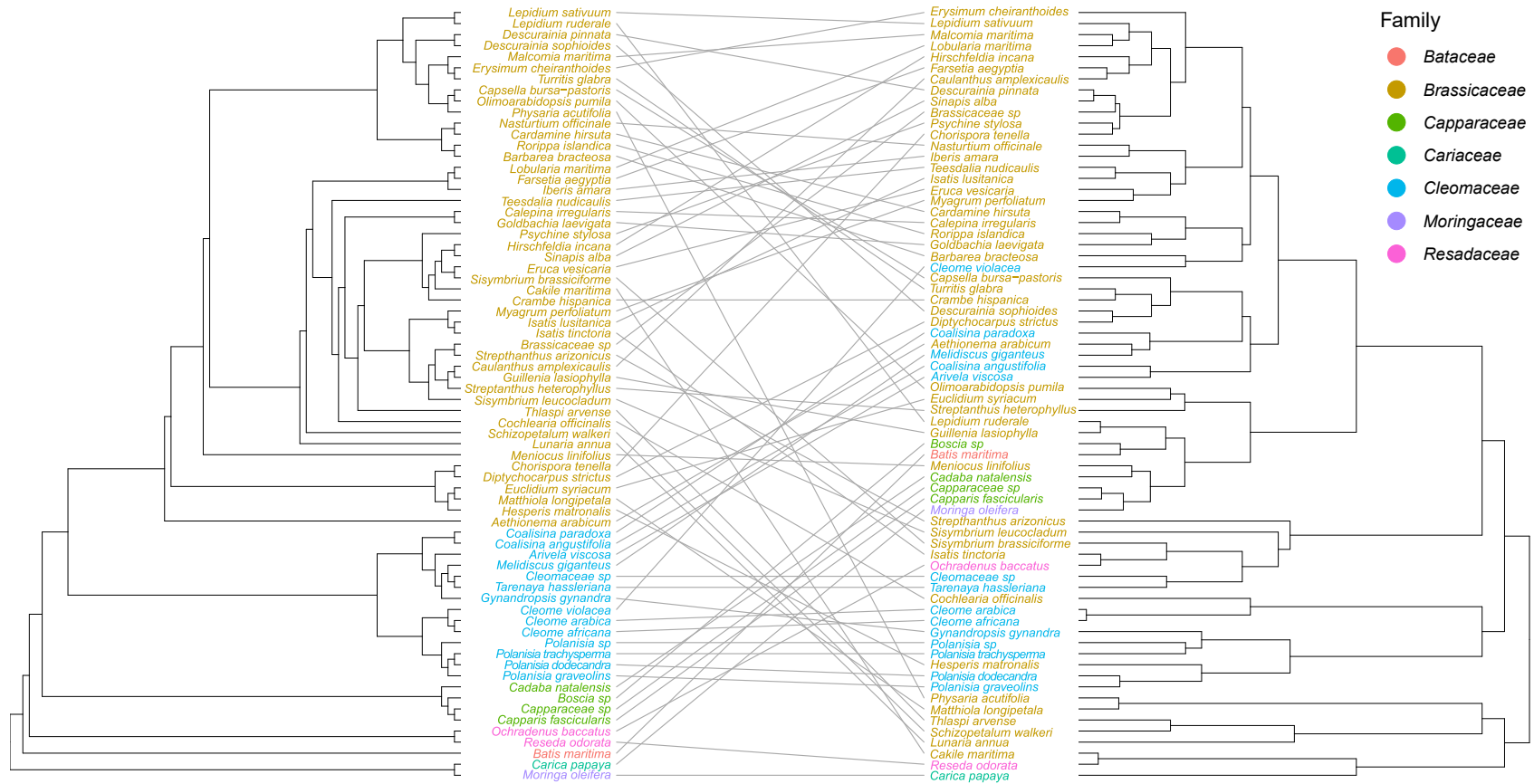
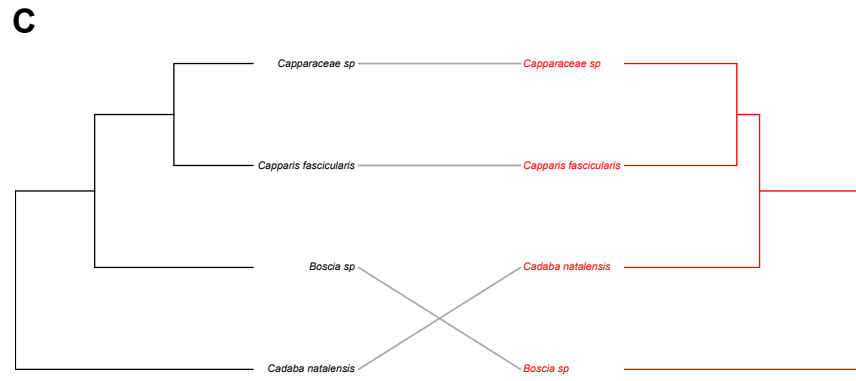
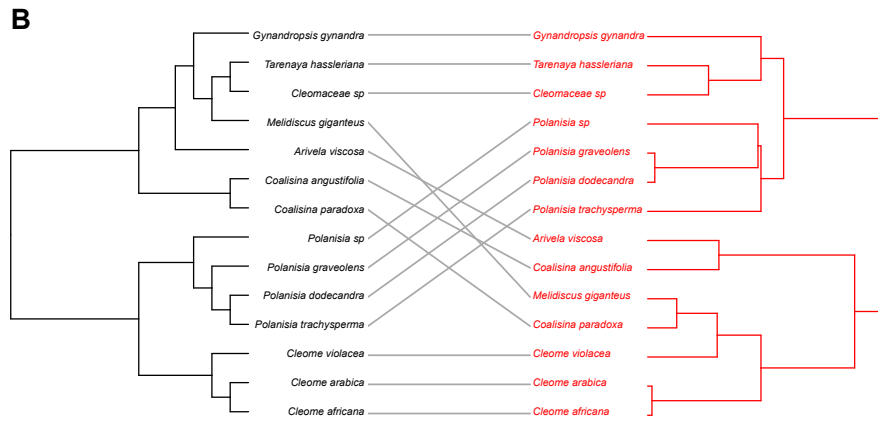
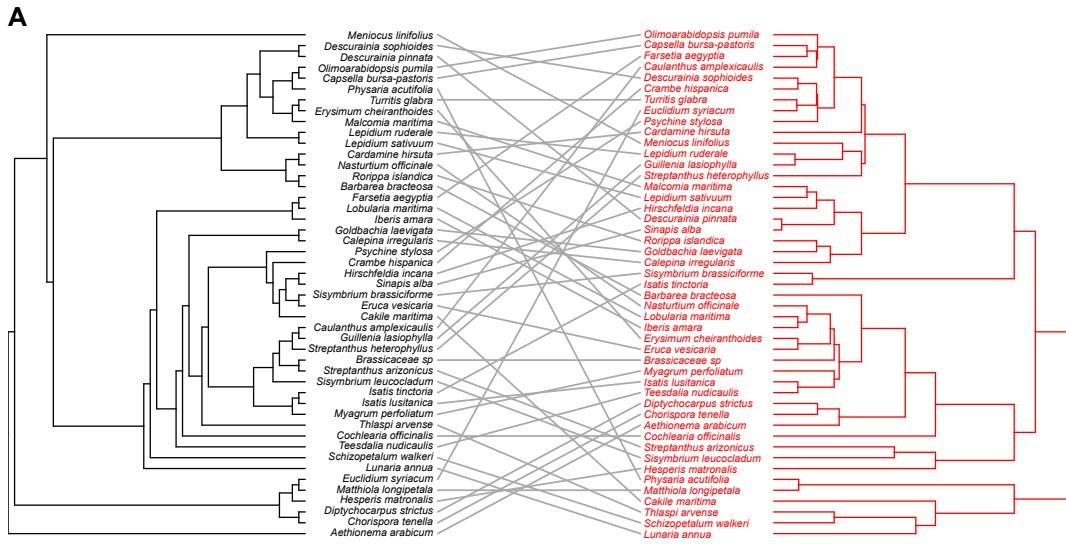


