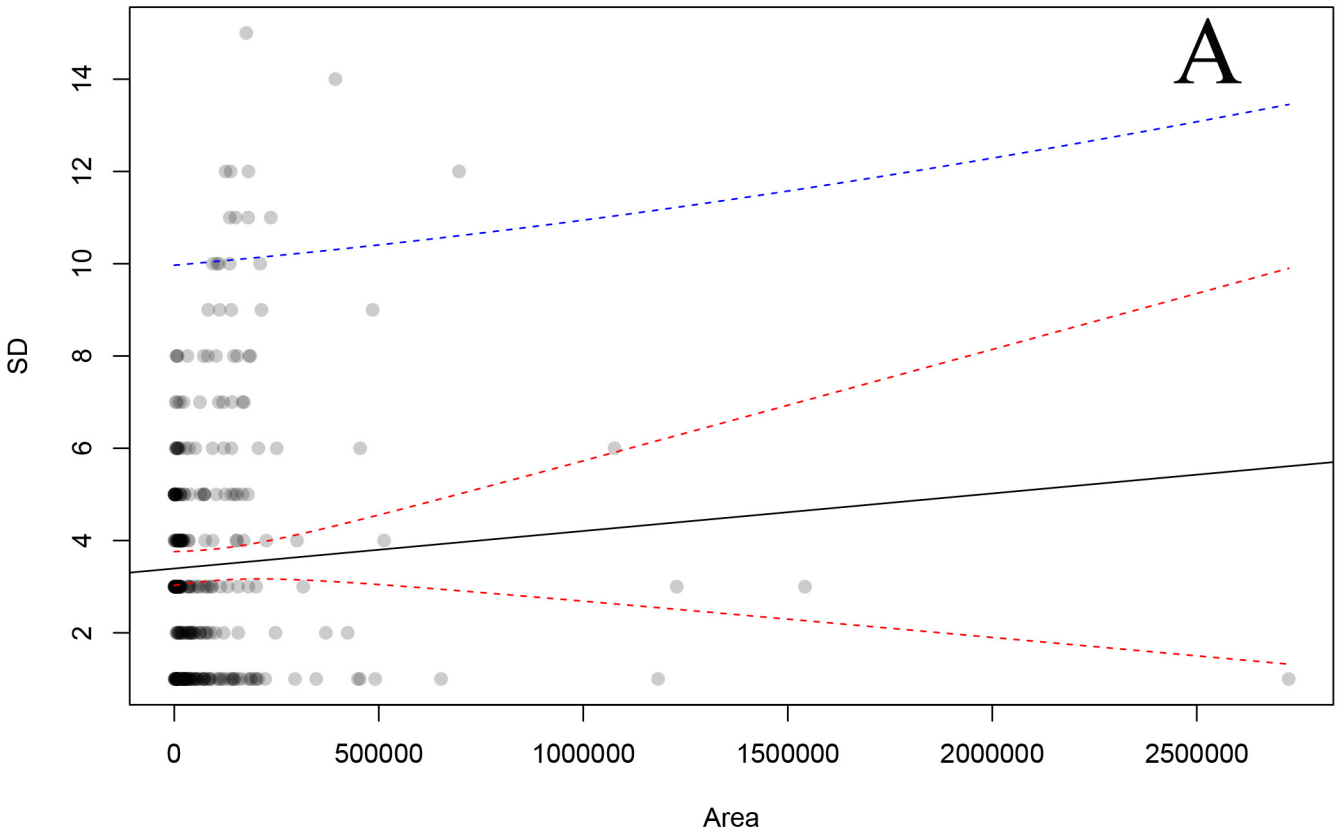
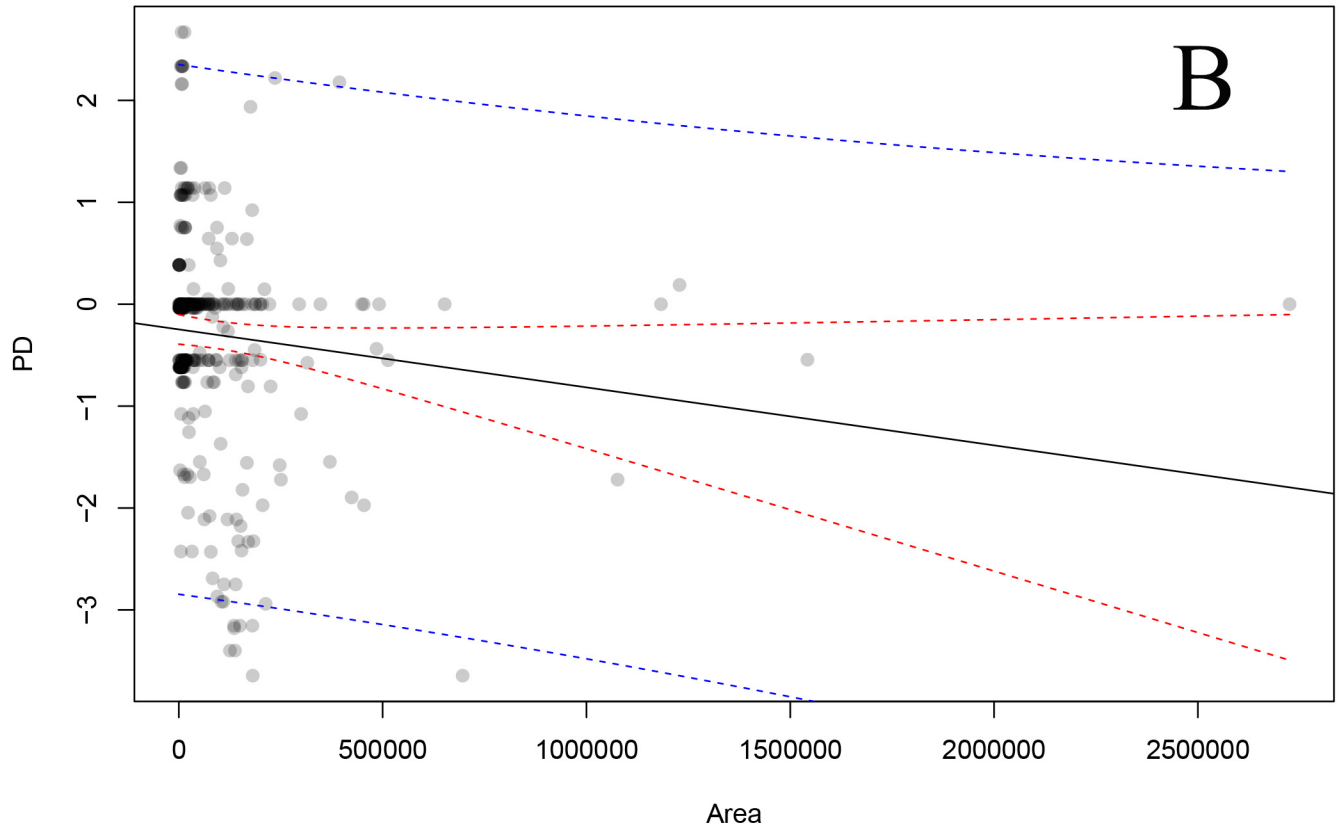

