

# TAXON

International Journal of Taxonomy, Phylogeny and Evolution

Electronic Supplement to

**Molecular phylogenetics and morphology of  
*Beaucarnea* (Ruscaceae) as distinct from *Nolina*,  
and the submersion of *Calibanus* into *Beaucarnea***

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***Taxon* 63: 1193–1211**

**Table S1.** Nucleotide divergence between pairs of sequences per partition and in combination. Range of nucleotide distances given as percentages (%). Pairs of species with the highest nucleotide distances, and pairs of species with no nucleotide divergence are shown.

	Nucleotide distances (%) and pairs of species with the highest values			
	ITS	<i>trnLF</i>	<i>ycf1</i>	Concatenated
Ingroup + outgroup	7.8–13.4 <i>D. serratifolium</i> & <i>O. planiscapus</i>	0.60–1.32 <i>B. sp2</i> & <i>O. planiscapus</i>	0.3–1.0 <i>B. hiriartiae</i> & <i>N. parviflora</i>	2.6–3.9 <i>B. hiriartiae</i> & <i>O. planiscapus</i>
Ingroup	0.0–9.6 <i>N. juncea</i> & <i>D. serratifolium</i>	0.00–0.70 <i>C. hookeri</i> & <i>D. longissimum</i>	0.0–1.0 <i>B. hiriartiae</i> & <i>N. parviflora</i>	0–2.8 <i>B. guatemalensis</i> & <i>N. duranguensis</i>
<i>Beaucarnea</i> & <i>Calibanus</i>	0.0–4.5 <i>B. pliabilis</i> & <i>C. hookeri</i>	0.00–0.61 <i>B. sp2</i> & <i>C. hookeri</i>	0.0–0.8 <i>B. goldmanii</i> & <i>C. glassianus</i>	0.0–1.8 <i>B. guatemalensis</i> & <i>C. hookeri</i>
<i>Beaucarnea</i> & <i>Nolina</i>	6.0–8.8 <i>B. pliabilis</i> & <i>N. juncea</i>	0.01–0.71 <i>B. sp2</i> & <i>N. duranguensis</i>	0.0–1.0 <i>B. hiriartiae</i> & <i>N. parviflora</i>	1.9–2.8 <i>B. guatemalensis</i> & <i>N. duranguensis</i>
<i>Beaucarnea</i> & <i>Dasyllirion</i>	6.2–8.8 <i>B. pliabilis</i> & <i>D. serratifolium</i>	0.01–0.72 <i>B. sp2</i> & <i>D. berlandieri</i>	0.2–0.6 <i>B. hiriartiae</i> & <i>D. glaucophyllum</i>	2.1–2.6 <i>B. guatemalensis</i> & <i>D. berlandieri</i>
Nucleotide distances = 0%	<i>B. pliabilis</i> & <i>B. guatemalensis</i> <i>B. sanctomariana</i> & <i>B. sp1</i> <i>B. compacta</i> & <i>C. glassianus</i>	<i>B. pliabilis</i> & <i>B. guatemalensis</i> <i>B. sanctomariana</i> & <i>B. sp1</i> <i>B. compacta</i> & <i>C. glassianus</i> <i>B. recurvata</i> & <i>B. sanctomariana</i> <i>B. recurvata</i> & <i>B. sp1</i>	<i>B. pliabilis</i> & <i>B. guatemalensis</i> <i>B. sanctomariana</i> & <i>B. sp1</i> <i>B. compacta</i> & <i>C. glassianus</i> <i>B. recurvata</i> & <i>B. sanctomariana</i> <i>B. recurvata</i> & <i>B. sp1</i>	<i>B. pliabilis</i> & <i>B. guatemalensis</i> <i>B. sanctomariana</i> & <i>B. sp1</i> <i>B. compacta</i> & <i>C. glassianus</i>

*B.*, *Beaucarnea*; *C.*, *Calibanus*; *D.*, *Dasyllirion*; *N.*, *Nolina*

**Table S2.** Support values for clades indicated in the text and figures. Maximum parsimony and maximum likelihood support values are bootstrap, and Bayesian inference support values are posterior probabilities.

Clade	Nuclear ITS			Plastid <i>trnLF/ycf1</i>			Concatenated ITS- <i>trnLF-ycf1</i>		
	Parsimony	Likelihood	Bayesian inference	Parsimony	Likelihood	Bayesian inference	Parsimony	Likelihood	Bayesian inference
Recurvata clade	87	97	1.00	65/–	73/–	0.99/–	95	99	1.00
Gracilis clade	63	87	0.87	–/–	50/–	–/–	64	88	0.92
Calibanus clade	96	99	1.00	65b/63 <sup>b</sup>	62 <sup>b</sup> /69 <sup>b</sup>	0.99/0.99	95	98	1.00
Purpusii clade	98 <sup>a</sup>	100 <sup>a</sup>	1.00 <sup>a</sup>	62/–	76/–	1.0/–	78	85	1.00
Stricta clade	84	87	1.00	–/–	–/–	–/–	80	92	0.98
Southern clade	100	100	1.00	–/64	68 <sup>c</sup> /100	0.72 <sup>c</sup> /0.99	100	100	1.00
<i>Dasyllirion</i> clade	100	100	1.00	56/–	71/–	1.0/–	100	100	1.00
<i>Nolina</i> clade	88	67	0.97	–/–	–/–	–/0.75 <sup>d</sup>	94	86	1.00

<sup>a</sup> Without *Beaucarnea* sp2 (Olson s.n.; Rojas 37)

<sup>b</sup> Without *Calibanus hookerii* (Rojas 27; García-Mendoza 7836)

