

## ORIGINAL RESEARCH ARTICLE

### Preliminary survey of the nutritional and palynological traits of honey bee-foraged pollen in Liguria (Italy)

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### Online Supplementary Material

Table S1. GIS coordinates and altitude of the pollen sampling sites.

Site	Locality	Latitude (N)	Longitude (E)	Altitude (m above s.l.)
RA	Rapallo	44.3599	9.1991	63
SL	Sestri Levante	44.3033	9.4325	116
CH	Chiavari	44.3267	9.3343	138
US	Uscio	44.4056	9.1563	288
SC	San Colombano	44.3690	9.3416	300
NE	Ne	44.3460	9.4405	420
BA	Bargagli	44.4347	9.0904	566

Figure S1. Land cover maps within an area of 1.5 km radius surrounding the experimental apiaries.

- [Blue square] Urban area and cultivations
- [Purple square] Mixed deciduous woodland
- [Yellow square] Heath
- [Pink square] Mixed woodland dominated by *Castanea sativa*
- [Orange square] High Mediterranean maquis
- [Red-orange square] Low Mediterranean maquis
- [Light pink square] Abandoned olive yards
- [Light green square] Cultivated olive yards
- [Brown square] *Fraxinus ornus*-*Ostrya carpinifolia* woodlands and *hygrophilus* woodland
- [Dark green square] Mixed woodland dominated by *Ostrya carpinifolia*
- [Medium green square] Mixed woodland dominated by *Pinus pinaster*
- [Red square] Grassland
- [Light blue square] Mixed woodland dominated by *Quercus pubescens*
- [Red star] Apiary

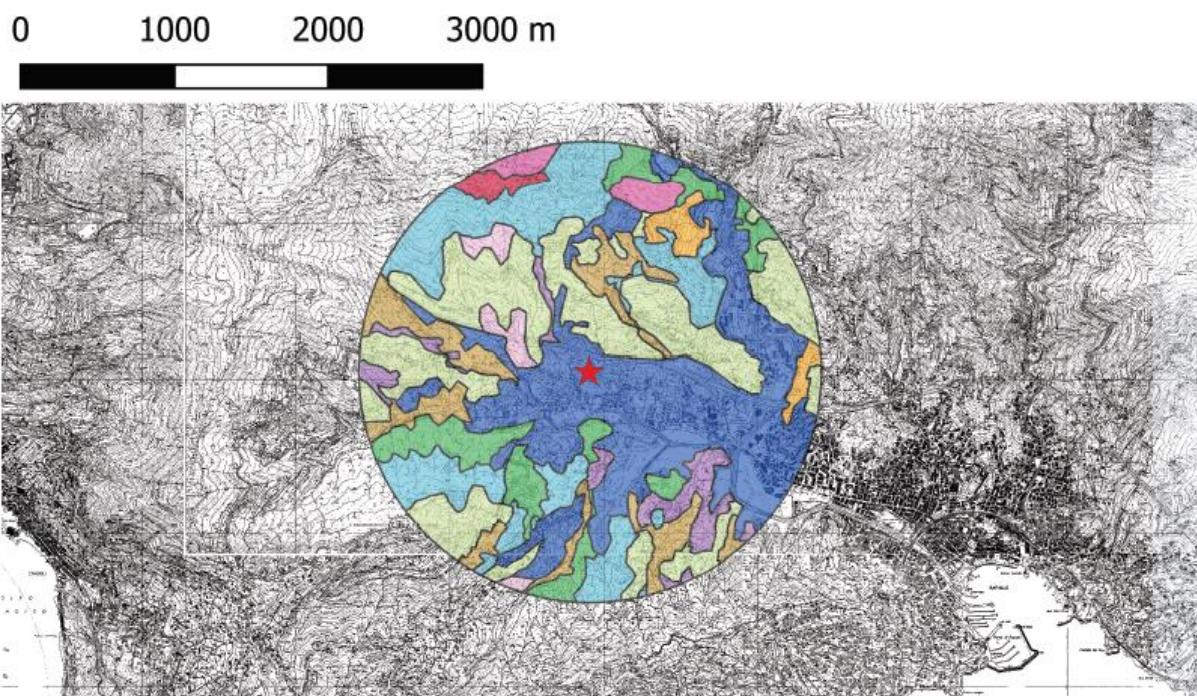


Figure S1A. Land cover types within an area of 1.5 km surrounding the apiary RA (Rapallo).

