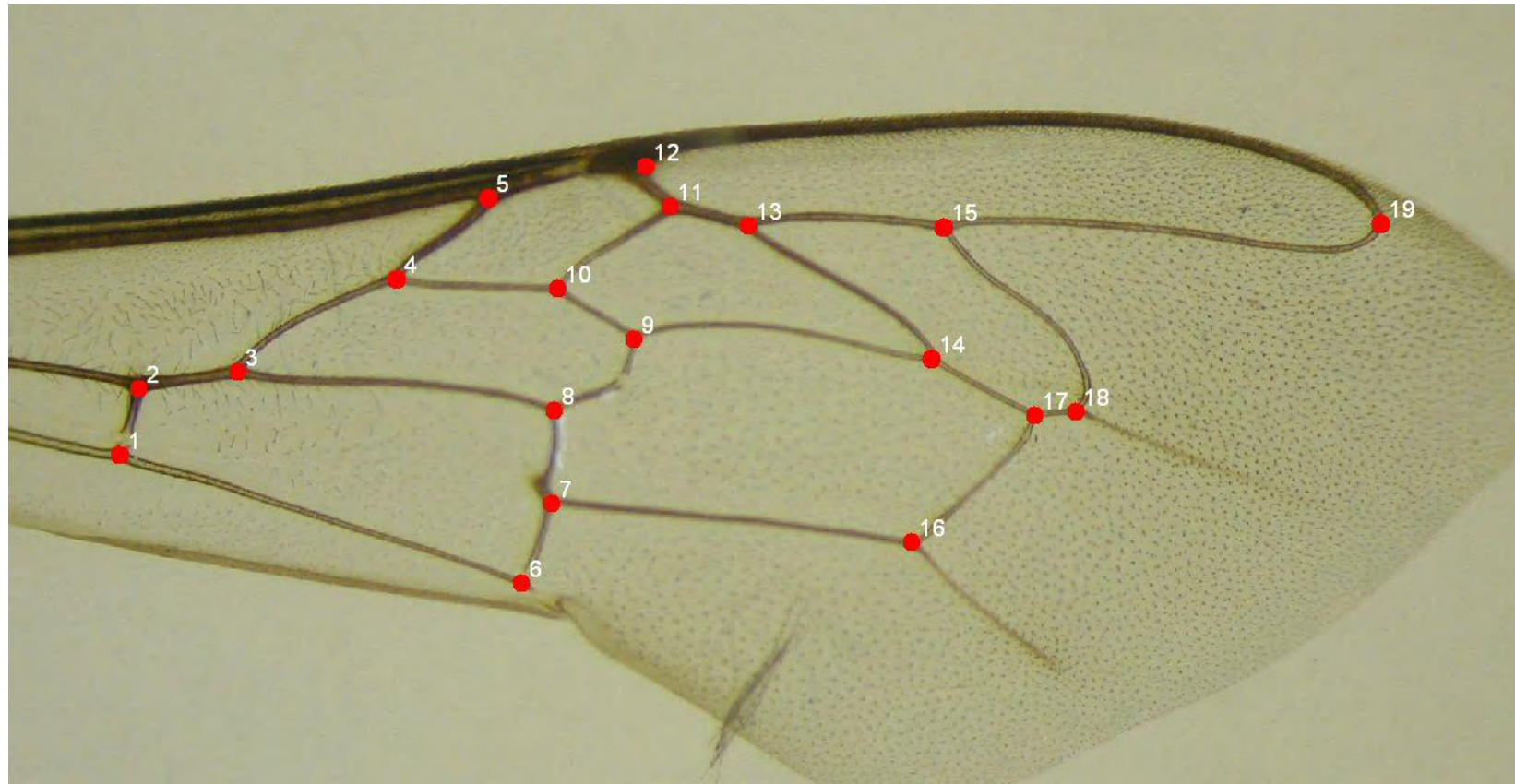


JOINING LANDMARK AND OUTLINE-BASED METHODS IS MORE EFFICIENT IN DISCRIMINATING EUGLOSSA SPECIES



Tiago Mauricio Francoy, Fernando de Faria Franco & David W Roubik

Standard Morphometrics

Friedrich Ruttner

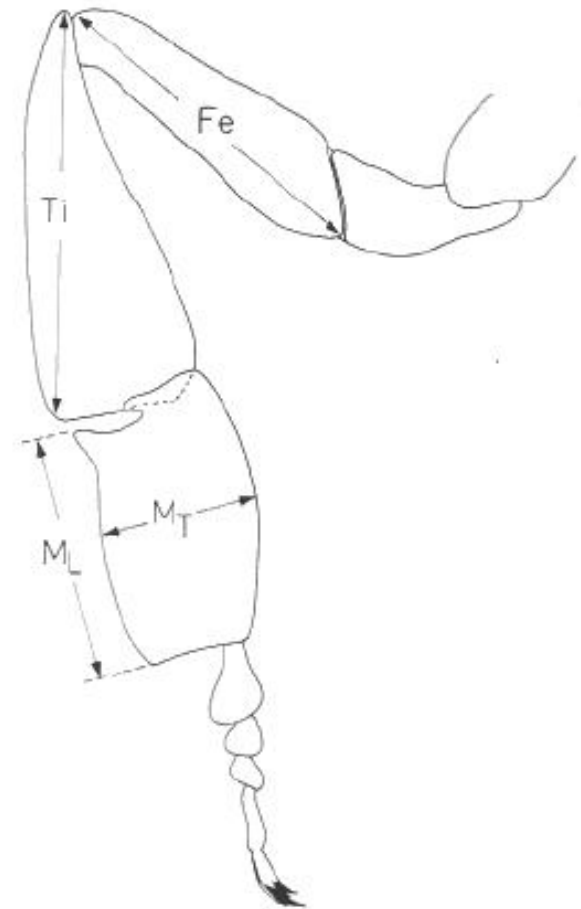


Fig. 6.4 Length of femur (*Fe*), tibia (*Ti*) and metatarsus (*M_L*); *M_T* width of metatarsus