A
SD
2
4
6
8
10
12
14
0
500000
1000000
1500000
2000000
2500000
Area


B
PD
−3
−2
−1
0
1
2
0
500000
1000000
1500000
2000000
2500000
Area


a


b


c


d


e

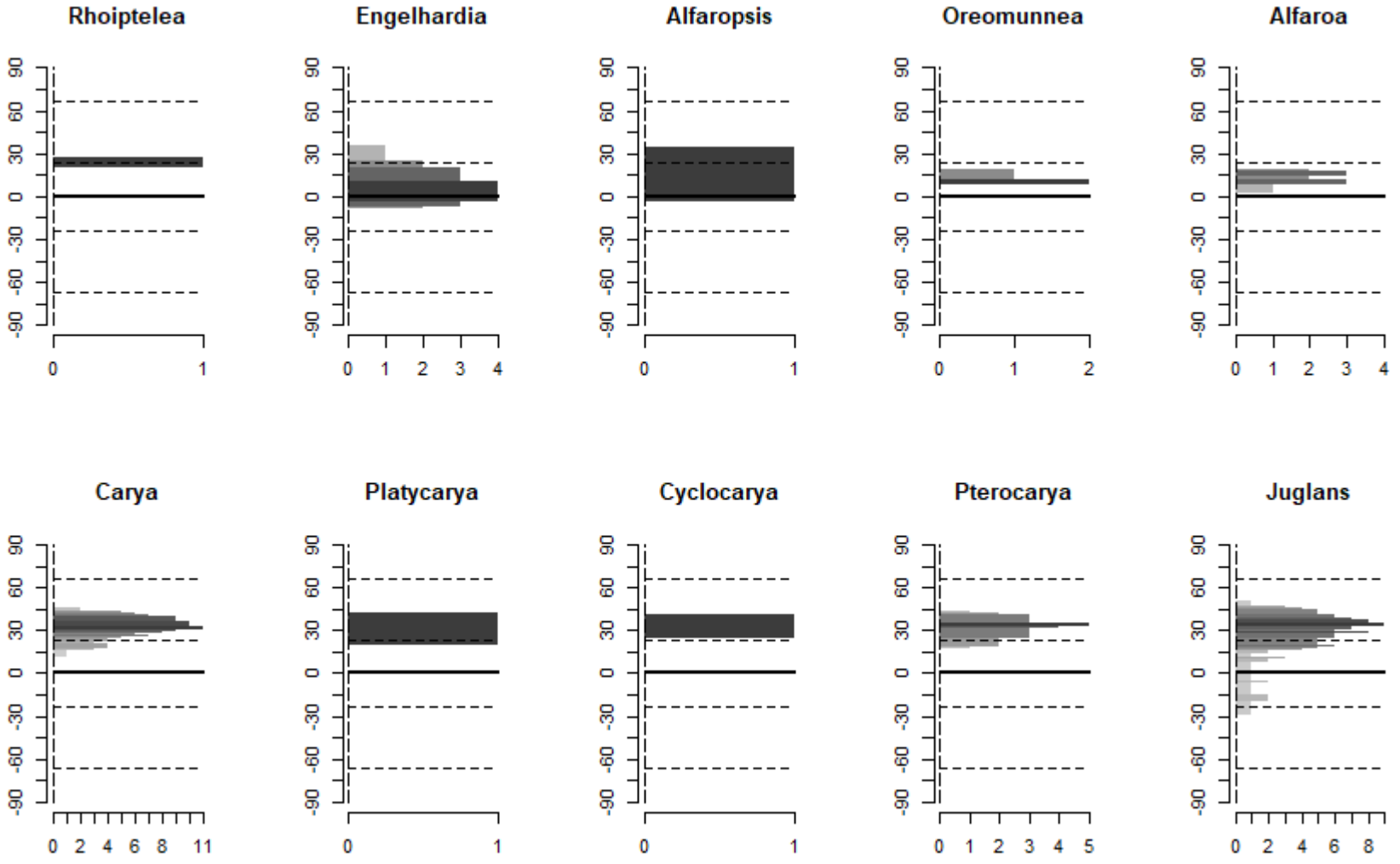

f

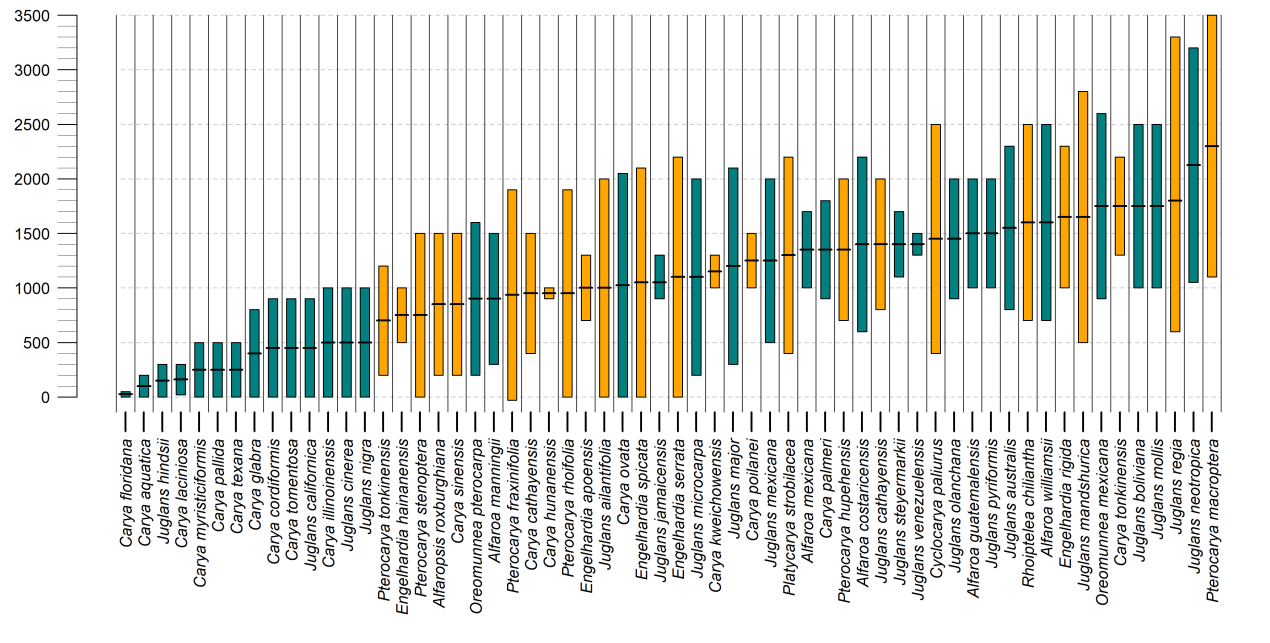

g

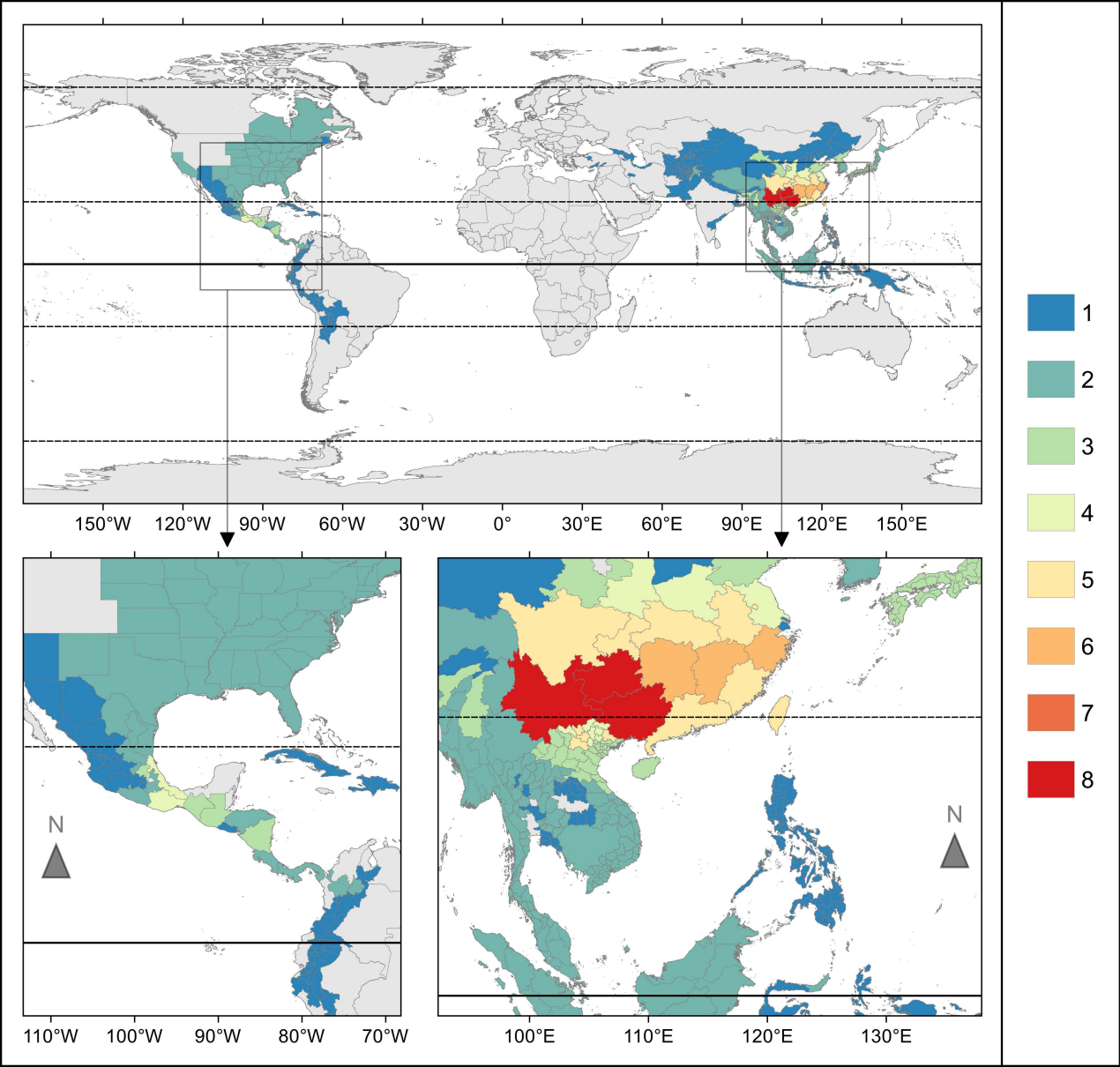

h

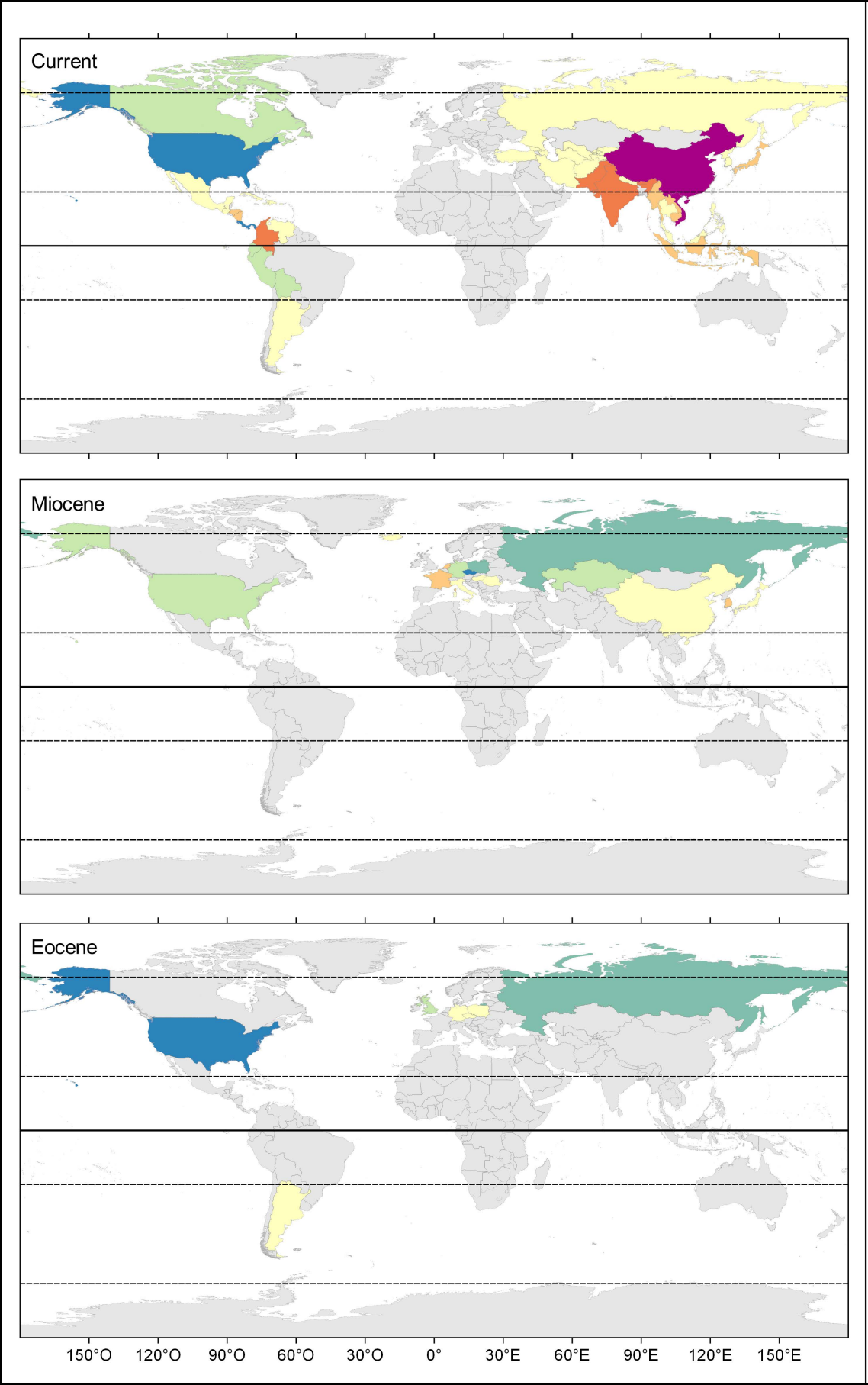

i

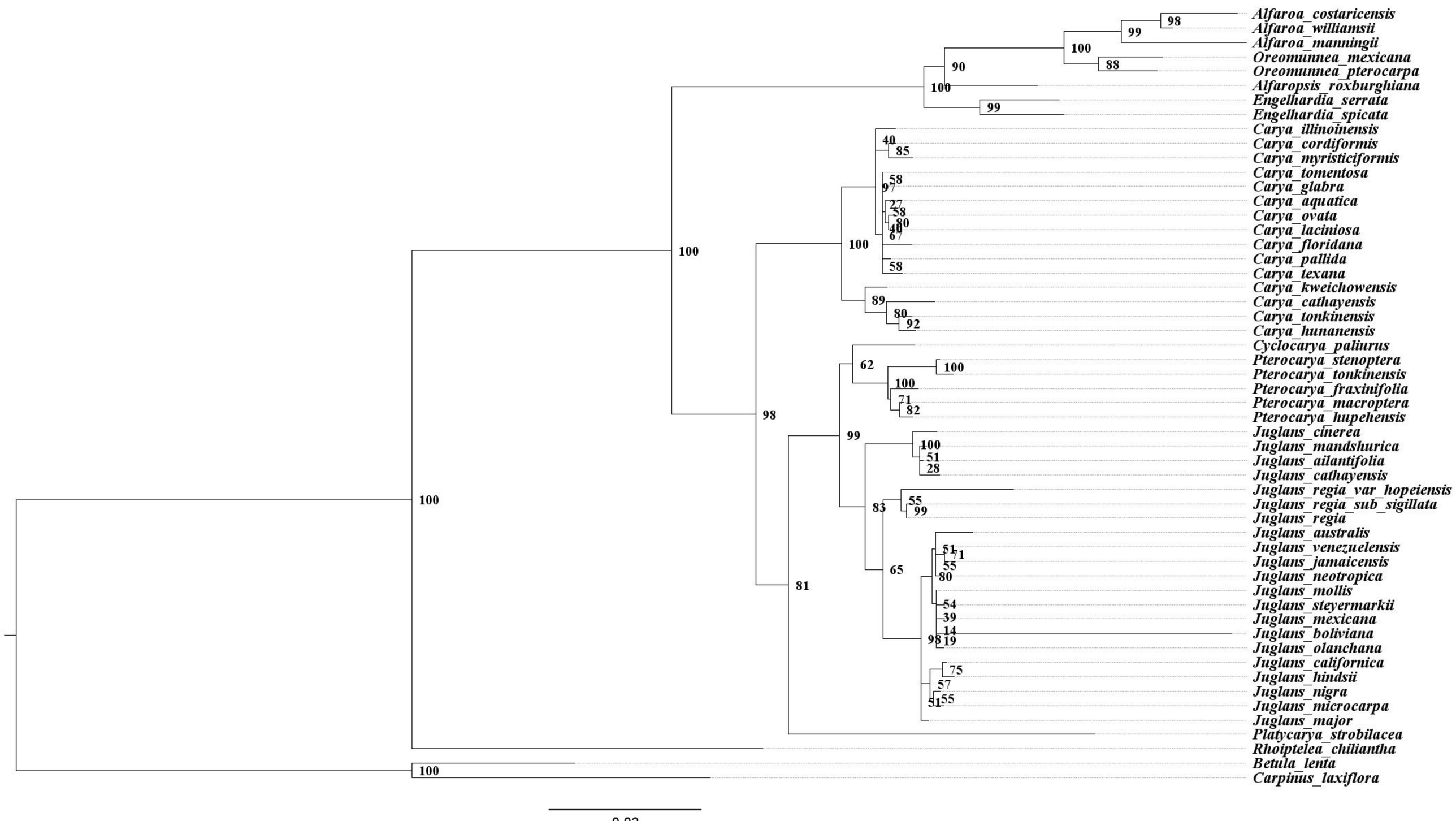

j

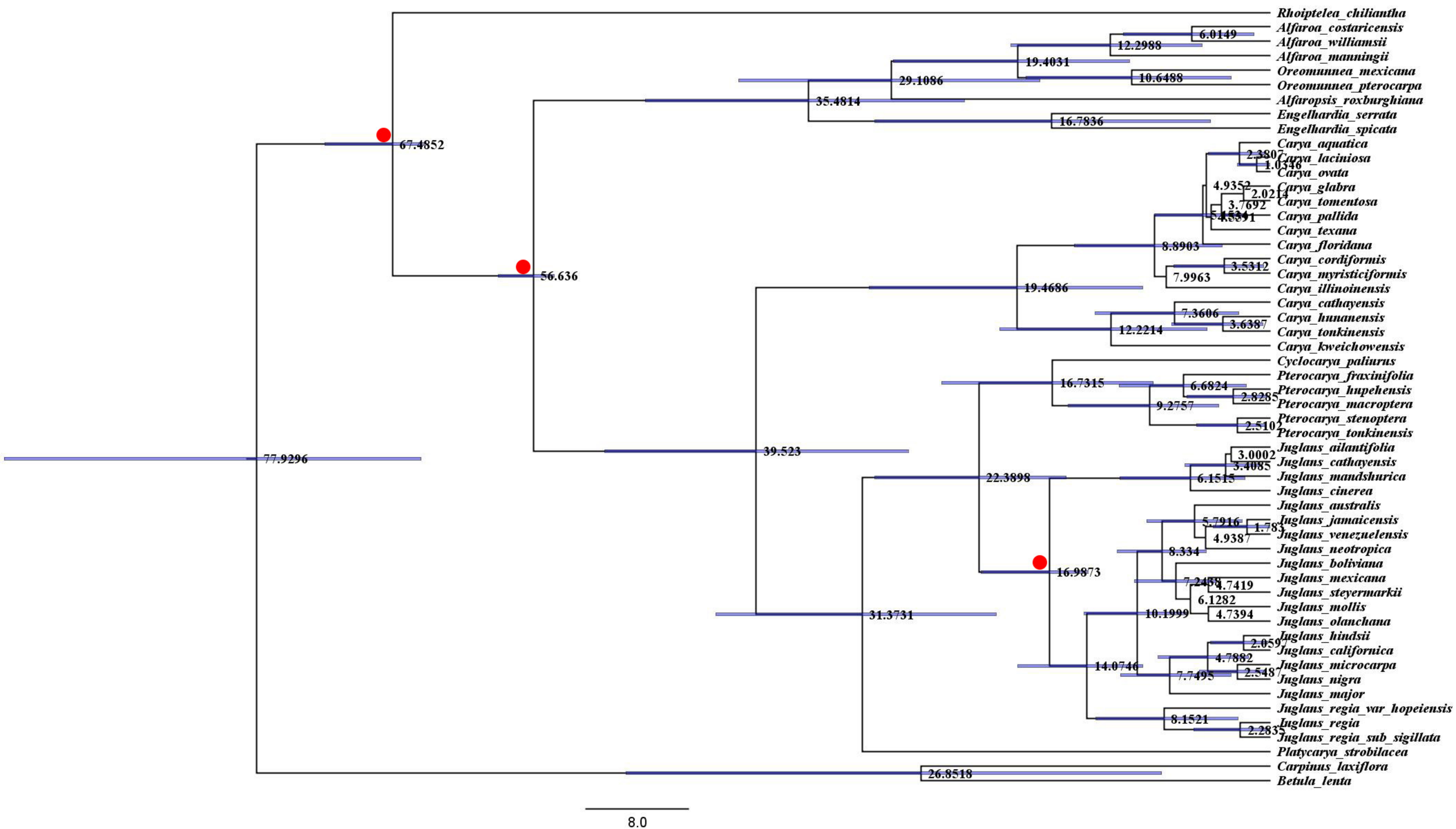

Rhoiptelea
Engelhardia
Alfaropsis
Oreomunnea
Alfaroa
Carya
Platycarya
Cyclocarya
Pterocarya
Juglans
90
60
30
0
-30
-60
-90


