

OP-091 [Bee Biology]

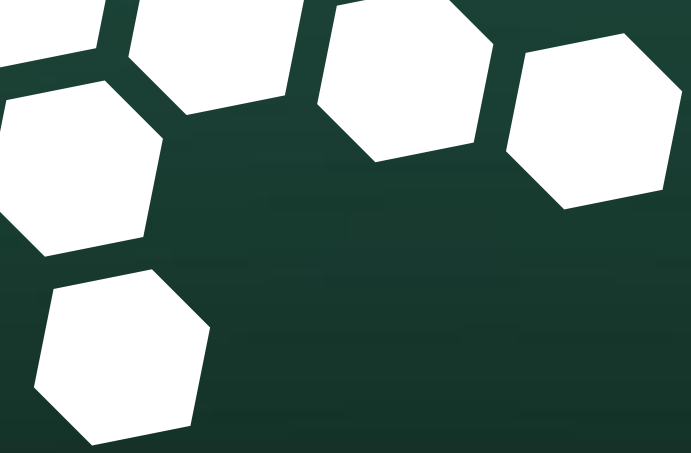
Morphometric and genetic diversity of Philippine stingless bees

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There are about 550 known species of stingless bees in the world (Grüter, 2020), where 61 are from Southeast Asia (Duangphakdee et al., 2024) and 12 are from the Philippines (Baltazar, 1966). The taxonomic classification of stingless bees based on morphological characters can often lead to a synonymous species. Thus, determining discriminatory morphometric characters for each species will be of great help for correct identification by other researchers in the future and proper assessment of the stingless bee diversity and conservation. To address these knowledge gaps, taxonomic profiling of Philippine stingless bees using morphological and molecular techniques was conducted. Samples of stingless bees were collected from 170 colonies in 26 localities in the Philippines. Characters (i.e., body, wing, leg length, and/or width) were measured, and the most discriminatory characters were determined using morphometric analysis. For the molecular part, 205 individuals were subjected to RAD seq, which resulted in several genetic clusters across the islands of the Philippines. This study has led to a proper assessment of the diversity and conservation of particular species and the establishment of a standardized method in stingless bee-keeping in a specific environment.



MORPHOMETRIC AND GENETIC DIVERSITY OF **PHILIPPINE STINGLESS BEES**

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49th APIMONDIA Congress / Copenhagen, Denmark / September 23-27, 2025



INTRODUCTION



1. *Heterotrigona erythrogastra* (Cameron, 1902)
Brunei, Indonesia, Malaysia, Philippines
2. *Lepidotrigona nitidiventris* (Smith, 1857)
Brunei, Indonesia, Malaysia, Philippines, Singapore, Thailand
3. *Lepidotrigona palavanica* (Cockerell, 1915)
Philippines
4. *Tetragonula biroi* (Friese, 1898) Cambodia, Indonesia, Philippines
5. *Tetragonula clypearis* (Friese, 1909)
Indonesia, Philippines
6. *Tetragonula dapitanensis* (Cockerell, 1925)
Philippines
7. *Tetragonula fuscobalteata* (Cameron, 1908)
Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam

8. *Tetragonula iridipennis* (Smith, 1854) Burma, Cambodia, Laos, Malaysia, Philippines, Thailand, Vietnam
9. *Tetragonula laeviceps* (Smith, 1857) Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam
10. *Tetragonula pagdeni* (Schwarz, 1939)
Cambodia, Malaysia, Philippines, Thailand, Vietnam
11. *Tetragonula sapiens* (Cockerell, 1911)
Indonesia, Philippines
12. *Tetragonula valdezi* (Cockerell, 1918) Brunei, Cambodia, Laos, Malaysia, Philippines, Singapore, Thailand



STINGLESS BEE-KEEPING IN THE PHILIPPINES



Tetragonula biroi



Tetragonula laeviceps OR
Tetragonula fuscobalteata

RESISTANCE TO PESTS
AND DISEASES

DIVERSE POPULATION

RICH IN GENETIC
POOL

ADAPTED TO THE
LOCAL ENVIRONMENT

BEST POLLINATORS OF
NATIVE PLANTS

RESILIENT TO
CLIMATE CHANGE

Philipp Ent 35 (1): 8-21	ISSN 0048-3753	January-June 2021
ECONOMICS OF THE STINGLESS BEE, <i>TETRAGONULA BIROI</i> (FRIESE), PRODUCTION IN THE PHILIPPINES		
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ABSTRACT		
This study evaluated the feasibility of establishing a stingless bee farm in the Philippines by calculating the Net Present Value (NPV), the Net Benefit Cost Ratio (BCR), the Internal Rate of Return (IRR), and the Payback Period (PP) of the honey, pot pollen, and propolis produced from five commercial melliponaries. Among the species of stingless bees present in the country, <i>Tetragonula biroi</i> Friese was selected because of its high productivity rates in terms of colony population build up and honey, pot pollen, and propolis production. Our survey from 2017 to 2019 revealed that stingless bee-keepers are spread in the three main island groups of the country, most of which are found on Luzon (n=1,969), followed by Mindanao (n=260) and Visayas (n=195). However, the present economic analysis was based only on five stingless bee yards that had over 1,000 colonies. Analysis showed that the investment yielded an NPV (USD 42,758) which is greater than zero, thus the investment is feasible. Likewise, the IRR is 21%, which is higher than the interest rate of 6% and as shown in the value of BCR (1.25) and PP of 2.91, the investment for stingless bee-keeping can be a sustainable enterprise in the Philippines.		
Key words: Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR), Payback Period (PP), Philippine stingless bee, <i>Tetragonula biroi</i>		

OBJECTIVES

To characterize the Philippine stingless bees through molecular and morphological techniques.

