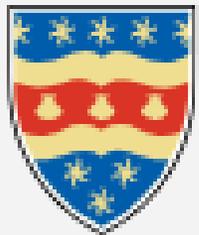
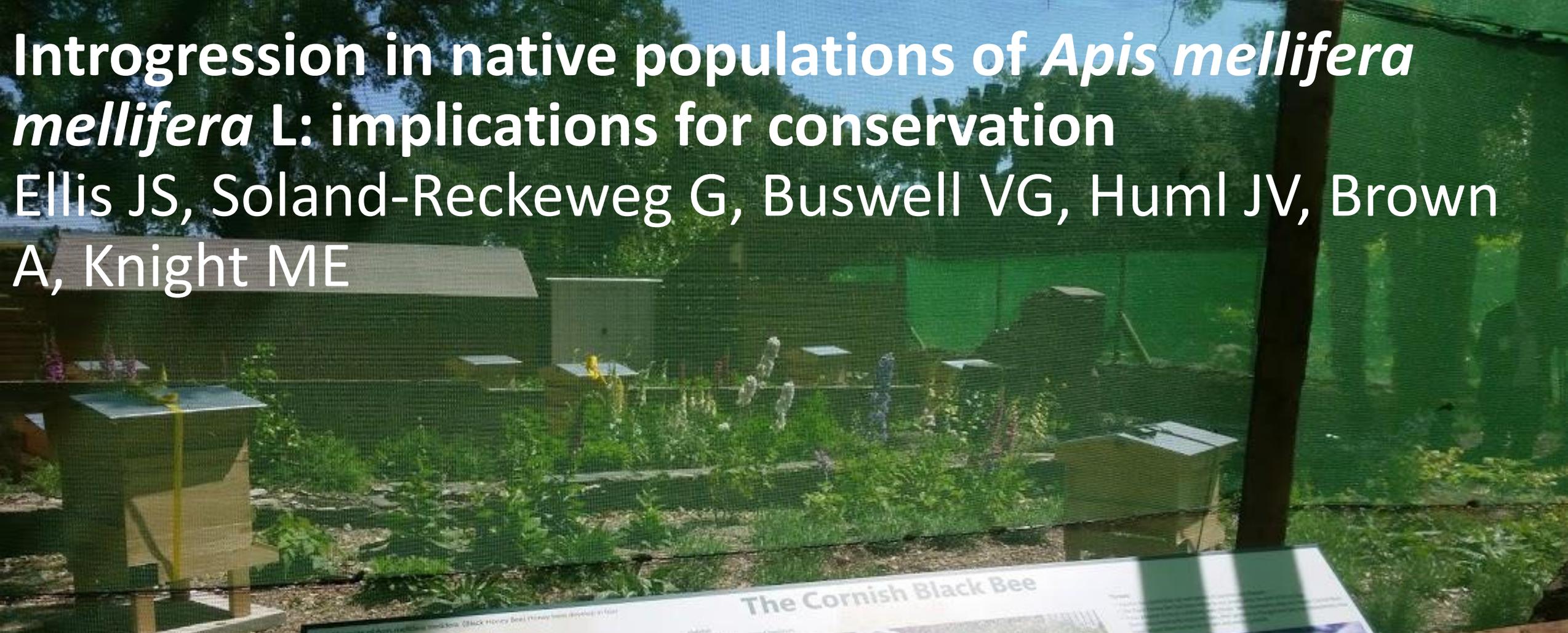


Introgression in native populations of *Apis mellifera mellifera* L: implications for conservation

Ellis JS, Soland-Reckeweg G, Buswell VG, Huml JV, Brown A, Knight ME



UNIVERSITY OF
PLYMOUTH

B4 Project

Bringing Back Black Bees

HOME THE PROJECT THE PURPOSE THE PEOPLE PARTNERS LINKS EVENTS CONTACT



Apigenix

Institute for beegenetics



- Hybridization can lead to genomic extinction or can augment genetic diversity
- There are many varieties/subspecies of honey bee (*Apis mellifera*)
- Threatened by very many impacts
- Some conservationists/beekeepers interested in conservation of the varieties/subspecies that arose due to natural processes
- In SW England, there is an organisation “B4” interested in conservation of UK dark European honey bee (*A. mellifera mellifera*)
- They are creating “black bee” reserves in SW England

