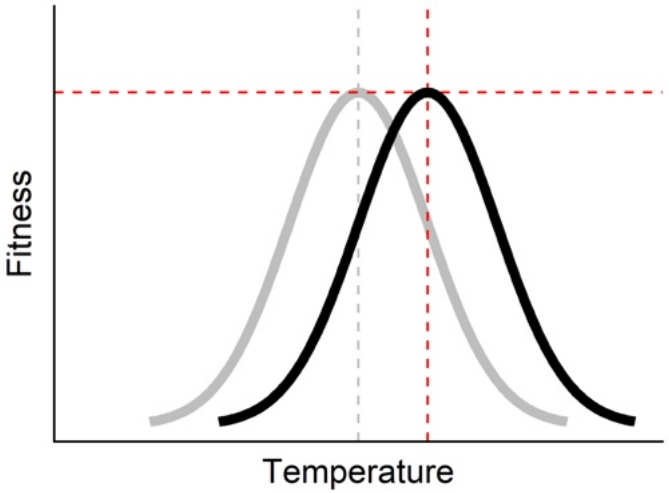
Experimental Evolution of the Temperature Niche

Iain R. Moodie, Sarthak Malusare, Marie-Ange Devillez, Claire Gougat-Barbera, Emanuel A. Fronhofer



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Adapt Disperse Extinct

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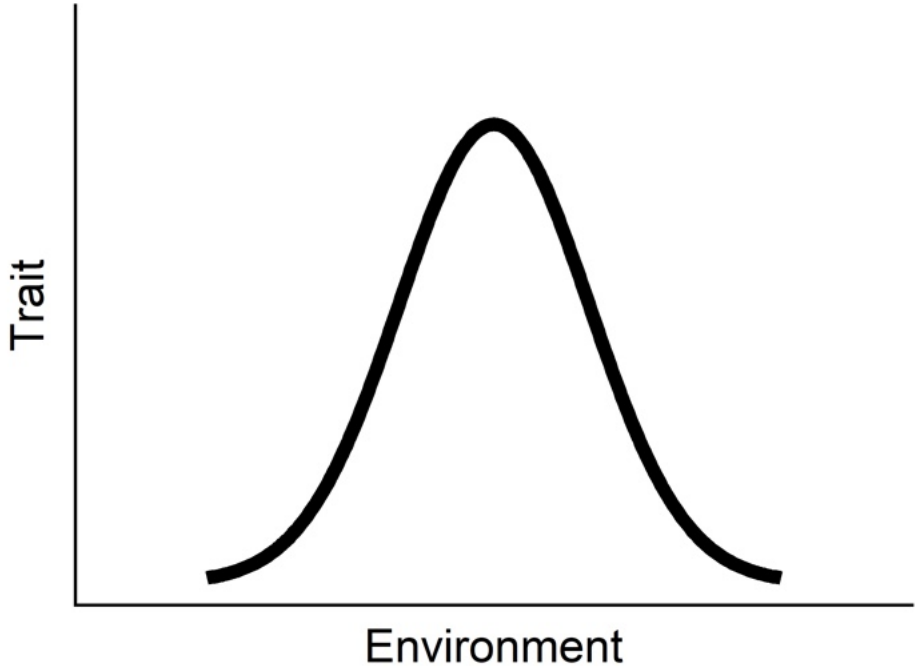
Adapt to increased temperature

The plastic response

- Reaction norm for a given genotype in response to environmental variation



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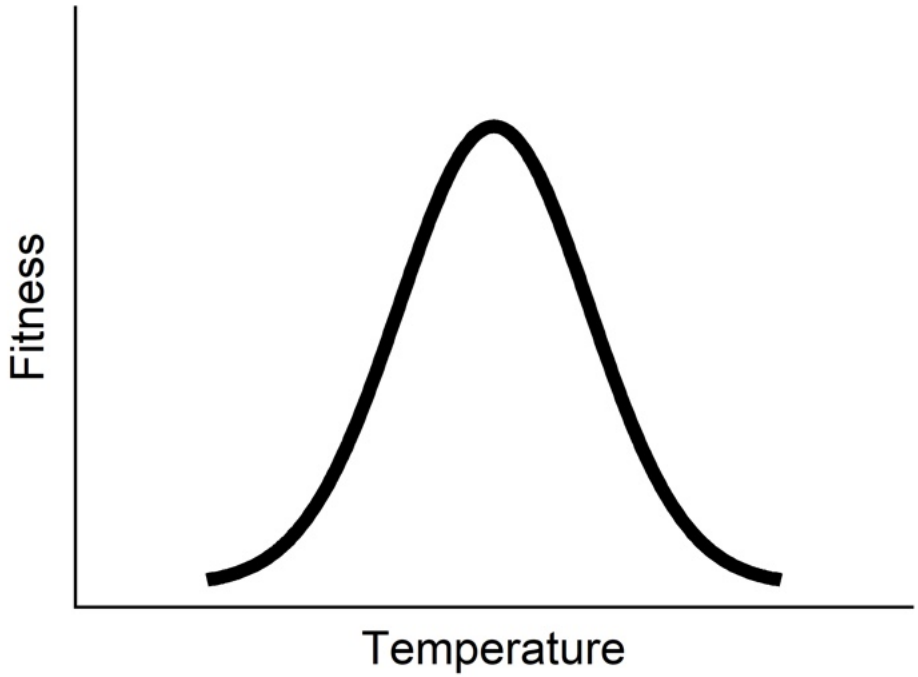

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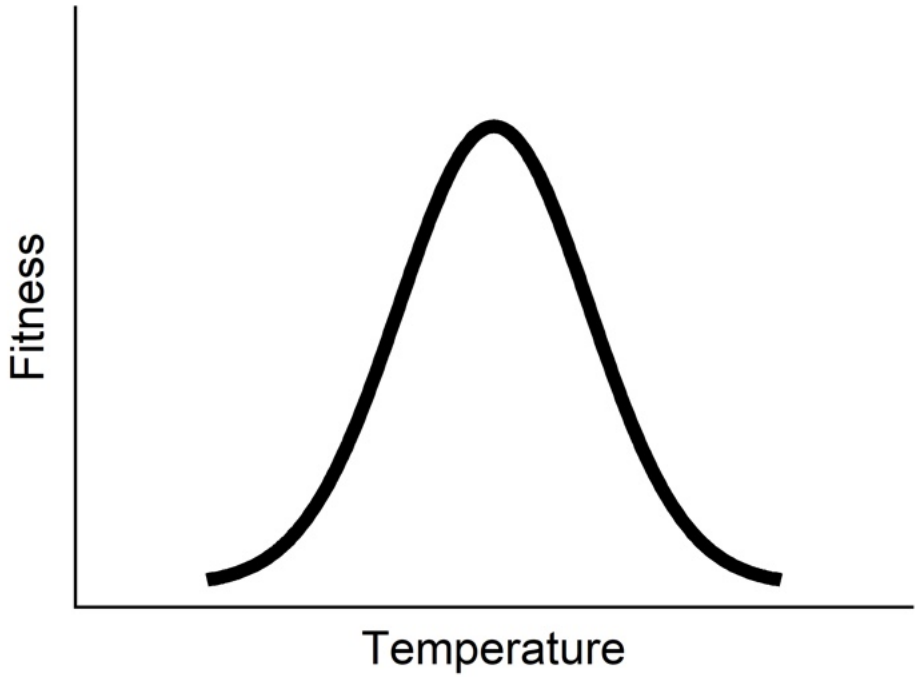
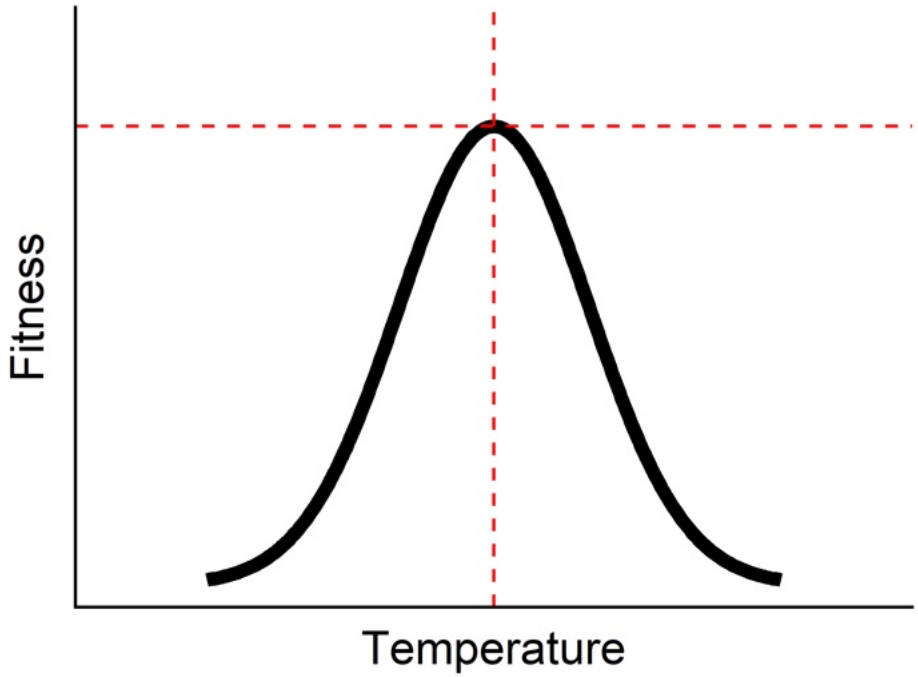


The temperature niche

- Reaction norm for a given genotype in response to environmental variation
- a priori – we expect the maximum to match closely with the mean temperature of the environment (in ectotherms)



