Supplementary material for:

Evolutionary bursts in *Euphorbia* (Euphorbiaceae) are linked with photosynthetic pathway

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Supplemental Methods

PHYLOGENETIC ANALYSIS

Bayesian MCMC analyses were conducted using MrBayes v3.2.1 (Ronquist et al. 2012) with the markers partitioned and modeled independently using the PartitionFinder v1.0.1 (Lanfear et al. 2012) results. Default priors were used for the rate matrix, gamma shape parameter (Yang 1993), and the proportion of invariant sites (where appropriate; Reeves 1992) within each partition. A flat Dirichlet distribution was used for the base frequency parameters. A uniform prior was used for the tree topology. The exponential branch length prior for each partition was increased from 10 to 50 to ensure that branch-length estimates reasonably approximated (Brown et al. 2010). We executed three concurrent runs of one cold and five heated chains for 5×10^7 generations, sampling the chains every 1000 generations. The program AWTY (Wilgenbusch et al. 2004; Nylander et al. 2008) was used to diagnose topological convergence, with emphasis placed on the results of the Cumulative, Split, and Compare diagnostics. These results indicated a burn-in period of 4.2×10^7 generations. Trees from the post burn-in period of each analysis were pooled together (2.4×10^4 trees in total) to calculate Bayesian posterior probabilities (PP) shown in Fig. S1.

CARBON ISOTOPE RATIO ($\delta^{13}C$) DETERMINATION

Leaf or photosynthetic stem tissue (0.3–0.6 mg) stored over silica gel was analyzed at the Smithsonian OUSS/MCI Stable Isotope Mass Spectrometry Laboratory (http://www.si.edu/mci/irms/) with a Thermo Delta V Advantage (ThermoFisher Scientific, Waltham, MA) isotope-ratio mass spectrometer in continuous flow mode coupled to a Costech 4010 Elemental Analyzer (Costech Analytical Technologies, Valencia, CA) via a Conflo IV (ThermoFisher Scientific). Reference standards of acetanilide (Costech) and urea (Urea-UIN3) calibrated to L-glutamic acid (USGS40 and USGS41) were run every 12 samples under the same conditions as the samples (Schimmelmann et al. 2009). Raw isotope values were corrected using a 2-point linear correction on the calibrated standard; the error associated with the sample data points is ±0.2‰.

CALIBRATION

The fossil taxon *Hippomanoidea warmanensis*, consisting of male flowers borne on branched, spicate inflorescences, is known from middle Eocene deposits of the Claiborne Formation (Crepet and Daghlian 1982). *Hippomanoidea* presents a much larger range of structural complexity and detail than other related Eocene Euphorbiaceae fossils (e.g., *Crepetocarpon perkinsii*, Dilcher and Manchester 1988), enabling a more confident placement using a “global similarity” method (Sauquet et al. 2012) than these other fossils. We assigned *Hippomanoidea* to the crown node of the clade inclusive of *Senefelderopsis* and *Mabea* because of several shared inflorescence and pollen traits. Moreover, the fossil is closely comparable to the modern genera *Gymnanthes* and *Senefeldera* (section *Inclinatae*; Crepet and Daghlian 1982; Esser 1999), which Wurdack et al. (2005) found attributable to a clade congruent in membership with our calibration clade. These similarities suggest *Hippomanoidea* might lie close to the calibration node.

Therefore, we modeled the node age prior using an exponential distribution with a hard minimum age of 43 Ma, reflecting biostratigraphic analysis of the age of the Warman clay pit, Henry Co., Tennessee (Potter and Dilcher 1980; Davis et al. 2004), and a mean of 2.5 to extend the 95% interval to 50.5 Ma.

We obtained the two secondary calibration points from the Malpighiales divergence dating analysis of Xi et al. (2012): i) at the root of our analysis, exactly congruent with the clade of Euphorbioideae (including *Pimelodendron* and *Euphorbia*) in Xi et al. (2012) and ii) the clade of Euphorbioideae exclusive of tribe Stomatocalyceae (this tribe represented by *Nealchornea* in our analysis and *Pimelodendron* in Xi et al. [2012]). We modeled these two priors using a normal distribution, with the mean age and standard deviation of each set to reflect the mean age and 95% highest posterior density (HPD) interval discovered for the corresponding nodes in Xi et al. (2012; root: 69.08 [HPD: 55.43–85.26] Ma; Euphorbioideae excluding Stomatocalyceae: 52.79 [HPD: 41.77–67.39] Ma).

DIVERSITY TREE CONSTRUCTION

To construct the set of 1000 diversity trees, we pruned the subset of 1000 chronograms to 104 tips of exemplar species to create a set of diversity trees that would maximize robustly supported phylogenetic information and also accurately reflect clade diversity estimates for the total species diversity of Euphorbioideae. Although the exemplars we chose generally represent sectional level subclades, current phylogenetic evidence and the taxonomic knowledge of EuphORBia PBI project researchers enabled us to further break down many large sectional subclades into yet smaller subclades to more finely parse the phylogenetic diversity within these groups. Tip-diversity estimates are based on Riina et al. (2013) for subgenus *Esula*, Yang et al. (2012) for subgenus *Chamaesyce*, and Dorsey et al. (2013) for subgenus *Euphorbia*. Tip diversity estimates of subdivisions within large sectional subclades of the aforementioned *Euphorbia* subgenera are based on estimates of these authors (and coauthors). Tip diversity estimates of the Euphorbioideae outgroups are based on Radcliffe-Smith (2001), with estimates for Hippomaneae tips provided by K. J. Wurdack based on a combination of Radcliffe-Smith's diversity estimates for each genus and Wurdack's expert phylogenetic knowledge of Euphorbiaceae. For *Euphorbia* subgenus *Athymalus*, tip diversity estimates reflect the knowledge of EuphORBia PBI collaborators in mid-2012 based on accepted names in Govaerts et al. (2012), particularly for section *Anthacanthae*. In the latest study of subgenus *Athymalus* by Peirson et al. (2013), fewer species were recognized in each of the *Anthacanthae* subsections, but this is the result of differing opinions of species limits in these rapidly evolving lineages. In total, 2256 species, representing the complete known species diversity for Euphorbioideae (excepting the monotypic section *Szovitsiae*), were modeled across the 104 tips (Fig. 3; Table S4).

Figure and Table Legends

Figure S1. 95% majority-rule consensus tree of pool of all post burn-in trees from Bayesian MCMC analysis using MrBayes v3.2.1 with the 197-tip data set (15-partiton scheme; see Table S2); posterior probability values (PP) ≥0.95 are indicated above branches.

Figure S2. Chronogram (maximum clade credibility tree) inferred from the BEAST analysis of the 197-tip data set of *Euphorbia* and outgroups (15-partition scheme; see Table S2). The blue bars indicate the 95% HPD for the node age.

Figure S3. Histogram plot of δ^{13}C values for *Euphorbia* and outgroups. Frequency of occurrence in the data set (i.e., Table S3) vs. ‰. Note the strongly bimodal distribution, with the two peaks centered at about -27.5‰ and -16‰.

Figure S4. Ancestral state reconstructions of photosynthetic pathway type (C_3-like, with atmospheric CO_2 predominantly fixed by RuBisCO, or CCM with CO_2 principally fixed by PEPCase). Based on δ^{13}C values in *Euphorbia* and outgroups under a two-rate transition model, with values of q_{01} and q_{10} set according to the median values obtained from analysis of the full, six parameter BiSSE model across 1000 diversity trees. The values of δ^{13}C were binned as binary characters using three cutoff values: -19‰, -20‰, and -21‰. Ancestral states for each character were estimated using maximum likelihood optimizations across the randomly selected subset of 1000 post burn-in trees from the BEAST analysis of the 15-partition dataset and plotted onto the 95% majority rule tree of the complete set of post burn-in trees. Pie charts at each node represent the proportion of trees in which a given state was optimized using a likelihood decision threshold of 2.0 (>2 log units better than the raw likelihood value of the other state). Superscript numbers to the right of species names indicates weak or facultative CAM is present: [a]*E. aphylla*, Mies et al. 1996; [b]*E. milii*, Herrera 2013. **Fig. S4a** are optimizations for outgroups and *Euphorbia* subgenera *Esula* and *Athymalus*; continued in **Fig. S4b** with subgenera *Chamaesyce* and *Euphorbia*.

Figure S5. Ancestral state reconstructions of photosynthetic pathway type (C_3-like, with atmospheric CO_2 predominantly fixed by RuBisCO, or CCM with CO_2 principally fixed by PEPCase). Based on δ^{13}C values in *Euphorbia* and outgroups under a single-rate transition model, with the value of q set according to the median values obtained from analysis of a five parameter BiSSE model (q_{01} and q_{10} constrained as equal) across 1000 diversity trees. The values of δ^{13}C were binned as binary characters using three cutoff values: -19‰, -20‰, and -21‰. Ancestral states for each character were estimated using maximum likelihood optimizations across the randomly selected subset of 1000 post burn-in trees from the BEAST analysis of the 15-partition dataset and plotted onto the 95% majority rule tree of the complete set of post burn-in trees. Pie charts at each node represent the proportion of trees in which a given state was optimized using a likelihood decision threshold of 2.0 (>2 log units better than the raw likelihood value of the other state). Superscript numbers to the right of species names indicates weak or facultative CAM is present: [a]*E. aphylla*, Mies et al. 1996; [b]*E. milii*, Herrera 2013. **Fig. S5a** are optimizations for outgroups and *Euphorbia* subgenera *Esula* and *Athymalus*; continued in **Fig. S5b** with subgenera *Chamaesyce* and *Euphorbia*.

Figure S6. Density plot of the number of piecewise models fit to the 1000, 104-tip diversity trees in the MEDUSA analysis of *Euphorbia* and outgroups. Note that the initial model is fit to the entire tree, with additional piecewise models inserted at significant rate shifts.

Figure S7. Posterior probability distributions of the net diversification rate of speciation rate (λ), extinction rate (μ), and character state transition rate (q) for *Euphorbia* and outgroups estimated from a Bayesian MCMC analysis the confidence set of BiSSE submodels. Analyses used the 104-tip diversity tree based on the maximum clade credibility tree from the BEAST analysis with associated tip diversity information and character states codings given in Table S4. **A**, **C**, **E**. Estimated values of parameters from the full, six-parameter BiSSE model. **B**, **D**, **F**. Estimated values of parameters from the five-parameter BiSSE submodel in which forward and reverse transition rates are constrained ($q_{01} = q_{10}$). The full distributions are indicated within the outline of each curve; the shaded area within each curve is the 95% HPD interval, which is further indicated by the bar beneath the curve.

Table S1. GenBank accession numbers for DNA sequences of the 23 *Euphorbia* species added to the matrix of Horn et al. (2012). Herbarium acronym follows Index Herbariorum (Thiers, continuously updated).