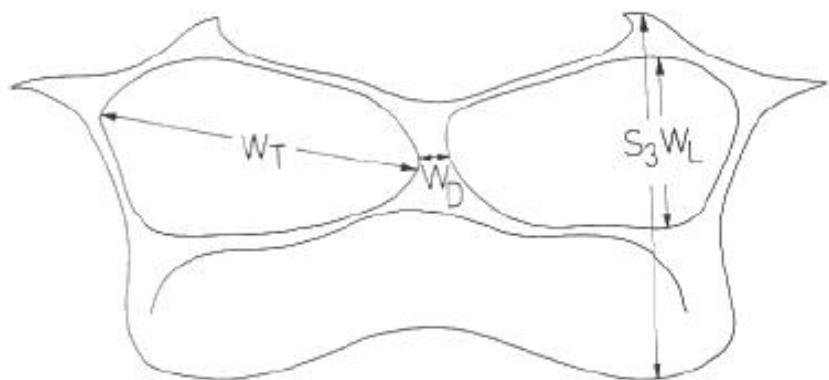


Fig. 6.6 Measurements of sternite 3: longitudinal (S_3), wax plate longitudinal (W_L), and transversal (W_T) and distance between wax plates (W_D)

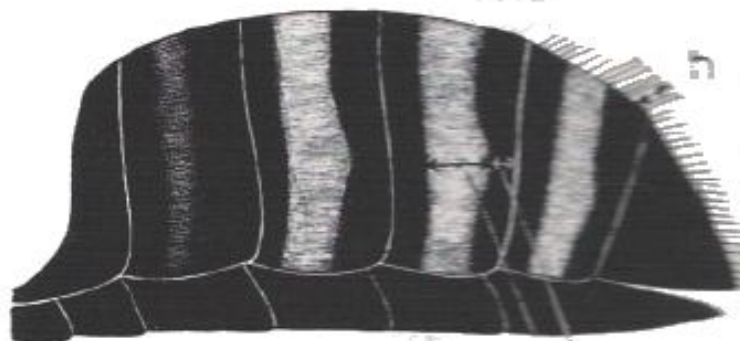


Fig. 6.2 Measurement of hair length on tergite 5 (h) and tomentum on tergite 4 (a , b)

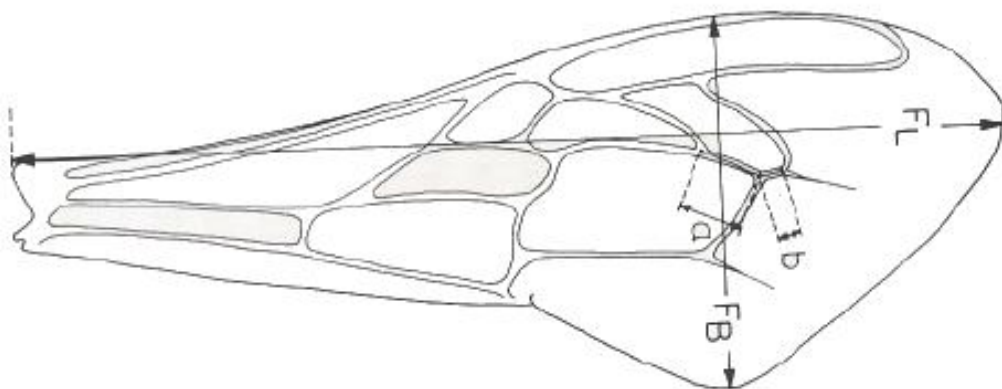


Fig. 6.8 Fore wing length (F_L) and width (F_B); distances a and b of cubital vein