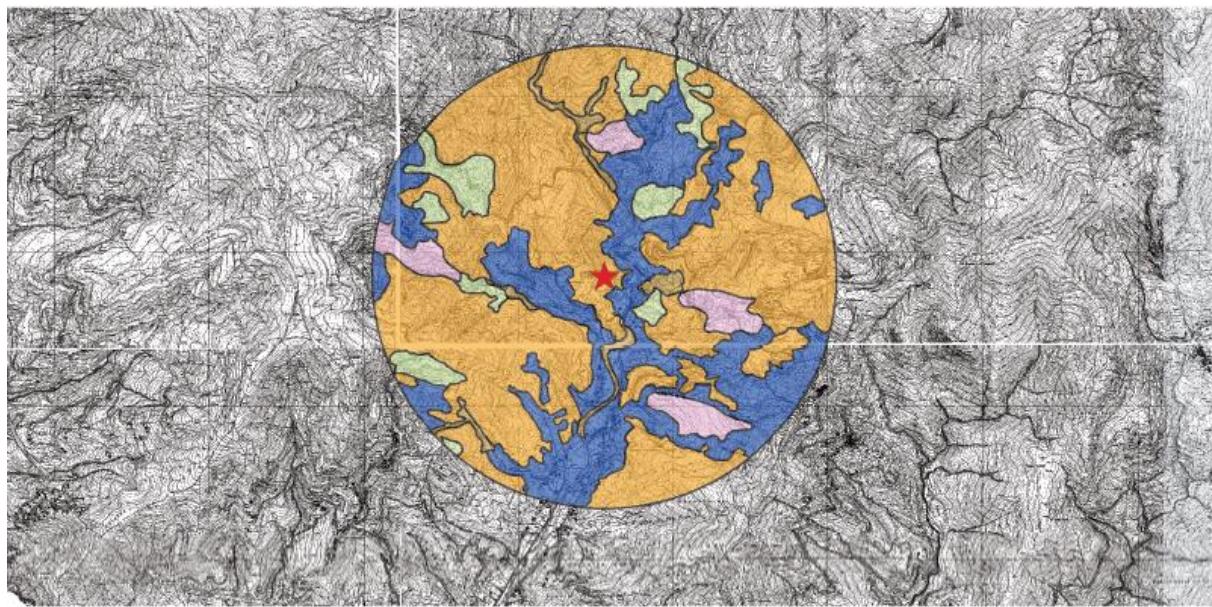


Figure S1B. Land cover types within an area of 1.5 km surrounding the apiary SL (Sestri Levante).

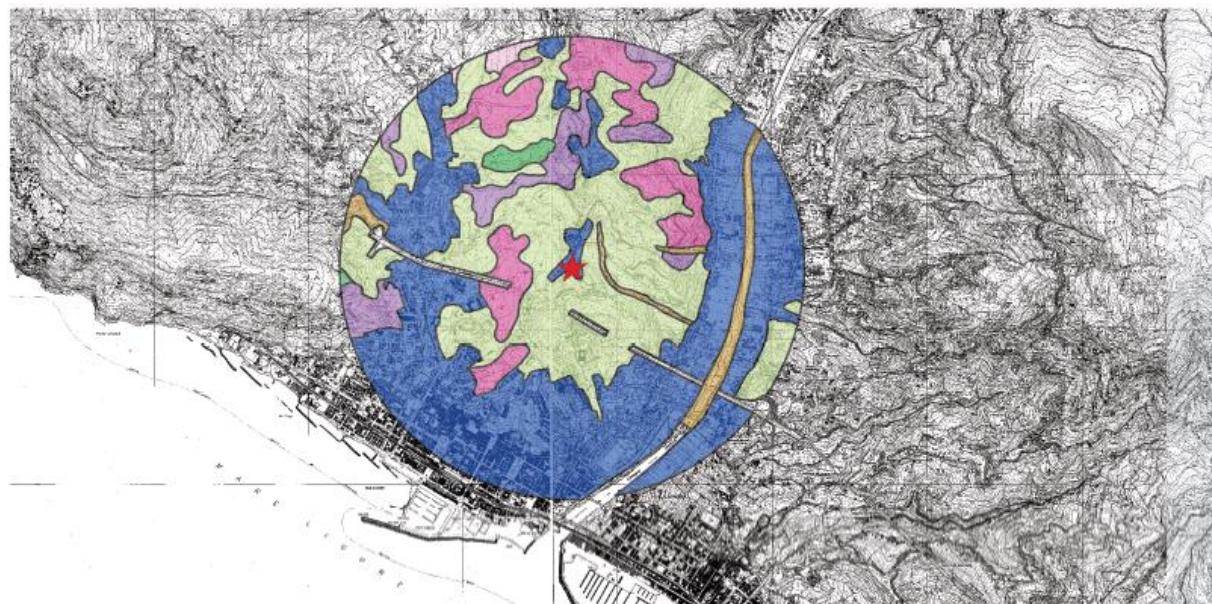


Figure S1C. Land cover types within an area of 1.5 km surrounding the apiary CH (Chiavari).