Table S2. Best-fit, 15-partition scheme and corresponding models of evolution for the 10-marker, 197-tip data set of *Euphorbia* and outgroups selected using BIC from analysis with the “greedy” heuristic search algorithm in PartitionFinder v1.0.1.

Table S3. Values of $\delta^{13}C$ and associated voucher information for taxa of *Euphorbia* and outgroups included in the 197-tip data set. Isotope analyses mostly sourced subsamples of the same tissues previously used for DNA extractions in Horn et al. (2012) except as noted: (*) indicates the voucher listed for isotope analysis differs from the DNA source, (#) indicates additional isotope data not directly used in analyses herein but was generated to evaluate variation, and (NA) indicates the sample was not available. Herbaria acronyms follow Index Herbariorum (Thiers, continuously updated).
The error associated with the $\delta^{13}C$ values is ±0.2‰

Table S4. Clade tip-diversity estimates used in the 104-tip MEDUSA and BiSSE analyses, and character state codings used in BiSSE analyses. Tip-diversity estimates are based on Riina et al. (2013) for subgenus *Esula*, Yang et al. (2012) for subgenus *Chamaesyce*, and Dorsey et al. (2013) for subgenus *Euphorbia*. Tip diversity estimates of subdivisions within large sectional subclades of the aforementioned *Euphorbia* subgenera are based on estimates of these authors (and coauthors). Tip diversity estimates of the Euphorbioideae outgroups are based on Radcliffe-Smith (2001), with estimates for Hippomaneae tips provided by K. J. Wurdack based on a combination of Radcliffe-Smith’s diversity estimates for each genus and Wurdack’s expert phylogenetic knowledge of Euphorbiaceae. For *Euphorbia* subgenus *Athymalus*, tip diversity estimates reflect the knowledge of EuphORBia PBI collaborators in mid-2012 based on accepted names in Govaerts et al. (2012), particularly for section *Anthacanthae*. In the latest study of subgenus *Athymalus* by Peirson et al. (2013), fewer species were recognized in each of the *Anthacanthae* subsections, but this is the result of differing opinions of species limits in these rapidly evolving lineages.

Table S5. Clades in which a significant shift in the net diversification rate (*r*) was modeled in 10%–50% of the 1000 diversity trees using the MEDUSA method. Shift values are relative to those of a background value of *r*. Values of *r* are interpreted as net speciation events per million years.

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Fig. S1. 95% majority-rule consensus tree of pool of all post burn-in trees from Bayesian MCMC analysis using MrBayes v3.2.1 with the 197-tip data set (15-partiton scheme); posterior probability values (PP) ≥0.95 are indicated above branches.

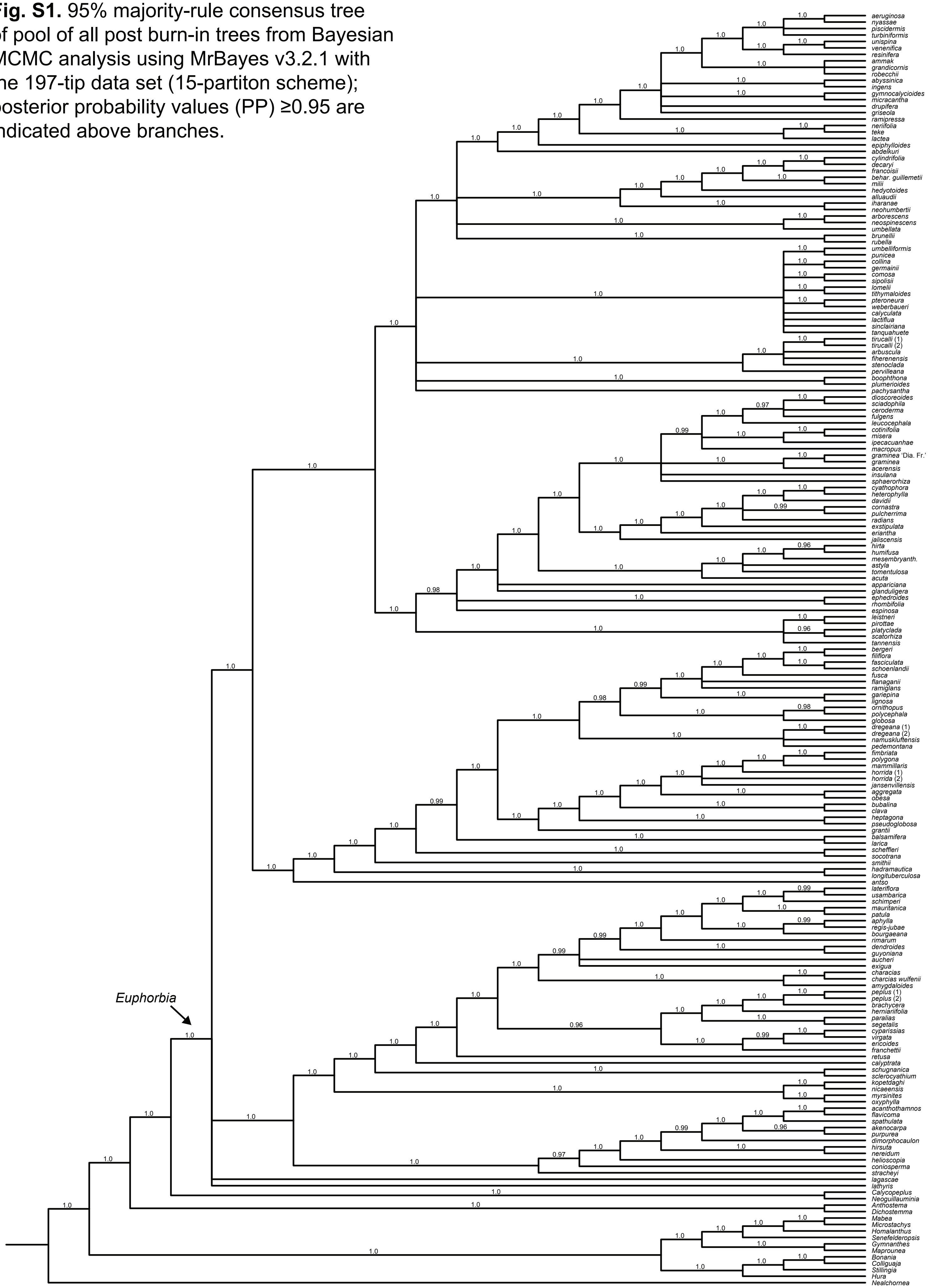


Fig. S2. Chronogram (maximum clade credibility tree) inferred from BEAST analysis (15-partition scheme) of 197-tip data set.

