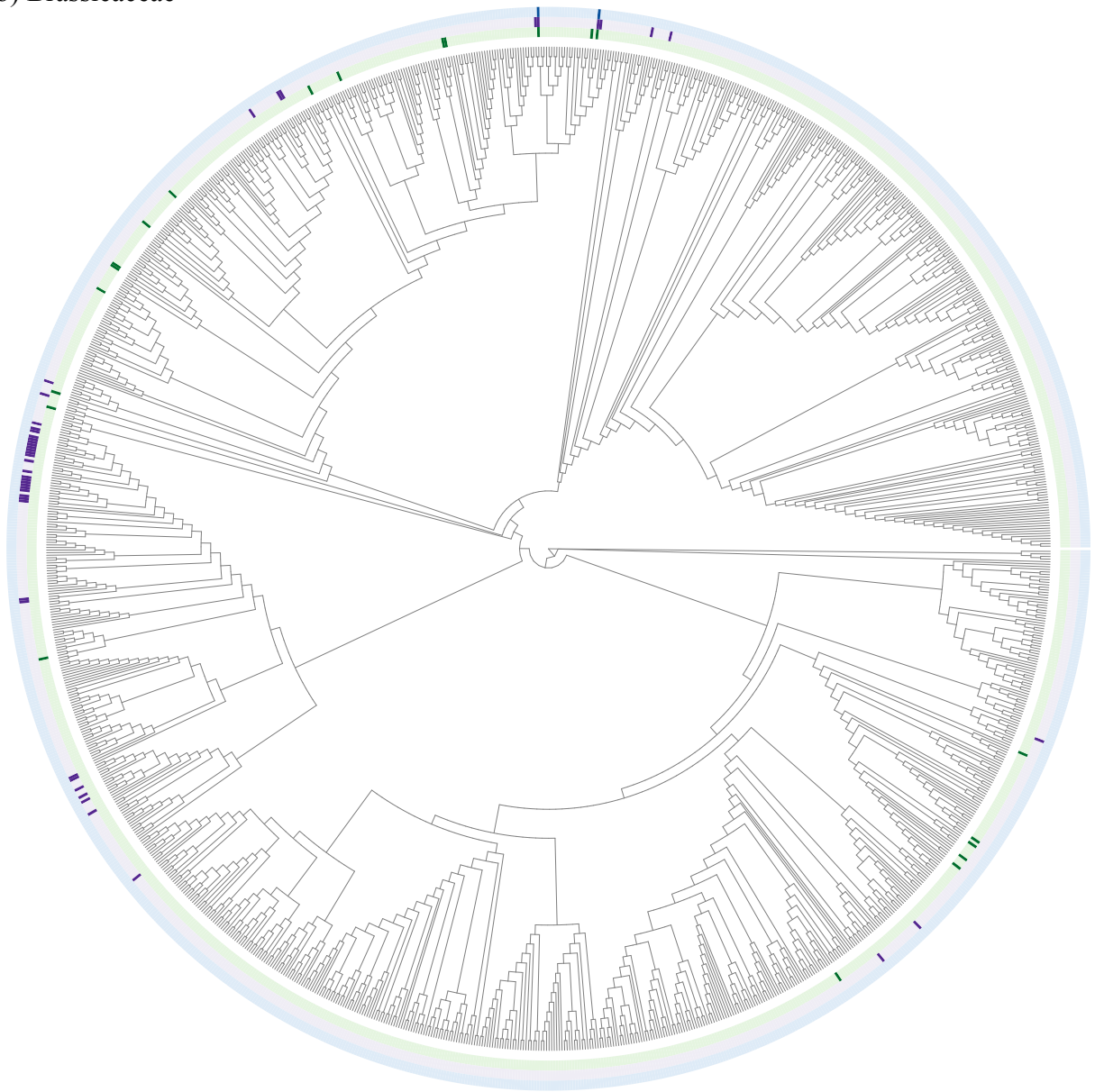


Figure S2: Phylogenies for the sample of seven angiosperm families analyzed (a-g). Tips in the phylogenies identified as halophytes are marked in dark green, tips identified as hyperaccumulators are marked in dark purple, and tips identified as both a halophyte and hyperaccumulator are marked in dark blue in the ring around each phylogeny. Color labels around each phylogenies were added using the ‘trait.plot’ function in the R package *diversitree* (FitzJohn 2012).

