

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

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

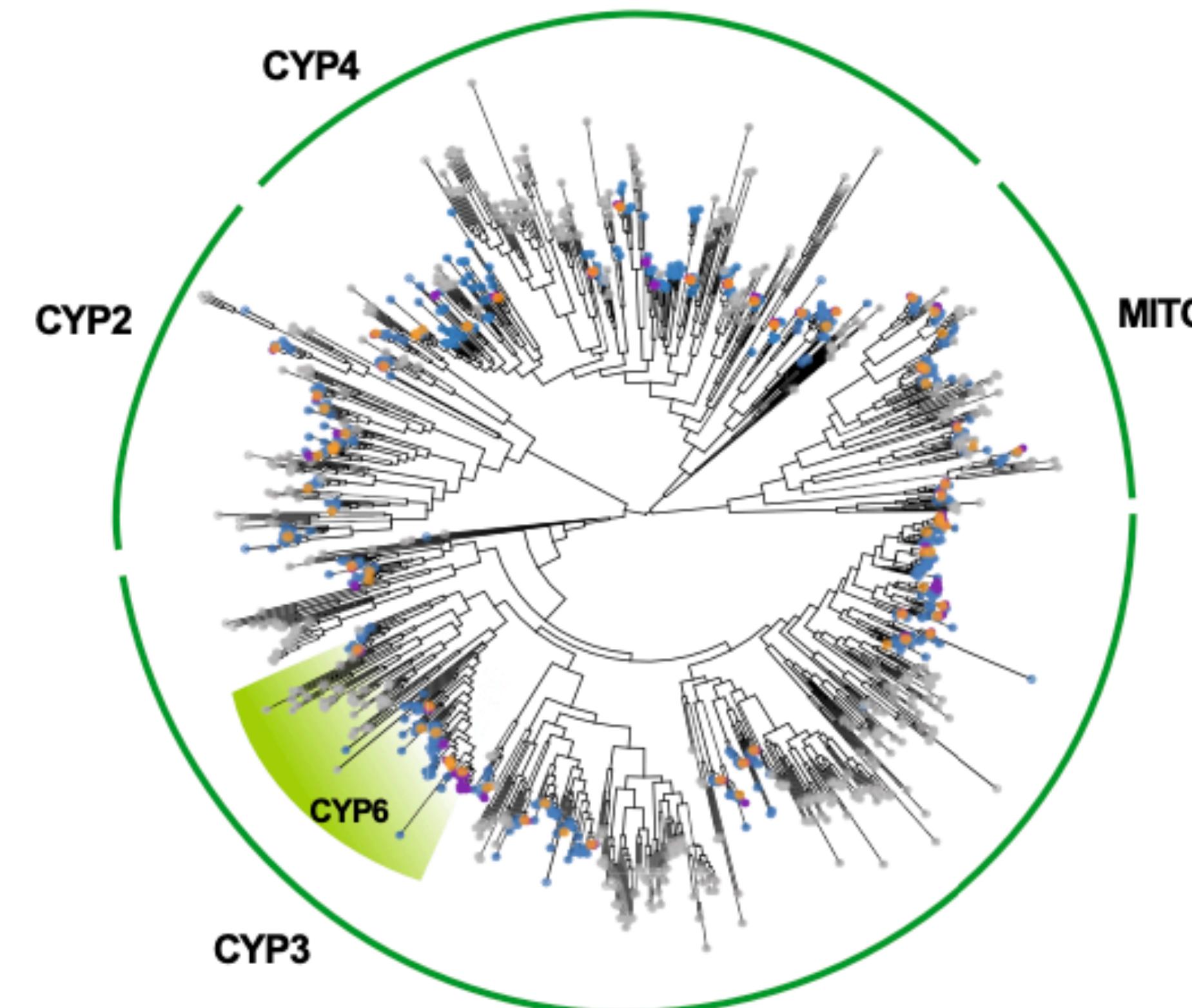
MY EXPERTISE

I am an **evolutionary biologist!**

My expertise encompasses:

- phylogenetics comparative methods
- comparative genomics
- comparative transcriptomics

...