**Supplemental Figure 1.** Proportion plots of transposable element abundance scaled to 100%. (A) phylogeny of taxa, (B) by superfamily, (C) by order.



**Supplemental Figure 2.** Comparison of phylogenetic relationships across Brassicales in the ASTRAL tree obtained from transcriptome data (left) and based on hierarchical clustering of TE abundances (right).



**Supplemental Figure 3.** Comparison of phylogenetic relationships in the ASTRAL tree obtained from transcriptome data (black) and based on hierarchical clustering of TE abundances (red) in (A) Brassicaceae, (B) Cleomaceae, and (C) Capparaceae.

**Supplemental Table 1.** Taxon sampling with genome size, chromosome counts, and repetitive element abundance. Chromosome counts as in <http://legacy.tropicos.org/Project/PCN>. Asterisks (\*) indicate samples with known ploidy level.

Family	Species	Genome Size (Mbp)	Chromosome count (n)	Copia	Gypsy	Harbinger	hAT	Helitron	L1	MuDR	other DNA transposon	other ltr retrotransposon	other non-ltr retrotransposon	Penelope	SINEZ/IRNA	Novosib	RTE	RTEX	RandI	Total_RE
Bataceae	<i>Batis maritima</i>	356.97	11	0.0734	0.1192	0.0058	0.0138	0.0571	0.0075	0.0625	1.38E-02	4.17E-04	0.00E+00	8.34E-04	0.00E+00	4.17E-04	8.34E-04	0.00E+00	0.00E+00	0.3556
Brassicaceae	<i>Aethionema arabicum</i> *	933.99	11	0.1557	0.1632	0.0129	0.0235	0.0811	0.0163	0.115	1.23E-02	1.36E-02	4.04E-04	2.16E-03	2.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.5964
Brassicaceae	<i>Meniocus linifolius</i>	899.76		0.0997	0.1382	0.0098	0.0132	0.0581	0.0049	0.0768	7.48E-03	1.23E-03	3.79E-04	5.68E-04	0.00E+00	9.47E-05	2.84E-04	9.47E-05	0.00E+00	0.4107
Brassicaceae	<i>Barbarea bracteosa</i>	268.95	8	0.1068	0.2629	0.0124	0.0218	0.0637	0.0073	0.0491	1.13E-02	3.59E-03	7.98E-05	5.59E-04	1.92E-03	0.00E+00	3.19E-04	0.00E+00	0.00E+00	0.5417
Brassicaceae	<i>Cakile maritima</i> *	1383.87	9	0.1463	0.3109	0.0133	0.0082	0.0225	0.0101	0.0444	1.03E-02	1.33E-03	0.00E+00	6.66E-04	1.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.5817
Brassicaceae	<i>Calepina irregularis</i>	254.28	14	0.0957	0.2056	0.0104	0.0213	0.0483	0.0095	0.0471	1.57E-02	2.97E-03	6.20E-04	2.48E-04	3.72E-03	0.00E+00	2.48E-04	1.24E-04	0.00E+00	0.4617
Brassicaceae	<i>Capsella bursa-pastoris</i>	420.54	8,16	0.1275	0.1617	0.0116	0.0218	0.0571	0.0122	0.0631	2.27E-02	7.04E-03	8.80E-04	6.40E-04	1.84E-03	3.20E-04	8.00E-04	1.60E-04	0.00E+00	0.4893
Brassicaceae	<i>Cardamine hirsuta</i>	489	7,8	0.0911	0.1797	0.0145	0.0153	0.0953	0.0036	0.0608	9.44E-03	1.42E-03	3.78E-04	2.83E-04	4.72E-04	0.00E+00	7.55E-04	0.00E+00	0.00E+00	0.4731
Brassicaceae	<i>Caulanthus amplexicaulis</i> *	484.11		0.1521	0.1708	0.0084	0.0146	0.0362	0.0074	0.0549	7.60E-03	1.36E-03	3.90E-04	0.00E+00	0.00E+00	9.74E-05	5.84E-04	0.00E+00	0.00E+00	0.4544
Brassicaceae	<i>Chorispora tenella</i>	366.75	7	0.174	0.1702	0.0126	0.0175	0.0471	0.0167	0.0578	7.26E-03	3.98E-03	6.96E-04	2.59E-03	8.95E-04	9.94E-05	3.98E-04	0.00E+00	0.00E+00	0.5118
Brassicaceae	<i>Cochlearia officinalis</i>	734	12	0.1941	0.231	0.009	0.0271	0.0615	0.0082	0.0707	1.32E-02	1.12E-03	3.75E-04	2.50E-04	0.00E+00	5.00E-04	9.99E-04	0.00E+00	0.00E+00	0.6181
Brassicaceae	<i>Crambe hispanica</i> *	660.15	15,30	0.1942	0.1496	0.0099	0.0126	0.0362	0.0053	0.0513	9.91E-03	5.08E-04	2.54E-04	2.54E-04	4.49E-03	0.00E+00	1.69E-04	8.47E-05	0.00E+00	0.4749
Brassicaceae	<i>Descurainia pinnata</i> *	371.64	7	0.1866	0.1963	0.0069	0.0124	0.0356	0.0056	0.0383	5.44E-03	4.57E-03	3.89E-04	1.36E-03	9.72E-05	9.72E-05	2.91E-04	0.00E+00	0.00E+00	0.4939
Brassicaceae	<i>Descurainia sophioides</i> *	195.6	7,14	0.175	0.1532	0.0096	0.014	0.0897	0.0045	0.0412	6.16E-03	2.22E-03	1.01E-04	1.01E-03	3.03E-04	0.00E+00	1.01E-04	0.00E+00	0.00E+00	0.4973
Brassicaceae	<i>Diptychocarpus strictus</i> *	557.46	7	0.1625	0.1509	0.0106	0.0168	0.1085	0.0051	0.0385	1.05E-02	4.98E-03	4.24E-04	4.24E-04	3.18E-04	1.06E-04	3.18E-04	0.00E+00	0.00E+00	0.5101
Brassicaceae	<i>Eruca vesicaria</i> *	709.05	11	0.1464	0.2511	0.012	0.008	0.0465	0.0053	0.0529	5.58E-03	4.04E-04	2.42E-04	0.00E+00	5.33E-03	1.62E-04	3.23E-04	1.62E-04	0.00E+00	0.5345
Brassicaceae	<i>Erysimum cheiranthoides</i>	420.54	8	0.1424	0.2372	0.0056	0.0196	0.041	0.0093	0.0274	1.84E-02	7.27E-03	2.32E-03	1.83E-04	5.01E-03	2.44E-04	3.05E-04	0.00E+00	0.00E+00	0.5164
Brassicaceae	<i>Euclidium syriacum</i> *	298.29	7	0.1686	0.1255	0.0105	0.014	0.0591	0.0027	0.0554	7.99E-03	2.00E-03	5.26E-04	4.20E-04	1.05E-04	4.20E-04	4.20E-04	0.00E+00	0.00E+00	0.4477
Brassicaceae	<i>Farsetia aegyptica</i>	2004.9	24	0.142	0.1715	0.0101	0.0155	0.0753	0.0067	0.0471	6.58E-03	2.55E-03	8.22E-05	2.47E-04	8.22E-04	8.22E-05	3.29E-04	8.22E-05	0.00E+00	0.479
Brassicaceae	<i>Goldbachia laevigata</i>	547.68	14	0.0885	0.2542	0.0076	0.0168	0.0314	0.0072	0.0382	1.14E-02	4.31E-03	1.96E-04	1.96E-04	2.06E-03	2.94E-04	4.89E-04	0.00E+00	0.00E+00	0.463
Brassicaceae	<i>Guillenia lasiophylla</i>	621.03		0.0908	0.0997	0.0116	0.0153	0.0846	0.0066	0.06	8.36E-03	1.38E-03	2.30E-04	1.53E-04	0.00E+00	1.53E-04	0.00E+00	0.00E+00	0.00E+00	0.3788
Brassicaceae	<i>Hesperis matronalis</i>	3261.63	7	0.395	0.1763	0.0056	0.0097	0.0321	0.0038	0.0354	4.32E-03	4.75E-03	0.00E+00	0.00E+00	7.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.6677
Brassicaceae	<i>Hirschfeldia incana</i>	552.57	7	0.1222	0.1947	0.0072	0.0107	0.0505	0.0056	0.0616	6.36E-03	1.47E-03	4.71E-04	5.89E-05	4.59E-03	0.00E+00	1.18E-04	5.89E-05	0.00E+00	0.4655
Brassicaceae	<i>Iberis amara</i> *	831.3	7	0.1167	0.1951	0.0173	0.014	0.0897	0.0046	0.0929	7.37E-03	2.05E-03	2.12E-04	4.96E-04	1.35E-03	7.08E-05	2.12E-04	0.00E+00	0.00E+00	0.542
Brassicaceae	<i>Isatis lusitanica</i>	381.42	14	0.1909	0.2181	0.0067	0.0139	0.0602	0.0085	0.0359	9.47E-03	1.99E-02	1.39E-04	0.00E+00	1.39E-03	0.00E+00	2.79E-04	0.00E+00	0.00E+00	0.5654
Brassicaceae	<i>Isatis tinctoria</i> *	616.14	8,16	0.2403	0.1527	0.0044	0.0102	0.0346	0.0086	0.0271	8.30E-03	4.12E-03	4.31E-04	5.54E-04	9.84E-04	6.15E-05	1.85E-04	0.00E+00	0.00E+00	0.4925