- **Molecular analysis**
- **Morphometric analysis**

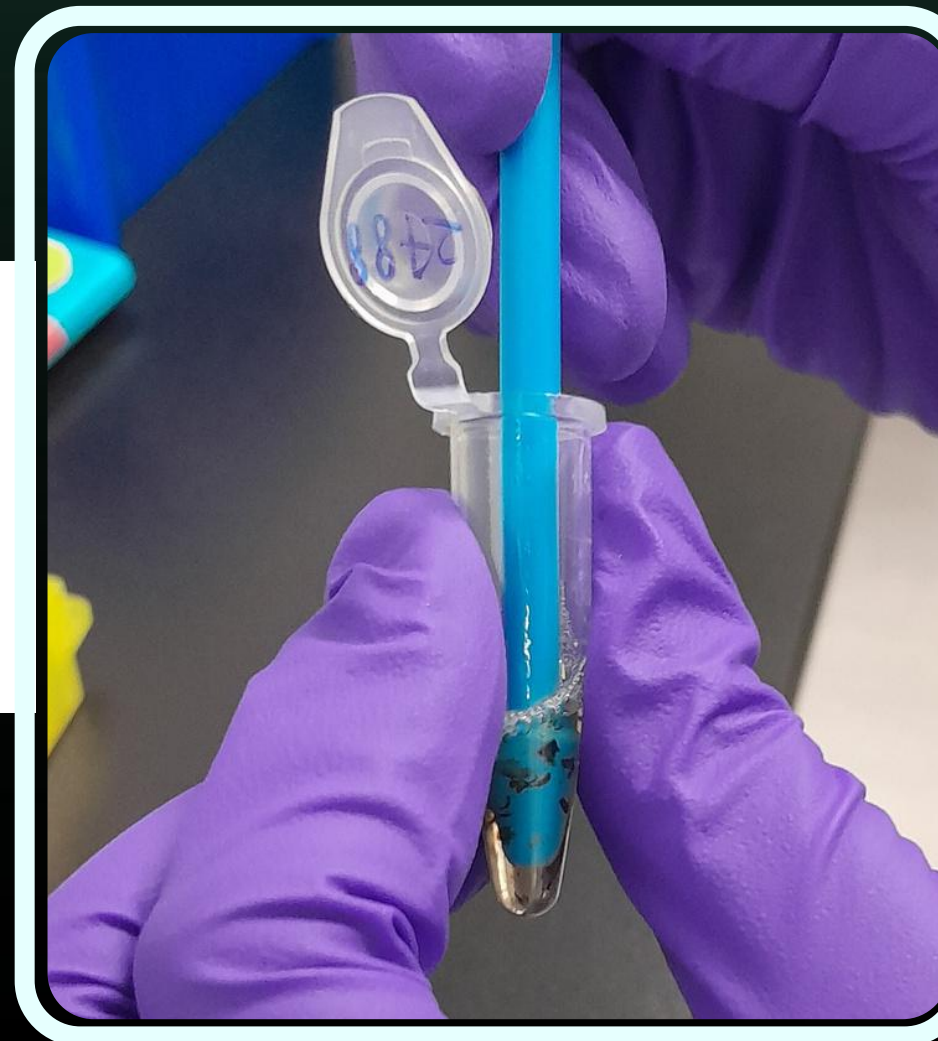


METHODOLOGIES

170 colonies



MOLECULAR



**Restricted site associated
DNA sequencing**

MORPHOLOGICAL



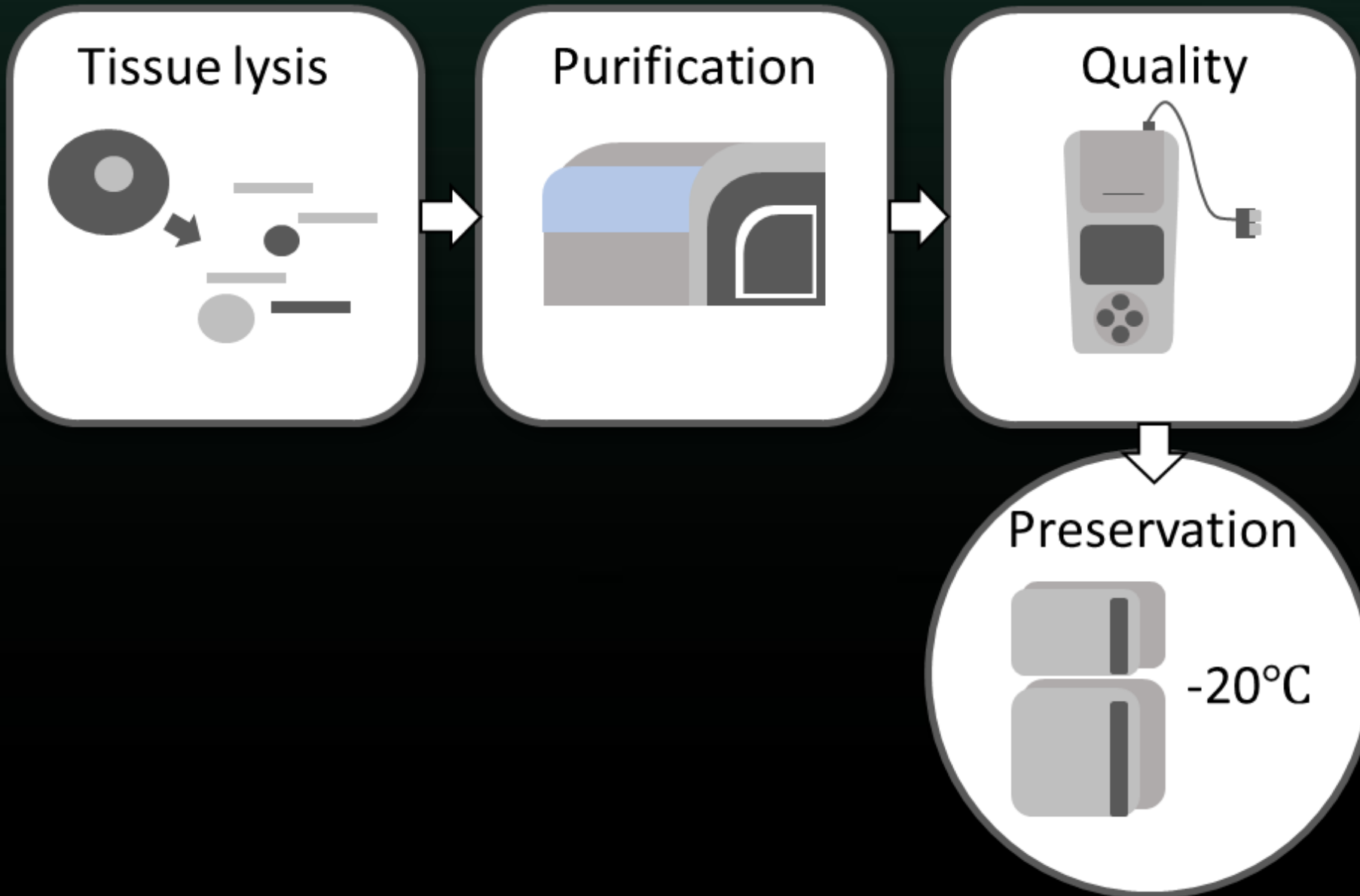
**Leica S8 AP0 equipped with
Nikon D5600 camera**