3500
3000
2500
2000
1500
1000
500
0
Carya floridana
Carya aquatica
Juglans hindsii
Carya laciniosa
Carya myristiciformis
Carya pallida
Carya texana
Carya glabra
Carya cordiformis
Carya tomentosa
Juglans californica
Carya illinoinensis
Juglans cinerea
Juglans nigra
Pterocarya tonkinensis
Engelhardia hainanensis
Pterocarya stenoptera
Alfaropsis roxburghiana
Carya sinensis
Oreomunnea pterocarpa
Alfaroa manningii
Pterocarya fraxinifolia
Carya cathayensis
Carya hunanensis
Pterocarya rhoifolia
Engelhardia apoensis
Juglans ailantifolia
Carya ovata
Engelhardia spicata
Juglans jamaicensis
Engelhardia serrata
Juglans microcarpa
Carya kweichowensis
Juglans major
Carya pollanei
Juglans mexicana
Platycarya strobilacea
Alfaroa mexicana
Carya palmeri
Pterocarya hupehensis
Alfaroa costaricensis
Juglans cathayensis
Juglans steyermarkii
Juglans venezuelensis
Cyclocarya paliurus
Juglans olanchana
Alfaroa guatemalensis
Juglans pyriformis
Juglans australis
Rhoiptelea chiliantha
Alfaroa williamsii
Engelhardia rigida
Juglans mandshurica
Oreomunnea mexicana
Carya tonkinensis
Juglans boliviana
Juglans mollis
Juglans regia
Juglans neotropica
Pterocarya macroptera


150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
N
110°W
100°W
90°W
80°W
70°W
N
100°E
110°E
120°E
130°E
1
2
3
4
5
6
7
8


Current
Miocene
Eocene
150°O
120°O
90°O
60°O
30°O
0°
30°E
60°E
90°E
120°E
150°E
[-4, -3]
[-3, -2]
[-2, -1]
[-1, 0]
[0, 1]
[1, 2]
[2, 3]
[3, 4]


Alfaroa_costaricensis
Alfaroa_williamsii
Alfaroa_manningii
Oreomunnea_mexicana
Oreomunnea_pterocarpa
Alfaropsis_roxburghiana
Engelhardia_serrata
Engelhardia_spicata
Carya_illinoinensis
Carya_cordiformis
Carya_myristiciformis
Carya_tomentosa
Carya_glabra
Carya_aquatica
Carya_ovata
Carya_laciniosa
Carya_floridana
Carya_pallida
Carya_texana
Carya_kweichowensis
Carya_cathayensis
Carya_tonkinensis
Carya_lunanensis
Cyclocarya_paliurus
Pterocarya_stenoptera
Pterocarya_tonkinensis
Pterocarya_fraxinifolia
Pterocarya_macroptera
Pterocarya_hupehensis
Juglans_cinerea
Juglans_mandshurica
Juglans_ailantifolia
Juglans_cathayensis
Juglans_regia_var_hopeiensis
Juglans_regia_sub_sigillata
Juglans_regia
Juglans_australis
Juglans_venezuelensis
Juglans_jamaicensis
Juglans_neotropica
Juglans_mollis
Juglans_steyermarkii
Juglans_mexicana
Juglans_boliviana
Juglans_olanchana
Juglans_californica
Juglans_hindsii
Juglans_nigra
Juglans_microcarpa
Juglans_major
Platycarya_strobilacea
Rhoiptelea_chiliantha
Betula_lenta
Carpinus_laxiflora
0.02


Rhoiptelea_chiliantha
Alfaroa_costaricensis
Alfaroa_williamsii
Alfaroa_manningii
Oreomunnea_mexicana
Oreomunnea_pterocarpa
Alfaropsis_roxburghiana
Engelhardia_serrata
Engelhardia_spicata
Carya_aquatica
Carya_laciniosa
Carya_ovata
Carya_glabra
Carya_tomentosa
Carya_pallida
Carya_texana
Carya_floridana
Carya_cordiformis
Carya_myristiciformis
Carya_illinoinensis
Carya_cathayensis
Carya_hunanensis
Carya_tonkinensis
Carya_kweichowensis
Cyclocarya_paliurus
Pterocarya_fraxinifolia
Pterocarya_hupehensis
Pterocarya_macroptera
Pterocarya_stenoptera
Pterocarya_tonkinensis
Juglans_ailantifolia
Juglans_cathayensis
Juglans_mandshurica
Juglans_cinerea
Juglans_australis
Juglans_jamaicensis
Juglans_venezuelensis
Juglans_neotropica
Juglans_boliviana
Juglans_mexicana
Juglans_steyermarkii
Juglans_mollis
Juglans_olanchana
Juglans_hindsii
Juglans_californica
Juglans_microcarpa
Juglans_nigra
Juglans_major
Juglans_regia_var_hopeiensis
Juglans_regia
Juglans_regia_sub_sigillata
Platycarya_strobilacea
Carpinus_laxiflora
Betula_lenta
67.4852
56.636
77.9296
39.523
35.4814
29.1086
19.4031
12.2988
6.0149
10.6488
16.7836
2.3807
1.0546
4.9352
2.0214
3.7692
8.8903
3.5312
7.9963
19.4686
7.3606
3.6387
12.2214
16.7315
6.6824
2.8285
9.2757
2.5102
3.0002
3.4085
6.1515
22.3898
5.7916
1.783
4.9387
8.334
16.9873
7.2458
4.7419
6.1282
4.7394
10.1999
31.3731
2.059
4.7882
2.5487
14.0746
7.7495
8.1521
2.2835
26.8518
8.0

Appendix S1

An update on the classification of subfamilies, genera and species of the relict tree family Juglandaceae

Yi-Gang Song[1,2,3], Yann Fragnière[1], Hong-Hu Meng[4], Ying Li[2,3], Sébastien Bétrisey[1], Adriana Corrales[5], Steven Manchester[6], Min Deng[2,3], Anna K. Jasińska[7], Hoàng Văn Sâm[8], Gregor Kozlowski[1,9]

[1] Department of Biology and Botanic Garden, University of Fribourg, Chemin du Musée 10, CH-1700 Fribourg, Switzerland

[2] Shanghai Chenshan Plant Science Research Centre, Chinese Academy of Sciences / Shanghai Chenshan Botanical Garden, 3888 Chenhua Road, Songjiang, Shanghai 201602, China

[3] Eastern China Conservation Centre for Wild Endangered Plant Resources, Shanghai Chenshan Botanical Garden, 3888 Chenhua Road, Songjiang, Shanghai 201602, China

[4] Centre for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Xuefu Rd. 88, Wuhua District, Kunming 650223, China

[5] Facultad de Ciencias Naturales y Matemáticas, Universidad del Rosario, Carrera 24No. 63C-69, Bogota 111221, Colombia

[6] Florida Museum of Natural History, University of Florida, 1659 Museum Rd, Gainesville, FL 32611, USA

[7] Institute of Dendrology, Polish Academy of Sciences, Parkowa 5, 62-035 Kórnik, Poland

[8] Vietnam National University of Forestry, Xuan Mai, Ha Noi, Vietnam

[9] Natural History Museum Fribourg, Chemin du Musée 6, CH-1700 Fribourg, Switzerland

Correspondence

Gregor Kozlowski, Department of Biology and Botanic Garden, University of Fribourg, Chemin du Musée 10, CH-1700 Fribourg, Switzerland. E-mail: gregor.kozlowski@unifr.ch

Juglandaceae is monophyletic and belongs to the Fagales (Manos et al., 2007; APG III, 2009). Based on the newest angiosperm phylogenetic classification, APG III and IV (APG III, 2009; APG IV, 2016), and the recently published Juglandaceae phylogenies (Manos & Stone, 2001; Manos et al., 2007), the family consists of three subfamilies (Rhoipteleoideae, Engelhardioideae and Juglandoideae) and 10 genera: *Rhoiptelea*, *Engelhardia*, *Alfaropsis*, *Oreomunnea*, *Alfaroa*, *Carya*, *Platycarya*, *Cyclocarya*, *Pterocarya*, and *Juglans* (Appendix S2).

1 Rhoipteleoideae (1 genus, 1 species)

1.1 *Rhoiptelea*

Phylogenetically, this genus is the most isolated and potentially primitive one in the family. Until recently, it was treated as a separate family, Rhoipteleaceae. However, it is now included in the Juglandaceae (Manos et al., 2007; APG III, 2009). There is no taxonomic controversy within *Rhoiptelea*, which is a monotypic genus consisting of only one species, *R. chiliantha* (Appendix S2) (Lu, Stone, & Grauke, 1999).

2 Engelhardioideae (4 genera, 13 species)

2.1 *Engelhardia*

The phylogeny and number of species within the genus *Engelhardia* are not well understood. Several narrow endemic species described in the Sunda Islands are very doubtful candidates for inclusion and should not be accepted without solid molecular phylogenetic and detailed morphological comparisons with the whole genus. Thus, the IUCN and other assessments should follow the more conservative division of the genus into 5 species, as proposed by Flora of China (English version) and Flora Malesiana (Appendix S2) (Jacobs, 1960; Lu et al., 1999). Additionally, *Alfaropsis roxburghiana* (= *E. roxburghiana*) is no longer included in this genus (Appendix S2) (Manos & Stone, 2001; Manos et al., 2007).

2.2 *Alfaropsis*

This new genus was separated from *Engelhardia* and accepted by the majority of taxonomists. It consists of one species, *Alfaropsis roxburghiana* (Appendix S2) (Manos & Stone, 2001; Manos et al., 2007; Stone, 2010; Meng, Su, Huang, Zhu, & Zhou, 2015).

2.3 *Oreomunnea*

There are 2 accepted species in *Oreomunnea*: *O. mexicana* and *O. pterocarpa*. Another described species (*O. munchiquensis*) is similar to *O. pterocarpa*, but its taxonomic status still requires revision (Stone, 2009), and this taxon should be merged with *O. pterocarpa* (Appendix S2).

2.4 *Alfaroa*

The phylogeny and number of species within *Alfaroa* are not well understood. We based our list on an experienced specialist (Donald E. Stone) who worked on this genus throughout his life and was well versed in the morphology of the genus across the whole distribution area. His most recent taxonomic assessments suggest that there are only 5 species (Stone, 2009; Stone, 2010). According to morphological comparisons across the whole Mesoamerica of Stone (2009), *A. hondurensis* should be included with *A. guatemalensis*, *A. guanacastensis* with *A. manningii*, and *A. colombiana* with *A. williamsii*. Thus, the 5 accepted species in the genus are as follows: *A. costaricensis*, *A. guatemalensis*, *A. manningii*, *A. mexicana*, and *A. williamsii* (Appendix S2).

3 Juglandoideae (5 genera, 48 species)

3.1 *Carya*

There are a total of 18 species (6 in Eastern Asia and 12 in Eastern North America) in this genus (Appendix S2). In Eastern Asia, there are 4 species of *Carya* in the Flora of China. *Carya sinensis*, which is endemic to southwestern China, was formerly treated as the monotypic genus *Annamocarya*, but it belongs to *Carya* according to molecular phylogenetic analyses (Leroy, 1955; Lu et al., 1999; Manos & Stone, 2001; Manos et al., 2007; Zhang et al., 2013). In Eastern North America, there are 11 species in Flora of North America (Stone, 1997), and one species (*C. palmeri*) is endemic to Mexico (Stone, 1962).

3.2 *Platycarya*

The taxonomic status within the extant *Platycarya* has been modified several times, comprising up to 4 species (e.g., *P. strobilacea, P. simplicifolia*, *P. longipes* and *P. longzhouensis*) (Kuang & Lu, 1979). However, according to the newest treatments, the genus is monotypic, consisting of a single species, *P. strobilacea* (Appendix S2) (Lu et al., 1999; Chen et al., 2012; Wan, Zheng, Huang, Guichoux, & Petit, 2017).

3.3 *Cyclocarya*

There is no taxonomic controversy within *Cyclocarya*. It is a monotypic genus with only one species, *C. paliurus* (Appendix S2) (Lu et al., 1999).

3.4 *Pterocarya*

The taxonomy of *Pterocarya* has also changed between the English version and Chinese version of Flora of China. Here, we will follow the new treatment in the English version, consisting of five species (Kuang & Lu, 1979; Lu et al., 1999). There is also one species from South Caucasus (Appendix S2).

3.5 *Juglans*

There is still some controversy about the species number. Based on Flora of China, Flora of North America and the new global phylogenetic treatments, we identified 20 species in this genus (Appendix S2) (Stone, 1997; Lu et al., 1999; Stanford, Harden, & Parks, 2000; Aradhya, Potter, Gao, & Simon, 2007; Stone, Oh, Tripp, Rios, & Manos, 2009; Hu, Woeste, & Zhao, 2017, Zhang, et al., 2019).

Thus, according to our survey, there are a total of 10 genera with 60 species in the Juglandaceae (Appendix S2).

REFERENCES

APG III (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society*, 161, 105–121.

APG IV (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society*, 181, 1–20.

Aradhya, M. K., Potter, D., Gao, F., & Simon, C. J. (2007). Molecular phylogeny of *Juglans* (Juglandaceae): a biogeographic perspective. *Tree Genetics & Genomes*, 3, 363–378.

Chen, S. C., Zhang, L., Zeng, J., Shi, F., Yang, H., Mao, Y. R., & Fu, C. X. (2012). Geographic variation of chloroplast DNA in *Platycarya strobilacea* (Juglandaceae). *Journal of Systematics and Evolution*, 50, 374–385.

Hu, Y. H., Woeste, K. E., & Zhao, P. (2017). Completion of the chloroplast genomes of give Chinese *Juglans* and their contribution to chloroplast phylogeny. *Frontiers in Plant Science*, 7, 1955.

Jacobs, M. (1960). Juglandaceae. In van Steenis C. G. G. J. (Eds.), *Flora of Malesiana* (Ser.1, Vol. 6, pp. 143–154). Djakarta & Leiden: Noordhoff-Kolff.

Kuang, K. R., & Lu, A. M. (1979). Juglandaceae. In Editorial Committee of Flora of China, Chinese Academy of Sciences (Eds.), *Flora of China* (Vol. 21, pp. 8–42). Beijing: Science Press.

Leroy, J. F. (1955). Étude sur les Juglandaceae. à la recherche d'une conception morphologique de la fleur femelle et du fruit. *Bulletin Museums Natl Histoire Nat*, 6, 1–246.