Brassicaceae	<i>Lepidium ruderale</i>	371.64	12,16	0.1015	0.1015	0.0234	0.0158	0.0561	0.003	0.0795	7.69E-03	2.53E-03	0.00E+00	3.89E-04	0.00E+00	0.00E+00	3.89E-04	9.73E-05	0.00E+00	0.3918
Brassicaceae	<i>Lepidium sativuum*</i>	591.69	12	0.1574	0.2023	0.0225	0.0131	0.038	0.0044	0.0439	5.46E-03	3.64E-03	1.07E-04	1.07E-04	0.00E+00	0.00E+00	4.28E-04	0.00E+00	0.00E+00	0.4912
Brassicaceae	<i>Lobularia maritima</i>	312.96	15	0.1145	0.1981	0.01	0.0185	0.0507	0.0447	0.0483	1.12E-02	6.33E-03	0.00E+00	1.09E-02	1.45E-03	2.64E-04	7.92E-04	0.00E+00	0.00E+00	0.5158
Brassicaceae	<i>Lunaria annua*</i>	498.78	8	0.1296	0.4807	0	0.002	0.0024	0	0.0016	0.00E+00	1.05E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.6269
Brassicaceae	<i>Malcomia maritima*</i>	312.96	7	0.1218	0.1949	0.0136	0.0129	0.07	0.0048	0.0436	1.62E-02	6.46E-03	2.75E-04	1.38E-04	3.16E-03	0.00E+00	2.75E-04	0.00E+00	0.00E+00	0.4882
Brassicaceae	<i>Matthiola longipetala</i>	1599.03	7	0.2362	0.316	0.0086	0.0146	0.0395	0.0118	0.0432	7.71E-03	9.56E-03	7.14E-04	1.28E-03	0.00E+00	0.00E+00	7.14E-04	0.00E+00	0.00E+00	0.69
Brassicaceae	<i>Myagrurn perfoliatum*</i>	352.08	16	0.1296	0.2265	0.0053	0.01	0.1219	0.006	0.041	6.75E-03	3.45E-03	1.57E-04	0.00E+00	7.85E-04	1.57E-04	3.14E-04	0.00E+00	0.00E+00	0.552
Brassicaceae	<i>Nasturtium officinale</i>	430.32	15	0.1584	0.206	0.0046	0.0198	0.052	0.029	0.0463	1.35E-02	6.96E-03	1.31E-04	2.23E-03	3.94E-04	2.63E-04	2.63E-04	1.31E-04	0.00E+00	0.54
Brassicaceae	<i>Olimoarabidopsis pumila</i>	410.76	5	0.132	0.1227	0.0119	0.0191	0.0773	0.012	0.0425	1.81E-02	4.07E-03	9.20E-04	3.94E-04	8.54E-04	6.57E-05	5.26E-04	6.57E-05	0.00E+00	0.4424
Brassicaceae	<i>Physaria acutifolia</i>	2322.75		0.2462	0.2936	0.0066	0.0115	0.0627	0.0274	0.0348	1.04E-02	1.27E-02	6.49E-05	1.62E-02	0.00E+00	0.00E+00	6.49E-04	1.30E-04	0.00E+00	0.723
Brassicaceae	<i>Sisymbrium leucocladum</i>	498.78	8	0.2872	0.1753	0.0099	0.0098	0.0325	0.0072	0.0331	7.51E-03	5.03E-03	2.40E-04	0.00E+00	8.79E-04	3.19E-04	2.40E-04	0.00E+00	0.00E+00	0.5693
Brassicaceae	<i>Psychine stylosa</i>	518.34	16	0.1695	0.1805	0.0121	0.0147	0.0432	0.0085	0.0509	7.72E-03	2.86E-04	4.77E-04	9.53E-05	5.62E-03	0.00E+00	2.86E-04	0.00E+00	0.00E+00	0.4938
Brassicaceae	<i>Rorippa islandica*</i>	567.24	10	0.0786	0.2426	0.0082	0.0121	0.0672	0.0123	0.0574	6.64E-03	3.50E-03	1.21E-04	3.62E-04	6.64E-04	0.00E+00	1.81E-04	0.00E+00	0.00E+00	0.4899
Brassicaceae	<i>Schizopetalum walkeri</i>	1775.07	12	0.1289	0.3687	0.0073	0.0074	0.0363	0.009	0.0584	7.69E-03	7.84E-03	0.00E+00	2.22E-03	0.00E+00	1.48E-04	1.48E-04	0.00E+00	0.00E+00	0.634
Brassicaceae	<i>Sinapis alba*</i>	557.46	7	0.1894	0.1884	0.0103	0.0137	0.0391	0.0038	0.0434	6.77E-03	4.90E-04	3.92E-04	1.96E-04	2.45E-03	9.81E-05	1.96E-04	9.81E-05	0.00E+00	0.4989
Brassicaceae	<i>Sisymbrium brassiciforme</i>	NA	14	0.2708	0.1461	0.0091	0.0063	0.0223	0.004	0.0292	4.39E-03	4.18E-04	1.04E-04	5.22E-05	2.40E-03	0.00E+00	3.13E-04	5.22E-05	0.00E+00	0.4955