METHODOLOGY

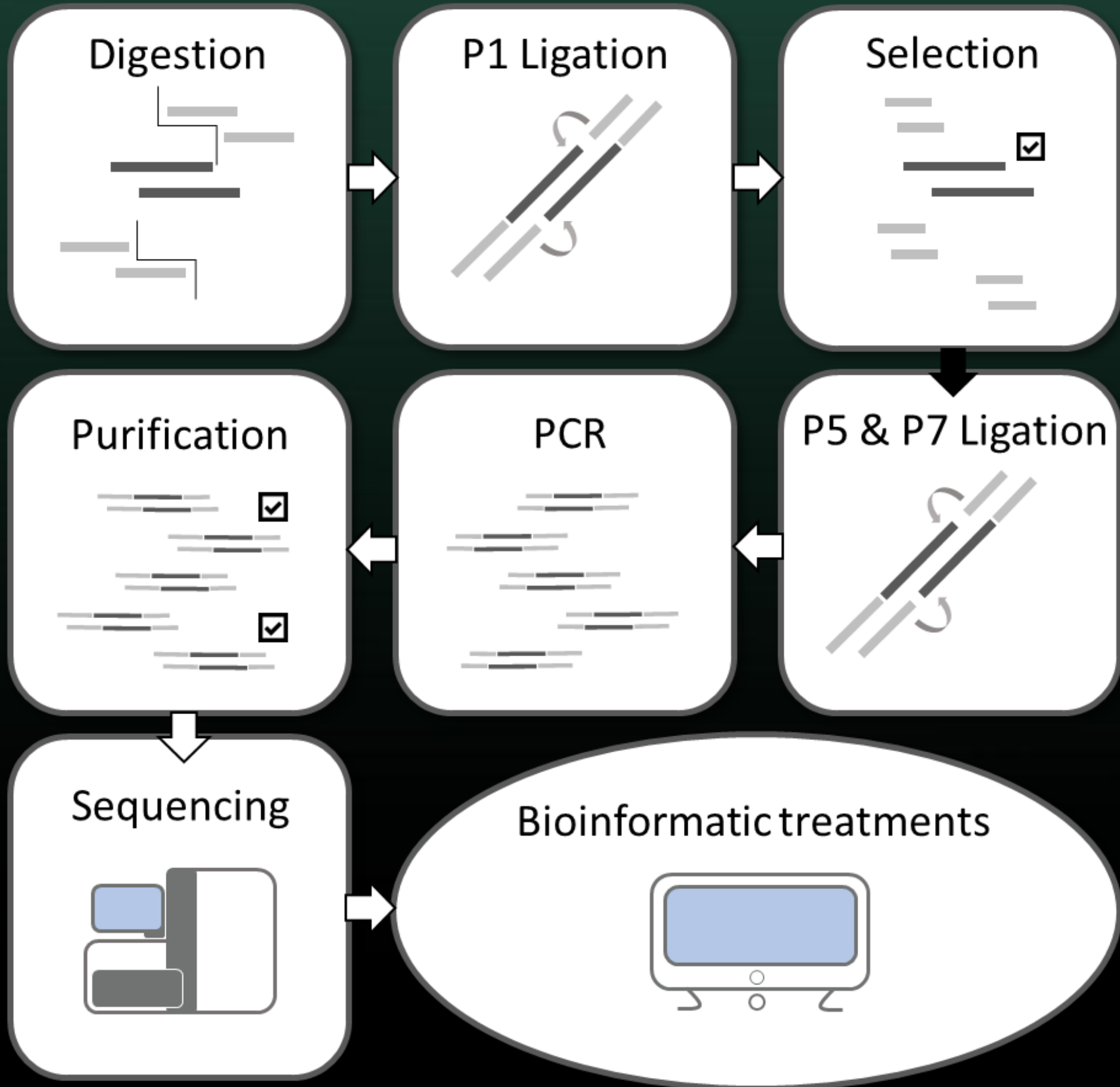
Molecular

Andolfatto et al., 2011

DNA extraction



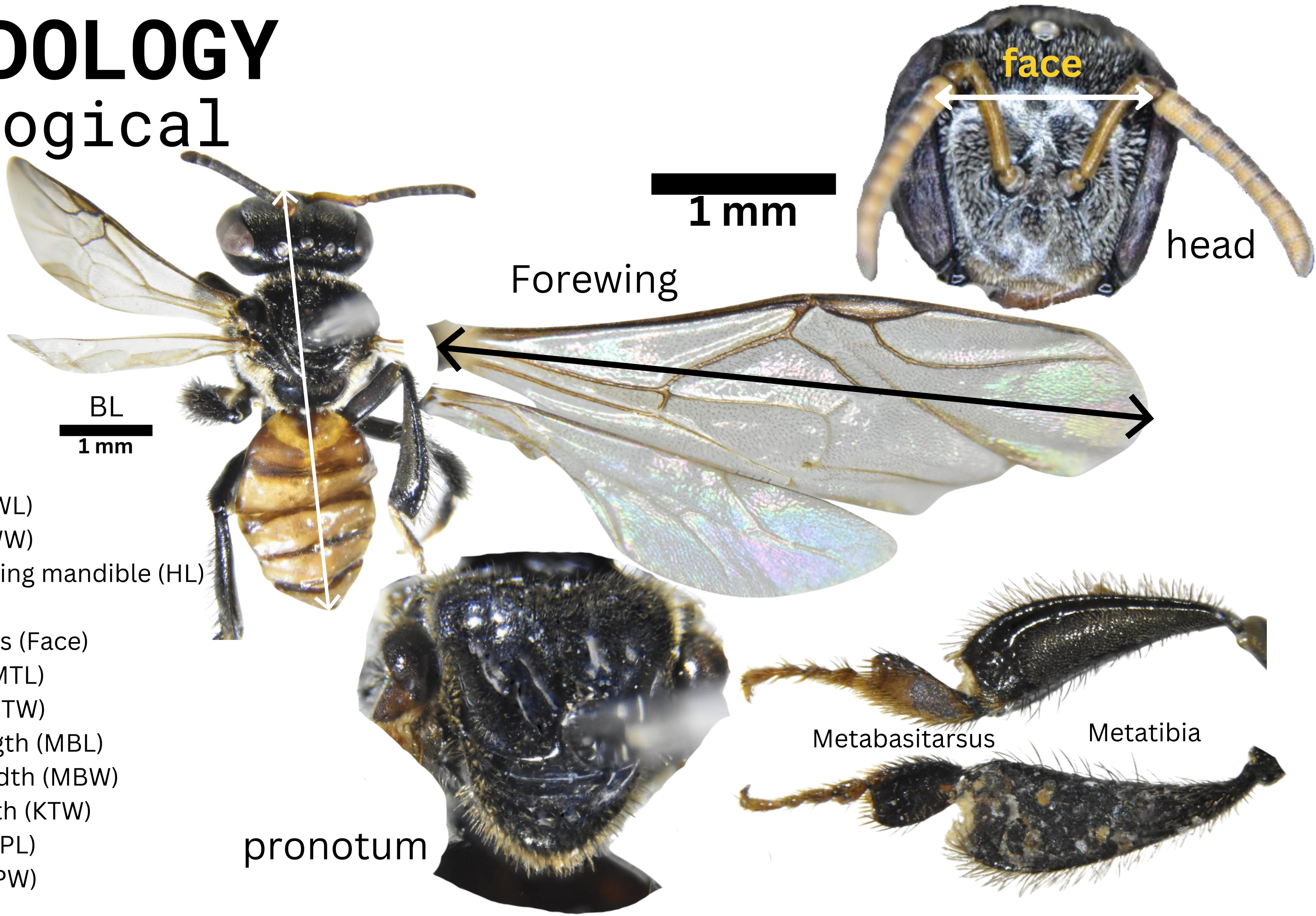
Paired-end RAD-seq library



METHODOLOGY

Morphological

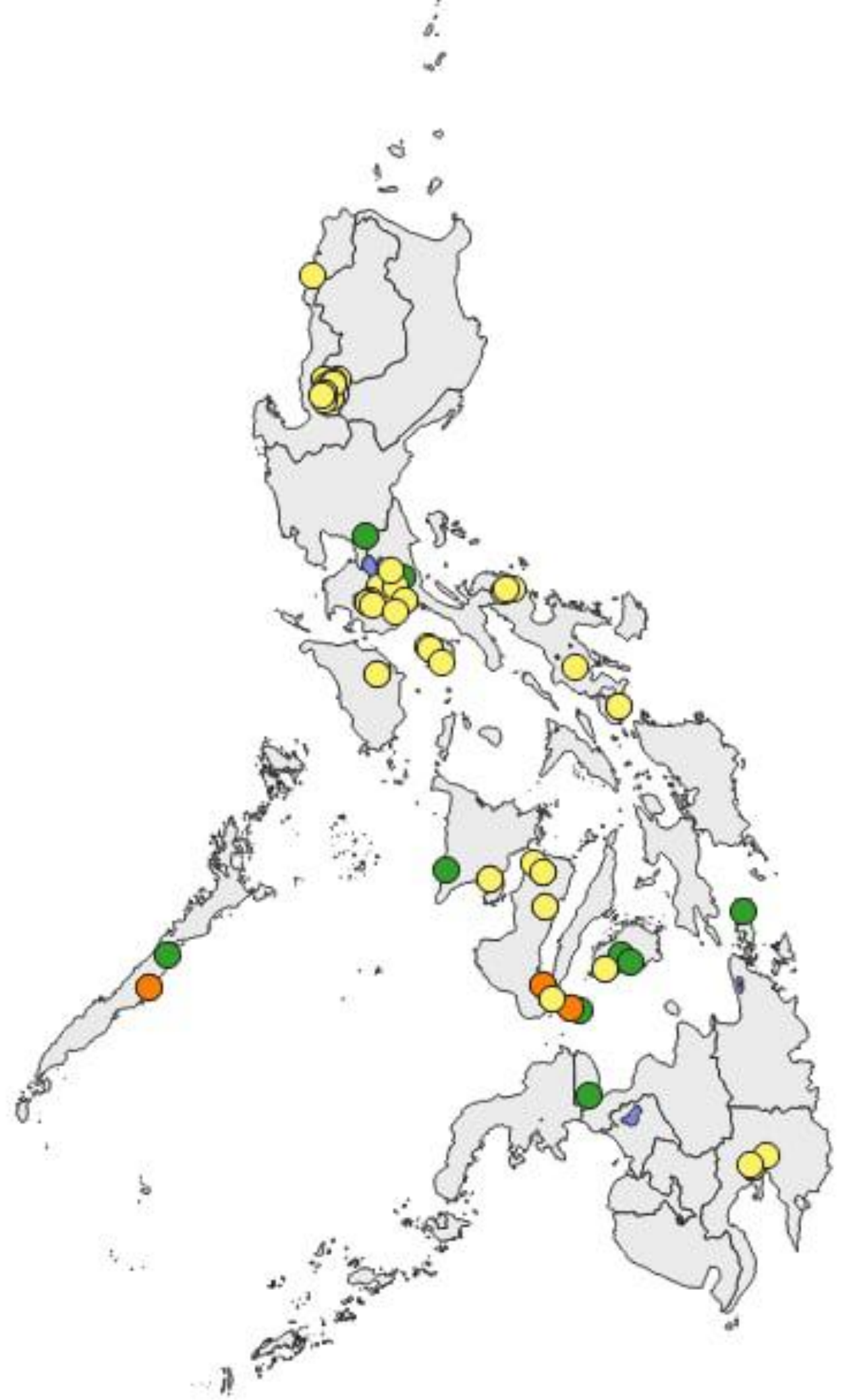
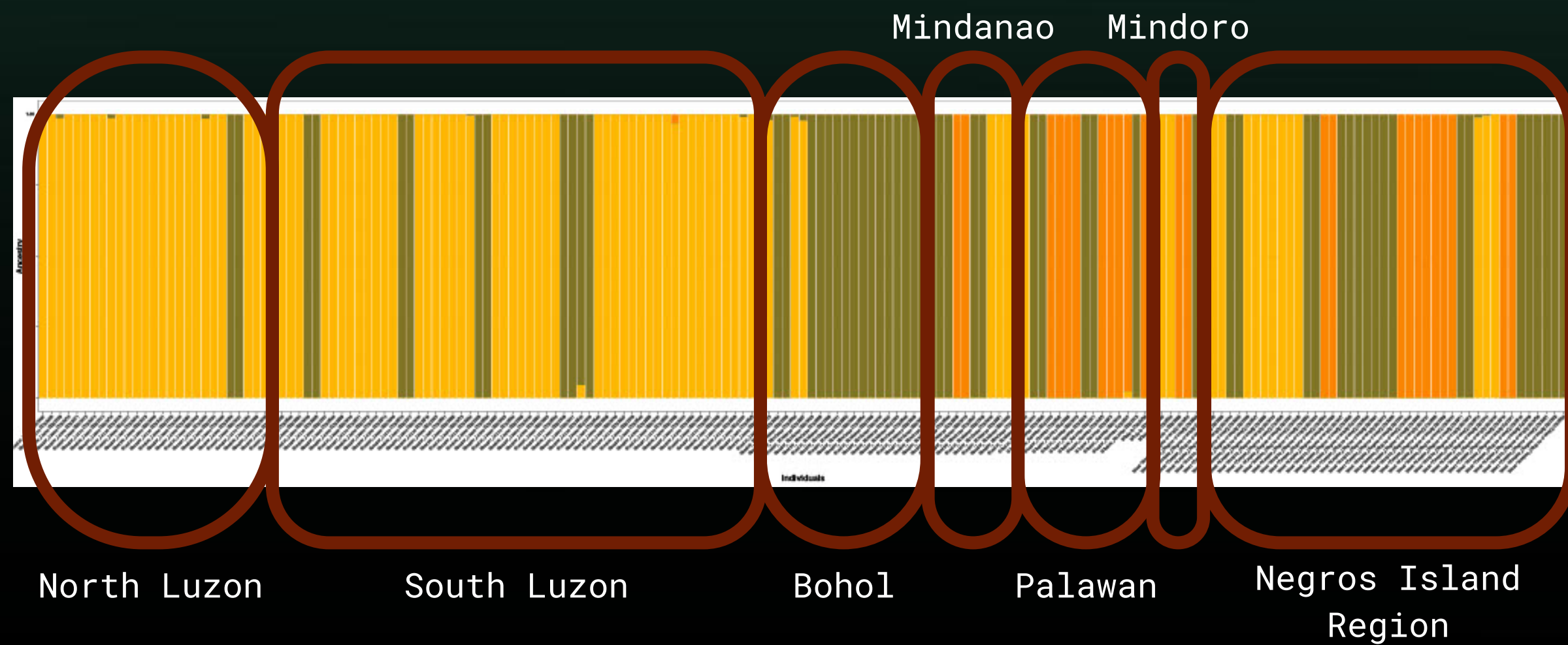
Engel et al., 2023, 2018;
Rasmussen et al., 2017



