

# MOLECULAR PHYLOGENETICS

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B5791  
SSD: BIO/05

MSc in Bioinformatics  
academic year 2025 - second semester

6 CFUs  
64 hours in 20 classes

# THE TEACHER

**Giobbe Forni**

Department of Biological, Geological, and Environmental Sciences

Via Selmi 3 - Natural History museum, Second floor on the right

room ???! ... just ask at the entrance

[giobbe.forni2@unibo.it](mailto:giobbe.forni2@unibo.it)

If I do not answer to your email within 48h ... **PLEASE** write to me again 😊

*"I always start my classes by telling students about a Talmudic dictum on the correct way to learn and the correct way to teach:*

***"The shy cannot learn and the strict cannot teach"***

*In other words, I beg my students:*

*Please interrupt.*

*Please ask questions.*

*Please identify mistakes and let me know that I have erred.*

*Please do not be afraid of exposing my ignorance and your ignorance - after all, we are all ignorant.*

*And, please take advantage of office hours."*

**Dan Graur**

via Fabrizio Ghiselli

# YOUR CAREER?

2025 class

**BACKGROUND IN INFORMATICS**

**BACKGROUND IN BIOLOGY**

12

24

36

# MY PATH

- BSc in Biotechnology at University of Bologna
- MSc in Biodiversity and Evolution at University of Bologna
- PhD in Earth, Life and Environmental Sciences at University of Bologna
- 2 years PostDoc at the University of Milan (and Naples)
- 2 years Postdoc at the University of Bologna

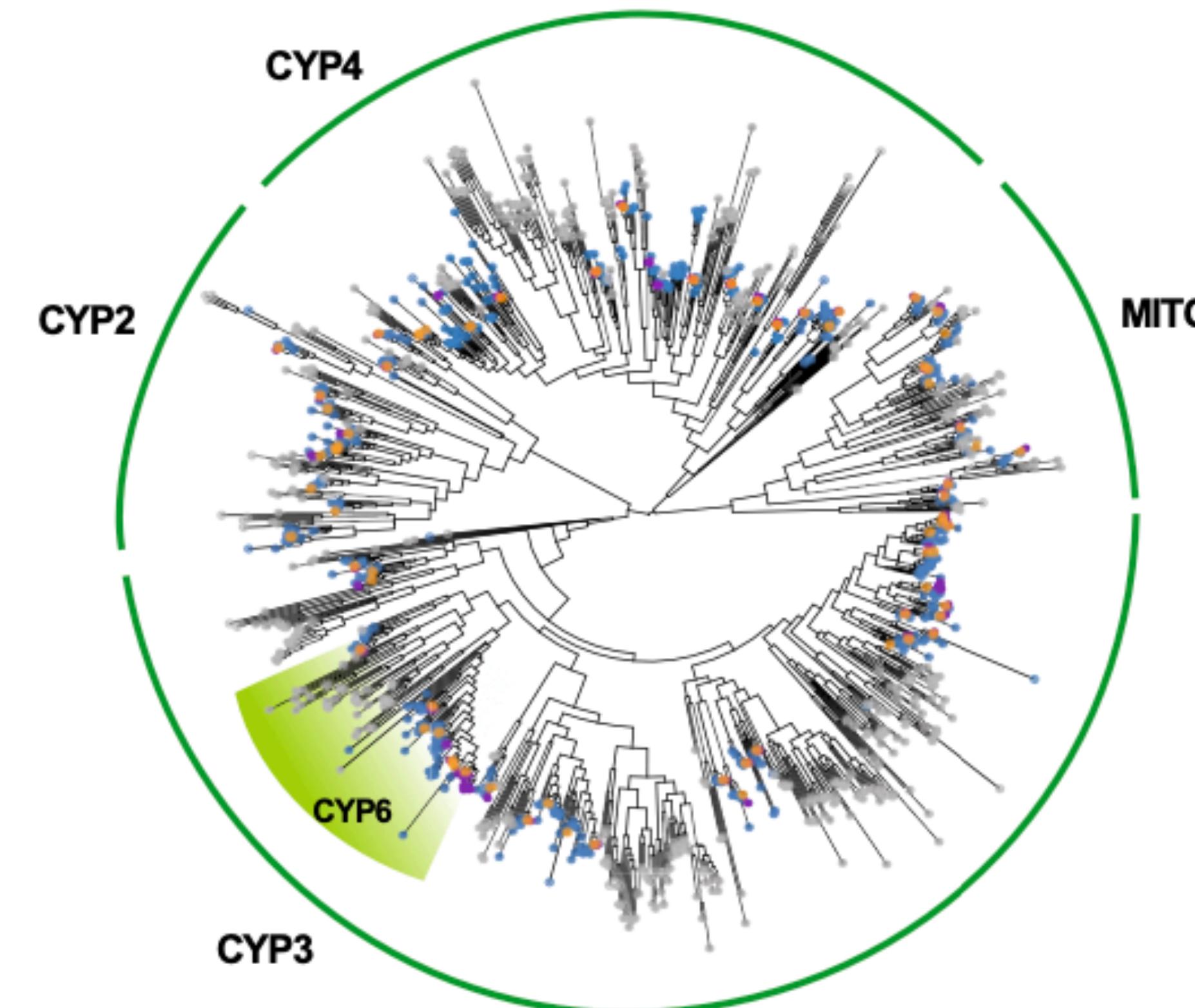
# MY EXPERTISE

I am an **evolutionary biologist!**

My expertise encompasses:

- phylogenetics comparative methods
- comparative genomics
- comparative transcriptomics

...