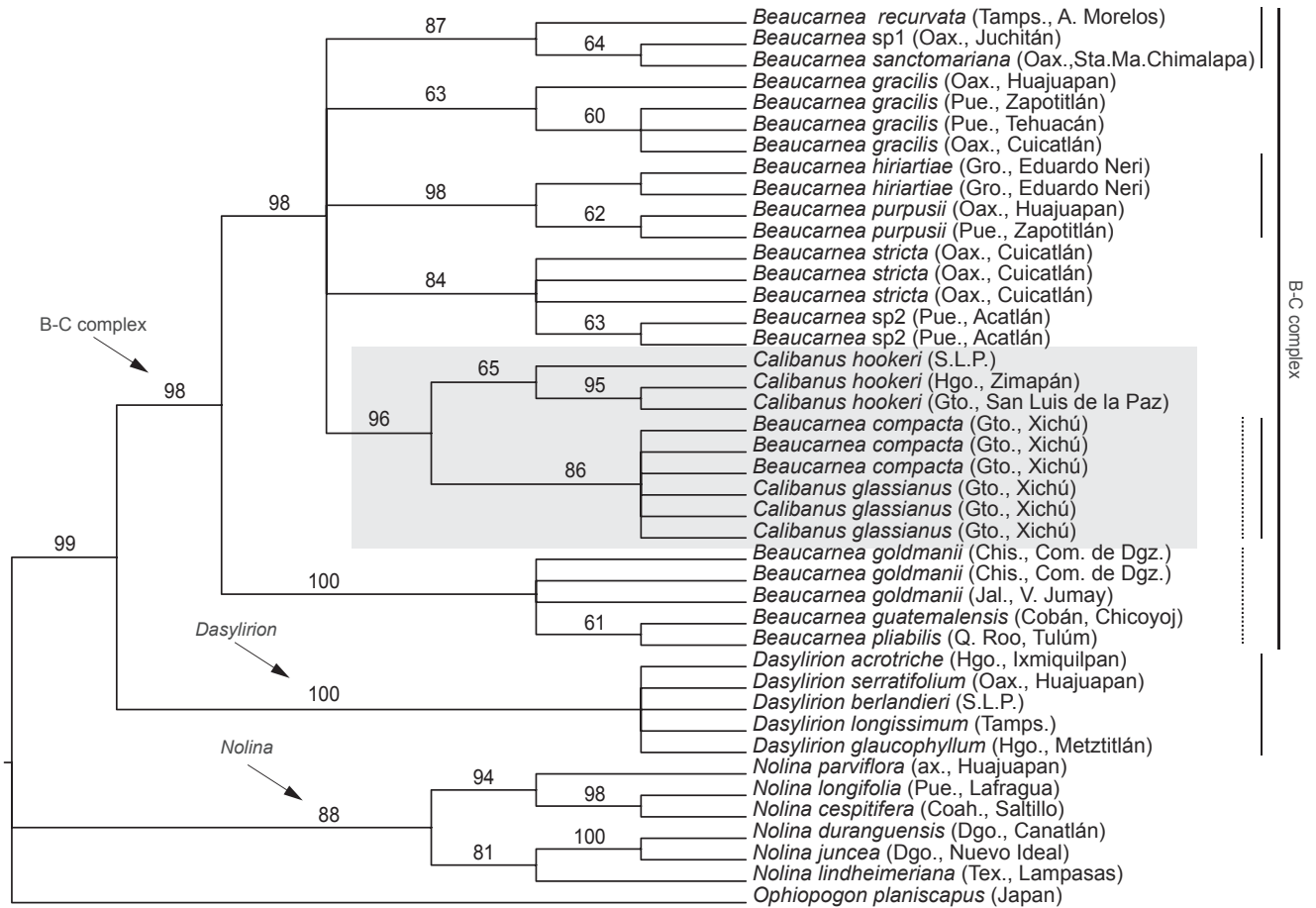
<sup>c</sup> Without *Beaucarnea goldmanii* (Montero-Castro 1004)

<sup>d</sup> Without *Nolina duranguensis* (García-Mendoza 5970)

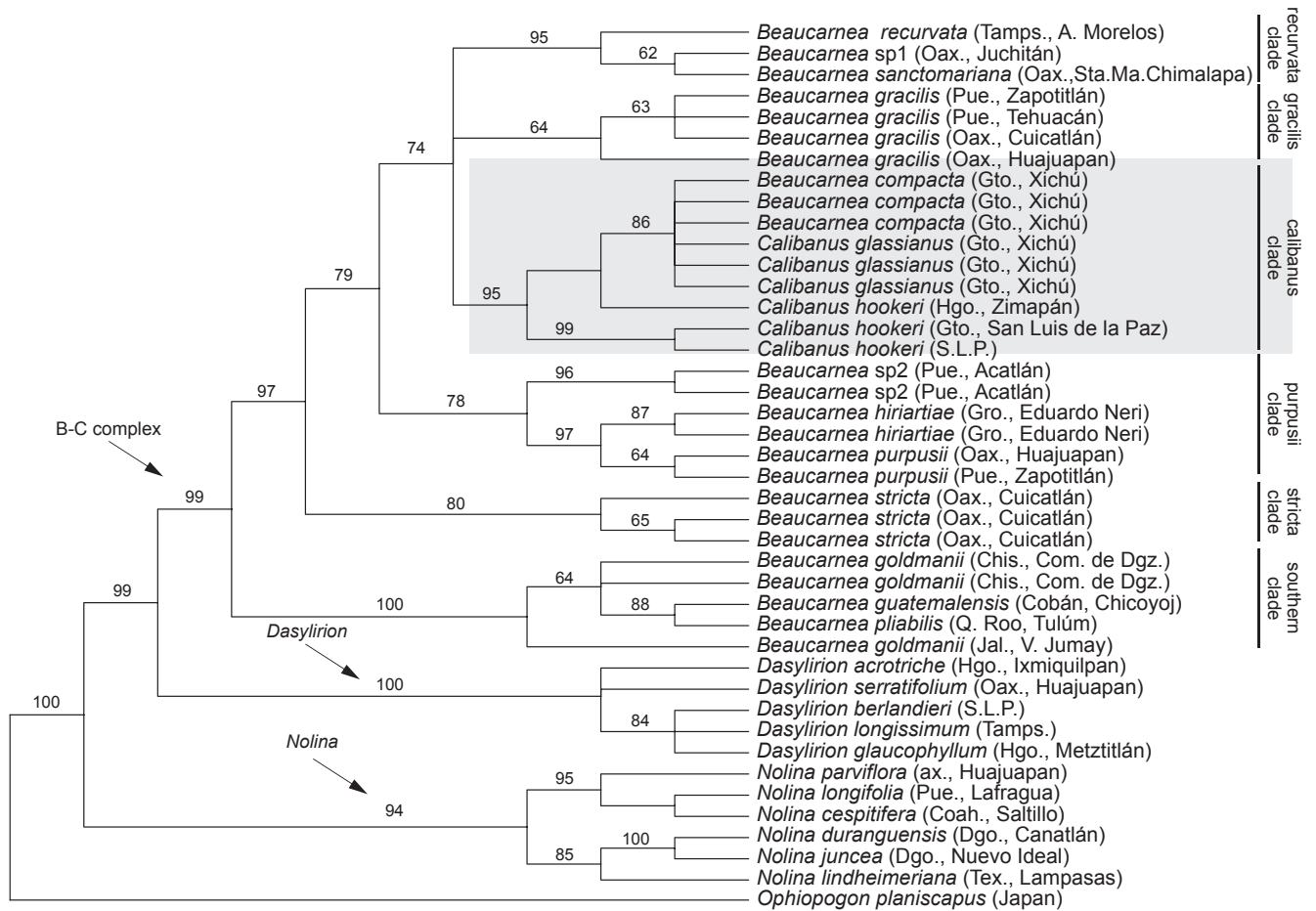
**Table S3.** Morphological matrix used in this study. Characters and character states as in Appendix 3.