- 1.Body length (BL)
- 2.Forewing length (FWL)
- 3.Forewing width (FWW)
- 4.Head length excluding mandible (HL)
- 5.Head width (HW)
- 6.Width between eyes (Face)
- 7.Metatibial length (MTL)
- 8.Metatibial width (MTW)
- 9.Metabasitarsal length (MBL)
- 10.Metabasitarsal width (MBW)
- 11.Keirottrichiate width (KTW)
- 12.Pronotum length (PL)
- 13.Pronotum width (PW)

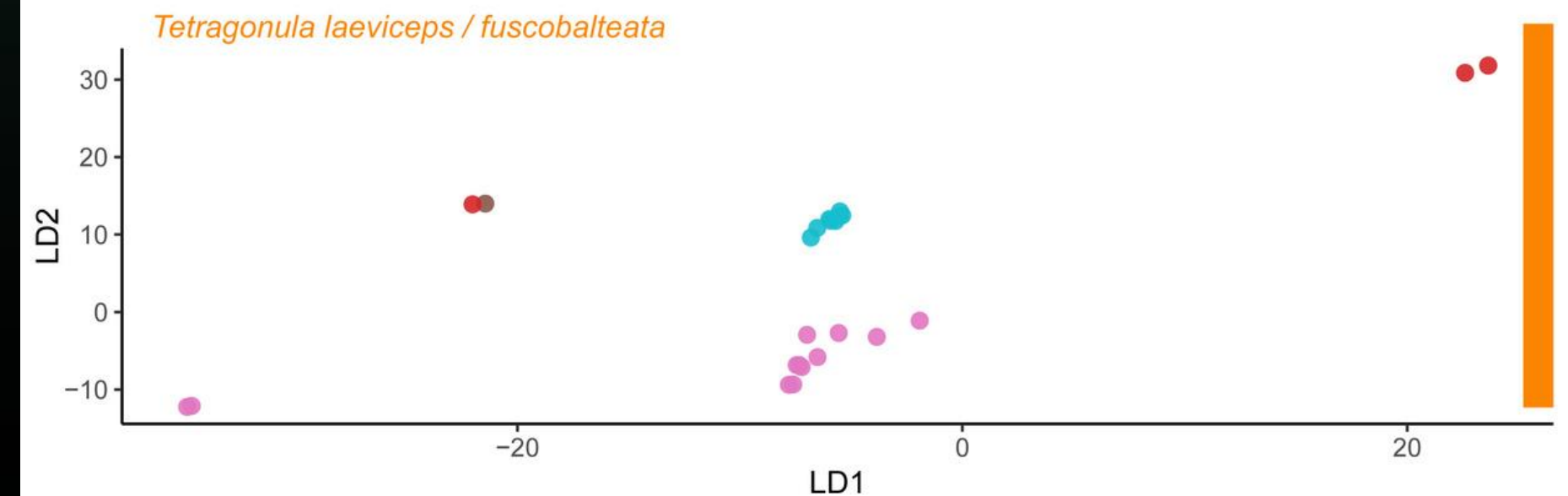
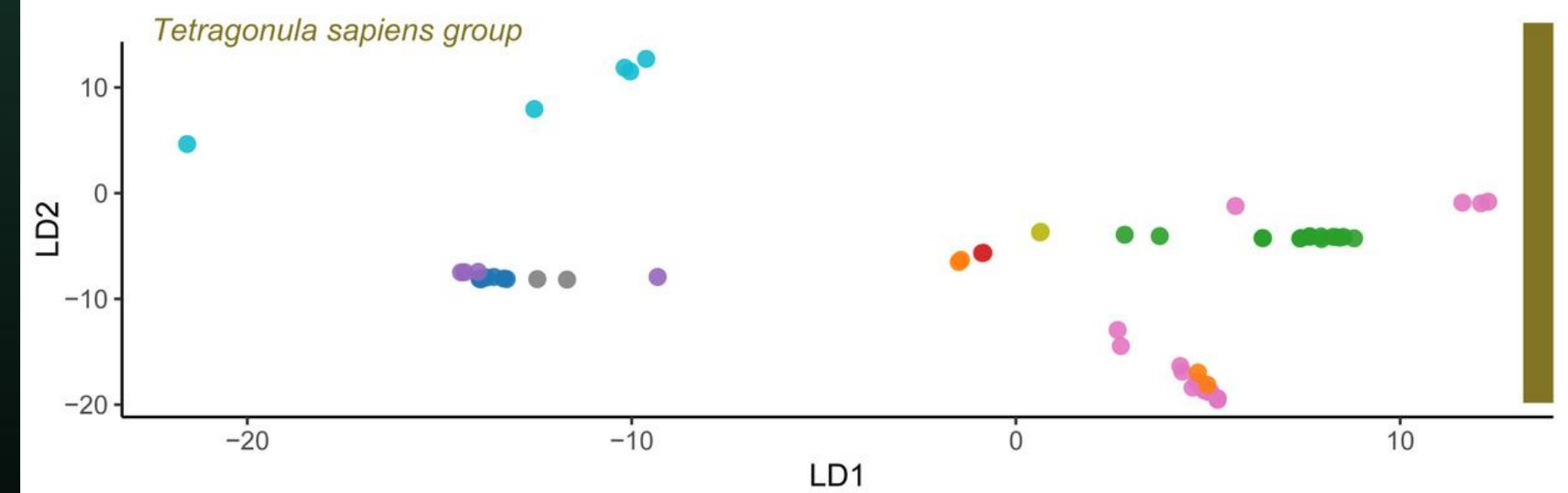
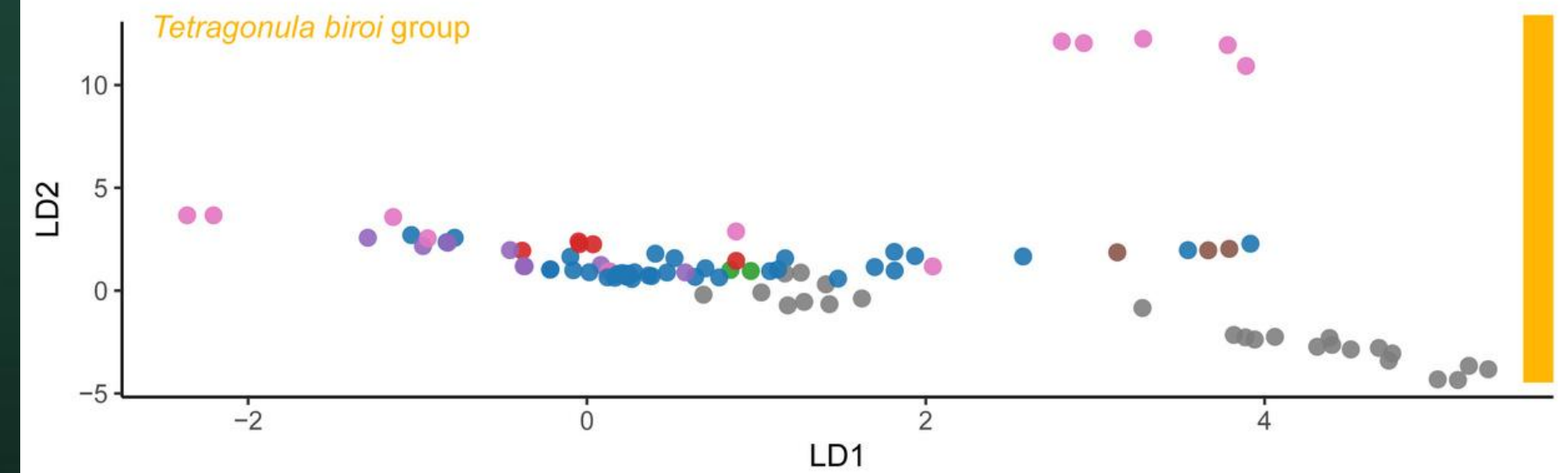
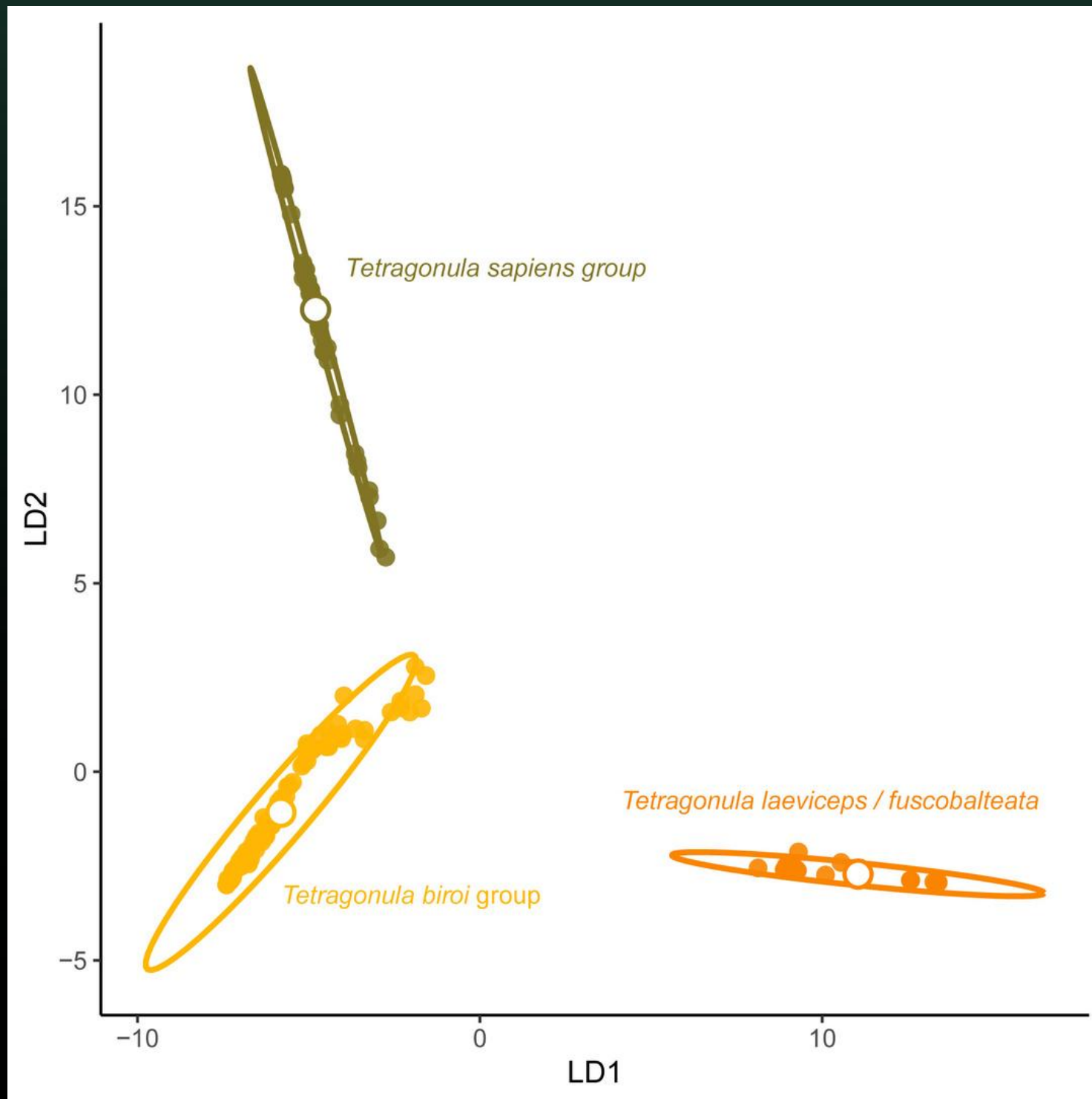
RESULTS