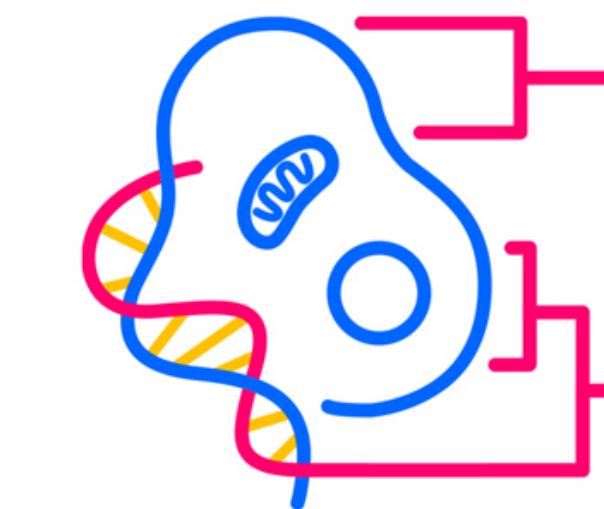


just average knowledge of informatics 😭

MY NETWORK



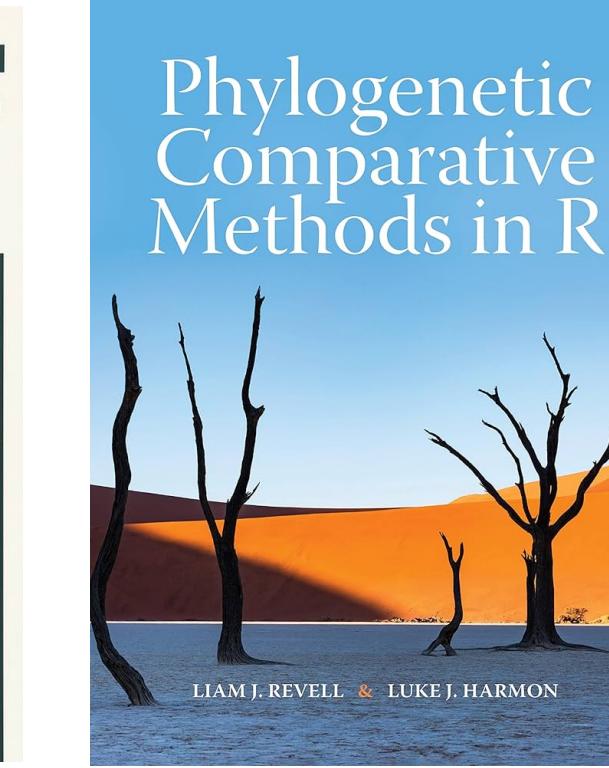
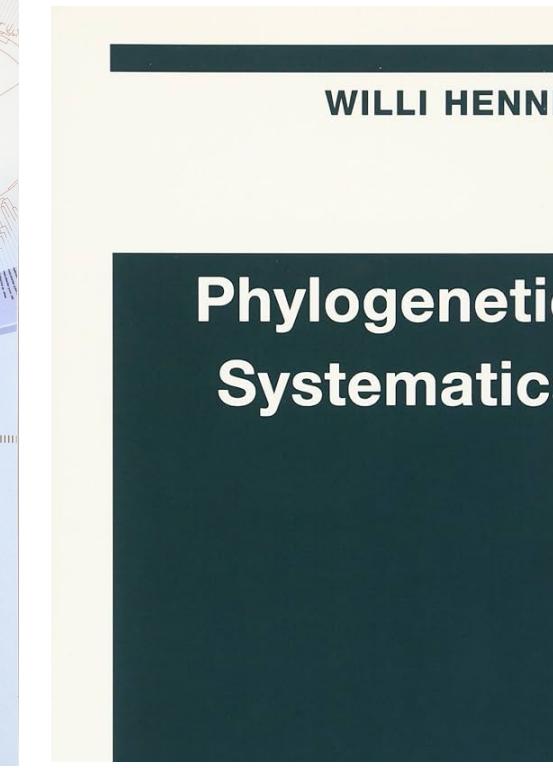
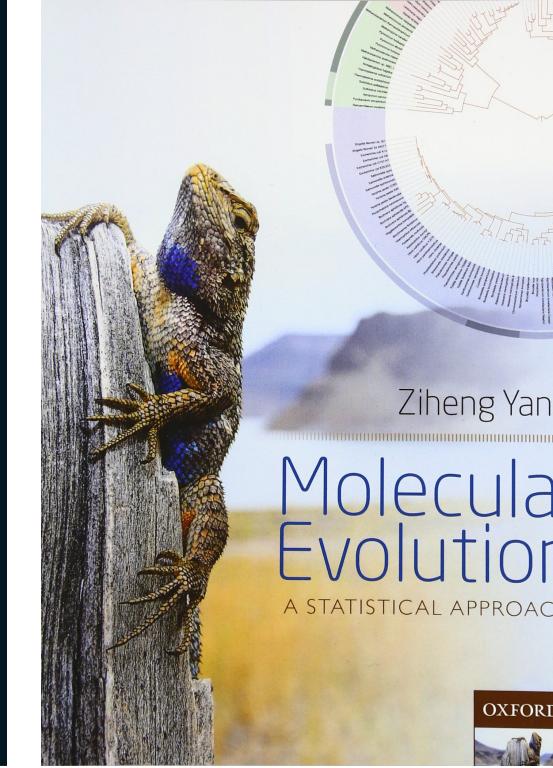
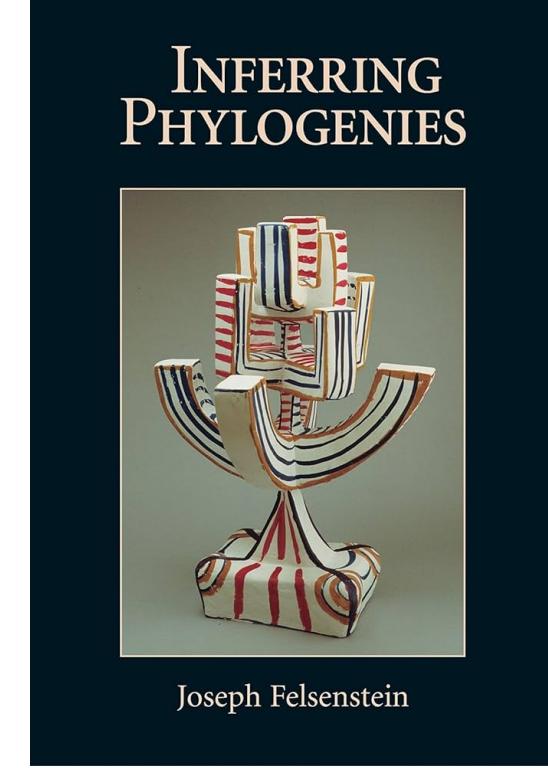
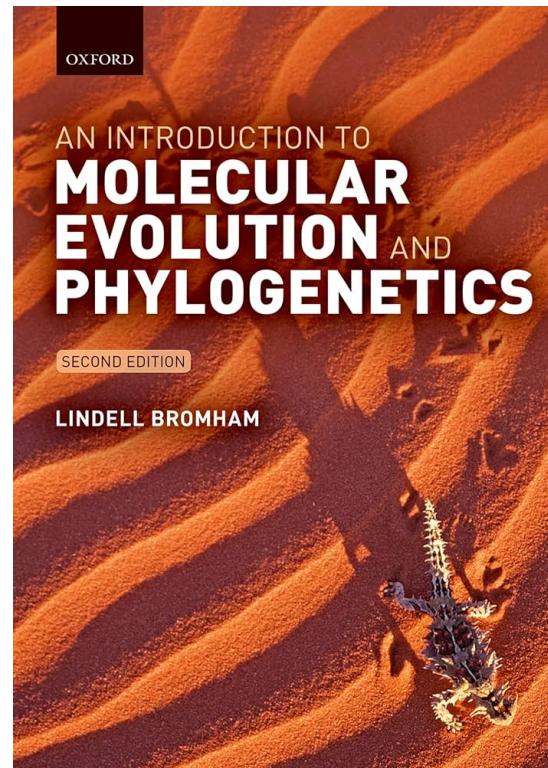
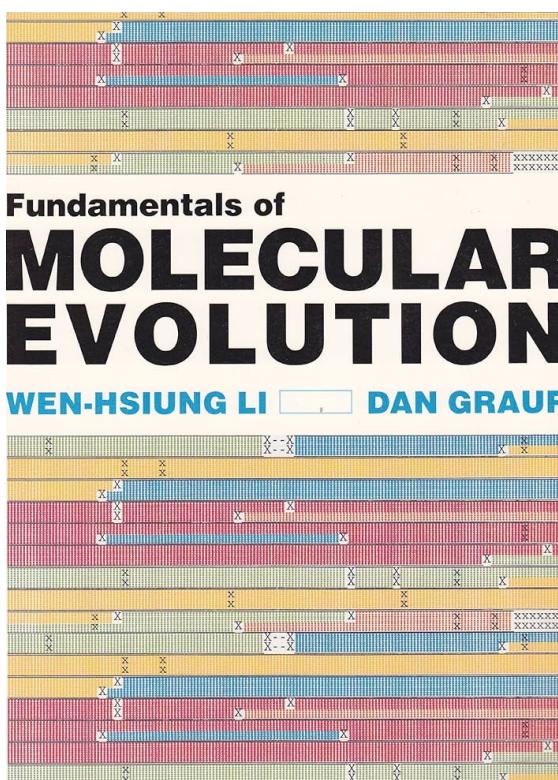
SOCIETA ITALIANA DI BIOLOGIA EVOLUZIONISTICA



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 to [virtuale](#).

INSTALLATIONS

A handful of **executables**:

- Aliview
- FigTree
- Tracer
- R and Rstudio
- Beast and Beauti

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

- mafft
- trimal
- iqtree
- ... the list is constantly WIP - see the [github](#) for this!