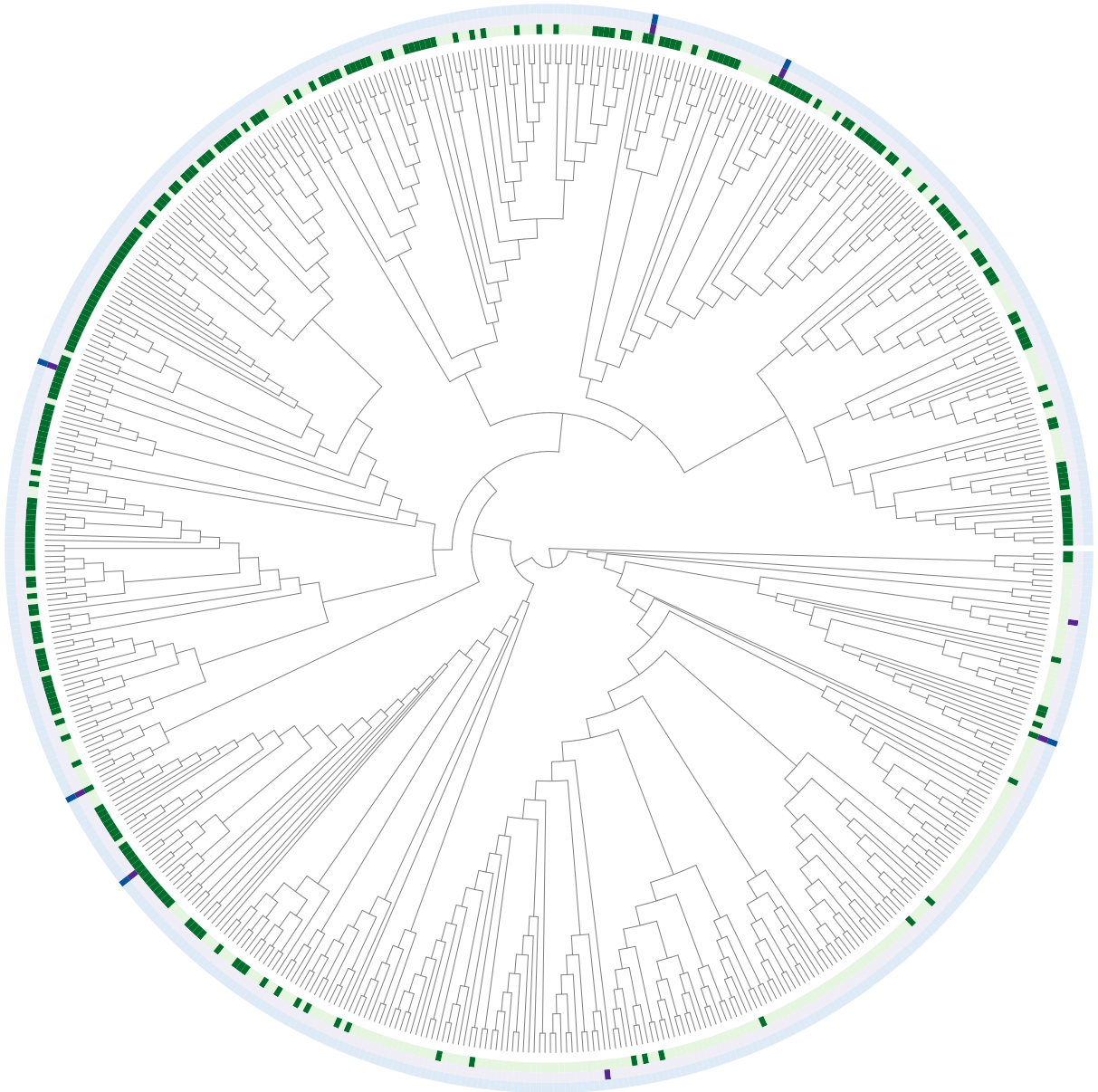
a) Asteraceae



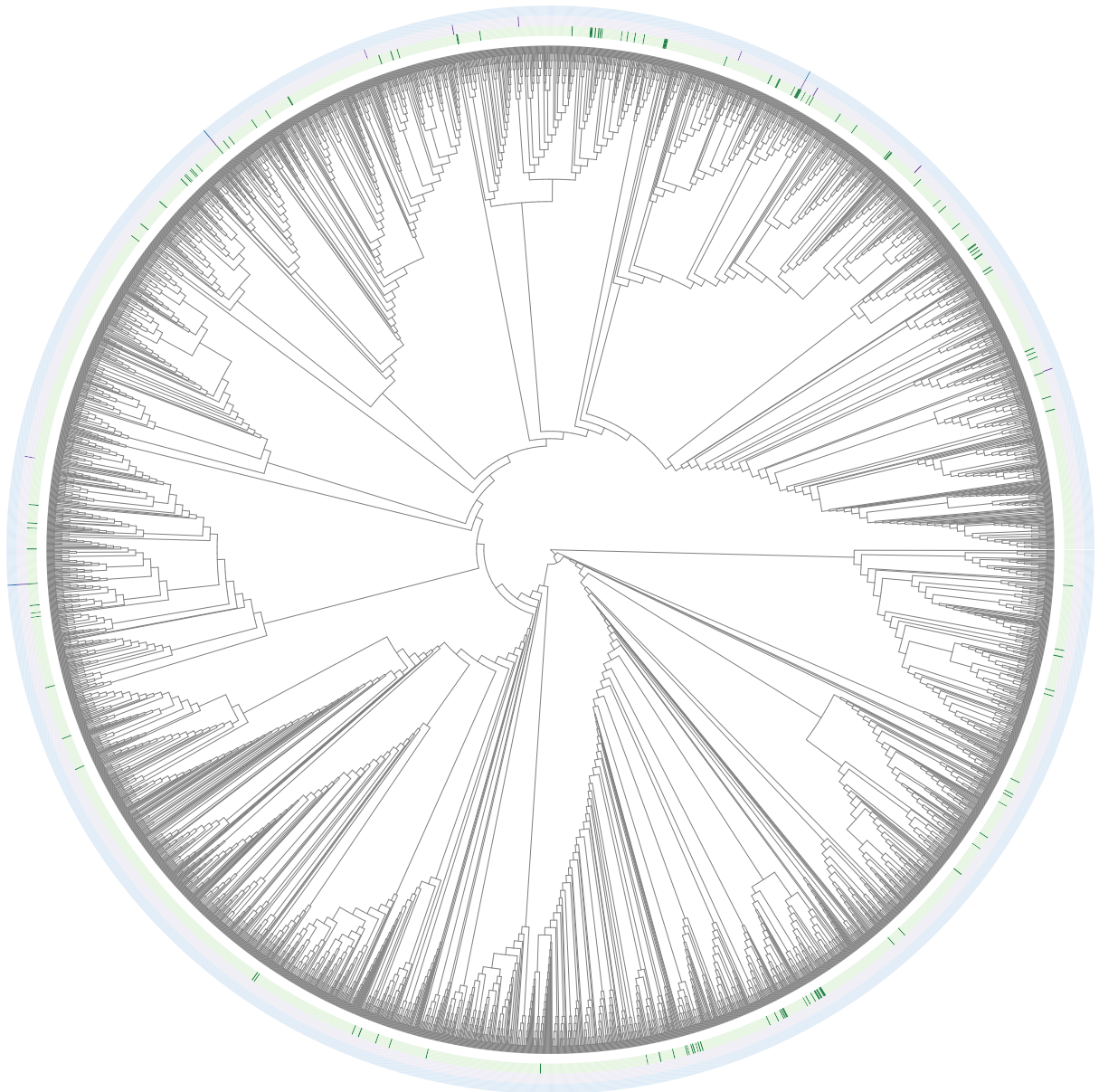
