

Table S1. Properties of analyzed orchid traits, including nectar characteristics. Life form: T- terrestrial, E - epiphitic, El - epilithic; pollinators: B - bees, M - moths, H - birds, Bu - butterflies, F - flies, W- wasps, Bt - beetles, D - various; pollinator specialization: S - specialist, G - generalist; nectar presentation: S - in spur, O - in open nectaries; spur category: S - short, M - medium, L - long.

Species	Subfamily	Continent	Life form	Pollinators	Specialist/ generalist	Nectar presentation	Spur length (mm)	Spur category	Sugar concentration (%)	S:G+ F	F:G	Source
<i>Acrolophia cochlearis</i>	Epidendroideae	Africa	T	B	S	S	3	S	90	2.33	0.88	Peter & Johnson 2009
<i>A. micrantha</i>	Epidendroideae	Africa	T	B	S	S	3	S	71	-	-	Peter & Johnson 2009
<i>Aeranthus arachnitis</i>	Epidendroideae	Africa	E	M	S	S	-	M	14.5	-	-	Roberts 2007
<i>Aerangis brachycarpa</i>	Epidendroideae	Africa	E	M	S	S	159	L	22.5	-	-	Martins & Johnson 2007
<i>A. confusa</i>	Epidendroideae	Africa	El	M	S	S	45	M	23	-	-	Martins & Johnson 2007
<i>A. ellisii</i>	Epidendroideae	Africa	E.	M	S	S	158	L	16.2	-	-	Nilsson & Rabakonandrianina 1988
<i>A. thomsonii</i>	Epidendroideae	Africa	E	M	S	S	135	L	14	-	-	1988
<i>A. verdickii</i>	Epidendroideae	Africa	E	M	S	S	150	L	16.35	-	-	Martins & Johnson 2007
<i>Rangaeris amaniensis</i>	Epidendroideae	Africa	E	M	S	S	156	L	20.5	-	-	Koopowitz & Marchant 1998
<i>Angraecum arachnites</i>	Epidendroideae	Africa	E	M	S	S	100	L	13.3	-	-	Martins & Johnson 2007
<i>A. striatum</i>	Epidendroideae	Africa	E	H	S	S	11.6	M	9.7	-	-	Nilsson et al. 1985;
<i>A. bracteosum</i>	Epidendroideae	Africa	E	H	S	S	8	S	9.6	-	-	Johnson & Raguso 2016
<i>A. sesquipedale</i>	Epidendroideae	Africa	E	M	S	S	333	L	16.5	-	-	Micheneau et al. 2006
<i>A. sororium</i>	Epidendroideae	Africa	El	M	S	S	264	M	10.3	-	-	
<i>Beadlea dufræ</i>		S. America	T	B	S	O	-	-	60.45	18.7	0.72	Wasserthal 1997
<i>Bonatea cassidea</i>	Orchidoideae	Africa	T	Bu	S	S	20.8	M	27.9	67.50	3.29	Wasserthal 1997
<i>B. polypodantha</i>	Orchidoideae	Africa	T	M	S	S	43.9	M	20	4.34	1.14	
<i>B. speciosa</i>	Orchidoideae	Africa	T	M	S	S	50	M	27.3	-	-	Galetto et al. 1997
<i>B. macroceras</i>	Orchidoideae	Africa	T	F	S	S	36.2	M	30.5	-	-	Balducci et al. 2019
<i>B. parviflora</i>	Orchidoideae	Africa	T	B	S	S	3.7	S	33.43	-	-	Balducci et al. 2020
<i>Caladenia arenaria</i>	Orchidoideae	Australia	T	W	S	O	-	-	-	19.00	1	Johnson & Liltved 1997;
<i>C. colorata</i>	Orchidoideae	Australia	T	W	S	O	-	-	-	19.00	1	Ponsie et al. 2007
<i>C. concolor</i>	Orchidoideae	Australia	T	W	S	O	-	-	-	-	-	Larsen et al. 2008
<i>C. nobilis</i>	Orchidoideae	Australia	T	W	S	O	-	-	-	1.00	1.6	Larsen et al. 2008
<i>C. paludosa</i>	Orchidoideae	Australia	T	W	S	O	-	-	-	2.37	1.02	Reiter et al. 2019b
<i>C. versicolor</i>	Orchidoideae	Australia	T	B	S	O	-	-	-	19.00	1	Reiter et al. 2018
<i>Cleisostoma yersinii</i>	Epidendroideae	Asia	E	B	S	S	10	S	74.51	20.89	0.84	Reiter et al. 2019b
<i>Comparetia coccinea</i>	Epidendroideae	S. America	E	Bu	S	S	18	M	22.5	-	-	Phillips et al. 2019