	Characters															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>B. compacta</i> (Rojas 31)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. compacta</i> (Rojas 32)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. compacta</i> (Rojas 33)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. gracilis</i> (Rojas 9)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. gracilis</i> (Rojas 11)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. gracilis</i> (Rojas 18)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. gracilis</i> (Rojas 25)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. hiriartiae</i> (Medina-Lemos E424)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. hiriartiae</i> (Medina-Lemos E425)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. guatemalensis</i> (Montero-Castro 1033)	1	0	2	0	0	1	1	0	1	0	0	1	0	1	1	1
<i>B. purpusii</i> (Rojas 14)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. purpusii</i> (Rojas 38)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. sanctomariana</i>	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. stricta</i> (Rojas 21)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. stricta</i> (Rojas 22)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. stricta</i> (Rojas 23)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. sp2</i> (Rojas 37)	1	0	2	0	0	1	1	0	1	0	0	1	?	1	1	1
<i>B. sp2</i> (Olson s.n.)	1	0	2	0	0	1	1	0	1	0	0	1	?	1	1	1
<i>B. recurvata</i> (Rojas 28)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	1	1
<i>B. sp1</i> (Olson 1124)	1	0	2	0	0	1	1	0	1	0	0	1	?	1	1	1
<i>B. pliabilis</i> (Cervantes 44)	1	0	2	0	0	1	1	0	1	0	0	1	0	1	1	1
<i>B. goldmanii</i> (Olson 1103)	1	0	2	0	0	1	1	0	1	0	0	1	0	1	1	1
<i>B. goldmanii</i> (Olson 1104)	1	0	2	0	0	1	1	0	1	0	0	1	0	1	1	1
<i>B. goldmanii</i> (Montero-Castro 1004)	1	0	2	0	0	1	1	0	1	0	0	1	0	1	1	1
<i>C. hookeri</i> (García-Mendoza 7836)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>C. hookeri</i> (García-Mendoza 7838)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>C. hookeri</i> (Rojas 27)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>C. glassianus</i> (Rojas 34)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>C. glassianus</i> (Rojas 35)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>C. glassianus</i> (Rojas 36)	1	0	2	0	0	1	1	0	1	0	0	1	1	1	0	1
<i>N. cespitifera</i> (Hernández 2344)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>N. longifolia</i> (Galván 1150)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>N. parviflora</i> (García-Mendoza 7563)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>N. duranguensis</i> (García-Mendoza 7570)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>N. juncea</i> (López 107)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>N. lindheimeriana</i> (Webster 33296)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>D. glaucophyllum</i> (García-Mendoza 7226)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>D. acrotrichum</i> (García-Mendoza 7862)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>D. berlandieri</i> (García-Mendoza 5917)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>D. serratifolium</i> (García-Mendoza 5816)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>D. longissimum</i> (Rojas s.n.)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>O. planiscapus</i> (Saiki 4452)	0	0	3	0	2	2	1	0	1	2	1	0	2	?	0	0

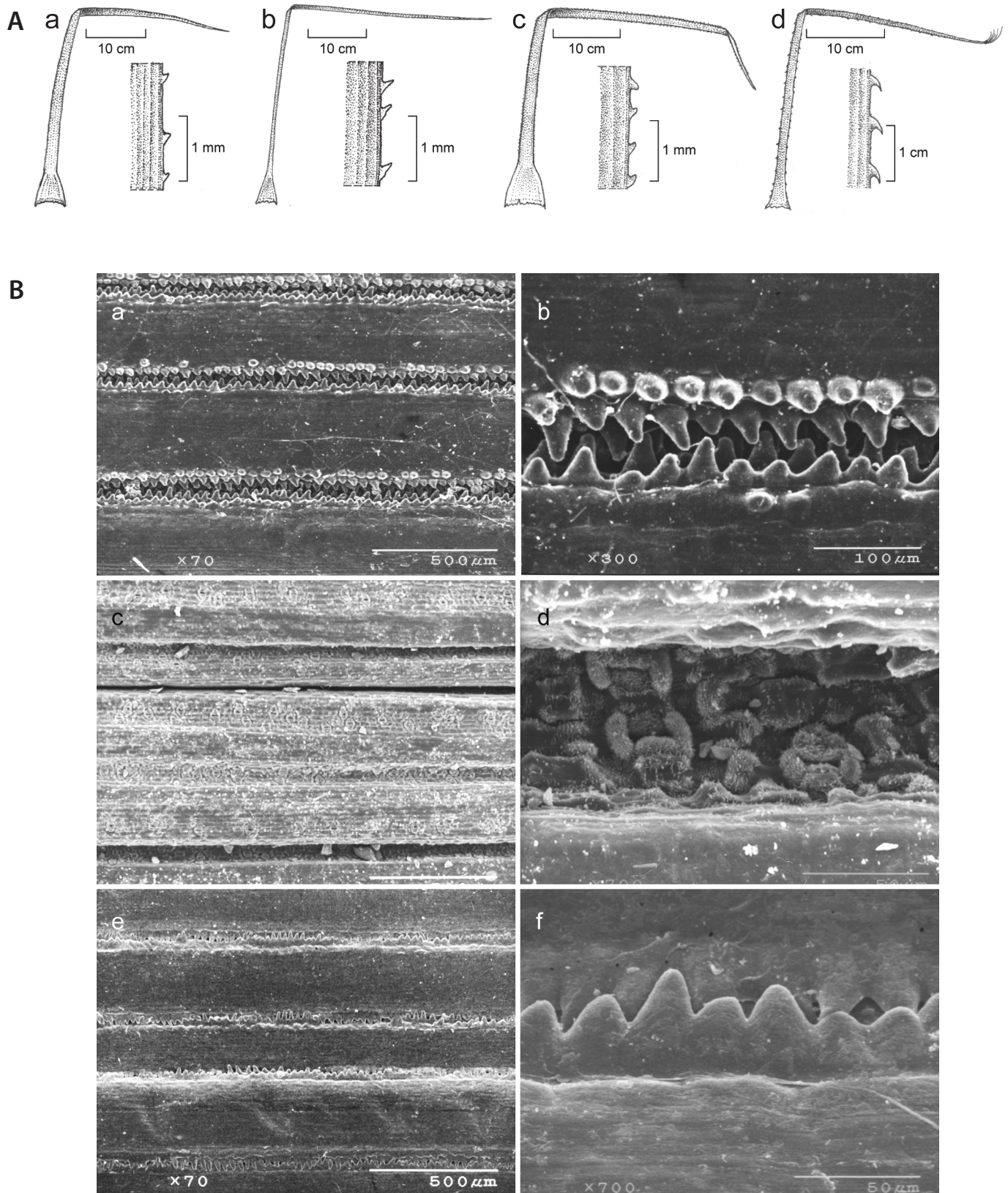
*B.*, *Beaucarnea*; *C.*, *Calibanus*; *D.*, *Dasyllirion*; *N.*, *Nolina*; *O.*, *Ophiopogon*. Collection numbers in parentheses.