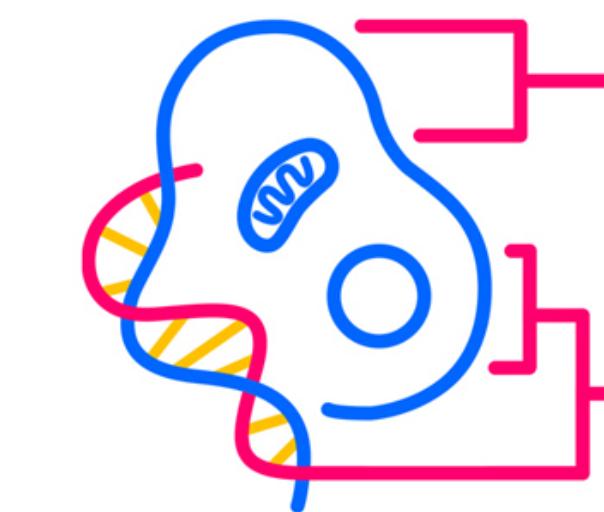


just average knowledge of informatics 😭

# MY NETWORK



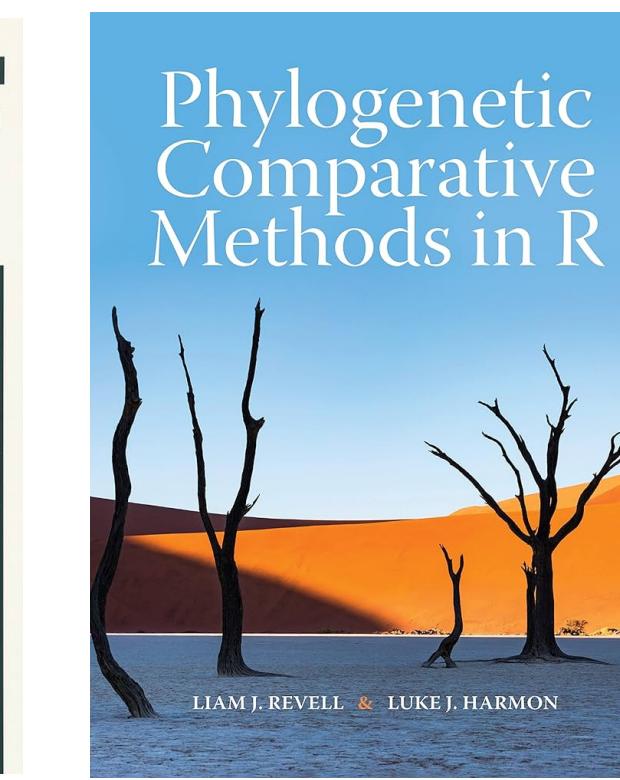
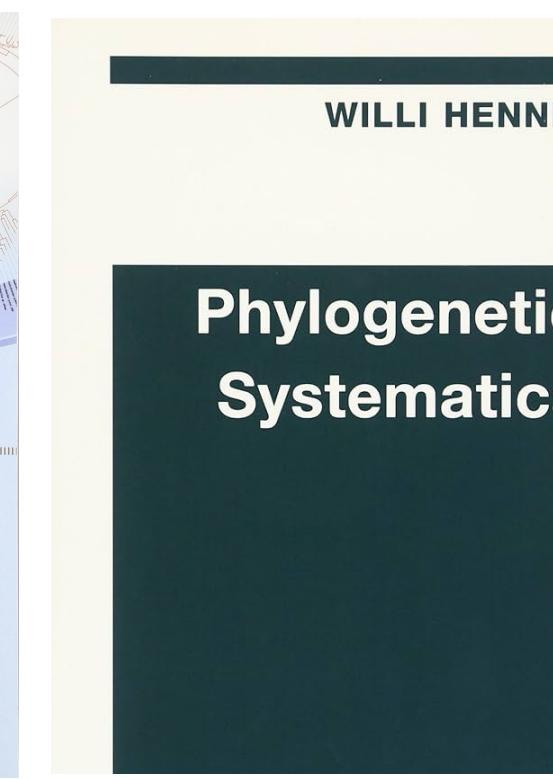
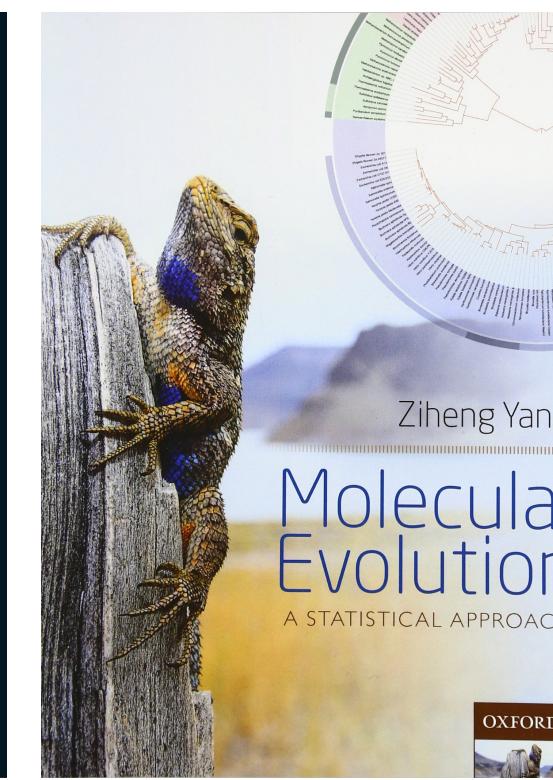
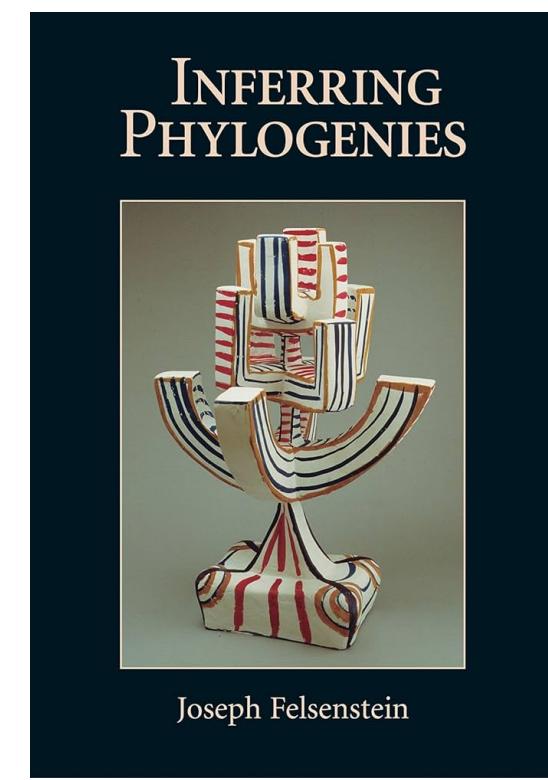
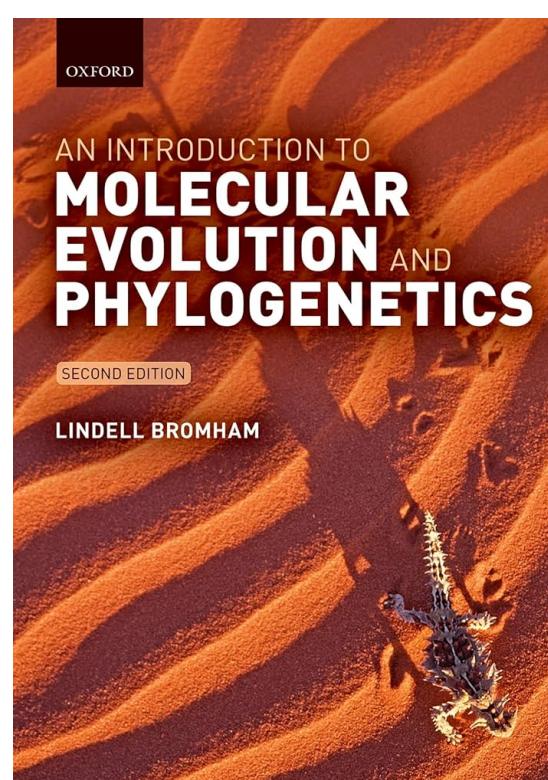
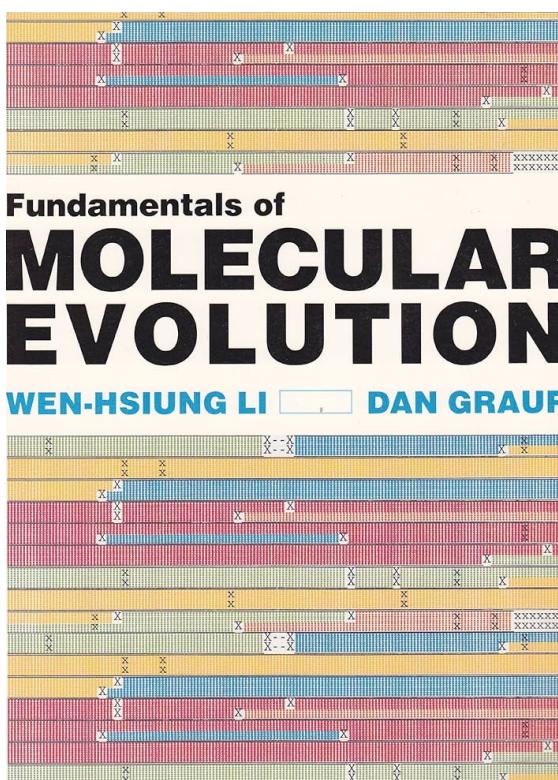
SOCIETA ITALIANA DI BIOLOGIA EVOLUZIONISTICA



**EVOLUTIONARY COMPARATIVE BIOLOGY GROUP @UNIVERSITY OF BOLOGNA**  
EVOLUTIONARY COMPARATIVE BIOLOGY GROUP

# COURSE MATERIAL

- slides - you are looking at one!
- papers (either PDFs or doi)
- books - as additional resources



All the course materials will be permanently uploaded to [github](#). Slides will also be uploaded at the end of each week, also to [virtuale](#).

# INSTALLATIONS

A handful of **executables**:

- [Aliview](#)
- [FigTree](#)
- [Tracer](#)
- R and [Rstudio](#)

**CONDA** - it allow us to be flexible with installations. See how to get it [here](#).

- mafft
- trimal
- iqtree
- astral
- ... see the github for this

# COURSE STRUCTURE

lessons are subdivided in 3 parts:

- 1h'20 of theoretical explanation of an aspect of phylogenetics
  - 20' of pause - we can relax or chat about the topic of the day
  - 1h20' of practice on the topic of the theoretical session
- 

**NB:** examination does not include any hands on or question on specific commands, **BUT** the practical sessions are fundamental for you to consolidate theory, and eventually will ease the exam.