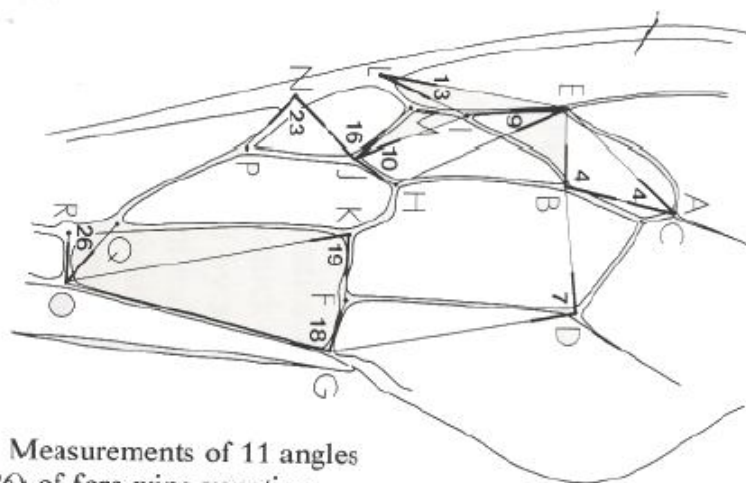


Fig. 6.9 Measurements of 11 angles ($A4 - 026$) of fore wing venation

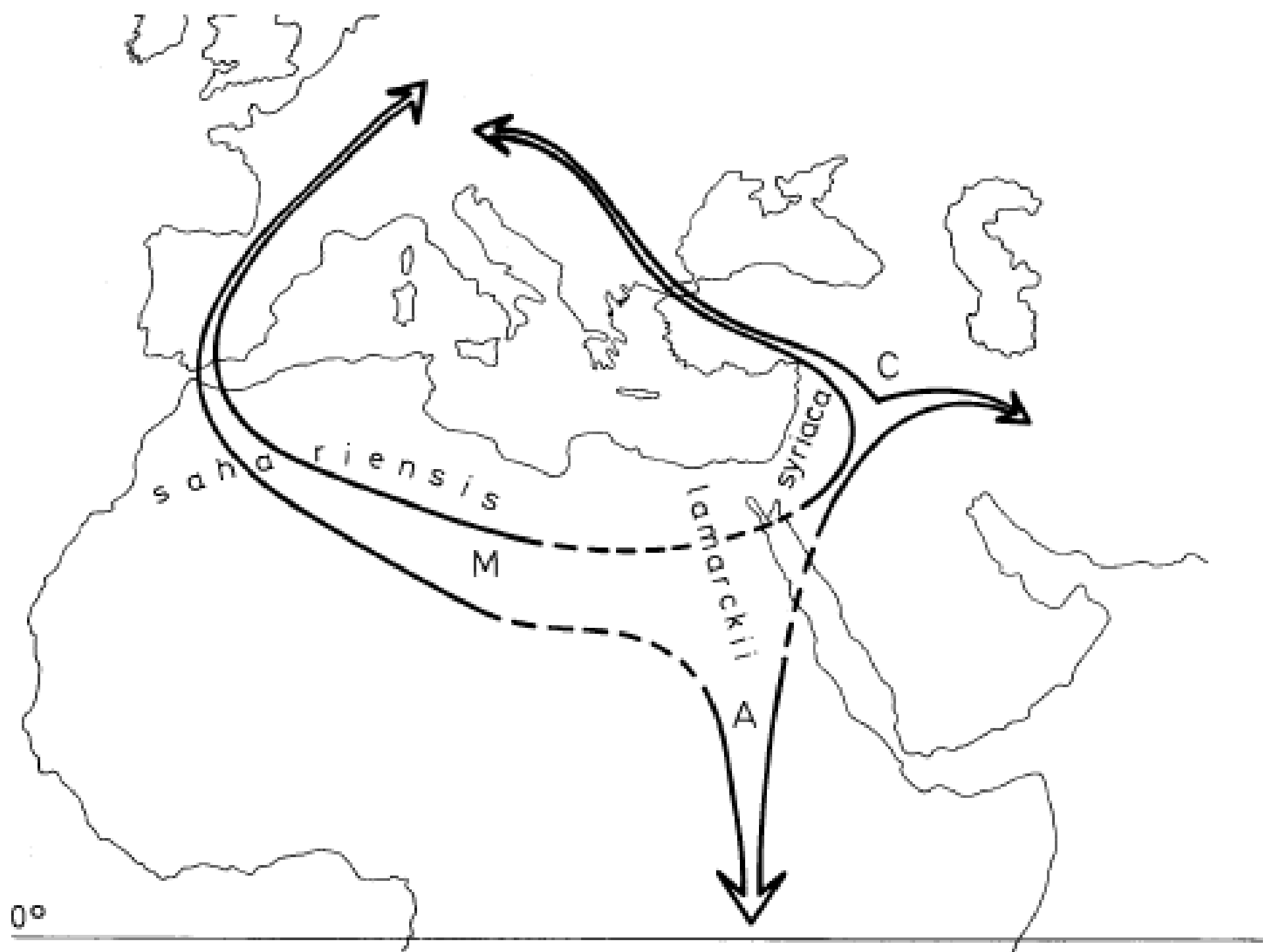
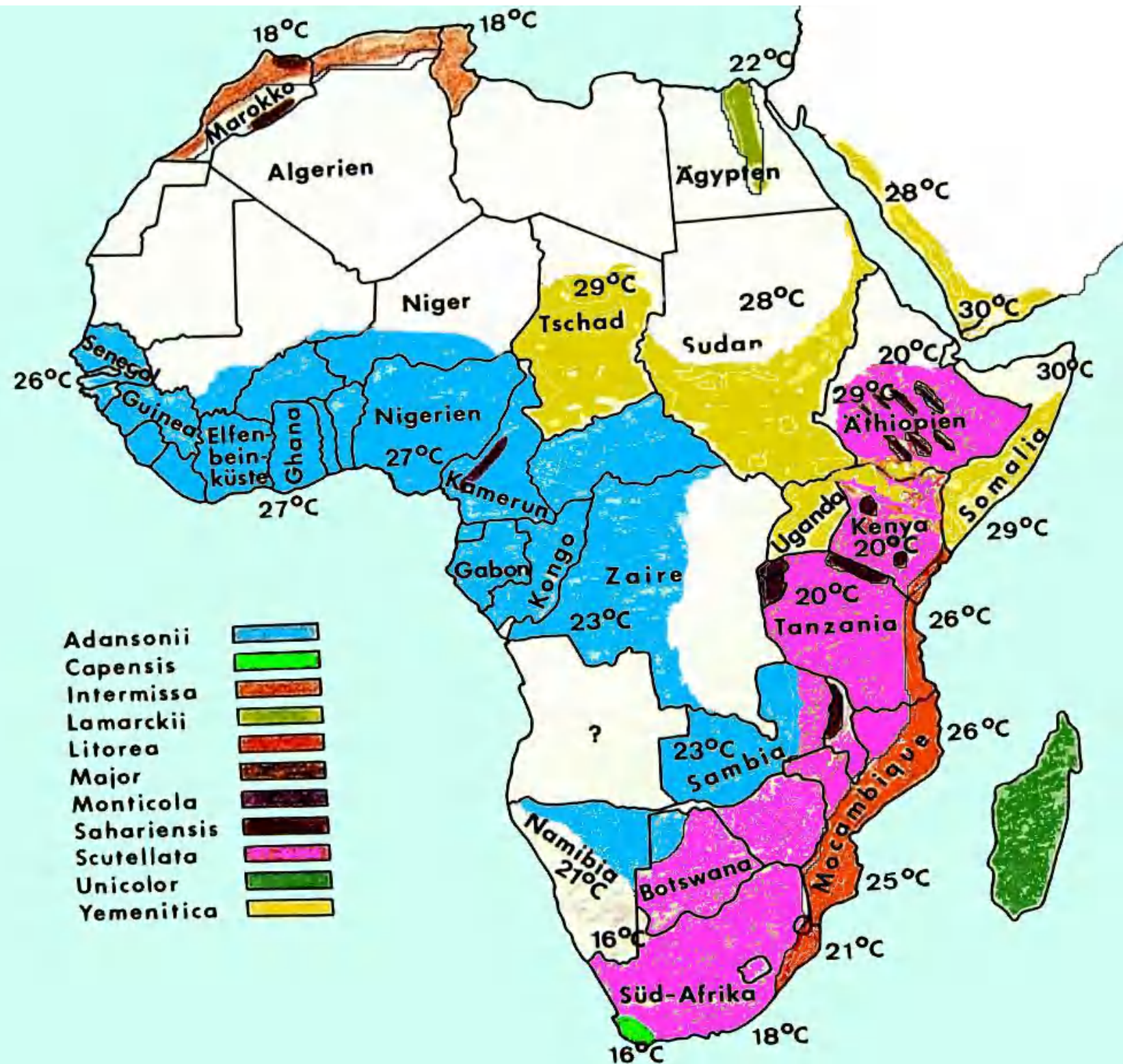
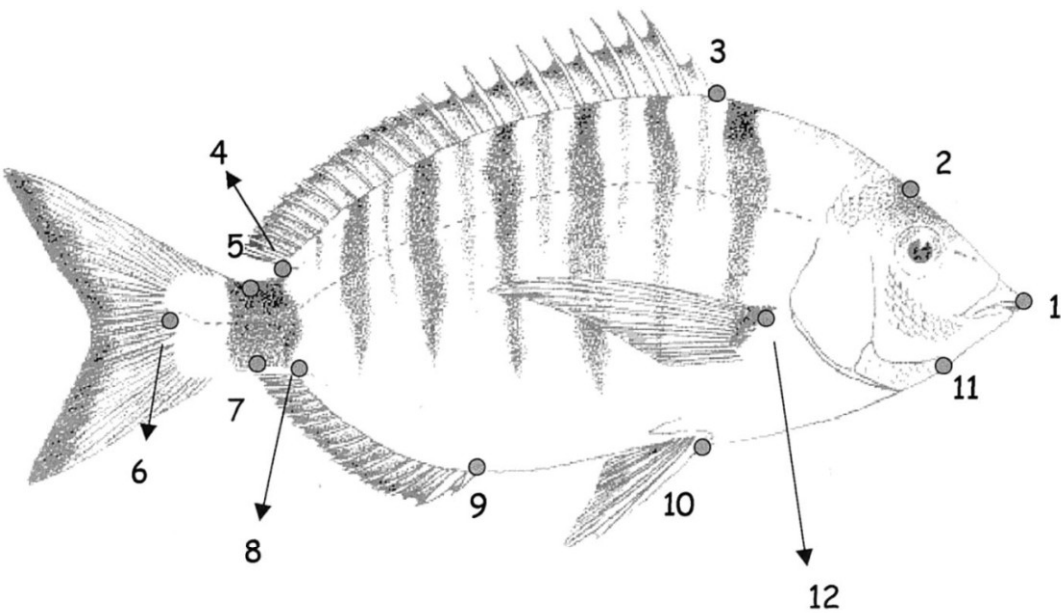