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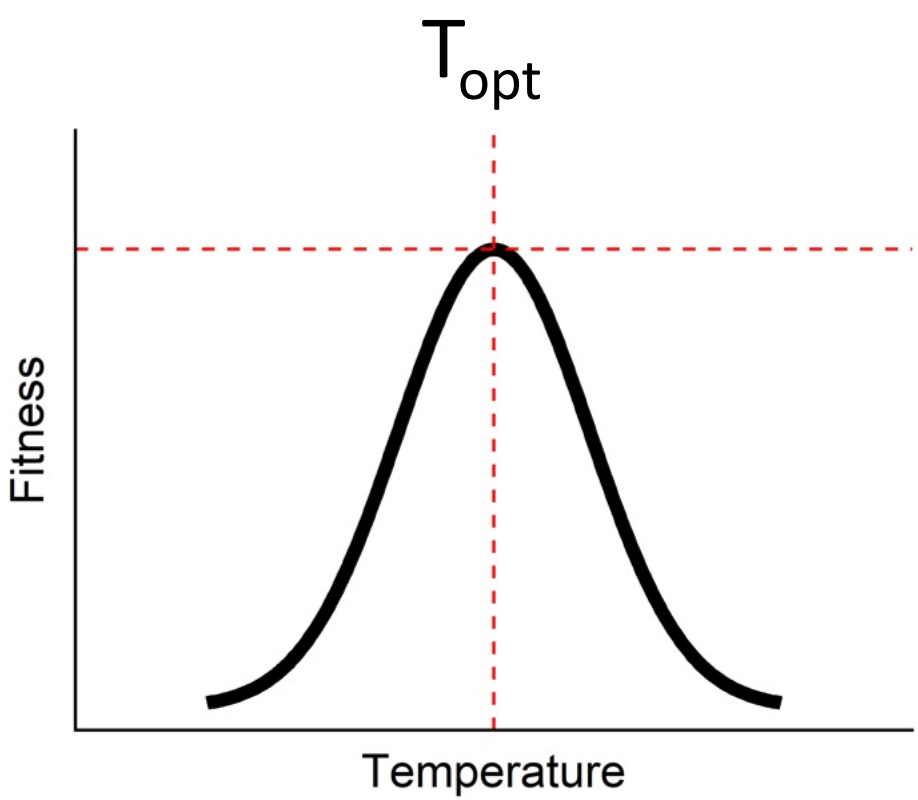
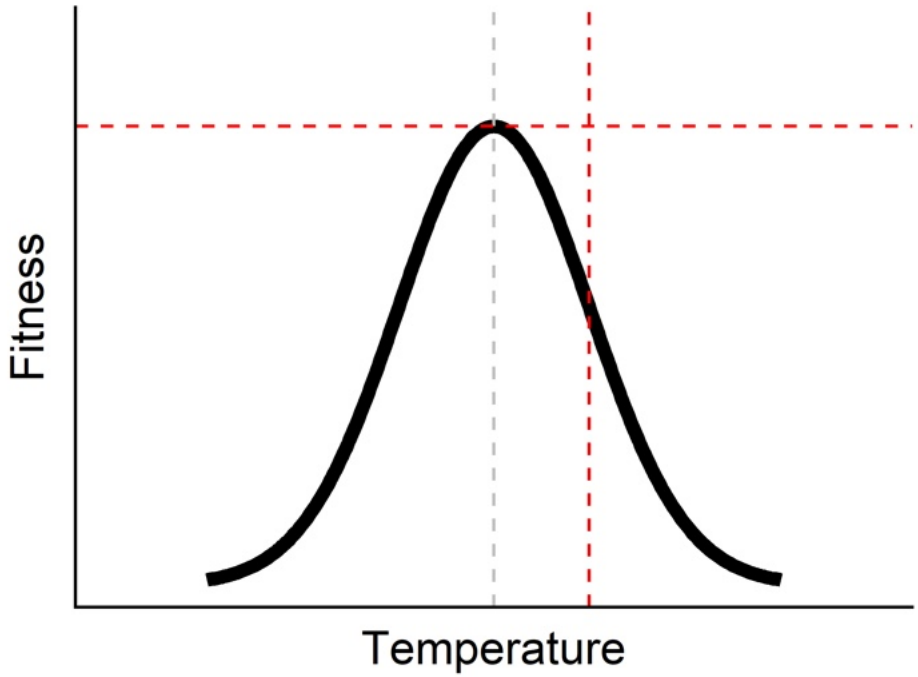
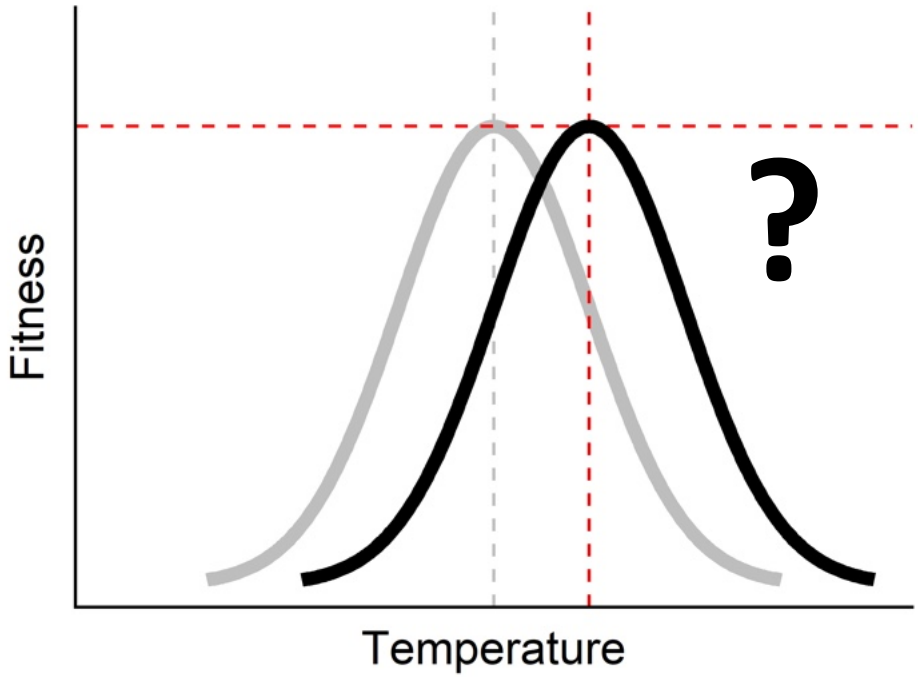


The temperature niche

- Reaction norm for a given genotype in response to environmental variation
- a priori – we expect the maximum to match closely with the mean temperature of the environment (in ectotherms)
- Can this plasticity evolve in response to environmental change?



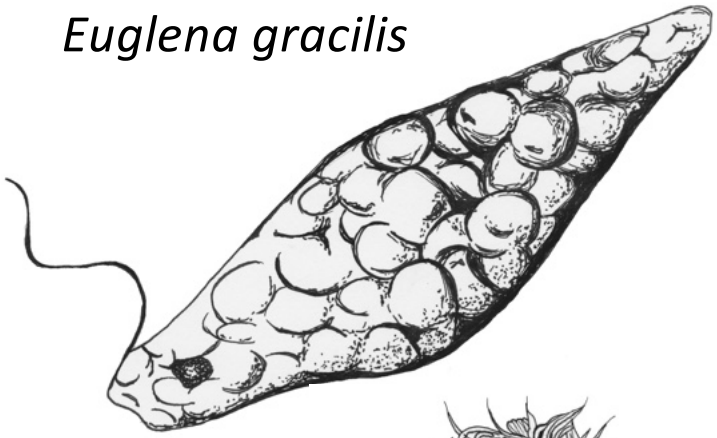
Can the temperature niche evolve?



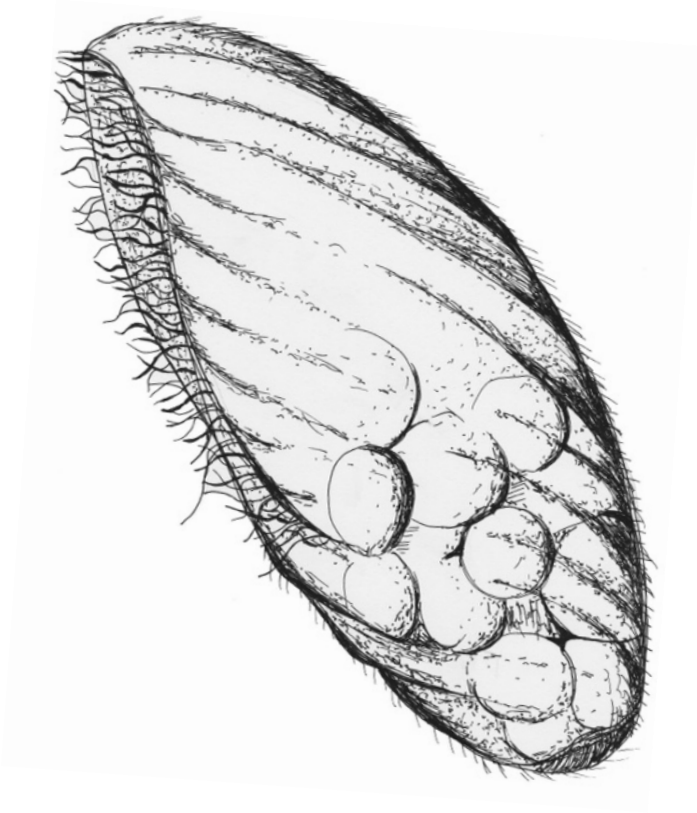
The experiment

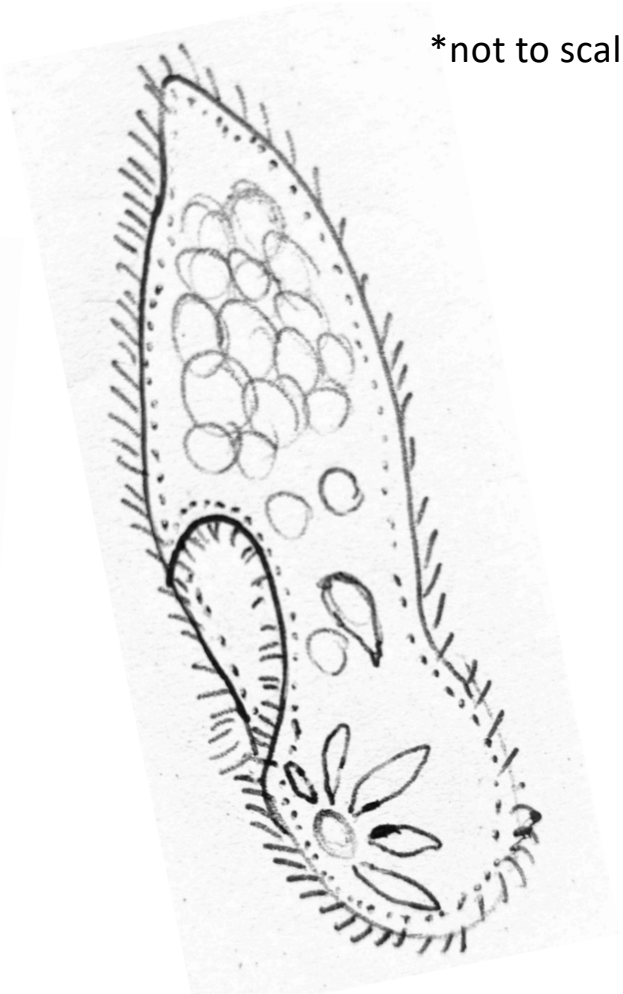
*not to scale

Euglena gracilis

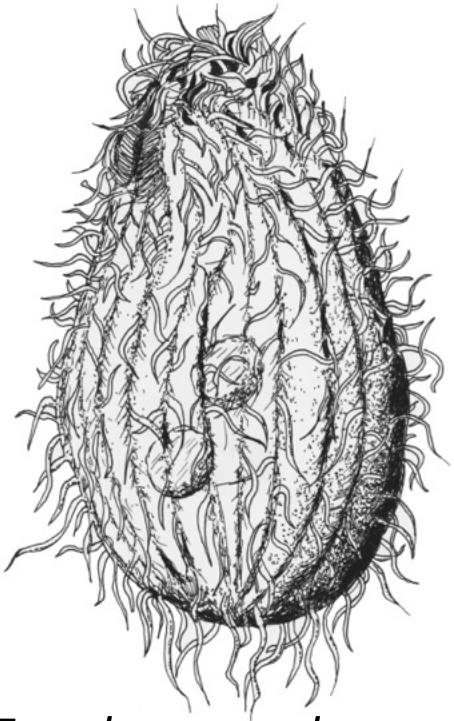


Blepharisma sp.





