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Taxonomic affinity of bee fossils based on geometric morphometrics of wing shape

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What is the taxonomy of bee fossils?

Bee fossils = rare

↓

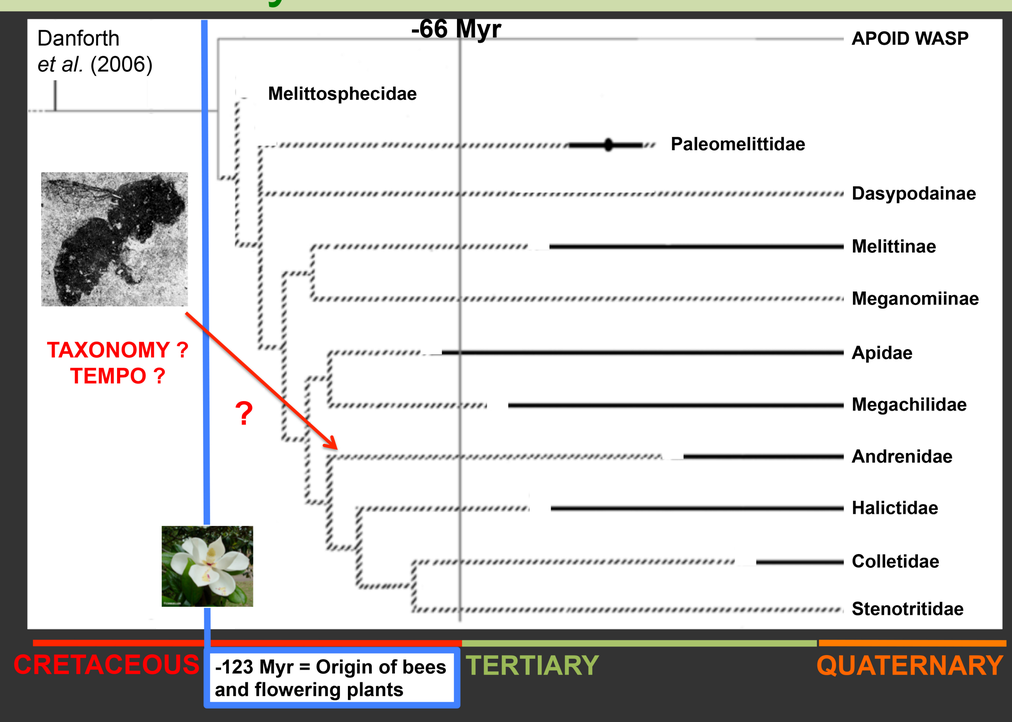
Only 196 species described

↓

Taxonomic affinities?

↓

Geometric morphometrics of the forewing

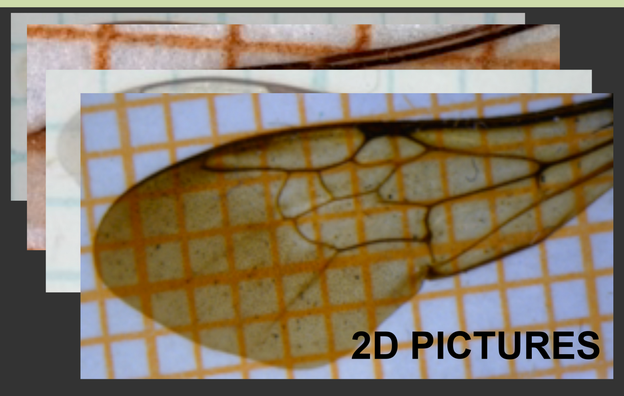


Aims

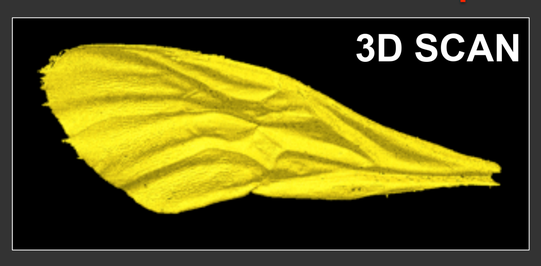
✓ Validation of forewing shape diagnostic character at family, subfamily and tribe levels.

✓ Taxonomy of described and undescribed bee fossils by using geometric morphometric analyses of forewing shape.

