Bavarian Food and Health Safety Authority
LGL Oberschleißheim

Where in Europe was my honey foraged?

Methods to assure the geographical origin of honey

Antje Schellenberg

TRACE Workshop, 17.12.2009, York

Honey

Produced by *Apis mellifera* bees from the nectar of plants

Flavours of honey based on the nectar source

- Blossom honey or nectar honey
- Honeydew honey

Alpine rose Honeydew Dandelion

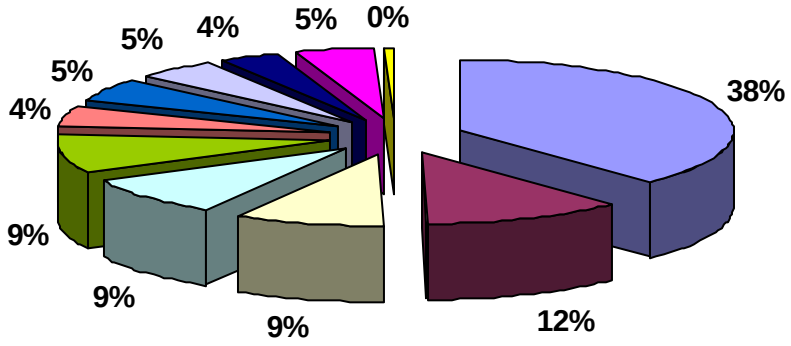
Consumption per capita (EU)

Country	kg
Greece	1.8
Germany	1.5
Italy, Spain, France, Hungary	0.6 – 0.9

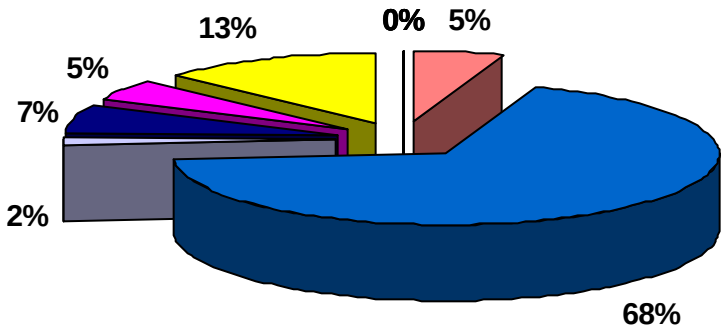
http://www.apiservices.com

Honey production, export and import

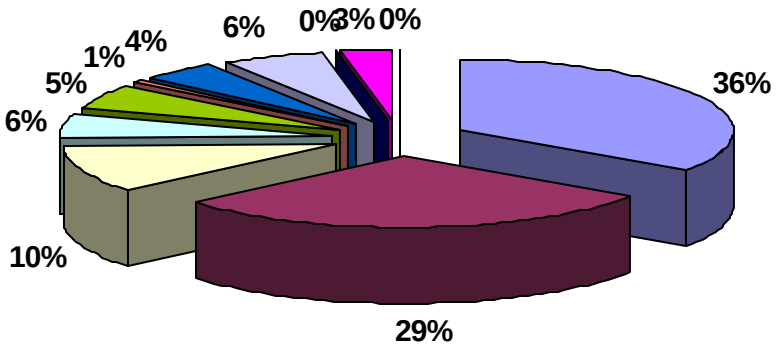
Production



Import



Export



China
Argentina
Mexico
Turkey
Ukraine
France
Germany
Greece
Italy
Spain
United Kingdom

http://www.apiservices.com

Council Directive 2001/110/EC

HONEY ORIGIN

- The country (ies) of origin where the honey has been harvested shall be indicated on the label.

- If honey originates in more than one Member State or third country, that indication may be replaced by:
  - ‘blend of EC honeys’
  - ‘blend of non-EC honeys’
  - ‘blend of EC and non-EC honeys’

Consumer awareness / expectations

Preference for commodities produced in their local region, country or the EU

- Increased confidence in the quality and safety
- Support local producer and economy
- Concerns about long transit and delivery times

Honey labelling

- Accuracy of the declared geographical origin
- Specific origin ex 5 €/500 g
  no-specific origin ~ 2 €/500 g

Geographical origin of honey

Geology
Agricultural practice

Sunflower

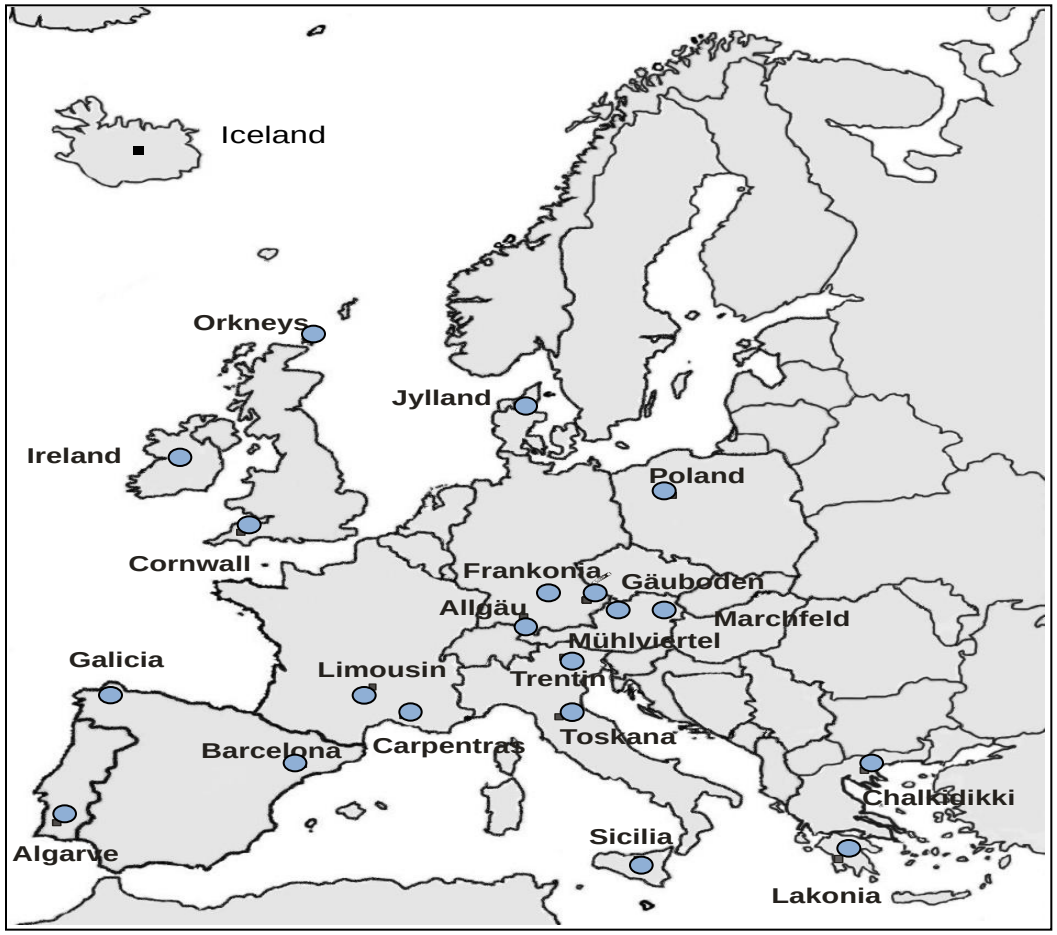
Rape

Fire

Rain
(local) water

Characteristic ‘local’ isotopic signal in honey

Samples



- 20 Sites in Europe
- 40 samples / site in two years
- monofloral and polyfloral honeys
- 513 analysed samples