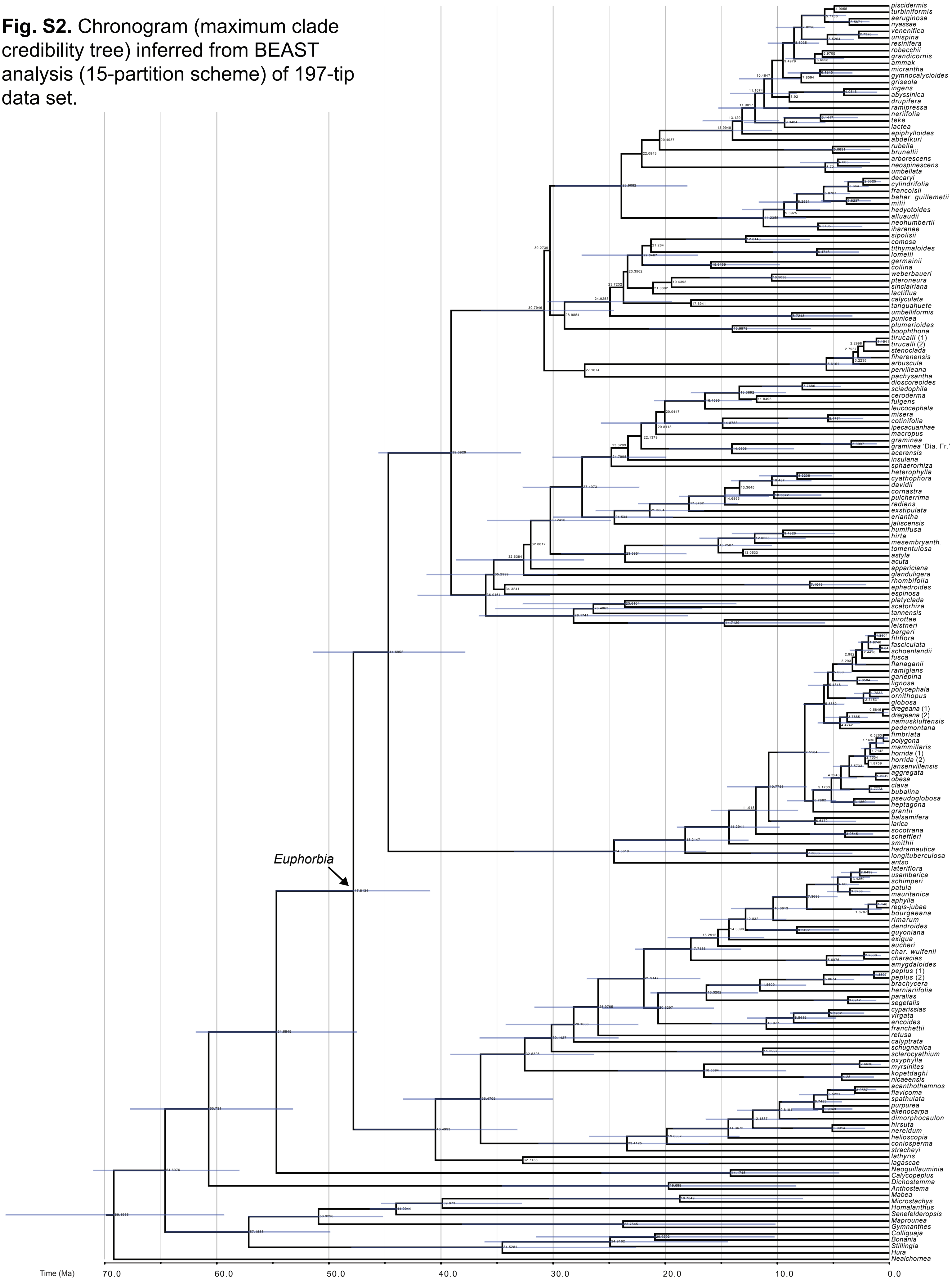


Fig. S3. Histogram plot of δ13C values

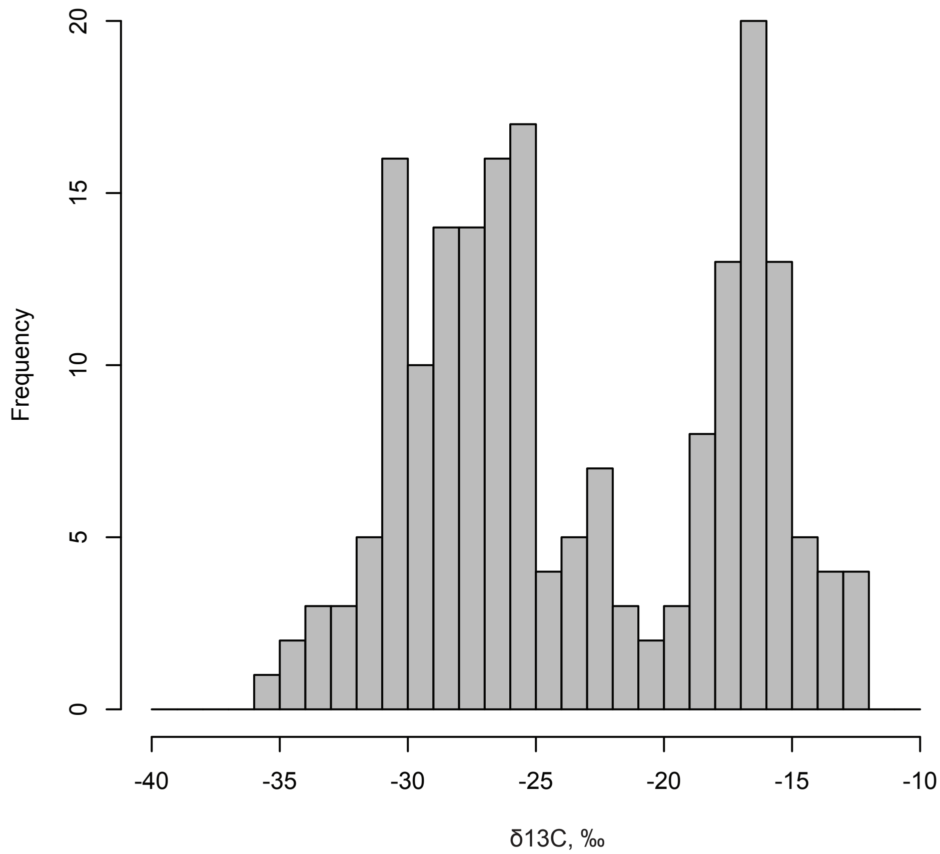
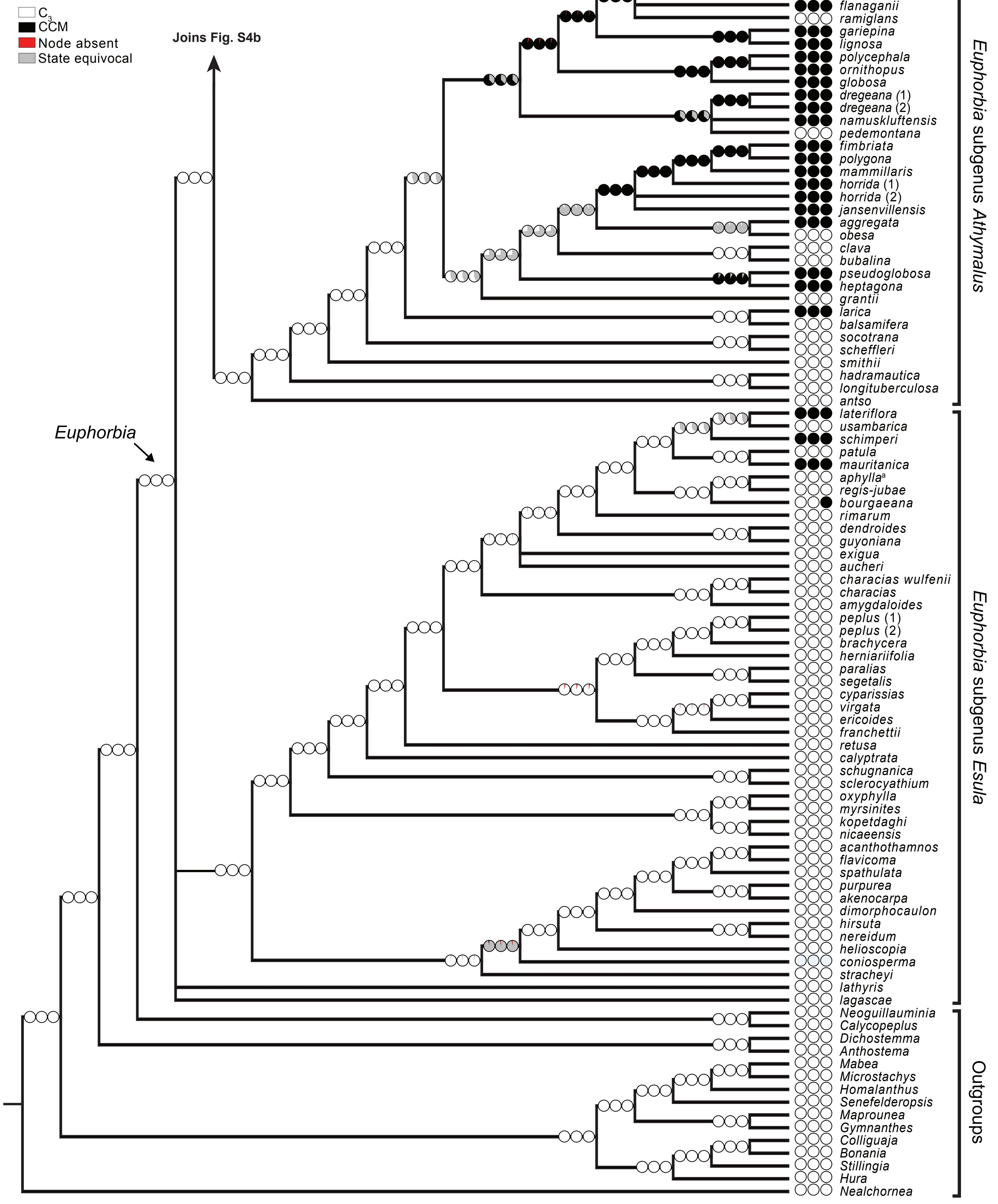


Fig. S4a. Ancestral state reconstructions of photosynthetic pathway type under a two-rate transition model. δ13C cutoff values of -19‰, -20‰, and -21‰.



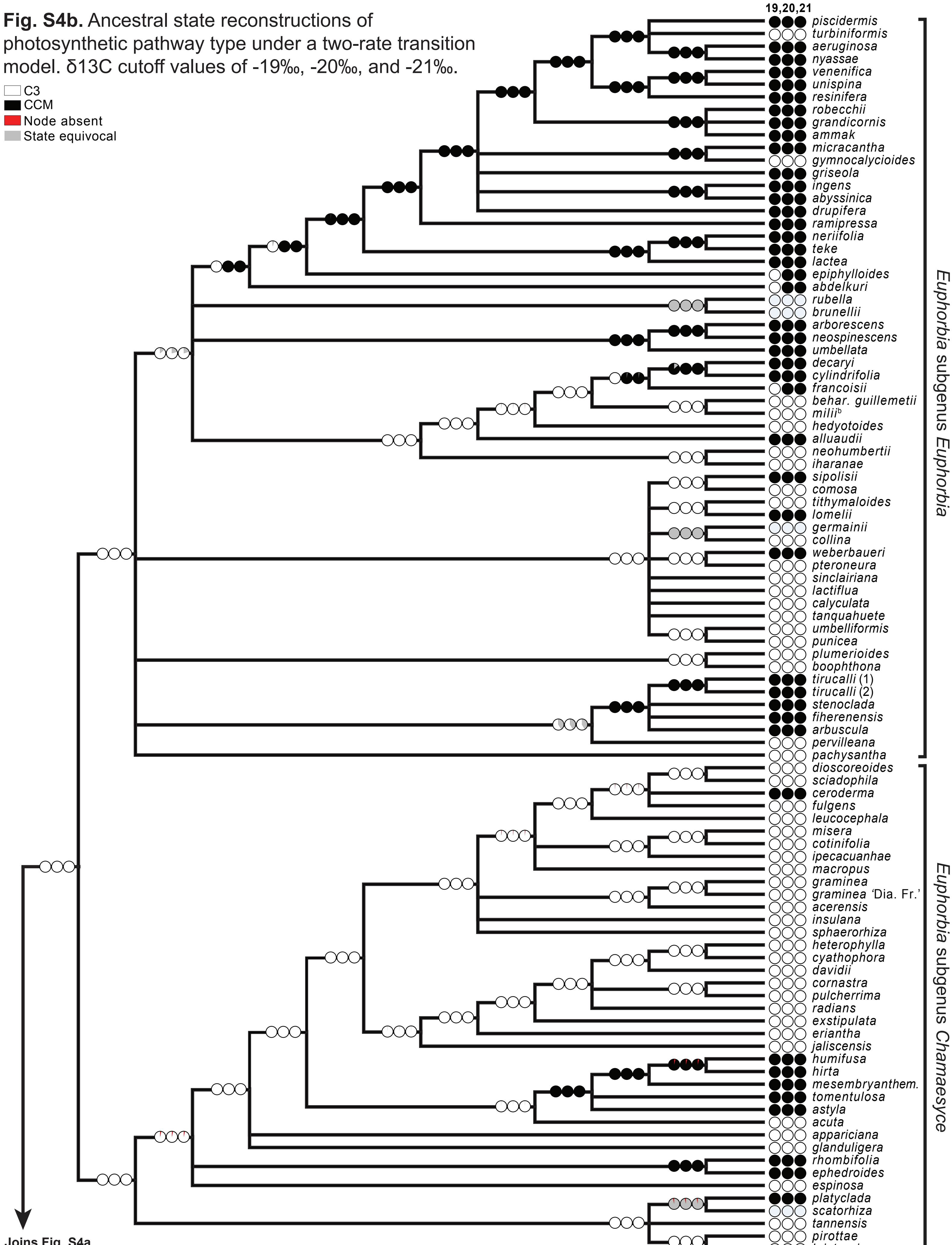


Fig. S4b. Ancestral state reconstructions of photosynthetic pathway type under a two-rate transition model. δ13C cutoff values of -19‰, -20‰, and -21‰.

Fig. S5a. Ancestral state reconstructions of photosynthetic pathway type under a single-rate transition model. δ13C cutoff values of -19‰, -20‰, and -21‰.