Paramecium caudatum

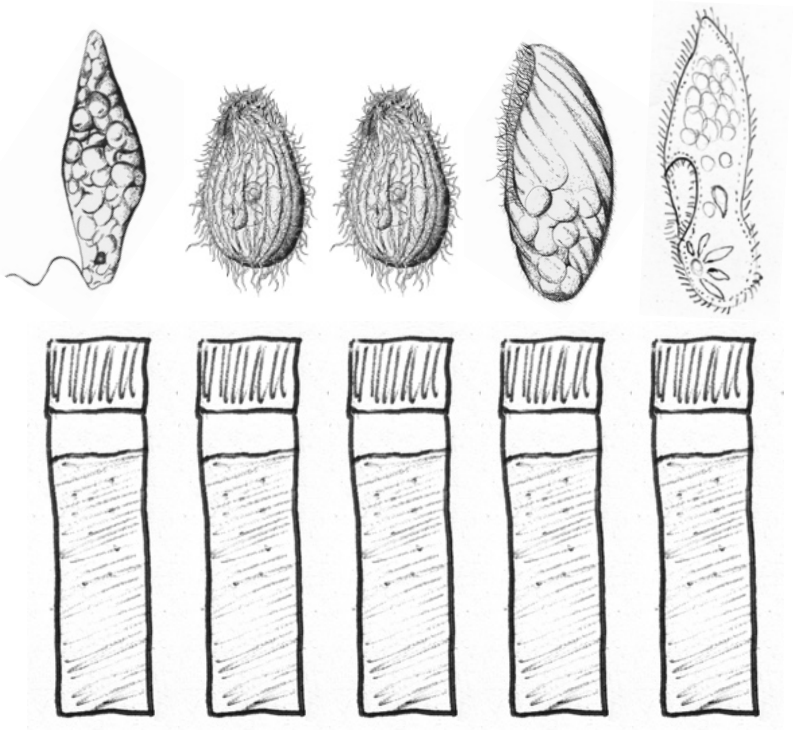


Tetrahymena thermophila

Nice drawings: Martina Ramel ©

The experiment

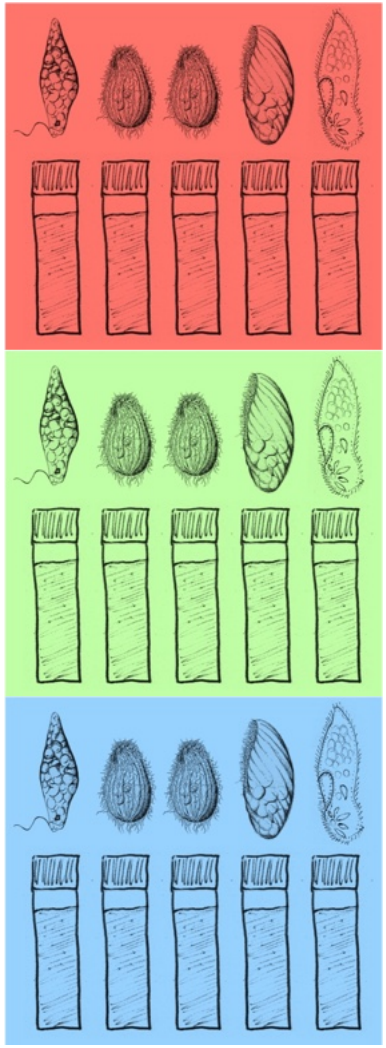
- **Four** protist species



The experiment

- **Four** protist species
- **Three** biological replicates

Replicate A

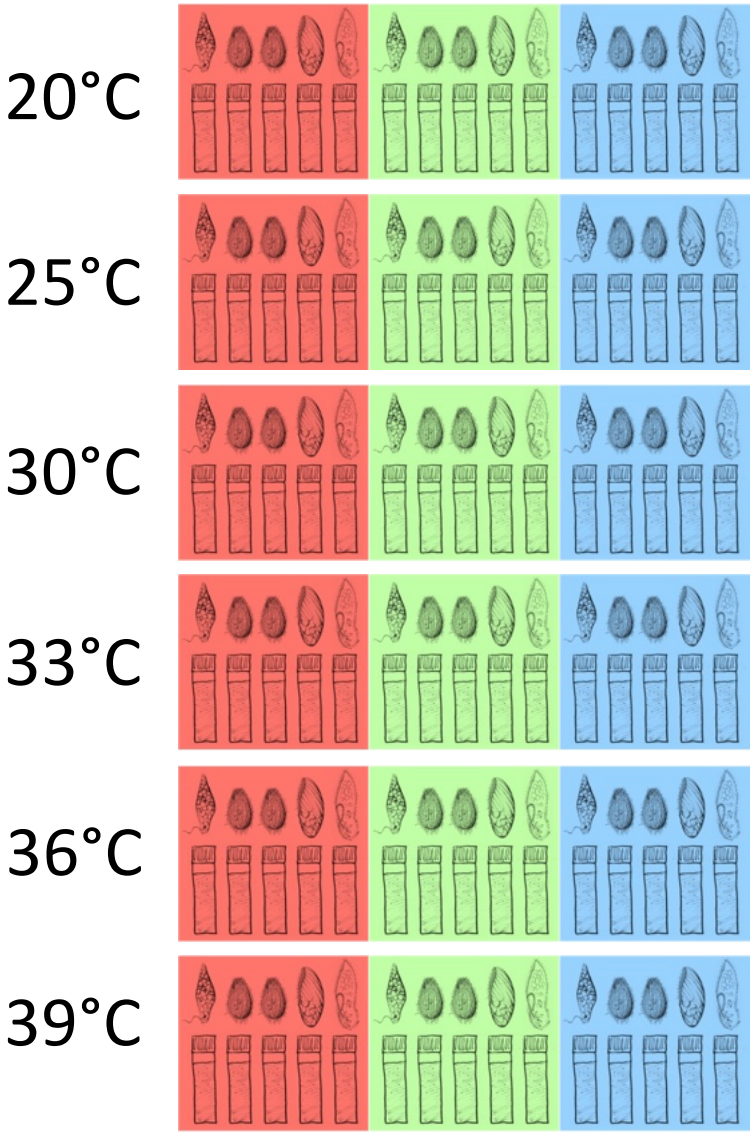


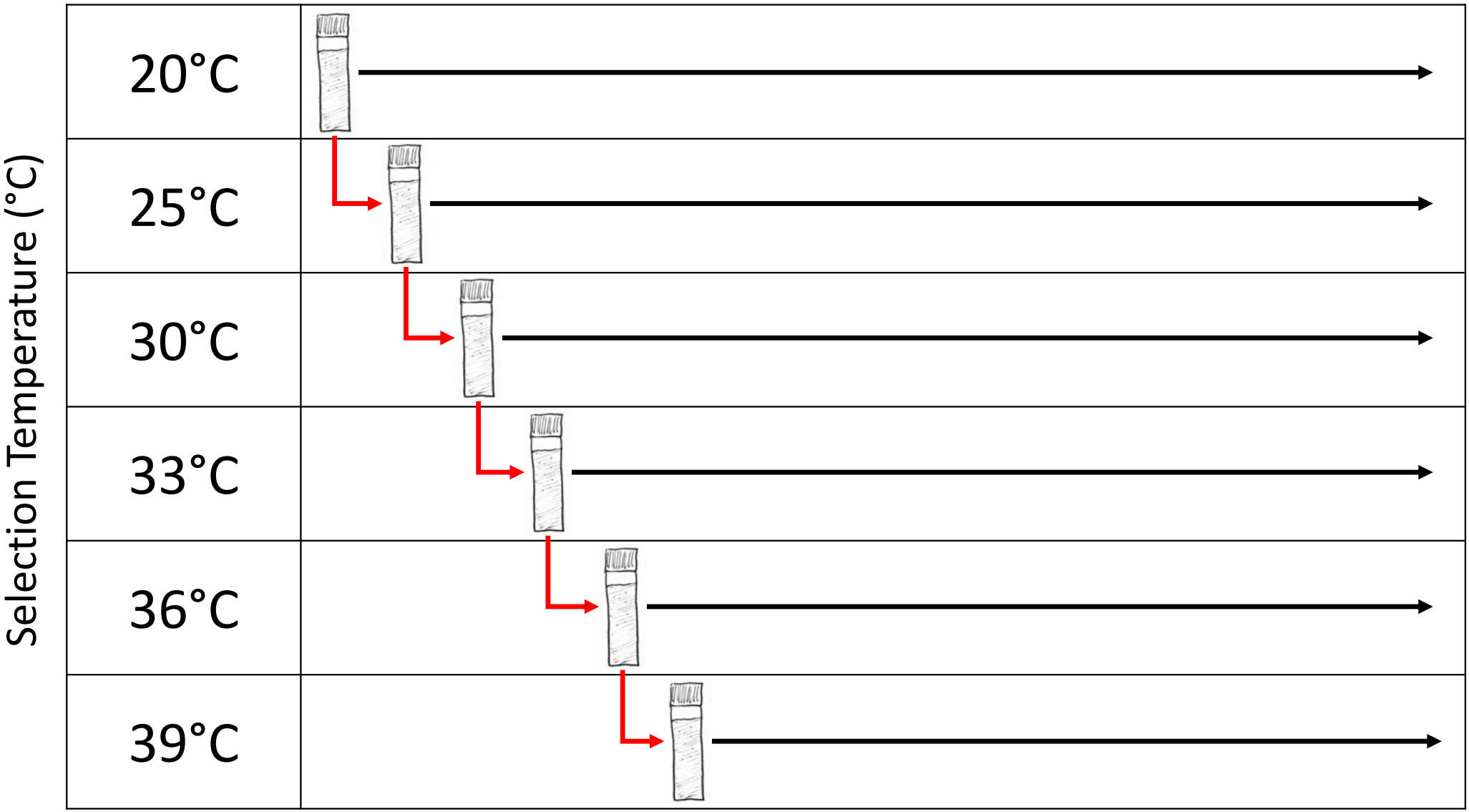
Replicate B

Replicate C

The experiment

- **Four** protist species
- **Three** biological replicates
- **Six** selection temperatures
  - (20, 25, 30, 33, 36, 39°C)