Brassicaceae	<i>Brassicaceae sp*</i>	1036.68	14	0.1639	0.1945	0.0108	0.0112	0.0858	0.0041	0.0377	5.69E-03	4.90E-04	2.94E-04	0.00E+00	2.65E-03	9.81E-05	2.94E-04	1.96E-04	0.00E+00	0.5176
Brassicaceae	<i>Streptanthus arizonicus</i>	1090.47		0.3666	0.1325	0.0053	0.0089	0.0259	0.0059	0.0318	3.97E-03	5.68E-04	2.27E-04	7.95E-04	0.00E+00	0.00E+00	2.27E-04	0.00E+00	0.00E+00	0.5826
Brassicaceae	<i>Streptanthus heterophyllus</i>	748.17	18	0.1889	0.0898	0.0052	0.009	0.0298	0.0046	0.0384	7.93E-03	1.00E-03	7.70E-05	7.70E-05	0.00E+00	2.77E-03	1.00E-03	0.00E+00	7.70E-05	0.3787
Brassicaceae	<i>Teesdalia nudicaulis</i>	557.46	7	0.1623	0.2155	0.0056	0.0154	0.0625	0.0117	0.0674	1.02E-02	1.70E-03	9.26E-04	1.23E-03	0.00E+00	1.54E-04	9.26E-04	0.00E+00	0.00E+00	0.5555
Brassicaceae	<i>Thlaspi arvense*</i>	205.38	6	0.173	0.3441	0.0067	0.009	0.0807	0.005	0.0264	6.04E-03	1.56E-03	2.08E-04	0.00E+00	0.00E+00	1.04E-04	3.12E-04	0.00E+00	0.00E+00	0.653
Brassicaceae	<i>Turritis glabra</i>	919.32		0.1671	0.1524	0.0046	0.0171	0.0281	0.0084	0.0498	2.00E-02	7.78E-03	1.60E-03	1.50E-04	4.59E-03	2.49E-04	1.50E-04	0.00E+00	0.00E+00	0.462
Capparaceae	<i>Boscia sp</i>	410.76		0.0452	0.1392	0.0076	0.0183	0.0691	0.0079	0.0791	1.37E-02	6.31E-03	0.00E+00	1.77E-04	5.89E-05	1.18E-03	2.36E-03	0.00E+00	0.00E+00	0.3903
Capparaceae	<i>Cadaba natalensis</i>	259.17		0.0935	0.1473	0.0061	0.0239	0.0699	0.0057	0.0735	1.39E-02	4.74E-04	0.00E+00	0.00E+00	1.18E-04	1.36E-03	4.14E-04	0.00E+00	0.00E+00	0.4359
Capparaceae	<i>Capparis fascicularis</i>	1139.37		0.0744	0.1245	0.0057	0.0194	0.0598	0.0099	0.0867	1.46E-02	8.99E-03	0.00E+00	9.46E-05	5.68E-04	2.93E-03	1.14E-03	9.46E-05	0.00E+00	0.4088
Capparaceae	<i>Capparaceae sp</i>	611.25	9	0.0661	0.1331	0.0063	0.0194	0.0712	0.0094	0.0887	1.28E-02	9.71E-03	9.16E-05	1.83E-04	3.66E-04	1.92E-03	1.92E-03	2.75E-04	0.00E+00	0.4215
Cariaceae	<i>Carica papaya</i>	372		0.0588	0.3111	0.0048	0.0052	0.0104	0.0166	0.0131	2.39E-03	7.02E-05	1.40E-05	2.81E-05	0.00E+00	2.39E-04	0.00E+00	0.00E+00	0.00E+00	0.4228
Cleomaceae	<i>Cleome africana</i>	484.11		0.0735	0.2358	0.0122	0.0221	0.1306	0.0088	0.1201	1.58E-02	1.49E-02	9.97E-05	1.99E-04	0.00E+00	4.99E-04	6.98E-04	1.99E-04	0.00E+00	0.6354
Cleomaceae	<i>Coalisina angustifolia</i>	342.3	10	0.1041	0.1621	0.0076	0.0133	0.0747	0.0062	0.0982	1.07E-02	7.96E-04	1.33E-04	3.98E-04	1.33E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.4783
Cleomaceae	<i>Cleome arabica</i>	464.55		0.0757	0.2393	0.0121	0.022	0.1364	0.0082	0.1171	1.42E-02	1.38E-02	0.00E+00	3.89E-04	0.00E+00	9.72E-05	9.72E-05	9.72E-05	0.00E+00	0.6394
Cleomaceae	<i>Polanisia sp</i>	709.05		0.2838	0.1974	0.0087	0.0212	0.0746	0.0045	0.1143	1.13E-02	3.64E-04	0.00E+00	9.10E-05	0.00E+00	9.10E-05	9.10E-05	0.00E+00	0.00E+00	0.7165
Cleomaceae	<i>Coalisina paradoxa</i>	484.11		0.1414	0.1237	0.0097	0.0341	0.0859	0.0084	0.1387	2.76E-02	9.02E-04	8.20E-05	1.64E-04	0.00E+00	4.10E-04	4.10E-04	0.00E+00	0.00E+00	0.5715