FIG. 12. — The three main branches (A, C, M) of morphogenetic evolution of the races of *A. mellifera*.

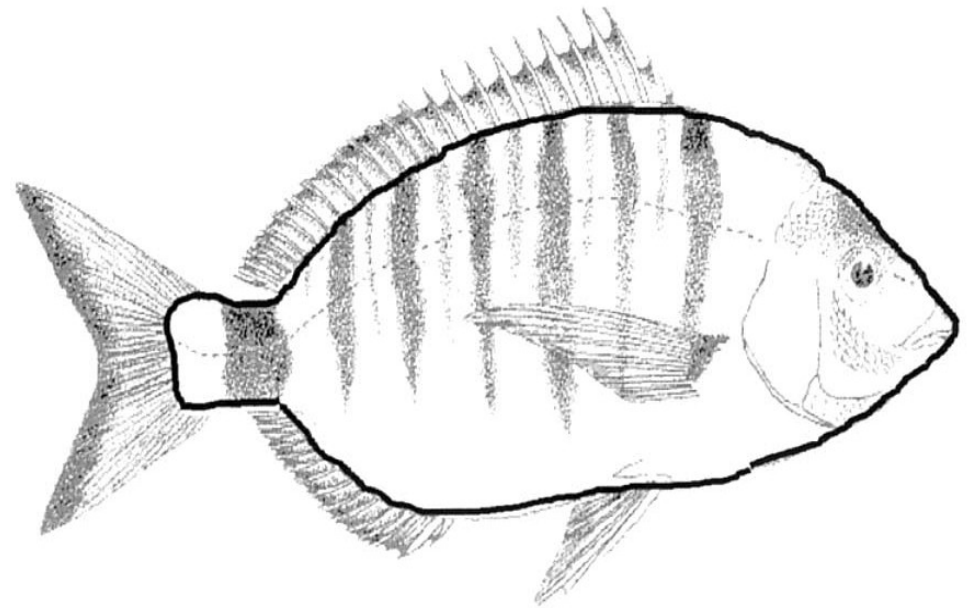




Geometric morphometrics



Landmark based methods



Outline based methods

Identification of Africanized honey bees through wing morphometrics: two fast and efficient procedures*

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Reçu le 28 December 2007 – Accepté le 19 Mars 2008

	N	<i>A. m. carnica</i>	<i>A. m. ligustica</i>	<i>A. m. mellifera</i>	<i>A. m. scutellata</i>	AHB
<i>A. m. carnica</i>	15	93	7	0	0	0
<i>A. m. ligustica</i>	10	0	100	0	0	0
<i>A. m. mellifera</i>	15	0	0	100	0	0
<i>A. m. scutellata</i>	14	0	0	0	50	50
AHB	394	0	0.3	0	0.5	99.2

Geometric morphometrics of the wing as a tool for assigning genetic lineages and geographic origin to *Melipona beecheii* (Hymenoptera: Meliponini)