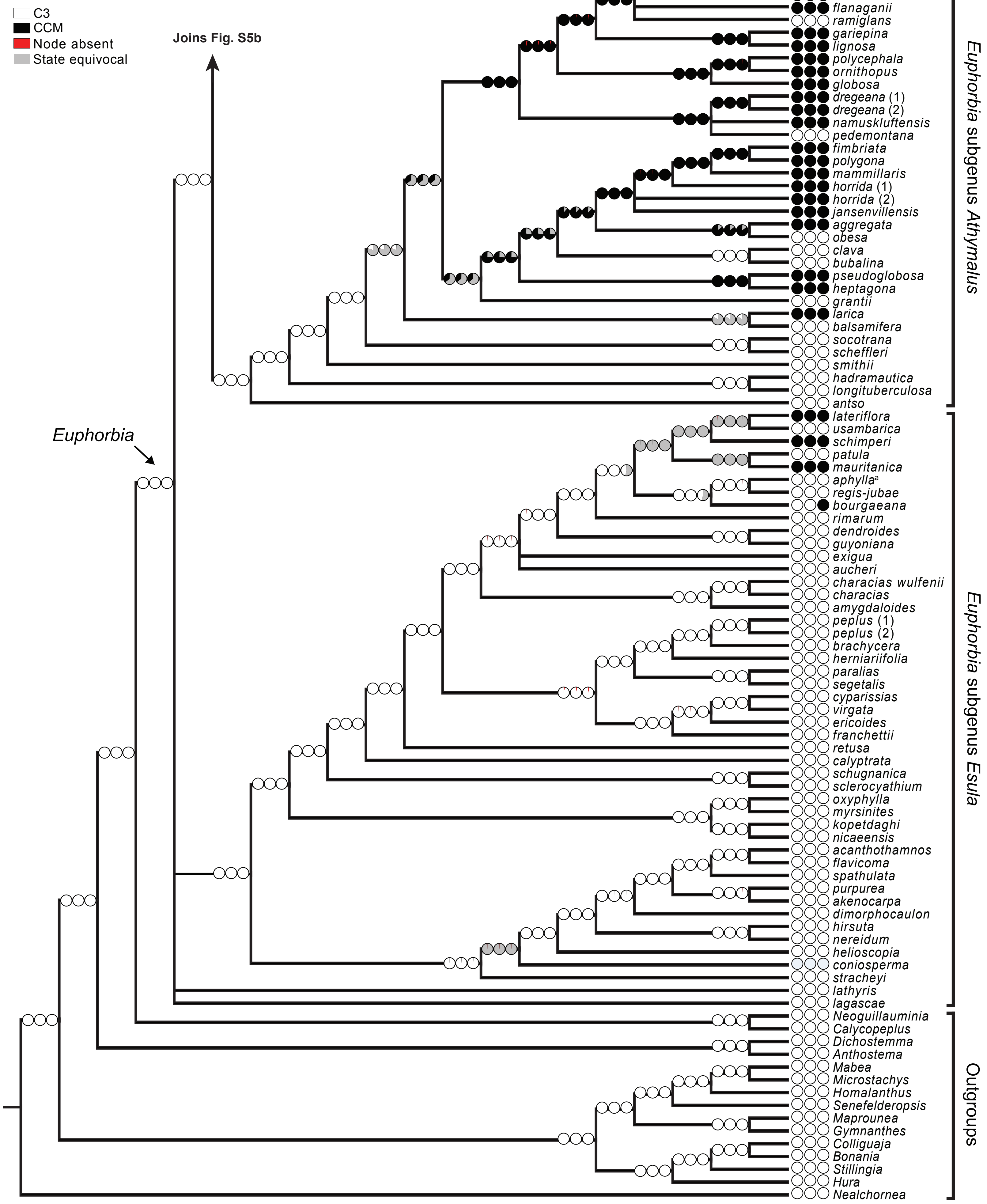


Fig. S5b. Ancestral state reconstructions of photosynthetic pathway type under a single-rate transition model. δ13C cutoff values of -19‰, -20‰, and -21‰.

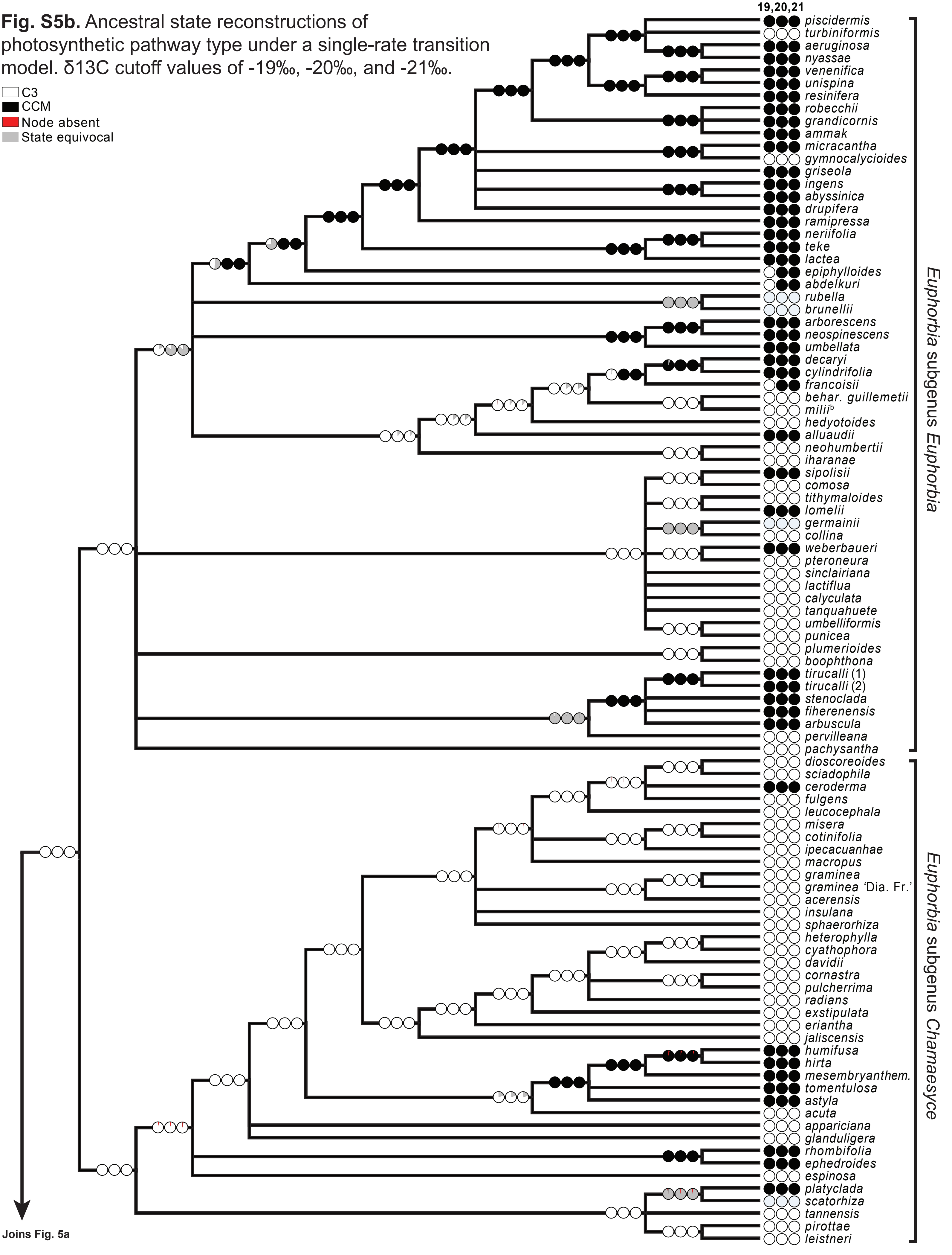


Fig. S6. Density plot of the number of piecewise models fit to each of the 1000 diversity trees in the MEDUSA analysis.

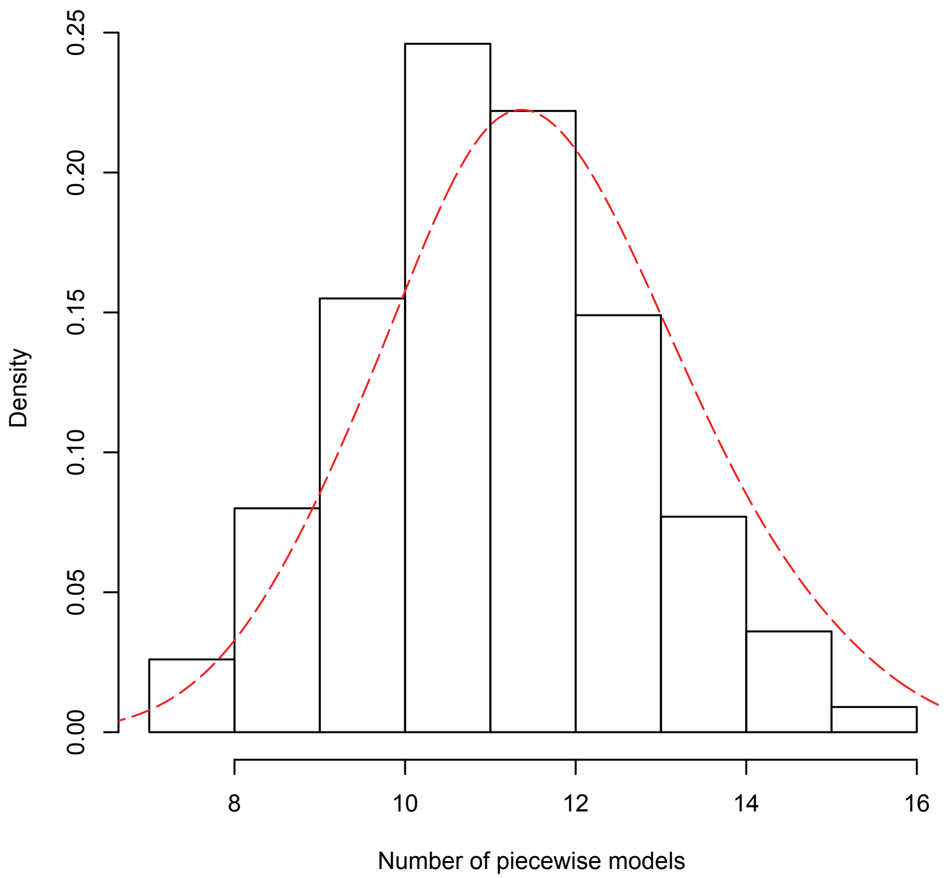


Fig. S7. Density plots of BiSSE model parameter values. A, C, E. Full, six-parameter BiSSE submodel; B, D, F. Five-parameter BiSSE submodel ($q_{01} = q_{10}$).