Cleomaceae	<i>Cleomaceae sp</i>	322.74		0.2117	0.139	0.0083	0.0284	0.0647	0.0064	0.11	1.80E-02	3.70E-04	2.22E-04	7.40E-05	0.00E+00	4.44E-04	1.63E-03	0.00E+00	7.40E-05	0.5891
Cleomaceae	<i>Cleome violacea</i>	474.33		0.1074	0.1905	0.0094	0.021	0.1124	0.0045	0.1136	1.34E-02	1.35E-02	1.09E-04	5.45E-04	0.00E+00	3.27E-04	6.54E-04	0.00E+00	0.00E+00	0.5874
Cleomaceae	<i>Melidiscus giganteus</i>	420.54	10	0.1345	0.1361	0.0094	0.0381	0.0889	0.0097	0.1485	2.26E-02	1.58E-03	7.55E-05	2.26E-04	0.00E+00	7.55E-04	4.53E-04	0.00E+00	0.00E+00	0.5909
Cleomaceae	<i>Arivela viscosa</i>	268.95	16,17	0.0521	0.1302	0.0099	0.0231	0.0931	0.0067	0.1282	1.94E-02	2.19E-03	0.00E+00	1.29E-04	0.00E+00	1.29E-04	2.58E-04	0.00E+00	0.00E+00	0.4654
Cleomaceae	<i>Cleomella serrulata</i>	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cleomaceae	<i>Gynanadropsis gynandra</i>	1124.7	17,18	0.2219	0.2522	0.0055	0.0183	0.0476	0.0049	0.0756	1.29E-02	8.43E-04	0.00E+00	1.40E-04	0.00E+00	2.81E-04	7.02E-04	0.00E+00	0.00E+00	0.6408
Cleomaceae	<i>Polanisia dodecandra</i>	733.5	10	0.3409	0.1883	0.0072	0.0154	0.0596	0.0042	0.0945	1.31E-02	1.68E-04	1.68E-04	0.00E+00	0.00E+00	1.68E-04	8.42E-05	0.00E+00	0.00E+00	0.7239
Cleomaceae	<i>Polanisia graveolens</i>	723.72		0.3499	0.1821	0.0078	0.0181	0.054	0.0042	0.096	1.20E-02	2.56E-04	8.52E-05	2.56E-04	0.00E+00	8.52E-05	8.52E-05	0.00E+00	0.00E+00	0.7248
Cleomaceae	<i>Polanisia trachysperma</i>	699.27	10	0.288	0.2218	0.0071	0.0198	0.0657	0.0051	0.1022	1.18E-02	6.44E-04	0.00E+00	9.19E-05	0.00E+00	9.19E-05	2.76E-04	0.00E+00	0.00E+00	0.7224
Cleomaceae	<i>Tarenaya hassleriana</i>	435.21	10	0.2576	0.1102	0.0069	0.0221	0.046	0.0052	0.0855	1.39E-02	1.51E-03	6.57E-05	1.31E-04	0.00E+00	1.97E-04	5.19E-03	0.00E+00	0.00E+00	0.5544
Moringaceae	<i>Moringa oleifera</i>	386.31	11	0.0596	0.1354	0.0147	0.0241	0.0694	0.0134	0.0972	1.86E-02	6.46E-04	0.00E+00	3.23E-04	0.00E+00	4.84E-04	1.61E-04	0.00E+00	0.00E+00	0.4339
Resadaceae	<i>Ochradenus baccatus</i>	870.42	24,28	0.2406	0.1654	0.0017	0.0091	0.0349	0.002	0.0424	4.27E-03	1.86E-04	1.86E-04	1.86E-04	0.00E+00	1.86E-04	1.86E-04	0.00E+00	0.00E+00	0.5014
Resadaceae	<i>Reseda odorata</i>	498.78		0.1566	0.3133	0.0022	0.0091	0.0562	0.0046	0.0398	9.51E-03	4.42E-04	4.42E-04	4.42E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.5926