Preparation of honey protein

100 g Honey + 40 g Water

80 °C, add 4 ml 20 % Na_2WO_4
+ 4 ml 1.34 N H_2SO_4

Precipitation of protein

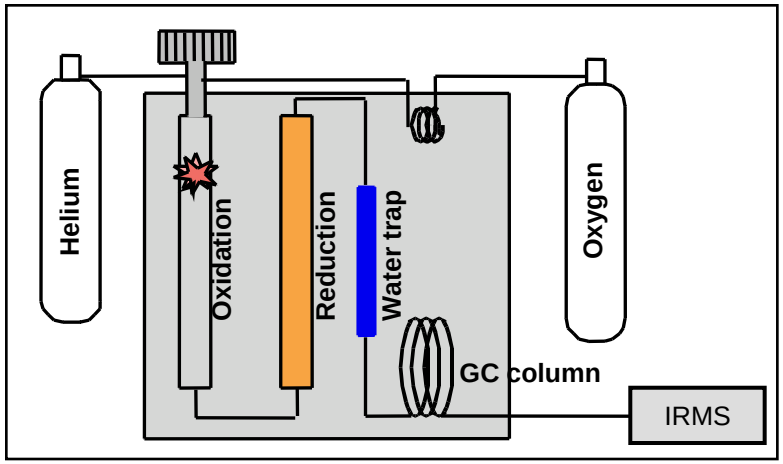
Centrifugation
(3250 rpm, 10 min)

Washing /drying of protein

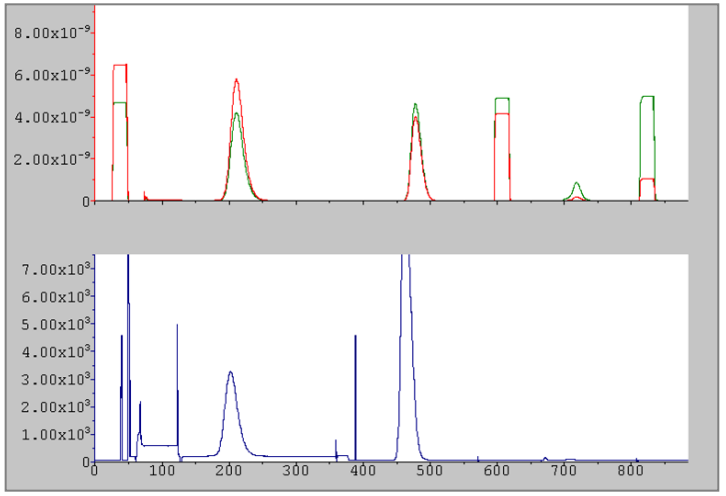
IRMS-Measuring

Stable isotope ratio analysis

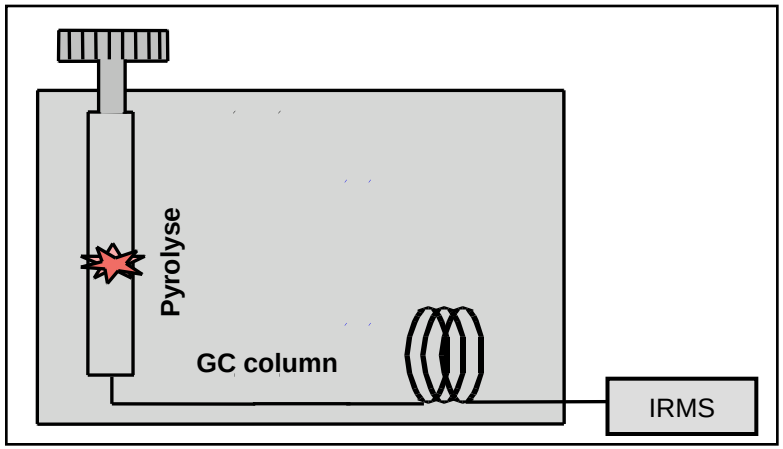
$\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$



C, N, S single run



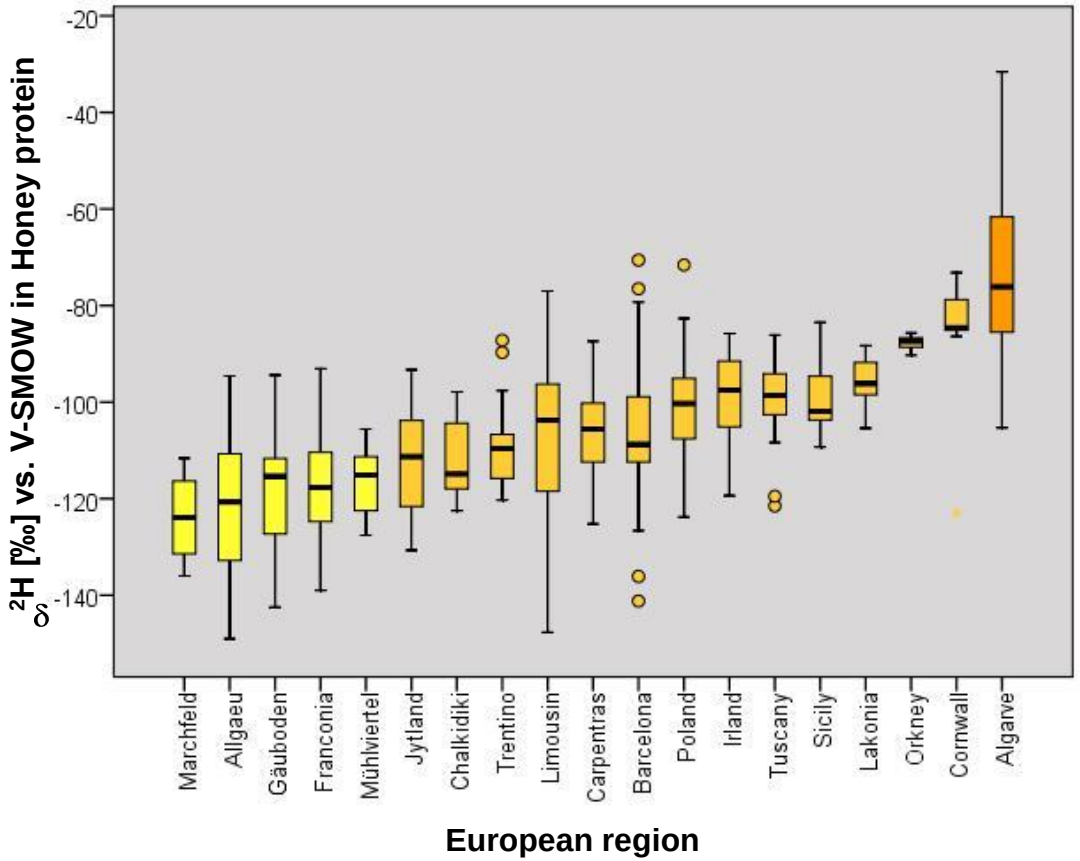
$\delta^{2}H$

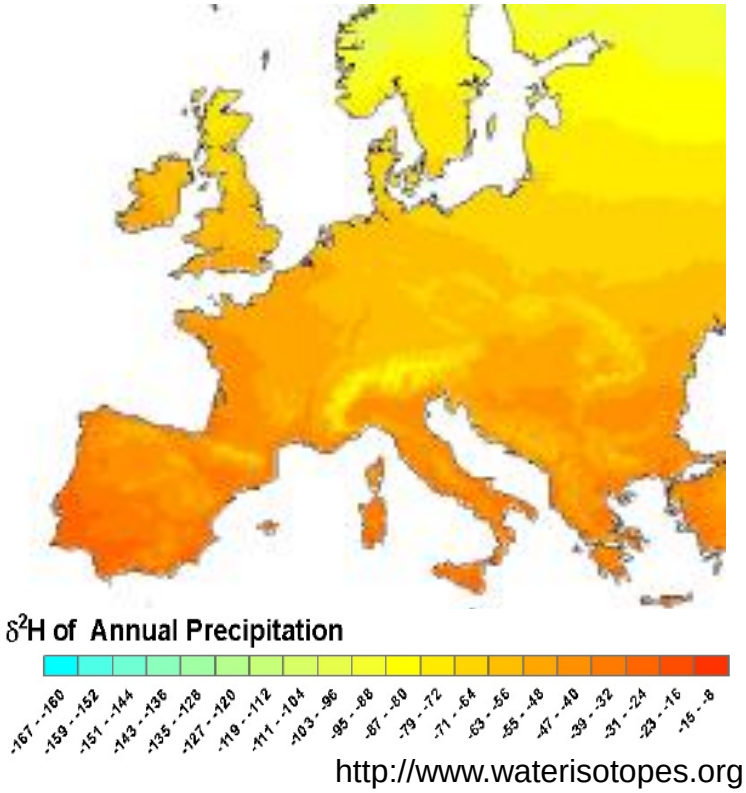


The isotopic data are expressed in ‚δ ‰‘:

$$\delta\,(‰) = \left[\frac{R_{Sample}}{R_{Standard}} - 1 \right] * 1000$$

Hydrogen isotopes values





http://www.waterisotopes.org

Alpine regions

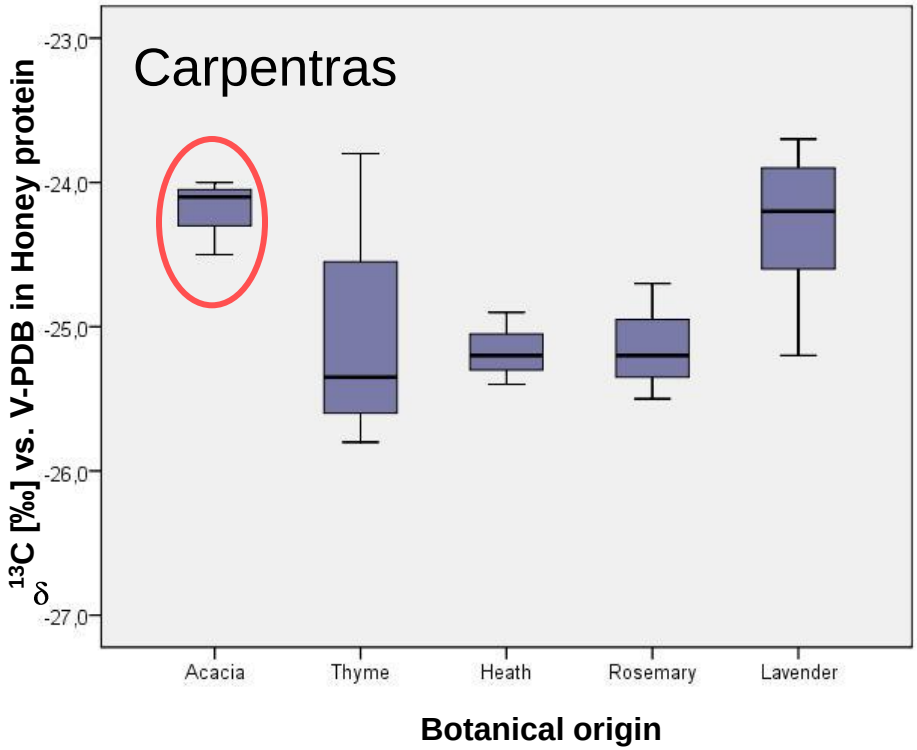
Increase of δ^2H values

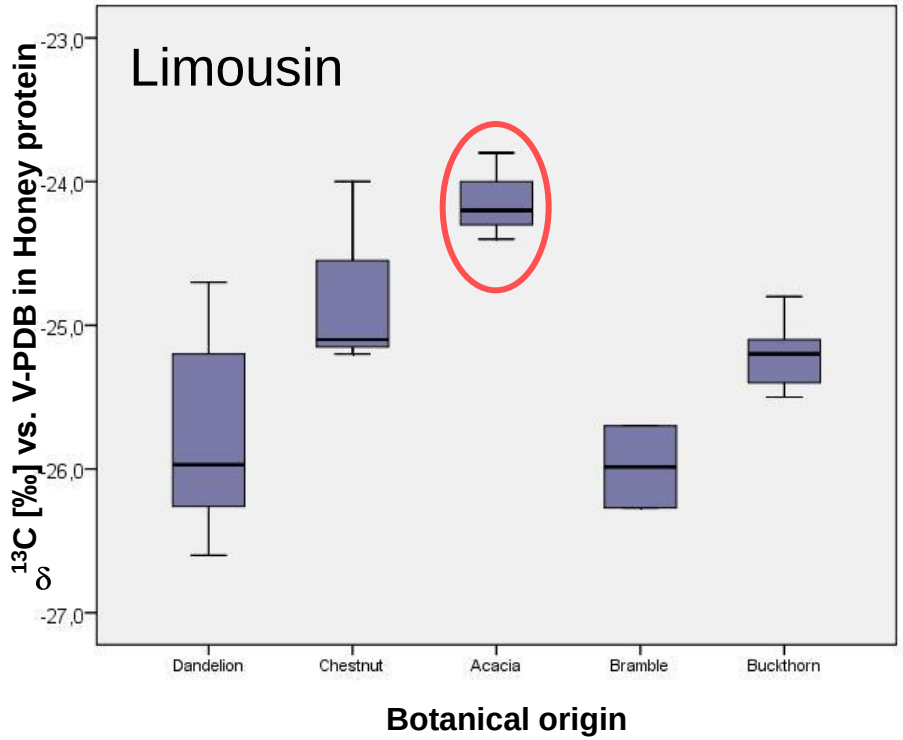
Atlantic regions

Carbon isotopes values

Is $\delta^{13}C$ a parameter to determine the botanical origin?

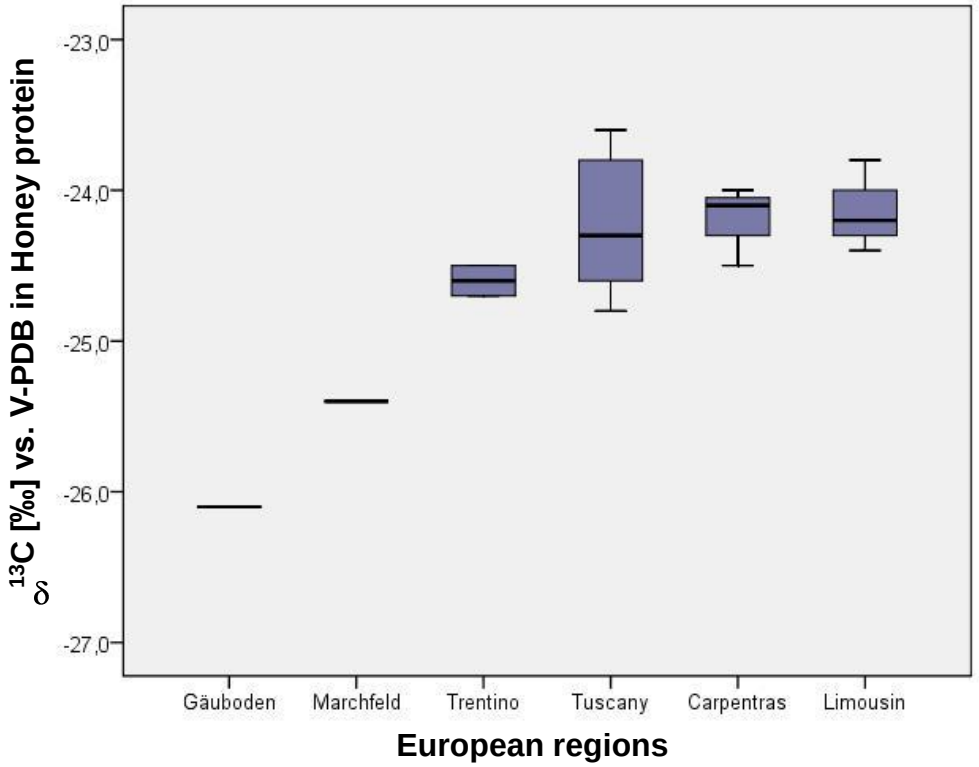
Carpentras and Limousin - regions with similar climate