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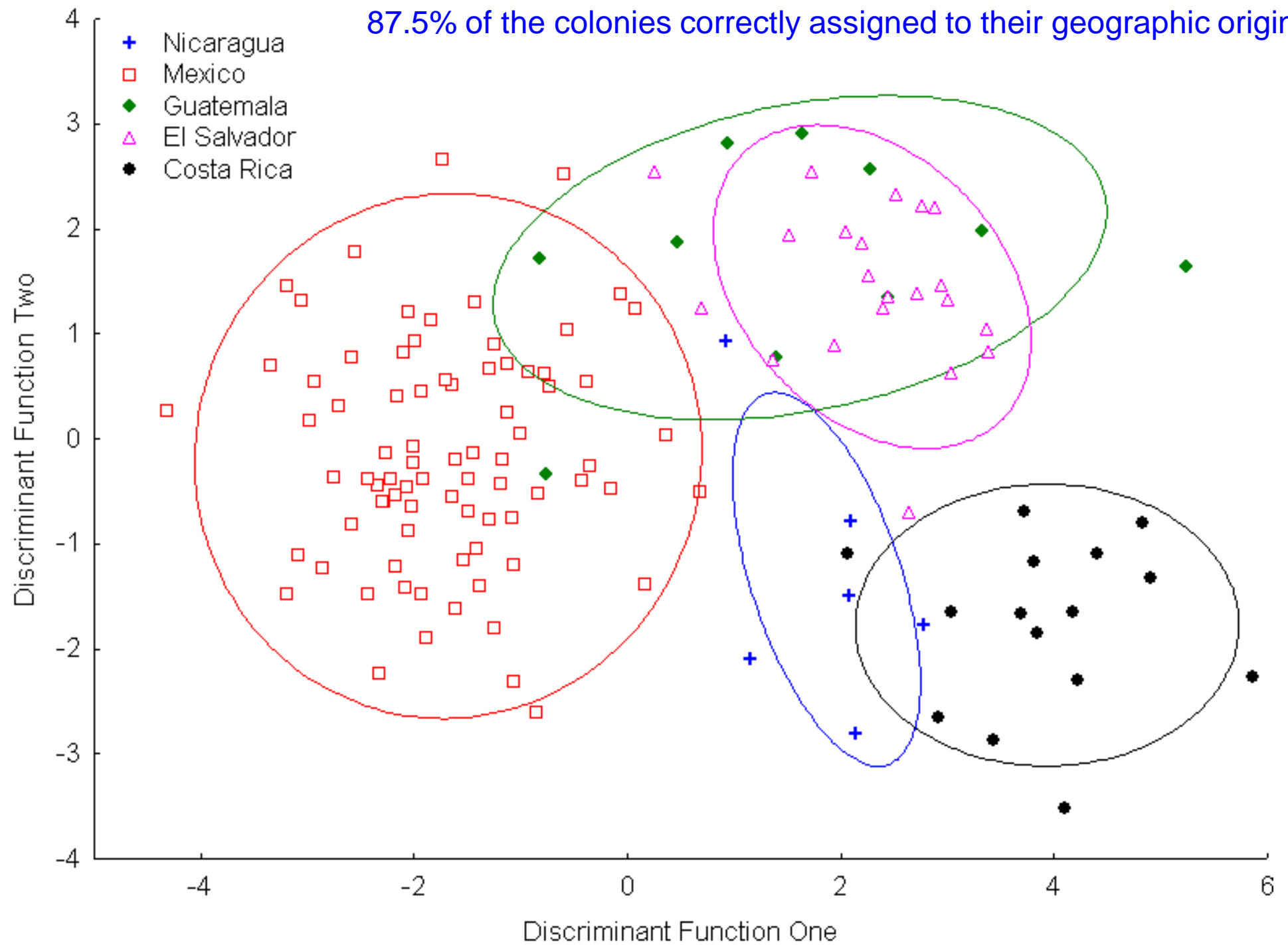
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Received 16 April 2010 – Revised 13 September 2010 – Accepted 13 September 2010

87.5% of the colonies correctly assigned to their geographic origin



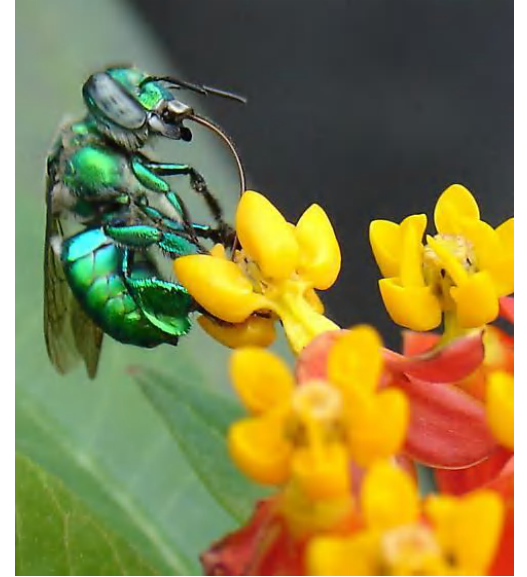
2 main objectives

1. To test the effectiveness of geometric morphometric methods in discriminating closely related *Euglossa* species (Glossura subgenus, piliventris group)

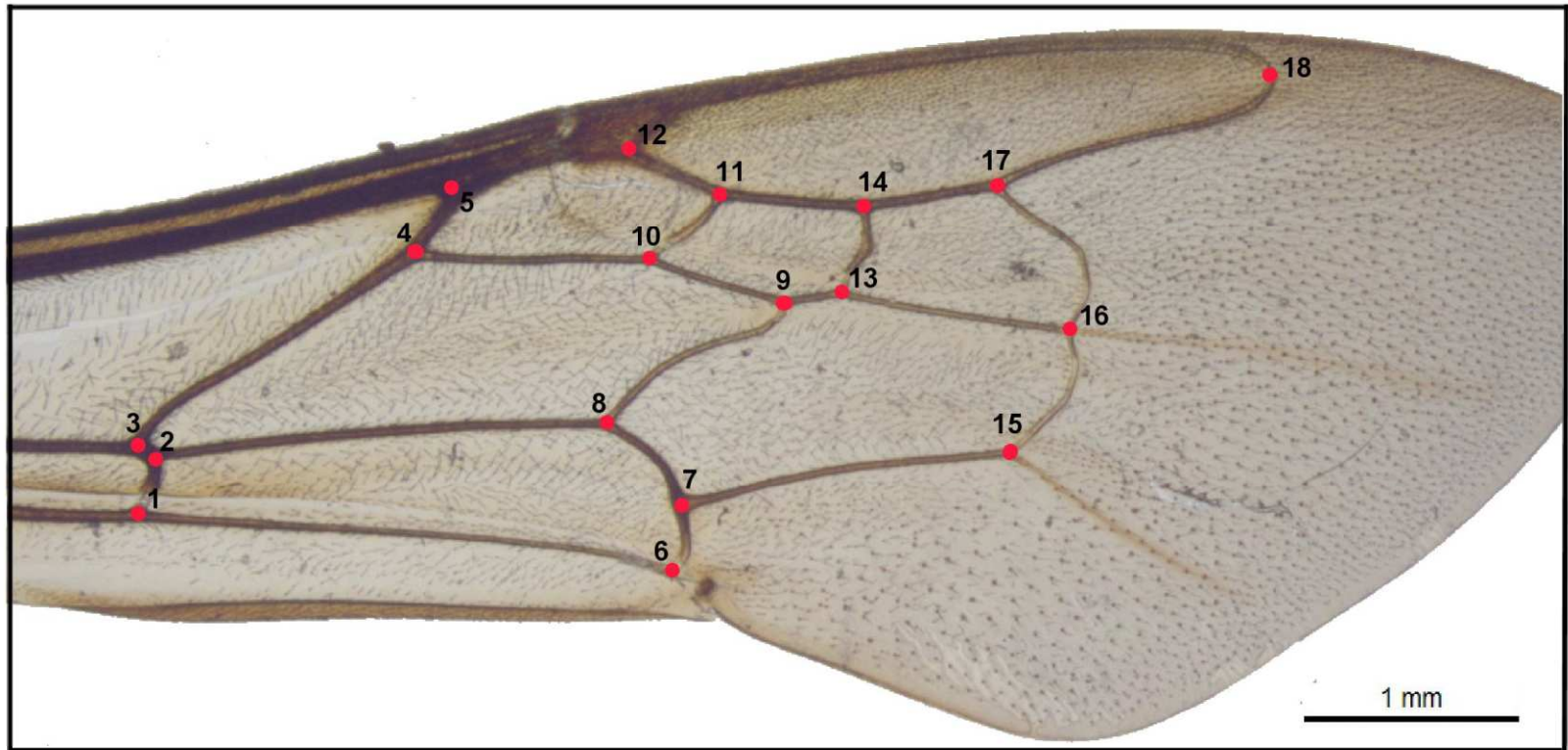
1. To investigate whether combining morphological information from landmark and outline-based methodologies could improve discrimination between species