**Supplemental Table 2.** List of mitochondrial and chloroplast sequences used for data filtering.

Mitochondrial reads	Chloroplast reads
Brassica napus mitochondrial linear plasmid, complete sequence	Arabidopsis thaliana chloroplast, complete genome
Brassica napus mitochondrion, complete genome	Aethionema cordifolium chloroplast, complete genome
Carica papaya mitochondrion, complete genome	Aethionema grandiflorum chloroplast, complete genome
Brassica oleracea mitochondrion, complete genome	Olimarabidopsis pumila chloroplast, complete genome
Brassica carinata mitochondrion, complete genome	Arabis hirsuta chloroplast, complete genome
Brassica juncea mitochondrion, complete genome	Barbarea verna chloroplast, complete genome
Brassica rapa subsp. campestris mitochondrion, complete genome	Capsella bursa-pastoris chloroplast, complete genome
Raphanus sativus mitochondrion, complete genome	Crucihimalaya wallichii chloroplast, complete genome
Batis maritima mitochondrion, complete genome	Draba nemorosa chloroplast, complete genome
Brassica nigra mitochondrion, complete genome	Lepidium virginicum chloroplast, complete genome
Sinapis arvensis mitochondrion, complete genome	Lobularia maritima chloroplast, complete genome
Arabis alpina mitochondrion, complete genome	Nasturtium officinale chloroplast, complete genome
Arabidopsis thaliana ecotype Col-0 mitochondrion, complete genome	Carica papaya chloroplast, complete genome
Boechera stricta mitochondrion, complete genome	Brassica rapa subsp. pekinensis chloroplast, complete genome
	Brassica napus chloroplast, complete genome
	Pachycladon enysii chloroplast, complete genome
	Pachycladon cheesemanii chloroplast, complete genome
	Arabis alpina complete chloroplast genome
	Raphanus sativus chloroplast, complete genome
	Capsella rubella chloroplast, complete genome
	Eutrema salsugineum chloroplast, complete genome
	Brassica juncea chloroplast, complete genome
	Isatis tinctoria voucher cp-824 chloroplast, complete genome
	Capsella grandiflora chloroplast, complete genome
	Schrenkiella parvula chloroplast, complete genome
	Eutrema yunnanense chloroplast, complete genome
	Eutrema heterophyllum chloroplast, complete genome
	Cochlearia borzaeana chloroplast genome, complete sequence, isolate Cbor_1063
	Cochlearia islandica chloroplast genome, complete sequence, isolate Cisla_1233
	Cochlearia pyrenaica chloroplast genome, complete sequence, isolate Cpyr_0260
	Cochlearia tridactylites chloroplast genome, complete sequence, isolate Ctri_1288
	Ionopsidium acaule chloroplast genome, complete sequence, isolate Iacau_1072
	Arabidopsis arenosa chloroplast genome, complete sequence, specimen voucher PUSTE-A
	Arabidopsis cebennensis chloroplast genome, complete sequence, specimen voucher 138R-17
	Arabidopsis pedemontana chloroplast genome, complete sequence, specimen voucher 114R-03
	Camelina sativa chloroplast genome, complete sequence, specimen voucher B-2007-0434-12
	Eutrema halophilum chloroplast, complete genome
	Eutrema botschantzevii chloroplast, complete genome
	Arabidopsis arenicola chloroplast genome, complete sequence, isolate 2329
	Arabidopsis croatica chloroplast genome, complete sequence, isolate ACR

Arabidopsis neglecta chloroplast genome, complete sequence, isolate AA095-F
Arabidopsis petrogena chloroplast genome, complete sequence, isolate SK08-h
Arabidopsis suecica chloroplast genome, complete sequence, isolate AS459
Arabidopsis umezawana chloroplast genome, complete sequence, isolate 504865
Brassica nigra chloroplast, complete genome
Pugionium dolabratum chloroplast, complete genome
Pugionium cornutum chloroplast, complete genome
Cakile arabica chloroplast, complete genome
Orychophragmus diffusus chloroplast, complete genome
Orychophragmus taibaiensis chloroplast, complete genome
Orychophragmus hupehensis chloroplast, complete genome
Alliaria grandifolia chloroplast, complete genome
Cardamine limprichtiana chloroplast, complete genome
Alyssum desertorum voucher ADES20160707 chloroplast, complete genome
Megadenia pygmaea chloroplast, complete genome
Matthiola incana chloroplast, complete genome
Solms-laubachia eurycarpa chloroplast, complete genome
Megacarpaea delavayi chloroplast, complete genome
Neotorularia korolkowii chloroplast, complete genome
Thlaspi arvense chloroplast, complete genome
Lepidium meyenii chloroplast, complete genome
Tarenaya hassleriana chloroplast, complete genome
Arabidopsis lyrata chloroplast, complete genome
Arabidopsis halleri chloroplast, complete genome
Aethionema arabicum chloroplast, complete genome
Arabidopsis lyrata subsp. lyrata chloroplast DNA, complete genome, strain: MN47
Sinapis arvensis chloroplast, complete genome
Hesperis matronalis chloroplast, complete genome
Hesperis sylvestris chloroplast, complete genome
Lobularia libyca chloroplast, complete genome
Morettia canescens chloroplast, complete genome
Braya humilis chloroplast, complete genome
Bunias erucago chloroplast genome, complete sequence, specimen voucher OSBU:12478
Bunias orientalis chloroplast genome, complete sequence, specimen voucher RO12
Arabis flagellosa Kifune chloroplast DNA, complete genome
Bretschneidera sinensis chloroplast, complete genome
Draba oreades chloroplast, complete genome
Sisymbrium irio chloroplast J04 DNA, complete genome
Biscutella baetica isolate Bba1 chloroplast, complete genome
Biscutella lyrata isolate Bly2 chloroplast, complete genome
Heldreichia bupleurifolia isolate Hbu3 chloroplast, complete genome
Lunaria rediviva isolate Lre4 chloroplast, complete genome
Ricotia aucheri isolate Rau5 chloroplast, complete genome



Ricotia carnosula isolate Rca6 chloroplast, complete genome
Ricotia cretica isolate Rcr7 chloroplast, complete genome
Ricotia davisiana isolate Rda8 chloroplast, complete genome
Ricotia isatoides isolate Ris9 chloroplast, complete genome
Ricotia lunaria isolate Rlu10 chloroplast, complete genome
Brassica rapa isolate c13 chloroplast, complete genome
Brassica oleracea isolate HDEM chloroplast, complete genome
Moringa oleifera chloroplast, complete genome