<i>C. falcata</i>	Epidendroideae	S. America	E	H	S	S	13.1	M	14	-	-	Rodríguez-Robles et al. 1992
<i>Cynorkis uniflora</i>	Orchidoideae	Africa	T	M	S	S	-	-	18.4	-	-	Nilsson et al. 1992
<i>Cyrtorchis arcuata</i>	Epidendroideae	Africa	E	M	S	S	33	M	16.65	-	-	Luyt 2002
<i>Diaphananthe caffra</i>	Epidendroideae	Africa	E	M	S	S	14	M	14.86	4.26	1.1	Luyt 2002
<i>D. millarii</i>	Epidendroideae	Africa	E	M	S	S	18.1	M	13.42	-	-	Luyt 2002
<i>Disa chrysostachya</i>	Orchidoideae	Africa	T	H	S	S	7.7	S	9.9	-	-	Johnson & Brown 2004
<i>D. cooperi</i>	Orchidoideae	Africa	T	M	S	S	42	M	34.9	0.89	1.3	Johnson 1995; Johnson 2006
<i>D. satyriopsis</i>	Orchidoideae	Africa	T	H	S	S	10.9	M	14.7	-	-	Johnson & Brown 2004
<i>D. scullyi</i>	Orchidoideae	Africa	T	F	S	S	42	M	30.3	3.0	0.79	Johnson 2006
<i>Elleanthus aurantiacus</i>	Epidendroideae	S. America	T	H	S	O	-	-	23.5	-	-	Neubig et al. 2015
<i>E. brasiliensis</i>	Epidendroideae	S. America	E	H	S	O	-	-	21.11	27.90	1.37	Nunes et al. 2013
<i>E. caravata</i>	Epidendroideae	S. America	E	H	S	O	-	-	26	-	-	Neubig et al. 2015
<i>E. cynarocephalus</i>	Epidendroideae	S. America	E	H	S	O	-	-	13	-	-	Neubig et al. 2015
<i>E. sodiroi</i>	Epidendroideae	S. America	T	H	S	O	-	-	16	-	-	Neubig et al. 2015
<i>Epipactis atropurpurea</i>	Epidendroideae	Europe	T	D	G	O	-	-	20	0.27	0.8	Pais & Neves 1980
<i>E. atropurpurea</i>	Epidendroideae	Europe	T	D	G	O	-	-	32	-	-	Pais et al. 1986
<i>Eulophia alta</i>	Epidendroideae	S. America	T	B	S	O	-	-	-	0.80	1.00	Jürgens et al. 2009
<i>Gymnadenia conopsea</i>	Orchidoideae	Europe	T	Bu	S	S	18	M	-	4.20	0.76	Gijbels et al. 2014
<i>G. odoratissima</i>	Orchidoideae	Europe	T	F	S	S	4.55	S	15.64	-	-	Sun et al. 2014
<i>Habenaria aitchisonii</i>	Orchidoideae	Asia	T	M	S	S	9	S	27.11	-	-	Xiong et al. 2019
<i>H. davidii</i>	Orchidoideae	Asia	T	M	S	S	63.98	L	24.5	-	-	Zang et al. 2017
<i>H. epipactidea</i>	Orchidoideae	Africa	T	M	S	S	29.5	M	27.9	-	-	Peter et al. 2009
<i>H. fordii</i>	Orchidoideae	Asia	T	M	S	S	65.31	L	16.47	-	-	Zang et al. 2017
<i>H. glaucifolia</i>	Orchidoideae	Asia	T	M	S	S	25.22	M	30.55	-	-	Xiong et al. 2015
<i>H. gourlieana</i>	Orchidoideae	S. America	T	M	S	S	133.9	L	14.47	7.94	0.75	Galetto et al. 1997, Singer & Cocucci 1997
<i>H. hieronymi</i>	Orchidoideae	S. America	T	M	S	S	13.2	M	50.9	0.20	2.05	Galetto et al. 1997; Singer & Cocucci 1997
<i>H. johannensis</i>	Orchidoideae	S. America	T	M	S	S	13.8	M	14.6	-	-	Amorim et al. 2014
<i>H. johannensis</i>	Orchidoideae	S. America	T	M	S	S	130.9	L	24.46	-	-	Pedron et al. 2012
<i>H. limprichtii</i>	Orchidoideae	Asia	T	M	S	S	19.22	L	26.2	-	-	Tao et al. 2018
<i>H. macronectar</i>	Orchidoideae	S. America	T	M	S	S	66.6	L	18.12	-	-	Pedron et al. 2012
<i>H. megapotaensis</i>	Orchidoideae	S. America	T	M	S	S	75.1	L	19.04	-	-	Pedron et al. 2012
<i>H. montevidensis</i>	Orchidoideae	S. America	T	Bu	S	S	16.2	M	26.2	-	-	Pedron et al. 2012
<i>H. paulistana</i>	Orchidoideae	S. America	T	M	S	S	12.9	M	19.2	-	-	Amorim et al. 2014
<i>H. pleiophylla</i>	Orchidoideae	S. America	T	M	S	S	22.3	M	40	-	-	Singer et al. 2007
<i>H. ornithoides</i>	Orchidoideae	S. America	T	M	S	S	40	M	-	27.09	2.16	Gottsberger et al. 1984
<i>H. rhodocheila</i>	Orchidoideae	Asia	T	Bu	S	S	41.26	M	20.89	-	-	Chen et al. 2021
<i>Jumellea stenopylla</i>	Epidendroideae	Africa	E	M	S	S	137.9	L	10.7	-	-	Micheneau et al. 2008
<i>Limodorum abortivum</i>	Orchidoideae	Europe	T	B	G	S	15	M	16.9	-	-	Pais et al. 1986; Vakhremeeva
<i>Luisia teres</i>	Epidendroideae	Asia	E	Bt	S	O	-	-	3.5	-	-	Arakaki et al. 2016
<i>Maxillaria anceps</i>	Epidendroideae	S. America	E	B	S	O	-	-	66.5	70.86	0.44	Davies et al. 2005