**course syllabus**

lesson 00	04 March (Tu)	10-13	intro to the course + software installation checks	
lesson 01	05 March (We)	10-13	phylogenetics 101 + software installation checks	<b>WEEK 1</b>
lesson 02	06 March (Th)	10-13	phylogenetics 101 + software installation checks	
lesson 03	11 March (Tu)	10-13	orthology inference and taxon sampling	
lesson 04	12 March (We)	10-13	sequence alignment and filtering	<b>WEEK 2</b>
lesson 05	13 March (Th)	10-13	distance-based <i>versus</i> character-based algorithms	
lesson 06	17 March (Tu)	10-13	MK models of molecular evolution	
lesson 07	18 March (We)	10-13	Maximum Likelihood (ML)	<b>WEEK 3</b>
lesson 08	19 March (Th)	10-13	Bayesian Inference (BI)	
lesson 09	20 March (Fr)	10-13	statistical support in phylogenetics	
lesson 10	26 March (We)	10-13	mixture models	
lesson 11	27 March (Th)	10-13	assessing phylogenetic assumptions	<b>WEEK 4</b>
lesson 12	28 March (Fr)	10-13	concatenation-based <i>versus</i> coalescence-based inferences	
lesson 13	01 April (Tu)	10-13	gene tree correction and reconciliation on the species tree	
lesson 14	02 April (We)	10-13	stochastic and systematic bias	<b>WEEK 5</b>
lesson 15	03 April (Th)	10-13	divergence times analyses	
lesson 16	08 April (Tu)	10-13	modelling trait evolution on phylogenies: continuous traits	
lesson 17	09 April (We)	10-13	modelling trait evolution on phylogenies: discrete traits	<b>WEEK 6</b>
lesson 18	10 April (Th)	10-13	inferring selection	
lesson 19	14 April (Mo)	10-13	implementation of phylogenetics in bioinformatics pipeline	
lesson 20	16 April (We)	09-13	case studies + final remarks	<b>WEEK 7</b>

# THE EXAM

- 25 multiple choice questions: **25 points**  
only one is correct and there is no penalty for errors
- 1 open ended and general question: **6 points**  
predefined length, you should use your ability to synthesize

The exam is designed to be easy ...  
if you come consistently to lessons 😓





# INTERROGATION ORAL EXAM

# MY RESEARCH

PNAS

RESEARCH ARTICLE

APPLIED BIOLOGICAL SCIENCES

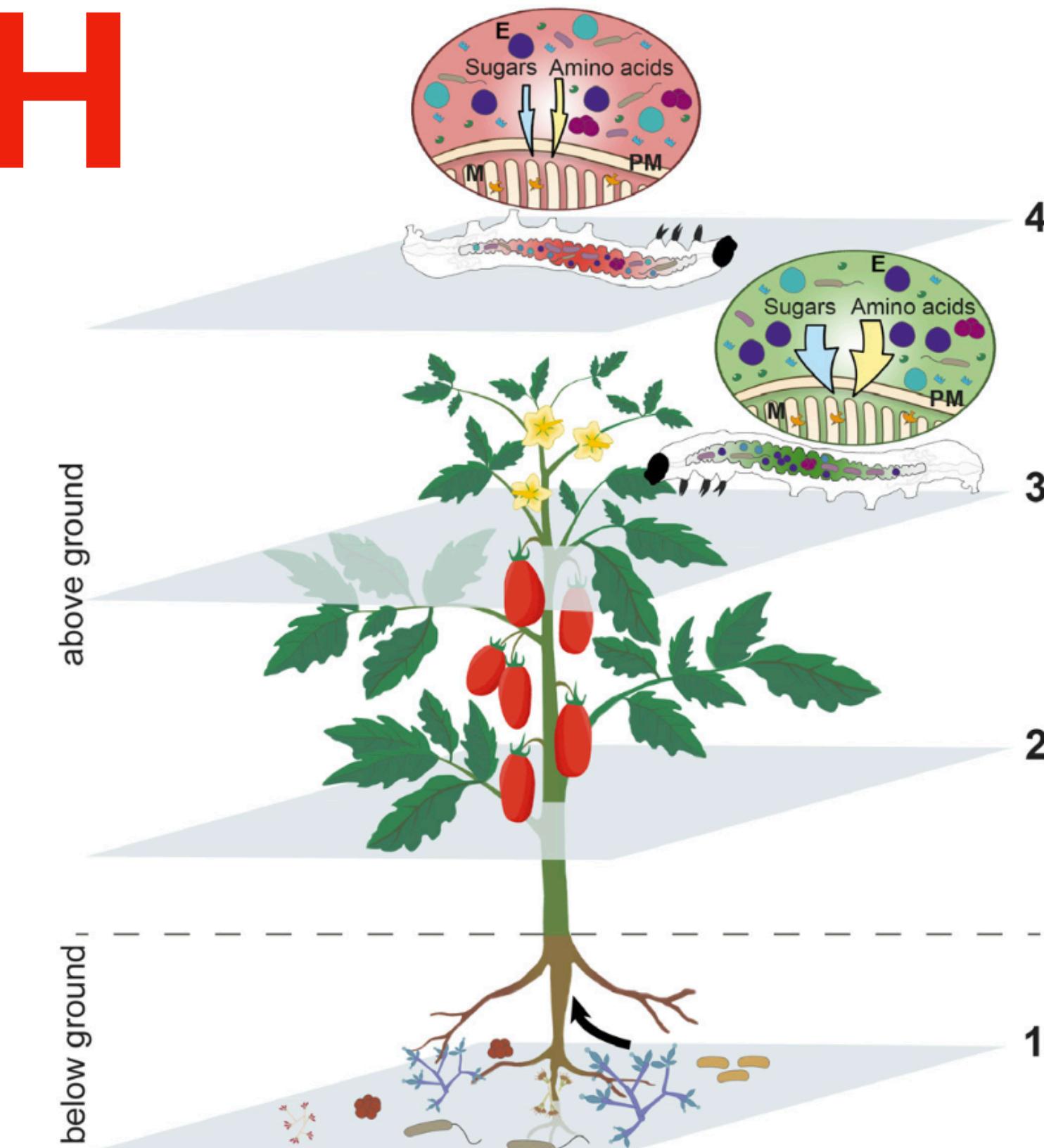
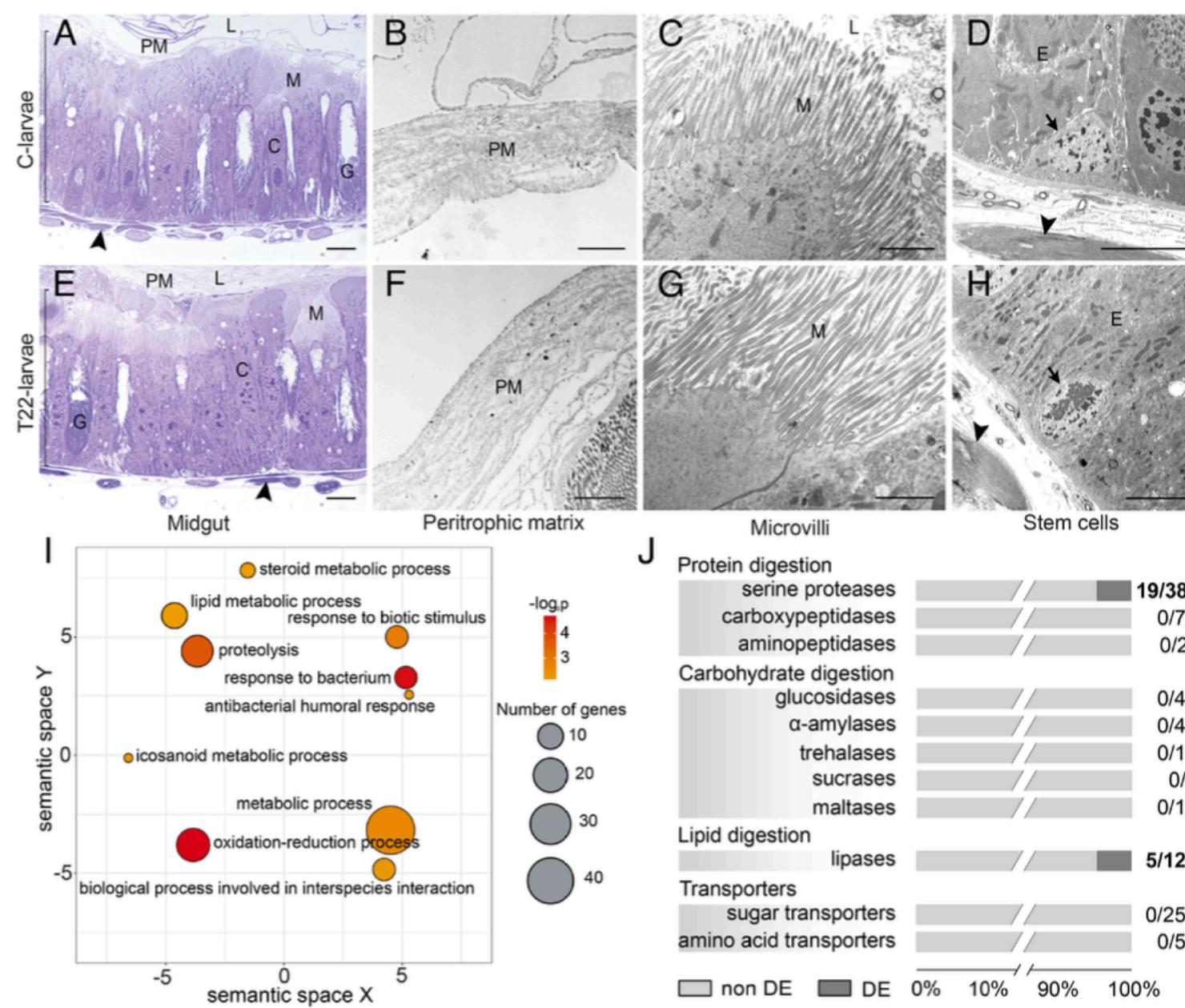
OPEN ACCESS