b) Brassicaceae



c) Amaranthaceae



d) Fabaceae



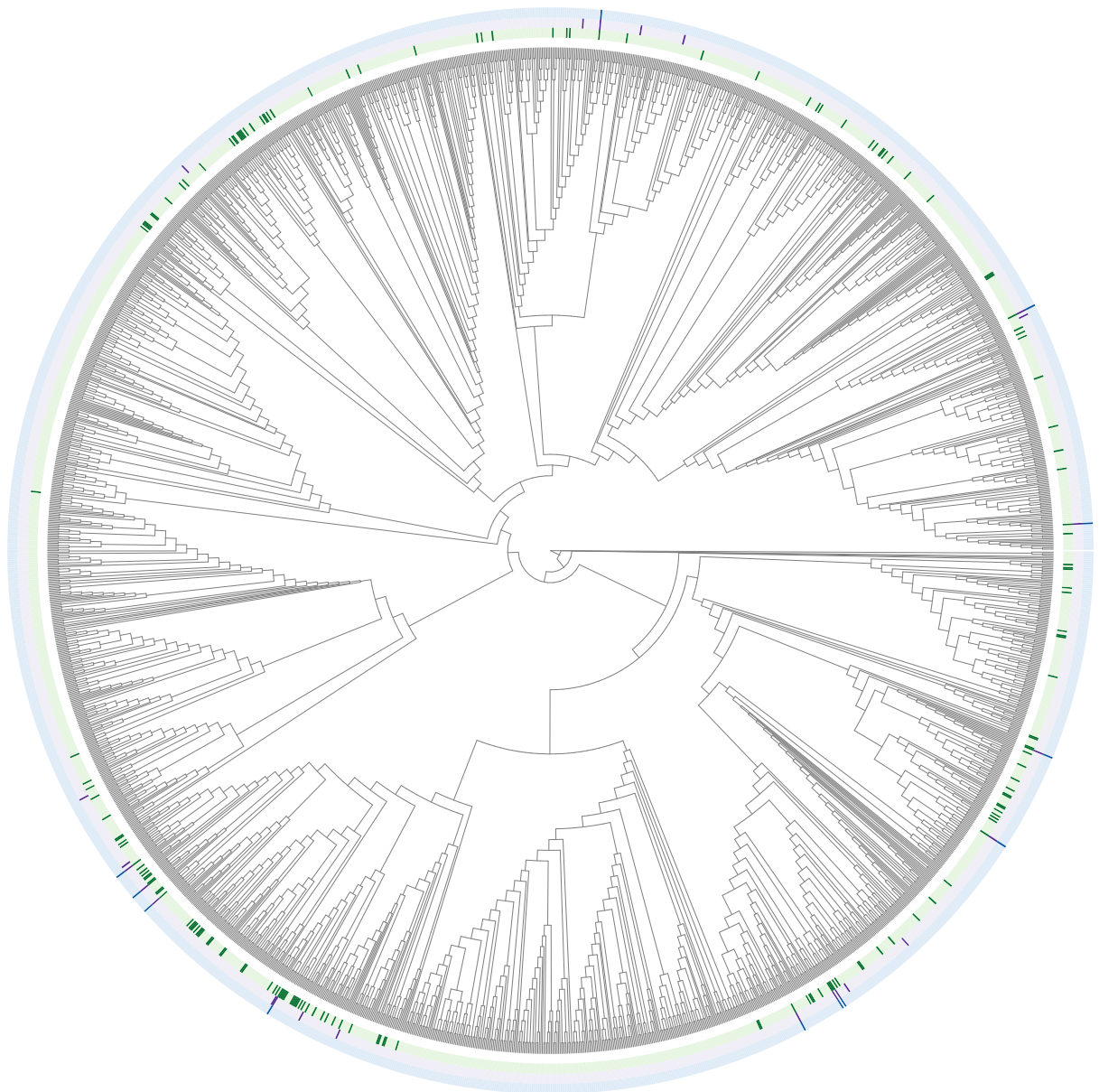
e) Euphorbiaceae



f) Phyllanthaceae



g) Poaceae



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