RAD-seq analysis



RESULTS

RAD-seq analysis

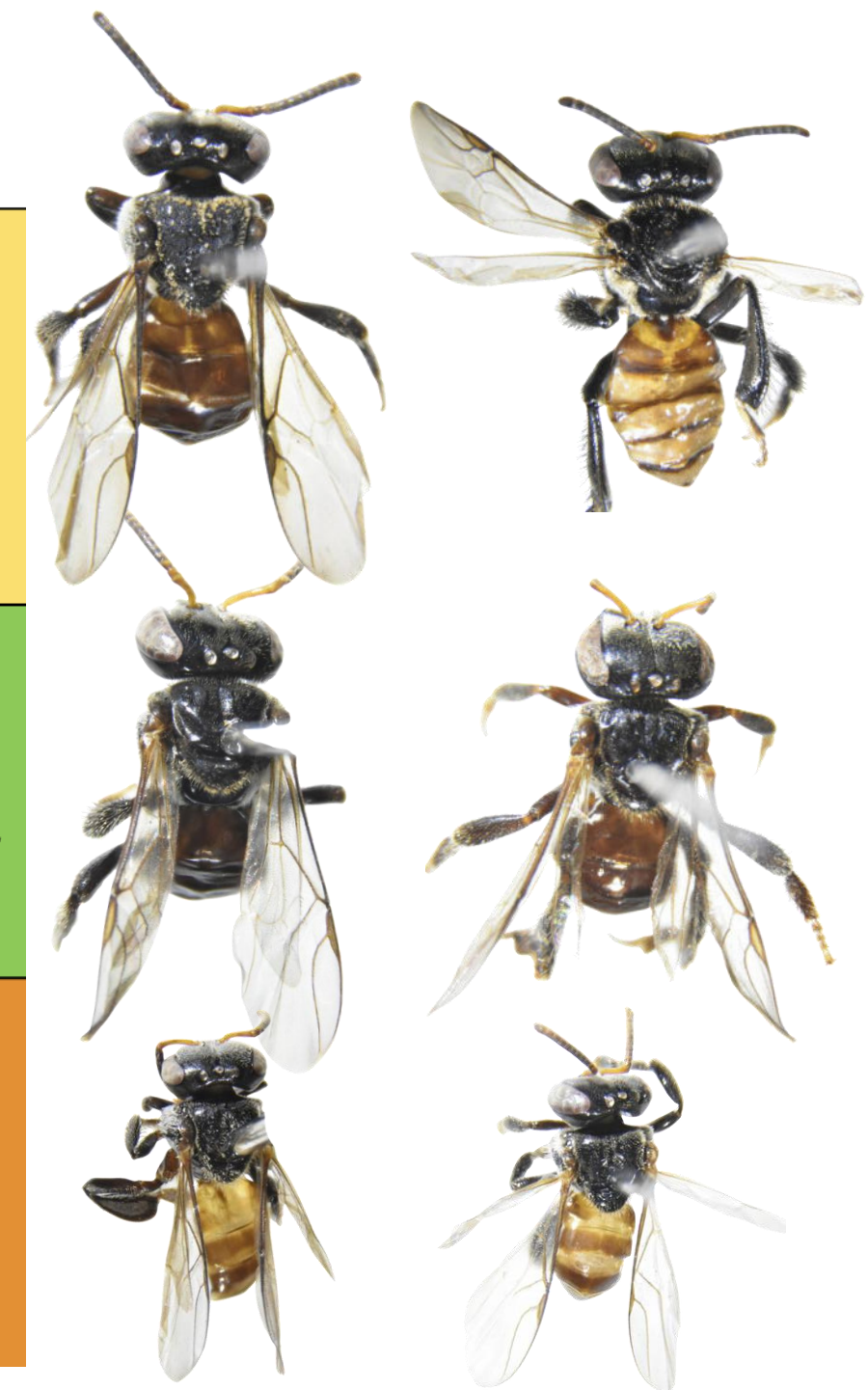


- Bicol Region
- Davao Region
- Negros Island Region
- Palawan
- CARAGA
- Marinduque
- North Luzon
- South Luzon
- Central Visayas
- Mindoro
- Northern Mindanao
- West Visayas