COURSE STRUCTURE

lessons are subdivided in 3 parts (the timing may vary):

- 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	WEEK 1
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	WEEK 2
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)	WEEK 3
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	WEEK 4
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	WEEK 5
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	WEEK 6
lesson 18	10 April (Th)	10-13	inferring selection	
lesson 19	14 April (Mo)	10-13	mini journal club pt. A	
lesson 20	16 April (We)	09-13	mini journal club pt. B	WEEK 7

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



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

Edited by David Denlinger, The Ohio State University, Columbus, OH; received October 7, 2022; accepted December 16, 2022

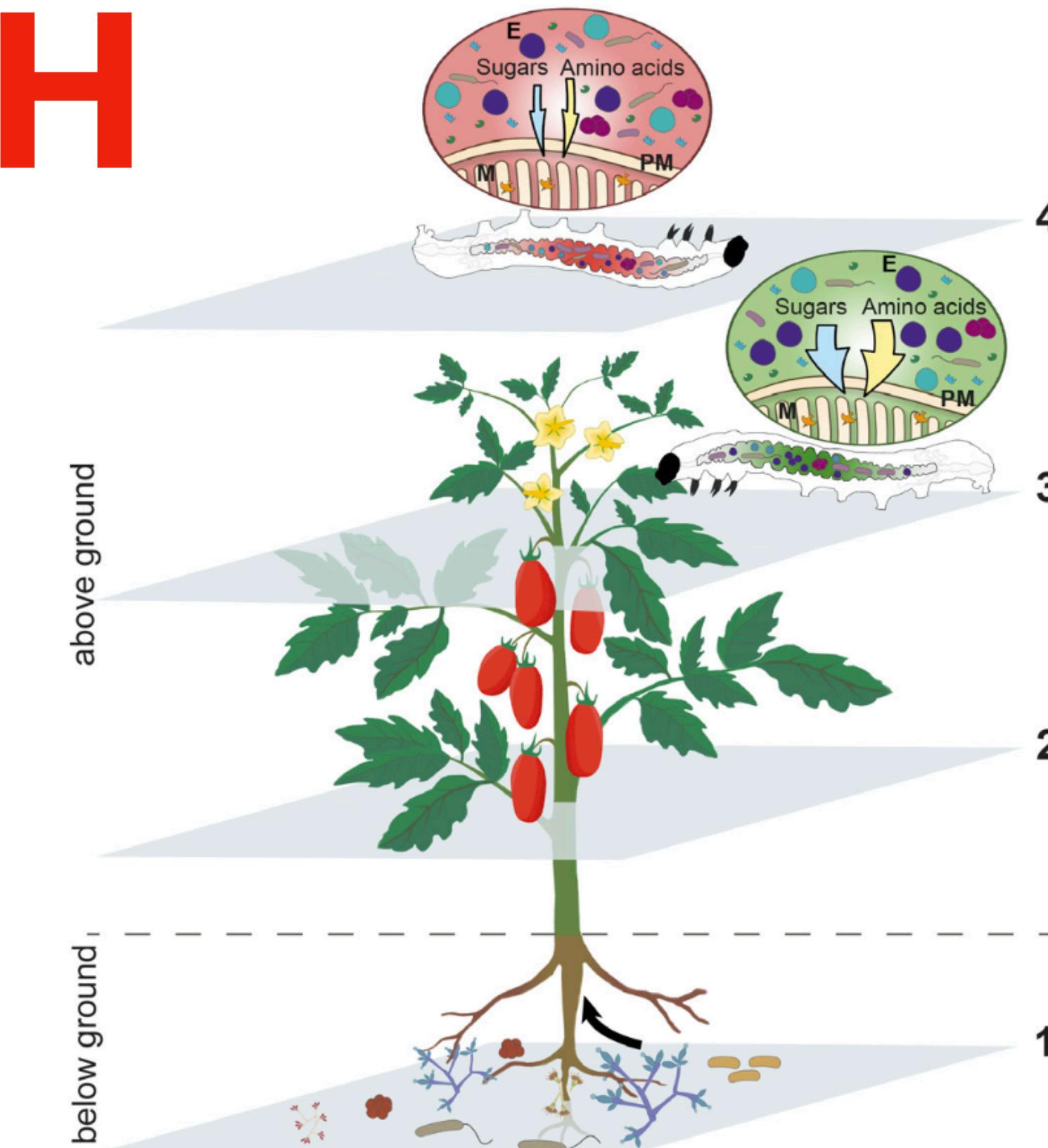
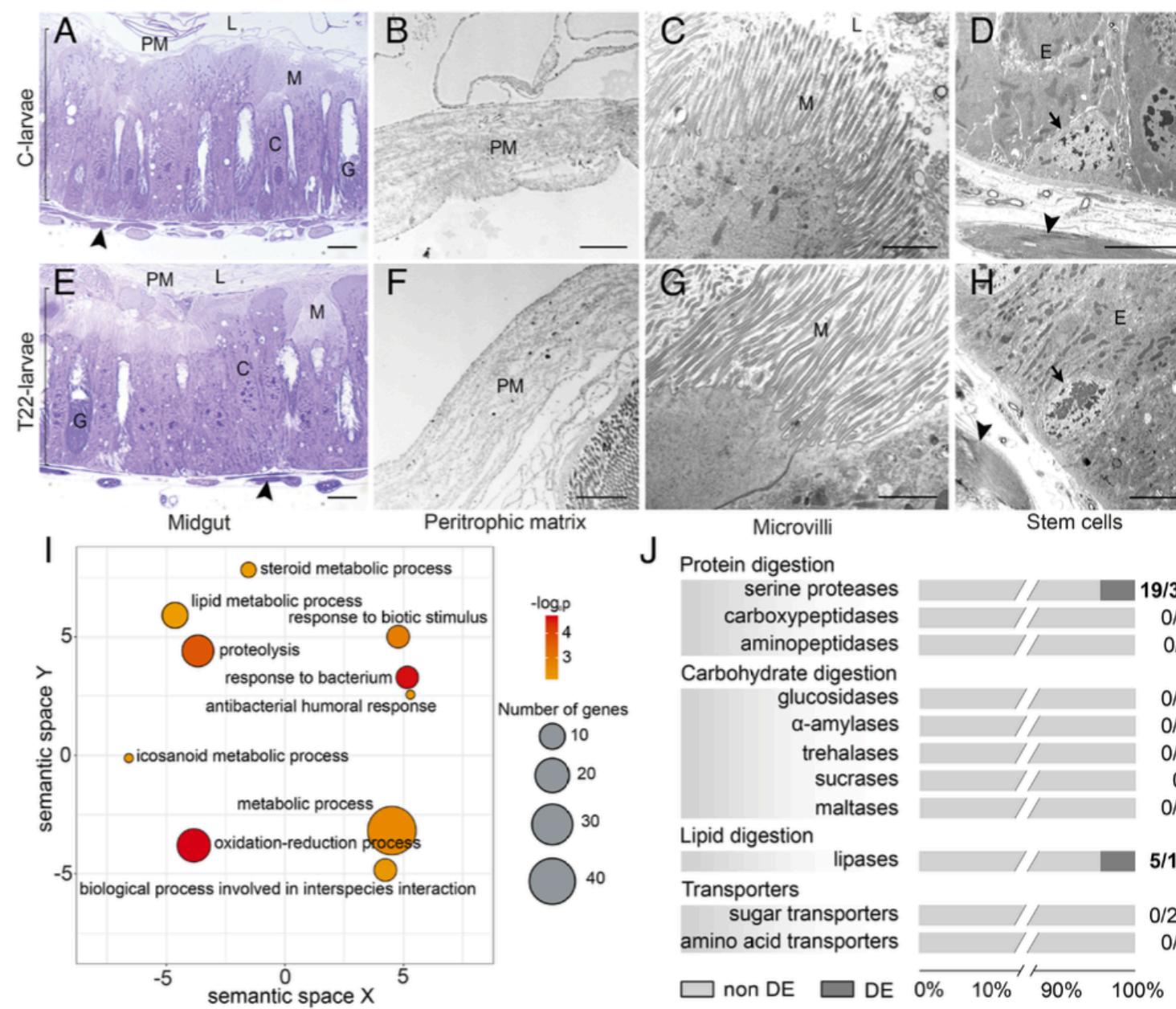
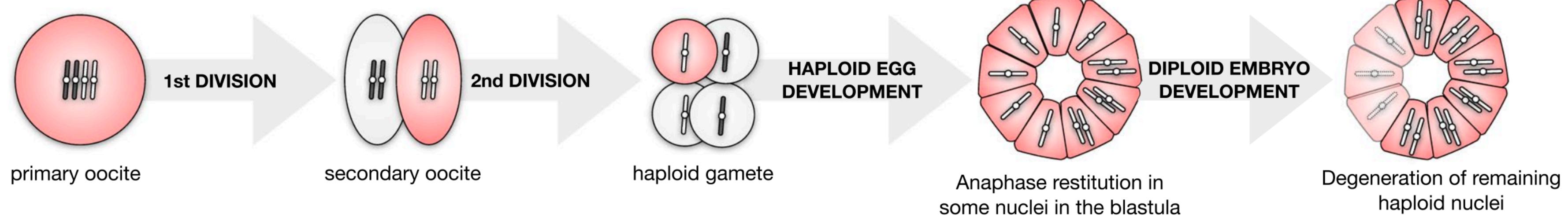
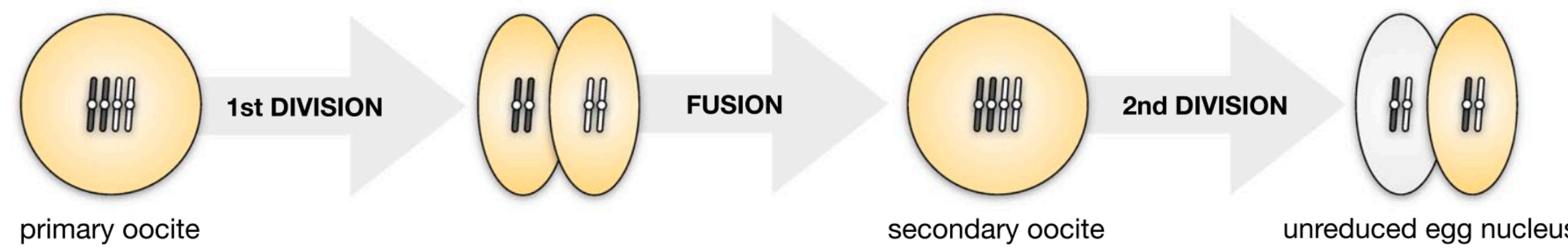
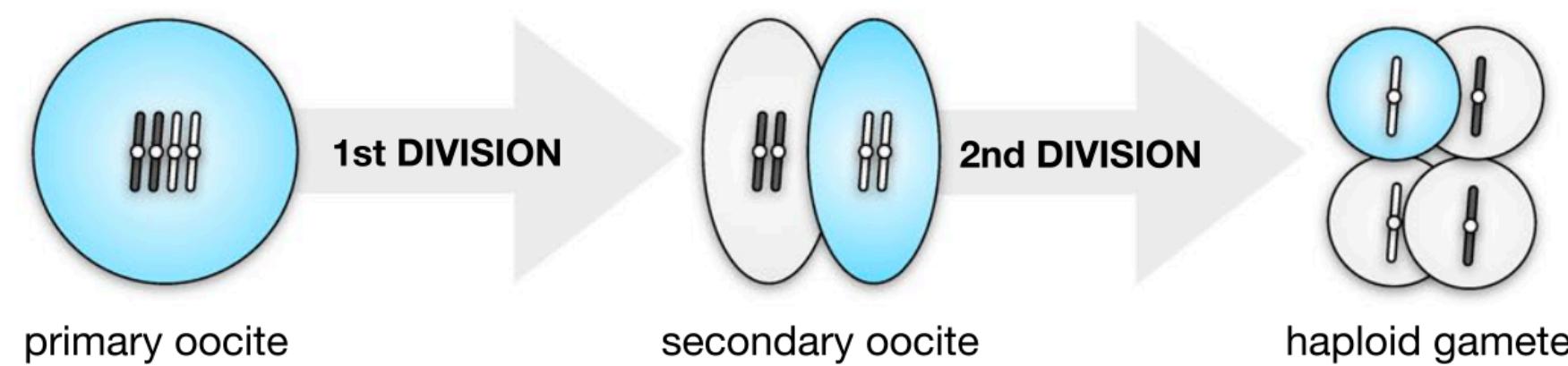