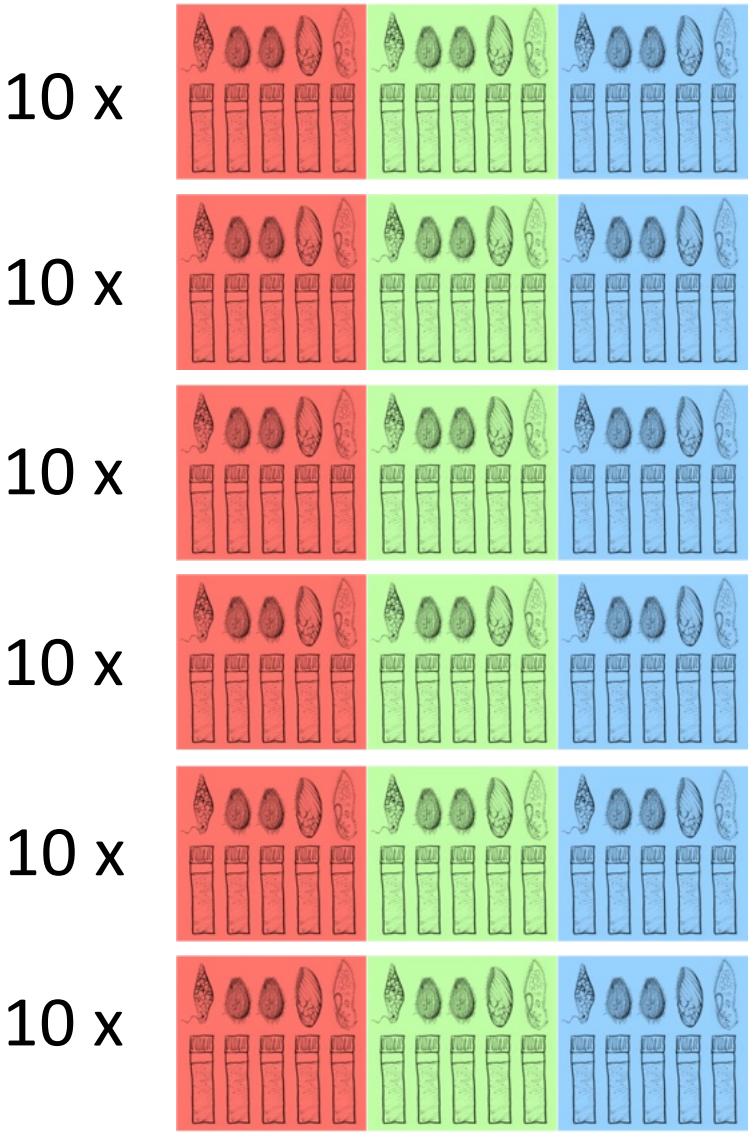



Selection Temperature (°C)
20°C
25°C
30°C
33°C
36°C
39°C

The experiment

- **Five** protist species
- **Three** biological replicates
- **Six** selection temperatures
  - (20, 25, 30, 33, 36, 39°C)

- After nearly **one year** of selection
- **Ten** assayed temperatures
  - (5 – 40 °C)



The experiment

After nearly **one year** of selection

- **Ten** assayed temperatures
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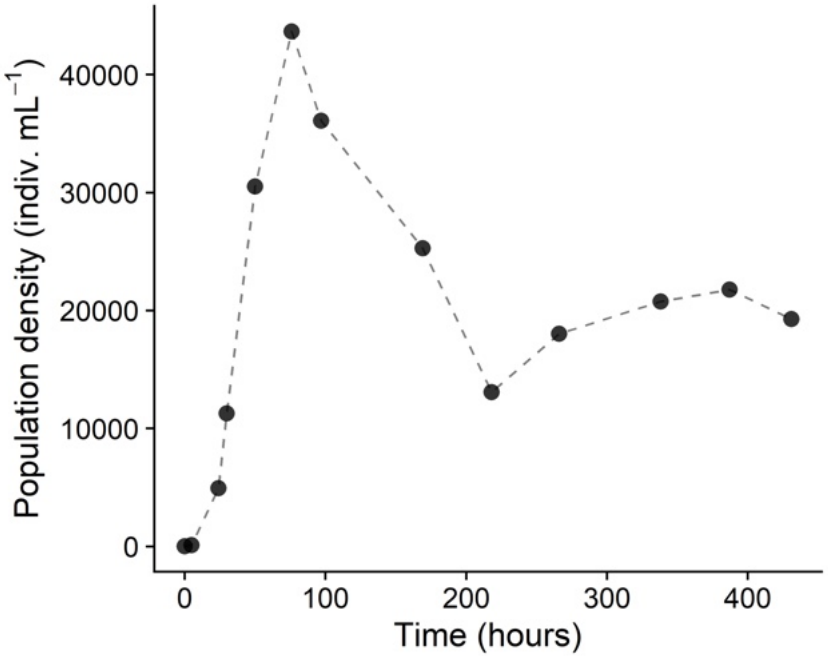
- Measure population density over time



The experiment

After nearly **one year** of selection

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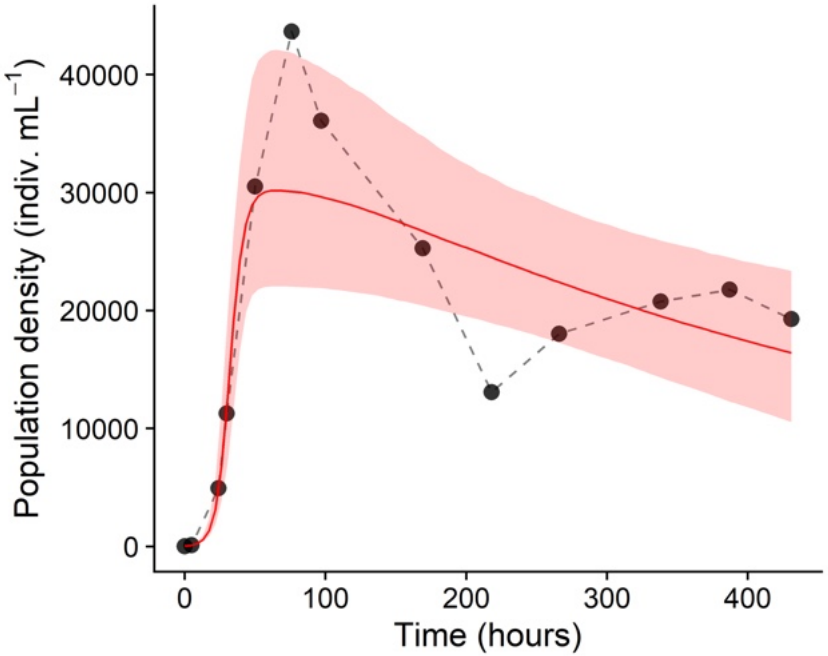
- Fit growth models to get r_0 estimates



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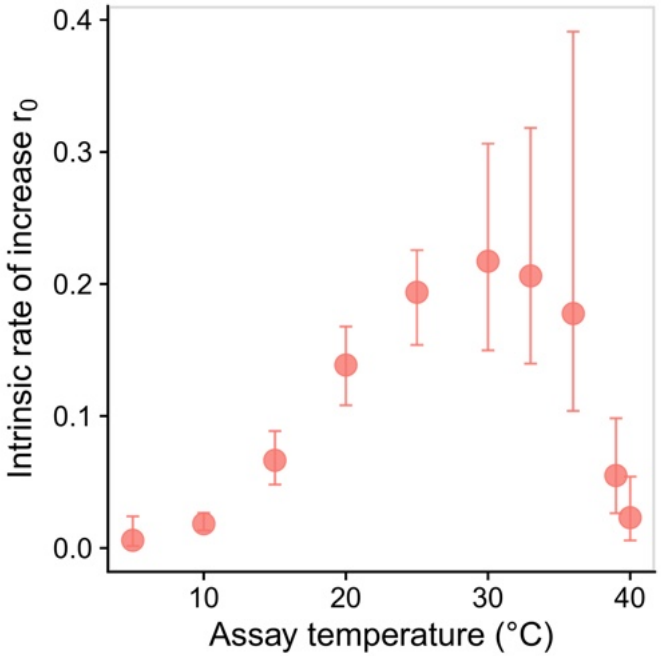
- Use the r_0 estimates to fit the niche function for each selected population