## A soil fungus confers plant resistance against a phytophagous insect by disrupting the symbiotic role of its gut microbiota

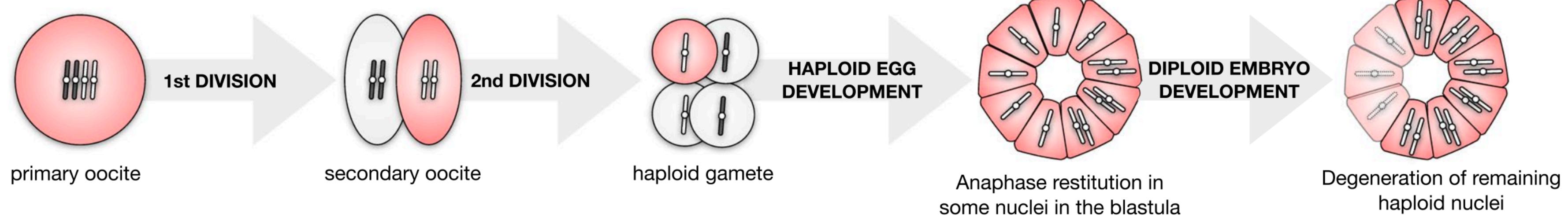
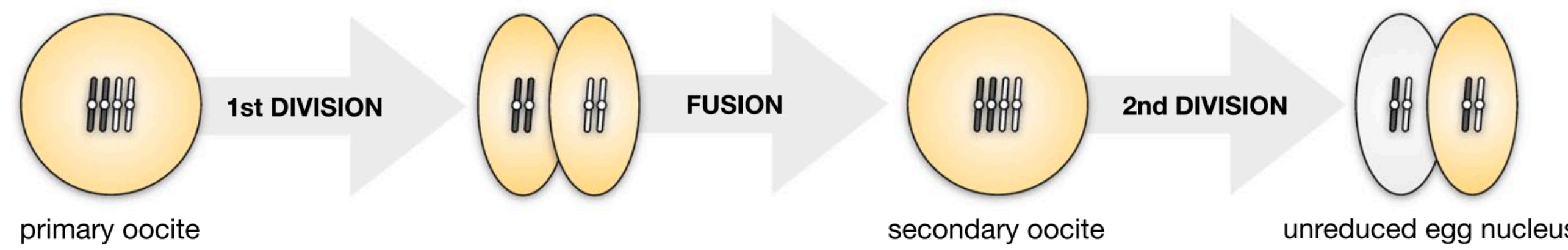
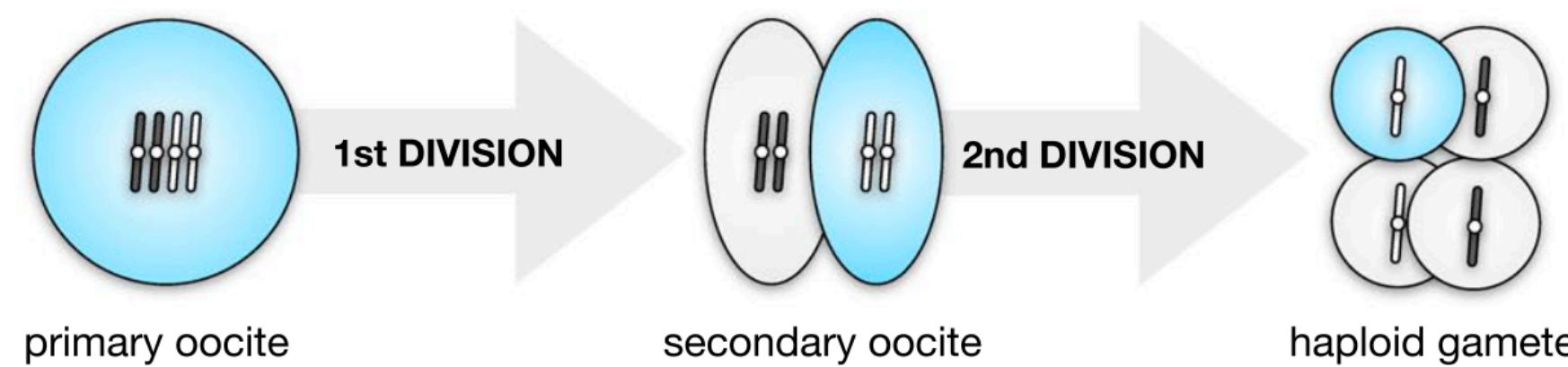
Ilaria Di Lelio<sup>a,1</sup> Giobbe Forni<sup>b,1</sup>, Giulia Magoga<sup>b</sup> Matteo Brunetti<sup>b</sup> Daniele Bruno<sup>c</sup>, Andrea Becchimanzia<sup>a</sup> Maria G. De Luca<sup>a</sup> Martina Sinnio<sup>a</sup>, Eleonora Barra<sup>a</sup> Marco Bonelli<sup>d</sup> Sarah Frusciante<sup>e</sup> Gianfranco Diretto<sup>e</sup> Maria C. Digilio<sup>a,f</sup>, Sheridan L. Woo<sup>fg</sup> Gianluca Tettamanti<sup>c,f</sup> Rosa Rao<sup>a,f</sup> Matteo Lorito<sup>a,f</sup>, Morena Casartelli<sup>d,f,2</sup> Matteo Montagna<sup>a,f,2</sup> and Francesco Pennacchio<sup>a,f,2</sup>

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**Fig. 6.** Schematic representation of the interactions among the plant *S. lycopersicum*, the fungus *T. afroharzianum* strain T22, and the phytophagous insect *S. littoralis* and its gut microbiome. The colonization of *S. lycopersicum* roots by the fungus *T. afroharzianum* strain T22 (1) systemically conditions the plant (2), generating a dysbiosis of the gut microbiome in *S. littoralis* larvae feeding on tomato leaves with neither structural damages to the midgut epithelium and peritrophic matrix nor alterations in the digestive capacity of the insect. This dysbiosis, among others, affects symbiotic bacteria of the genus *Enterococcus* and the functional capability of *E. casseliflavus* to nutritionally support the insect host with sugars and amino acids (3), with a consequent negative impact on *S. littoralis* development and survival (4). E: *E. casseliflavus* bacterial cells; M: microvilli; PM: peritrophic matrix; orange, green, and light blue shapes: insect digestive enzymes.