<i>Mystacidium brayboniae</i>	Epidendroideae	Africa	E	M	S	S	19.4	M	11.42	46.00	-	Luyt 2002
<i>M. capense</i>	Epidendroideae	Africa	E	M	S	S	39.1	M	15.96	7.30	2.45	Luyt 2002
<i>M. flanaganii</i>	Epidendroideae	Africa	E	M	S	S	19.6	M	23.6	1.38	1.21	Luyt 2002
<i>M. gracile</i>	Epidendroideae	Africa	E	M	S	S	25.6	M	18.26	2.45	0.96	Luyt 2002
<i>M. pusillum</i>	Epidendroideae	Africa	E	M	S	S	20.4	M	21.46	1.27	0.83	Luyt 2002
<i>M. pusillum</i>	Epidendroideae	Africa	E	M	S	S	20.4	M	24.2	-	-	Peter & Venter 2016
<i>M. tanganyikense</i>	Epidendroideae	Africa	E	M	S	S	16.8	M	-	4	1.5	Luyt 2002
<i>M. venosum</i>	Epidendroideae	Africa	E	M	S	S	47	M	16	6.70	3.33	Luyt & Johnson 2001; Luyt 2002
<i>Neottia ovata</i>	Epidendroideae	Europe	T	D	G	O	-	-	3.39	0.22	0.88	Brzosko et al. 2021
<i>Oeceoclades maculata</i>	Epidendroideae	S. America	T	Bu	S	S	5	S	33.73	-	-	Aguiar & Pansarin; Gonzales-Dias, Ackerman 1988
<i>Platanthera chlorantha</i>	Orchidoideae	Europe	T	M	S	S	30	M	19.37	-	-	Stpiczyńska & Pielecki 2002
<i>P. bifolia</i>	Orchidoideae	Europe	T	M	S	S	27.9	M	12.07	0.32	0.67	Brzosko & Bajguz 2019
<i>P. chlorantha</i>	Orchidoideae	Europe	T	M	S	S	32.37	M	15.78	0.09	0.61	Brzosko & Bajguz 2019
<i>P. ciliaris</i>	Orchidoideae	N. America	T	Bu	S	S	23.7	M	21	-	-	Robertson & Wyatt
<i>P. praeclara</i>	Orchidoideae	N. America	T	M	S	S	44.5	M	24.7	-	-	Westwood et al. 2011
<i>P. stricta</i>	Orchidoideae	N. America	T	D	S	S	3.97	S	8	-	-	Patt et al. 1989
<i>Pelexia bonariensis</i>	Orchidoideae	S. America	T	B	S	O	-	-	39.55	1.70	0.57	Galetto et al. 1997
<i>Pteroglossa glazioviana</i>	Orchidoideae	S. America	T	Bu	S	S	13	M	26.75	-	-	Pansarin & Ferreira 2015
<i>P. roseoalba</i>	Orchidoideae	S. America	T	Bu	S	S	31	M	27.98	-	-	Pansarin & Ferreira 2015
<i>Rhynchostylis retusa</i>	Epidendroideae	Asia	E	B	S	S	5	S	45.7	-	-	Buragohain et al. 2015
<i>Rodriguezia bahiensis</i>	Epidendroideae	S. America	E	B	G	O	-	-	16.57	-	-	Carvalho & Machado 2006