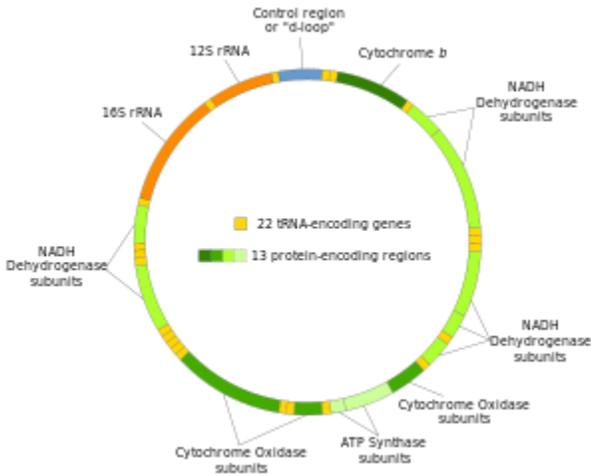
The aim was to sample only dark European honey bees & measure degree of introgression

Samples from 46 hives from 34 apiaries were taken from Cornwall by B4 members





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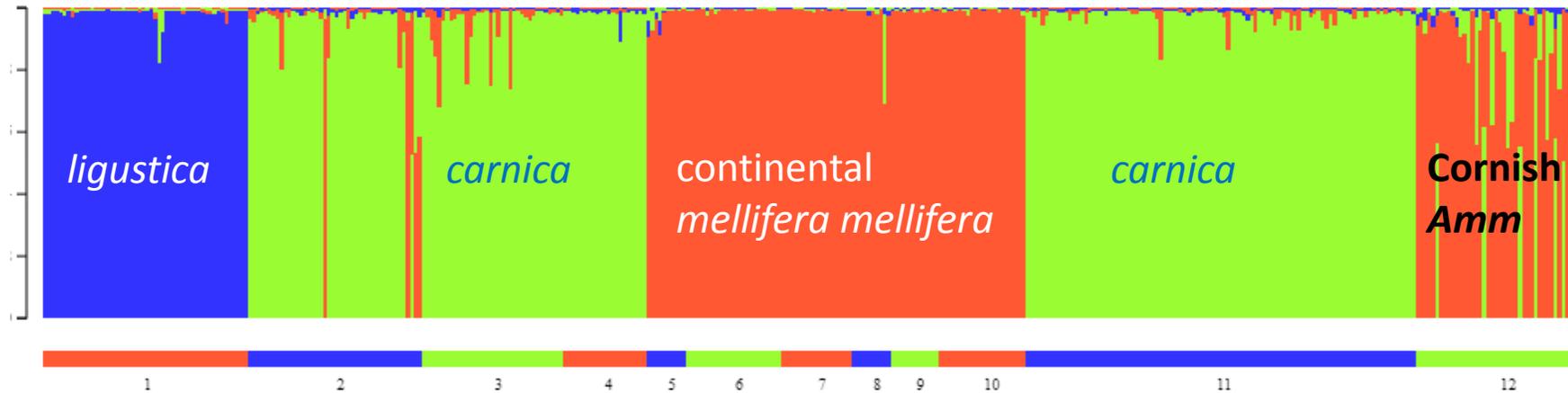