RESULTS

Morphometric analysis

SPECIES GROUP	BL	FWL	FWW	HL	HW	FACE	MTL	MTW	MBL	MBW	KTW	PL	PW	Characters
<i>Tetragonula biroi</i> group [YELLOW] (n=34)	4.11 ± 0.37	3.92 ± 0.23	1.30 ± 0.12	1.41 ± 0.11	1.73 ± 0.09	1.28 ± 0.06	1.59 ± 0.09	0.56 ± 0.06	0.55 ± 0.07	0.35 ± 0.03	0.29 ± 0.03	1.28 ± 0.10	1.15 ± 0.07	head and pronotum black, abdomen orange to brown with brown or black linings; pronotum with yellow to orange margin
<i>Tetragonula sapiens</i> group [GREEN] (n=31)	3.98 ± 0.25	3.96 ± 0.22	1.24 ± 0.16	1.51 ± 0.14	1.88 ± 0.10	1.29 ± 0.06	1.68 ± 0.14	0.59 ± 0.05	0.58 ± 0.07	0.35 ± 0.04	0.28 ± 0.04	1.37 ± 0.09	1.20 ± 0.10	dominant black, abdomen sometimes orange to brown; pronotum with white or yellow margin
<i>Tetragonula laeviceps/fuscobalteata</i> group [ORANGE] (n=16)	3.61 ± 0.22	3.51 ± 0.23	1.11 ± 0.14	1.30 ± 0.12	1.60 ± 0.12	1.15 ± 0.06	1.41 ± 0.10	0.51 ± 0.03	0.46 ± 0.04	0.28 ± 0.03	0.22 ± 0.03	1.14 ± 0.10	1.04 ± 0.12	head and pronotum black; abdomen yellow to orange sometimes with brown linings; pronotum sometimes with white or yellow margin