Fig. 6. Schematic representation of the interactions among the plant *S. lycopersicum*, the fungus *T. afroharzianum* strain T22, and the phytophagous insect *S. littoralis* and its gut microbiome. The colonization of *S. lycopersicum* roots by the fungus *T. afroharzianum* strain T22 (1) systemically 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^{1,2,*}, ALEX CUSSIGH^{1,2}, PAUL D. BROCK³, BRAXTON R. JONES⁴, FILIPPO NICOLINI¹, JACOPO MARTELOSSI¹, ANDREA LUCHETTI^{1,5,*} and BARBARA MANTOVANI¹

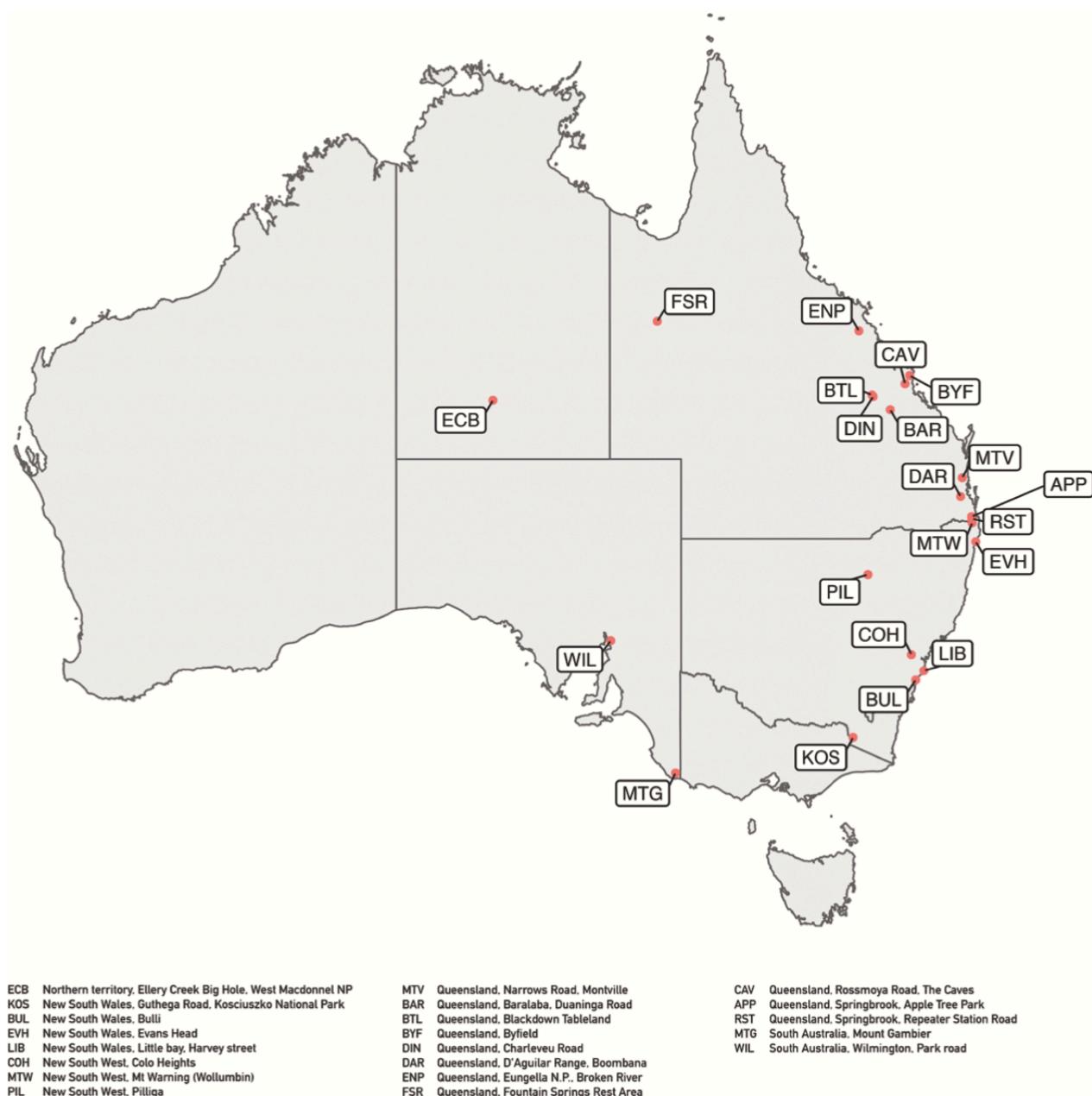
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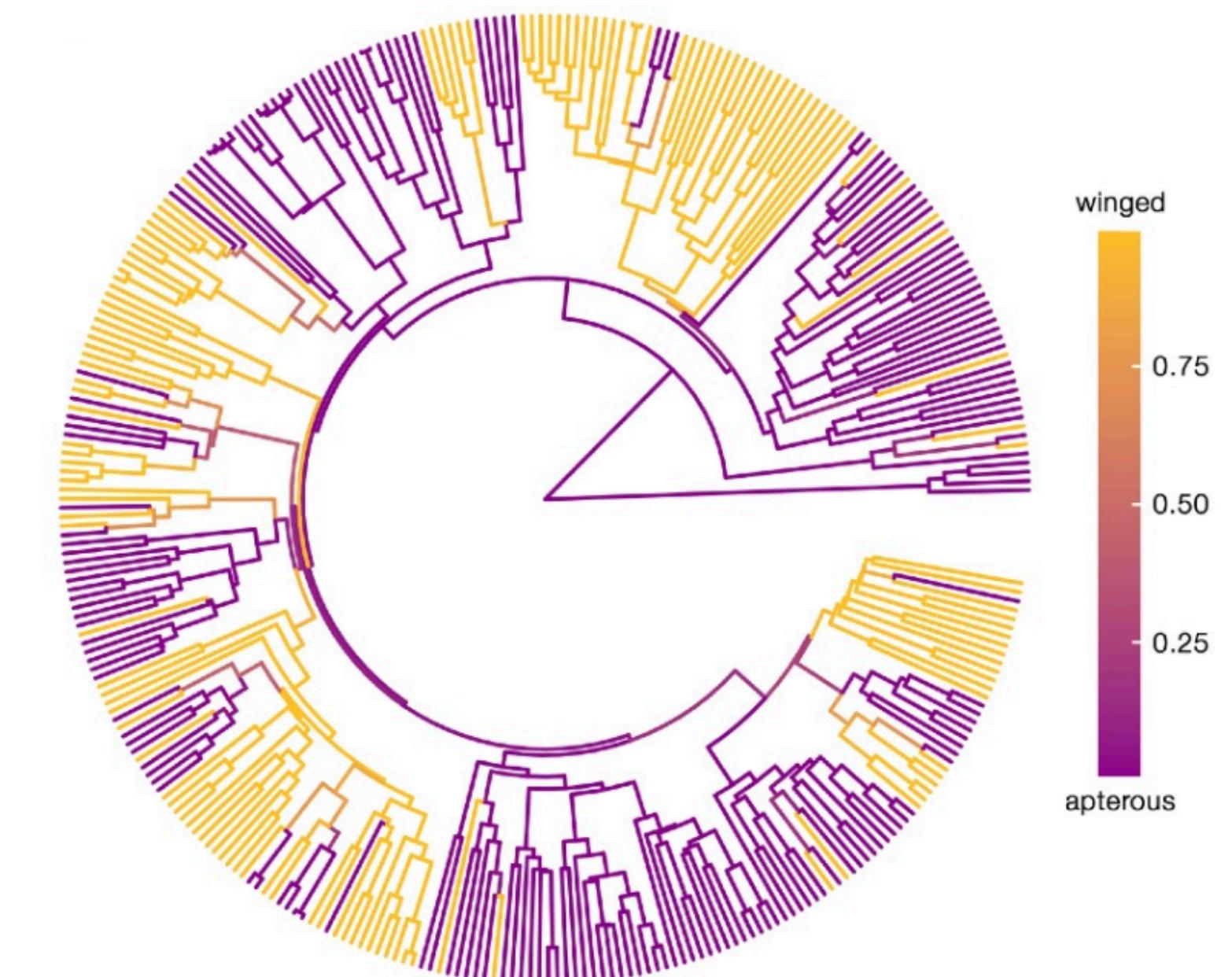
Received 18 March 2022; revised 4 July 2022; accepted for publication 8 August 2022