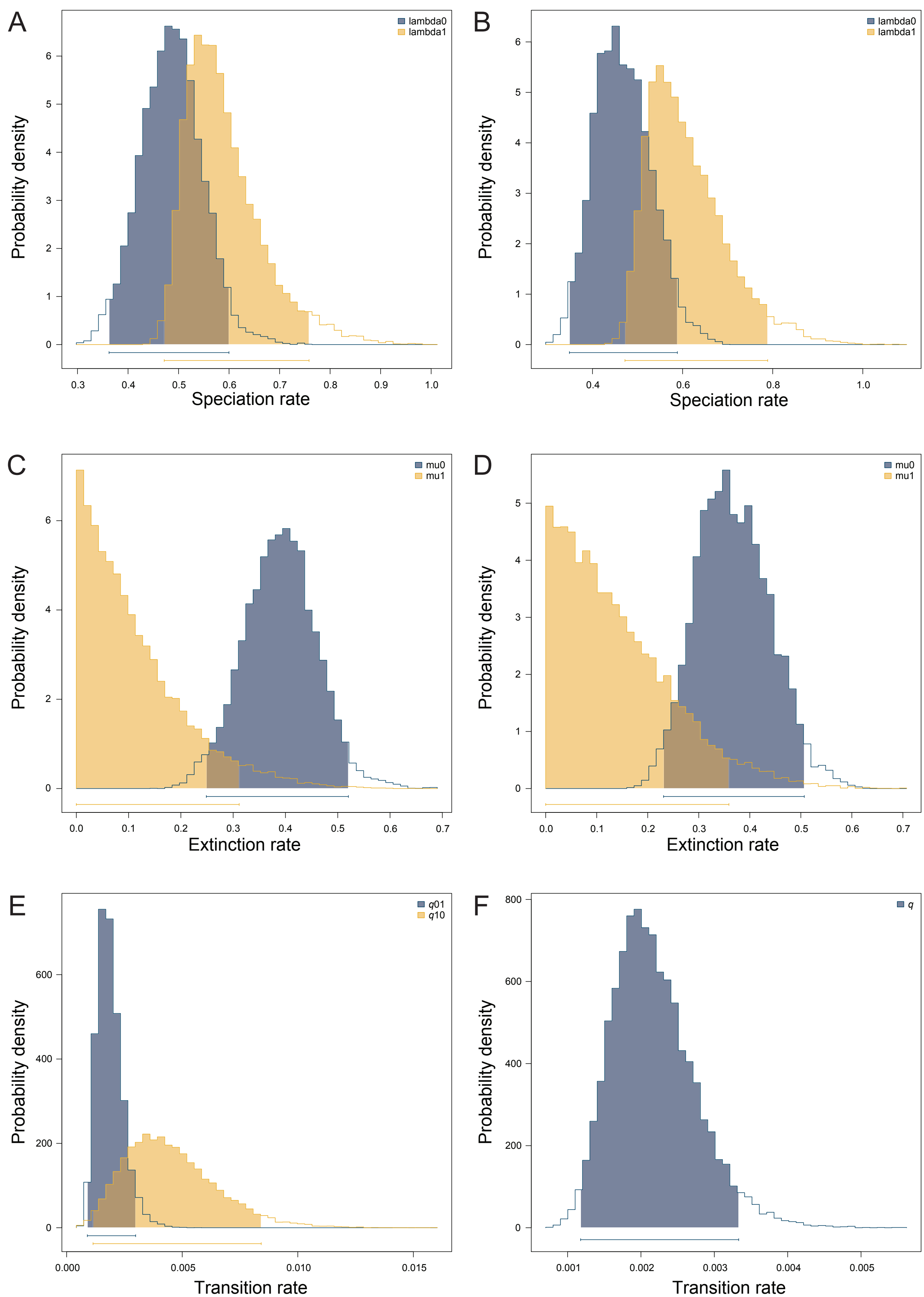


Table S1. GenBank accession numbers for DNA sequences of the 23 *Euphorbia* species added to the matrix of Horn et al. (2012).

Euphorbia abyssinica J.F.Gmel.; *rbcL*: AY794824; *trnL-F*: JN207633; *rps3*: EF135446; ITS: JN207734.
Euphorbia astyla Engelm. ex Boiss.; *trnL-F*: HQ645535; *rpl16* intron: HQ645381; *EMB2765* exon 9: HQ650902; ITS: HQ645229.
Euphorbia aucheri Boiss.; *ndhF*: KC212446; ITS: KC212181.
Euphorbia brunellii Choiv. ex Chiarugi; *ndhF*: AF538203; ITS: AF537486.
Euphorbia calyculata Kunth; *ndhF*: AF538221; ITS: KJ888151*.
Euphorbia ceroderma I.M.Johnst.; *ndhF*: AF538153; ITS: AF537389.
Euphorbia coniosperma Boiss. & Buhse; ITS: KC212210.
Euphorbia exstipulata Engelm.; *ndhF*: AF538171; ITS: AF537433.
Euphorbia franchetii B.Fedtsch.; *ndhF*: KC212516; ITS: KC212256.
Euphorbia hirta L.; *rbcL*: GQ436322; *ndhF*: JQ750815; *trnL-F*: HQ645584; *rpl16* intron: HQ645430; *EMB2765* exon 9: HQ650950; ITS: HQ645278.
Euphorbia humifusa Willd.; *rbcL*: AB233884; *ndhF*: JQ750817; *trnL-F*: HQ645587; *rpl16* intron: HQ645433; *EMB2765* exon 9: HQ650954; ITS: HQ645281.
Euphorbia ingens E.Mey. ex Boiss.; *trnL-F*: JN207678; ITS: JN207781.
Euphorbia insulana Vell.; *ndhF*: JQ750819; ITS: JQ750930.
Euphorbia jaliscensis Rob. & Greenm.; *ndhF*: AF538166; ITS: AF537442.
Euphorbia lactiflua Phil.; *ndhF*: AF538219; ITS: AF537528.
Euphorbia lagascae Spreng.; *ndhF*: KC212552; ITS: KC212292.
Euphorbia larica Boiss.; *trnL-F*: JN207681; ITS: JN207784.
Euphorbia macropus (Klotzsch) Boiss.; *ndhF*: JQ750828; ITS: AF537378.
Euphorbia mesembryanthemifolia Jacq.; *rbcL*: AY794820; *trnL-F*: AY794601; *rpl16* intron: HQ645454; *EMB2765* exon 9: HQ650975; ITS: HQ645301.
Euphorbia rubella Pax; *ndhF*: AF538204; ITS: AF537487.
Euphorbia stracheyi Boiss.; *ndhF*: KC212646; ITS: KC212390.
Euphorbia tanquahuete Sessé & Moç.; *ndhF*: AF538224; ITS: AF537525.
Euphorbia usambarica Pax; *ndhF*: KC212670; *trnL-F*: HQ900520; ITS: KC212419.

*Voucher for newly generated ITS sequence of *E. calyculata* Kunth: Torres 13839 (NY), Mexico: Oaxaca.

Table S2. Best partition scheme and associated models of evolution selected using the Bayesian Information Criterion (BIC) from analysis with the "greedy" heuristic search algorithm in PartitionFinder v1.0.1.

Scheme Name: 3031
Scheme ln*L*: –127855.21515
Scheme AIC: 256770.4303
Scheme AICc: 256821.340213
Scheme BIC: 260669.979001
Num params: 530
Num sites: 11587
Num subsets: 15

Subset	Best Model	Subset Partitions	Subset Sites
1	GTR+I+G	rbcL_pos1	1–1377\3
2	SYM+I+G	rbcL_pos2	2–1377\3
3	GTR+G	rbcL_pos3	3–1377\3
4	GTR+I+G	accD-rbcL_IGS, rpl16_3'exon_pos3, trnL-F	1378–1992, 4471–5395, 6205–6328\3
5	GTR+G	accD_pos1, accD_pos2, ndhF_pos1	1993–2972\3, 1994–2972\3, 2973–4470\3
6	GTR+G	accD_pos3, ndhF_pos3	1995–2972\3, 2975–4470\3
7	GTR+I+G	ndhF_pos2	2974–4470\3
8	GTR+I+G	rpl16_intron	5396–6202
9	GTR+I+G	rpl16_3'exon_pos1, rps3_pos1, rps3_pos2, rps3_pos3	6203–6328\3, 6329–7807\3, 6330–7807\3, 6331–7807\3
10	SYM+I+G	EMB2765ex12_pos1, EMB2765ex9_pos1, rpl16_3'exon_pos2	6204–6328\3, 9281–10099\3, 10100–11041\3
11	K80+I+G	nad1	7808–9280
12	GTR+I+G	EMB2765ex12_pos2, EMB2765ex9_pos2	9282–10099\3, 10101–11041\3
13	GTR+I+G	EMB2765ex12_pos3, EMB2765ex9_pos3	9283–10099\3, 10102–11041\3
14	SYM+I+G	ITS1, ITS2	11042–11244, 11409–11587
15	TrNef+I+G	5.8S	11245–11408

Table S3. Values of δ13C and associated voucher information for taxa of *Euphorbia* and Euphorbioideae outgroups included in the 197-tip analysis.

Taxon		**Voucher**	**Source**	**δ13C, ‰**
Anthostema	*senegalense* A.Juss.	Madsen 305	Senegal	-28.69
Bonania	*microphylla* Urb.	HAJB 81924 (MICH)	Cuba	-31.53
Calycopeplus	*casuarinoides* L.S.Sm.	Hyland 10775 (MO)	Australia	-27.31*
C.	*collinus* P.I.Forst.	van der Werff 11848 (MO)	Australia: Northern Territory	-29.40#
Colliguaja	*integerrima* Gillies & Hook.	van Ee 575 (US)	Argentina: Mendoza	-25.99
Dichostemma	*glaucescens* Pierre	Chatrou 614 (WAG)	Cameroon	-31.59
Euphorbia	*abdelkuri* Balf.f.	Berry 7835 (MICH)	Cultivated USA: California	-19.05
E.	*abyssinica* J.F.Gmel.	Horn s.n. (photovoucher, US)	Cultivated USA: Arizona	-17.16*
E.	*acanthothamnos* Heldr. & Sart. ex Boiss.	Riina 1563 (MICH)	Greece: Crete	-27.67
E.	*acerensis* Boiss.	van Ee 670 (MICH)	Argentina: Salta	-29.37
E.	*acuta* Engelm.	Yang YY0019 (MICH)	USA: Texas	-25.18
E.	*aeruginosa* Schweick.	Berry 7806 (MICH)	Cultivated USA: California	-15.37
E.	*aggregata* A.Berger	Riina 1677 (MICH)	Cultivated: Netherlands	-18.03
E.	*akenocarpa* Guss.	Barres BCN 53041 (MICH)	Spain: Cádiz	-29.41
E.	*alluaudii* Drake	Berry 7818 (MICH)	Cultivated USA: California	-16.90
E.	*ammak* Schweinf.	Berry 7813 (MICH)	Cultivated USA: California	-17.26
E.	*amygdaloide*s L.	van Ee 743 (US)	Cultivated USA: District of Columbia	-30.91
E.	*antso* Denis	Labat et al. 2106 (MO)	Madagascar	-25.04*
E.	*aphylla* Brouss. ex Willd.	Dorsey 4 (MICH)	Spain: Canary Islands	-26.77
E.	*appariciana* Rizzini	Steinmann 1442 (RSA)	Cultivated USA: Maryland	-22.06
E.	*arbuscula* Balf.f.	Berry 7836 (MICH)	Cultivated USA: California	-16.89
E.	*astyla* Engelm. ex Boiss.	Iltis & Lasseigne 282 (DAV)	Mexico	-14.26*
E.	*aucheri* Boiss.	Gillett 9586 (US)	Iraq	-25.04*
E.	*balsamifera* Aiton	Dorsey 3 (MICH)	Spain: Canary Islands	-26.32