Carbon isotopes values

Acacia honeys from different European regions

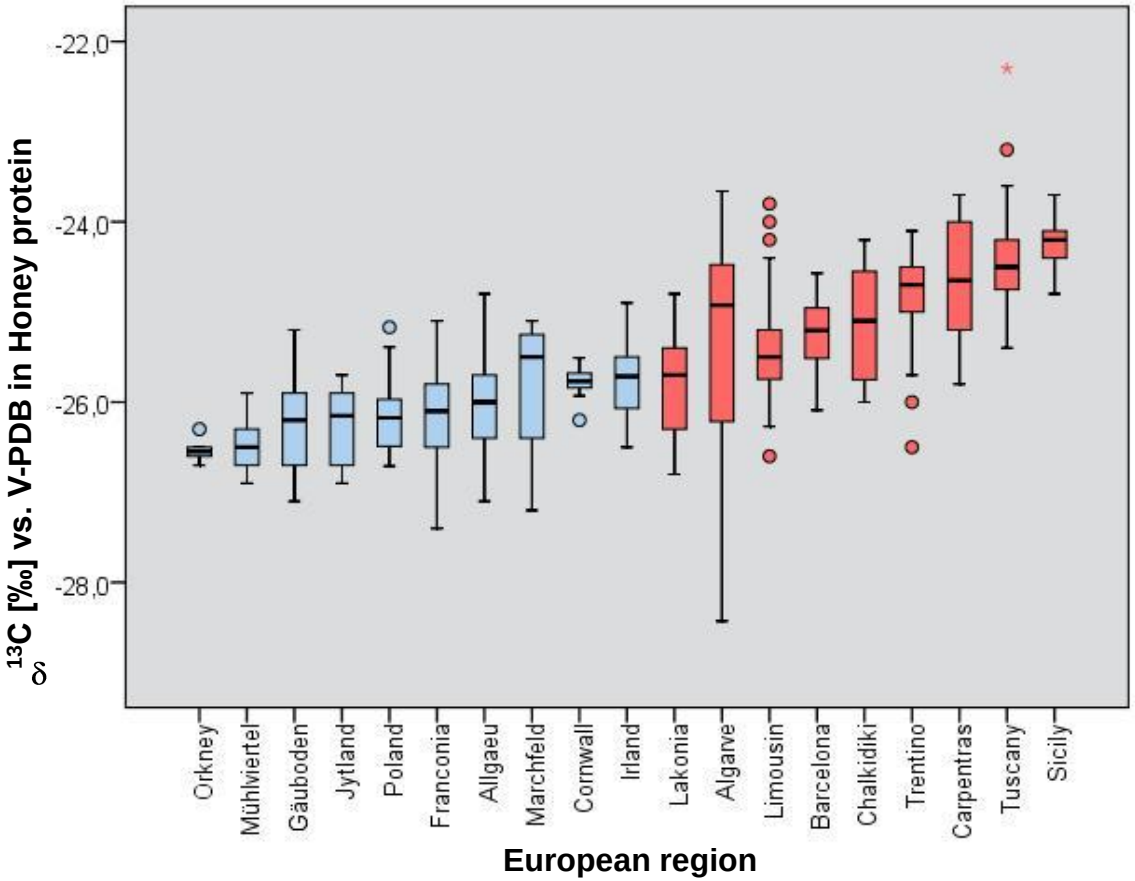


Regions with moderate and mediterranean climate

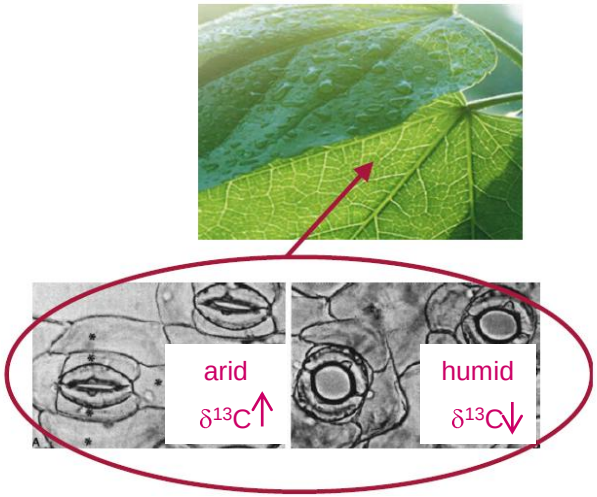
Regions with humid and alpine climate

$\delta^{13}C$: Significant influence by climate

Carbon isotopes values



Stomata

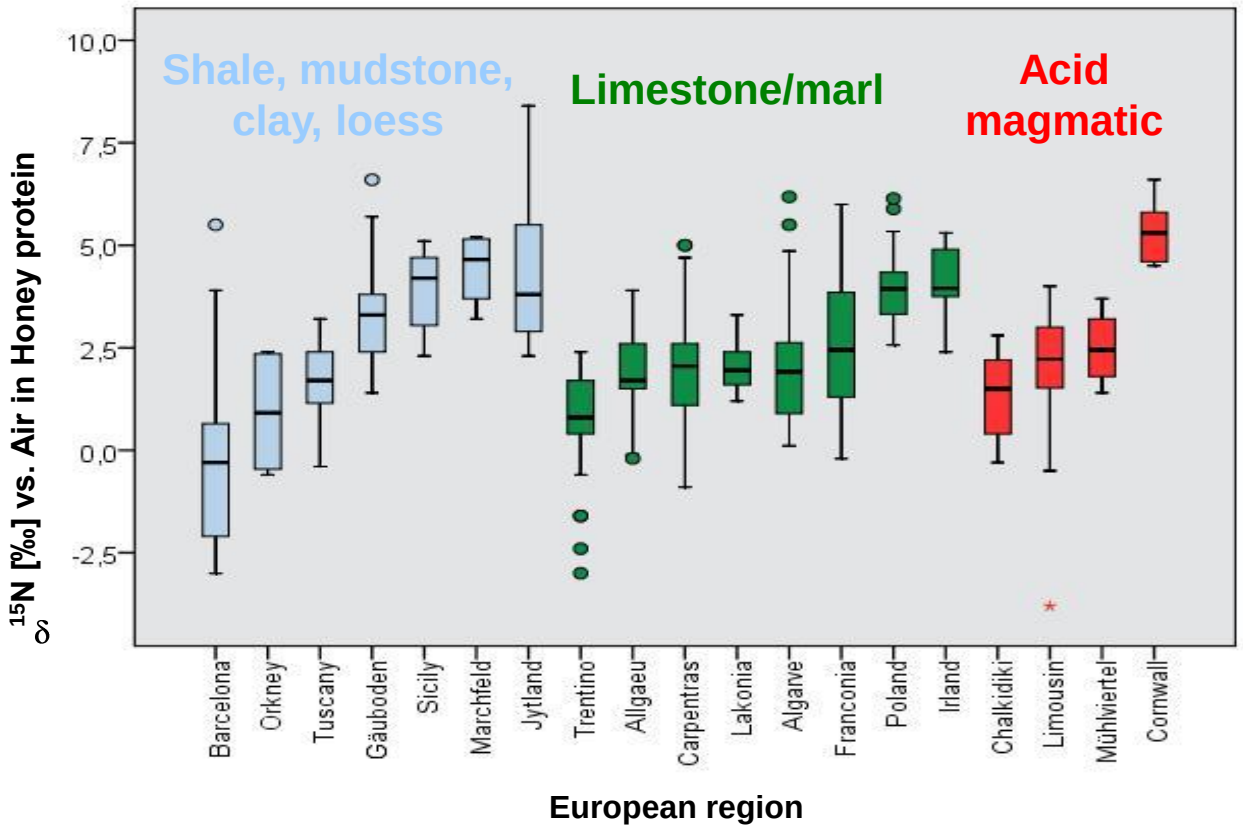


Regions with humid climate

Increase of $\delta^{13}C$ values