**Supplemental Table 3.** Data processing summary.

Family	Species	Genome_Size_Mbp	Raw_reads	Filtered_reads	Total_reads_sampled	Total_reads_clustered	Percent_unannotated
Brassicaceae	<i>Aethionema arabicum</i>	933.99	17,515,712	13,704,622	500,000	298,181	0.787799994
Brassicaceae	<i>Meniocus linifolius</i>	899.76	19,025,676	17,900,990	500,000	205,355	0.866199996
Brassicaceae	<i>Barbarea bracteosa</i>	268.95	17,958,660	16,274,282	500,000	270,845	1.117800003
Bataceae	<i>Batis maritima</i>	356.97	16,618,110	15,093,764	500,000	177,780	0.171599998
Capparaceae	<i>Boscia sp</i>	410.76	21,741,004	19,951,552	500,000	195,140	1.424399998
Capparaceae	<i>Capparaceae sp</i>	259.17	18,732,834	15,702,982	500,000	217,968	1.441000001
Brassicaceae	<i>Cakile maritima</i>	1383.87	20,109,922	17,345,778	500,000	290,826	0.769600012
Brassicaceae	<i>Calepina irregularis</i>	254.28	18,945,186	14,996,774	500,000	230,865	0.667199996
Capparaceae	<i>Capparis fascicularis</i>	1139.37	20,757,542	19,626,330	500,000	204,412	0.881599999
Capparaceae	<i>Capparis tomentosa</i>	611.25	18,850,070	16,916,978	500,000	210,754	0.937799997
Brassicaceae	<i>Capsella bursa-pastoris</i>	420.54	19,924,400	17,596,938	500,000	244,673	1.018199992
Brassicaceae	<i>Cardamine hirsuta</i>	489	14,327,238	13,353,298	500,000	236,564	0.893800004
Cariaceae	<i>Carica papaya</i>	372	26,670,784	22,740,686	500,000	211,407	2.305599995
Brassicaceae	<i>Caulanthus amplexicaulis</i>	484.11	17,276,330	13,566,798	500,000	227,219	0.618400004
Brassicaceae	<i>Chorispora tenella</i>	366.75	21,426,658	17,199,758	500,000	255,923	0.669999999
Cleomaceae	<i>Cleome africana</i>	484.11	14,535,678	12,523,252	500,000	317,696	1.167200004
Cleomaceae	<i>Coalisina angustifolia</i>	342.3	17,685,930	16,598,982	300,000	143,503	1.172000003
Cleomaceae	<i>Cleome arabica</i>	464.55	15,921,148	12,608,460	500,000	319,725	1.200000004
Cleomaceae	<i>Polanisia sp</i>	709.05	16,484,740	14,702,180	500,000	358,263	0.9018
Cleomaceae	<i>Coalisina paradoxa</i>	484.11	20,093,758	17,333,978	500,000	285,751	1.307799997
Cleomaceae	<i>Cleomaceae sp</i>	322.74	20,481,152	17,552,776	500,000	294,564	1.399400005
Cleomaceae	<i>Cleome violacea</i>	474.33	15,366,960	13,381,026	400,000	234,951	1.143750005
Cleomaceae	<i>Melidiscus giganteus</i>	420.54	18,036,600	15,768,938	500,000	295,440	1.648799998
Cleomaceae	<i>Arivela viscosa</i>	268.95	18,197,094	14,690,618	400,000	186,177	2.092499998
Brassicaceae	<i>Cochlearia officinalis</i>	734	19,571,568	17,680,152	500,000	309,075	0.633400004
Brassicaceae	<i>Crambe hispanica</i>	660.15	17,962,804	16,030,190	500,000	237,458	0.847600007
Brassicaceae	<i>Descurainia pinnata</i>	371.64	21,064,170	18,911,684	500,000	246,938	0.555600003
Brassicaceae	<i>Descurainia sophioides</i>	195.6	14,299,738	11,722,246	500,000	248,632	0.685599997
Brassicaceae	<i>Diptychocarpus strictus</i>	557.46	14,976,410	13,219,700	500,000	255,043	0.805800004
Brassicaceae	<i>Eruca vesicaria</i>	709.05	19,393,468	16,238,972	500,000	267,256	0.8802
Brassicaceae	<i>Erysimum cheiranthoides</i>	420.54	19,255,900	14,718,730	500,000	258,177	1.210200004
Brassicaceae	<i>Euclidium syriacum</i>	298.29	16,998,370	15,169,108	500,000	223,832	0.641799998
Brassicaceae	<i>Farsetia aegyptica</i>	2004.9	17,029,968	16,121,632	500,000	239,500	0.934600003
Brassicaceae	<i>Goldbachia laevigata</i>	547.68	19,699,580	18,035,220	500,000	231,487	0.6218
Brassicaceae	<i>Guillenia lasiophylla</i>	621.03	11,213,854	9,994,886	500,000	189,388	1.013799997
Cleomaceae	<i>Gynanadropsis gynandra</i>	1124.7	18,472,870	16,563,780	500,000	320,397	0.499200002
Brassicaceae	<i>Hesperis matronalis</i>	3261.63	15,614,640	15,174,086	500,000	333,859	0.537600005
Brassicaceae	<i>Hirschfeldia incana</i>	552.57	23,055,074	21,141,192	500,000	232,731	1.167399996
Brassicaceae	<i>Iberis amara</i>	831.3	13,691,982	13,178,566	500,000	270,980	1.225400004
Brassicaceae	<i>Isatis lusitanica</i>	381.42	23,390,698	17,191,612	500,000	282,703	0.580399999
Brassicaceae	<i>Isatis tinctoria</i>	616.14	18,892,040	15,557,688	500,000	246,272	0.846399996