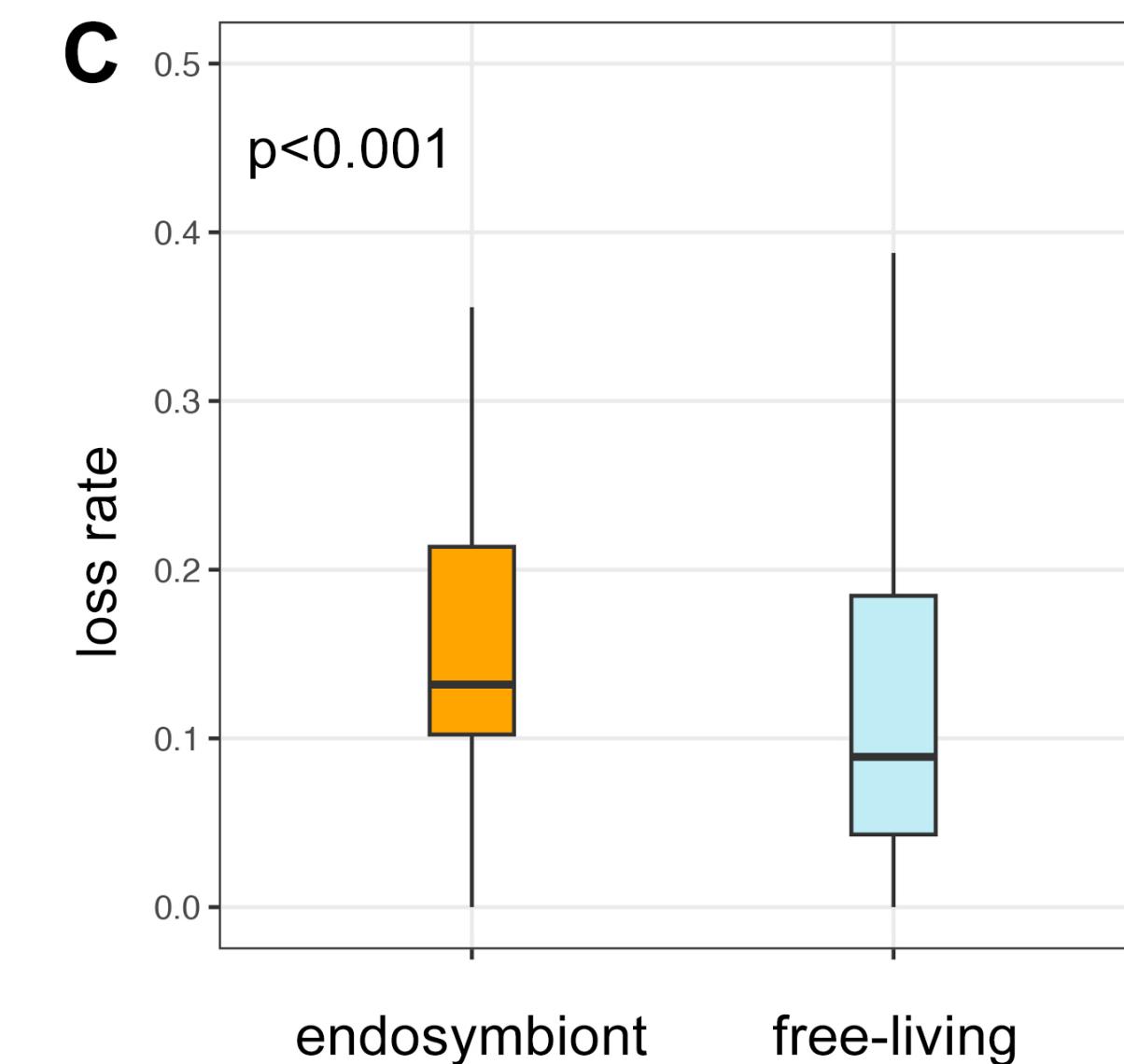
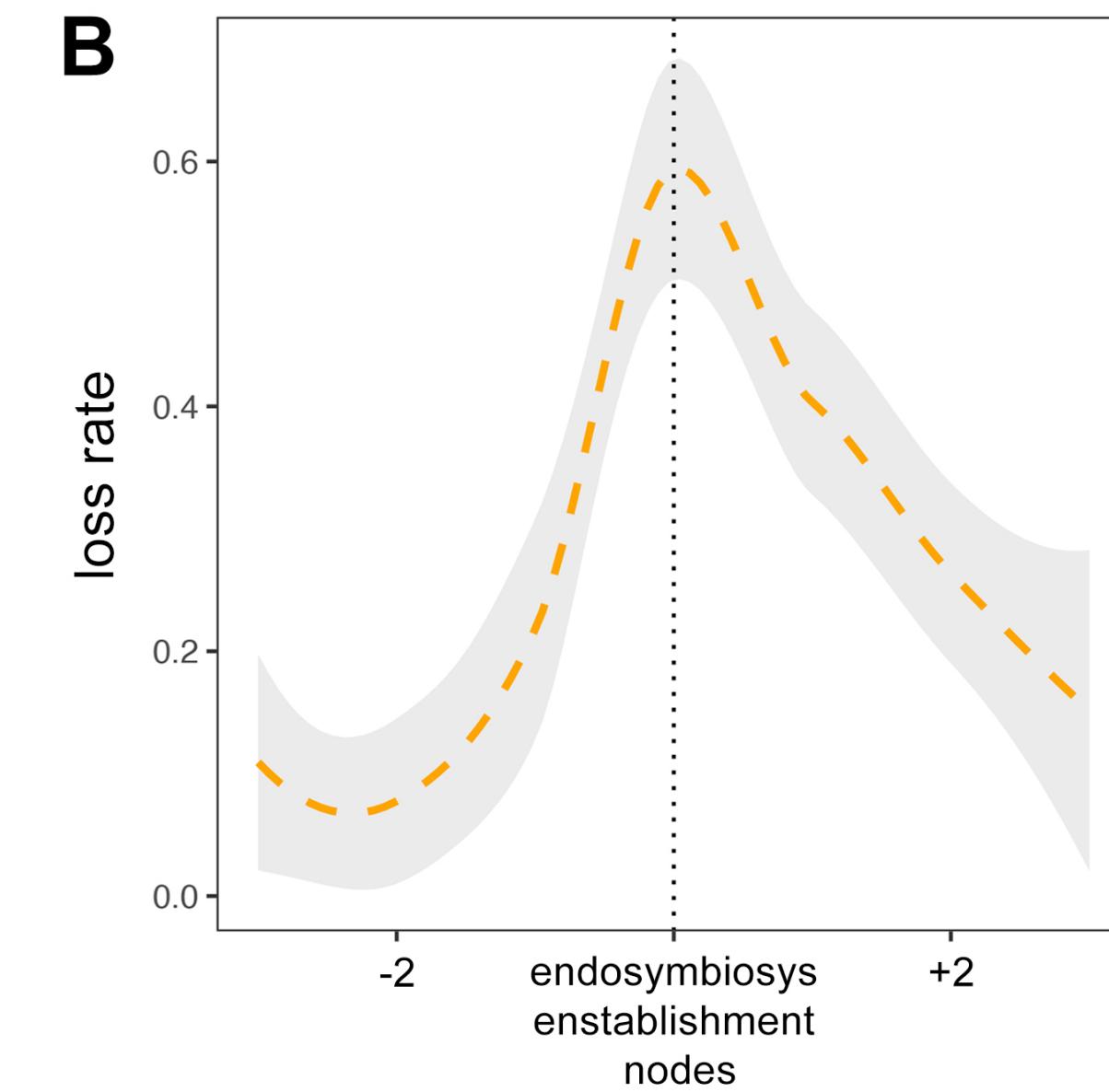
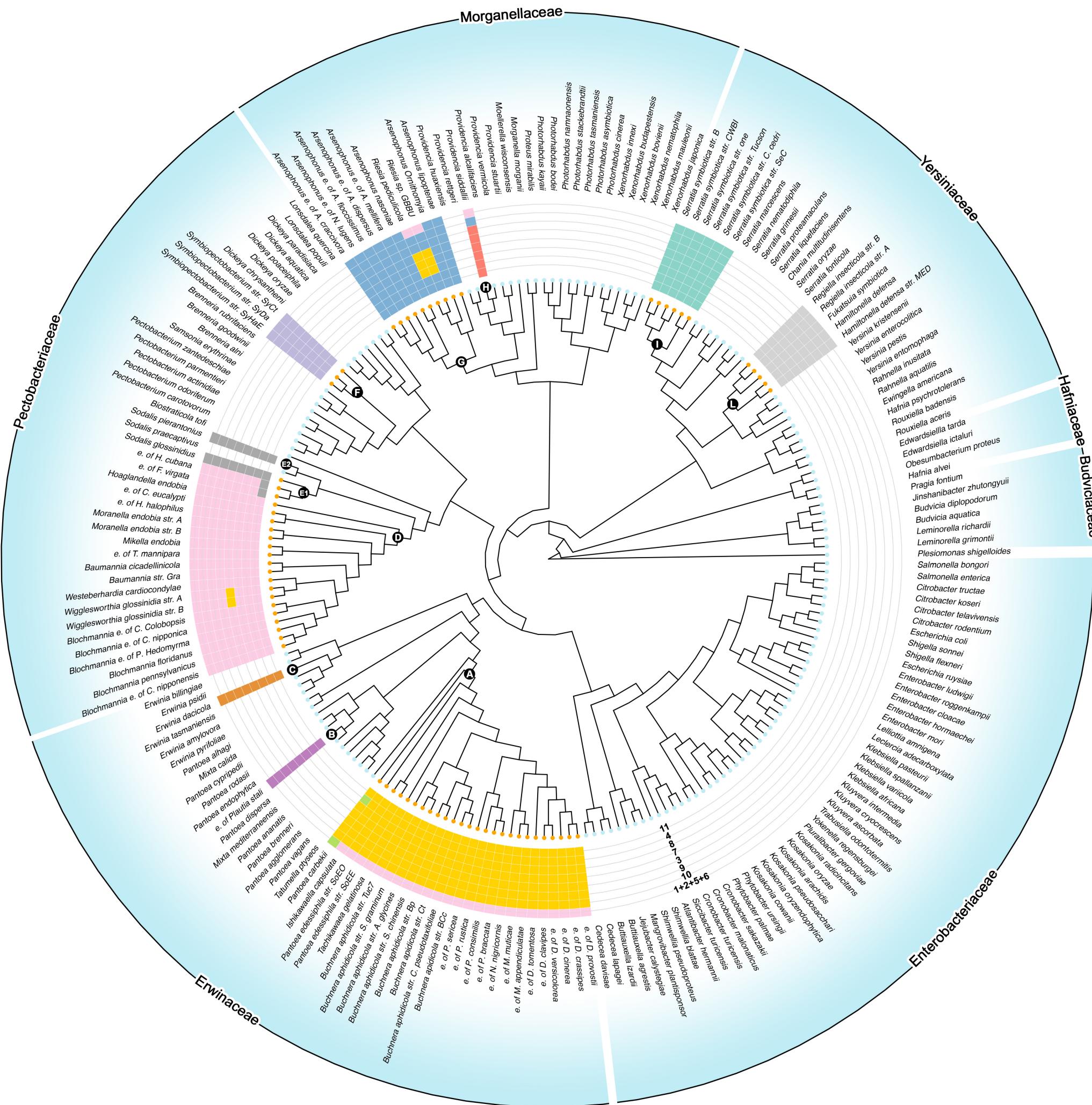
MY RESEARCH