# MY RESEARCH



# MY RESEARCH

## Taxonomic revision of the Australian stick insect genus *Candovia* (Phasmida: Necrosciinae): insight from molecular systematics and species-delimitation approaches

GIOBBE FORNI<sup>1,2,\*</sup>, ALEX CUSSIGH<sup>1,2</sup>, PAUL D. BROCK<sup>3</sup>, BRAXTON R. JONES<sup>4</sup>, FILIPPO NICOLINI<sup>1</sup>, JACOPO MARTELOSSI<sup>1</sup>, ANDREA LUCHETTI<sup>1,2,\*</sup> and BARBARA MANTOVANI<sup>1</sup>

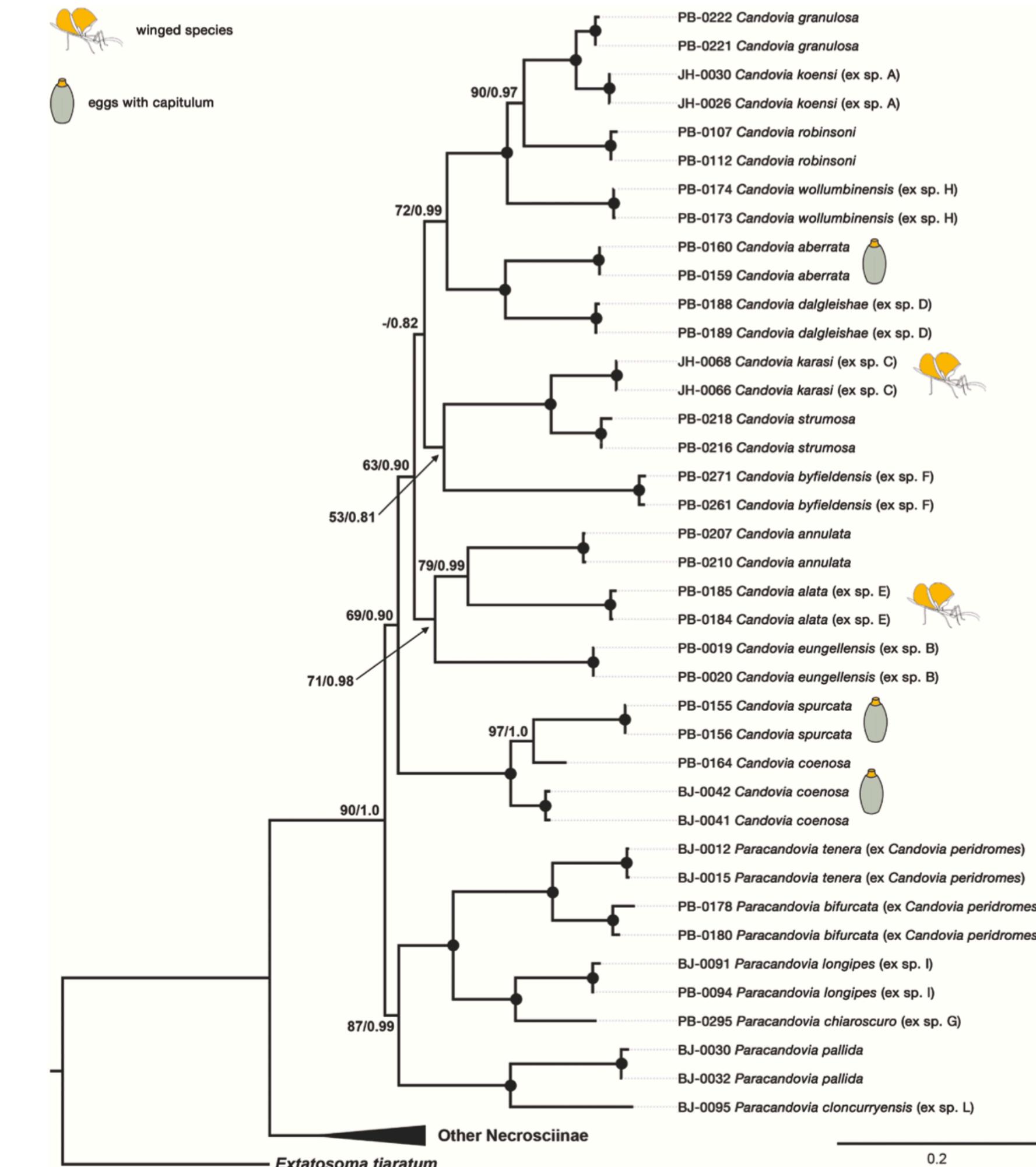
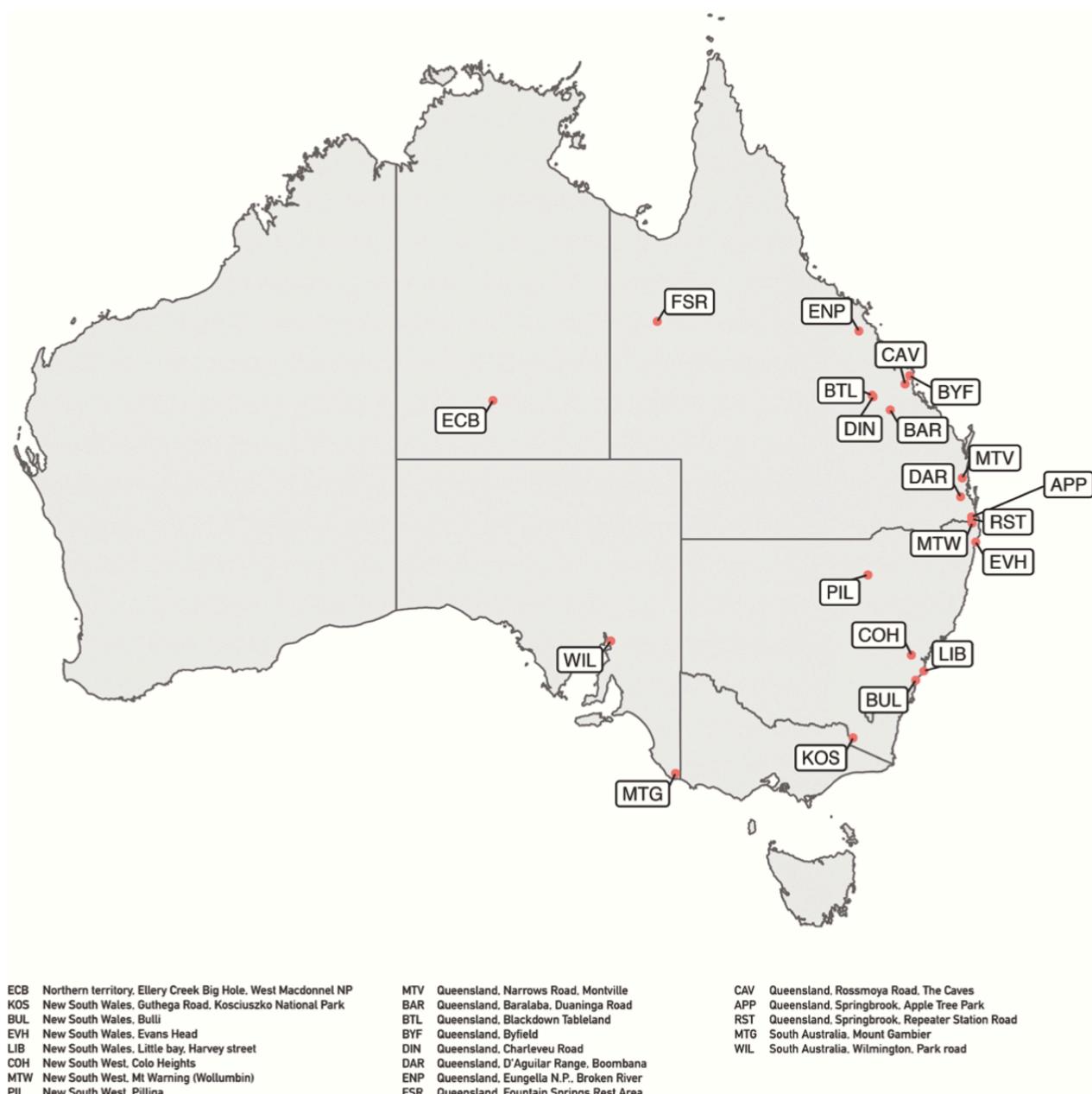
<sup>1</sup>Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy

<sup>2</sup>Department of Agricultural and Environmental Sciences, University of Milan, Milano, Italy

<sup>3</sup>The Natural History Museum, Cromwell Road, London, UK

<sup>4</sup>School of Life and Environmental Sciences, The University of Sydney, Sydney NSW 2006, Australia

Received 18 March 2022; revised 4 July 2022; accepted for publication 8 August 2022