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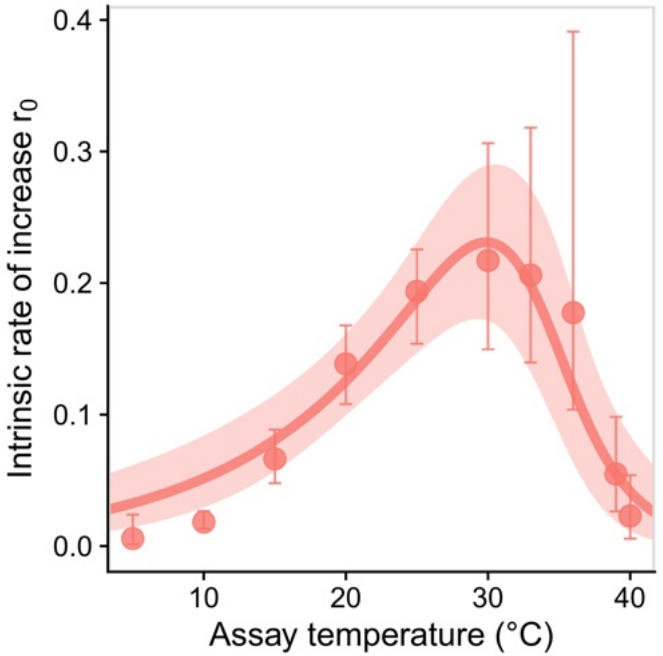
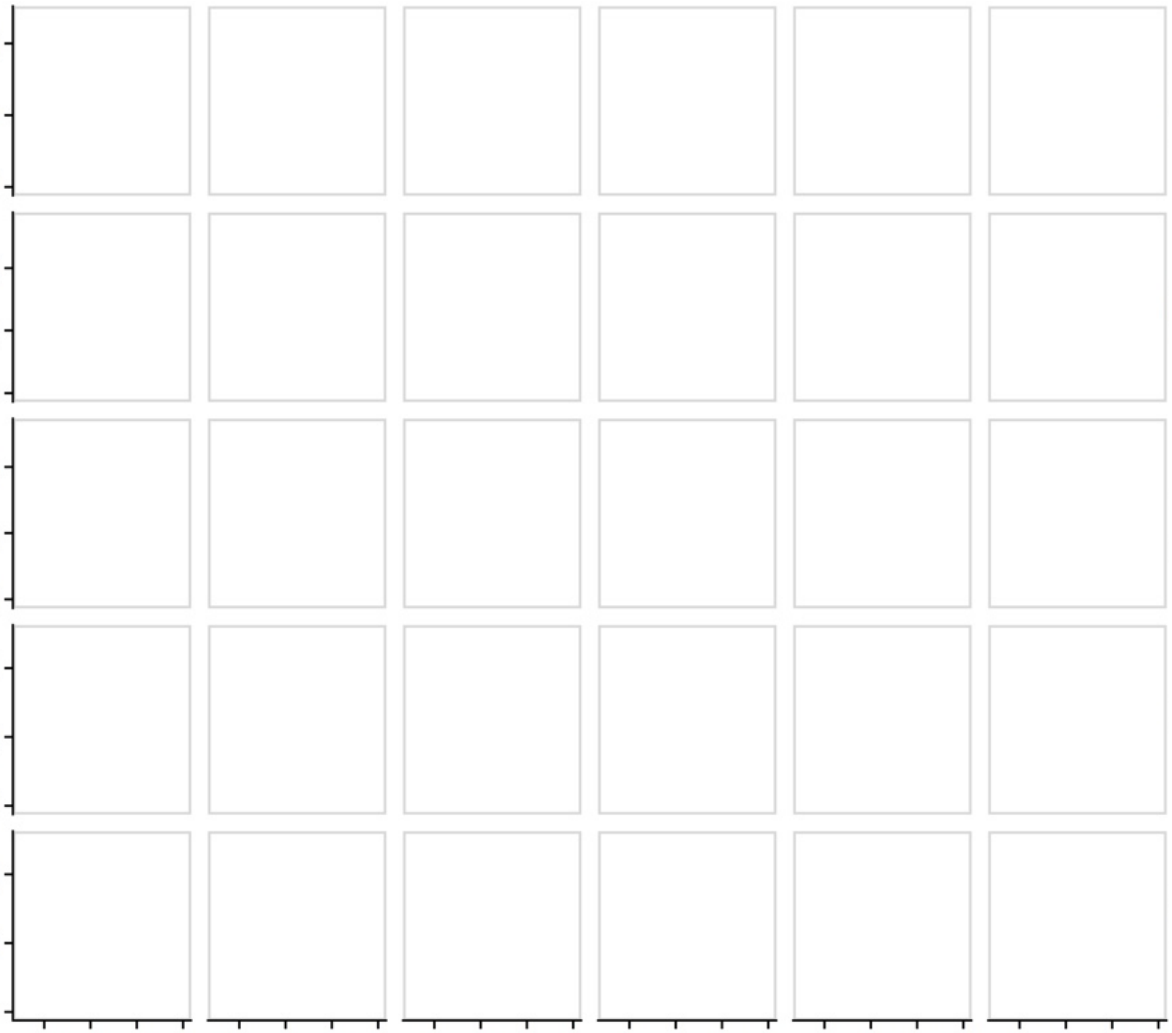
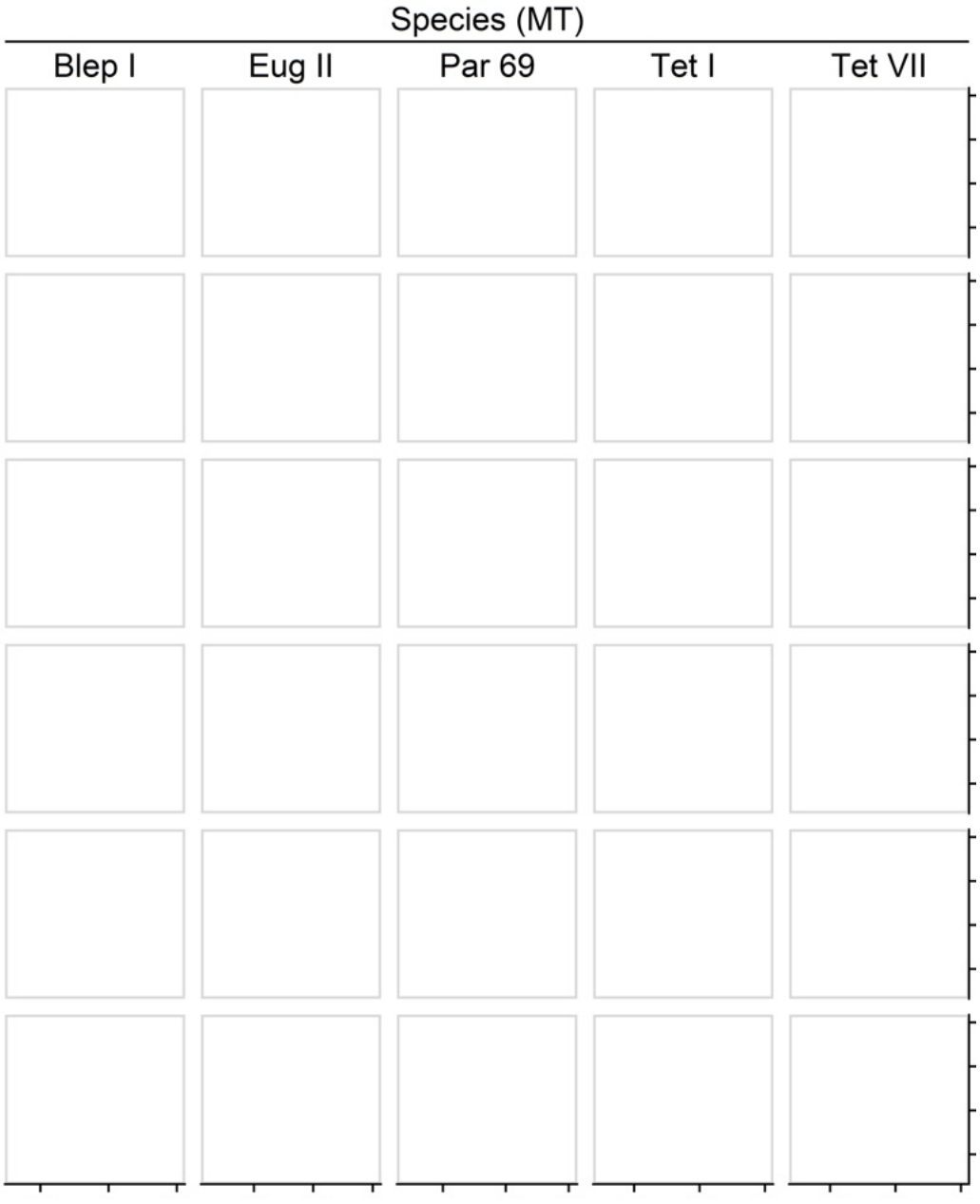
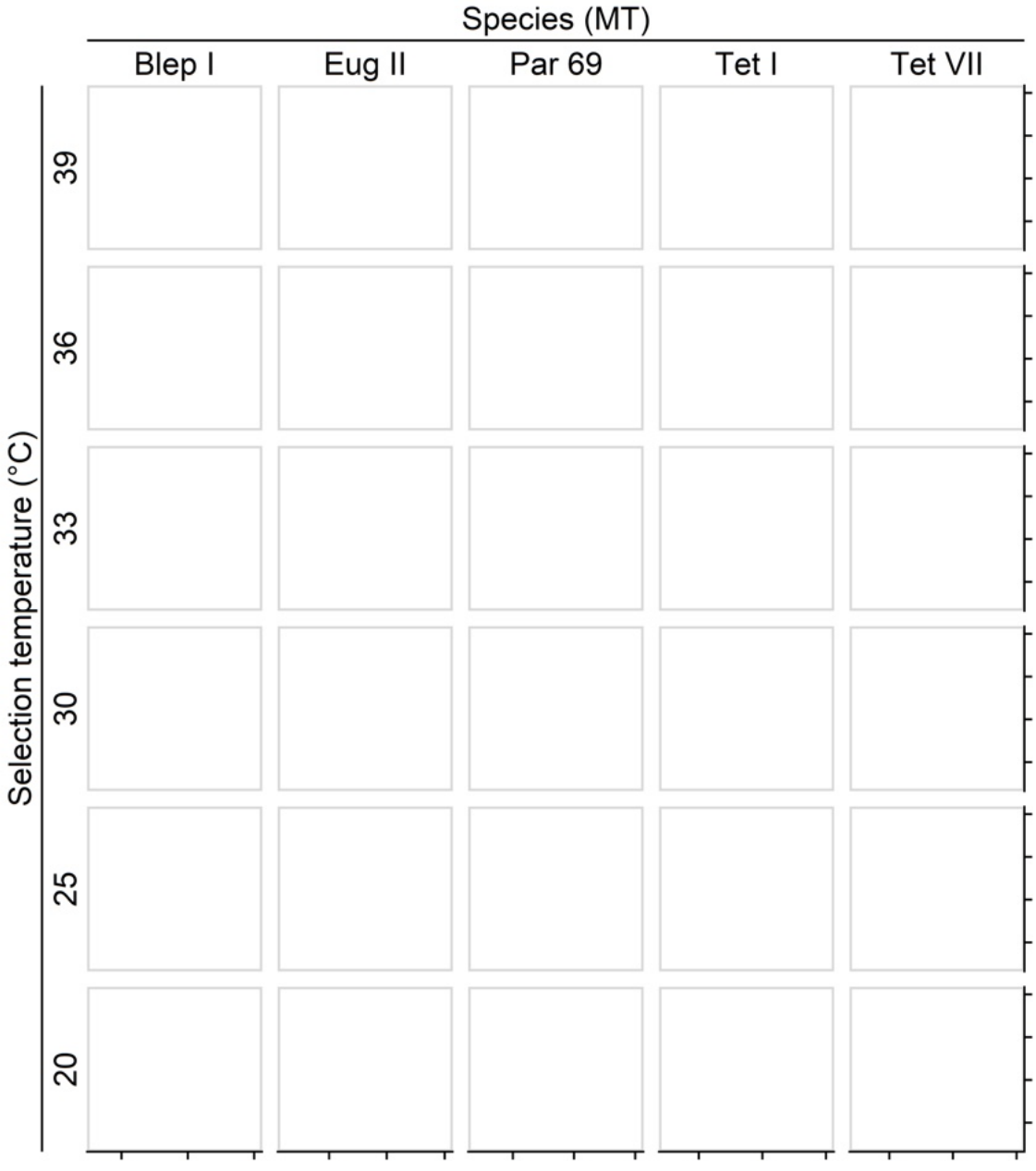
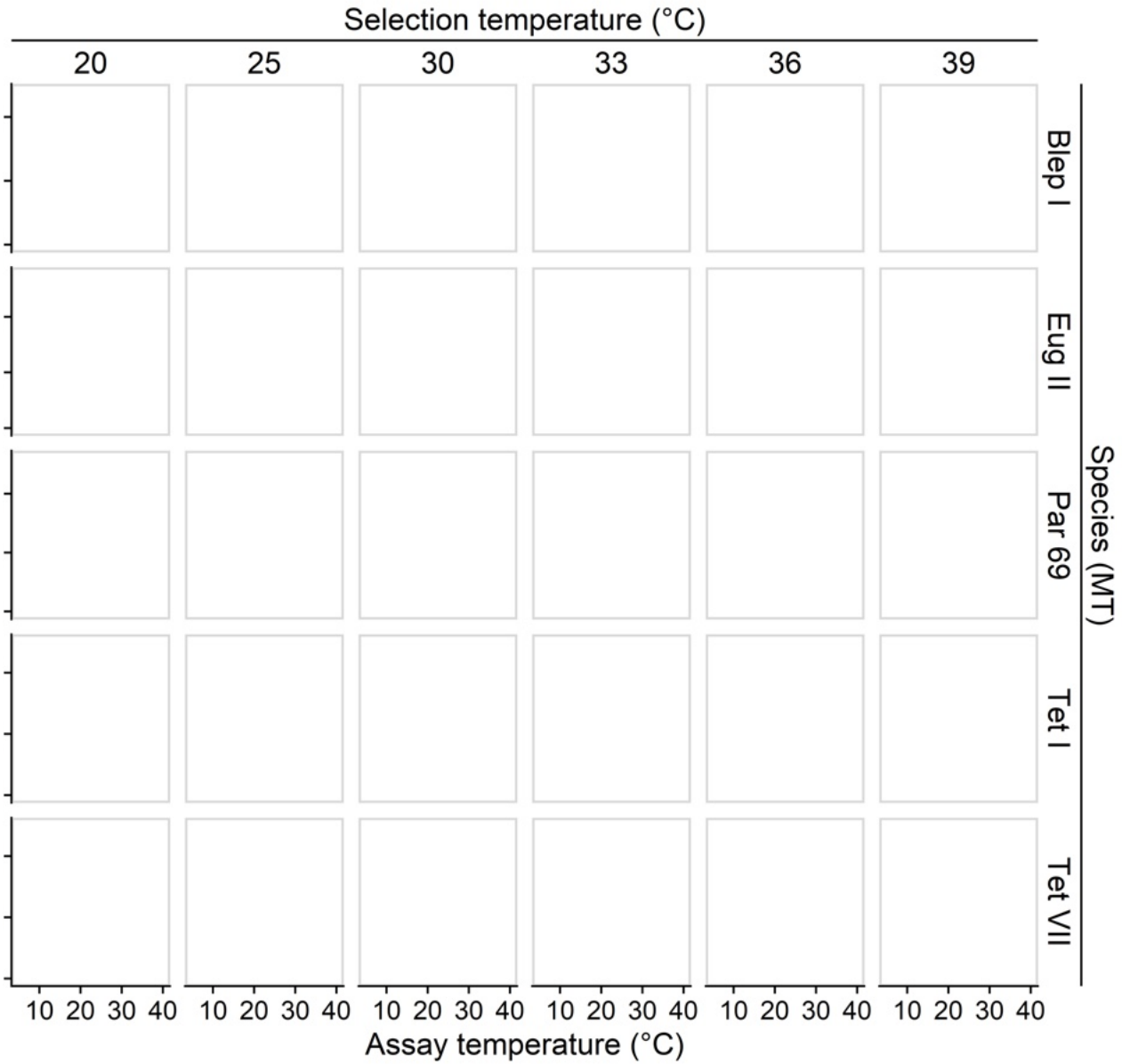