Geometric morphometrics of the wings



OR

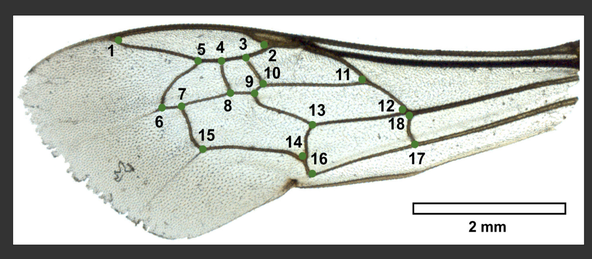


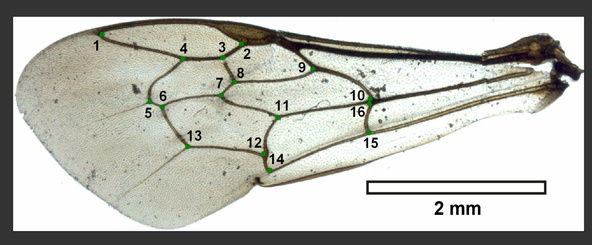
A: Data acquisition

B: Compilation of the wings pictures in data sets

3 submarginal cells
632 specimens
188 species
39 tribes
10 families
18 landmarks

2 submarginal cells
573 specimens
138 species
28 tribes
6 families
16 landmarks

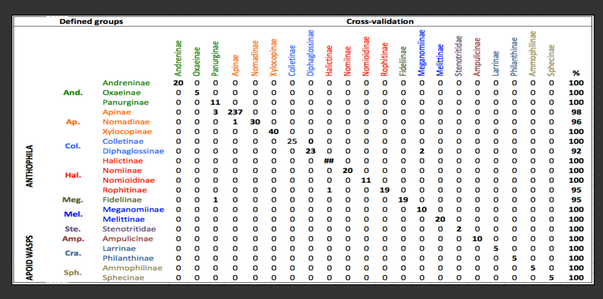




C: Digitization

D: Analyses

Assignment table

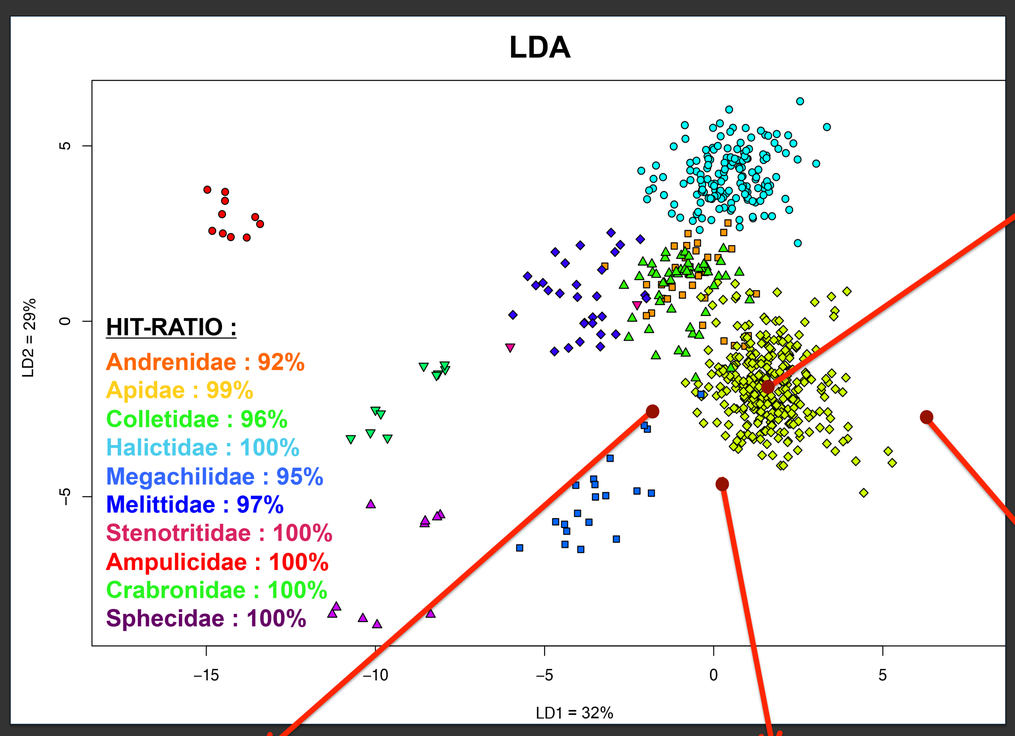


Defined groups			Cross-validation																													
			Andreninae	Oxaeinae	Panurginae	Apinae	Nomadinae	Xylocopinae	Colletinae	Diphaglossinae	Halictinae	Nomiinae	Nomioidinae	Rophitinae	Fidelinae	Meganomiinae	Melittinae	Stenotritidae	Ampulicinae	Larrinae	Philanthinae	Ammophilinae	Sphecinae	%
ANTHOPHILA		Andreninae	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
	And.	Oxaeinae	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
		Panurginae	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
		Apinae	0	0	3	237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98
	Ap.	Nomadinae	0	0	0	1	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96
		Xylocopinae	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
		Colletinae	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
	Col.	Diphaglossinae	0	0	0	0	0	0	0	23	0	0	0	0	0	2	0	0	0	0	0	0	0	92
		Halictinae	0	0	0	0	0	0	0	0	##	0	0	0	0	0	0	0	0	0	0	0	0	100
		Nomiinae	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	100
	Hal.	Nomioidinae	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	100
		Rophitinae	0	0	0	0	0	0	0	0	1	0	0	19	0	0	0	0	0	0	0	0	0	95
	Meg.	Fidelinae	0	0	1	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	95
		Meganomiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	100
	Mel.	Melittinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	100
	Ste.	Stenotritidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	100
	Amp.	Ampulicinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	100
		Larrinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	100
	Cra.	Philanthinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	100
	Sph.	Ammophilinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	100
		Sphecinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	100

LDA = Linear Discriminant Analysis

Taxonomic affinities of the bee fossils

✓ **Analysis of four new bee fossil species at family level :**



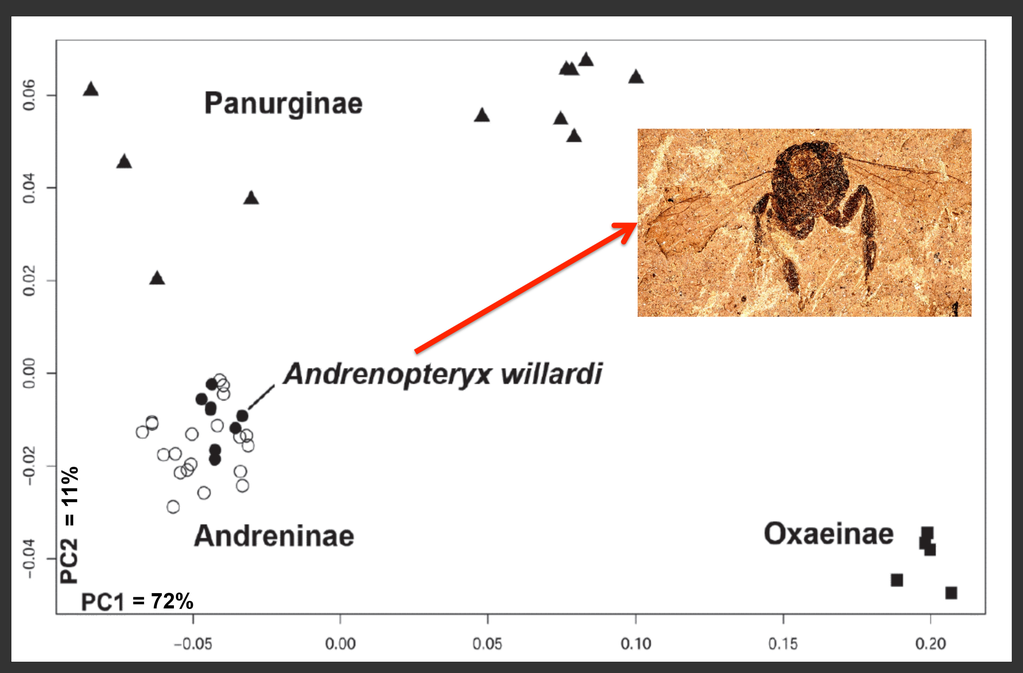
***Bombus cerdanyensis* sp. nov.**
Bombini, Apinae, Apidae

***Euglossopteryx biesmeijeri* gen. nov. sp. nov.**
Corbicula, Apinae, Apidae

***Andrena antoinei* sp. nov.**
Andrenini, Andreninae, Andrenidae

***Protohabropoda pauli* gen. nov. sp. nov.**
Anthophorini, Apinae, Apidae

✓ **Analysis of already described fossil species at tribe level :**



***Melitta willardi* Cockerell, 1909** ✗
***Andrenopteryx willardi* (Cockerell, 1909)** ✓
(Andreninae, Andrenidae)

More information? Check those papers:

- **Dewulf A, De Meulemeester T, Dehon M, Engel MS, Michez D (2014)** A new interpretation of the bee fossil *Melitta willardi* Cockerell (Hymenoptera, Melittidae) based on geometric morphometrics of the wing. ZooKeys 389: 35–48.
- **Dehon M, Michez D, Nel A, Engel MS, De Meulemeester T (2014)** Wing shape of four new bee fossils (Hymenoptera: Anthophila) provides insights to bee evolution. PLoS ONE, 9(10): e108865.

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