Lu, A. M., Stone, D. E., & Grauke, L. J. (1999). Juglandaceae. In Wu, Z.Y. & Raven, P. H. (Eds.), *Flora of China* (Vol. 4, pp. 277–285). Beijing & St. Louis: Science Press & Missouri Botanical Garden Press.

Manos, P. S., Soltis, P. S., Soltis, D. E., Manchester, S. R., Oh, S. H., Bell, C. D., … Stone, D. E. (2007). Phylogeny of extant and fossil Juglandaceae inferred from the integration of molecular and morphological data sets. *Systematic Biology*, 56, 412–430.

Manos, P. S., & Stone, D. E. (2001). Evolution, phylogeny, and systematics of the Juglandaceae. *Annals of the Missouri Botanical Garden*, 88, 231–269.

Meng, H. H., Su, T., Huang, Y. J., Zhu, H., & Zhou, Z. K. (2015). Late Miocene *Palaeocarya* (Engelhardieae: Juglandaceae) from Southwest China and its biogeographic implications. *Journal of Systematics and Evolution*, 53, 499–511.

Stanford, A. M., Harden, R., & Parks, C. R. (2000). Phylogeny and biogeography of *Juglans* (Juglandaceae) based on matK and ITS sequence data. *American Journal of Botany*, 87, 872–882.

Stone, D. E. (1962). Affinities of a Mexican endemic, *Carya palmeri*, with American and Asian hickories. *American Journal of Botany*, 15, 199–212.

Stone, D. E. (1997). Juglandaceae. In Flora of North America Editorial Committee (Eds.), *Flora of North Amerrica north of Mexico* (Vol. 3, pp. 416–428). New York: Oxford University Press.

Stone, D. E. (2009). Juglandaceae. In Davidse, G., Sousa, S., & Chater, A. O. (Eds.), *Flora Mesoamericana* (Vol. 2, pp. 1–24). México, D.F.: Universidad Nacional Autónoma de México; St. Louis: Missouri Botanical Garden; London: The Natural History Museum.

Stone, D. E. (2010). Review of New World *Alfaroa* and Old World *Alfaropsis* (Juglandaceae). *Novon*, 20, 215–224.

Stone, D. E., Oh, S. H., Tripp, E. A., Rios, L. E., & Manos, P. S. (2009). Natural history, distribution, phylogenetic relationships, and conservation of Central American black walnuts (*Juglans* sect. *Rhysocaryon*). *Journal of the Torrey Botanical Society*, 136, 1–25.

Wan, Q. C., Zheng, Z., Huang, K. Y., Guichoux, E., & Petit, R. J. (2017). Genetic divergence within the monotypic tree genus *Platycarya* (Juglandaceae) and its implications for species' past dynamics in subtropical China. *Tree Genetics & Genomes*, 13, 73.

Zhang, J. B., Li, R. Q., Xiang, X. G., Manchester, S. R., Lin, L., Wang, W., … Chen, Z. D. (2013). Integrated fossil and molecular data reveal the biogeographic diversification of the eastern Asian-eastern North American disjunct hickory genus (*Carya* Nutt.). *PloS one*, 8, e70449.

Zhang, B. W., Xu, L. L., Li, N., Yan, P. C., Jiang, X. H., Woeste, K. E., … Bai, W. N. (2019). Phylogenomics reveals an ancient hybrid origin of the Persian Walnut. *Molecular Biology and Evolution*, msz112, DOI: https://doi.org/10.1093/molbev/msz112.

Supporting Information

Table S1 A taxonomically-arranged list of GenBank accession numbers used in this study.

Family	Species	*atp*B-*rbc*L	ITS	*mat*K	*trn*L-*trn*F
Betulaceae	*Betula lenta*	FJ423682.1	KT308936.1	FJ011827.1	KF419078.1
Betulaceae	*Carpinus laxiflora*	FJ423645.1	FJ011722.1	AB060076.1	AY211404.1
Juglandaceae	*Rhoiptelea chiliantha*	AF303746.1	AF303800.1	U92852.1	AF303773.1
Juglandaceae	*Engelhardia serrata*	EF140992.1	EF141010.1	KF419015.1	EF141001.1
Juglandaceae	*Engelhardia spicata*	AF303748.1	AF303802.1	KR530783.1	AF303775.1
Juglandaceae	*Alfaropsis roxburghiana*	EF140989.1	EF141007.1	KF201339.1	AF303774.1
Juglandaceae	*Oreomunnea mexicana*	EF140994.1	EF141012.1	KF419014.1	AF303780.1
Juglandaceae	*Oreomunnea pterocarpa*	EF140996.1	EF141014.1		EF141005.1
Juglandaceae	*Alfaroa costaricensis*	AF303749.1	AF303803.1		AF303776.1
Juglandaceae	*Alfaroa manningii*	AF303751.1	AF303805.1		AF303778.1
Juglandaceae	*Alfaroa williamsii*	AF303752.1	AF303806.1	U92849.1	AF303779.1
Juglandaceae	*Carya aquatica*	KF418855.1	KF201301.1	KF201324.1	KF419055.1
Juglandaceae	*Carya cathayensis*	KF418856.1	AF303819.1	KF201325.1	AF303792.1
Juglandaceae	*Carya cordiformis*	AF303766.1	KF201303.1	KF201326.1	AF303793.1
Juglandaceae	*Carya floridana*	KF418857.1	KF201304.1	KJ772635.1	KF419057.1
Juglandaceae	*Carya glabra*	AF303769.1	KF201310.1	KF201327.1	AF303796.1
Juglandaceae	*Carya hunanensis*	KF418858.1	KF201306.1	KF419016.1	KF419058.1
Juglandaceae	*Carya illinoinensis*	AF303771.1	AF303825.1	KF201329.1	AF303798.1
Juglandaceae	*Carya kweichowensis*	KF201479.1	KF201307.1	KF201330.1	KF201496.1
Juglandaceae	*Carya laciniosa*	KF418859.1	KF201308.1	KF201331.1	KF419060.1
Juglandaceae	*Carya myristiciformis*	AF303767.1	KF201309.1	KF201332.1	AF303794.1
Juglandaceae	*Carya ovata*	AF303768.1	AF174620.1	KF201334.1	AF303795.1
Juglandaceae	*Carya pallida*	KF201482.1	KF201312.1		KF201499.1
Juglandaceae	*Carya texana*	KF201484.1	KF201314.1	KF201336.1	KF201501.1
Juglandaceae	*Carya tomentosa*	AF303770.1	KF201315.1	KF201337.1	AF303797.1
Juglandaceae	*Carya tonkinensis*	AF303772.1	KF201316.1	KF201338.1	KF201503.1
Juglandaceae	*Platycarya strobilacea*	AF303754.1	AF179584.1	KF201342.1	KF201506.1
Juglandaceae	*Cyclocarya paliurus*	KP671806.1	AF179583.1	AY147098.1	AF303790.1
Juglandaceae	*Pterocarya fraxinifolia*		KT934647.1	KF419019.1	KY574108.1
Juglandaceae	*Pterocarya hupehensis*		KF214260.1	KF201343.1	KF214263.1
Juglandaceae	*Pterocarya macroptera*	AF303760.1	AF303814.1	MH748974.1	AF303787.1
Juglandaceae	*Pterocarya stenoptera*	KF201490.1	KF201321.1	KF201344.1	KF419065.1
Juglandaceae	*Pterocarya tonkinensis*	KF201491.1	KF201322.1	AF118043.1	KF419066.1
Juglandaceae	*Juglans ailantifolia*	AY293314.1	AF179567.1	AF118024.1	KF419062.1
Juglandaceae	*Juglans australis*	AY293319.1	AF179568.1	AF118025.1	AY231171.1
Juglandaceae	*Juglans boliviana*		FJ043010.1	AF118026.1	

Juglandaceae	*Juglans californica*	AY293323.1	AF338473.1	AF118027.1	
Juglandaceae	*Juglans cathayensis*	KF201487.1	KF201318.1	AF118028.1	KF201505.1
Juglandaceae	*Juglans cinerea*	AF303759.1	AF303813.1	AF118029.1	AF303786.1
Juglandaceae	*Juglans hindsii*	AY293326.1	MF182369.1	AF118031.1	
Juglandaceae	*Juglans mexicana*		FJ043014.1		
Juglandaceae	*Juglans regia* var. *hopeiensis*	AY293320.1	KY652952.1		
Juglandaceae	*Juglans jamaicensis*		FJ043017.1		
Juglandaceae	*Juglans major*	AY293325.1	AF338484.1	AF118032.1	
Juglandaceae	*Juglans mandshurica*	AY293315.1	MH092017.1	AF118033.1	AF303785.1
Juglandaceae	*Juglans microcarpa*	AF303757.1	AF338487.1	AF118034.1	AF303784.1
Juglandaceae	*Juglans mollis*	AY293329.1	FJ043020.1		
Juglandaceae	*Juglans neotropica*	AY293321.1	FJ043021.1	AF118035.1	AY231168.1
Juglandaceae	*Juglans nigra*	AY293327.1	AF174626.1	AF118036.1	AF303783.1
Juglandaceae	*Juglans olanchana*	AY293328.1	FJ043025.1	AF118037.1	
Juglandaceae	*Juglans regia*	EF140993.1	AF399875.1	AF118038.1	AF399880.1
Juglandaceae	*Juglans regia* sub. *sigillata*	AY293317.1	MF182371.1	KX526663.1	AY231173.1
Juglandaceae	*Juglans steyermarkii*		FJ043027.1		
Juglandaceae	*Juglans venezuelensis*		FJ043029.1		

Table S2 AIC of biogeographic reconstruction with DEC, DEC+J, DIVALIKE, DIVALIKE+J, BAYAREALIKE, and BAYAREALIKE+J models.

model	No. parameters	LnL	AIC	d	e	j
DEC	2	-71.72	147.7	0.0035	1.00E-12	0
DEC+J	3	-68.21	142.9	0.0023	1.00E-12	0.014
DIVALIKE	2	-70.02	144.3	0.0041	1.00E-12	0
DIVALIKE+J	3	-68.95	144.4	0.003	8.20E-10	0.0091
BAYAREALIKE	2	-89.14	182.5	0.0024	3.00E-02	0
BAYAREALIKE+J	3	-71.15	148.8	0.0015	1.80E-03	0.019

Table S3 Species diversity and phylogenetic diversity of the administrative units with species diversity equal or higher than five.

Country	Province/State	Species diversity (SD)	Phylogenetic diversity (PD)
China	Guizhou	14	1.94
China	Yunnan	13	2.18
China	Guangxi	11	2.22
China	Hunan	9	0.15
China	Sichuan	8	-0.44
China	Chongqing	7	-0.12
China	Hubei	8	-0.45
China	Zhejiang	8	0.43
China	Jiangxi	7	0.64
China	Anhui	6	-0.69
China	Fujian	6	0.15
China	Gansu	6	-1.97
China	Shaanxi	6	-1.97
China	Taiwan	6	0.15
China	Guangdong	5	0.92
China	Henan	5	-1.56
China	Jiangsu	5	-1.37
Costa Rica		6	-0.48
Guatemala		7	-0.22
Indonesia	Central Kalimantan	5	-0.55
Indonesia	East Kalimantan	5	-0.55
Indonesia	North Kalimantan	5	-0.55
Indonesia	South Kalimantan	5	-0.55
Indonesia	West Kalimantan	5	-0.55
Laos	Bokeo	5	0.75
Laos	Bolikhamsai	5	0.75
Laos	Luang Namtha	5	0.75
Laos	Oudomxay	5	0.75
Laos	Xieng Khouang	5	0.75
Malaysia	Sabah	5	-0.55
Malaysia	Sarawak	5	-0.55
Mexico	Veracruz	9	0.05
Mexico	Oaxaca	7	0.55
Mexico	Chiapas	6	0.64
Mexico	Nuevo León	5	-1.05
United States of America	Arkansas	12	-3.40
United States of America	Mississippi	12	-3.40
United States of America	Oklahoma	12	-3.65
United States of America	Texas	12	-3.65

United States of America	Alabama	11	-3.18
United States of America	Illinois	11	-3.15
United States of America	Missouri	11	-3.15
United States of America	Indiana	10	-2.87
United States of America	Kentucky	10	-2.92
United States of America	Louisiana	10	-3.15
United States of America	Tennessee	10	-2.92
United States of America	Kansas	9	-2.94
United States of America	North Carolina	9	-2.75
United States of America	South Carolina	9	-2.69
United States of America	Virginia	9	-2.75
United States of America	Delaware	8	-2.43
United States of America	Georgia	8	-2.42
United States of America	Iowa	8	-2.33
United States of America	Maryland	8	-2.43
United States of America	Ohio	8	-2.33
United States of America	Florida	7	-2.33
United States of America	New Jersey	7	-2.05
United States of America	New York	7	-2.11
United States of America	Pennsylvania	7	-2.11
United States of America	West Virginia	7	-2.11
United States of America	Connecticut	6	-1.70
United States of America	Massachusetts	6	-1.70
United States of America	Michigan	6	-1.72
United States of America	Rhode Island	5	-1.63
United States of America	Vermont	5	-1.26
Vietnam	Lang Son	8	2.16
Vietnam	Lao Cai	8	2.16
Vietnam	Phu Tho	7	0.77
Vietnam	Son La	7	2.67
Vietnam	Yen Bai	7	2.67
Vietnam	Bac Kan	6	2.34
Vietnam	Cao Bang	6	2.34
Vietnam	Dien Bien	6	2.34
Vietnam	Ha Giang	6	2.34
Vietnam	Lai Chau	6	2.34
Vietnam	Thai Nguyen	6	1.34
Vietnam	Tuyen Quang	6	1.34
Vietnam	Bac Giang	5	1.07
Vietnam	Bac Ninh	5	0.39
Vietnam	Ha Nam	5	0.39
Vietnam	Ha Noi	5	0.39
Vietnam	Hai Duong	5	0.39
Vietnam	Hai Phong	5	0.39

Vietnam	Hoa Binh	5	1.07
Vietnam	Hung Yen	5	0.39
Vietnam	Nam Dinh	5	0.39
Vietnam	Ninh Binh	5	0.39
Vietnam	Quang Ninh	5	1.07
Vietnam	Thai Binh	5	0.39
Vietnam	Vinh Phuc	5	0.39

Figure legends

Figure S1 Correlation between species diversity (A) or phylogenetic diversity (B) and administrative unit area (km^2).