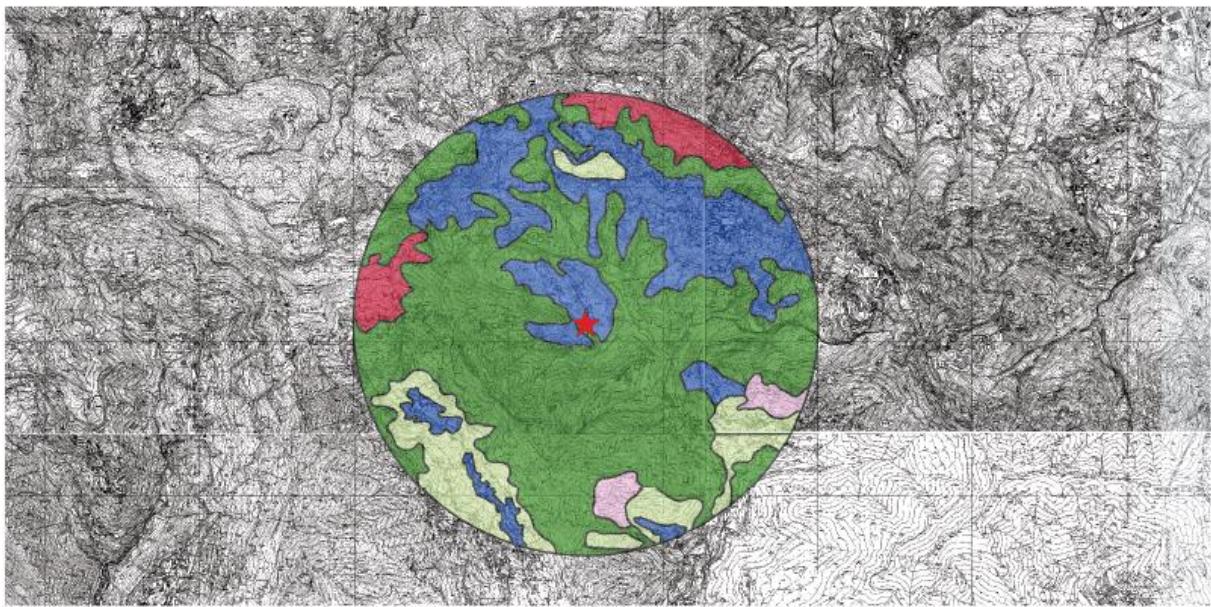


Figure SID. Land cover types within an area of 1.5 km surrounding the apiary US (Uscio).