Regions with Mediterranean climate

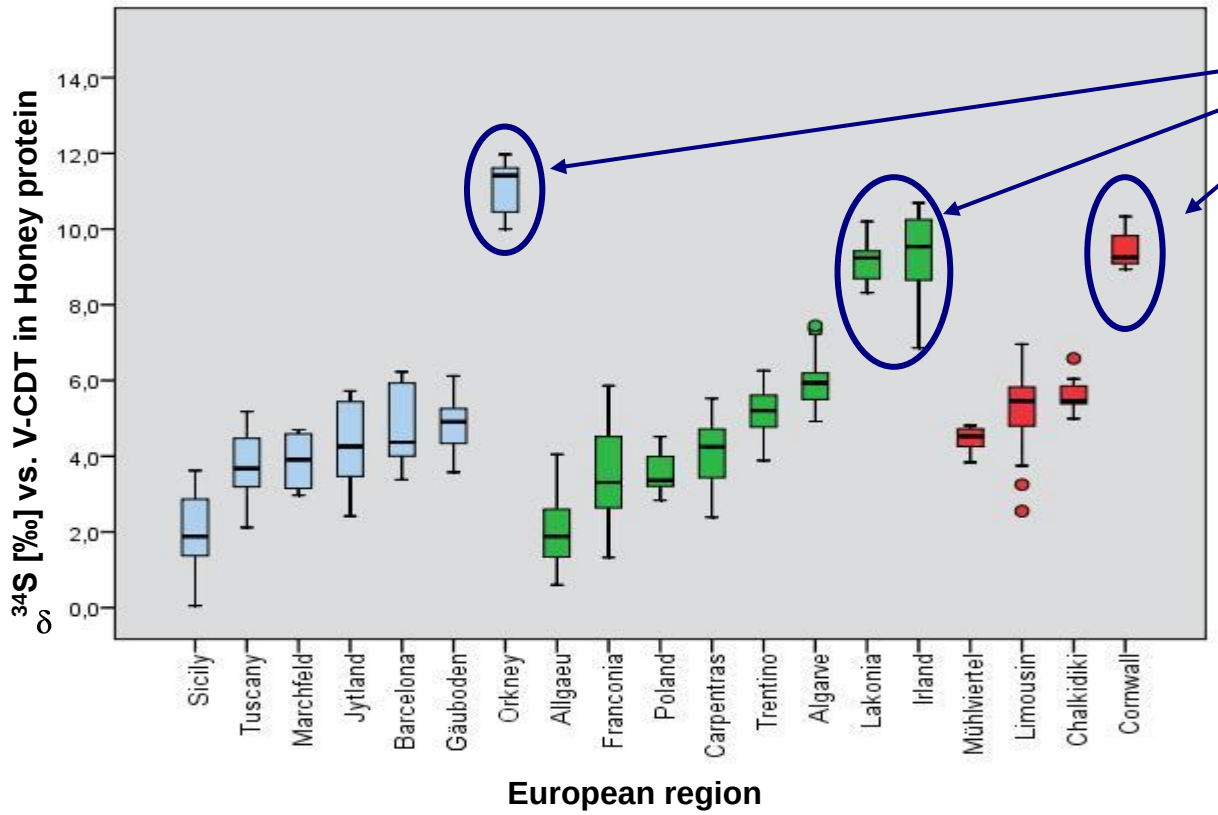
Nitrogen isotopes values



- Soil bacteria nitrogen fixation
- Agricultural practice
- Nitrogen assimilation of plants

No significant differences between soil types and regions
(Tukey Test $p<0.001$)

Sulphur isotopes values



Sea spray effect

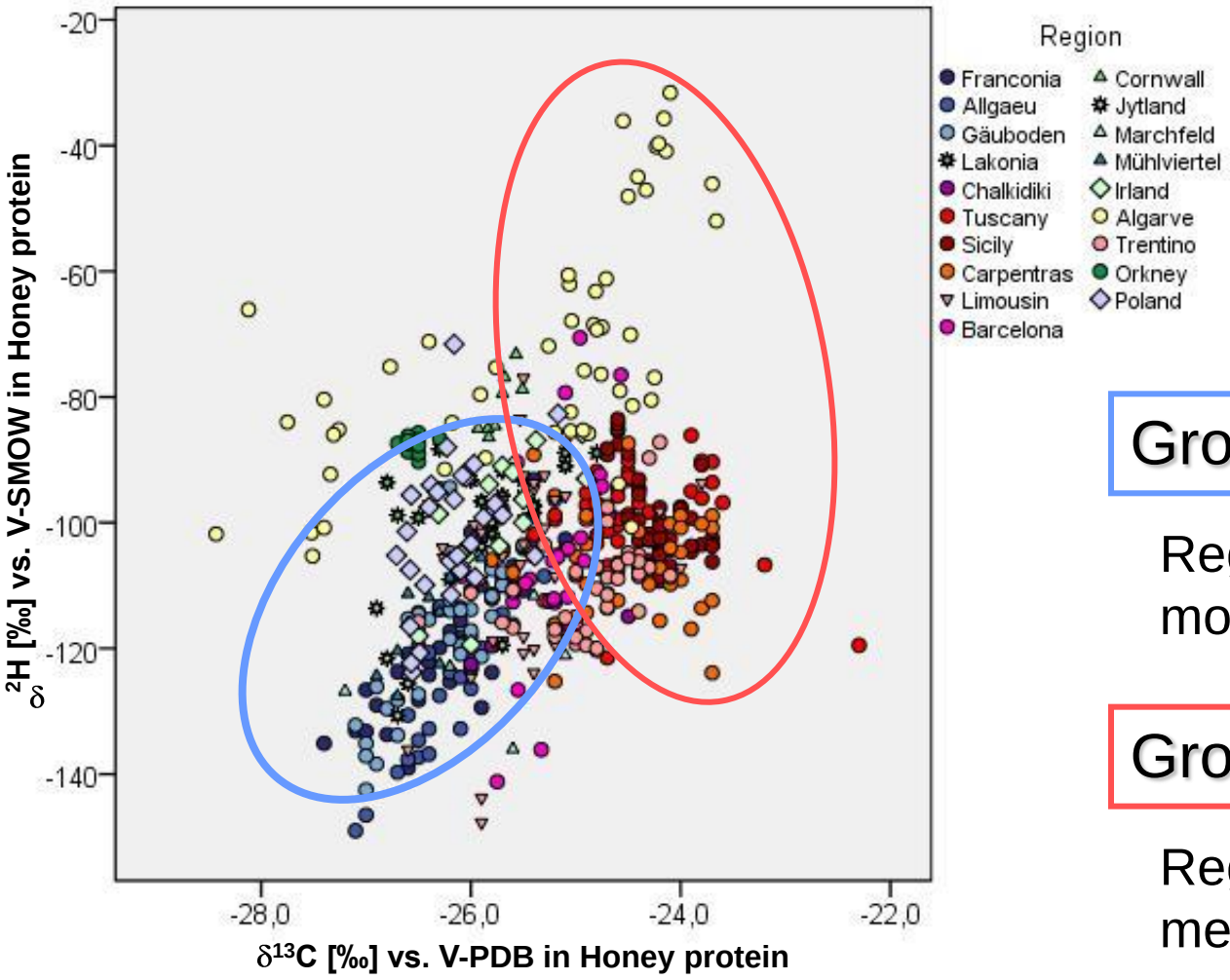
Plants with higher $\delta^{34}S$ values