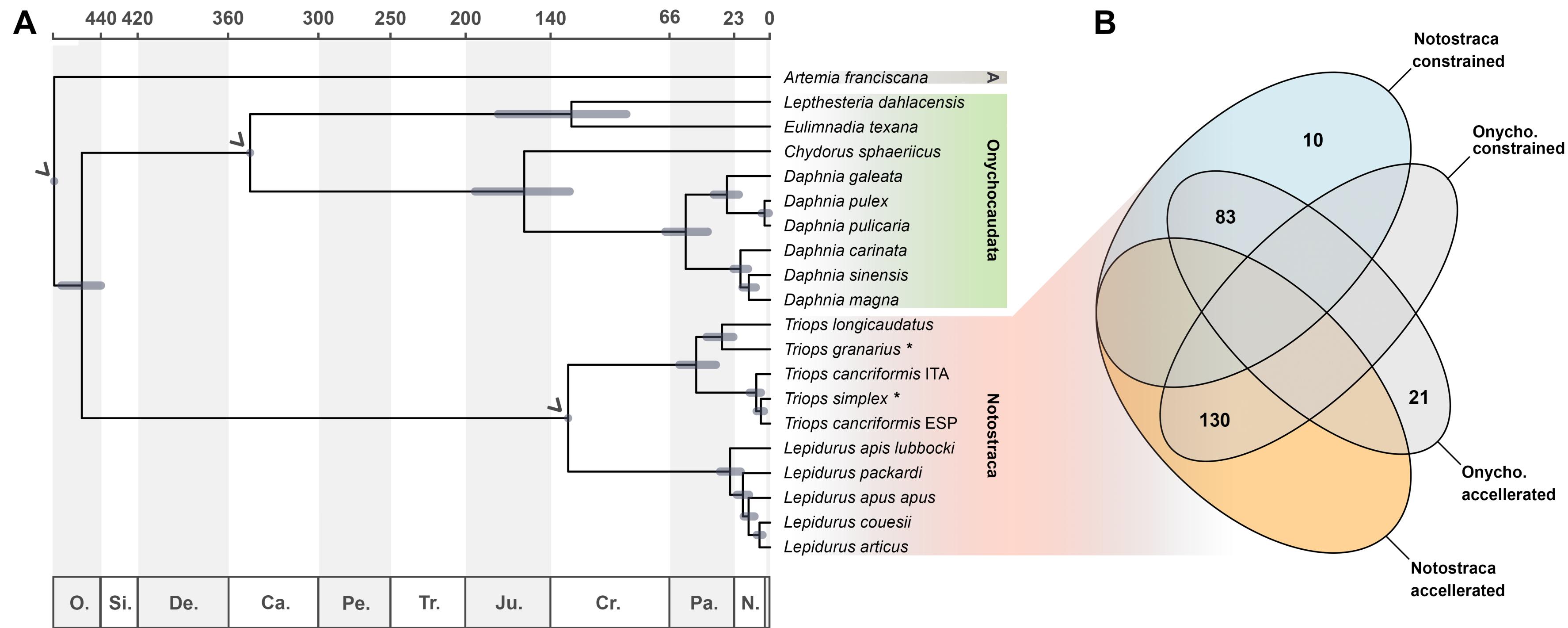
● 0_A - apterous + hidden state A ● 0_B - apterous + hidden state B ● 1_A - winged + hidden state A ● 1_B - winged + hidden state B