<i>R. granadensis</i>	Epidendroideae	S. America	E	B	S	S	26.5	M	33	-	-	Ospina-Calderón et al. 2015
<i>R. lanceolata</i>	Epidendroideae	S. America	E	H	S	S	3	S	36	-	-	Pansarin et al. 2018
<i>Satyrium carneum</i>	Orchidoideae	Africa	E	H	S	S	23.4	M	31.2	-	-	Johnson 1996
<i>S. coriifolium</i>	Orchidoideae	Africa	T	H	S	S	12.3	M	23.6	-	-	Johnson 1996; Ellis and Johnson 1999
<i>S. hallackii ssp. hallackii</i>	Orchidoideae	Africa	T	B	S	S	13.6	M	23.1	1.63	1	Johnson 1997
<i>S. hallackii ssp. ocellatum</i>	Orchidoideae	Africa	T	D	S	S	32.8	M	18.9	2.70	1.08	Johnson 1997
<i>S. princeps</i>	Orchidoideae	Africa	E	H	S	S	21.9	M	28.6	-	-	Johnson 1996
<i>S. rhodanthum</i>	Orchidoideae	Africa	T	H	S	S	31.89	M	24.8	-	-	van der Niet et al. 2015
<i>S. crassicaule</i>	Epidendroideae	Africa	T	M	S	S	16	M	23.3	2.23	1.07	Johnson et al. 2011
<i>S. cristatum var. cristatum</i>	Epidendroideae	Africa	T	B	S	S	10	S	27.5	1.63	0.8	Johnson et al. 2011
<i>S. cristatum var. longilabiatum</i>	Epidendroideae	Africa	T	B	S	S	10	S	35.1	-	-	Johnson et al. 2011
<i>S. longicauda</i>	Epidendroideae	Africa	T	M	S	S	40	M	31.2	4.00	1	Johnson et al. 2011
<i>S. macrophyllum</i>	Epidendroideae	Africa	T	F	S	S	33	M	27.9	100.00	-	Johnson et al. 2011
<i>S. monadenum</i>	Epidendroideae	Africa	T	H	S	S	18	M	16.4	-	-	Johnson et al. 2011
<i>S. neglectum</i>	Epidendroideae	Africa	T	D	G	S	16	M	31.3	1.70	0.95	Johnson et al. 2011
<i>S. parviflorum</i>	Epidendroideae	Africa	T	M	S	S	12	M	15.7	1.94	1.27	Johnson et al. 2011
<i>S. sceptrum</i>	Epidendroideae	Africa	T	H	S	S	37.9	M	18.7	7.33	1	Johnson et al. 2011
<i>S. sphaerocarpum</i>	Epidendroideae	Africa	T	B	S	S	13	M	24.6	100.00	-	Johnson et al. 2011
<i>S. trinerve</i>	Epidendroideae	Africa	T	D	S	S	5.96	S	12.4	-	-	Johnson et al. 2011
<i>Sobralia bouchei</i>	Epidendroideae	S. America	E	B	S	O	-	-	20	-	-	Neubig et al. 2015
<i>S. callosa</i>	Epidendroideae	S. America	E	H	S	O	-	-	15.75	-	-	Neubig et al. 2015
<i>S. macrophylla</i>	Epidendroideae	S. America	E	B	S	O	-	-	20	-	-	Neubig et al. 2015