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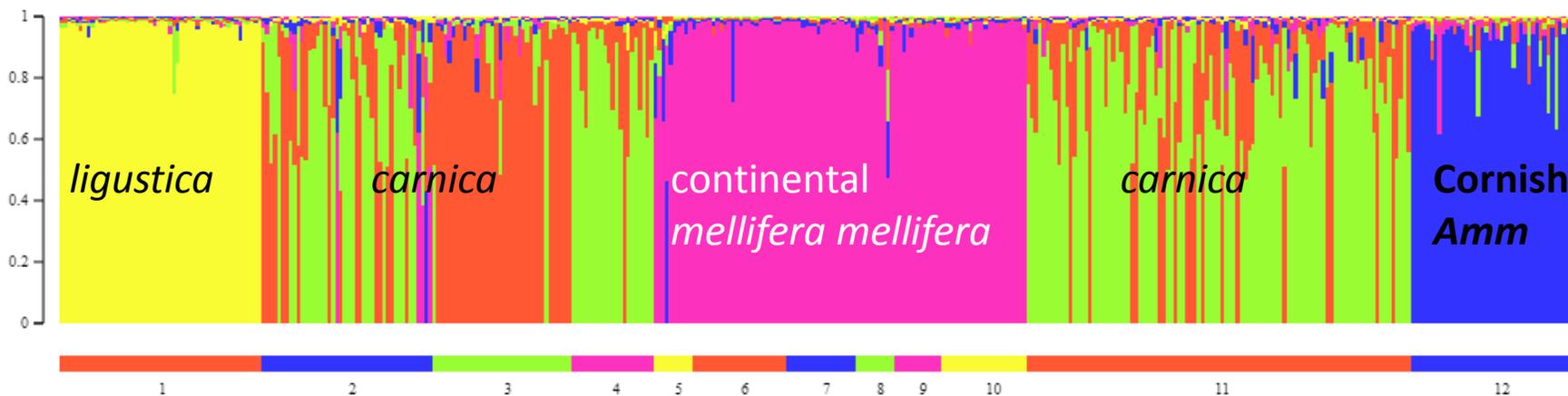
- mitochondrial DNA
- maternally inherited

- “microsatellites”
- highly variable
- nuclear DNA
- reflects male and female parents of queen

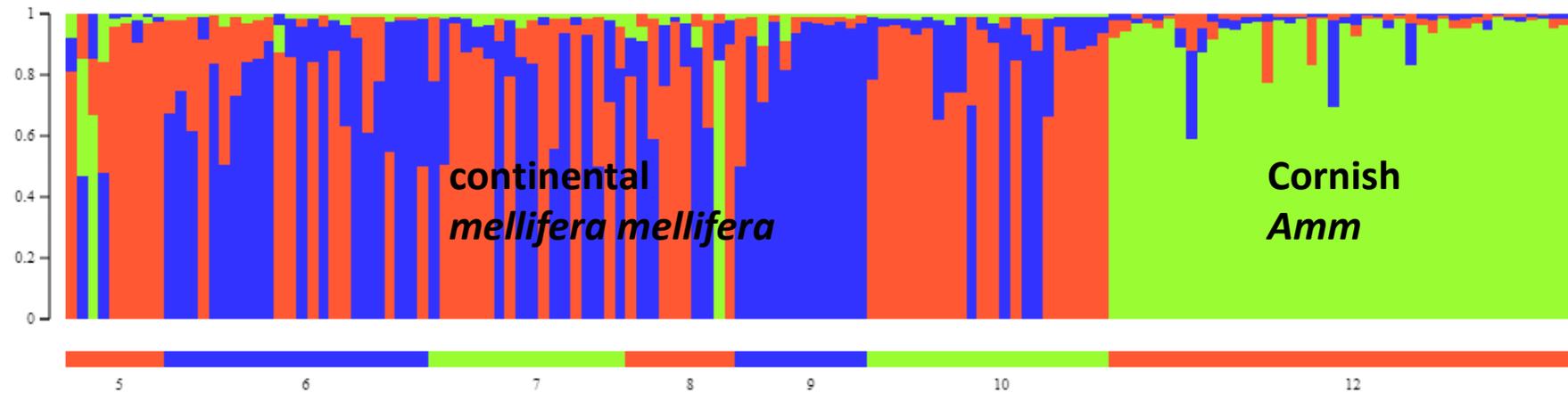
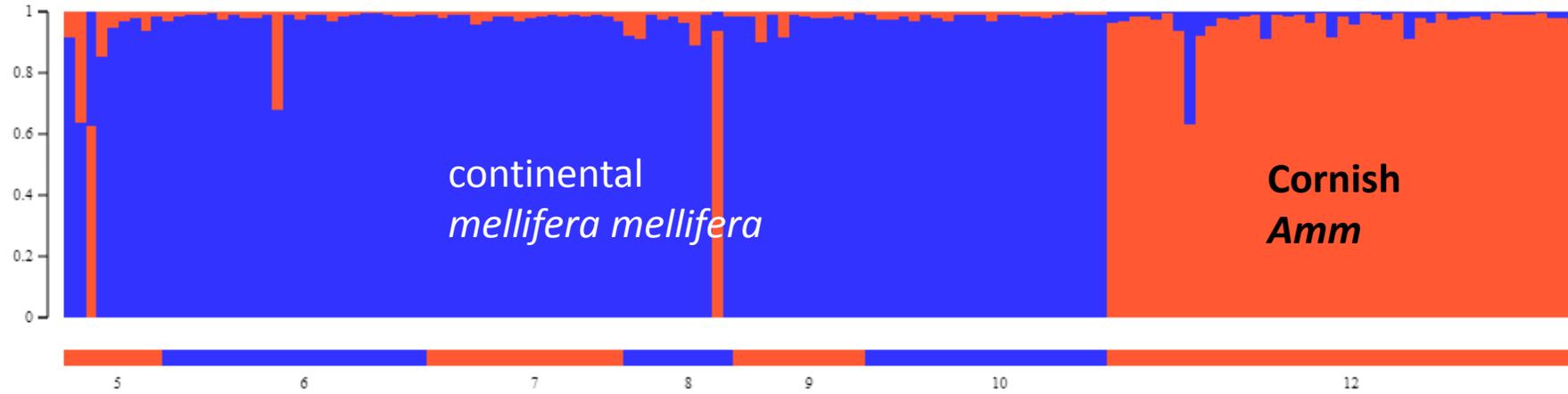
Genetic signals across *A. m. mellifera*, *A. m. ligustica*, *A. m. carnica* align well with subspecies, but Cornish samples are ‘admixed’