The results




Species (MT)
Blep I
Eug II
Par 69
Tet I
Tet VII


Species (MT)
Blep I
Eug II
Par 69
Tet I
Tet VII
Selection temperature (°C)
39
36
33
30
25
20


Selection temperature (°C)
20
25
30
33
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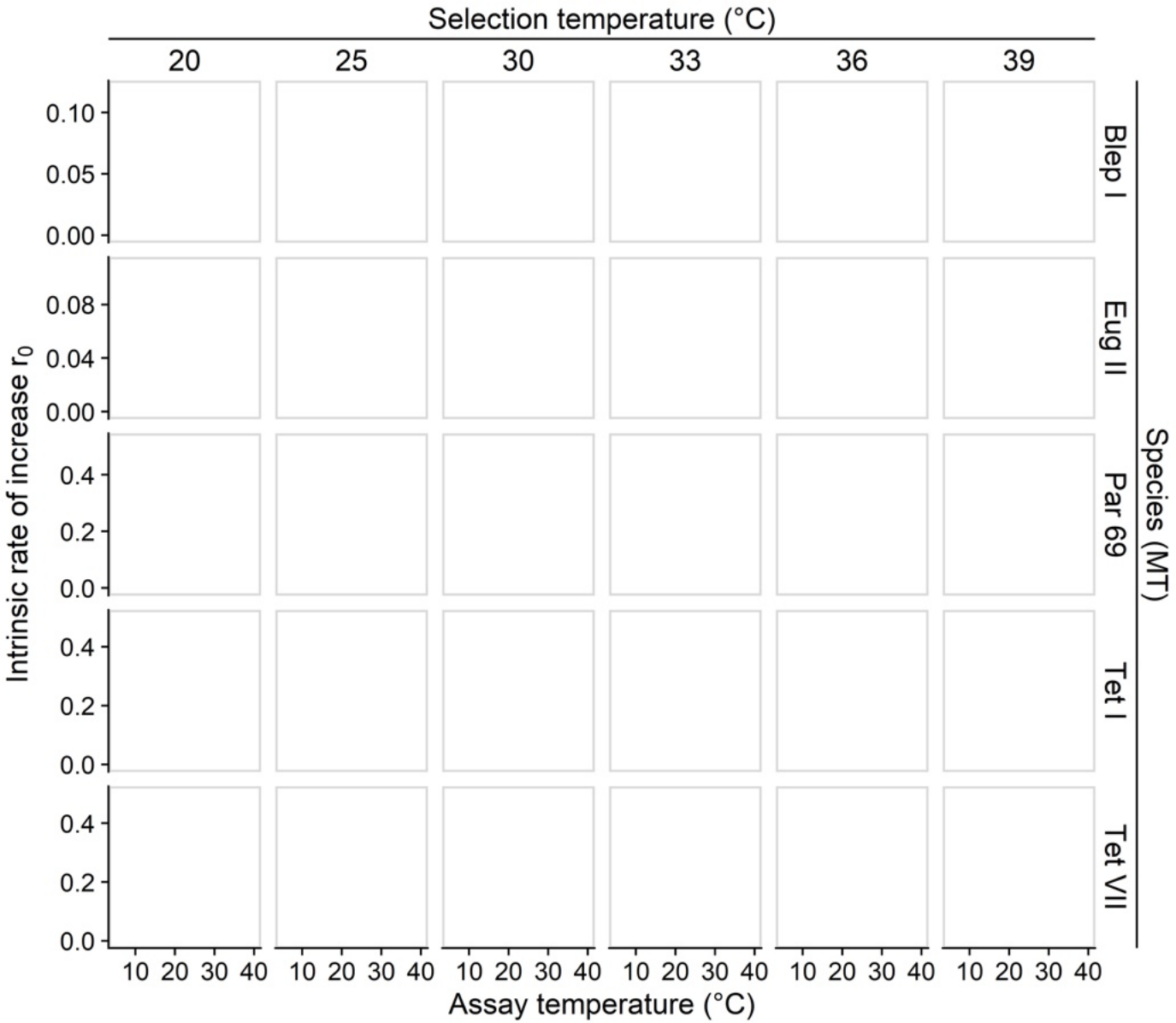
39
Blep I
Eug II
Par 69
Tet I
Tet VII
Species (MT)
10 20 30 40
Assay temperature (°C)