<i>S. rosea</i>	Epidendroideae	S. America	T	B	S	O	-	-	12.25	-	-	Neubig et al. 2015
<i>Stenorrhynchos orchioideis</i>	Orchidoideae	S. America	T	H	S	O	-	-	43.9	0.5	0.8	Galetto et al. 1997
<i>Schizochilus flexuosus</i>	Orchidoideae	Africa	T	B	S	S	4.73	S	30.25	-	-	Van der Niet et al. 2010
<i>S. zeyheri</i>	Orchidoideae	Africa	T	F	S	S	3.36	S	22.1	-	-	Van der Niet et al. 2010

Table S2. Sugar ratios in Orchidaceae in comparison with Baker and Baker (1983a) according to pollinator type. Data include the number of species studied with percentages in parentheses within the pollinator type.

Nectar sugar ratio	Source	Bird-pollinated species	Bee-pollinated species	Moth-pollinated species	Butterfly-pollinated species	Fly-pollinated species	Wasp-pollinated species	Generalist
Suchrose dominant	Present work	2 (66.6)	9 (100)	14 (77.8)	2 (100)	2 (100)	2 (66.6)	2 (50)
	Baker & Baker	77(55.0)	83 (17.8)	47 (45.2)	29 (38.7)			
Sucrose rich	Present work	0	0	1 (5.6)	0	0	1 (33.3)	0
	Baker & Baker	45(32.1)	77 (16.5)	30 (28.8)	24 (32.0)			
Hexose rich	Present work	1 (33.3)	0	2 (11.1)	0	0	0	2 (50)
	Baker & Baker	18 (12.8)	178 (38.2)	22 (21.1)	17 (22.6)			
Hexose dominant	Present work	0	0	1 (5.6)	0	0	0	0
	Baker & Baker	0(0)	128 (27.5)	5 (4.8)	5 (6.6)			

Table S3. Composition and performance of linear models explaining the logarithm of sugar concentration in flowers of 106 orchid species

#	Variables included	df	AIC	ΔAIC
1	Continent + climatic zone + habitat	11	152.00	28.66

2	Pollinator type + pollinator match + spur type	12	136.30	12.96
3	Continent + climatic zone + habitat + pollinator type + pollinator match + spur type	21	126.84	3.50
4	Continent + climatic zone + pollinator type + spur type	17	123.34	0

Table S4. Results of the Kruskal–Wallis tests comparing sugar ratios in the nectar of orchid species depending on their geographic location, habitat, and pollination mode.

Factor	$\chi^2$	df	p
<i>Saccharose to hexoses ratio</i>			
Continent	8.07	3	0.044
Climatic zone	10.99	2	0.0041
Habitat	2.58	1	0.11
Pollinator type	6.83	5	0.23
Pollinator match	0.73	1	0.39
Spur type	0.75	3	0.86
<i>Fructose to glucose ratio</i>			
Continent	8.34	3	0.039
Climatic zone	4.13	2	0.13
Habitat	1.23	1	0.27
Pollinator type	9.59	5	0.088
Pollinator match	2.06	1	0.16
Spur type	7.68	3	0.053