Euglossini Bees

- Also known as orchid bees, are found exclusively in the Neotropics;
- Can represent up to 25% of the bee fauna;
- Important pollinators of natural ecosystems.
- Have a difficult taxonomy and identification of species is hard. This problem is slowly being diminished, but it is a long walk...



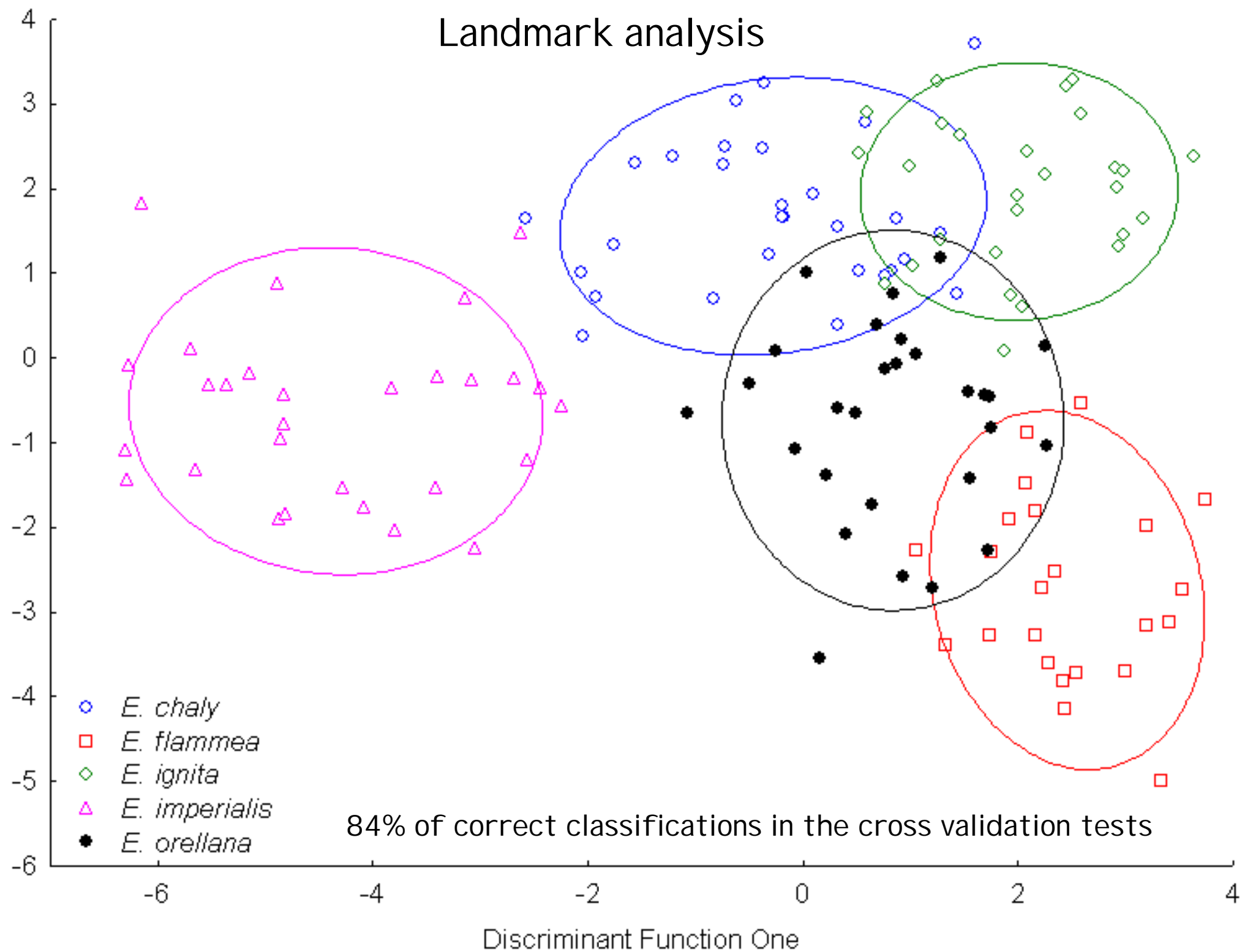
30 males from five closely related *Euglossa* species from Panama: *E. chalybeata*, *E. ignita*, *E. imperialis*, *E. Flammea* and *E. orellana*

