

Ecography

ECOG-03074

Williams, P. H., Lobo, J. M. and Meseguer, A. S. 2017. Bumblebees take the high road: climatically integrative biogeography shows that escape from Tibet, not Tibetan uplift, is associated with divergences of present-day *Mendacibombus*. – Ecography doi: 10.1111/ecog.03074

Supplementary material

Appendix 1

Table A1. Primer sequences for the sequenced regions of the four genes.

Gene	Primer name	Primer sequence	Reference
COI	LepF	5'- ATTCAACCAATCATAAAGATATTGG -3'	Hebert et al. 2004
	LepR	5'- TAAACTTCTGGATGTCCAAAAATCA -3'	Hebert et al. 2004
16S	16SWb	5'- CACCTGTTTATCACCTGTTTATCAAAAACAT -3'	Dowton and Austin 1994
	874-16SIR	5'- TATAGATAGAAACCAAYCTG -3'	Cameron et al. 1992
Opsin	LWRhF	5'- AATTGCTATTAYGARACNTGGGT -3'	Mardulyn and Cameron 1999
	LWRhR	5'- ATATGGAGTCCANGCCATRAACCA -3'	Mardulyn and Cameron 1999
PEPCK	FHv4	5'- TGTATRATAATTCGCAAYTTCAC -3'	Cameron et al. 2007
	RHv4	5'- CTGCTGGRGTCTAGATCC -3'	Cameron et al. 2007

Table A2. GenBank accession numbers for gene sequences with the species' names (in the genus *Bombus*) listed according to Williams *et al.* (2016), together with COI barcode numbers from the BOLD database (boldsystems.org). Outgroup species are shown with *. Sequences are also available from PW.

Species	COI barcode	16S	Opsin	PEPCK
<i>confusus</i> *	6876D11	DQ787992	DQ788324	EF051016
<i>soroensis</i> *	1550E10	DQ788107	AF493008	EF051013
<i>difficillimus</i> *	6876C09	DQ787998	DQ788327	EF050990
<i>gerstaeckeri</i> *	FBHAP779-09	DQ788017	DQ788335	EF051003
<i>balteatus</i> *	NOAPI567	DQ787974	AY739455	EF050870
<i>bimaculatus</i> *	4485F03	DQ787978	AY739456	EF050847
<i>nobilis</i> *	HJNO00012	DQ788071	AY739485	EF050912
<i>superbus</i>	HJS1	KX452097	KX452101	KX452104
<i>waltoni</i>	1550D06	DQ788134	DQ788385	EF051022
<i>convexus</i>	6876B05	DQ787993	DQ788325	EF051021
<i>makarjini</i>	6875G01	–	–	–
<i>marussinus</i>	19992G06	–	–	–
<i>avinoviellus</i>	1552D05	AY268416	AY268394	EF051020
<i>himalayanus</i>	6876D08	–	–	–
<i>turkestanicus</i>	6875F08	KX452098	KX452102	KX452105
<i>defector</i>	6875A05	KX452099	KX452103	KX452106
<i>margreiteri</i>	9808D12	KX452100	AF493025	KX452107
<i>handlirschianus</i>	1549E10	DQ788022	DQ788337	EF051017
<i>mendax</i>	6876B08	DQ788057	AF493024	EF051019

Table A3. Principal events in the most likely biogeographic reconstruction for species of the subgenus *Mendacibombus* from the S-DIVA analysis shown in Fig. 5a using the estimate of phylogeny for all species from Fig. 4 and the short-distance dispersal model in Fig. 3 with other bumblebees as the outgroup. Letters represent the areas listed in Table 1; arrows, range-state transitions; caret, local duplicate daughter populations; vertical lines, daughter species' ranges. Where alternative explanations of events exist, only one is shown.

Event	Ancestral range	Processes	Dispersal	Vicariance	Extinction	Daughter ranges
1	GHP	GHP → GH P	0	1	0	GH, P
2	G	GH → G H	0	1	0	G, H
3	P	P → P^P → P PT	1	0	0	P, PT
4	P	P → P^P → P PCA	2	0	0	P, PCA
5	P	P → P^P → PH HPT	3	0	0	PH, HPT
6	HPT	HPT → PT H	0	1	0	PT, H
7	PH	PH → P H	0	1	0	P, H
8	PCA	PCA → PCATM → PCA TM	2	1	0	PCA, TM

Table A4. Principal events in the most likely biogeographic reconstruction for species of the subgenus *Mendacibombus* from the S-DEC analysis shown in Fig. 5b using the estimate of phylogeny for all species from Fig. 4 and the short-distance dispersal model in Fig. 3 with other bumblebees as the outgroup. Letters represent the areas listed in Table 1; arrows, range-state transitions; caret, local duplicate daughter populations; vertical lines, daughter species' ranges. Where alternative explanations of events exist, only one is shown.