***T. biroi* Group**

1 mm

Los Baños
South Luzon

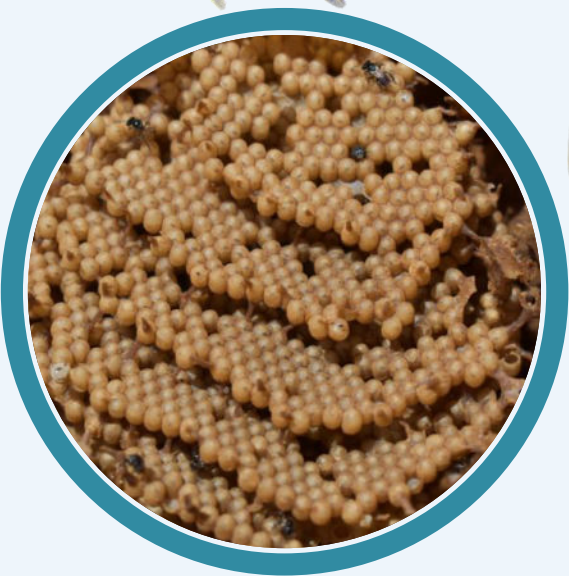
Sorsogon
Bicol Region

Canlaon
West Visayas

Pakil
South Luzon

Benguet
North Luzon

Tagum
Mindanao



***T. sapiens* Group**

1 mm

Bacolod

West Visayas

Caliraya

South Luzon

Palawan

Quezon Province

South Luzon

Davao

Mindanao

Bulacan

North Luzon

Marinduque

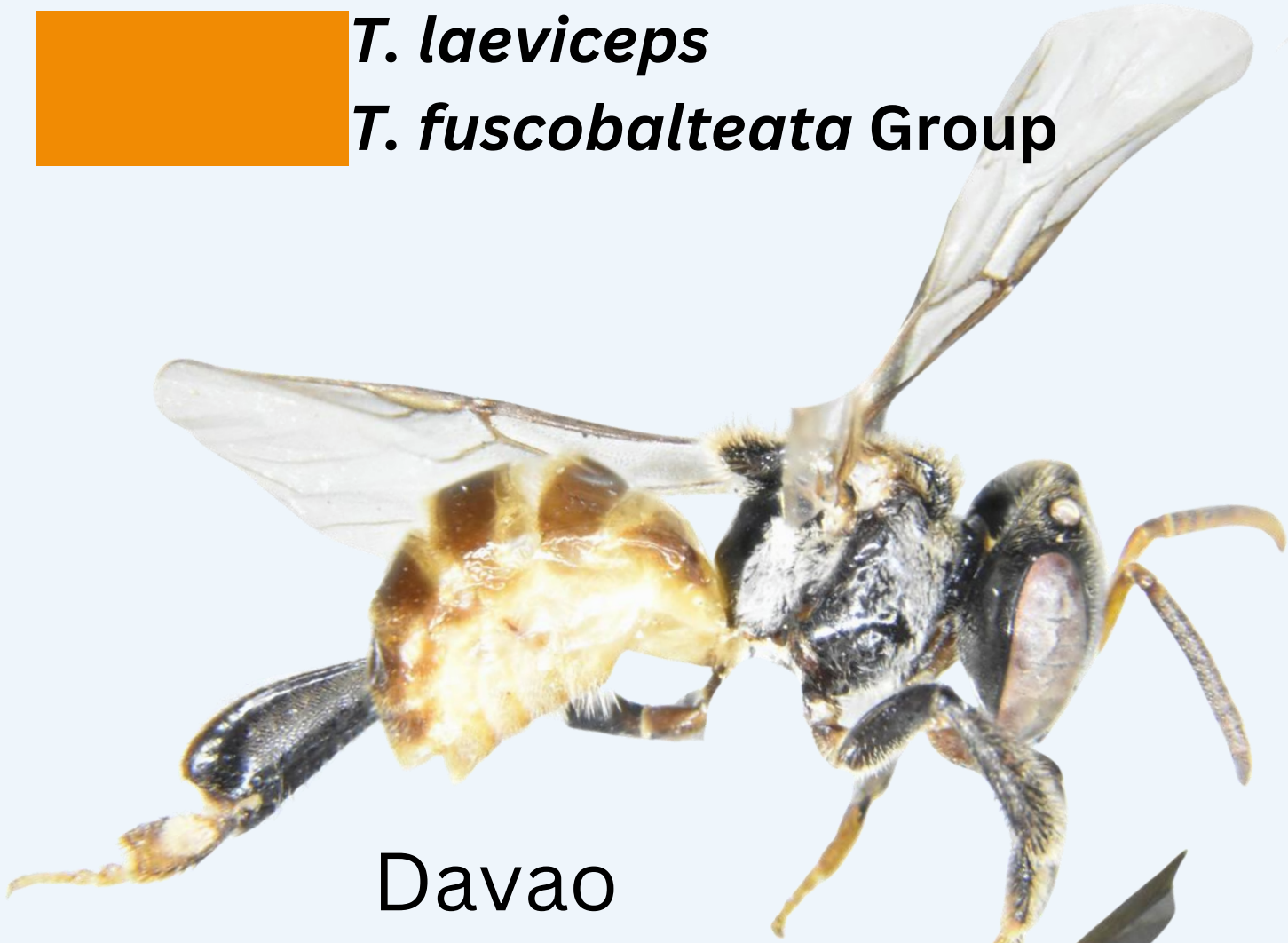
South Luzon



T. laeviceps

T. fuscobalteata Group

1 mm



Davao
Mindanao



Gawahon
Western Visayas



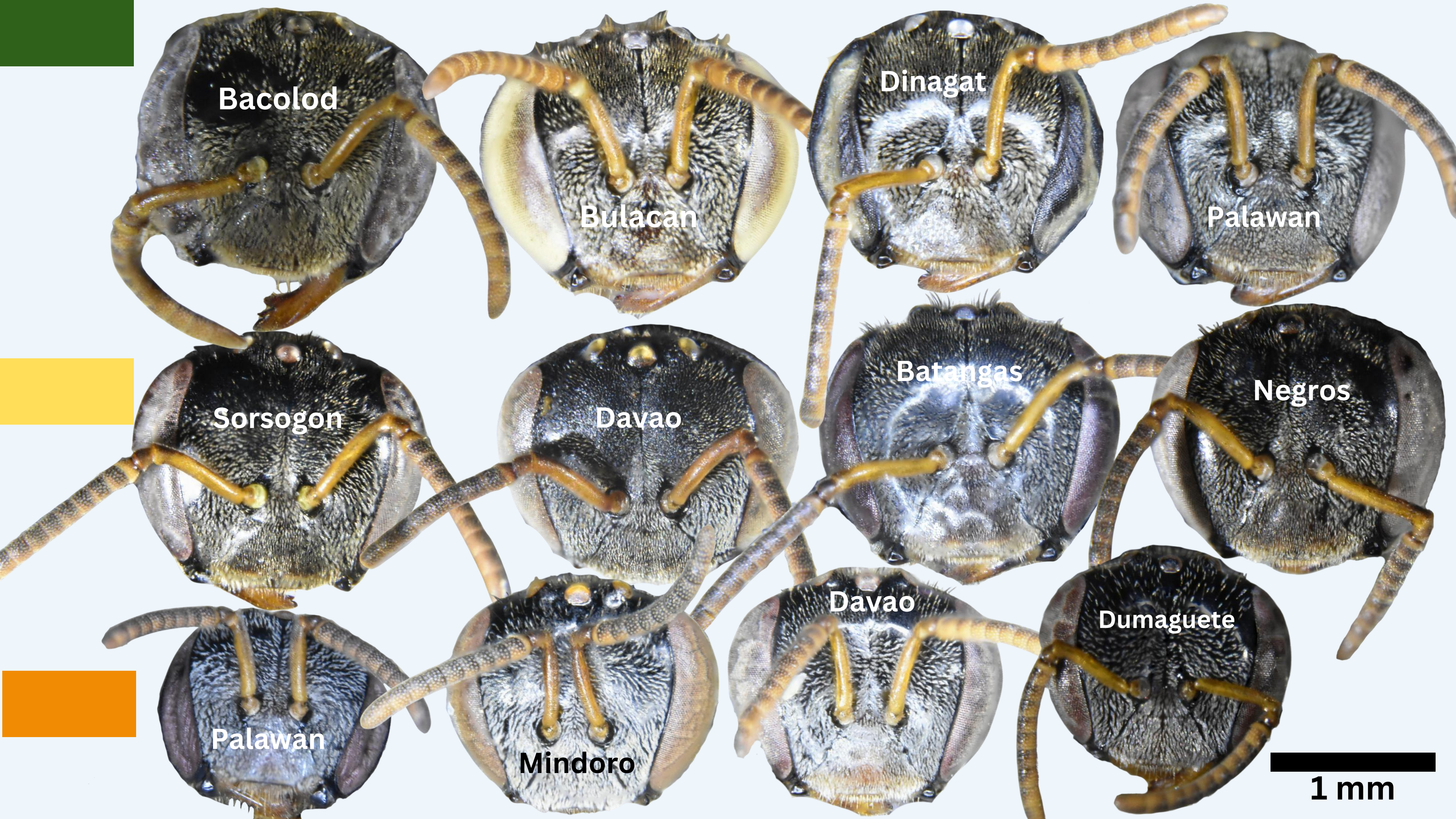
Siquijor
Western Visayas



Palawan



Dumaguete
Western Visayas



Bacolod

Bulacan

Dinagat

Palawan

Sorsogon

Davao

Batangas

Negros

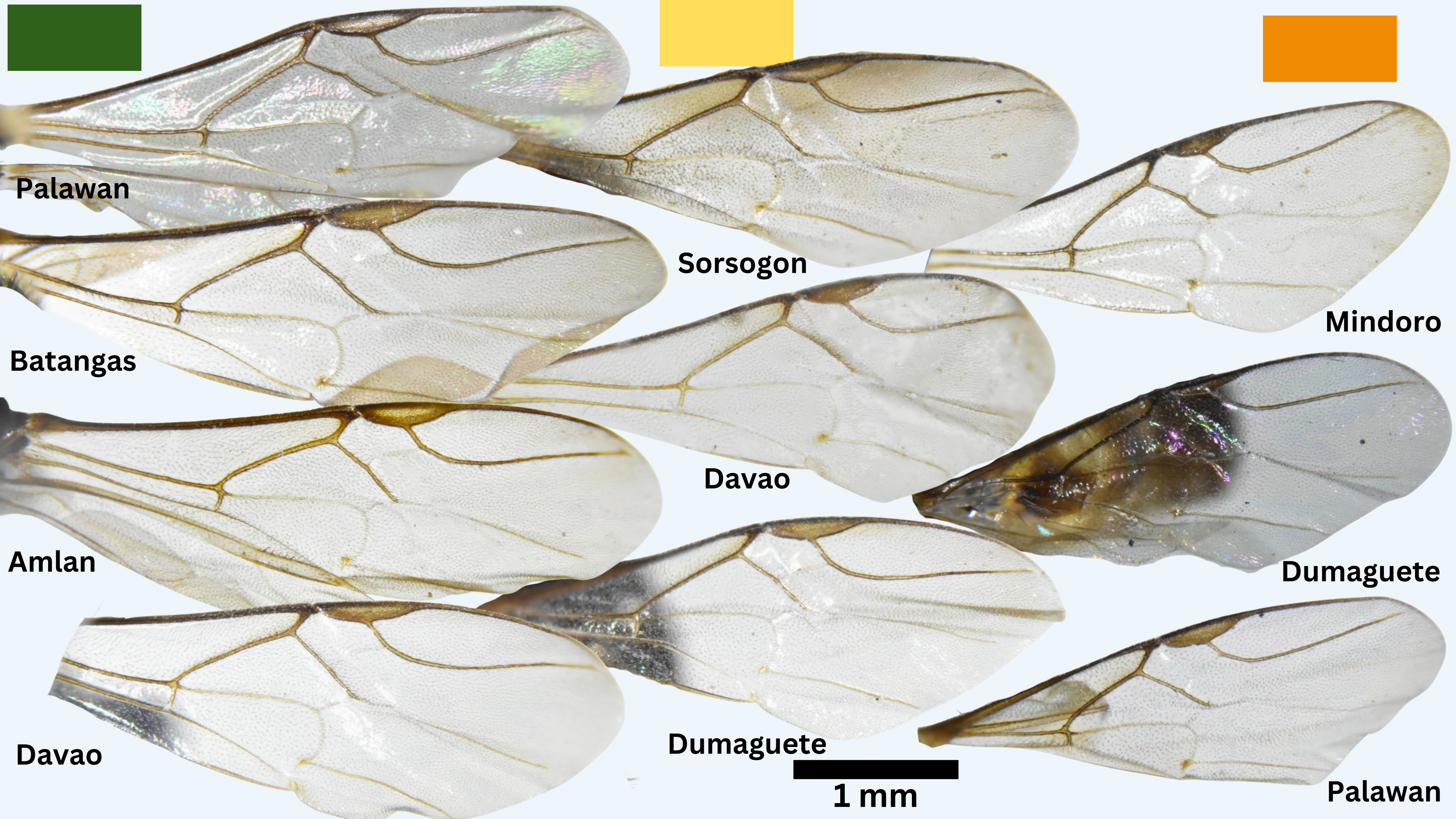
Palawan

Mindoro

Davao

Dumaguete

1 mm



Palawan

Sorsogon

Mindoro

Batangas

Davao

Dumaguete

Amlan

Dumaguete

Davao

Palawan

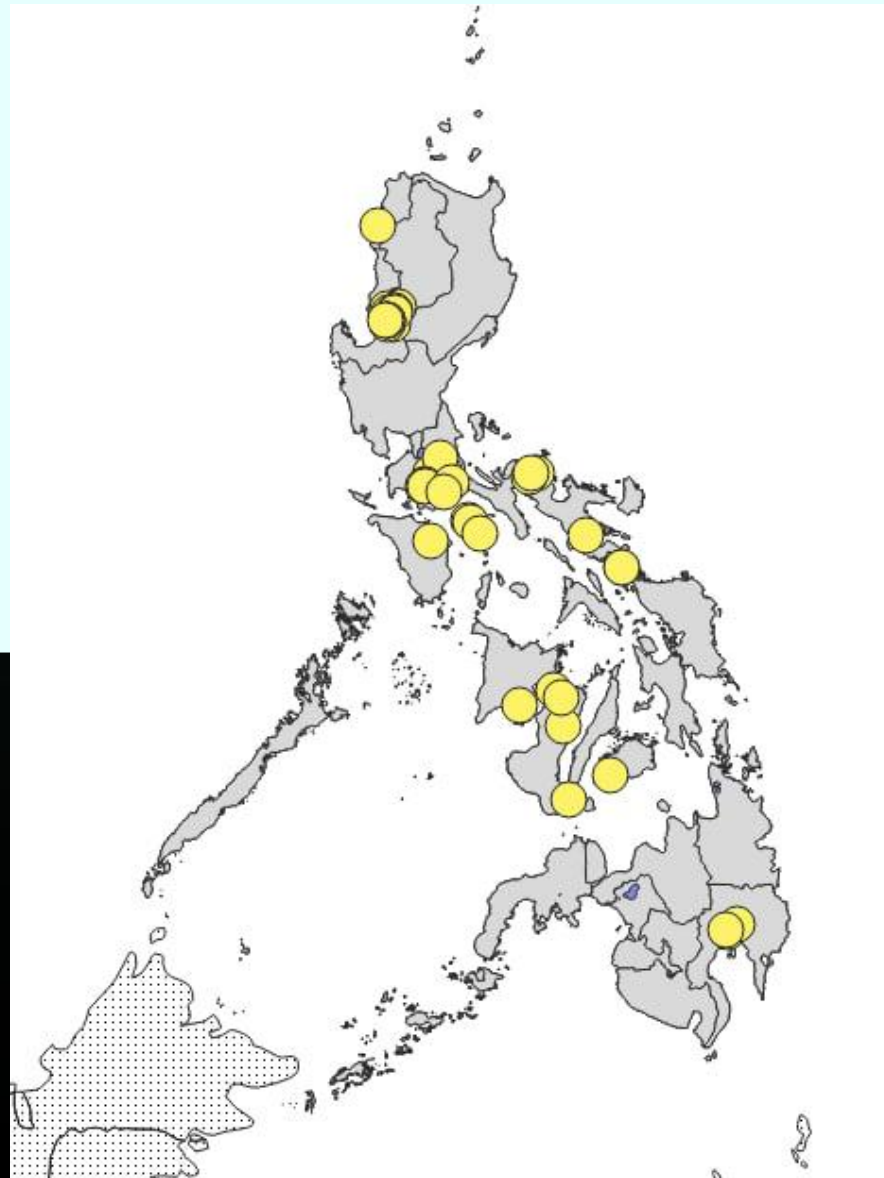
1 mm



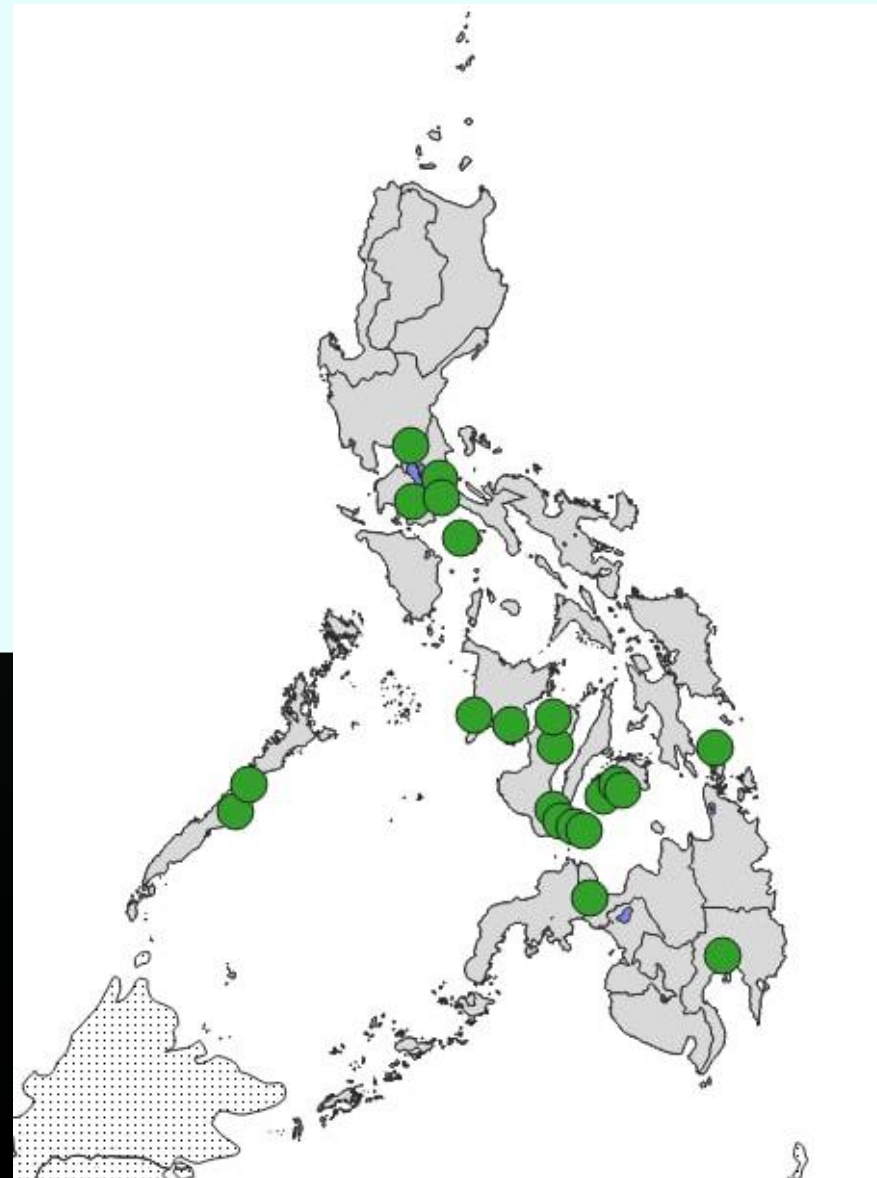