Brassicaceae	<i>Lepidium ruderale</i>	371.64	18,919,410	14,656,664	500,000	195,884	0.829600002
Brassicaceae	<i>Lepidium sativum</i>	591.69	18,902,354	16,242,402	500,000	245,618	0.521800004
Brassicaceae	<i>Lobularia maritima</i>	312.96	19,156,394	14,101,930	500,000	257,902	0.571799998
Brassicaceae	<i>Lunaria annua</i>	498.78	14,633,200	12,998,044	500,000	313,439	0.6024
Brassicaceae	<i>Malcomia maritima</i>	312.96	15,816,038	13,287,250	250,000	122,050	1.107999997
Brassicaceae	<i>Matthiola longipetala</i>	1599.03	20,089,766	19,078,766	500,000	344,981	0.498000005
Moringaceae	<i>Moringa oleifera</i>	386.31	20,478,894	17,095,412	500,000	216,954	0.590999995
Brassicaceae	<i>Myagrum perfoliatum</i>	352.08	13,275,434	10,829,146	400,000	220,796	0.700749995
Brassicaceae	<i>Nasturtium officinale</i>	430.32	16,369,294	13,096,042	500,000	270,006	0.548799996
Resadaceae	<i>Ochradenus baccatus</i>	870.42	18,680,706	17,328,066	500,000	250,676	0.341200004
Brassicaceae	<i>Olimoarabidopsis pumila</i>	410.76	14,092,992	11,158,530	500,000	221,195	1.072000003
Brassicaceae	<i>Physaria acutifolia</i>	2322.75	18,571,300	17,404,712	500,000	361,507	1.074200005
Cleomaceae	<i>Polanisia dodecandra</i>	733.5	17,592,446	16,046,308	500,000	361,926	0.840400003
Cleomaceae	<i>Polanisia graveolens</i>	723.72	20,436,352	18,930,976	500,000	362,412	0.833199998
Cleomaceae	<i>Polanisia trachysperma</i>	699.27	18,164,388	14,896,462	500,000	361,223	0.827400004
Brassicaceae	<i>Sisymbrium leucocladum</i>	498.78	21,306,942	17,347,804	500,000	284,673	0.703999996
Brassicaceae	<i>Psychine stylosa</i>	518.34	18,672,344	15,813,984	500,000	246,922	0.815000003
Resadaceae	<i>Reseda ordorata</i>	498.78	20,059,938	17,972,876	500,000	296,311	0.307800004
Brassicaceae	<i>Rorippa islandica</i>	567.24	14,323,126	12,382,424	500,000	244,939	1.065999997
Brassicaceae	<i>Schizopetalum walkeri</i>	1775.07	19,473,154	18,463,848	500,000	317,020	0.339599997
Brassicaceae	<i>Sinapis alba</i>	557.46	19,804,700	16,543,166	500,000	249,449	0.833399989
Brassicaceae	<i>Sisymbrium brassiciforme</i>	371.64	18,157,024	15,596,368	500,000	247,748	0.779399995
Brassicaceae	<i>Brassicaceae sp</i>	1036.68	14,359,594	12,039,944	500,000	258,811	0.911999998
Brassicaceae	<i>Streptanthus arizonicus</i>	1090.47	20,032,530	17,795,582	500,000	291,308	0.391000003
Brassicaceae	<i>Streptanthus heterophyllus</i>	748.17	20,440,916	18,181,630	500,000	189,327	0.588599995
Cleomaceae	<i>Tarenaya hassleriana</i>	435.21	24,418,660	22,321,972	500,000	277,209	1.194800003
Brassicaceae	<i>Teesdalia nudicaulis</i>	557.46	17,158,882	15,882,064	500,000	277,737	0.503399998
Brassicaceae	<i>Thlaspi arvense</i>	205.38	13,742,780	12,034,208	500,000	326,494	0.530000001
Brassicaceae	<i>Turritis glabra</i>	919.32	21,721,584	19,358,608	500,000	230,979	1.205600012
Cleomaceae	<i>Cleomella serrulata</i>	N/A	N/A	N/A	N/A	N/A	N/A

**Supplemental Table 4.** OUwie weighted AICc scores. Tests conducted are specified below as selection regime ~ modelled phenotype. BM1; single-rate Brownian motion, BMS; Brownian motion with different rate parameters for each state on a tree, OU1; Ornstein-Uhlenbeck model with a single optimum for all species, OUM; Ornstein-Uhlenbeck model with different state means and a single alpha and sigma<sup>2</sup> acting all selective regimes, OUMV; Ornstein-Uhlenbeck model that assumes different state means as well as multiple sigma<sup>2</sup>, OUMA; Ornstein-Uhlenbeck model that assumes different state means as well as multiple alpha, OUMVA; Ornstein-Uhlenbeck model that assumes different state means as well as multiple alpha and sigma<sup>2</sup> per selective regime. Asterisk (\*) indicated analyses which returned the warning, “You might not have enough data to fit this model well”.

Simmap	Test Conducted	OUM	OU1	BM1	BMS	OUMV	OUMA	OUMVA
	AtAlpha/All ~ Total TE	0.03478328	0.1026477 3	0.059294	<b>0.4075957</b>	0.05291083	0.10698661	0.23578184
	AtAlpha/All ~ Gypsy	0.23758937	<b>0.3186865</b>	0.00295855	0.00190546	0.14597727	0.20500947	0.08787339
	AtAlpha/All ~ Copia	0.29076304	<b>0.3509629</b>	0.00001552	0.000009	0.15800576	0.15221466	0.0480291
	Brassicaceae/Brassicaceae ~ Total TE	0.09524774	<b>0.2741048</b>	0.0795574	0.08170141	0.21402713 *	0.15597822 *	0.09938331 *
	Brassicaceae/Brassicaceae ~ Gypsy	0.11124287	<b>0.3679953</b>	0.32010442	0.10217491	0.04138997 *	0.03731004 *	0.0197825* *
	Brassicaceae/Brassicaceae ~ Copia	0.18430769	<b>0.5635547</b>	0.01588842	0.00555477	0.10066517 *	0.09134368 *	0.03868553 *
	ThAlpha/Cleomaceae ~ Total RE	0.09367094 *	0.1104097 *	<b>0.5775217</b> *	0.19361534 *	0.01500279 *	0.00897249 *	0.00080708 *
	ThAlpha/Cleomaceae ~ Gypsy	0.27132915 *	<b>0.3576261</b> *	0.12686794 *	0.11919859 *	0.05904368 *	0.06326126 *	0.00267328 *
	ThAlpha/Cleomaceae ~ Copia	0.05613062 *	<b>0.3893679</b> *	0.17259922 *	0.36403269 *	0.00970944 *	0.00778289 *	0.00037727 *
	Neo/BMAP ~ Total RE	0.09177786 *	0.1752389 *	<b>0.4870293</b> *	0.16334972 *	0.01504765 *	0.05696647 *	0.01059003 *
	Neo/BMAP ~ Gypsy	0.10288377 *	0.1438035 *	<b>0.4304128</b> *	0.15543752 *	0.01833382 *	0.14525589 *	0.00387266 *
	Neo/BMAP ~ Copia	0.37400051 *	<b>0.4134385</b> *	0.01666794 *	0.00857456 *	0.11452479 *	0.06447625 *	0.00831744 *