E.	*beharensis* Leandri var. *guillemetii* (Ursch & Leandri) Rauh	Berry 7829 (MICH)	Cultivated USA: California	-23.26
E.	*bergeri* N.E.Br.	Berry 7781 (MICH)	Cultivated USA: California	-16.40
E.	*boophthona* C.A.Gardner	Harris 2215	Australia: Western Australia	-25.67
E.	*bourgaeana* J.Gay ex Boiss.	Berry 7851 (MICH)	Cultivated USA: California	-20.32
E.	*brachycera* Engelm.	Rink 6201 (NY)	USA: Arizona	-26.26
E.	*brunellii* Chiov. ex Chiarugi			NA
E.	*bubalina* Boiss.	Berry 7856 (MICH)	Cultivated USA: California	-22.19
E.	*calyculata* Kunth	Torres 13839 (NY)	Mexico: Oaxaca	-25.21*
E.	*calyptrata* Coss. & Kralik	Riina 1810 (MICH)	Morocco: Tiznit	-22.56
E.	*celastroides* Boiss.	Berry 7864 (MICH)	Cultivated USA: California	-16.06#
E.	*ceroderma* I.M.Johnst.	van Devender 2007-1067	Mexico: Sonora	-15.82
E.	*characias* L.	van Ee 718 (MICH)	USA: California	-30.03
E.	*characias* L. subsp. *wulfenii* (Hoppe ex W.Koch) Radcl.-Sm.	Berry 7847 (MICH)	Cultivated USA: California	-29.21
E.	*clava* Jacq.	Berry 7881 (MICH)	Cultivated USA: California	-21.84
E.	*comosa* Vell.	Fonseca et al. 2387 (US)	Brazil: Goiás	-27.49
	coniosperma Boiss. & Buhse			NA
E.	*cornastra* (Dressler) Radcl.-Sm.	Berry 7840 (MICH)	Cultivated USA: California	-27.76
E.	*cotinifolia* L.	Berry 7842 (MICH)	Cultivated USA: California	-23.93
E.	*cyathophora* Murray	van Ee 736 (US)	Cultivated USA: District of Columbia	-30.75
E.	*cylindrifolia* Marn.-Lap. & Rauh	Berry 7832 (MICH)	Cultivated USA: California	-16.93
E.	*cyparissias* L.	van Ee 721 (US)	USA: Virginia	-26.39
E.	*davidii* Subils (as *E. dentata* Michx., in Horn et al. 2012)	van Ee 627 (MICH)	Argentina: Córdoba	-26.82
E.	*decaryi* Guillaumin	Berry 7828 (MICH)	Cultivated USA: California	-16.04
E.	*dendroides* L.	Riina 1555 (MICH)	Greece: Crete	-30.84
E.	*dimorphocaulon* P.H.Davis	Riina 1673 (MICH)	Cultivated: Netherlands	-34.83
E.	*dioscoreoides* Boiss.	Steinmann 1922 (RSA)	Mexico: Michoacán	-34.81

E.	*dregeana* E.Mey. ex Boiss. (1)	Berry 7815 (MICH)	Cultivated USA: California	-18.57
E.	*dregeana* E.Mey. ex Boiss. (2)	Becker 897 (PRE)	South Africa	-16.58
E.	*dregeana* E.Mey. ex Boiss.	Bolin 08-8 (WIND)	Namibia	-13.36#
E.	*drupifera* Thonn.	Berry 7774 (MICH)	Cultivated USA: California	-16.03
E.	*ephedroides* E.Mey. ex Boiss.	Becker 908 (PRE)	South Africa	-18.97
E.	*ephedroides* E.Mey. ex Boiss.	Bolin 08-9 (WIND)	Namibia	-14.62#
E.	*epiphylloides* Kurz	Riina 1665 (MICH)	Cultivated Netherlands	-19.69
E.	*eriantha* Benth.	van Ee 694 (US)	Mexico: Baja California Sur	-26.26
E.	*ericoides* Lam.	Killiuck 4489 (MO)	Lesotho	-26.34
E.	*eriophora* Boiss.	Koelz 16003 (US)	Iran	-27.22#
E.	*espinosa* Pax	Luke 9344 (MO)	Tanzania: Iringa	-28.27*
E.	*eustacei* N.E.Br.	Becker 1185 (PRE)	South Africa: Western Cape	-28.42#
E.	*exigua* L.	Riina 1550 (MICH)	Portugal: Beira Litoral	-30.75
E.	*exstipulata* Engelm.	Atwood 28933 (US)	USA: New Mexico	-30.35*
E.	*fasciculata* Thunb.	Berry 7785 (MICH)	Cultivated USA: California	-17.95
E.	*fiherenensis* Poiss.	Berry 7833 (MICH)	Cultivated USA: California	-17.35
E.	*filiflora* Marloth	Becker 891 (PRE)	South Africa	-20.99
E.	*fimbriata* Scop.	Berry 7782 (MICH)	Cultivated USA: California	-15.40
E.	*flanaganii* N.E.Br.	Berry 7800 (MICH)	Cultivated USA: California	-15.78
E.	*flavicoma* DC.	Molero BCN 53617 (MICH)	Spain: Santander	29.30
E.	*franchetii* B.Fedtsch.	Goloskokov 4481 (US)	Kazakhstan	-27.97*
E.	*francoisii* Leandri	Berry 7857 (MICH)	Cultivated USA: California	-19.12
E.	*fulgens* Karw. ex Klotzsch	Berry 7850 (MICH)	Cultivated USA: California	-29.53
E.	*fusca* Marloth	Riina 1633 (MICH)	Cultivated Netherlands	-17.76
E.	*gariepina* Boiss.	Becker 918 (PRE)	South Africa	-15.18
E.	*germainii* Phil.			NA
E.	*glanduligera* Pax	Seydel 3261 (US)	Namibia	-27.10
E.	*glanduligera* Pax	Bolin 09-31 (WIND)	Namibia	-27.57#
E.	*globosa* (Haw.) Sims	Berry 7814 (MICH)	Cultivated USA: California	-16.40
E.	*graminea* Jacq.	Berry 7843 (MICH)	Cultivated USA: California	-28.56

E.	*graminea* Jacq. cv. 'Diamond Frost'	van Ee s.n. (US)	Cultivated USA: District of Columbia	-33.01
E.	*grandicornis* Goebel ex N.E.Br.	Berry 7787 (MICH)	Cultivated USA: California	-16.00
E.	*grantii* Oliv.	Mwiga 108 (MO)	Tanzania: Tabora	-27.03
E.	*griseola* Pax	Berry 7812 (MICH)	Cultivated USA: California	-15.79
E.	*guyoniana* Boiss. & Reut.	Riina 1797 (MICH)	Morocco: Er Rachidia	-28.21
E.	*gymnocalycioides* M.G.Gilbert & S.Carter	Riina 1700 (MICH)	Cultivated Netherlands	-26.61
E.	*hadramautica* Baker	Morawetz 320 (MICH)	Oman: Dhofar	-29.68
E.	*hedyotoides* N.E.Br.	Berry 7831 (MICH)	Cultivated USA: California	-24.75
E.	*helioscopia* L.	Riina 1607 (MICH)	Spain: Castilla y León	-30.88
E.	*heptagona* L. (= *E. atrispina* N.E.Br., in Horn et al. 2012)	Morawetz 308 (MICH)	Cultivated South Africa	-12.08
E.	*herniariifolia* Willd.	Riina 1571 (MICH)	Greece: Crete	-26.90
E.	*heterophylla* L.	van Ee 720 (MICH)	USA: Florida	-29.67
E.	*hirta* L.	Strong 3627 (US)	USA: Florida	-13.28*
E.	*hirta* L.	Strong 2490 (US)	USA: Florida	-12.88#
E.	*hirsuta* L.	Riina 1769 (MICH)	Spain: Madrid	-28.57
E.	*horrida* Boiss. (1)	Berry 7783 (MICH)	Cultivated USA: California	-16.46
E.	*horrida* Boiss. (2)	Riina 1679 (MICH)	Cultivated Netherlands	-17.84
E.	*humifusa* Willd.	Środoń 531 (US)	Poland	-13.87*
E.	*iharanae* Rauh	Berry 7854 (MICH)	Cultivated USA: California	-24.80
E.	*ingens* E.Mey. ex Boiss.	SI 2012-004	Cultivated USA: Maryland	-16.80*
E.	*insulana* Vell.	Harley 16580 (US)	Brazil: Bahia	-30.55*
E.	*ipecacuanhae* L.	Strong 1350 (US)	USA: South Carolina	-28.17*
E.	*jaliscensis* Rob. & Greenm.	McVaugh 17305 (US)	Mexico: Jalisco	-28.41*
E.	*jansenvillensis* Nel	Riina 1681 (MICH)	Cultivated Netherlands	-17.30
E.	*kopetdaghi* (Prokh.) Prokh.	Kurbanov 761 (MO)	Turkmenistan	-25.30
E.	*lactea* Haw.	Berry 7816 (MICH)	Cultivated USA: California	-14.79
E.	*lactiflua* Phil.	Hutchinson 409 (US)	Chile	-22.97*
E.	*lagascae* Spreng.	Sterzing, Aug. 1884 (US)	Europe (cult. Germany?)	-25.44*