Figure S2 Diversity of the Juglandaceae: species representing all 10 extant genera of the walnut family. **Rhoipteleoideae**: a) *Rhoiptelea chiliantha*, **Engelhardioideae**: b) *Engelhardia spicata*, c) *Alfaropsis roxburghiana*, d) *Oreomunnea pterocarpa*, e) *Alfaroa williamsii*, **Juglandoideae**: f) *Carya glabra*, g) *Platycarya strobilacea*, h) *Cyclocaria paliurus*, i) *Pterocarya hupehensis*, j) *Juglans nigra*. Pictures were taken by Xin-Xin Zhu (a), Hong-Hu Meng (b), Hoang Van Sam (c), Evelyne Kozlowski (d, g), Erick Viquez Alvarado (e), Adriana Corrales (f), Yi-Gang Song (h, i), and Hans-Rüdiger Siegel (j).

Figure S3 The latitudinal distribution of Juglandaceae species separated for each genus. The horizontal dashed lines represent the Tropic and Polar circles, and the solid line the Equator. The histogram indicates the number of species/genera occurring in each 0.5° of latitude span.

Figure S4 The elevational distribution of all extant Juglandaceae species (m a.s.l.). The dark green boxes indicate the elevational range of the New World Juglandaceae, and the orange boxes the Old World species. The middle black line is the mean value.

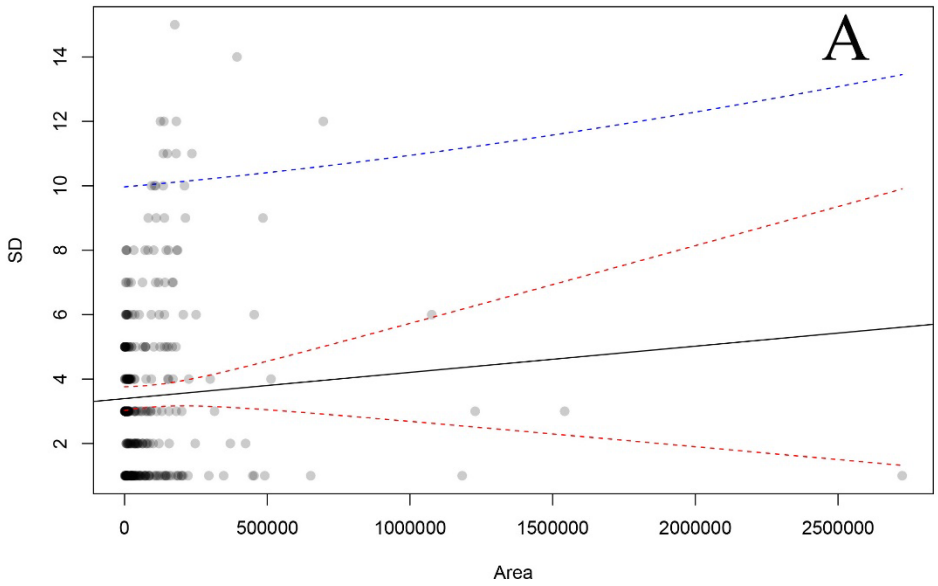
Figure S5 Generic diversity hotspots of Juglandaceae: regions with a high international conservation responsibility. The right colour scale indicates the number of genera in each administrative unit: blue and dark-green colours indicate low richness; and light-green, yellow, red and violet colours indicate high richness.

Figure S6 Historical phylogenetic diversity (PD) of Juglandaceae. The right colour scale indicates the PD in each region: blue and green colours indicate negative values; orange, red and violet colours indicate positive values of the PD.

Figure S7 Maximum likelihood phylogenetic tree of Juglandaceae. Nodes with bootstrap support value.

Figure S8 Timing of the diversification of Juglandaceae. The blue bars indicate 95% highest posterior density (HPD) intervals of the age estimate. Red solid cycles are the fossil calibration points.

Figure S1


A
SD
2
4
6
8
10
12
14
0
500000
1000000
1500000
2000000
2500000
Area

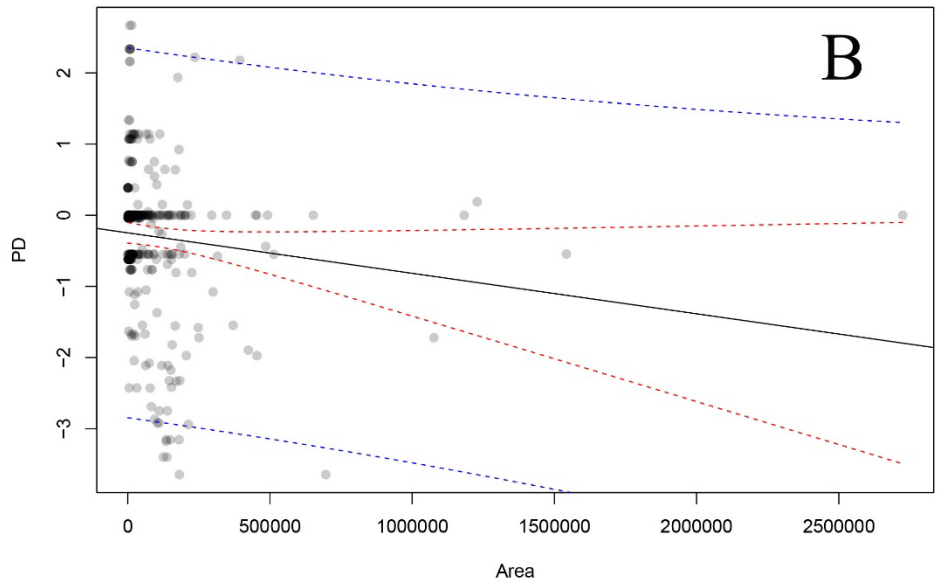

B
PD
−3
−2
−1
0
1
2
0
500000
1000000
1500000
2000000
2500000
Area

Figure S2

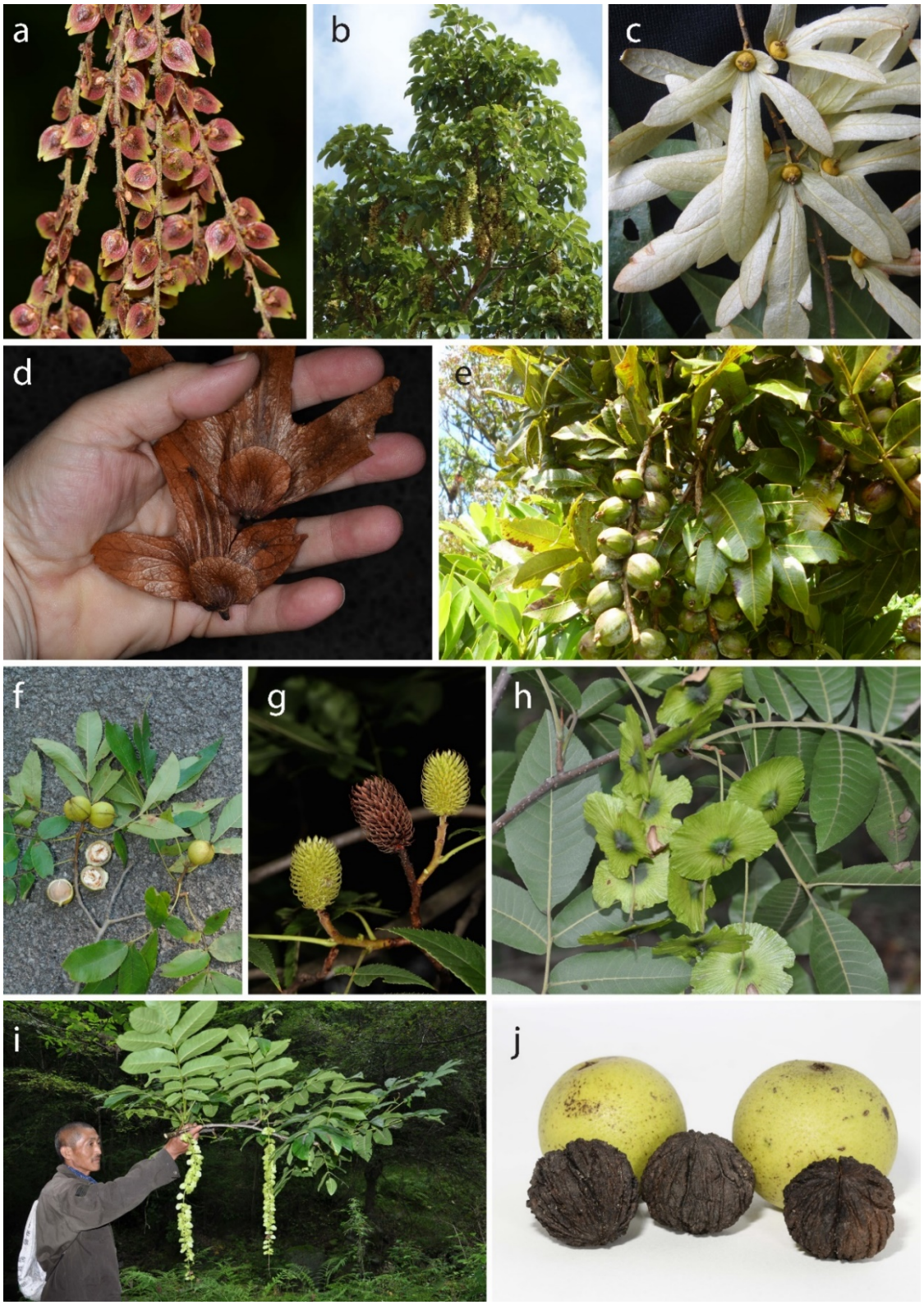


Figure S3

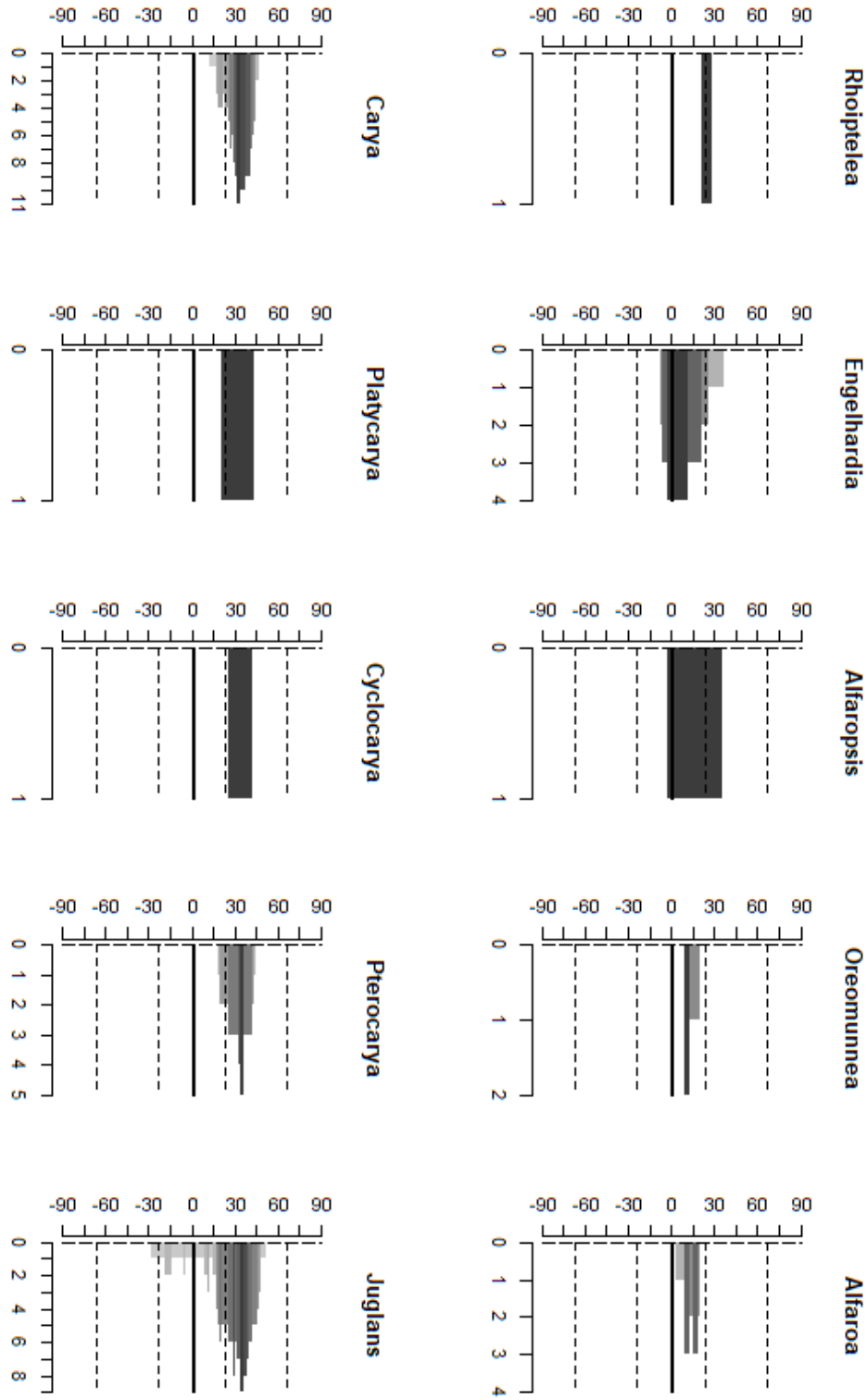

Rhoiptelea
Engelhardia
Alfaropsis
Oreomunnea
Alfaroa
Carya
Platycarya
Cyclocarya
Pterocarya
Juglans
-90 -60 -30 0 30 60 90