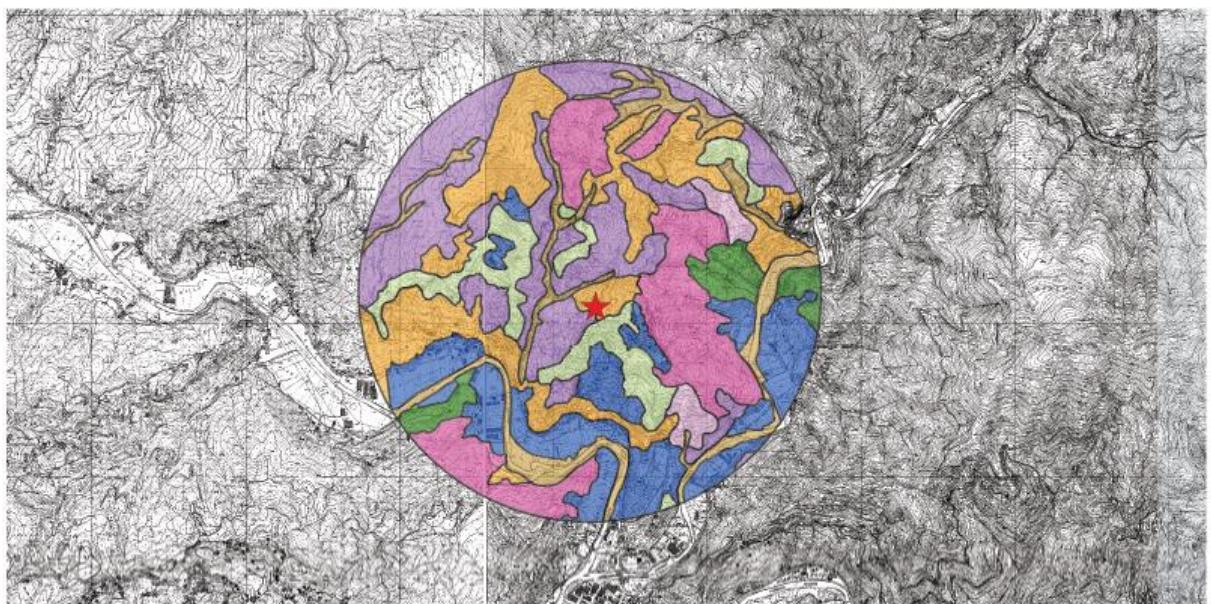


Figure SIE. Land cover types within an area of 1.5 km surrounding the apiary SC (San Colombano).

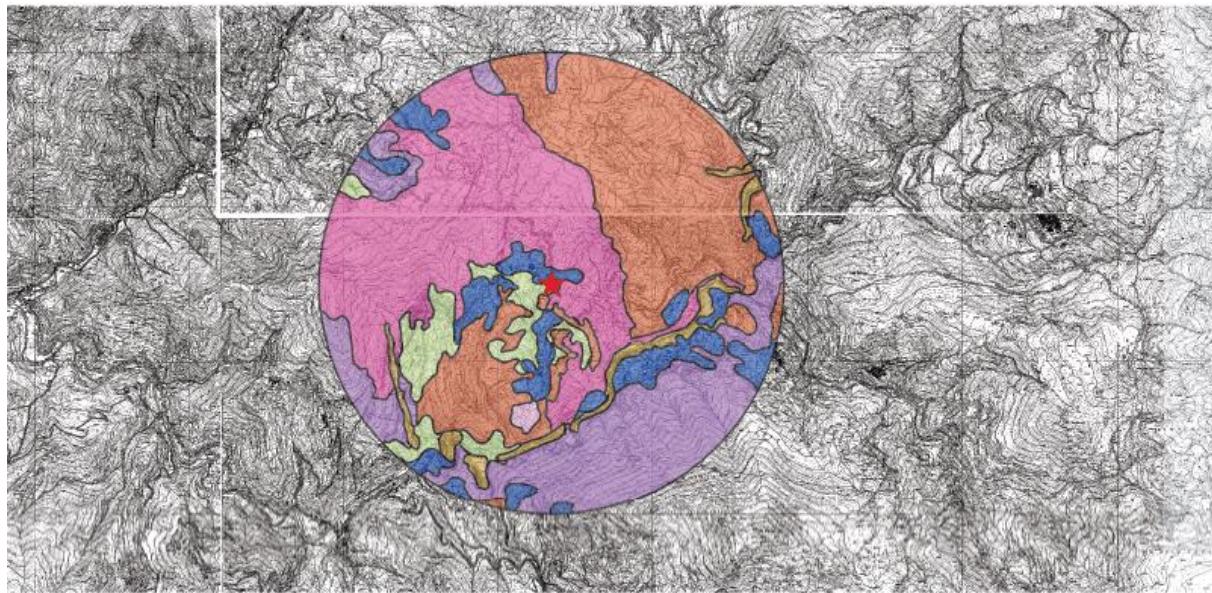


Figure S1F. Land cover types within an area of 1.5 km surrounding the apiary NE (Ne).