**Fig. S1.** Maximum parsimony strict consensus tree derived from the nuclear (ITS) gene analysis showing high support values for the paraphyly (highlighted by gray rectangle) of *Beaucarnea* and *Calibanus* (B-C complex), and the monophyly of *Dasylyrion* and *Nolina*. Dotted lines highlight species associations recovered with the *ycfI* plastid analysis. Unlabeled solid lines highlight species associations recovered with the *trnL-F* plastid analysis. Country is given in parentheses (G, Guatemala; M, Mexico; U, United States of America), state, and locality of each sample used. Bootstrap values  $\geq 60\%$  are shown above the branches.



**Fig. S2.** Maximum parsimony strict consensus tree derived from the concatenated datasets (ITS-*trnLF-ycf1*) analysis showing high support values for the paraphyly (highlighted by gray rectangle) of *Beaucarnea* and *Calibanus* (B-C complex), and the monophyly of *Dasyllirion*, and *Nolina*. Abbreviations as for Fig. S1.



**Fig. 53.** Representative leaves of *Beaucarnea*, *Calibanus*, *Nolina* and *Dasylirion*. **A**, illustrations of the leaf morphology with a detail of the leaf margin in **a**, *Beaucarnea*, **b**, *Calibanus*, **c**, *Nolina*, and **d**, *Dasylirion*. **B**, scanning electron microscope images of the leaf grooves in **a–b**, *B. stricta*, **c–d**, *B. goldmanii*, and **e–f**, *C. hookeri*. Note the distinctive papillae in the leaf grooves of *B. stricta* and *C. hookeri*, and the lack thereof in the leaf grooves of *B. goldmanii*.

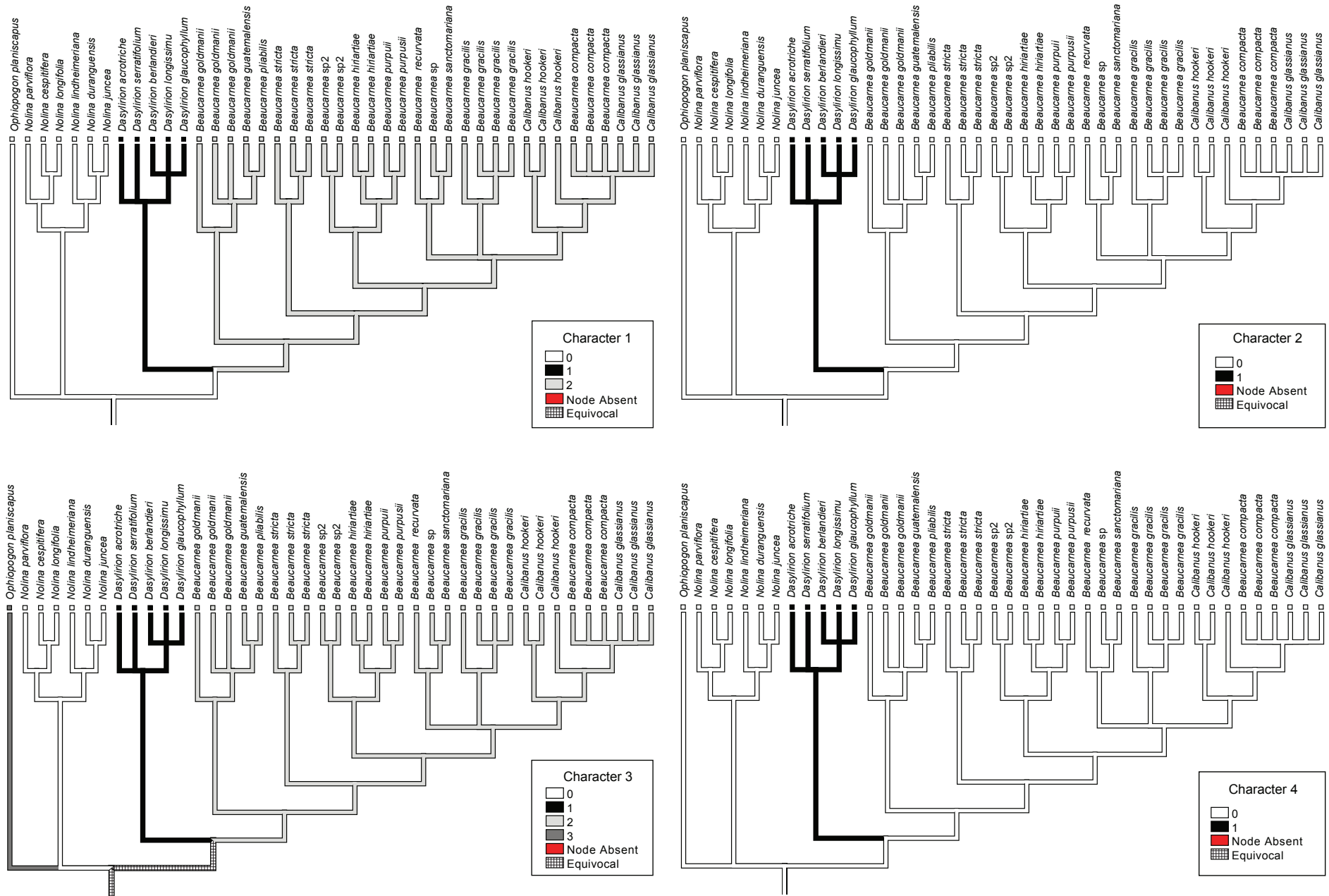


Fig. S4. Mapping of morphological characters from Appendix 3 on the MP strict consensus tree using Mesquite v.2.75. The morphological matrix used for this analysis can be found in Table S3.