MY RESEARCH



MY RESEARCH



C

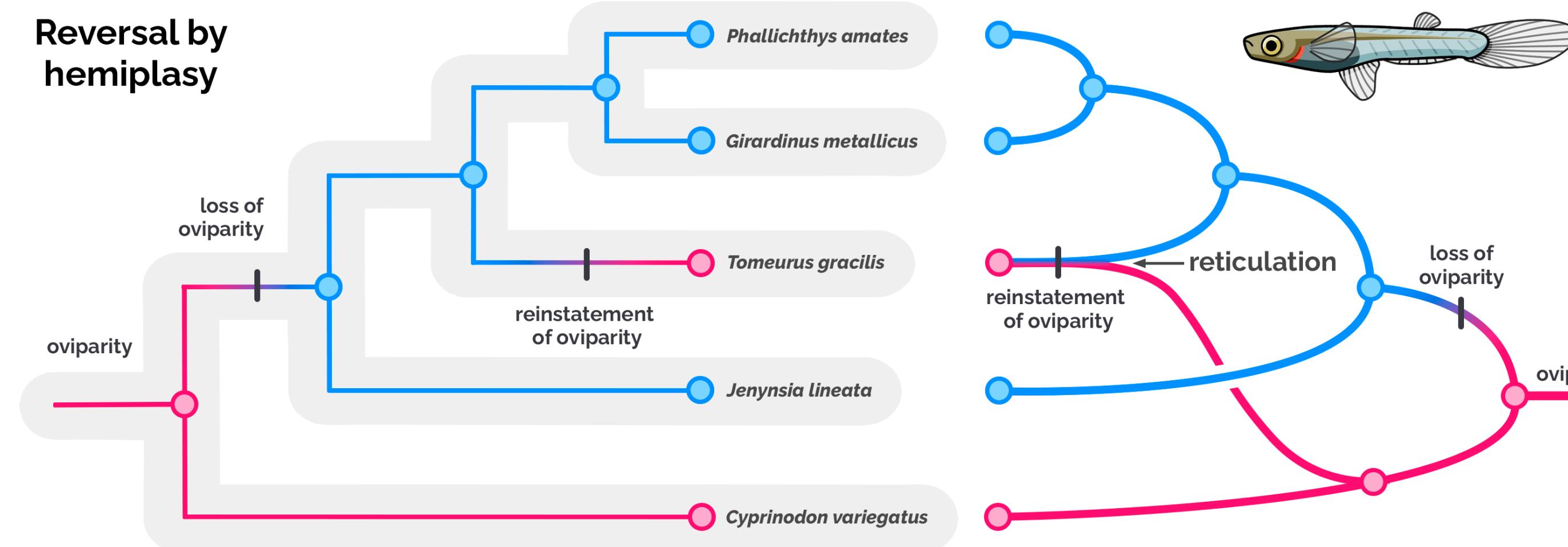
	constrained genes terms	p	significant / expected
GO:0007249	I-kappaB kinase/NF-kappaB signaling	0.00217	11.54
GO:0006357	regulation of transcription by RNA polym...	0.00384	2.37
GO:0006470	protein dephosphorylation	0.00784	5.06
GO:0006355	regulation of transcription, DNA-templat...	0.00819	1.93
GO:1903506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

D

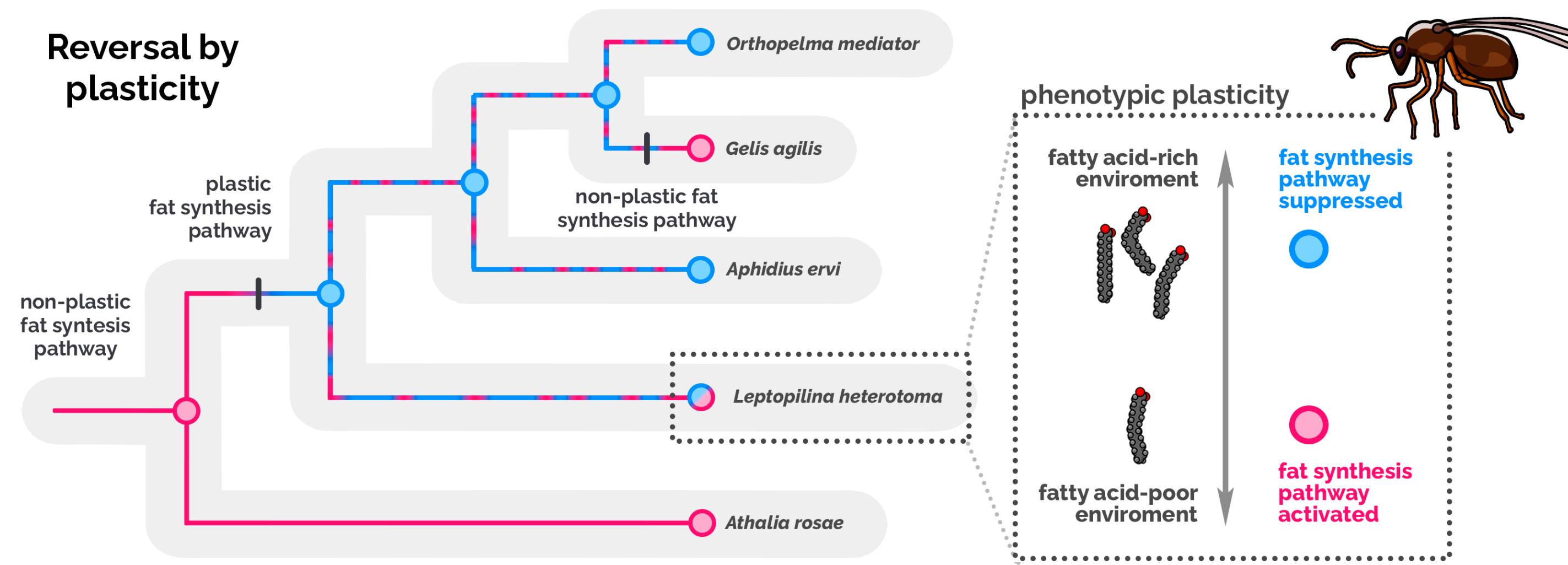
	accelerated genes terms	p	significant / expected
GO:0010466	negative regulation of peptidase activit...	0.0024	10.71
GO:0006397	mRNA processing	0.0024	2.86
GO:0016071	mRNA metabolic process	0.0029	2.48
GO:0097193	intrinsic apoptotic signaling pathway	0.0072	7.32
GO:0050684	regulation of mRNA processing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

MY RESEARCH

Reversal by hemiplasy



Reversal by plasticity



FINISH