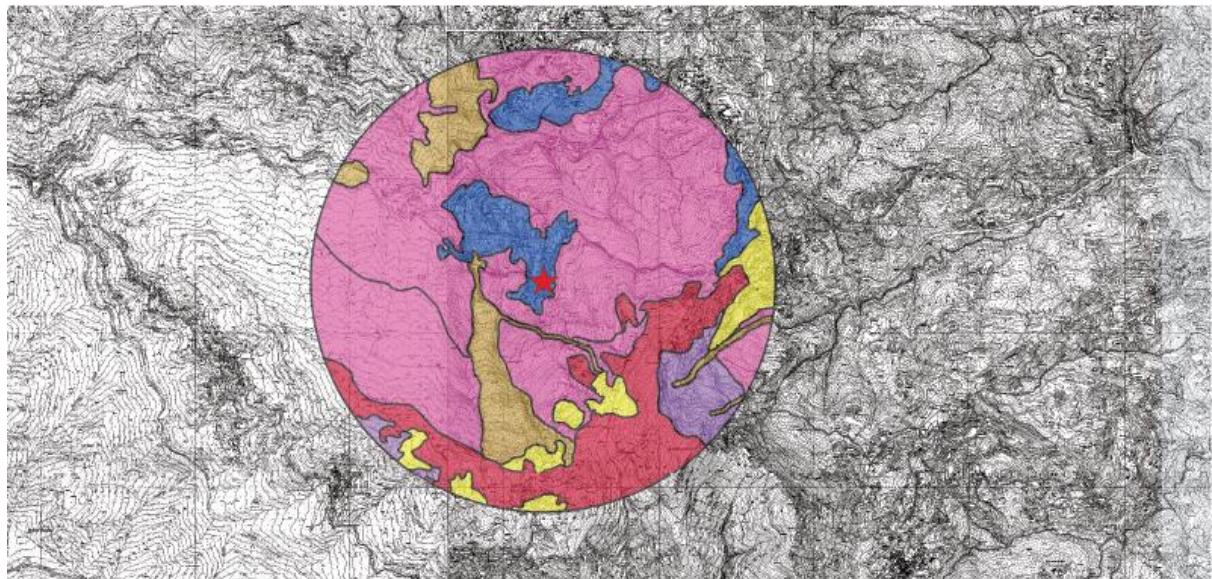


Figure S1G. Land cover types within an area of 1.5 km surrounding the apiary BA (Bargagli).

Table S2. Sampling dates.

Year	Sampling period								
	D1	D2	D3	D4	D5	D6	D7	D8	D9
2014	6 Apr	27 Apr	18 May	8 Jun	29 Jun	20 Jul	10 Aug	31 Aug	21 Sep
2015	5 Apr	26 Apr	17 May	7 Jun	28 Jun	19 Jul	9 Aug	30 Aug	20 Sep

**Table S3. Palynological spectra (expressed in volumetric terms) and nitrogen content (%N) of the samples collected in the experimental apiaries (sites). Gray rows correspond to palynological types found at least at 10% in three samples. YEAR (Y) - I: 2014 2: 2015; DATE (D) - see Table S2; SITE - see Table S1; FORAGING SEASON - see text.** \*the sample Y1D4BA was attributed to the foraging season II basing on the interpretation of its entire palynological spectrum, since it didn't respect any proposed criterion. \*\*Chen/Amar indicates Chenopodiceae/Amaranthaceae. \*\*\*0.0 indicates positive values lower than 0.05.