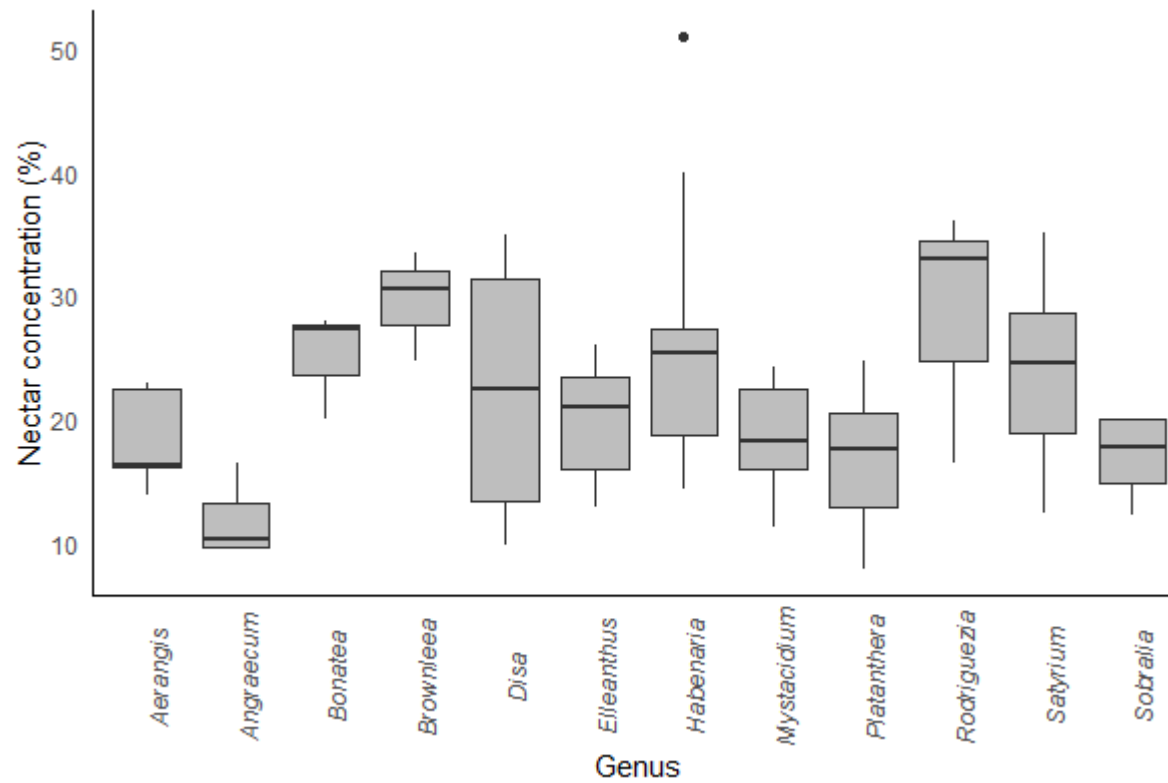


Figure S1. Variance in sugar concentration in flowers of different genera in Orchidaceae family

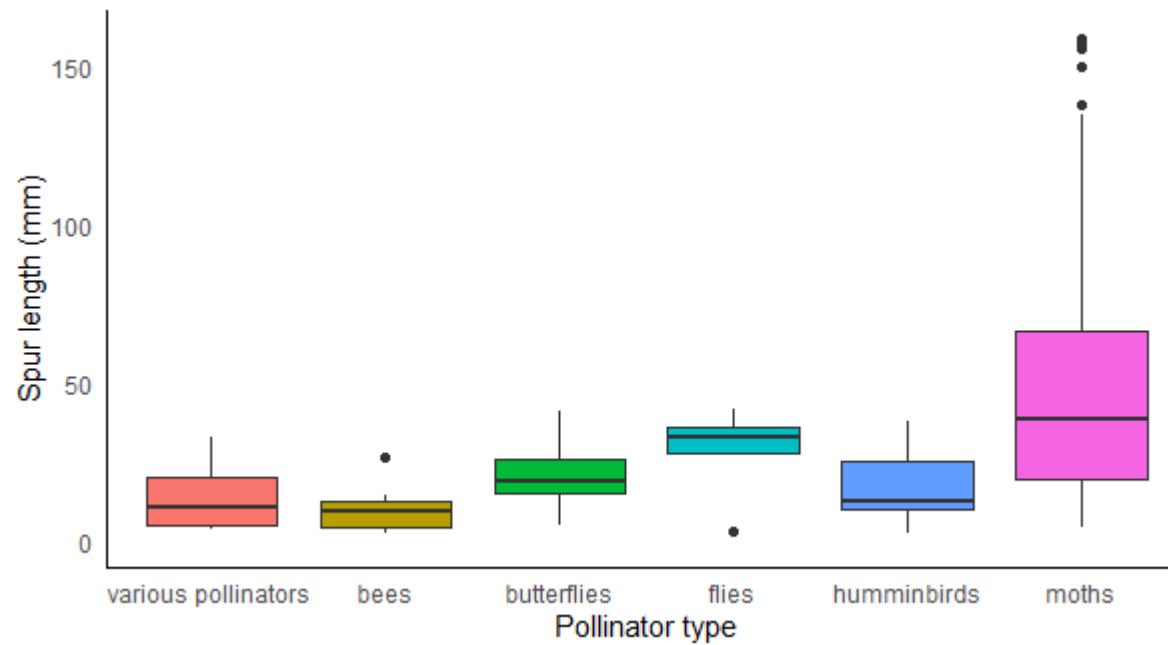


Figure S2. Spur length of different pollinator groups of 105 orchids included in our meta-analysis of nectar composition of the Orchidaceae (the single species pollinated by beetles was omitted).