Figure S4

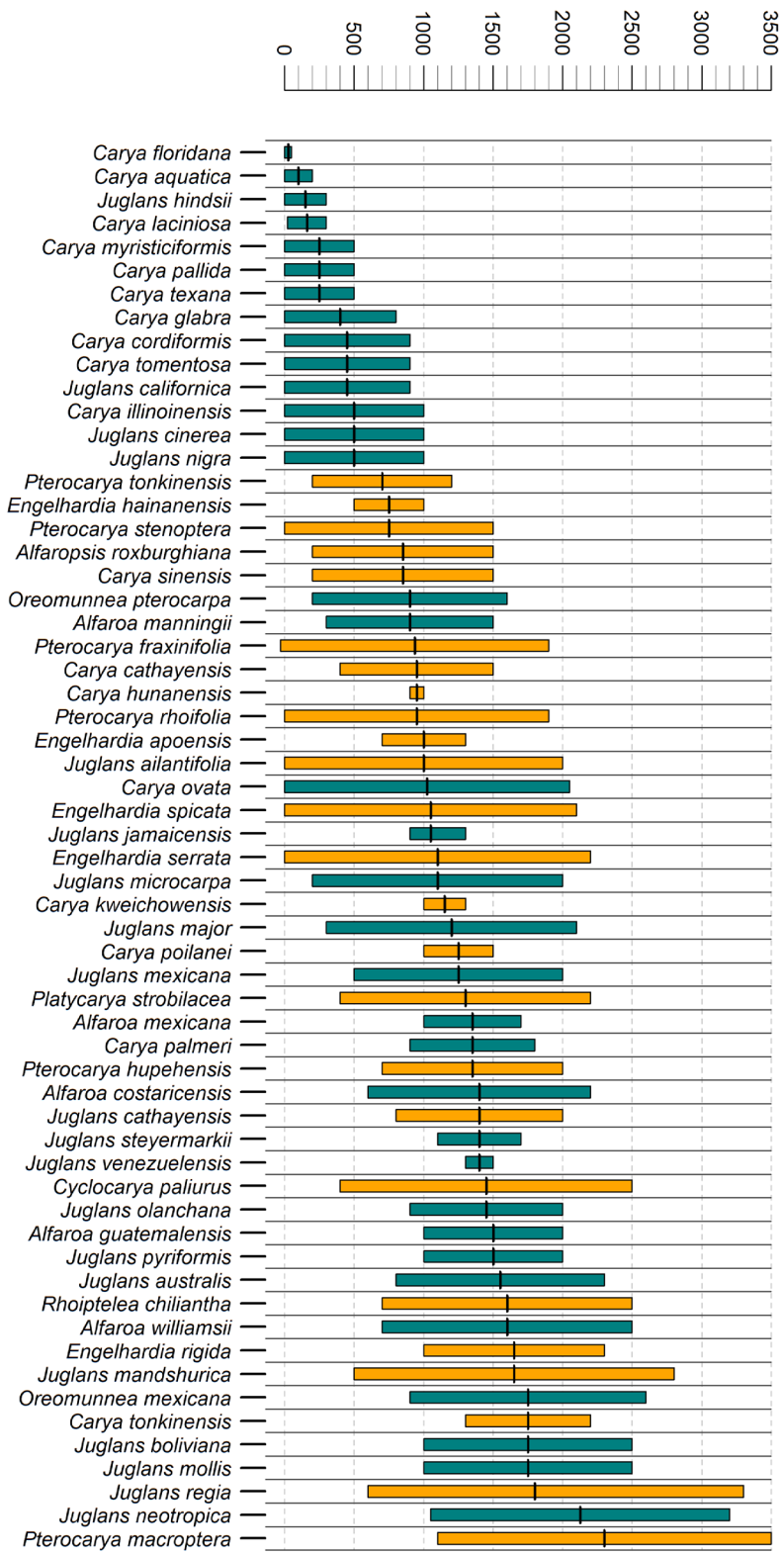

0
500
1000
1500
2000
2500
3000
3500
Carya floridana
Carya aquatica
Juglans hindsii
Carya laciniosa
Carya myristiciformis
Carya pallida
Carya texana
Carya glabra
Carya cordiformis
Carya tomentosa
Juglans californica
Carya illinoinensis
Juglans cinerea
Juglans nigra
Pterocarya tonkinensis
Engelhardia hainanensis
Pterocarya stenoptera
Alfaropsis roxburghiana
Carya sinensis
Oreomunnea pterocarpa
Alfaroa manningii
Pterocarya fraxinifolia
Carya cathayensis
Carya hunanensis
Pterocarya rhoifolia
Engelhardia apoensis
Juglans ailantifolia
Carya ovata
Engelhardia spicata
Juglans jamaicensis
Engelhardia serrata
Juglans microcarpa
Carya kweichowensis
Juglans major
Carya poilanei
Juglans mexicana
Platycarya strobilacea
Alfaroa mexicana
Carya palmeri
Pterocarya hupehensis
Alfaroa costaricensis
Juglans cathayensis
Juglans steyermarkii
Juglans venezuelensis
Cyclocarya paliurus
Juglans olanchana
Alfaroa guatemalensis
Juglans pyriformis
Juglans australis
Rhoiptelea chiliantha
Alfaroa williamsii
Engelhardia rigida
Juglans mandshurica
Oreomunnea mexicana
Carya tonkinensis
Juglans boliviana
Juglans mollis
Juglans regia
Juglans neotropica
Pterocarya macroptera

Figure S5

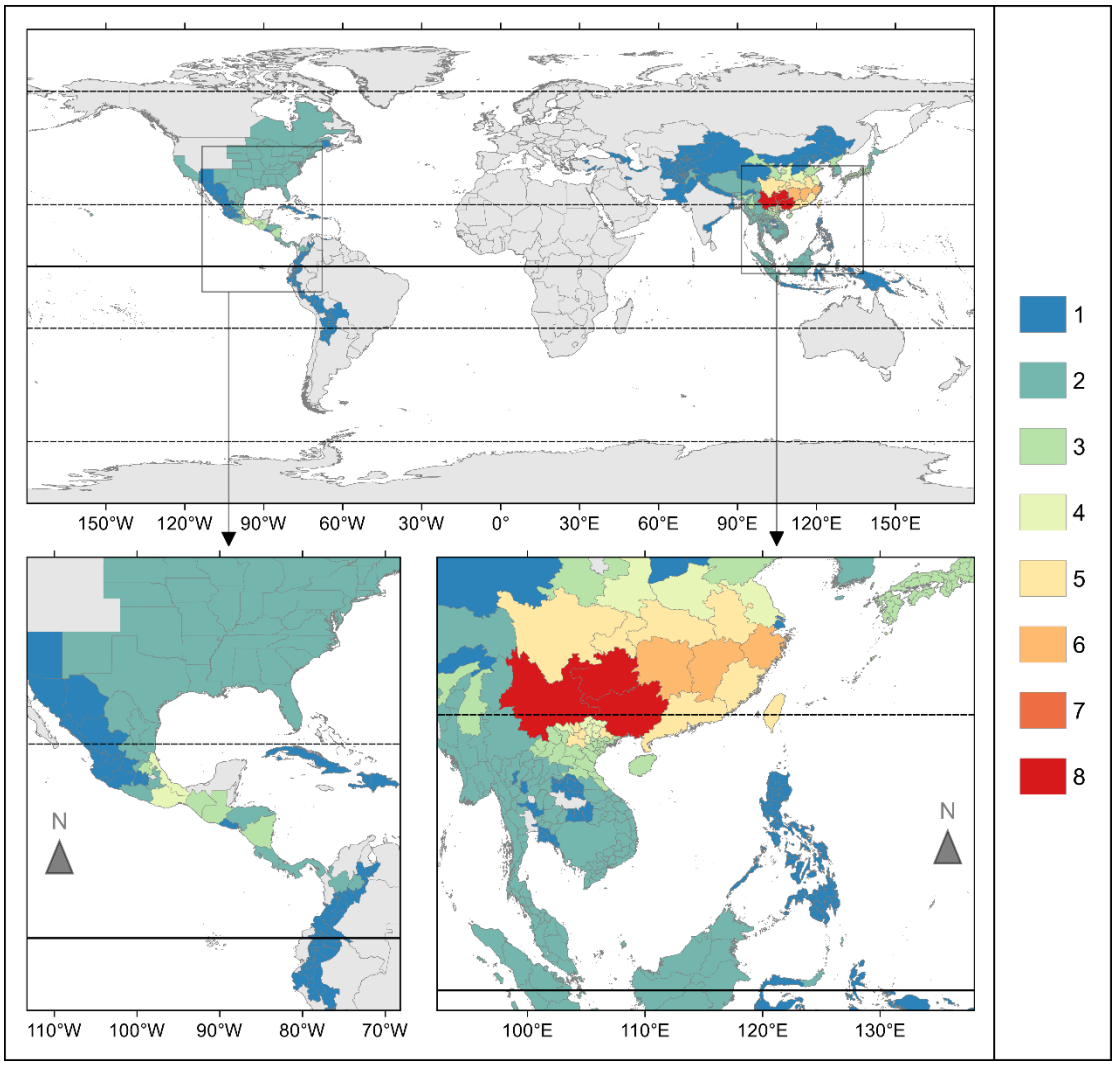

150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
N
110°W
100°W
90°W
80°W
70°W
N
100°E
110°E
120°E
130°E
1
2
3
4
5
6
7
8

Figure S6

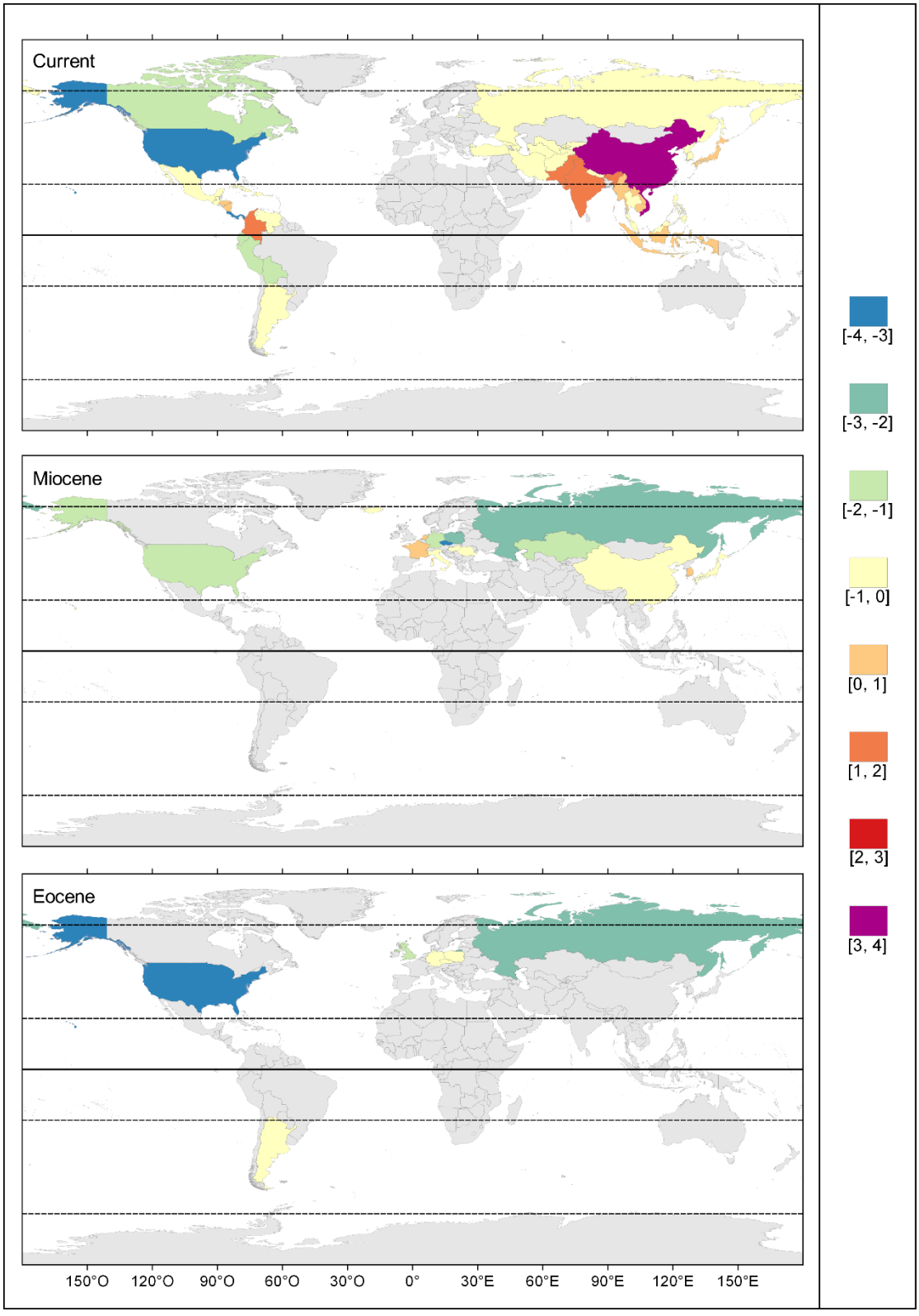

Current
Miocene
Eocene
150°O
120°O
90°O
60°O
30°O
0°
30°E
60°E
90°E
120°E
150°E
[-4, -3]
[-3, -2]
[-2, -1]
[-1, 0]
[0, 1]
[1, 2]
[2, 3]
[3, 4]