Selection temperature (°C)
20
25
30
33
36
39
Intrinsic rate of increase r_0
0.10
0.05
0.00
0.08
0.04
0.00
0.4
0.2
0.0
0.4
0.2
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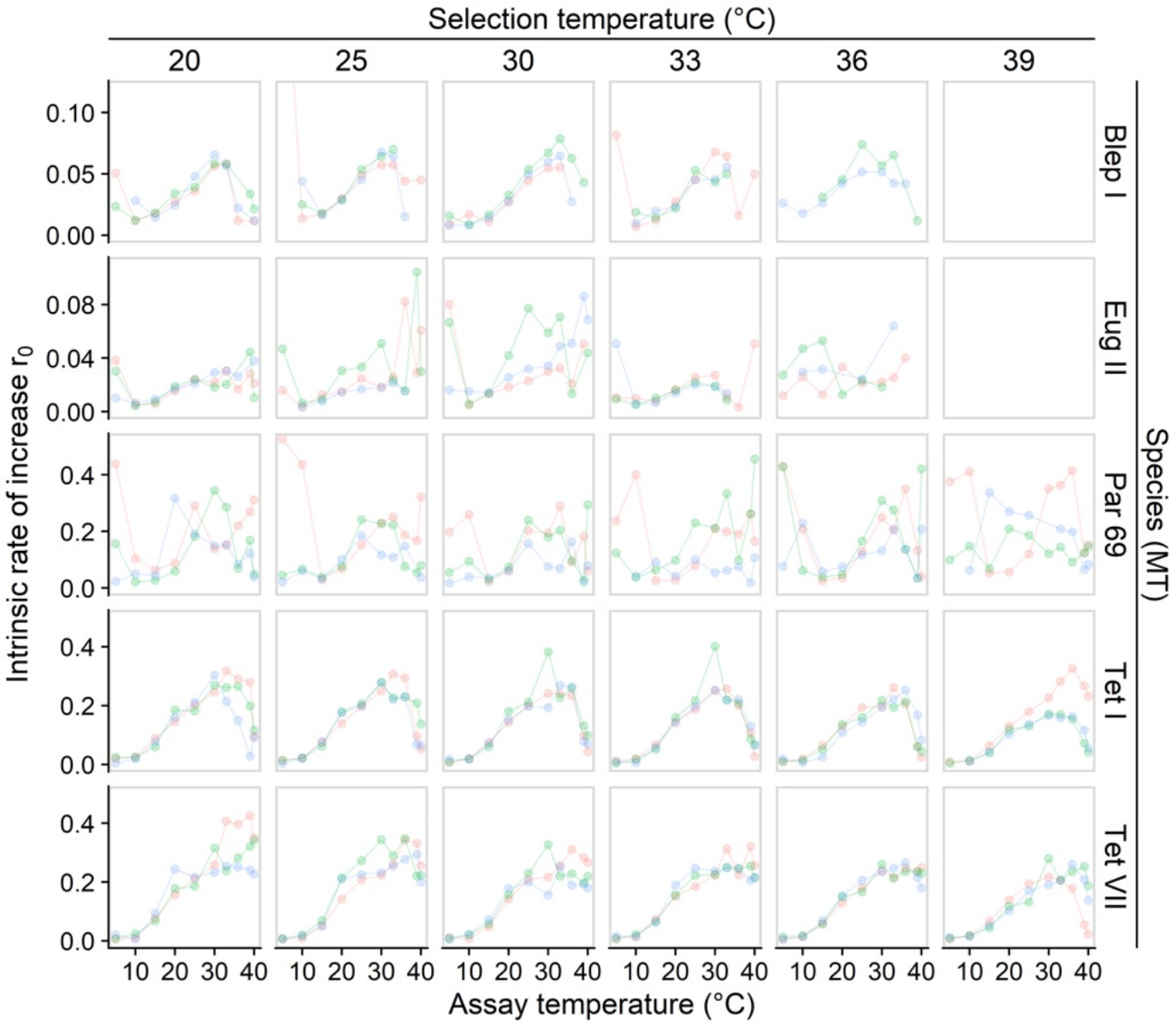
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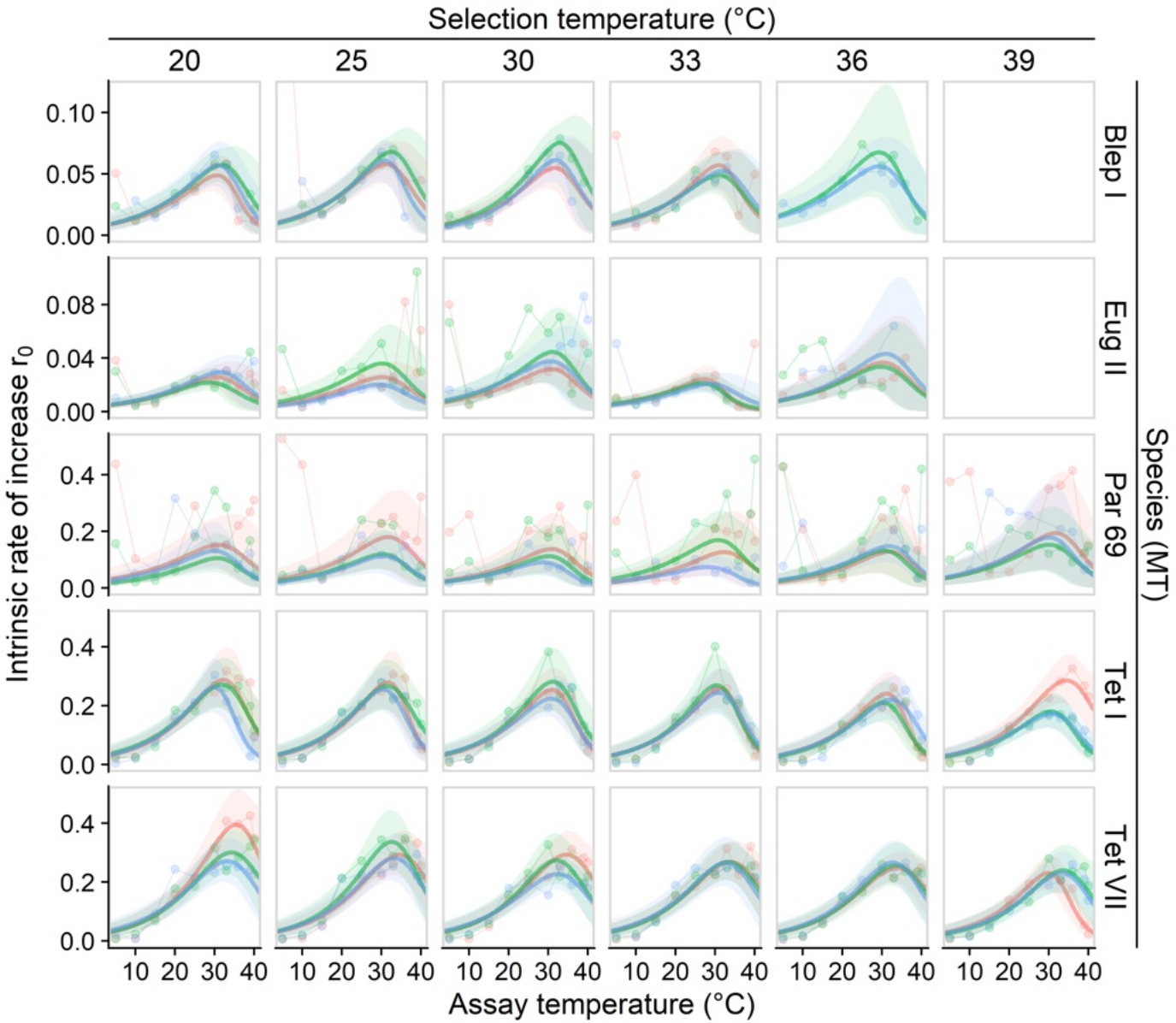
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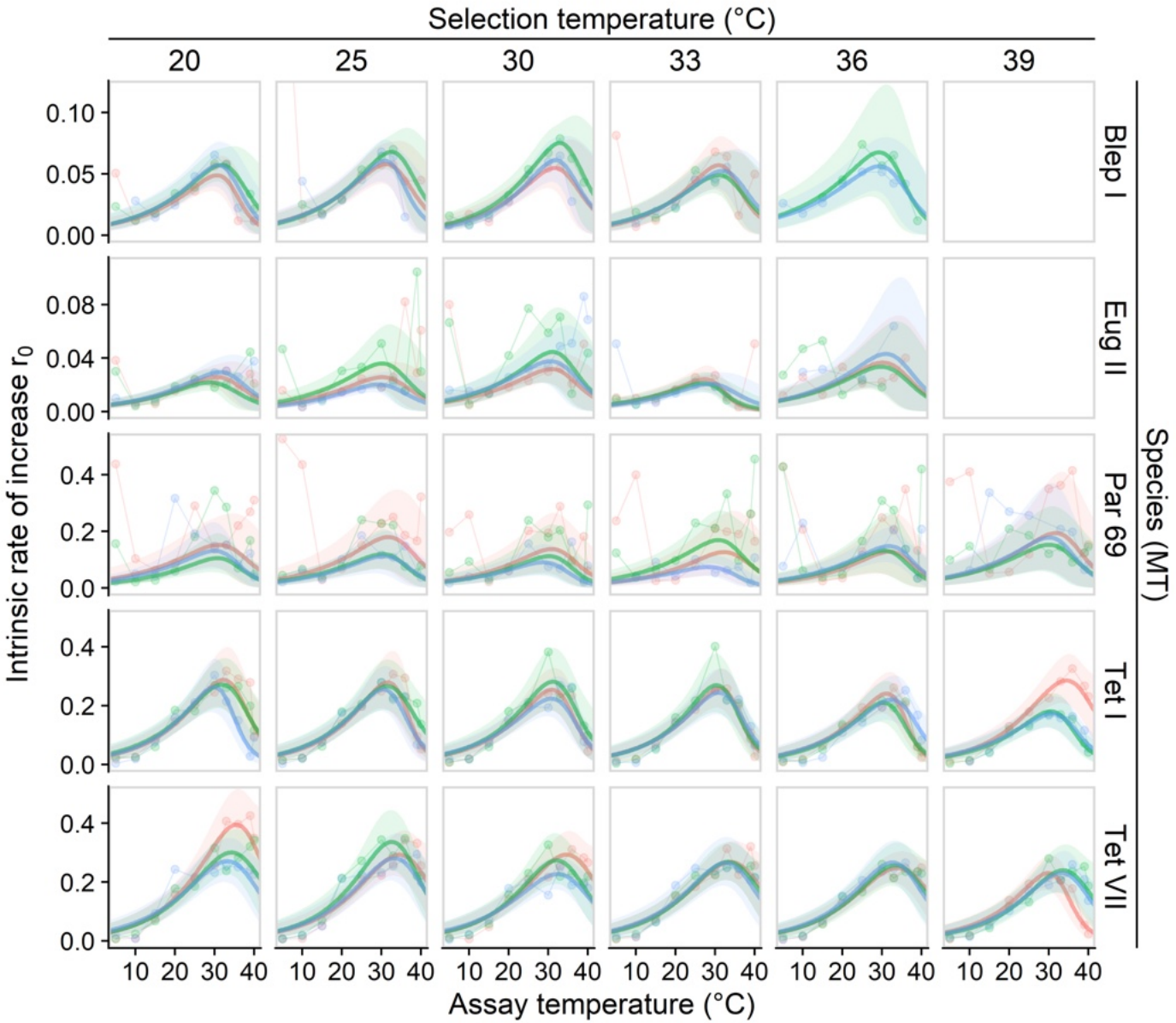
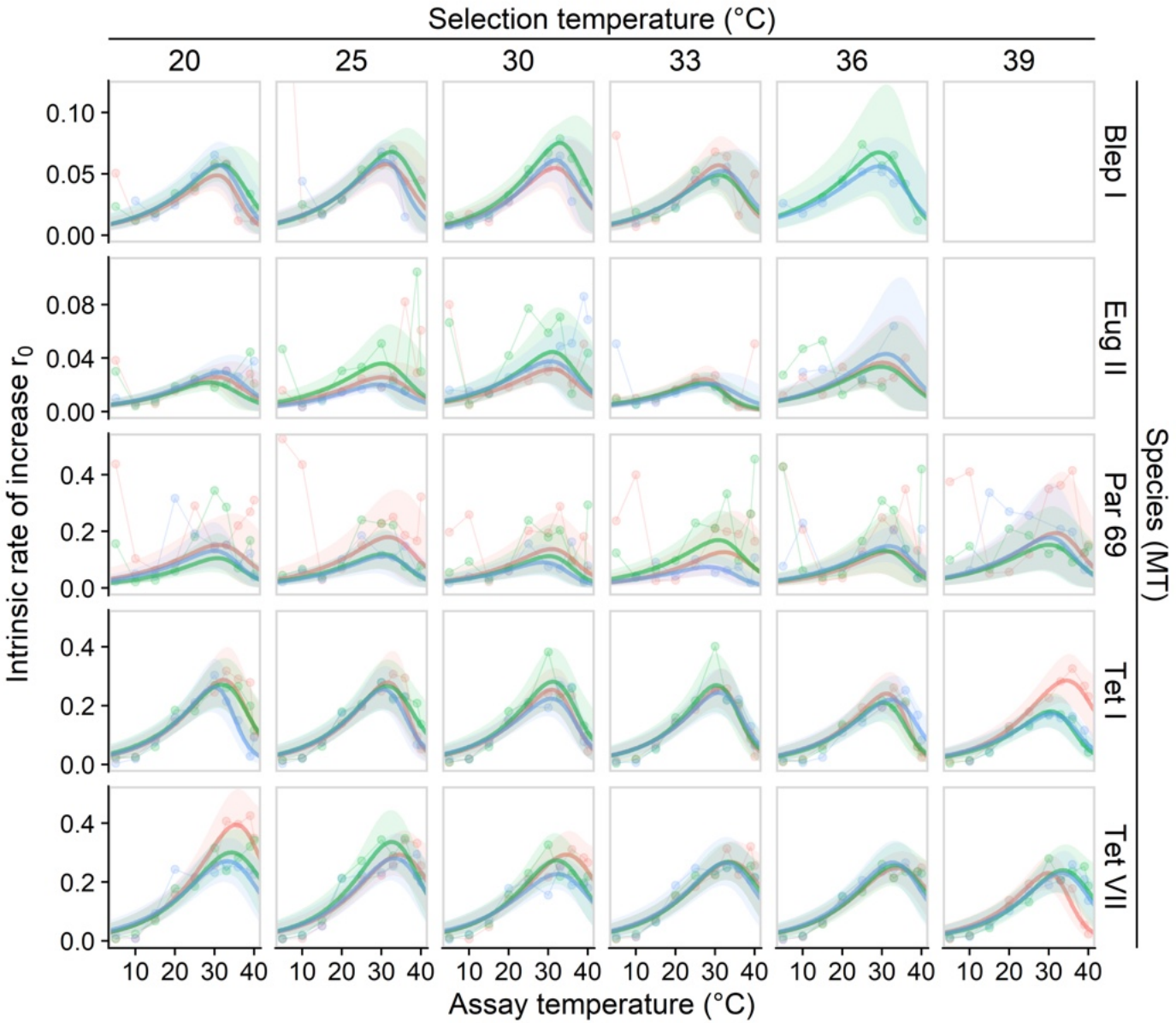
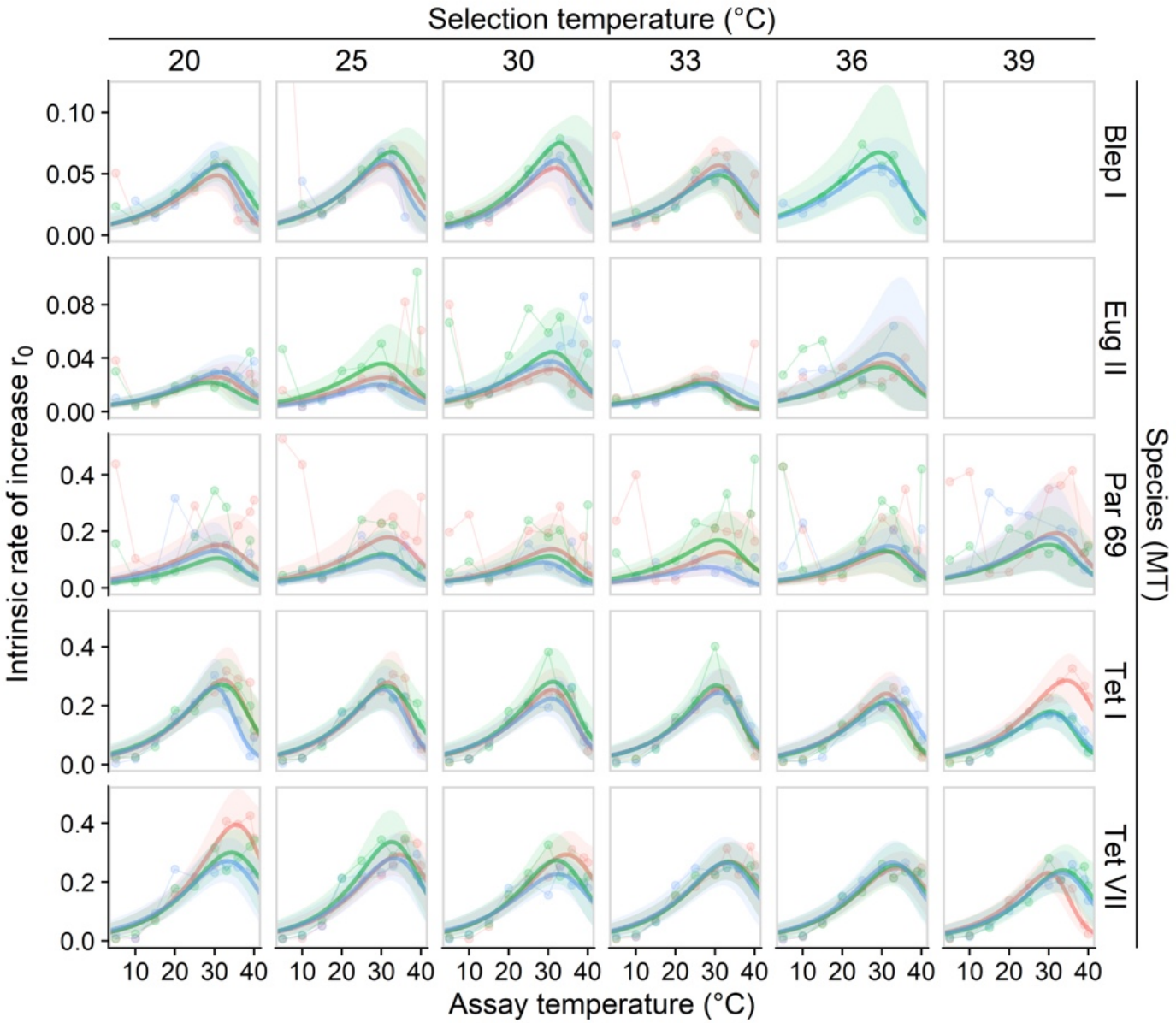