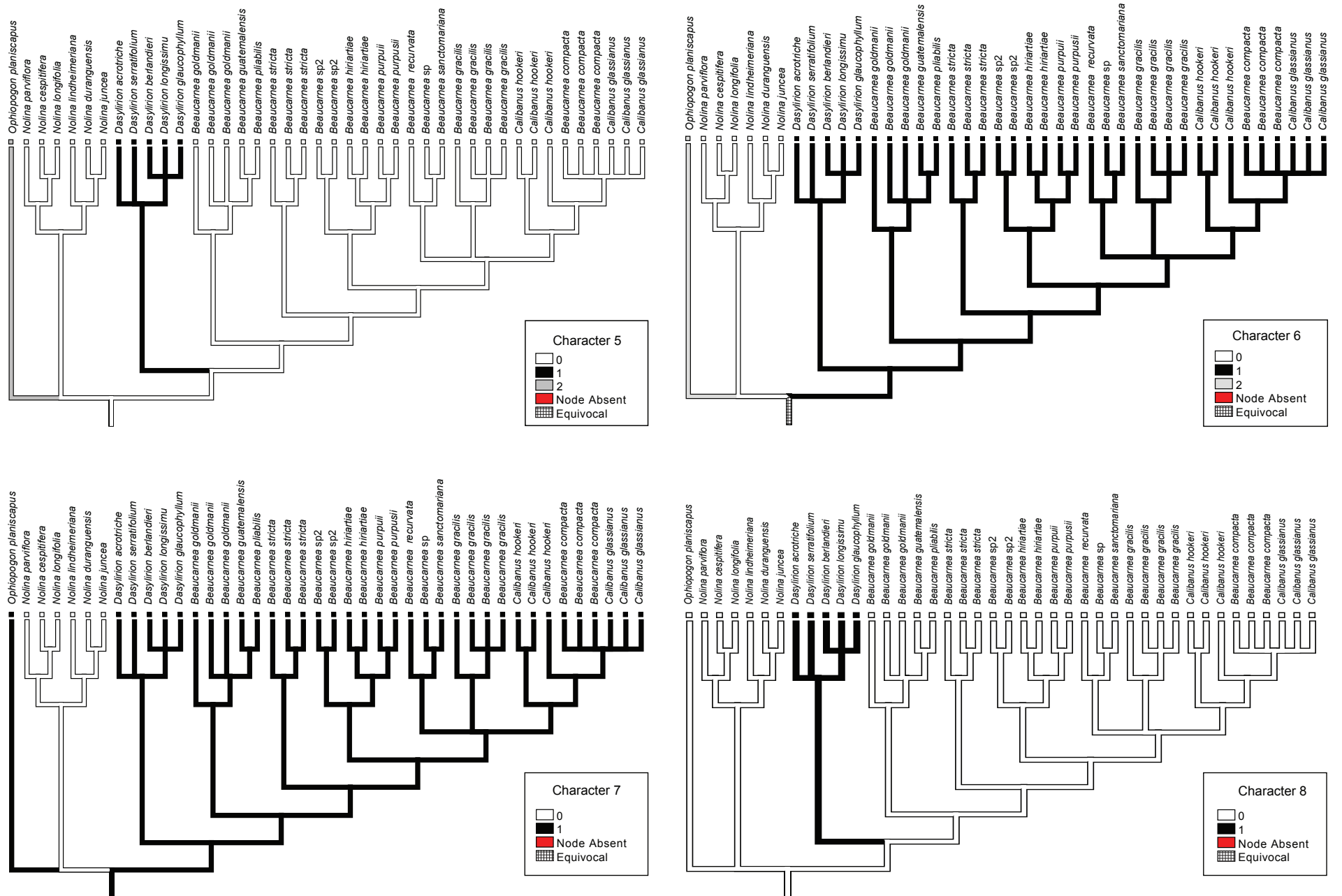


Fig. S4. Continued.