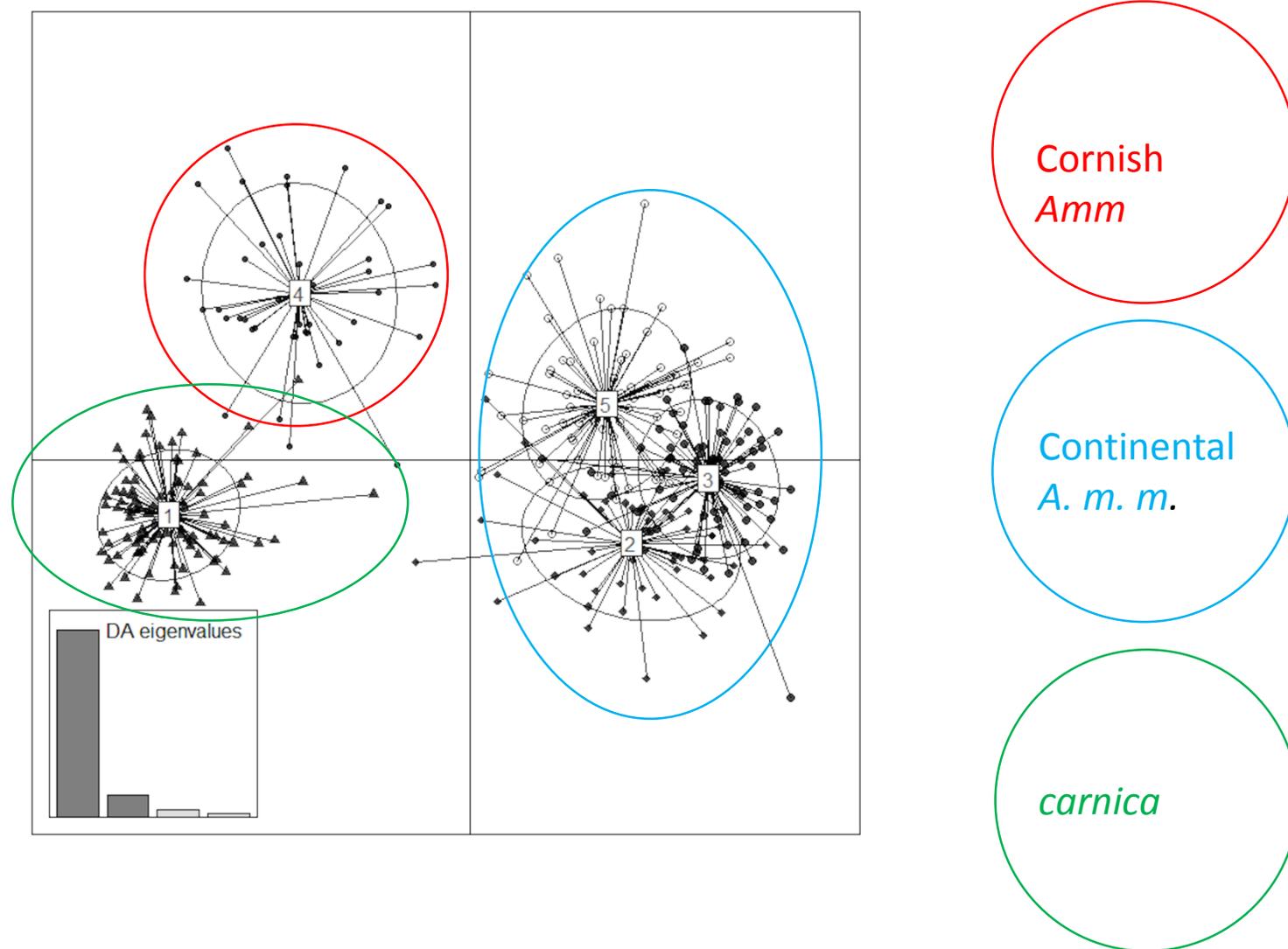
At a ‘finer’ level Cornish bees appear as a distinct cluster – but probably as a consequence of their unique history of admixture