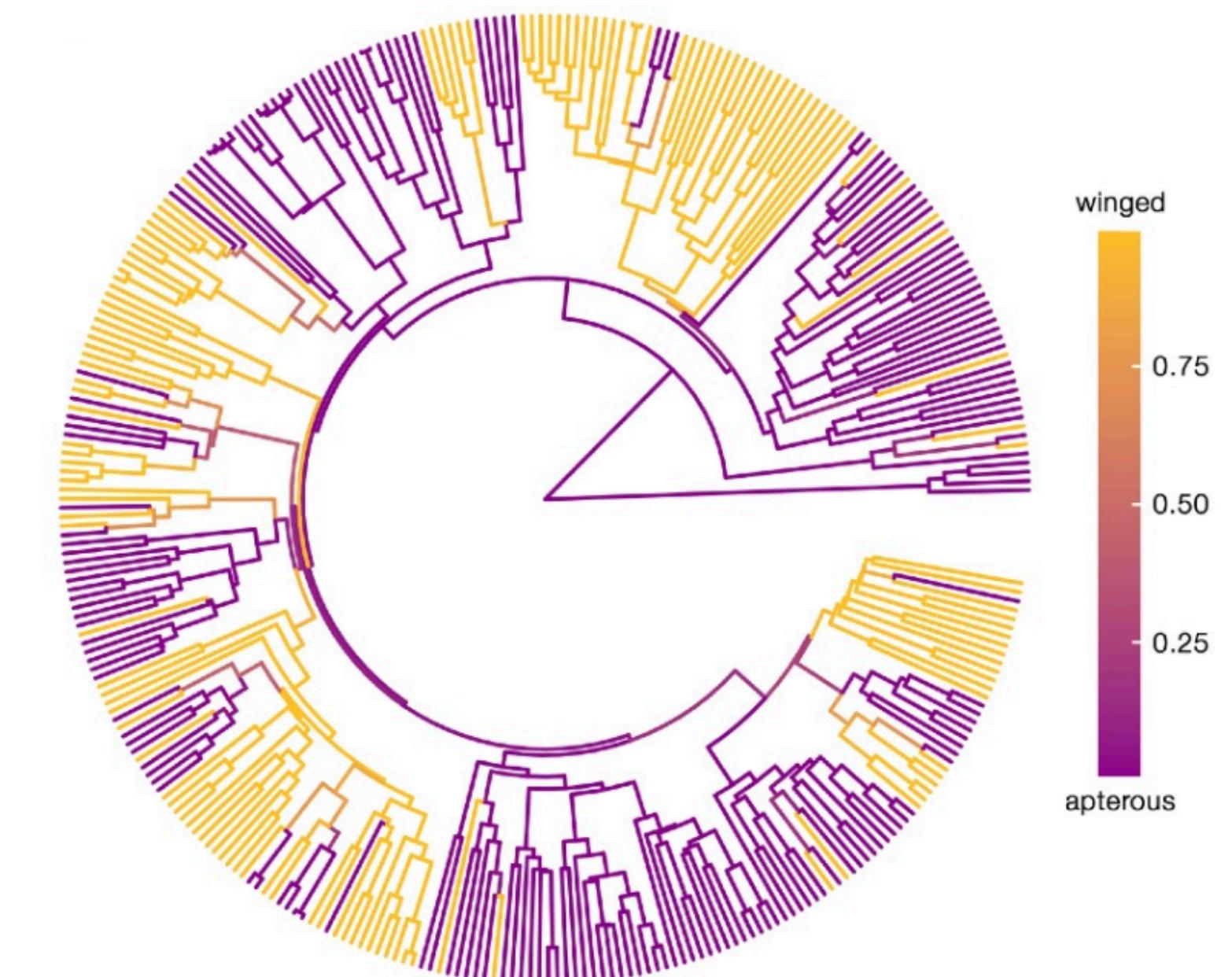


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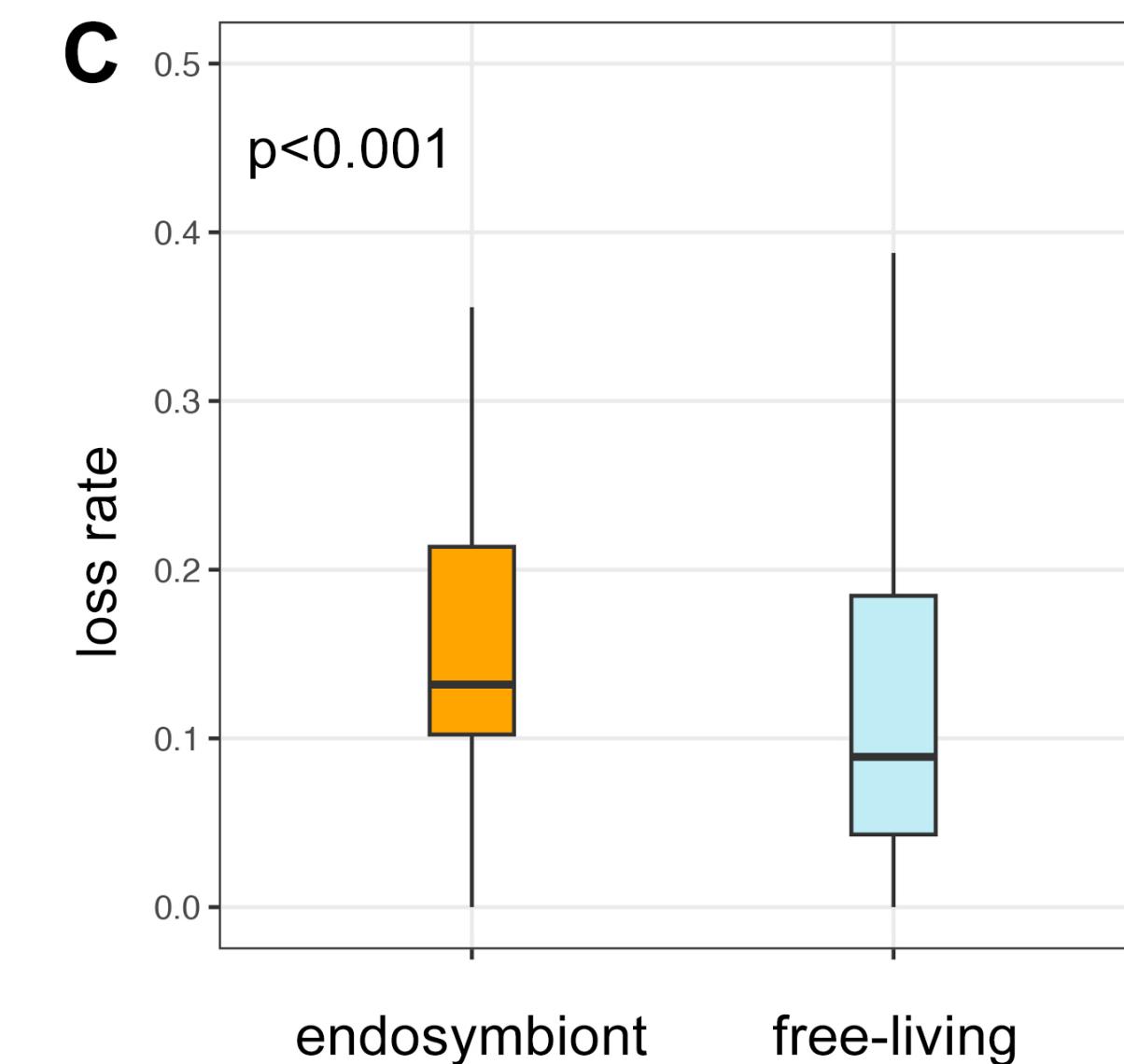