1 mm

DISTRIBUTION

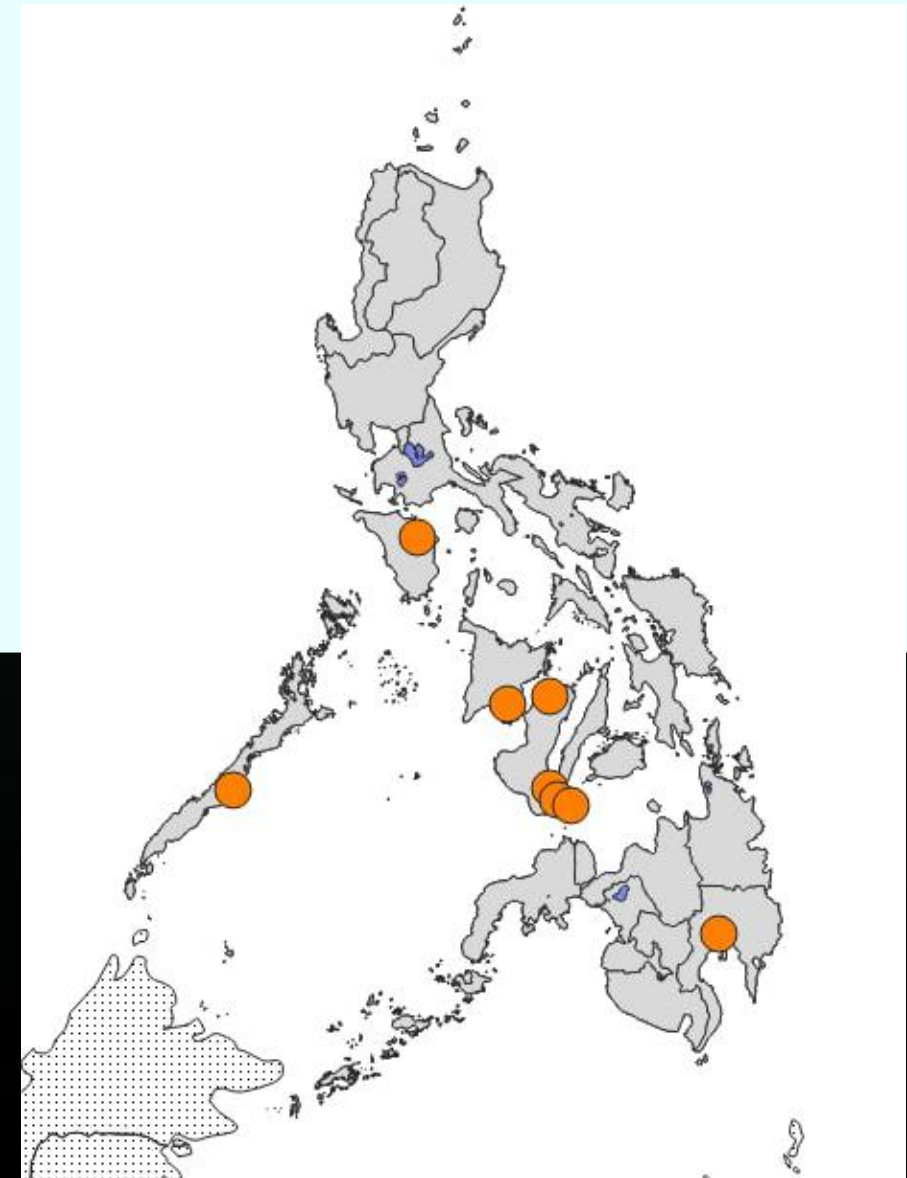
T. biroi Group



T. sapiens Group



T. laeviceps/
fuscobalteata Group



WAYS FORWARD

1. More sb collections
2. Update the taxonomy of the Philippine stingless bees (complex *Tetragonula* spp., *Heterotrigona eryhtrogaster*, *Lepidotrigona palavanica*)
3. Describe species new to science (Philippine *T. biroi*)





REPS Development Fund



Ecology and Evolution
Genomics Laboratory



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Education Division, Taipei Economic and Cultural Office in the Philippines

**TAIWAN EXPERIENCE
EDUCATION PROGRAM**



國家科學及技術委員會
National Science and Technology Council



ADAPTOR
GENOMIC SCIENCES LTD.



Donald Luna (distribution map)

Korawat Attassoppa (*Lepidotrigona* spp.)

John Ascher (*Lepidotrigona palavanica*)

Michael Engel (*Tetragonula biroi*)

THANK YOU



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