Figure S7

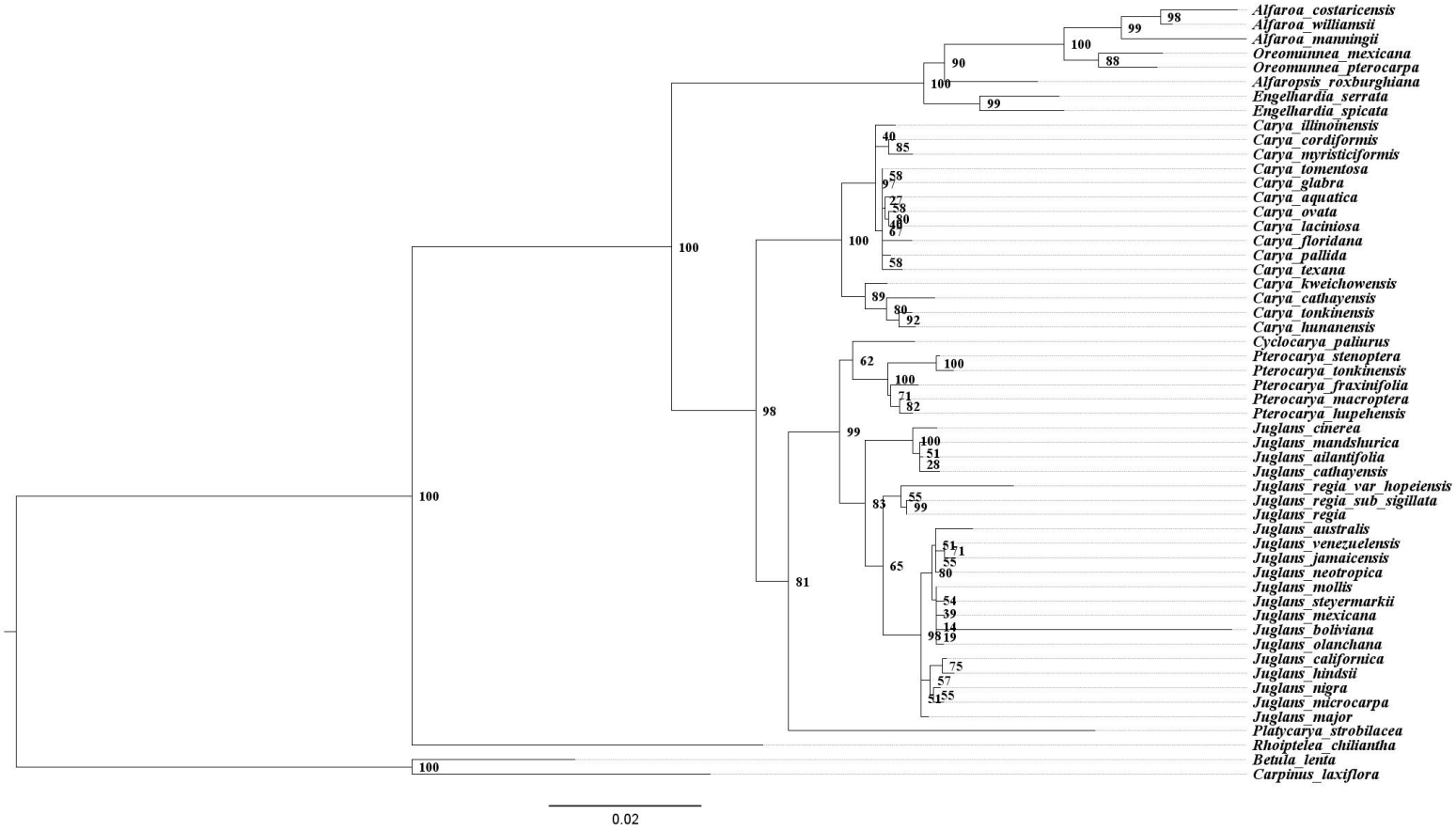
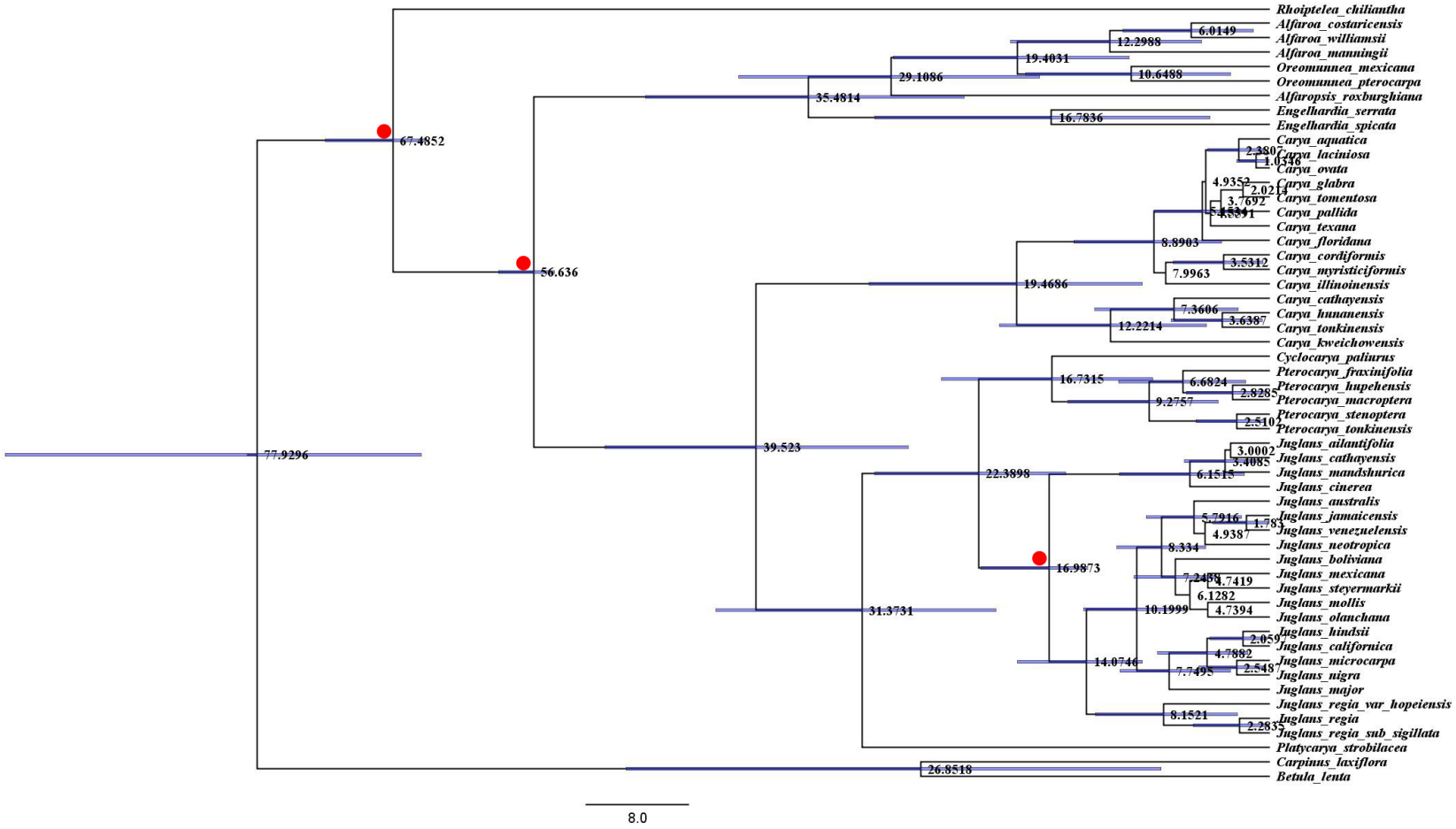

Alfaroa_costaricensis
Alfaroa_williamsii
Alfaroa_manningii
Oreomunnea_mexicana
Oreomunnea_pterocarpa
Alfaropsis_roxburghiana
Engelhardia_serrata
Engelhardia_spicata
Carya_illinoinensis
Carya_cordiformis
Carya_myristiciformis
Carya_tomentosa
Carya_glabra
Carya_aquatica
Carya_ovata
Carya_laciniosa
Carya_floridana
Carya_pallida
Carya_texana
Carya_kweichowensis
Carya_cathayensis
Carya_tonkinensis
Carya_hunanensis
Cyclocarya_paliurus
Pterocarya_stenoptera
Pterocarya_tonkinensis
Pterocarya_fraxinifolia
Pterocarya_macroptera
Pterocarya_hupehensis
Juglans_cinerea
Juglans_mandshurica
Juglans_ailantifolia
Juglans_cathayensis
Juglans_regia_var_hopeiensis
Juglans_regia_sub_sigillata
Juglans_regia
Juglans_australis
Juglans_venezuelensis
Juglans_jamaicensis
Juglans_neotropica
Juglans_mollis
Juglans_steyermarkii
Juglans_mexicana
Juglans_boliviana
Juglans_olanchana
Juglans_californica
Juglans_hindsii
Juglans_nigra
Juglans_microcarpa
Juglans_major
Platycarya_strobilacea
Rhoiptelea_chiliantha
Betula_lenta
Carpinus_laxiflora
0.02

Figure S8


Rhoiptelea_chiliantha
Alfaroa_costaricensis
Alfaroa_williamsii
Alfaroa_manningii
Oreomunnea_mexicana
Oreomunnea_pterocarpa
Alfaropsis_roxburghiana
Engelhardia_serrata
Engelhardia_spicata
Carya_aquatica
Carya_laciniosa
Carya_ovata
Carya_glabra
Carya_tomentosa
Carya_pallida
Carya_texana
Carya_floridana
Carya_cordiformis
Carya_myristiciformis
Carya_illinoinensis
Carya_cathayensis
Carya_hunanensis
Carya_tonkinensis
Carya_kweichowensis
Cyclocarya_paliurus
Pterocarya_fraxinifolia
Pterocarya_hupehensis
Pterocarya_macroptera
Pterocarya_stenoptera
Pterocarya_tonkinensis
Juglans_ailantifolia
Juglans_cathayensis
Juglans_mandshurica
Juglans_cinerea
Juglans_australis
Juglans_jamaicensis
Juglans_venezuelensis
Juglans_neotropica
Juglans_boliviana
Juglans_mexicana
Juglans_steyermarkii
Juglans_mollis
Juglans_olanchana
Juglans_hindsii
Juglans_californica
Juglans_microcarpa
Juglans_nigra
Juglans_major
Juglans_regia_var_hopeiensis
Juglans_regia
Juglans_regia_sub_sigillata
Platycarya_strobilacea
Carpinus_laxiflora
Betula_lenta
6.0149
12.2988
19.4031
10.6488
29.1086
35.4814
16.7836
67.4852
56.636
77.9296
39.523
31.3731
19.4686
12.2214
7.3606
7.9963
8.8903
16.7315
6.6824
9.2757
22.3898
16.9873
10.1999
14.0746
8.1521
26.8518
8.0

Appendix S2

References

1. Fu L. G., Xin Y. Q., Bartholomew B. (2003). Flora of China: Rhoipteleaceae, 5: 20, Science Press (Beijing) & Missouri Botanical Garden (St. Louis).
2. Lu A. M., Stone E. S., Grauke, L. J. (1999). Flora of China: Juglandaceae, 4: 277-285, Science Press (Beijing) & Missouri Botanical Garden (St. Louis).
3. Stone D. E. (1997). Flora of North America: Juglandaceae, 3, New York & Oxford.
4. The Plant List (2010). Version 1. Published on the Internet; http://www.theplantlist.org/
5. Tropicos (2017). http://www.tropicos.org. Saint Louis, Missouri: Missouri Botanical Garden.
6. GBIF: The Global Biodiversity Information Facility (2018). https://www.gbif.org/what-is-gbif
7. Jacobs, M. (1960). Flora Malesiana: Juglandaceae, 6: 143-154.
8. Stone, D. E. (2010). Review of New World Alfaroa and Old World Alfaropsis (Juglandaceae). Novon, 20(2): 215-224.
9. Kuang, K. R., Zheng, S. X., Li, P. Q. and Lu, A. M. (1979). Flora of China, Myricaceae, Juglandaceae and Betulaceae. Myricaceae, Juglandaceae and Betulaceae, 21. Science Press, Beijing.
10. CVH: Chinese Virtual Herbarium (2018). Available from: http://www.cvh.ac.cn/.
11. IUCN (2017). The IUCN Red List of Threatened Species. Version 2017-3. http://www.iucnredlist.org.
12. Horikawa, Y. (1972). Atlas of the Japanese flora: an introduction to plant sociology of East Asia. pp. 518-520, Toyko.