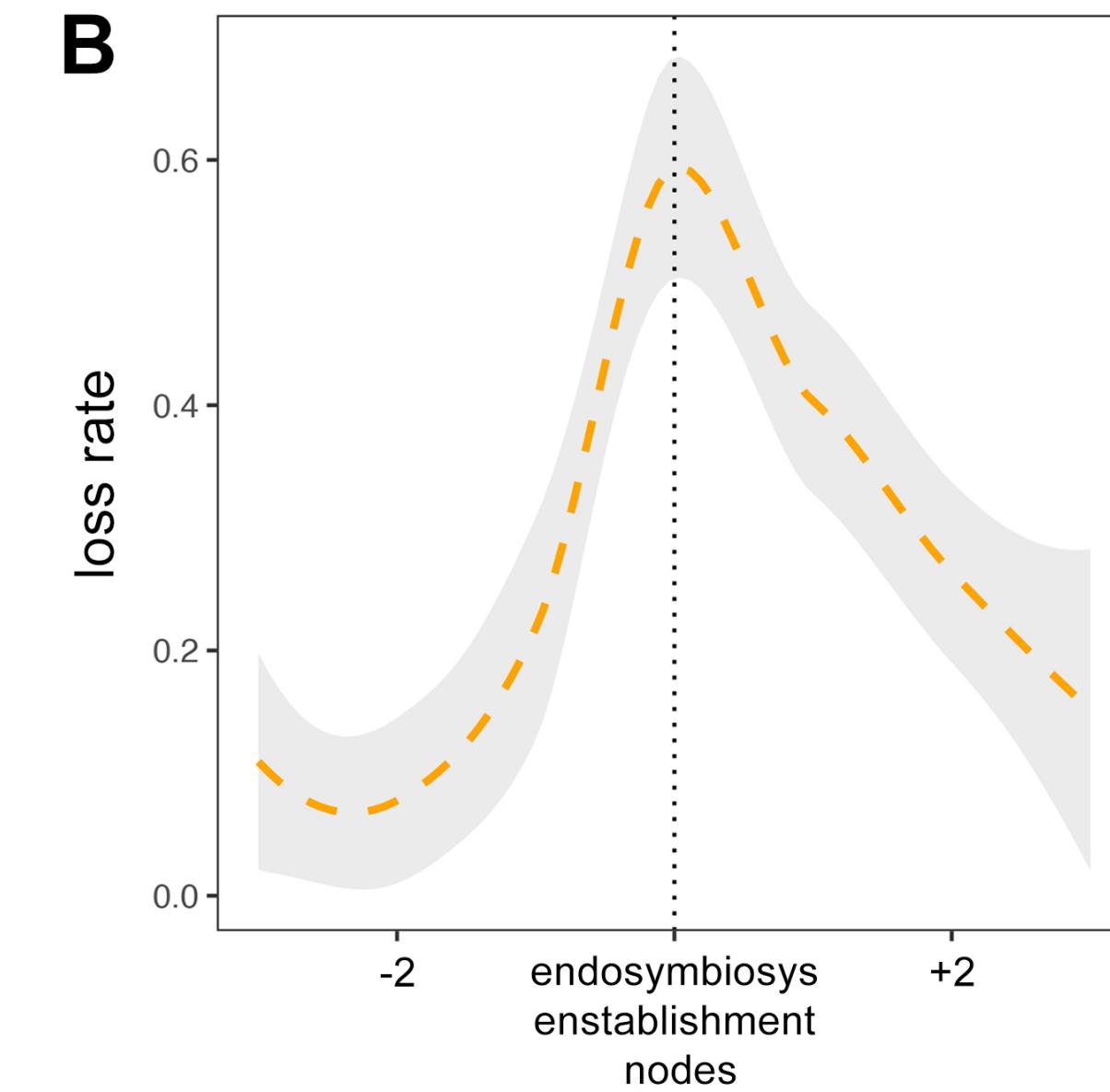
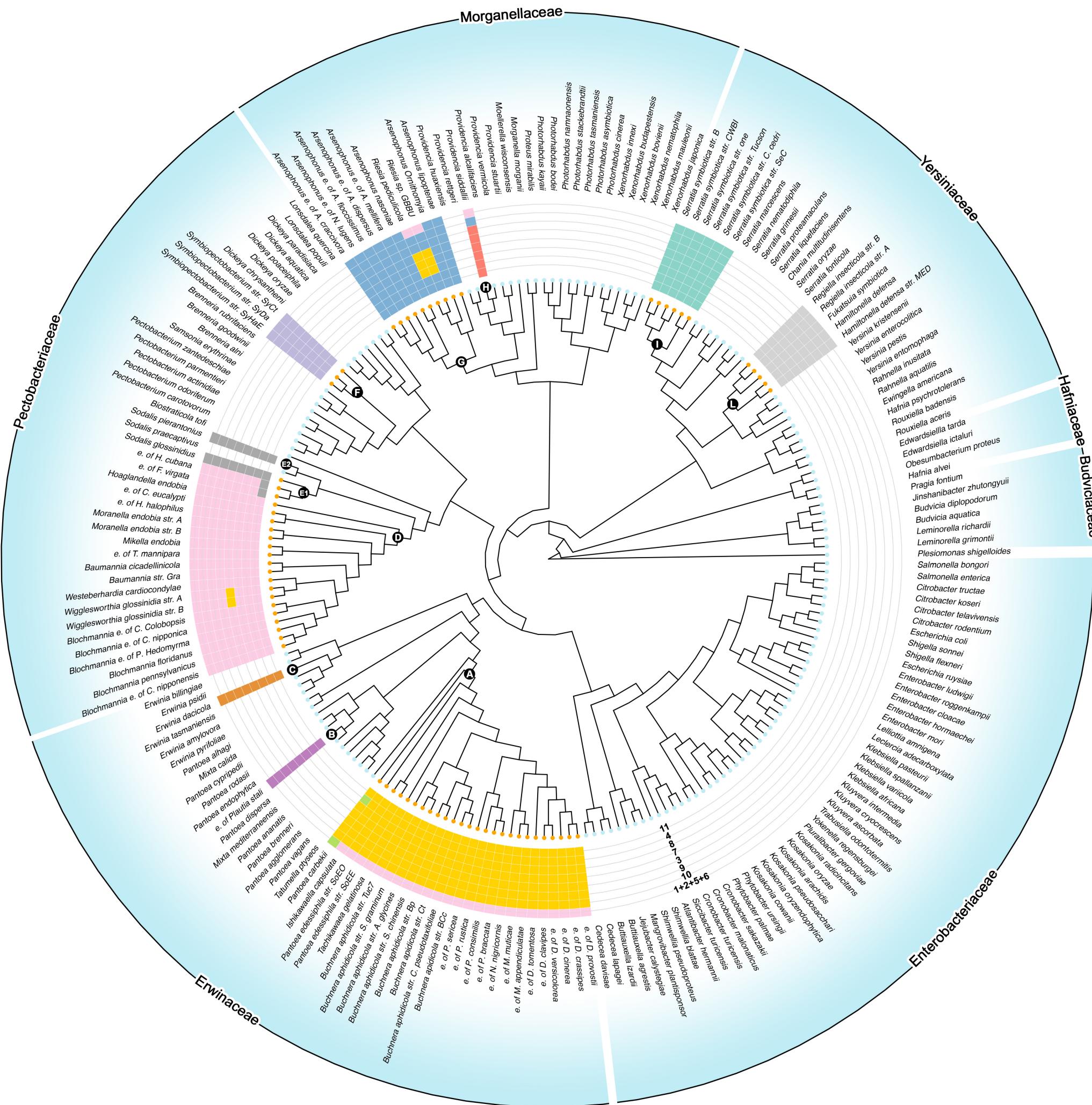
# MY RESEARCH