ID	YID 3BA	YID 3CH	YID 3NE	YID 3RA	YID 3SC	YID 3US	YID 4BA	YID 4NE	YID 4RA	YID 4SC	YID 4SL	YID 4US	YID 5BA	YID 5CH	YID 5NE	YID 5RA	YID 5SL	YID 5US	YID 6BA	YID 6CH	YID 6RA	YID 6SL	YID 7BA	YID 7CH	
YEAR	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
DATE	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	6	6	6	6	7	7	
SITE	BA	CH	NE	RA	SC	US	BA	NE	RA	SC	SL	US	BA	CH	NE	RA	SL	US	BA	CH	RA	SL	BA	CH	
FORAGING SEASON	II	QU	QU	QU	QU	QU	II*	QU	RC	RC	QU	RC	I2	RC	I2	RC	I2	RC							
%N	3.1	3.5	3.5	3.6	3.2	3.3	3.2	3.3	3.6	3.4	3.5	3.8	4.0	4.0	3.9	4.2	4.3	4.1	4.1	4.0	3.4	3.4	3.6	3.2	
Acer	0.1						0.4																		
Actinidia		7.7			0.8			0.0***		0.3										0.2			0.2		
Aesculus	0.1																								
Agave																									
Ailanthus											0.4	5.7	0.5	0.1											
Allium	0.0						2.4																		
Anemone	0.1																								
Arctium																			0.3				1.1		
Asparagus acutifolius																				42.6		38.4	1.4	0.0	
Asphodelus	3.4																								
Aster f.	0.0			0.1			0.0		0.0		0.0		0.1		0.2		0.1		0.0	0.1	0.3	1.5	0.1		
Borago																	0.2	0.6		0.2	0.1				
Brassica f. >25μ																				0.1		0.3	0.3		
Brassica f. 20-25μ	0.0			2.7	1.3		0.0		0.0		1.6	2.0										0.3			
Bryonia																							0.7		
Buxus																									
Calluna																									
Calystegia		1.8																				1.8		1.3	
Camellia																									
Campanulaceae							0.0		0.1		0.3	0.1	0.0				0.1			0.1	0.2	0.0	2.3		
Carex										0.1											0.1				
Castanea	0.0						0.0			1.0	0.3	0.1	0.2	82.1	45.2	42.0	22.6	32.1	55.4	2.7	0.0	0.0	3.7	0.0	0.0
Centaurea cyanus								0.1																	
Centaurea jacea gr.																				0.1		14.4	0.8		
Centranthus ruber gr.																									
Cephalaria	0.2							0.3												1.2					
Ceratonia																									
Chamaerops f.	1.0	0.5		9.5	0.5	0.9											0.1								
Chen/Amar<20μ**						0.1																			
Chen/Amar>25μ**																								0.0	
Cichorium f.		0.7	7.0					1.2			0.2		0.6						0.1	5.5	6.7	8.7	3.6	57.4	
Cistus salvifolius	0.2		6.2	0.1	12.1	0.8	1.0	5.6											0.1	0.8	1.2	4.9	1.0	0.9	
Citrullus														1.8											
Citrus <25μ																									
Citrus >25μ		0.1		0.6	0.1							0.5													
Clematis																0.1	1.0	0.3	0.6	0.8	1.2	4.9	1.0	0.9	
Commelinaceae																									
Compositae f. A	0.0	0.1		0.0			0.0		0.1	0.0	0.1														
Compositae f. S							0.1														1.0				
Convolvulus																								0.5	
Cornus sanguinea	84.8		8.8	7.2	23.1	56.6									3.8							0.3			
Cotinus/Schinus																				0.5					

ID	YID 3BA	YID 3CH	YID 3NE	YID 3RA	YID 3SC	YID 3US	YID 4BA	YID 4NE	YID 4RA	YID 4SC	YID 4SL	YID 4US	YID 5BA	YID 5CH	YID 5NE	YID 5RA	YID 5SL	YID 5US	YID 6BA	YID 6CH	YID 6RA	YID 6SL	YID 7BA	YID 7CH
Datura																								
Diospyros	2.3		1.9										0.5											
Echinops																								
Erica arborea gr.																						0.1		
Erica carnea																								
Eucalyptus f.	0.1		0.1													0.5					0.2			
Faboideae others																					0.0	0.1		
Fragaria/Potentilla f.							0.0	0.0					0.0											
Fraxinus ornus	0.3	2.3	0.5		0.2	0.5		0.6	0.0															
Genista f.															1.5					0.3	0.8			0.1
Gleditsia			1.4																					
Graminaceae <37µ		0.1			0.1		0.5	2.5	1.3	16.7	1.2	0.3				0.2				0.3	0.2	0.1		
Hedera																					0.2		0.6	0.2
Helianthemum	0.7			0.2		11.5	19.0	2.4		1.6		1.6										0.2	0.1	
Helianthus f.										0.2		7.2								3.0		1.6	0.0	
Hypericum																								0.4
Ilex																								
Impatiens																								
Juglans	0.0	0.6							3.5															
Koelreuteria															0.1									
Labiateae f. M <25µ			0.0																					
Lagerstroemia																				0.6		2.4	4.4	
Lathyrus/Vicia							0.0																	
Laurus																								
Ligustrum f.			0.1			0.3		5.7					0.7		0.1				0.2	20.5			0.3	
Liliaceae <20µ		0.0						0.3					0.1								0.0			
Liliaceae 20-35µ	0.0			0.0						0.6														
Liliaceae 35-60µ				3.1		0.5					0.2								12.1			8.9		
Liliaceae 60-70µ						6.3	3.1																	
Linum																							34.3	
Liriodendron				5.0	0.5			0.1																
Lonicera f.	18.4		9.9					5.4																
Lotus																							0.0	
Luzula	0.1																							
Magnolia <60µ																								
Magnolia >60µ		0.4							29.2					31.8		21.8			26.7	33.8				
Malus/Pyrus f.	6.1	0.4	29.5		0.8																			
Malva f.																				7.3	1.8			
Medicago																				0.2	0.1			
Melilotus			0.0																					
Mercurialis																				0.2	0.1			
Myrtus f.															29.3	0.0			1.0	2.4				
Ocimum																								
Odontites f.																								
Oenothera gr.																								
Olea f.	21.8		6.3	1.2			4.9	1.3	12.9		25.2													
Ostrya				0.0																				
Oxalis													0.9											
Papaver				0.9			0.8	0.0	2.2	9.1														
Parthenocissus								11.1		0.1	1.3		0.8		5.4	0.8	2.2		0.8	2.7	0.3			
Passiflora								0.4	1.1	2.2												1.1		
Phoenix										0.0									5.3	0.0		13.4		
Phormium t.				0.3											0.1									
Pinus															0.1	0.6	0.1		0.9	1.6	14.8	0.1	3.3	
Pistacia							3.6																	
Plantago	0.0	0.1		0.1	0.4	0.1	0.1	0.1	1.6	9.9	0.1	0.6			0.1	0.6	0.1		0.9	1.6	14.8	0.1	3.3	