This is also apparent when only examining *A. m. mellifera* samples (for two groups and three groups):



Alternative methods also show that Cornish bees are intermediate between continental *A. m. mellifera* and *A. m. carnica*

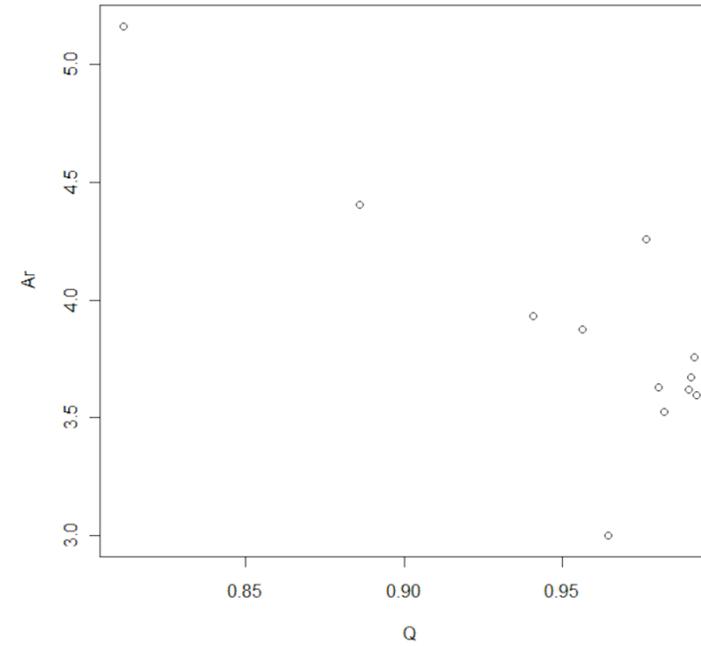
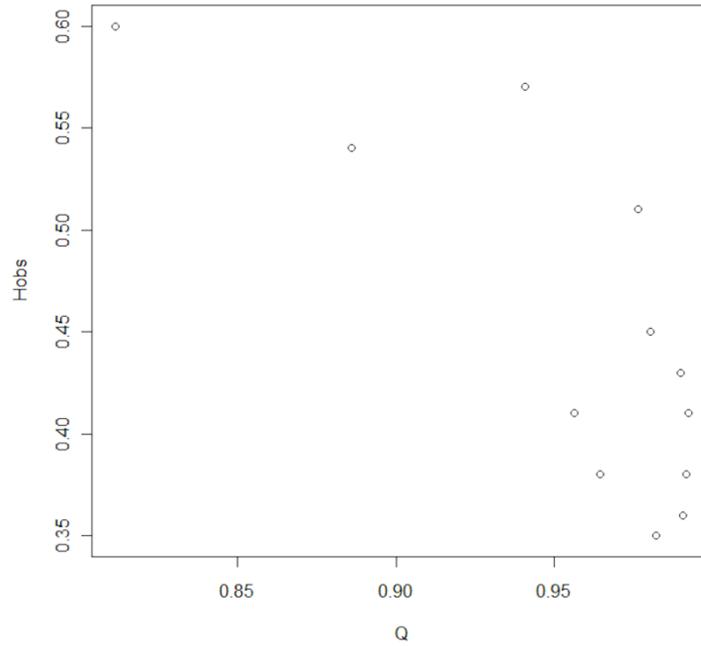