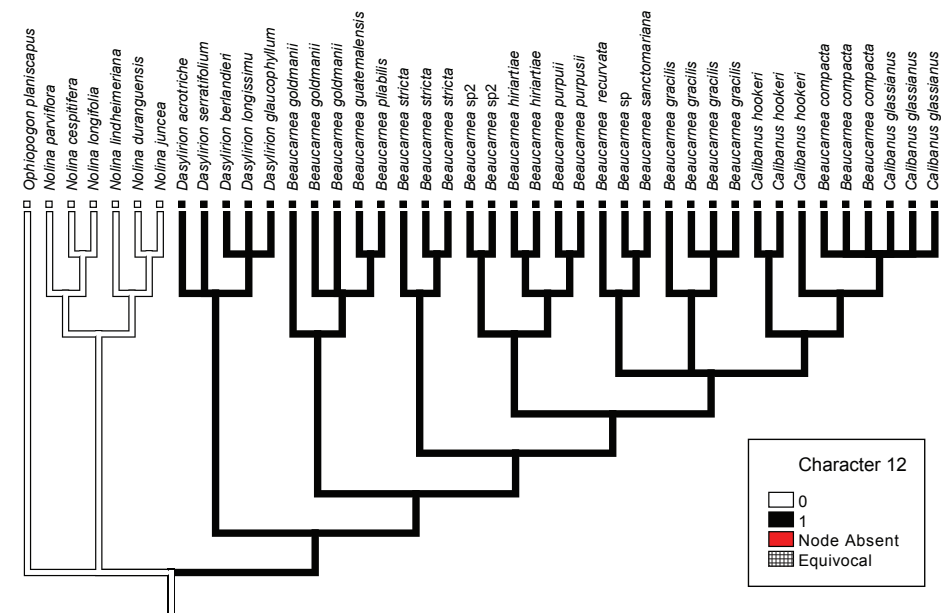
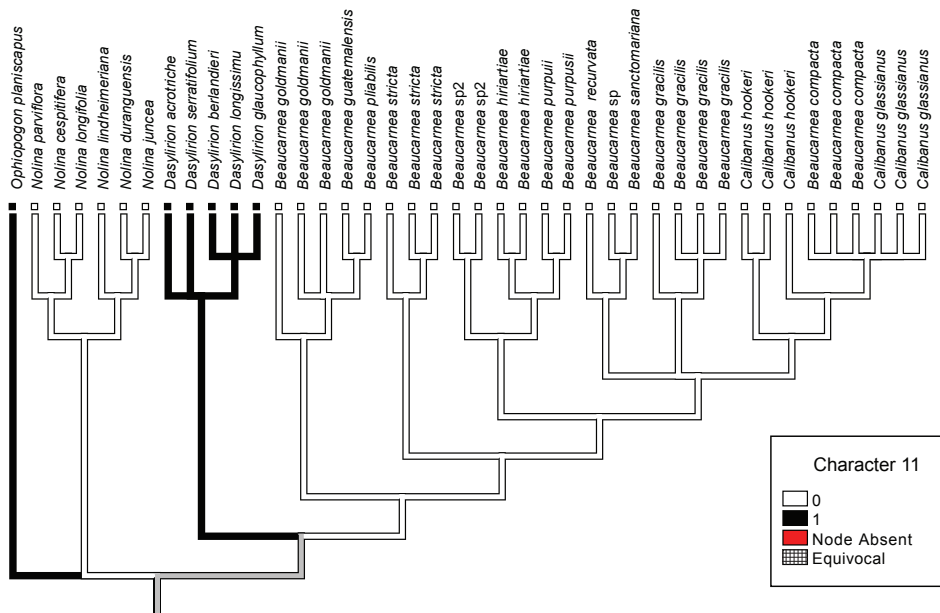
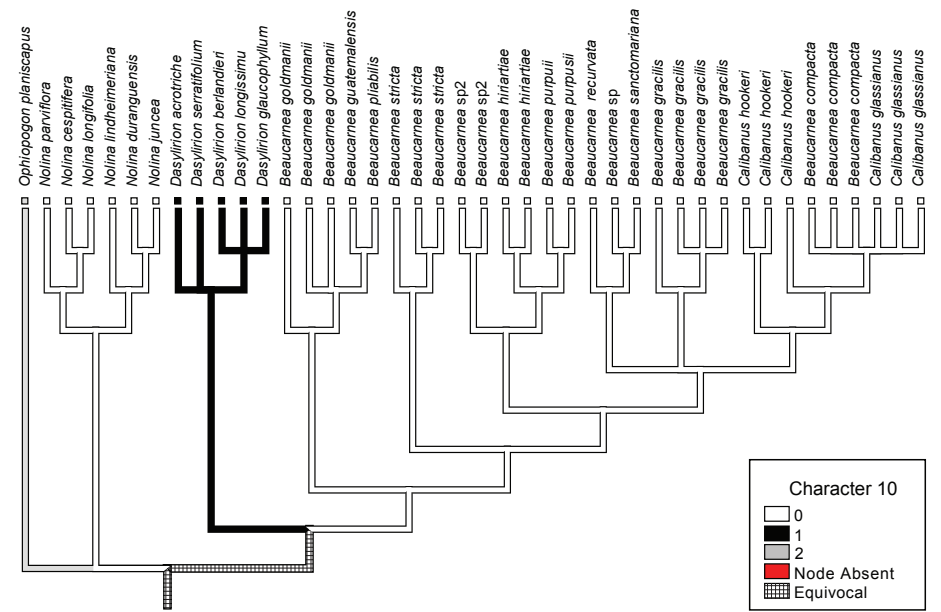
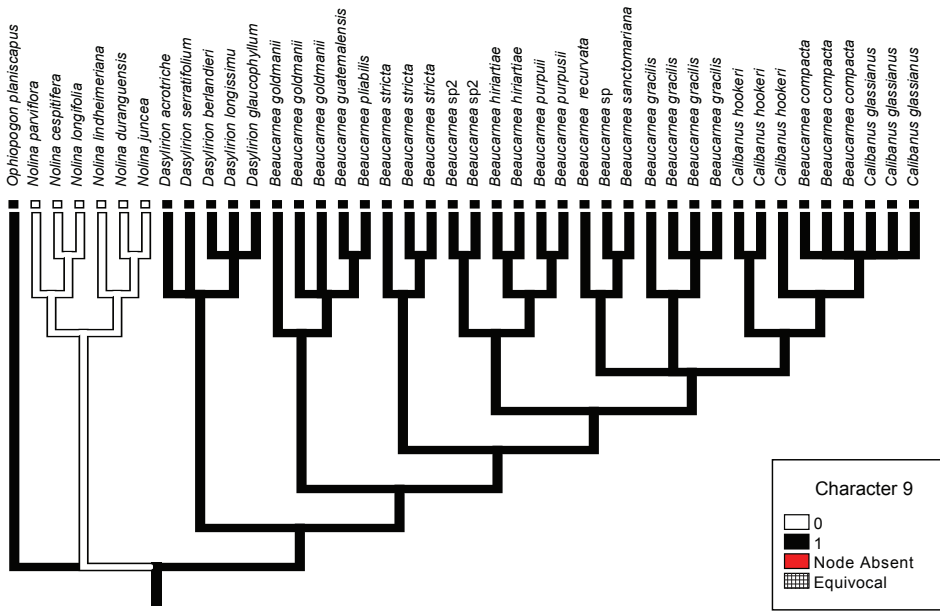


Fig. S4. Continued.