Shale, clay, mudstone, loess

Different $\delta^{34}S$ values
Tukey Test p<0.001

Limestone/marl
Acid magmatic

Combination of climatic factors



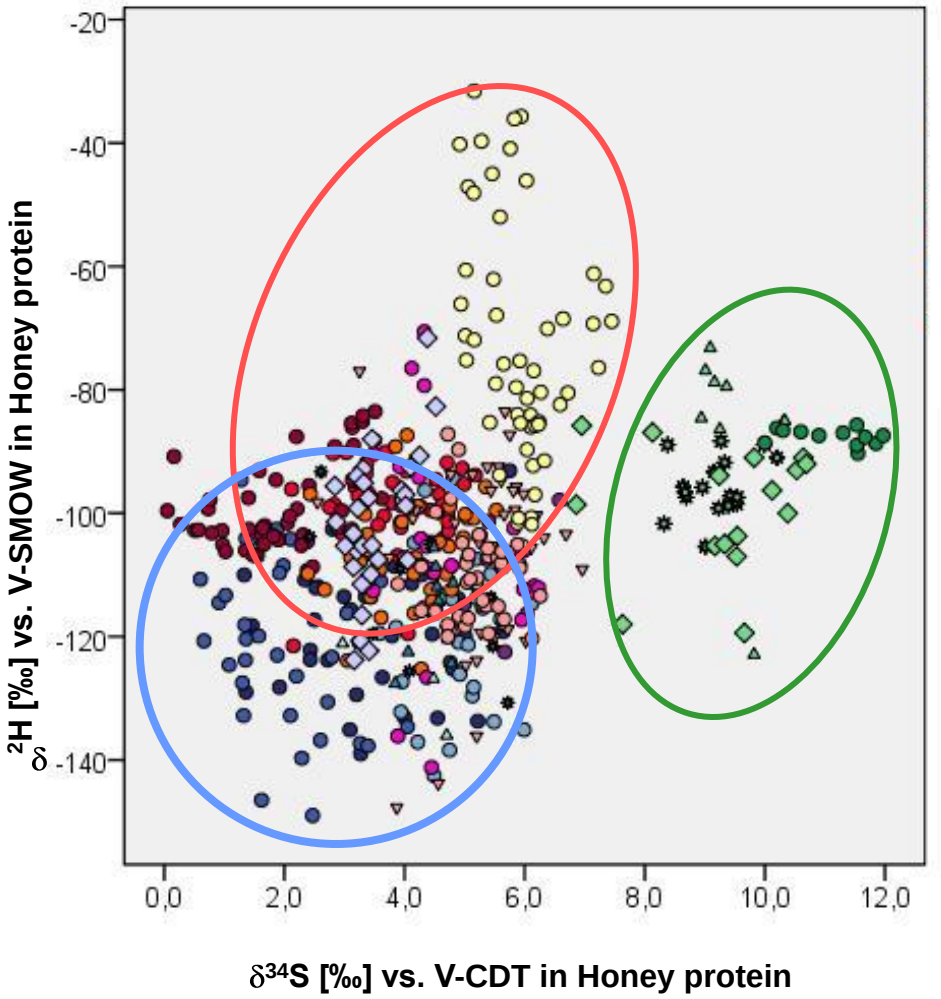
Group North:

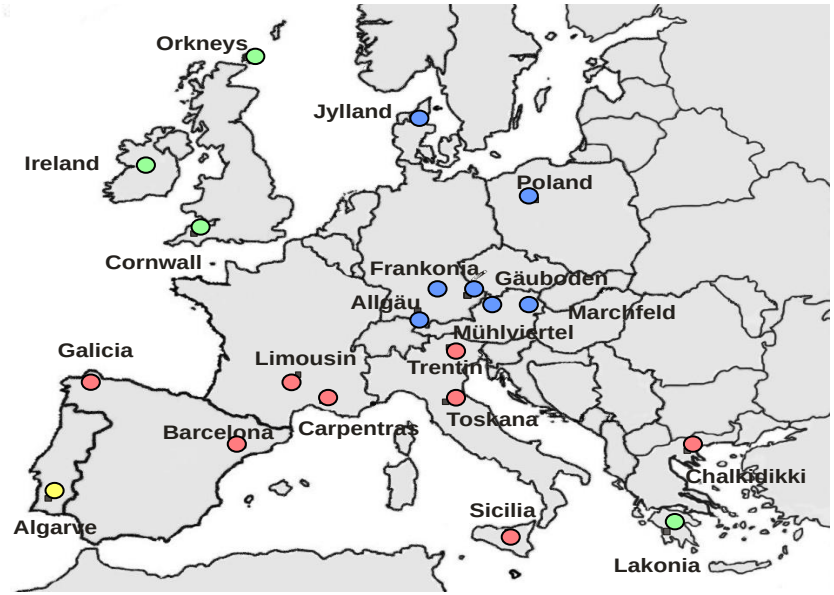
Regions with alpine and moderate climate

Group South:

Regions with mediterranean climate

Combination of climatic and geological factor

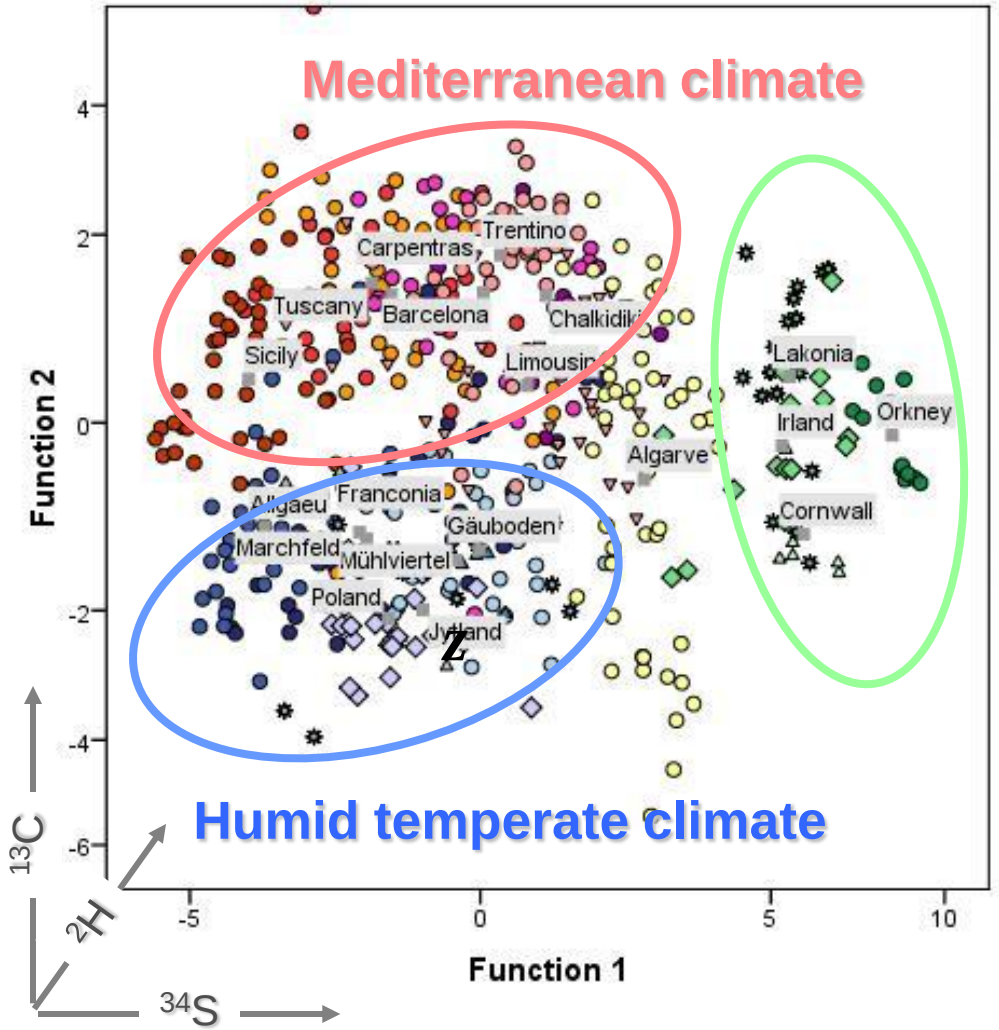


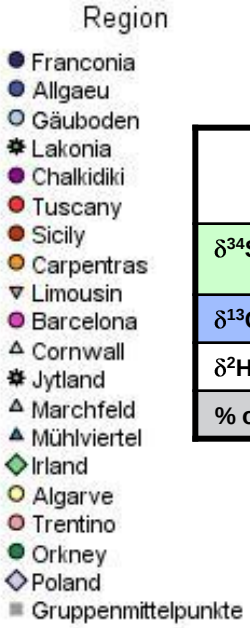


- Regions with alpine and moderate climate
- Regions with mediterranean climate
- Regions close to the sea

Canonical discriminant analysis

δ^2H, $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$





Structure matrix

	Function		
	1	2	3
$\delta^{34}S$	.941*	.135	-.170
$\delta^{13}C$	-.144	.798*	.522
δ^2H	.211	.086	.941*
% of variance	70.3	13.1	9.9