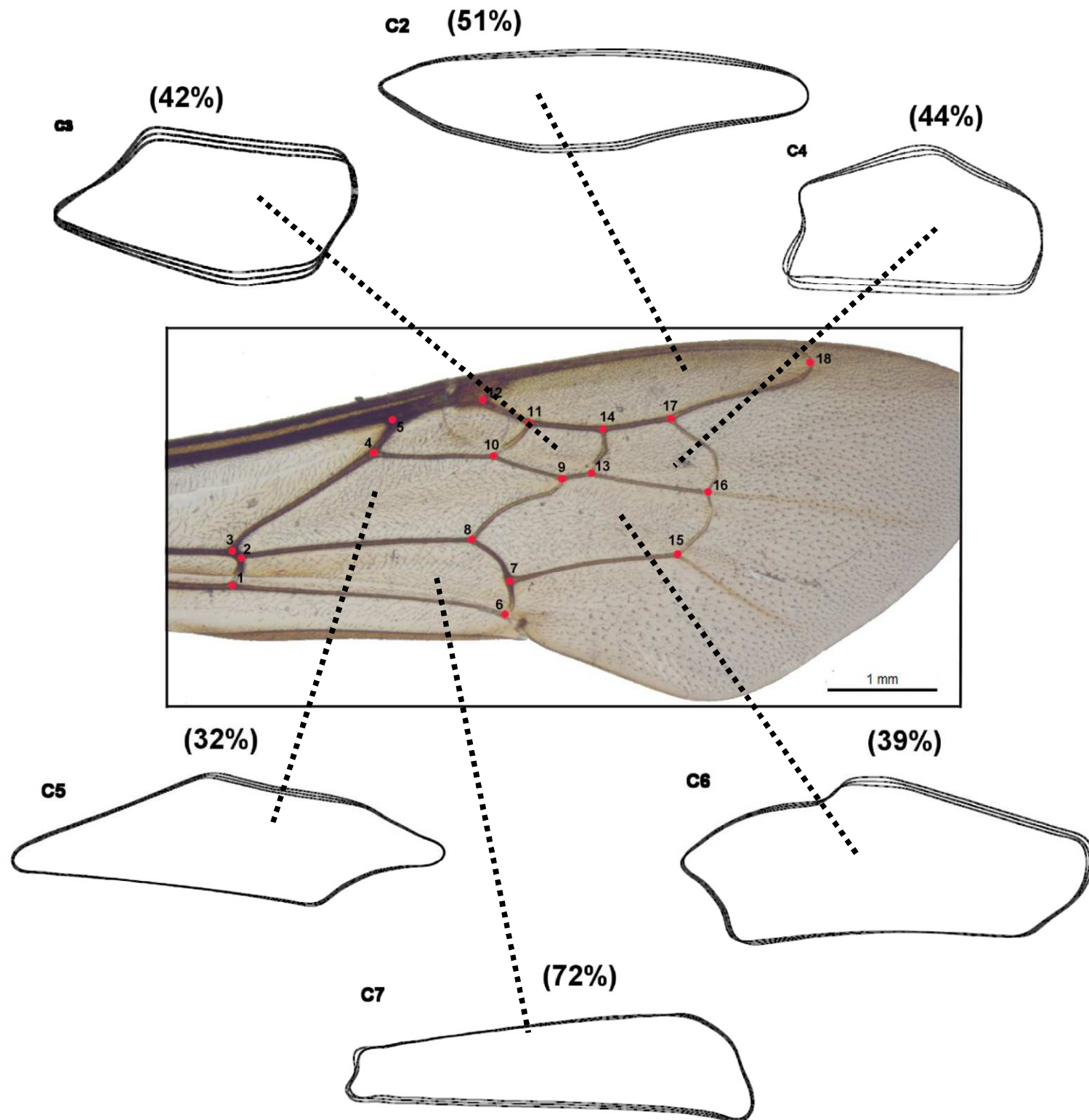


18 landmarks at the wing vein intersections in 30 male wings per species

Landmark analysis

Discriminant Function Two



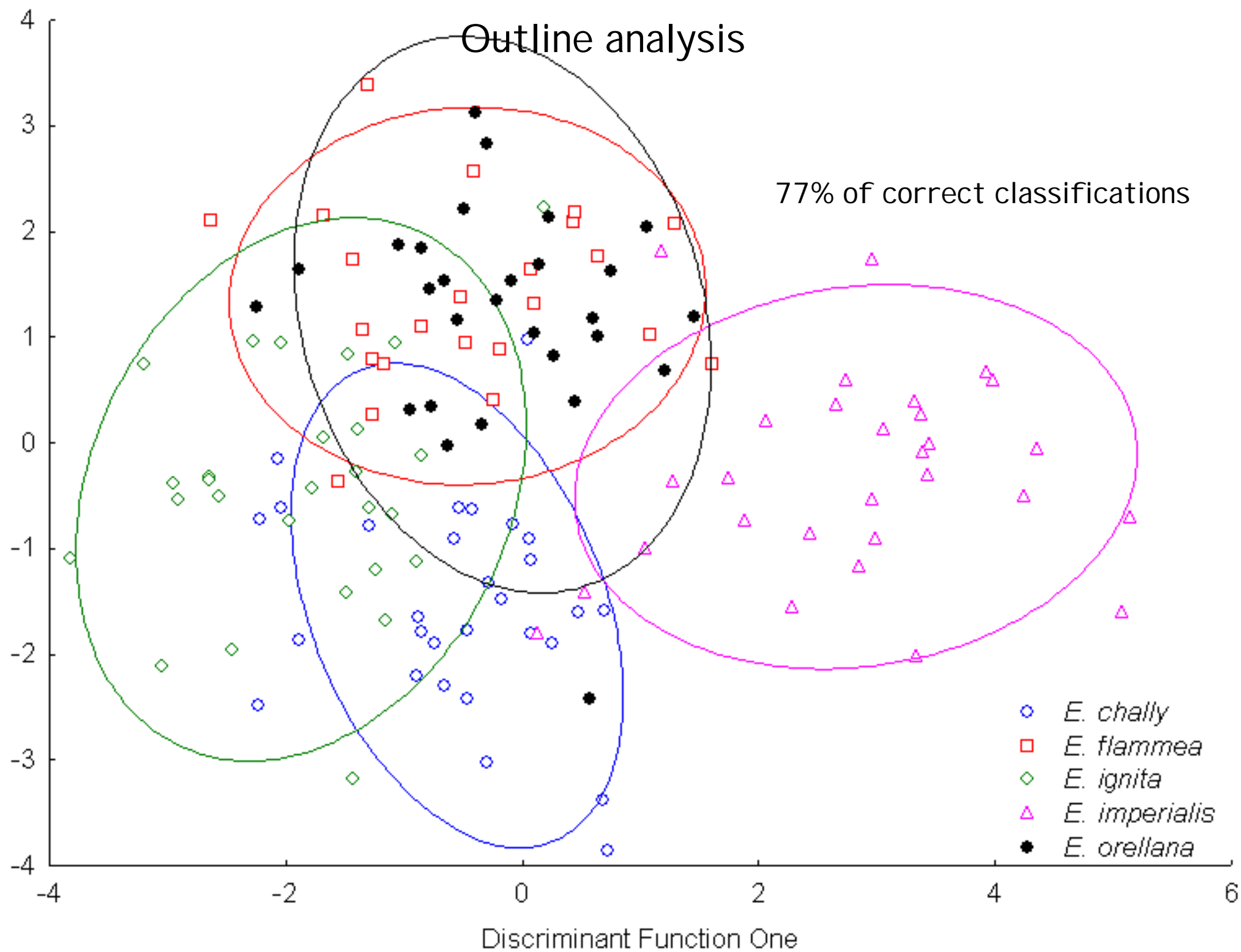


Wing cell	Number of PC (total variation explained)	Wilk's λ (p value)	Correct species Classification (CV)
Marginal	9 (91.85 %)	0.1192 (p < 0.0001)	74.46 (69,50)
2 nd submarginal	10 (92.08%)	0.0914 (p < 0.0001)	74.67 (70,00)
3 rd submarginal	9 (93.43%)	0.1480 (p < 0.0001)	70.92 (61,70)
1 st medial	11 (92.58%)	0.2545 (p < 0.0001)	60.87 (46,40)
2 nd medial	10 (92.25%)	0.1816 (p < 0.0001)	69.34 (55,50)
2 nd cubital	7 (93.02%)	0.1884 (p < 0.0001)	64.51 (58,90)
2 nd + 3 rd submarginal	11 (93,51%)	0,0574 (p < 0.0001)	83,60 (77,10)

Outline analysis