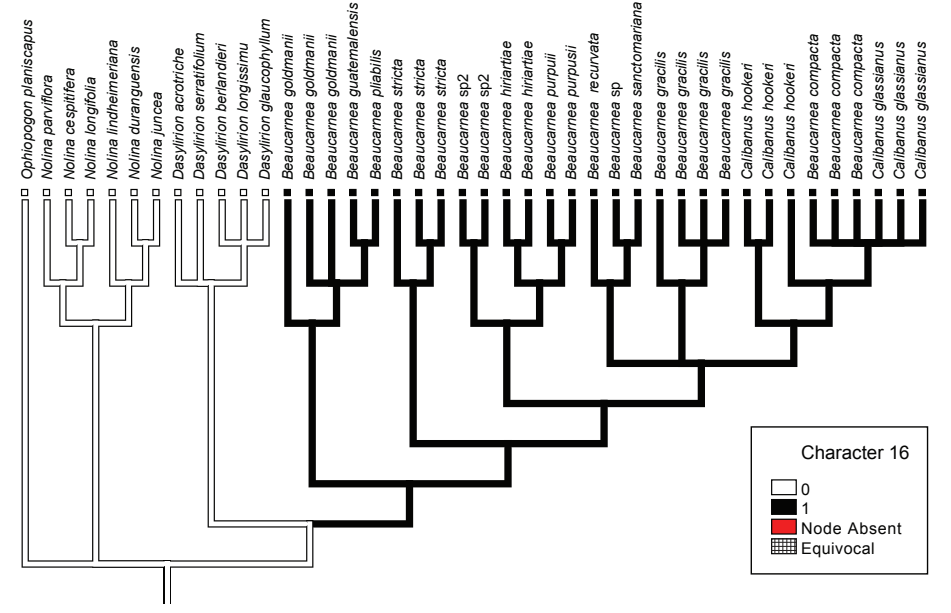
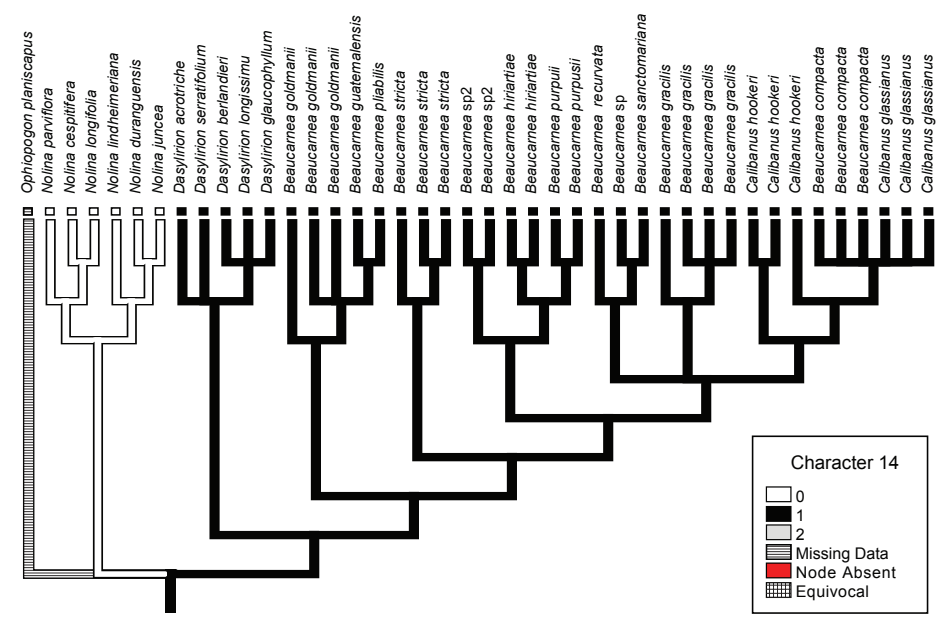
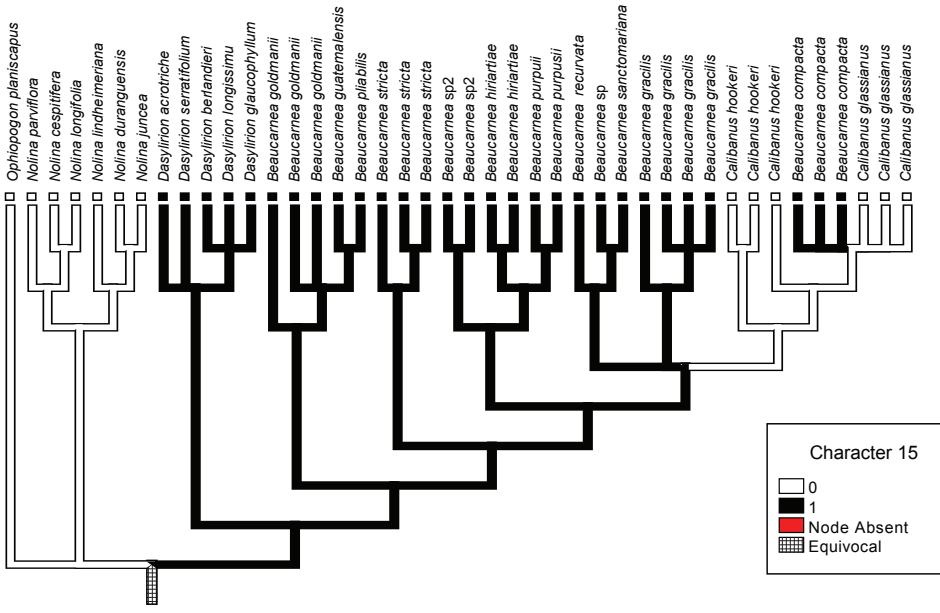
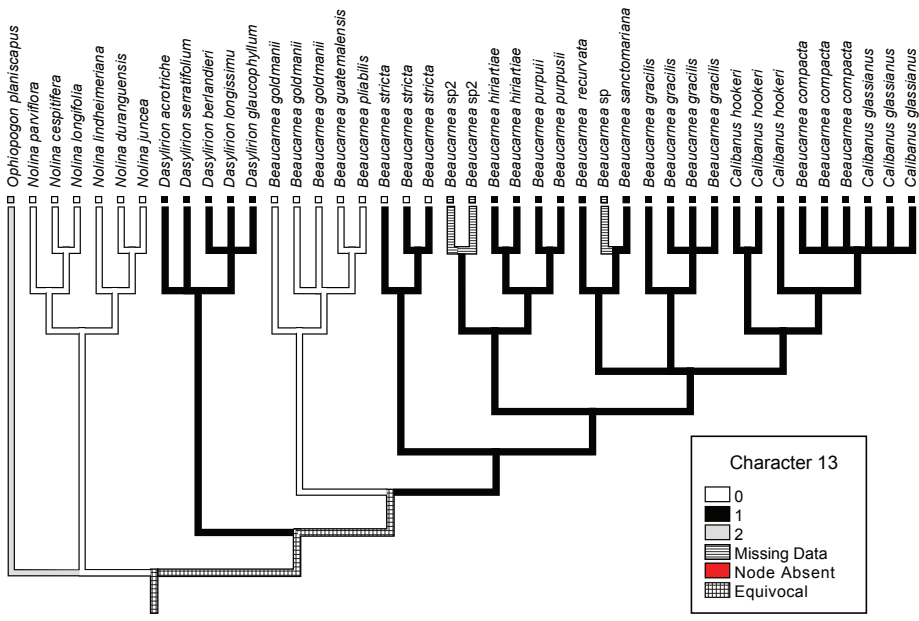
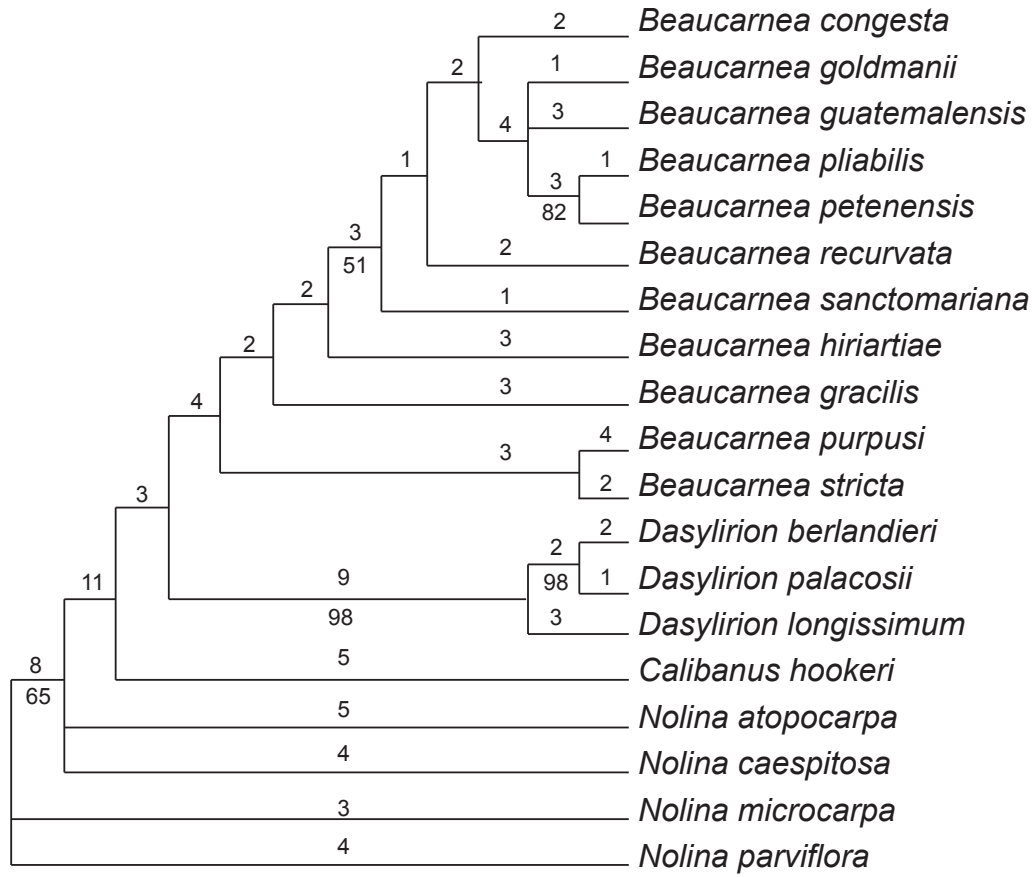
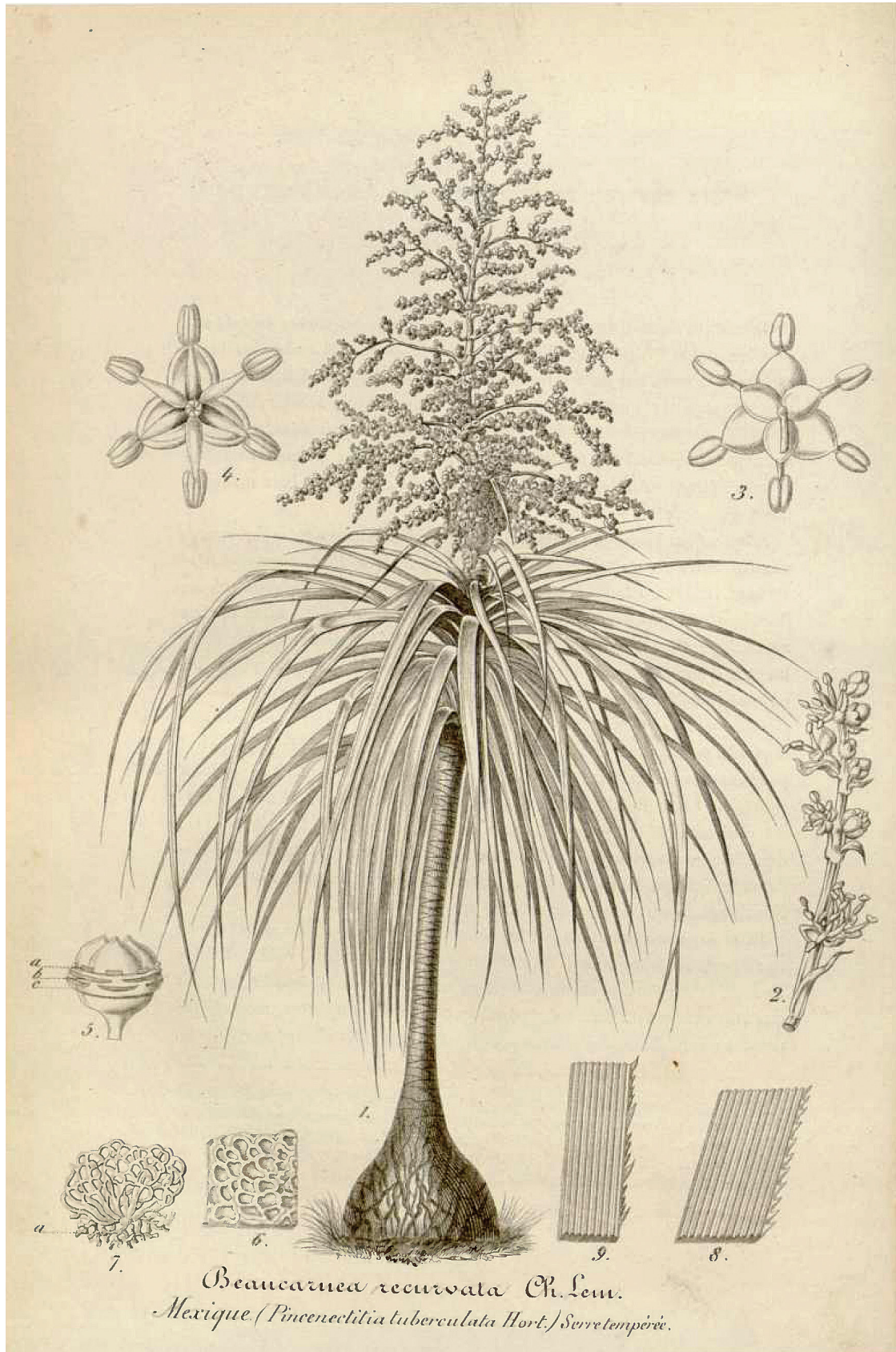


Fig. S4. Continued.



**Fig. S5.** Strict consensus tree of the Nolinaceae based on a parsimony analysis of 36 morphological characters (modified from Hernández, 1993a, unpub. data); length = 114, consistency index = 0.5. Numbers above branches indicate apomorphies, and numbers below branches indicate bootstrap values.



**Fig. S6.** Type of the name *Beaucarnea recurvata* Lem. (Lemaire, 1861: [59]). "1.", *Beaucarnea recurvata*, male specimen, illustrated from a photograph; "5.", pistillode of the staminate flowers.