E.	*lateriflora* Schumach.	Jongkind et al. 1720 (MO)	Ghana	-18.20
E.	*larica* Boiss.	Morawetz 357 (MICH)	Oman	-13.77
E.	*lathyris* L.	Wurdack 5558 (US)	Cultivated USA: Maryland	-31.80
E.	*leistneri* R.H.Archer	Morawetz 303 (MICH)	South Africa	-25.73
E.	*leucocephala* Lotsy	Berry 7841 (MICH)	Cultivated USA: California	-27.58
E.	*lignosa* Marloth	Davidse 6316 (MO)	Namibia	-13.98
E.	*lignosa* Marloth	Bolin 09-27 (WIND)	Namibia	-18.17#
E.	*lomelii* V.W.Steinm.	van Ee 703 (MICH)	Mexico: Baja California Sur	-12.65
E.	*longituberculosa* Hochst. ex Boiss.	Horn s.n. (photovoucher, US)	Cultivated USA: Arizona	-25.60*
E.	*macropus* (Klotzsch) Boiss.	McVaugh 16261 (US)	Mexico: Jalisco	-28.91*
E.	*maculata* L.	van Ee 723 (US)	USA: Maryland	-14.36#
E.	*mammillaris* L.	Berry 7775 (MICH)	Cultivated USA: California	-16.52
E.	*mauritanica* L.	Morawetz 277 (MICH)	South Africa: Western Cape	-16.08
E.	*mauritanica* L.	Bolin 09-42 (WIND)	Namibia	-17.37 (leaf)#; -14.64 (stem)#
E.	*mesembryanthemifolia* Jacq.	Brizicky & Stern 337 (US)	USA: Florida	-13.97*
E.	*micracantha* Boiss.	Berry 7802 (MICH)	Cultivated USA: California	-15.90
E.	*milii* Des Moul.	Berry 7826 (MICH)	Cultivated USA: California	-21.70
E.	*misera* Benth.	van Ee 711 (US)	Mexico: Baja California	-25.10
E.	*myrsinites* L.	Wurdack 5556 (US)	Cultivated USA: Maryland	-29.14
E.	*namuskluftensis* L.C.Leach	Riina 1674 (MICH)	Cultivated: Netherlands	-18.20
E.	*neoarborescens* Bruyns	Berry 7853 (MICH)	Cultivated USA: California	-18.34
E.	*neohumbertii* Boiteau	Berry 7874 (MICH)	Cultivated USA: California	-25.64
E.	*neospinescens* Bruyns	Berry 7773 (MICH)	Cultivated USA: California	-16.36
E.	*nereidum* Jahand. & Maire	Riina 1778 (MICH)	Morocco: Beni Mellal	-28.47
E.	*neriifolia* L.	Berry 7776 (MICH)	Cultivated USA: California	-17.58
E.	*nicaeensis* All.	Riina 1767 (MICH)	Spain: Madrid	-27.44
E.	*nyassae* Pax	Berry 7778 (MICH)	Cultivated USA: California	-14.51

E.	*obesa* Hook.f.	Wurdack D539 (US)	Cultivated USA: Maryland	-21.90
E.	*ornithopus* Jacq.	Berry 7779 (MICH)	Cultivated USA: California	-17.24
E.	*oxyphylla* Boiss.	Barres BCN 53036 (MICH)	Spain: Toledo	-26.41
E.	*oxystegia* Boiss.	Becker 1219 (PRE)	South Africa: Western Cape	-27.04#
E.	*pachysantha* Baill.	Rauh 73350 (HEID, P)	Cultivated (nat. Madagascar)	-22.38
E.	*paralias* L.	Riina 1565 (MICH)	Greece: Crete	-28.28
E.	*patula* Mill. (= *E. orthoclada* Baker, in Horn el al. 2012)	Riina 1739 (MICH)	Cultivated Netherlands	-26.29
E.	*pedemontana* L.C.Leach	Berry 7872 (MICH)	Cultivated USA: California	-23.30
E.	*peplus* L. (1)	van Ee 651 (MICH)	Argentina: Córdoba	-33.87
E.	*peplus* L. (2)	van Ee 717 (MICH)	USA: California	-32.76
E.	*pervilleana* Baill.	Dorsey 187 (MICH)	Madagascar: Toliara	-25.42
E.	*pirottae* N.Terrac.	Horn s.n. (photovoucher, US)	Cultivated USA: Arizona	-33.02
E.	*piscidermis* M.G.Gilbert	Wurdack s.n. (US)	Cultivated USA: Maryland	-15.51
E.	*platyclada* Rauh	Wurdack s.n. (US)	Cultivated USA: Maryland	-17.39
E.	*plumerioides* Teijsm. ex Hassk.	Berry 7884 (MICH)	Cultivated USA: California	-30.65
E.	*polycephala* Marloth	Riina 1667 (MICH)	Cultivated Netherlands	-16.99
E.	*polygona* Haw.	Morawetz 263 (MICH)	South Africa: Eastern Cape	-15.41
E.	*portulacoides* L. subsp. *collina* (Phil.) Croizat	van Ee 582 (MICH)	Argentina: Neuquén	-26.42
E.	*pseudoglobosa* Marloth	Berry 7803 (MICH)	Cultivated USA: California	-12.46
E.	*pteroneura* A.Berger	Berry 7792 (MICH)	Cultivated USA: California	-22.38
E.	*pulcherrima* Willd. ex Klotzsch	McVaugh 726 (US)	Mexico: Nayarit	-30.15*
E.	*punicea* Sw.	Berry 7848 (MICH)	Cultivated USA: California	-22.00
E.	*purpurea* (Raf.) Fernald	Wurdack 5557 (US)	Cultivated USA: Maryland	-30.79
E.	*radians* Benth.	Berry 7863 (MICH)	Cultivated USA: California	-32.52
E.	*ramiglans* N.E.Br.	Morawetz 305 (MICH)	Cultivated South Africa	-26.47
E.	*ramipressa* Croizat	Berry 7820 (MICH)	Cultivated USA: California	-16.50
E.	*regis-jubae* J.Gay	Riina 1804 (MICH)	Morocco: Tiznit	-25.57
E.	*resinifera* O.Berg	Berry 7817 (MICH)	Cultivated USA: California	-15.72

E.	*retusa* Forssk.	Khalik 2672 (WAG)	Egypt	-25.51
E.	*rhombifolia* Boiss.	Steinmann 1439 (RSA)	Cultivated USA: Maryland	-23.92
E.	*rhombifolia* Boiss.	SL 25 (WIND)	Namibia	-17.92#
E.	*rimarum* Coss. & Balansa	Riina 1774 (MICH)	Morocco: Azilal	-29.56
E.	*robecchii* Pax	Berry 7822 (MICH)	Cultivated USA: California	-15.15
E.	*rubella* Pax			NA
E.	*scatorhiza* S.Carter			NA
E.	*scheffleri* Pax	Berry 7877 (MICH)	Cultivated USA: California	-25.05
E.	*scheffleri* Pax	Morawetz 403 (MICH)	Oman	-26.87#
E.	*schimperi* C.Presl.	Riina 1675 (MICH)	Cultivated Netherlands	-15.27
E.	*schoenlandii* Pax	Becker 878 (PRE)	South Africa	-18.8 (leaf);-20.86 (stem)#
E.	*schugnanica* B.Fedtsch.	Konnov 266 (MO)	Tajikistan	-28.12
E.	*sciadophila* Boiss.	van Ee 650 (MICH)	Argentina: Córdoba	-28.69
E.	*sclerocyathium* Korovin & Popov	Kurbanov 705 (MO)	Turkmenistan: Karatengir	-27.69
E.	*segetalis* L.	Riina 1547 (MICH)	Portugal: Beira Litoral	-29.35
E.	*sinclairiana* Benth.	Ishiki et al. 2311 (NY)	Mexico: Veracruz	-35.93*
E.	*sipolisii* N.E.Br.	Berry 7873 (MICH)	Cultivated USA: California	-18.91
E.	*smithii* S.Carter	Morawetz 336 (MICH)	Oman: Dhofar	-30.40
E.	*socotrana* Balf.f.	Berry 7876 (MICH)	Cultivated USA: California	-24.87
E.	*spathulata* Lam.	Rink 5861 (NY)	USA: New Mexico	-28.62
E.	*sphaerorhiza* Benth.	Steinmann 1020 (RSA)	Mexico: Sonora	-32.03
E.	*stenoclada* Baill.	Berry 7804 (MICH)	Cultivated USA: California	-15.83
E.	*stracheyi* Boiss.	Maser 190 (US)	Nepal	-24.86*
E.	*stracheyi* Boiss.	Rock 8/90 (US)	China: Yunan	-24.23#
E.	*tannensis* Spreng.	Lazarides & Palmer 020 (MO)	Australia: Northern Territory	-27.94*
E.	*tanquahuete* Sessé & Moç.	McVaugh 17307 (US)	Mexico: Jalisco	-26.34*
E.	*teke* Schweinf. ex Pax	Berry 7834 (MICH)	Cultivated USA: California	-16.92

E.	*tirucalli* L. (1)	van Ee 741 (US)	Cultivated USA: District of Columbia	-17.44
E.	*tirucalli* L. (2)	Berry 7772 (MICH)	Cultivated USA: California	-16.60
E.	*tithymaloides* L. ssp. *tithymaloides*	Monsegur 668 (US)	Puerto Rico: Guánica	-23.94*
E.	*tomentulosa* S.Watson	van Ee 710 (US)	Mexico: Baja California Sur	-14.56
E.	*turbiniformis* Choiv.	Riina 1737 (MICH)	Cultivated Netherlands	-25.08
E.	*umbellata* (Pax) Bruyns	Wurdack	Cultivated USA: Maryland	-17.77
E.	*umbelliformis* (Urb. & Ekman) V.W.Steinm. & P.E.Berry	HAJB 81901 (HAJB, MICH)	Cuba: Guantánamo	-31.01
E.	*unispina* N.E.Br	Berry 7798 (MICH)	Cultivated USA: California	-16.67
E.	*usambarica* Pax	Beentjl et al. 1072 (US)	Kenya	-31.71*
E.	*usambarica* Pax	Gereau & Lovett 3021 (US)	Tanzania	-27.17*
E.	*venenifica* Tremaux ex Kotschy	Berry 7868 (MICH)	Cultivated USA: California	-18.60
E.	*virgata* Waldst. & Kit.	Sytsma 7328 (WIS)	USA: Wisconsin	-26.97
E.	*weberbaueri* Mansf.	Berry 7879 (MICH)	Cultivated USA: California	-18.17
Gymnanthes	cf. *albicans* (Griseb.) Urb.	HAJB 81718 (HAJB)	Cuba	-30.13
Homalanthus	*nutans* (G.Forst.) Guill.	Motley 2077 (NY)	French Polynesia: Tahiti	-27.90
Hura	*crepitans* L.	Carrington 2058 (U)	Barbados: St. Michael	-26.67*
Mabea	*taquari* Aubl.	Gillespie 2591 (US)	Guyana	-30.51*
Maprounea	*guianensis* Aubl.	Amaral et al. 720 (US)	Brazil: Amazonas	-30.36*
Microstachys	*chamaelea* (L.) Müll.Arg.	Sugumaram SM150 (US)	Malaysia: Kuala Lumpur	-30.78
Nealchornea	*yapurensis* Huber	Fine s.n. (NY)	Peru: Loreto	-31.59
Neoguillauminia	*cleopatra* (Baill.) Croizat	Cameron 2015 (NY)	New Caledonia	-23.51
Senefelderopsis	*croizatii* Steyerm.	Berry 6104 (MO)	Venezuela: Amazonas	-28.86
Stillingia	*sylvatica* L. subsp. *tenuis* (Small) D.J.Rogers	Rogers 13 (US)	USA: Florida	-27.08*

Table S4. Clade tip-diversity estimates used in the 104-tip MEDUSA and BiSSE analyses, and character state codings used in BiSSE analyses. Arabic numerals in parentheses next to the seven subclades of section *Alectoroctonum* correspond with subclades recognized in Yang et al. (2012; see their Fig. 3b).