Purity values for beekeepers

Individual	<i>Apis mellifera mellifera</i>		<i>Apis mellifera ligustica</i>		<i>Apis mellifera carnica</i>		mtDNA haplotype
	Q	s.d.	Q	s.d.	Q	s.d.	
15-001	0.94	0.000	0.04	0.001	0.02	0.000	
15-002	0.97	0.000	0.01	0.000	0.01	0.000	
15-003	0.91	0.002	0.04	0.001	0.05	0.001	
15-004	0.98	0.000	0.01	0.000	0.01	0.000	
15-1321	0.94	0.001	0.04	0.000	0.03	0.000	
15-1401	0.41	0.001	0.03	0.000	0.57	0.001	
15-1407	0.99	0.000	0.00	0.000	0.01	0.000	
15-1409	0.99	0.000	0.01	0.000	0.01	0.000	
15-1410	0.99	0.000	0.01	0.000	0.01	0.000	
15-1411	0.97	0.000	0.01	0.000	0.01	0.000	
15-1137	0.94	0.001	0.03	0.001	0.03	0.000	M
15-1188	0.91	0.001	0.00	0.000	0.09	0.001	M
15-1204	0.91	0.001	0.01	0.000	0.08	0.001	M
15-1310	0.82	0.001	0.01	0.000	0.17	0.001	M
15-1311	0.99	0.000	0.00	0.000	0.01	0.000	M
15-1312	0.56	0.001	0.03	0.001	0.41	0.002	C
15-1313	0.93	0.001	0.01	0.000	0.07	0.001	M
15-1315	0.37	0.002	0.01	0.000	0.62	0.002	C
15-1317	0.98	0.000	0.01	0.000	0.01	0.000	

Purer samples have lower genetic diversity:

GENETIC DIVERSITY

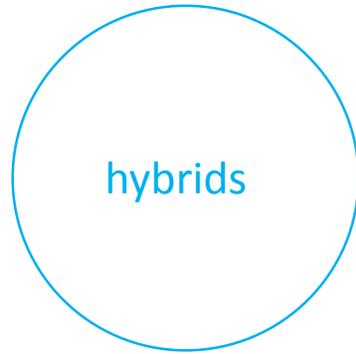
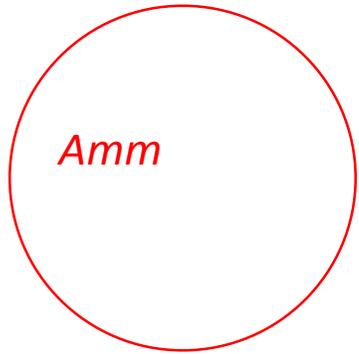


PURITY



What is an appropriate threshold for purity?

		mtDNA		Not sequenced
Q-threshold	nDNA	M	C	
0.99	'pure'	4	1	4
	introgressed	13	12	9
0.95	'pure'	6	3	8
	introgressed	11	10	5
0.90	'pure'	12	3	11
	introgressed	5	10	2
0.80	'pure'	15	3	11
	introgressed	2	10	2