ID	YID 7NE	YID 7RA	YID 7US	YID 8CH	YID 8NE	YID 8RA	YID 9CH	YID 9NE	YID 9SL	Y2D ICH	Y2D INE	Y2D IRA	Y2D ISC	Y2D IUS	Y2D 2NE	Y2D 2RA	Y2D 2SC	Y2D 2US	Y2D 3BA	Y2D 3CH	Y2D 3NE	Y2D 3RA	Y2D 3SC		
YEAR	I	I	I	I	I	I	I	I	I	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
DATE	7	7	7	8	8	8	9	9	9	I	I	I	I	I	2	2	2	2	3	3	3	3	3		
SITE	NE	RA	US	CH	NE	RA	CH	NE	SL	CH	NE	RA	SC	US	NE	RA	SC	US	BA	CH	NE	RA	SC		
FORAGING SEASON	RC	I2	I2	HE	HE	HE	HE	HE	HE	II	QU	II	QU	QU	QU	II	QU								
%N	3.4	3.2	2.8	3.6	4.4	4.0	3.9	4.3	3.7	4.0	3.2	3.3	3.1	3.1	3.3	3.5	3.1	3.3	3.3	3.2	3.0	3.3	3.2		
Acer													0.3				0.1	0.1	0.6	1.6					
Actinidia																				1.4		10.5		0.4	0.2
Aesculus																	0.4	0.8		0.2			0.0	0.1	
Agave																									
Ailanthus																									
Allium													4.0		3.0	2.9	0.5		2.2		0.3		0.3		1.3
Anemone													0.0	0.9	2.1	2.3	3.9		0.7	0.2	0.2				
Arctium													0.1												
Asparagus acutifolius		2.0	0.1	0.8						1.1															
Asphodelus																									
Aster f.	3.6	0.6	24.3				0.1				0.0	0.2	0.7	0.4	0.7	0.0	0.1		0.1				0.0	0.1	
Borago		0.4					0.5	0.5			0.2		1.2		1.5		1.6		0.1						
Brassica f. >25μ				0.1																					
Brassica f. 20-25μ		0.0									1.8	0.9	2.6		5.9		0.6	0.1	0.3					2.1	
Bryonia																									
Buxus													27.2		0.1	0.2									
Calluna	0.8			1.7					1.5	0.3															
Calystegia																								1.0	
Camellia											0.6		0.3		1.0										
Campanulaceae	1.7	0.2	0.2	1.8		0.1	0.2	0.0																	
Carex													0.1	0.5		2.4				0.1					
Castanea		0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0		0.0		0.0	0.0				0.0	0.0		
Centaurea cyanus																									
Centaurea jacea gr.		0.3	1.0	0.2		0.0																			
Centranthus ruber gr.																			2.2		0.5				
Cephalaria			5.1																						
Ceratonia			2.9			0.1		0.6										0.2	0.5		0.3	0.0	1.9	2.2	
Chamaerops f.																			0.1	0.2					
Chen/Amar<20μ**						0.0							0.0												
Chen/Amar>25μ**	1.0		0.2					0.0																	
Cichorium f.	15.5	38.9	0.4	19.7	0.4	7.7	1.5	2.5	0.2	0.6	4.6	8.2	2.2	10.8	2.7	0.3		1.3				6.4	0.2		
Cistus salvifolius																						0.2	22.4	0.3	4.8
Citrullus		0.4																							
Citrus <25μ																	0.0	0.6			2.3		0.3		
Citrus >25μ																									
Clematis	17.8	19.0	2.9	0.2	0.1	0.1																			
Commelinaceae																									
Compositae f. A			0.0								0.0								1.3						
Compositae f. S		0.4	0.2																	0.2					
Convolvulus			0.3																						
Cornus sanguinea															0.2			0.3				14.5			
Cotinus/Schinus																									
Datura		3.1																							
Diospyros																			7.7		0.1				
Echinops																									
Erica arborea gr.											0.2	18.2	31.4	19.2	1.4	16.0	1.3		0.2		0.1				
Erica carnea												32.7													
Eucalyptus f.											0.6											5.7	2.7		
Faboideae others		0.3																		1.5	0.1	0.1		0.2	
Fragaria/Potentilla f.													0.1		0.1		0.7								
Fraxinus ornus															45.5	24.4		23.7	0.3		40.1	38.8			