Appendix S3

Appendix S3 Database of all the fossil synthesis

Fossil species	Geologic age	Age (Ma) Stratum Range	Age (Ma) Random estimate age	Relationship with current species	Location	Distribution area code	Remarks
Rhoiptelea sp1.	Cretaceous	83.0-66.0	72.3	Rhoiptelea	NA	A	USA (Pollen)
Rhoiptelea sp2.	Late Cretaceous	83.0-66.0	70.1	Rhoiptelea	EU	B	Aachen, Germany
Polyptera manningii	Paleocene	66.0-56.0	65.7	NA	A		
Cruciptera sp.	Early Eocene	56.0-47.8	53.2	NA	A		
Cyclocarya							
Cyclocarya brownii	Late Paleocene	59.2-55.8	56.9	Cyclocarya	NA	A	USA (Wyoming)
Cyclocarya minuta	Late Paleocene	59.2-55.8	55.6	Cyclocarya	NA	A	USA (Wyoming)
Cyclocarya coalmontensis	Late Paleocene-early Eocene	59.2-48.6	50.7	Cyclocarya	NA	A	USA (Colorado)
Juglandicarya depressa	Early Eocene	55.8-48.6	49.1	Cyclocarya	EU	B	England
Cyclocarya tomskiana	Oligocene	33.9-23.0	32.8	Cyclocarya	EU	B	
Cyclocarya cycloptera	Oligocene	33.9-23.0	30.4	Cyclocarya	EU	B	
Cyclocarya cycloptera	Oligocene-Miocene	28.4-16.0	25.3	Cyclocarya	EU	B	Germany et al.
Cyclocarya weylandii	Early Oligocene to Pliocene	33.9-2.58	10.4	Cyclocarya	EU	B	Germany et al.
Cyclocarya nucifera	Late Pliocene	3.6-2.58	2.9	Cyclocarya	EU	B	North Italy
Cyclocarya tymensis	Oligocene	33.9-23.0	28.9	Cyclocarya	NWEA	C	
Cyclocarya tomskiana	Oligocene	33.9-23.0	26.4	Cyclocarya	NWEA	C	
Cyclocarya cycloptera	Oligocene	33.9-23.0	25.5	Cyclocarya	NWEA	C	
Cyclocarya tavdensis	Oligocene	33.9-23.0	23.1	Cyclocarya	NWEA	C	
Cyclocarya ezoana	Early Miocene to early Pliocene	20.44-3.6	5.2	Cyclocarya	NWEA	C	Japan
Cyclocarya simipaliurus	late Miocene	11.6-5.3	9.4	Cyclocarya	SA	D	South China
Palaeocarya							
Palaeocarya nevadensis	Middle or late Eocene	47.8-33.9	40.7	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (California)
Palaeocarya clarnensis	Middle Eocene	47.8-37.8	38.6	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Wyoming)
Palaeocarya wolfei	Late Eocene	37.8-33.9	35.2	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Washington)
Palaeocarya willamettensis	Oligocene	33.9-23.0	27.6	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Oregon)
Palaeocarya olsoni	Miocene	23.0-5.3	10.6	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Alaska, Idaho)
Palaeocarya mississippiensis	Eocene	56.0-33.9	50.3	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Mississippi)
Palaeocarya puryearensis	Middle Eocene	47.8-37.8	42.1	Engelhardia, Alfaropsis, Oreomunnea	NA	A	USA (Kentucky, Tennessee)
Palaeocarya uintaensis	Late Oligocene	27.8-23.0	27.7	Engelhardia, Alfaropsis, Oreomunnea	EU	B	France (Armissan)
Palaeocarya macroptera	Middle Eocene	47.8-37.8	43.9	Engelhardia, Alfaropsis, Oreomunnea	EU	B	Germany (Messel)
Palaeocarya oxyptera	Late Oligocene	27.8-23.0	23.1	Engelhardia, Alfaropsis, Oreomunnea	EU	B	France (Armissan)
Palaeocarya koreanica	Oligocene	33.9-23.0	24.8	Engelhardia, Alfaropsis, Oreomunnea	NWEA	C	Korea; Jilin, Chian
Palaeocarya guangxiensis	Oligocene	33.9-23.0	32.7	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Guangxi and Yunnan)
Palaeocarya ninmingensis	Oligocene	33.9-23.0	28.7	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Guangxi)
Palaeocarya hispida	Late Miocene	11.6-5.3	6.3	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Yunnan)
Palaeocarya longialata	Pliocene	5.3-2.6	5	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Yunnan)
Palaeocarya yunnanensis	Pliocene	5.3-2.6	2.9	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Yunnan)
Palaeocarya guangxiensis	Pliocene	5.3-2.6	3.8	Engelhardia, Alfaropsis, Oreomunnea	SA	D	China(Guangxi and Yunnan)
Alatonucula ignis	Early Eocene	56.0-47.8	55.3	Engelhardia, Alfaropsis, Oreomunnea	CSA	F	Argentina (Patagonia)
Carya							
Carya florissantensis	Early Oligocene	33.9-27.8	33.8	Carya	NA	A	USA (Colorado)
Carya washingtonensis	Middle Miocene	15.9-11.6	14.3	Carya	NA	A	USA (Washington)
Carya lacrymabunda	Late Eocene to middle Oligocene	37.8-27.8	30.9	Carya	EU	B	eastern Europe
Carya quadrangula	Middle Oligocene	33.9-27.8	28.1	Carya	EU	B	East and west Germany
Carya ventricosa	Late Oligocene to early Pliocene	33.9-3.6	10.7	Carya	EU	B	East Europe
Carya rostrata	Late Oligocene to Miocene	33.9-15.9	19.2	Carya	EU	B	East and west Germany
Carya caryoides	Middle Miocene	15.9-11.6	11.1	Carya	EU	B	West Germany
Carya costata	Oligocene	33.9-23.0	24.5	Carya	EU	B	Czechoslovkia, Poland
Carya strychnina	late Oligocene to middle Miocene	33.9-11.6	12.3	Carya	EU	B	Germany
Carya pusilla	Miocene	23.0-5.3	18.7	Carya	EU	B	Europe
Carya globosa	Miocene to early Pliocene	11.6-3.6	10.2	Carya	EU	B	Germany, Poland
Carya bohemica	Miocene	23.0-5.3	6.3	Carya	EU	B	Czechoslovkia, Poland
Carya angulata	Early Pliocene	5.3-3.6	3.1	Carya	EU	B	Netherlands, Germany, France
Carya rugosa	Miocene	23.0-5.3	20.8	Carya	EU	B	South Poland
Carya askenasyi	Pliocene	5.3-2.6	5.1	Carya	EU	B	West Germany
Carya kryshtofovichii	Oligocene	33.9-23.0	28.7	Carya	NWEA	C	Western Siberia
Carya kompassica	Oligocene or Miocene	33.9-15.9	16.4	Carya	NWEA	C	Western Siberia
Carya miocathayensis	Miocene	23.0-5.3	22.2	Carya	NWEA	C	China (Shandong)
Carya leiocarpa	Pliocene	5.3-2.6	4.1	Carya	NWEA	C	Japan
Carya nanocarpa	Pliocene	5.3-2.6	2.5	Carya	NWEA	C	Japan
Carya ovatocarpa	Pliocene	5.3-2.6	2.9	Carya	NWEA	C	Japan
Platycarya							
Paleoplatycarya wingii	Early Eocene	56.0-47.8	48.9	Platycarya	NA	A	USA (Wyoming)
Platycarya americana	Early Eocene	56.0-47.8	52.1	Platycarya	NA	A	USA (Dakota)
Platycarya richardsoni	Early Eocene	56.0-47.8	47.2	Platycarya	EU	B	Southern England
Pterocarya							
Pterocarya occidentalis	Oligocene	33.9-23.0	32.1	Pterocarya hupehensis	NA	A	USA (Oregon, California)
Pterocarya mixta	Oligocene	33.9-23.0	25.4	Pterocarya macroptera	NA	A	USA (Washington)
Pterocarya eomacroptera	Miocene	23.0-5.3	22.6	Pterocarya macroptera	NA	A	USA (Idaho, Oregon)
Pterocarya smileyi	Miocene	23.0-5.3	10.4	Pterocarya stenoptera	NA	A	USA (Idaho, Oregon)
Pterocarya nigella	Miocene	23.0-5.3	6.5	Pterocarya stenoptera	NA	A	USA (Alaska, Seldovia)
Pterocarya raciborskii	Middle Miocene	16.0-11.6	15	Pterocarya	EU	B	Poland
Pterocarya limburgensis	Pliocene	5.3-2.6	5.1	Pterocarya	EU	B	Germany, Poland
Pterocarya sp1.	Late Miocene	11.6-5.3	11.1	Pterocarya fraxinifolia	EU	B	Hungry, Iceland
Pterocarya castaneaefolia	Oligocene-Miocene	28.4-16.0	25.8	Pterocarya	NWEA	C	Russia
Pterocarya asymmetrosa	Miocene	23.0-5.3	20.2	Pterocarya rhoifolia	NWEA	C	Japan
Pterocarya protostenoptera	Miocene	23.0-5.3	17.6	Pterocarya stenoptera	NWEA	C	Japan, Korea

Pterocarya kireeevskiana Miocene 23.0-5.3 14.3 Pterocarya NWEA C Russia
Pterocarya crassa Miocene 23.0-5.3 18.9 Pterocarya stenoptera NWEA C Russia
Juglans
Juglans lacunosa Oligocene 33.9-23.0 33.8 Juglans NA A
Juglans siouxensis Lower Oligocene 28.4-23.0 27.3 Juglans NA A
Juglans carnensis Miocene 23.0-5.3 19.9 Juglans NA A
Juglans nevadensis Miocene 23.0-5.3 18.4 Juglans NA A
Juglans eocinerea Miocene 23.0-5.3 8.2 Juglans NA A
Juglans tephrodes Oligocene 33.9-23.0 29.3 Juglans EU B
Juglans megacinerwa Miocene-Pleistocene 23.0-0.01 9.5 Juglans NWEA C
Juglans siberica Miocene 23.0-5.3 16.2 Juglans NWEA C
Juglans linkii Miocene-Pliocene 23.0-2.6 11.1 Juglans CSA F

Distribution area
A: North America (NA)
B: Europe (EU)
C: North-west-east Asia (NWEA)
D: South Asia (SA)
E: Malay Archipelago (MA)
F: Central-south America (CSA)

Appendix S4
Appendix S4 Data setup for RASP running
Distribution area Time-stratified MRCA
1 Alfaroa_costaricensis F 0-4.3 Ma Taxon 1 Taxon 2 MRCA
2 Alfaroa_manningii F Abbreviations A B C D E F Alfaroa williamsii Oreomunnea mexicana AF
3 Alfaroa_williamsii F A: North America (NA) A 1 0 0 0 0 0 1 Alfaropsis roxburghiana Engelhardia serrata AB
4 Alfaropsis_roxburghiana D B: Europe (EU) B 0 1 1 1 0 0 Cyclocarya paliurus Platycarya strobilacea AB
5 Carya_aquatica A C: North-west-east Asia (NWEA) C 0 1 1 1 0 0 Carya aquatica Platycarya strobilacea AB
6 Carya_cathayensis D D: South Asia (SA) D 0 1 1 1 1 0
7 Carya_cordiformis A E: Malay Archipelago (MA) E 0 0 0 1 1 0
8 Carya_floridana A F: Central-south America (CSA) F 1 0 0 0 0 1
9 Carya_glabra A
10 Carya_hunanensis D 4.3-8.5 Ma
11 Carya_illinoinensis A A B C D E F
12 Carya_kweichowensis D A 1 0 1 0 0 1
13 Carya_laciniosa A B 0 1 1 1 0 0
14 Carya_myristiciformis A C 1 1 1 1 0 0
15 Carya_ovata A D 0 1 1 1 1 0
16 Carya_pallida A E 0 0 0 1 1 0
17 Carya_texana A F 1 0 0 0 0 1
18 Carya_tomentosa A
19 Carya_tonkinensis D 8.5-16.9 Ma
20 Cyclocarya_paliurus D A B C D E F
21 Engelhardia_serrata D A 1 0 1 0 0 1
22 Engelhardia_spicata DE B 1 0 1 0 0 1
23 Juglans_ailantifolia C C 0 1 1 1 0 0
24 Juglans_australis F D 0 1 1 1 1 0
25 Juglans_boliviana F E 0 0 0 1 1 0
26 Juglans_californica A F 1 0 0 0 0 1
27 Juglans_cinerea A
28 Juglans_hindsii A 16.9-33.7 Ma
29 Juglans_hirsuta F A B C D E F
30 Juglans_hopeiensis C A 1 1 1 0 0 1
31 Juglans_jamaicensis F B 1 1 1 1 0 0
32 Juglans_major A C 1 1 1 1 0 0
33 Juglans_mandshurica CD D 0 1 1 1 1 0
34 Juglans_microcarpa AF E 0 0 0 1 1 0
35 Juglans_mollis F F 1 0 0 0 0 1
36 Juglans_neotropica F
37 Juglans_nigra A 33.7-67.5 Ma
38 Juglans_olanchana F A B C D E F
39 Juglans_regia C A 1 1 1 0 0 0
40 Juglans_sigillata D B 1 1 0 0 0 0
41 Juglans_steyermarkii F C 1 0 1 1 0 0
42 Juglans_venezuelensis F D 0 0 1 1 1 0
43 Oreomunnea_mexicana F E 0 0 0 1 1 0
44 Oreomunnea_pterocarpa F F 0 0 0 0 0 1
45 Platycarya_strobilacea CD
46 Pterocarya_fraxinifolia B
47 Pterocarya_hupehensis D
48 Pterocarya_macroptera D
49 Pterocarya_stenoptera CD
50 Pterocarya_tonkinensis D
51 Rhoiptelea_chiliantha D
52 Juglans_cathayensis CD

Appendix S5
Appendix S5 Detailed information of fossils and current distribution of Juglandaceae

Age	Rhoipteloideae	Engelhardioideae							Juglandoideae																
	Rhoiptelea	Engelhardia, Alfaropsis, Oreomunnea, Alfaroa*							Carya		Cyclocarya		Pterocarya			Juglans				Platycarya	Polyptera			
	NA	EA	NA	MA	SA	Eu	EA	SEA	NA	Eu	EA	NA	Eu	WA	EA	NA	Eu	EA	NA	SA	Eu	EA	NA	Eu	EA	NA
Cretaceous	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Early Paleocene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Late Paleocene	Probable	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Early Eocene	Probable	No	Yes	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	Yes	No	No	No	Yes	Yes	No	No
Middle Eocene	No	No	Yes	No	No	Yes	No	No	No	No	No	Yes	Probable	No	No	No	No	No	Yes	No	No	No	Probable	Probable	Probable	No
Late Eocene	No	No	Yes	No	No	Probable	Yes	No	Yes	Yes	No	Yes	Probable	No	No	No	No	No	Probable	No	No	No	Probable	Probable	Probable	No
Early Oligocene	No	No	Yes	No	No	Probable	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Probable	Probable	Probable	No
Late Oligocene	No	No	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Probable	Probable	Probable	No	
Early Miocene	No	Probable	Yes	Yes	No	No	Probable	Probable	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Probable	Probable	Probable	No
Late Miocene	No	Probable	Yes	Probable	Probable	No	Yes	Probable	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Probable	Yes	Yes	Probable	Probable	Probable	No
Early Pliocene	No	Probable	No	Probable	Probable	No	Yes	Probable	Probable	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Probable	Probable	Probable	Yes	Yes	No	No	Probable	No
Late Pliocene	No	Probable	No	Probable	Probable	No	Yes	Probable	Probable	Yes	Yes	No	Yes	Yes	Probable	No	Yes	Probable	Probable	Probable	Yes	Yes	No	No	Probable	No
Quaternary	No	Probable	No	Probable	Probable	No	Probable	Probable	Probable	No	Probable	No	No	No	Probable	No	Probable	Probable	Probable	Probable						

Probable	Yes	No	No	Probable	No																						
Current distribution	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Probable	Yes	No	No	Yes	No	

Abbreviations Legends
"North America: NA;
Mesoamerica: MA;
South America: SA;
Europe: Eu;
West Asia: WA;
Eastern Asia: EA;
Southeast Asia: SEA" "Yes: accurrate fruit fossil data;
No: Without any fossil information;
Probable: other fossil evidence (e.g. pollen, leaves) or the epoch placed between accurrate fruit fossils."

References

"Hermanova Z., Kvacek J. & Daskova J. (2016). Caryanthus diversity in the Late Cretaceous. Review of Plaleobotany and Palynology, 231, 33-47.
"
Kozlowski G., Betrisey S. & Song Y. (2018). Wingnuts (Pterocarya) and walnut family. Relict trees: linking the past, present and future. Natural History Museum Fribourg, Switzerland.
Manchester S. R. (1987). The fossil history of the Juglandaceae. Missouri: Missouri Botanical Garden, 1-137.
Manchester S. R., Collinson M. E. & Goth K. (1994). Fruits of the Juglandaceae from the eocene of Messel, Germany, and implications for early Tertiary phytogeographic exchange between Europe and western North America. International Journal of Plant Science, 155, 388-394.
Manchester S. R. & Dilcher D. L. (1997). Reproductive and vegetative morphology of Polyptera (Juglandaceae) from the Paleocene of Wroming and Montana. American Journal of Botany, 84, 649-663.
"Meng, H. H., Su, T., Huang, Y. J., Zhu, H., & Zhou, Z. K. (2015). Late Miocene Palaeocarya (Engelhardieae: Juglandaceae) from Southwest China and its biogeographic implications. Journal of Systematics and Evolution, 53, 499-511.
"
"Xiang, X. G., Wang, W., Li, R. Q., Lin, L., Liu, Y., Zhou, Z. K., Li, Z. Y. & Chen, Z. D. (2014). Large-scale phylogenetic analyses reveal fagalean diversification promoted by the interplay of diaspores and environments in the Paleogene. Perspectives in Plant Ecology Evolution and Systematics, 16, 101-110.
"
Zhang, J. B., Li, R. Q., Xiang, X. G., Manchester, S. R., Lin, L., Wang, W., Wen, J. & Chen, Z. D. (2013). Integrated fossil and molecular data reveal the biogeographic diversification of the Eastern Asian-Eastern North American disjunct Hickory genus (Carya Nutt.). PloS One, 8, e70449.