60.2 % of the original grouped cases were correctly classified

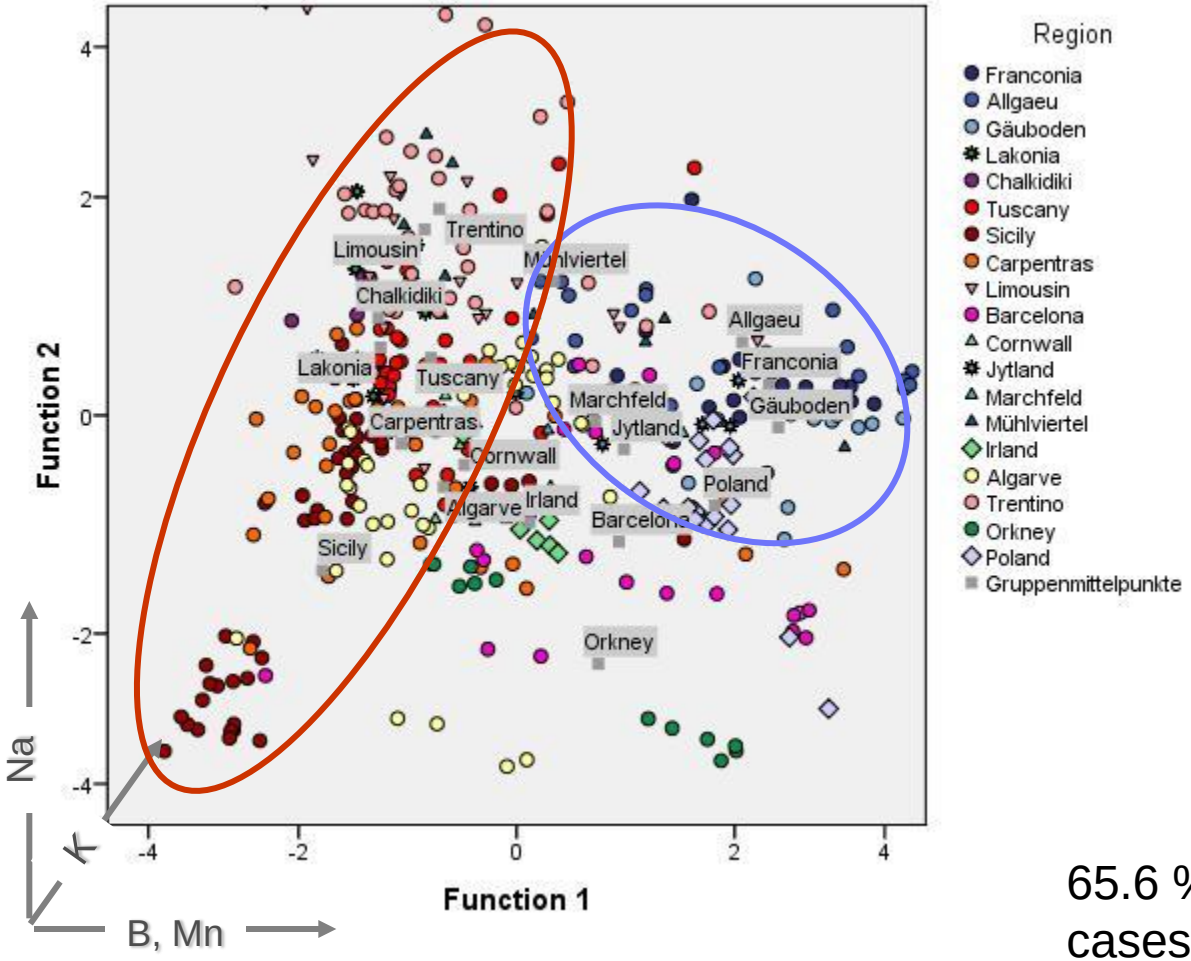
> 75 %: Allgäu, Sicily, Cornwall, Algarve, Poland

100 %: Lakonia, Orkney

Canonical discriminant analysis

Minerals
K >> Ca > Na, Mg

Trace elements
Ni, Cu, Zn, Mn, Al, Sr, B, Cd, Rb



Kruskal-Wallis Test ($p<0.05$)

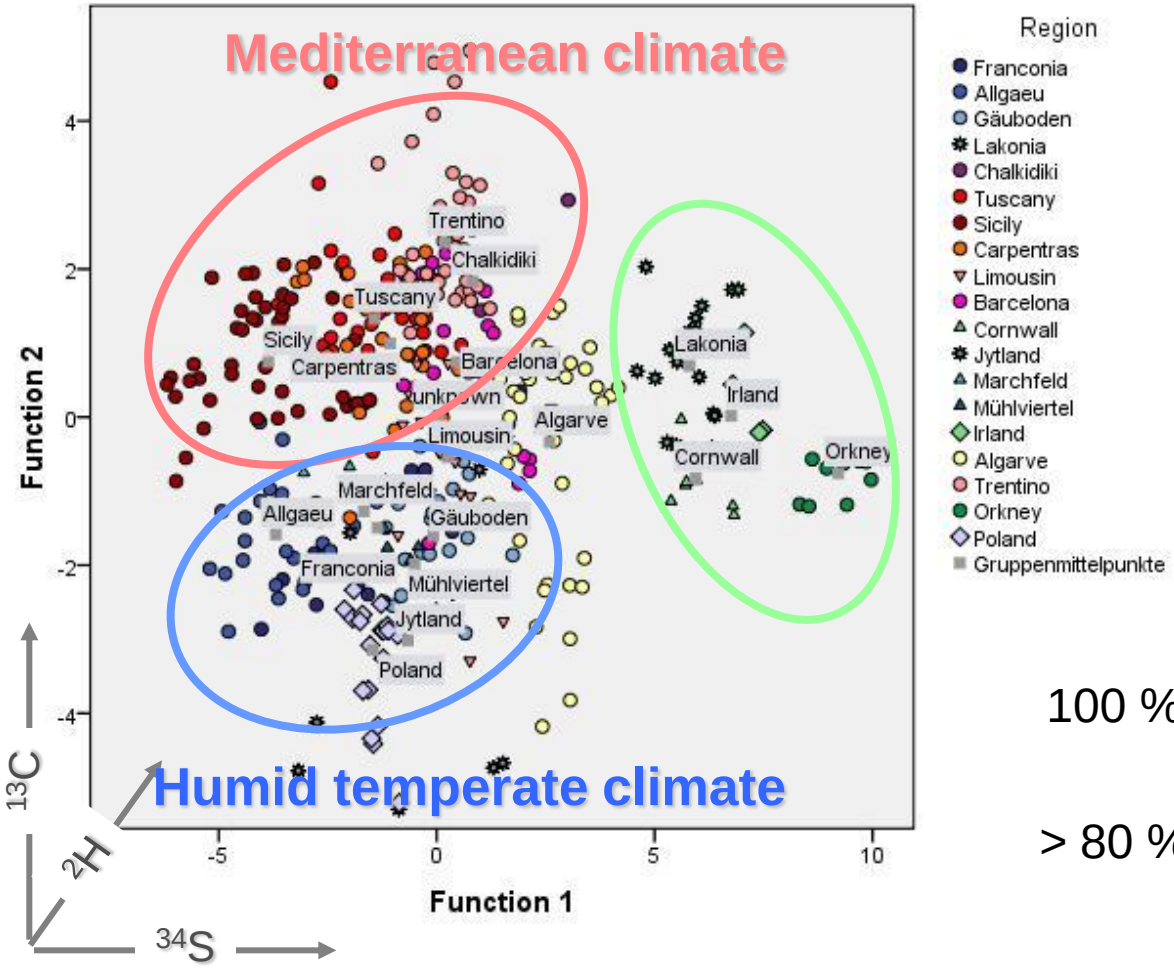
Significant differences between regions for Ca, Mg, Ni, Cu, Zn, Na, B, Al, K, Mn, Sr, Rb

Function	% of variance
1: B, Mn	29.2
2: Na	17.8
3: K	15.5

65.6 % of the original grouped cases were correctly classified

Canonical discriminant analysis

SIR, minerals and trace elements



Structure matrix

	Function		
	1	2	3
$\delta^{34}S$	.911*	.086	-.196
$\delta^{13}C$	-.155	.677*	.313
$\delta^{2}H$	.205	.156	.705*
% of variance	53.3	13.3	10.6

85.0 % of the original grouped cases were correctly classified

100 %: Allgäu, Lakonia, Orkney, Mühlviertel, Ireland,

> 80 %: Poland, Algrave, Sicily, Chalkidiki, Tuscany, Barcelona, Cornwall, Trentino