Event	Ancestral range	Processes	Dispersal	Vicariance	Extinction	Daughter ranges
1	GHP	GHP → GP → G P	0	1	1	G, P
2	G	G → G^G → G GH	1	0	0	G, GH
3	P	P → P^P → P PT	1	0	0	P, PT
4	P	P → P^P → P PTC	2	0	0	P, PTC
5	P	P → P^P → PH HPT	3	0	0	PH, HPT
6	HPT	HPT → PT H	0	1	0	PT, H
7	PH	HP → P H	0	1	0	P, H
8	PTC	PTC → TC → TMCA → CA TM	2	1	1	CA, TM

Table A5. Ancestral state reconstruction results for the selected variables. Node numbers correspond with node numbers in Fig. A1.

Node number		1	2	3	4	5	6	7	8	9	10	11
Annual variation in precipitation	Ancestral state	81.29	85.33	69.93	70.33	70.84	114.31	66.05	65.44	79.24	69.23	68.94
	Variance	200.92	192.63	129.21	85.63	75.67	137.67	74.43	77.04	88.88	78.34	71.43
	Lower 95% CI	53.51	58.13	47.65	52.19	53.79	91.31	49.14	48.24	60.76	51.88	52.37
	Upper 95% CI	109.07	112.53	92.20	88.46	87.89	137.31	82.96	82.64	97.71	86.58	85.50
Aridity	Ancestral state	64.67	66.58	59.32	60.15	57.60	59.19	52.43	51.37	60.03	70.30	72.39
	Variance	250.31	239.98	160.96	106.68	94.27	171.51	92.72	95.98	110.73	97.60	88.98
	Lower 95% CI	33.66	36.22	34.45	39.91	38.57	33.52	33.56	32.17	39.41	50.93	53.90
	Upper 95% CI	95.68	96.94	84.18	80.40	76.63	84.86	71.30	70.57	80.66	89.66	90.87
Max month temperature	Ancestral state	10.08	9.57	11.51	12.19	12.36	10.01	12.75	12.94	12.13	12.74	12.93
	Variance	2.77	2.65	1.78	1.18	1.04	1.90	1.02	1.06	1.22	1.08	0.98
	Lower 95% CI	6.82	6.38	8.90	10.07	10.36	7.31	10.77	10.92	9.97	10.70	10.99
	Upper 95% CI	13.34	12.76	14.13	14.32	14.36	12.71	14.73	14.96	14.30	14.77	14.88
Min month precipitation	Ancestral state	9.04	7.58	13.16	16.47	14.89	4.53	13.06	12.43	14.29	27.38	34.62
	Variance	207.13	198.58	133.20	88.27	78.00	141.93	76.73	79.42	91.63	80.77	73.63
	Lower 95% CI	-19.17	-20.04	-9.46	-1.94	-2.42	-18.82	-4.11	-5.04	-4.47	9.76	17.80
	Upper 95% CI	37.25	35.20	35.78	34.89	32.20	27.88	30.23	29.90	33.05	44.99	51.44

Figure A1. Trees showing the evolution of the ancestral climate niche within each of the selected climate variables along the dated tree of *Mendacibombus* species, estimated with *Phytools* from species' current climate niches from their current distributions (Fig. 1a) and the chronogram in Fig. 4. For each tree, colours on branches correspond with the estimated value of the trait on the scale bars shown below each tree.

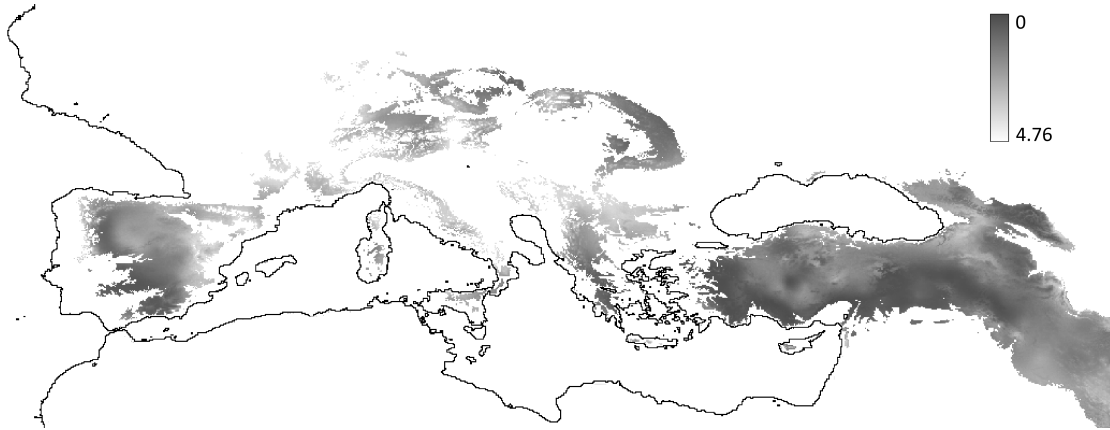


Figure A3. Reconstruction of climate suitability in the western Palearctic for the Last Glacial Maximum (22 ka) based on the climate conditions of current observations for *Mendacibombus* species and following the same methodological protocol as in Fig. 7. Data from the GCM simulation available at WorldClim (www.worldclim.org).

References

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