ID	Y1D 7NE	Y1D 7RA	Y1D 7US	Y1D 8CH	Y1D 8NE	Y1D 8RA	Y1D 9CH	Y1D 9NE	Y1D 9SL	Y2D ICH	Y2D INE	Y2D IRA	Y2D ISC	Y2D IUS	Y2D 2NE	Y2D 2RA	Y2D 2SC	Y2D 2US	Y2D 3BA	Y2D 3CH	Y2D 3NE	Y2D 3RA	Y2D 3SC			
Genista f.		0.5	0.1	0.6		0.1									0.2											
Gleditsia																										
Graminaceae <37µ	0.5	0.2	0.5																		0.6	0.2				
Hedera	0.3	1.1	0.6	32.5	97.6	81.9	89.1	85.4	86.6																	
Helianthemum															0.8		0.5	36.5	22.3	0.9	1.3	0.1				
Helianthus f.		0.1	0.5	0.5			6.1	4.0	4.1						0.1											
Hypericum	1.0			0.1																						
Ilex															0.1											
Impatiens																										
Juglans														0.1		0.3						0.7				
Koelreuteria																										
Labiatae f. M <25µ																										
Lagerstroemia		8.3		2.3		0.7	0.1																			
Lathyrus/Vicia		0.0												0.1												
Laurus										0.3		4.7		30.9				0.4								
Ligustrum f.		0.0																			1.0	0.2				
Liliaceae <20µ																										
Liliaceae 20-35µ		0.5									0.0															
Liliaceae 35-60µ										0.3		0.9									0.2	2.0				
Liliaceae 60-70µ																			1.6							
Linum														0.5								4.7				
Liriodendron																					1.7					
Lonicera f.																										
Lotus										0.0				0.0			0.0				0.0					
Luzula																										
Magnolia <60µ														0.2												
Magnolia >60µ		1.0			0.4																					
Malus/Pyrus f.											18.7	0.1	15.3		8.2	0.3	9.8	2.2	3.7		1.3	0.3				
Malva f.		11.3			2.0																					
Medicago																	0.3									
Melilotus																					0.0	0.0				
Mercurialis	0.3	0.0	2.4		0.2						0.2		0.0		0.0											
Myrtus f.					0.0																					
Ocimum																										
Odontites f.							0.3																			
Oenothera gr.																			26.2		4.1		6.8	25.0		
Olea f.																										
Ostrya										0.4	4.1	5.0	2.4	2.7	0.3				0.2							
Oxalis										0.4		0.8		0.1		0.2										
Papaver																								0.3		
Parthenocissus		1.0	4.2		0.3																					
Passiflora		0.9																								
Phoenix				36.2		4.6	0.3		0.3																	
Phormium t.																										
Pinus														0.2		0.3					1.1		1.1			
Pistacia																0.1			0.3							
Plantago	11.6	6.2	24.8	0.3	0.1	0.1		0.1					0.0		1.3			0.2								
Prunus f.										35.5	8.3	12.7	29.0	23.8		0.3	0.7	2.9					0.2			
Psoralea																										
Puccinia t.		0.5	30.6																							
Punica																										
Quercus ilex gr.										0.0		0.0						45.7		54.9	73.4	24.8	8.6	55.5		
Quercus robur gr.										9.1		0.9			33.1	55.3	10.5	27.4						4.9		
Ranunculus														0.5	2.9	1.7	1.5	0.2	0.7							
Rhamnus f.														1.2		0.1							0.0			
Robinia f.																					0.1	2.9	0.5	5.5		