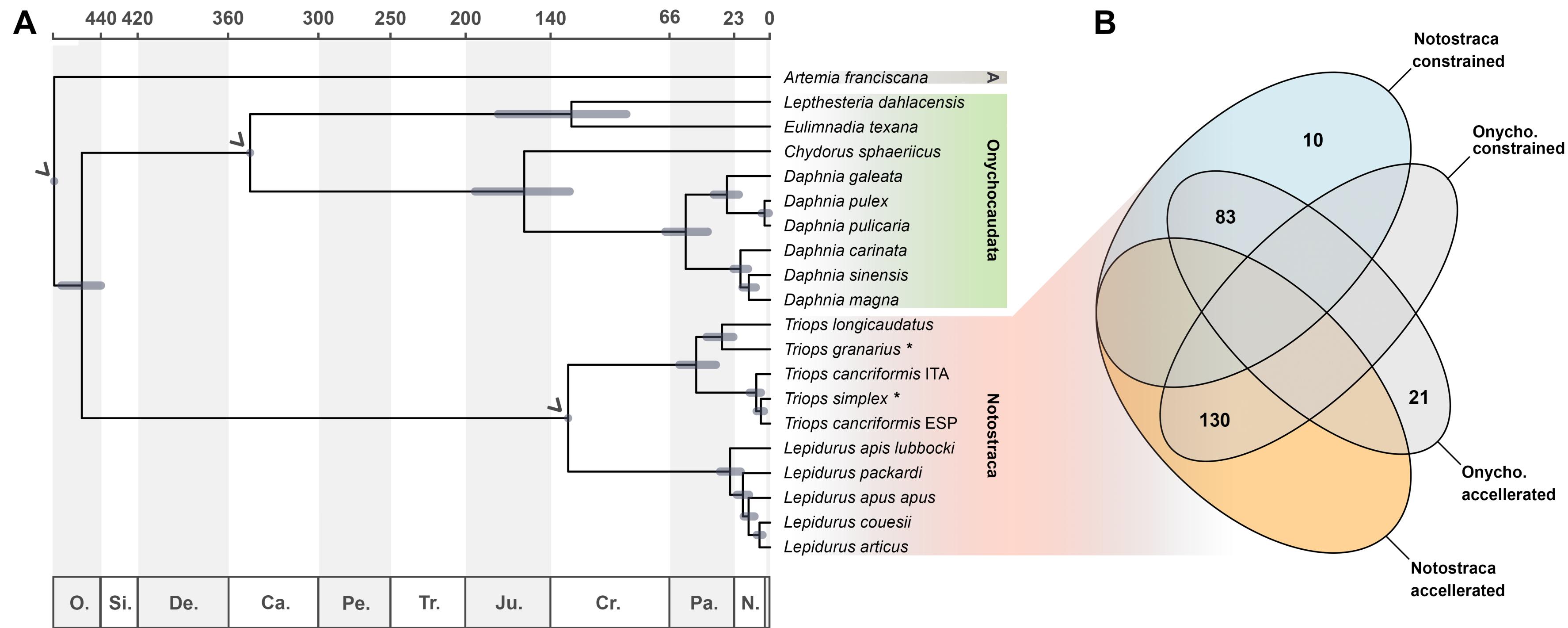
●  $0_A$  - apterous + hidden state A   ●  $0_B$  - apterous + hidden state B   ●  $1_A$  - winged + hidden state A   ●  $1_B$  - winged + hidden state B



# MY RESEARCH



# MY RESEARCH



**C**

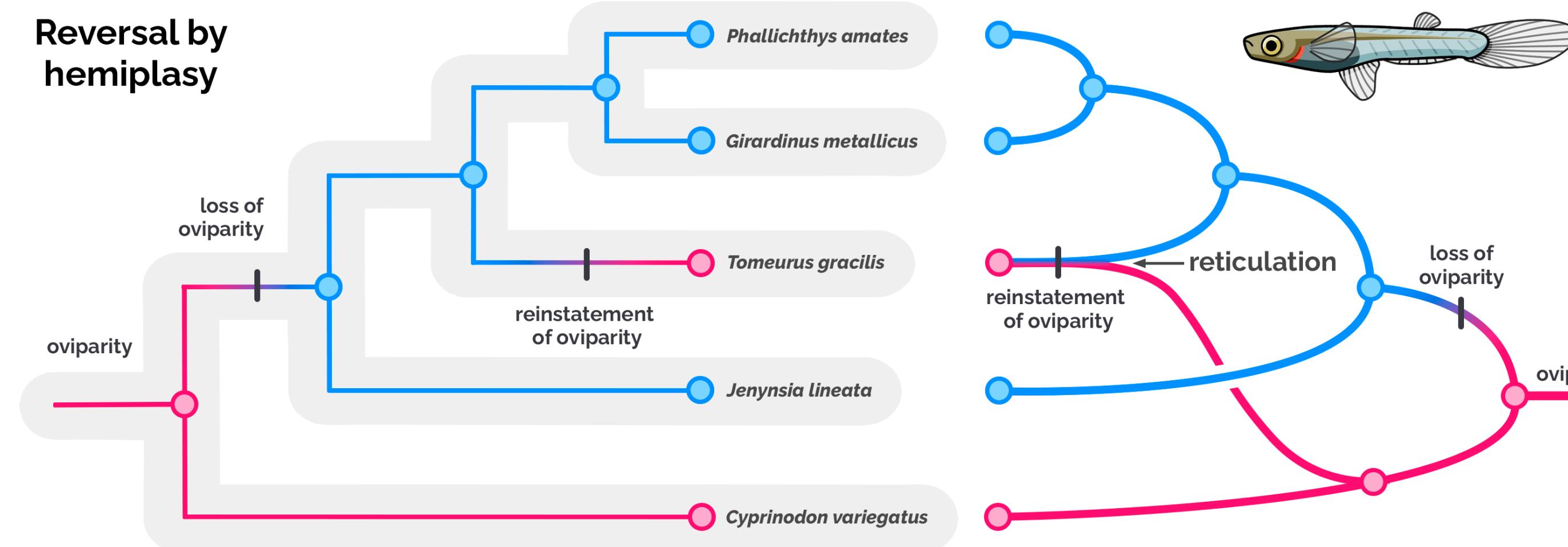
	constrained genes terms	p	significant / expected
GO:0007249	I-kappaB kinase/NF-kappaB signaling	0.00217	11.54
GO:0006357	regulation of transcription by RNA polym...	0.00384	2.37
GO:0006470	protein dephosphorylation	0.00784	5.06
GO:0006355	regulation of transcription, DNA-templat...	0.00819	1.93
GO:1903506	regulation of nucleic acid-templated tra...	0.00819	1.93

**D**

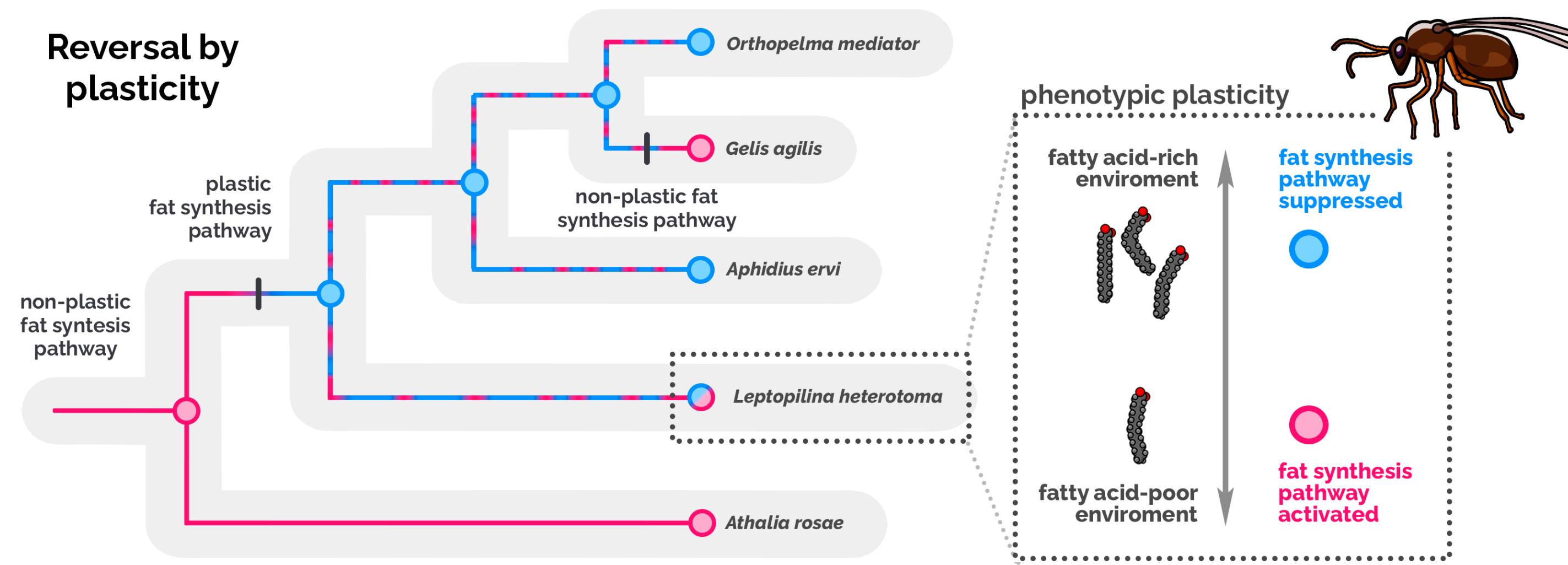
	accelerated genes terms	p	significant / expected
GO:0010466	negative regulation of peptidase activit...	0.0024	10.71
GO:0006397	mRNA processing	0.0024	2.86
GO:0016071	mRNA metabolic process	0.0029	2.48
GO:0097193	intrinsic apoptotic signaling pathway	0.0072	7.32
GO:0050684	regulation of mRNA processing	0.0077	5.06

# MY RESEARCH

## Reversal by hemiplasy



## Reversal by plasticity



**FINISH**