Tip clade name as shown in Figure 3	Exemplar species	Number of species included	Number of C_3 species (state 0)	Number of CCM species (state 1)	Number of species with ambiguous coding
Outgroups:					
Stomatocalyceae	*Nealchornea yapurensis*	12	12	0	0
Hippomaneae I	*Hura crepitans*	20	20	0	0
Hippomaneae II	*Bonania microphylla*	128	128	0	0
Hippomaneae III	*Maprounea guianensis*	10	10	0	0
Hippomaneae IV	*Senefelderopsis croizatii*	176	176	0	0
Anthostema	*Anthostema senegalense*	3	3	0	0
Dichostemma	*Dichostemma glaucescens*	2	2	0	0
Calycopeplus	*Calycopeplus casuarinoides*	5	5	0	0
Neoguillauminia	*Neoguillauminia cleopatra*	1	1	0	0
***Euphorbia*:**					
Lagascae	*E. lagascae*	3	3	0	0
Lathyris	*E. lathyris*	1	1	0	0
Holophyllum	*E. stracheyi*	27	27	0	0
Helioscopia I	*E. coniosperma*	1	1	0	0
Helioscopia II	*E. helioscopia*	5	5	0	0
Helioscopia III	*E. nereidum*	14	14	0	0
Helioscopia IV	*E. dimorphocaulon*	7	7	0	0
Helioscopia V	*E. acanthothamnos*	107	107	0	0
Pithyusa	*E. nicaeensis*	54	54	0	0
Myrsinitae	*E. oxyphylla*	14	14	0	0
Sclerocyathium I	*E. sclerocyathium*	1	1	0	0
Sclerocyathium II	*E. shugnanica*	8	8	0	0
Calyptratae	*E. calyptrata*	2	2	0	0
Chylogala	*E. retusa*	4	4	0	0
Paralias	*E. paralias*	12	12	0	0
Tithymalus	*E. peplus*	35	35	0	0
Esula	*E. ericoides*	96	96	0	0
Arvales	*E. franchettii*	7	7	0	0
Patellares	*E. amygdaloides*	14	14	0	0
Herpetorrhizae	*E. aucheri*	12	12	0	0
Exiguae I	*E. exigua*	2	2	0	0
Guyonianae (+ *Biumbellatae* + *Pachycladeae*)	*E. guyoniana*	6	6	0	0
Exiguae II	*E. rimarum*	3	3	0	0
Aphyllis subsect. *Macaronesicae*	*E. aphylla*	11	11	0	0
Aphyllis subsect. *Africanae*	*E. patula*	12	2	10	0
Antso	*E. antso*	1	1	0	0
Pseudacalypha	*E. hadramautica*	6	2	0	4
Lyciopsis (+ *Crotonoides*)	*E. smithii*	13	13	0	0
Somalica	*E. socotrana*	4	4	0	0
Balsamis I	*E. larica*	3	0	3	0
Balsamis II	*E. balsamifera*	3	3	0	0
Anthacanthae subsect. *Florispinae*	*E. jansenvillensis*	62	2	60	0
Anthacanthae subsect. *Platycephalae*	*E. grantii*	7	7	0	0
Anthacanthae subsect. *Pseudeuphorbium* I	*E. dregeana*	6	1	5	0
Anthacanthae subsect. *Dactylanthes*	*E. globosa*	21	0	21	0
Anthacanthae subsect. *Medusea*	*E. ramiglans*	64	0	62	2
Anthacanthae subsect. *Pseudeuphorbium* II	*E. lignosa*	6	0	6	0

Frondosae	*E. pirottae*	7	6	0	1
Eremophyton (+ *Cheirolepidium*)	*E. tannensis*	5	5	0	0
Scatorhizae	*E. scatorhiza*	7	7	0	0
Madagascar Clade (*Denisiae* + *Bosseriae* + *Plagianthae*)	*E. platyclada*	7	2	3	2
Articulofruticosae	*E. ephedroides*	18	0	18	0
Espinosae	*E. espinosa*	2	2	0	0
Tenellae	*E. glanduligera*	4	4	0	0
Crossadenia (+ *Gueinziae*)	*E. appariciana*	11	11	0	0
Anisophyllum subsect. *Acutae*	*E. acuta*	3	3	0	0
Anisophyllum subsect. *Hypericifoliae* I	*E. astyla*	2	0	2	0
Anisophyllum subsect. *Hypericifoliae* II	*E. tomentulosa*	80	0	80	0
Anisophyllum subsect. *Hypericifoliae* III	*E. mesembryanthemifolia*	80	0	80	0
Anisophyllum subsect. *Hypericifoliae* IV	*E. hirta*	90	0	90	0
Anisophyllum subsect. *Hypericifoliae* V	*E. humifusa*	110	0	110	0
Poinsettia subsect. *Lacerae*	*E. jaliscensis*	2	2	0	0
Poinsettia subsect. *Erianthae*	*E. eriantha*	1	1	0	0
Poinsettia subsect. *Exstipulatae*	*E. exstipulata*	2	2	0	0
Poinsettia subsect. *Stormieae*	*E. pulcherrima*	21	21	0	0
Alectoroctonum I (15-2)	*E. sphaerorhiza*	7	7	0	0
Alectoroctonum II (15-1)	*E. insulana*	6	6	0	0
Alectoroctonum III (15-3)	*E. acerensis*	7	7	0	0
Alectoroctonum IV (15-4)	*E. macropus*	7	7	0	0
Alectoroctonum V (15-5–15-8)	*E. ipecacuanhae*	30	27	0	3
Alectoroctonum VI (15-10–15-13)	*E. dioscoreoides*	55	48	5	2
Alectoroctonum VII (15-9)	*E. leucocephala*	3	3	0	0
Pachysanthae	*E. pachysantha*	4	4	0	0
Pervilleanae	*E. pervilleana*	7	7	0	0
Tirucalli	*E. tirucalli*	25	0	25	0
Pacificae	*E. boophthona*	11	10	1	0
NW *Cubanthus*	*E. punicea*	9	9	0	0
NW *Tanquahuete*	*E. tanquahuete*	2	2	0	0
NW *Calyculatae*	*E. calyculata*	2	2	0	0
NW *Lactifluae*	*E. lactiflua*	1	1	0	0
NW *Euphorbiastrum*	*E. pteroneura*	6	5	1	0
NW *Mesophyllae*	*E. sinclairiana*	1	1	0	0
NW *Nummulariopsis*	*E. portulacoides*	37	37	0	0
NW *Portulacastrum*	*E. germainii*	2	0	0	2
NW *Crepidaria* I	*E. lomelii*	13	7	6	0
NW *Crepidaria* II	*E. tithymaloides*	2	1	1	0
NW *Stachydium*	*E. comosa*	7	6	0	1
NW *Brasilienses*	*E. sipolisii*	4	0	4	0
Goniostema I	*E. neohumbertii*	5	5	0	0
Deuterocalli	*E. alluaudii*	3	0	3	0
Denisophorbia	*E. hedyotoides*	13	13	0	0
Goniostema II	*E. milii*	70	35	35	0
Monadenium I	*E. umbellata*	15	0	15	0
Monadenium II	*E. neoarborescens*	75	0	75	0
Rubellae	*E. brunellii*	3	0	0	3
Euphorbia I	*E. abdelkuri*	2	0	2	0
Euphorbia II	*E. epiphylloides*	2	0	2	0
Euphorbia III	*E. lactea*	15	0	15	0
Euphorbia IV	*E. ramipressa*	20	0	20	0
Euphorbia V	*E. ingens*	6	0	6	0
Euphorbia VI	*E. drupifera*	5	0	5	0
Euphorbia VII	*E. gymnocalycioides*	8	1	7	0
Euphorbia VII	*E. griseola*	2	0	2	0
Euphorbia IX	*E. grandicornis*	140	0	140	0
Euphorbia X	*E. resinifera*	157	1	156	0

Table S5. Clades in which a significant shift in the net diversification rate (*r*) was modeled in 10%–50% of the 1000 diversity trees using the MEDUSA method. Shift values are relative to those of a background value of *r*. Values of *r* are interpreted as net speciation events per million years.

Clade membership, placement of shift in *r*, and characteristic photosynthetic pathway type of clade	Percentage of trees in which shift was modeled	Mean value of shift in *r*	Median value of shift in *r*	Standard deviation of shift value	Maximum value of shift in *r*	Minimum value of shift in *r*
Anthacanthae (crown; alternative to stem placement modeled in shift 8; CAM)	47.0%	0.5451	0.5422	0.0905	0.8679	0.3196
Lagascae + *Lathyris* (crown; C_3)	44.6%	-0.0645	-0.0594	0.0191	-0.0134	-0.1254
Alectoroctonum V + VI + VII (stem; C_3, with nested CAM lineage of ~5 spp.)	41.7%	0.1086	0.1061	0.0211	0.1944	0.0672
subgenus *Chamaesyce* (stem; ancestrally C_3)	41.1%	0.0200	0.0220	0.0169	0.0710	-0.0513
Anisophyllum subsect. *Hypericifoliae* II (stem; C_4)	34.0%	0.2233	0.2214	0.0497	0.4312	0.1011
Section *Euphorbia*, exclusive of *Euphorbia* I & II (stem; CAM)	32.3%	0.1828	0.1843	0.0358	0.2931	0.0903
Clade inclusive of sections *Paralias* and *Aphyllis* in subgenus *Esula* (stem; predominantly C_3, CAM activity in sect. *Aphyllis*)	15.3%	0.1447	0.1391	0.0384	0.2326	0.0730
Anisophyllum subsect. *Hypericifoliae* III + IV + V (crown; C_4)	13.3%	0.4501	0.4312	0.1219	0.8142	0.2010
subgenus *Esula*, exclusive of *Lagascae* + *Lathyris* (stem; predominantly C_3, CAM activity in sect. *Aphyllis*)	12.5%	0.0354	0.0301	0.0317	0.1368	-0.0722