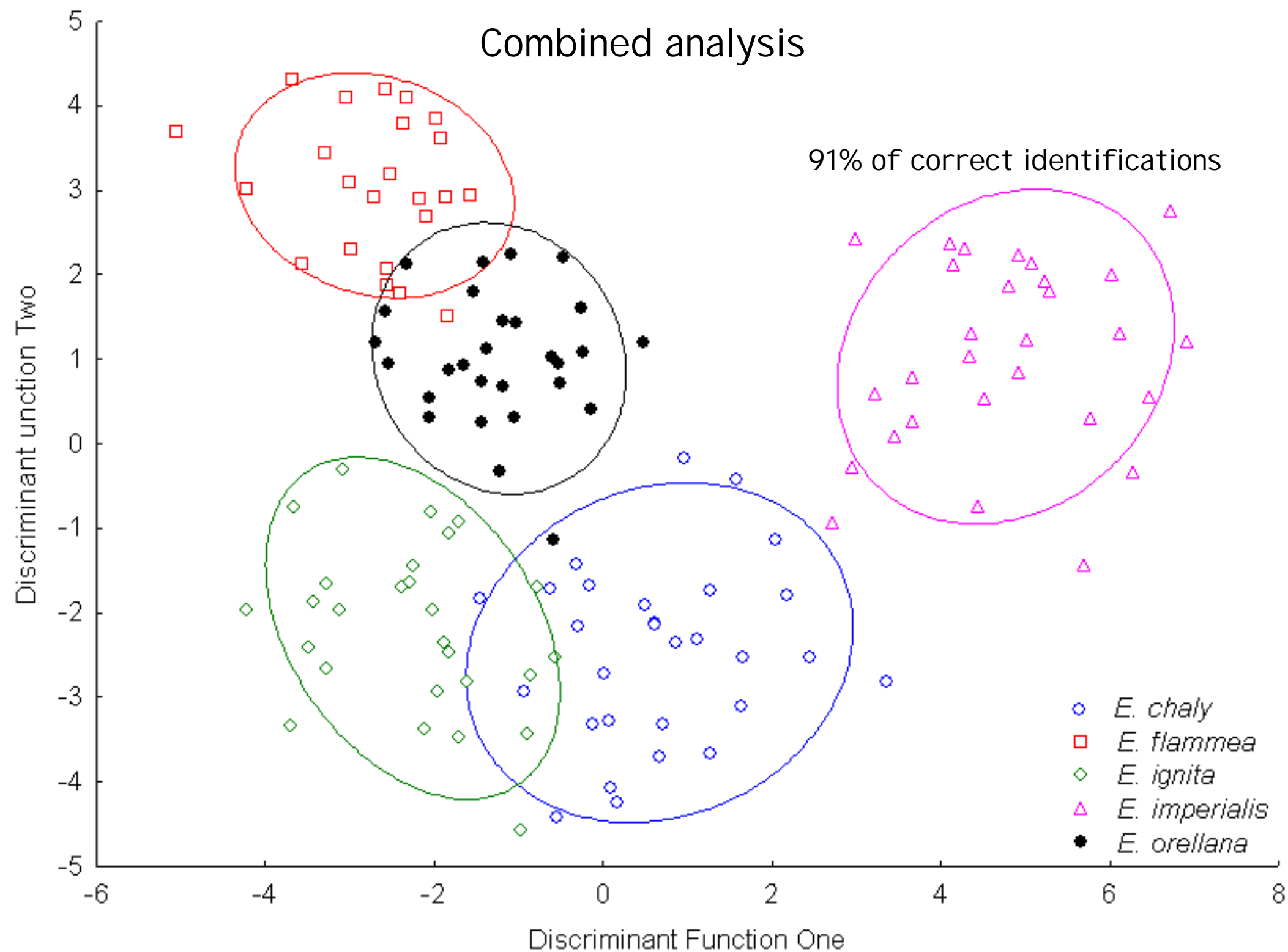
77% of correct classifications

Discriminant Function Two



Combined analysis

91% of correct identifications



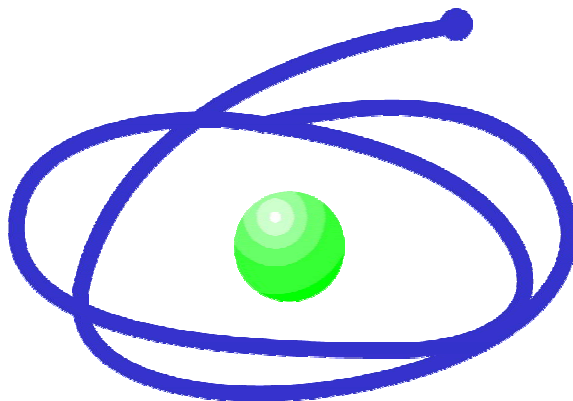
Main Conclusions

- Landmark and outline based methods are efficient at discriminating *Euglossa* species;
- The usage of outline based methods opens the possibility of analysing damaged wings;
- The combination of outline and landmark based methods considerably improves the identification rates;
- Geometric morphometrics is a powerful, inexpensive and fast tool to be used in species identification, leaving more costly molecular methods to be used only in doubtful cases.

Acknowledgements



EACH



C A P E S



Thanks for your kind attention