Quantify phenotypic traits using a survey

Worker longevity

Foraging temperature

Rate of brood development

Aggression/defence/docility

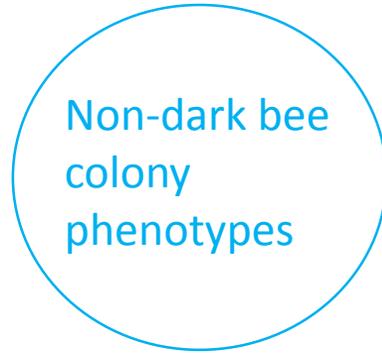
etc

Future work: Local adaptation



Victoria Buswell – Ph.D candidate

NERC-CASE

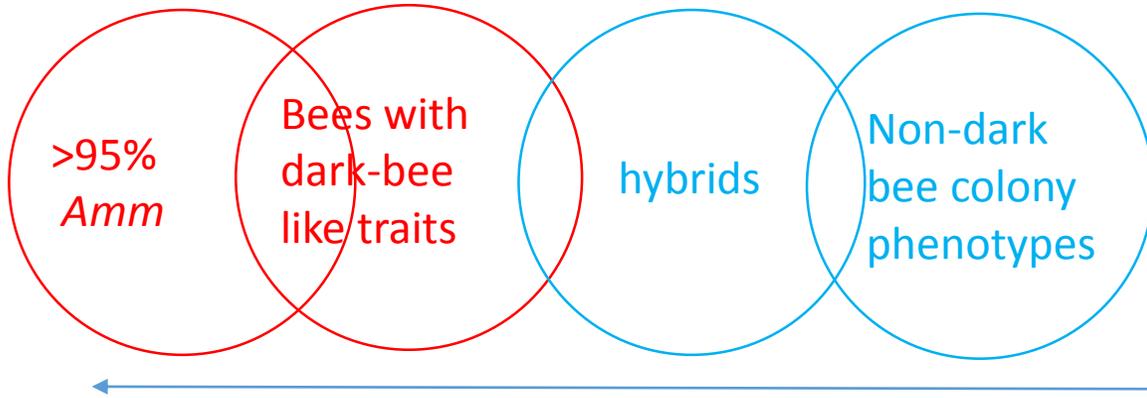


Match genotypic data to phenotype
(GWAS & genome scan approaches by RAD-Seq)

Future work



Victoria Buswell – Ph.D candidate



Synthesis: relationship between degree of introgression, frequency of GWAS-markers associated with dark bees and phenotype

Future work



Victoria Buswell – Ph.D candidate

Outcomes:

- Analyses show that Cornish *A. m. m.* distinct
- Most likely a consequence of admixture, which is hardly surprising given bee keeping history in the UK
- Some hives were relatively pure based on mitochondrial and nuclear genetic analyses
- Need to:
 - Identify appropriate values of 'purity'
 - Establish an acceptable level of introgression
 - Further sample South-West to identify dark bee stock
 - Do this across the UK

Conservation of subspecies

- A Wright & Dobzhansky point of view?
- **Local adaptation** and **non-adaptive processes** like isolation and drift create subspecies and races
- “a differentiation into numerous semi-isolated colonies is the most favourable one for a progressive evolution” (Dobzhansky, *Genetics and the Origin of Species*)
- “If population sizes in most species tend to be small on the average ... the scattering of variability will loom large as evolutionary agents” (Dobzhansky, *Genetics and the Origin of Species*)
- “A much more favourable condition would be that of a large population, broken up into imperfectly isolated strains....The rate of evolutionary change depends primarily on the balance between effective population size ... and the amount of interchange of individuals...The consequence would seem to be a rapid differentiation of local strains...permitting selective increase or decrease of the numbers of different strains” (Wright, 1930)

Commercialization

- More emphasis on hybridization
- Managed bees have high levels of introgression and genetic diversity -> human management increases diversity by promoting admixture (Harpur *et al.* 2012)
- This is due to polyandry, regular stock importation, movement of colonies over large spatial scales
- “Beekeepers may be, intentionally or unintentionally, selecting hybrid colonies which tend to have higher fitness at some colony-level traits...” (Harpur *et al.* 2012)

Bee Improvement AND conservation

- Beekeepers are interested in conserving the local varieties
- But they still manage them as a semi-domesticated animal
- This includes improvement of the local stock for whatever traits the beekeeper is interested in
- In essence, we would have local varieties with limited dispersal, but the beekeeper would be a strong selective agent working on the genetic variation available in his or her local pool
- Could cause reduction of genetic diversity
- Is not exactly conservation, since there is deliberate manipulation of phenotype and genotype
- **Need for managed dispersal when some favourable genotypes arise in some populations (e.g. disease resistance)?**

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