PDO and PGI products

PDO *(protected designation of origin)*

produced, processed and prepared in a given geographical area using recognised know-how

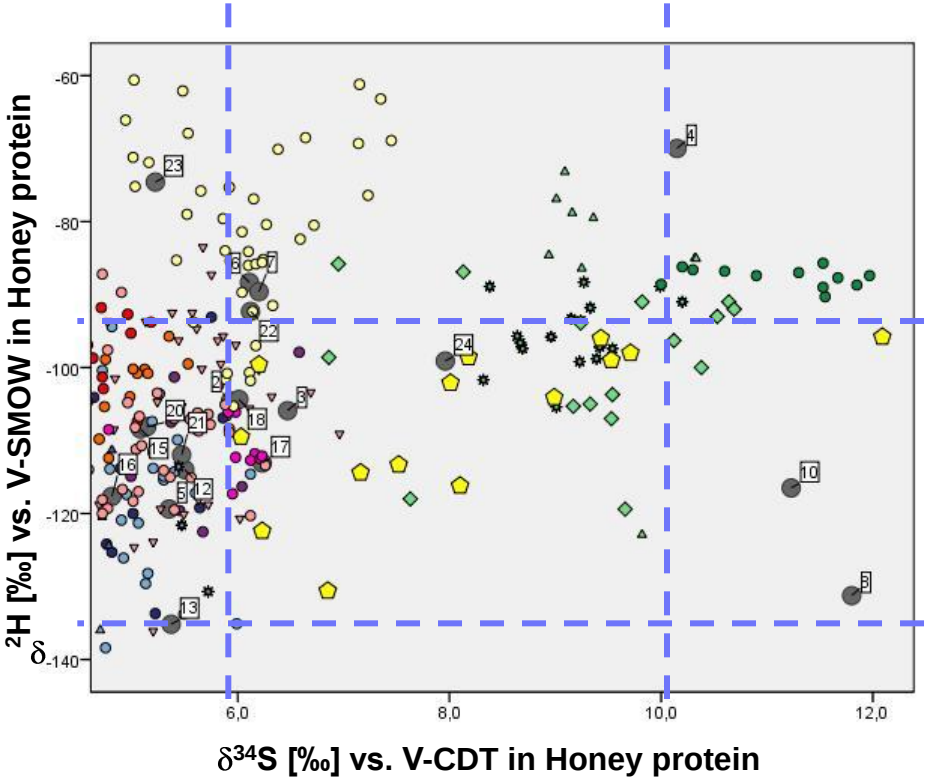
PGI *(protected geographical indication)*

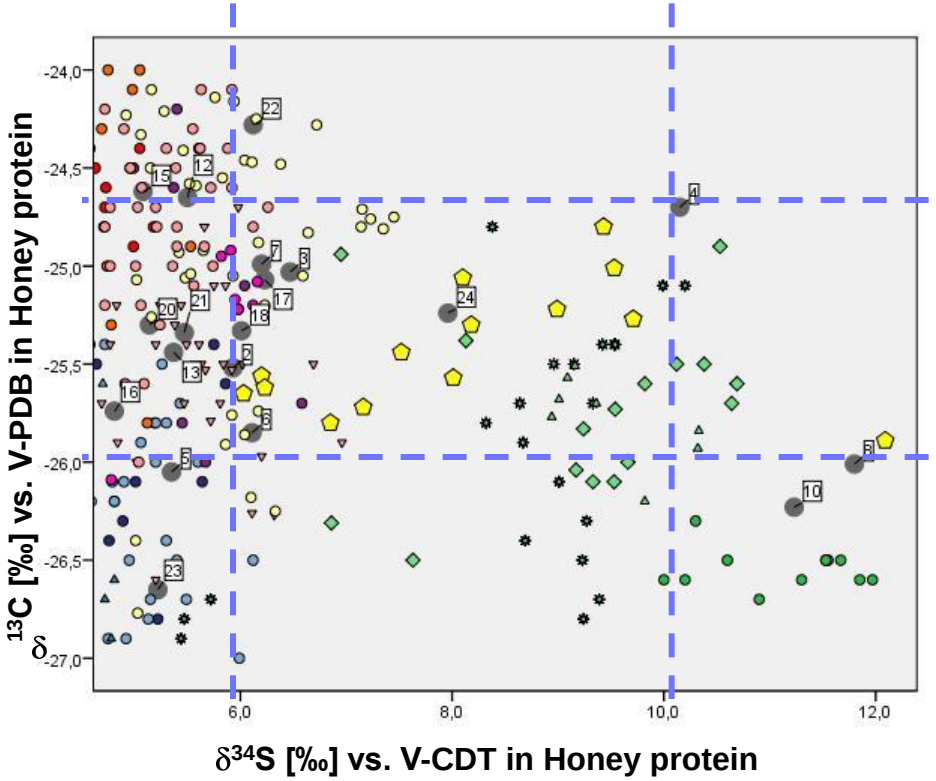
one of the stages of production, processing or preparation takes place in the area

Country	PDO	PGI
Portugal	9	-
France	2	1
Spain	2	1
Italy	1	-
Luxembourg	1	-
Poland	-	1

http://ec.europa.eu/agriculture/quality/database/index_en.htm

Honey challenge





- Corsica
- Unknown

δ^2H: (-135 ‰) – (-95 ‰)

$\delta^{13}C$: (-26.0 ‰) – (-24.6 ‰)

$\delta^{34}S$: (6.0 ‰) – (10.0 ‰)

Honey challenge

Honey from Corsica
$\delta^{87}Sr$: > 2.0 ‰

No	$\delta^{2}H$	$\delta^{13}C$	$\delta^{15}N$	$\delta^{34}S$	Corsica	$\delta^{87}Sr$	Corsica	True Origin
1	-109	-24,9	1,0	4,5	No	1.8	No	EU
2	-105	-25,5	2,7	5,9	Yes	2.4	Yes	Argentina
3	-106	-25,0	3,3	6,5	Yes	-1.0	No	Spain
4	-70	-24,7	2,4	10,2	No	-1.8	No	Mexico
5	-119	-26,1	5,1	5,4	No	-1.5	No	UK
6	-88	-25,9	0,4	6,1	Yes	3.0	Yes	Corsica
7	-90	-25,0	1,2	6,2	Yes	1.8	Yes	Corsica
8	-131	-26,0	3,6	11,8	No	-3.1	No	New Sealand
9	-115	-24,7	1,0	4,5	No	5.9	No	Italy
10	-117	-26,2	1,9	11,2	No	-1.9	No	New Sealand
11	-102	-25,3	-2,0	14,0	No	4.7	No	Australia
12	-114	-24,7	4,0	5,5	No	1.4	No	Hungary
13	-135	-25,4	2,8	5,4	No	-1.4	No	France
14	-115	-24,7	0,1	2,0	No	0.2	No	Italy
15	-108	-24,6	4,4	5,1	No	-1.3	No	Spain
16	-118	-25,7	2,6	4,8	No	-1.4	No	France
17	-113	-25,1	1,9	6,2	Yes	-1.0	No	Spain
18	-104	-25,3	1,6	6,0	Yes	8.5	Yes	France
19	-104	-23,8	-0,02	4,2	No	-0.4	No	Italy
20	-108	-25,3	3,6	5,1	No	-2.8	No	Mexico
21	-112	-25,3	1,3	5,5	No	-0.8	No	Spain
22	-92	-24,3	-0,9	6,1	No	1.5	No	France
23	-75	-26,7	-3,3	5,2	No	1.9	No	UK
24	-99	-25,2	1,9	8,0	Yes	3.2	Yes	Corsica

Conclusion

Isotope ratio of sulphur, carbon and hydrogen could be a useful component in the multivariate analysis to check the geographical origin of honey.

Combination of stable isotope, minerals and trace element data did not lead to a significant improvement in classification of geographical origin for the investigated samples.

Compliance with a declared origin (Corsica) can be checked with a combination of light stable isotope and strontium isotope data.

Co-Authors

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Thank you for your attention!