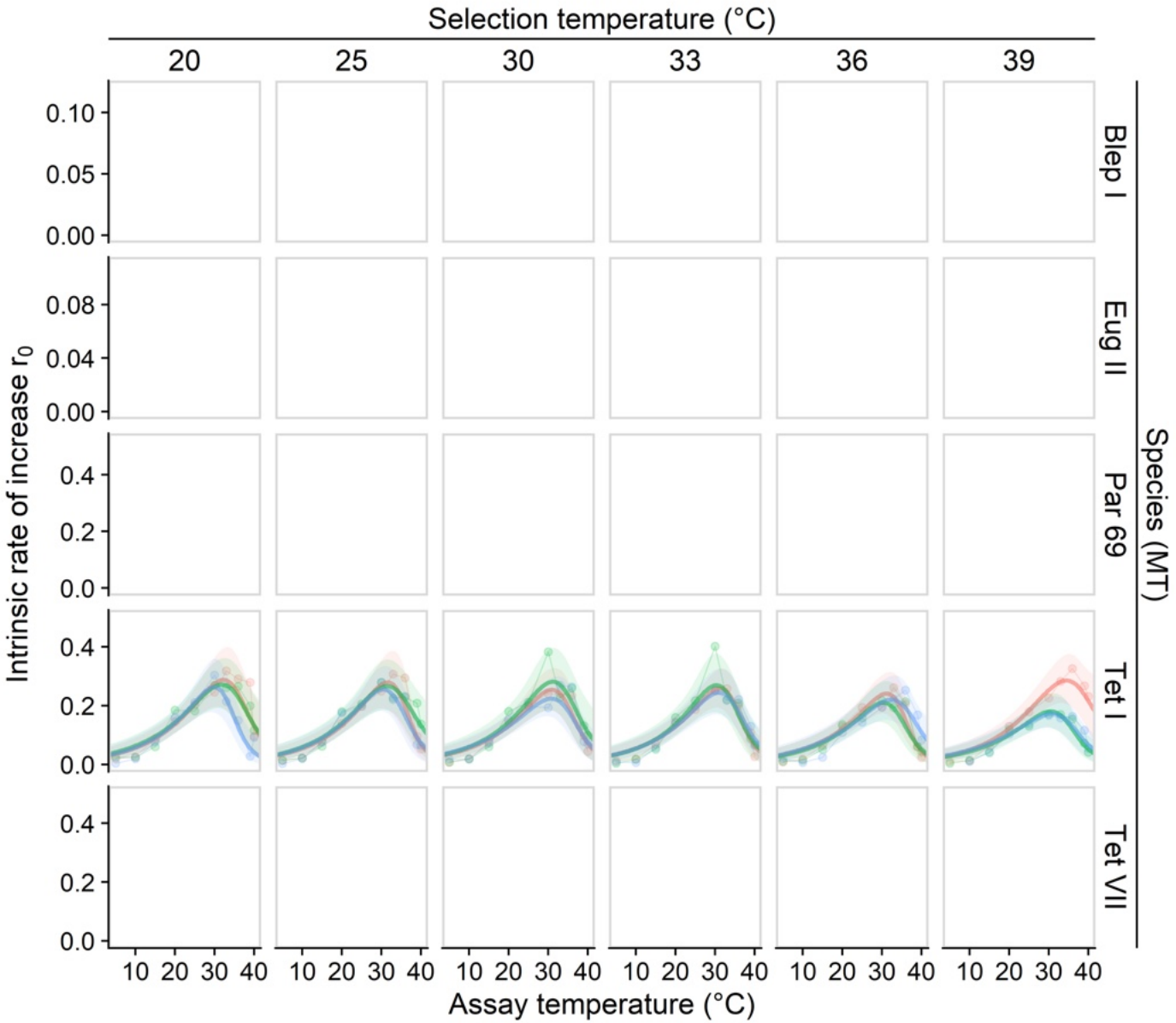
- No strong signal of selection



- No strong signal of selection
- Very similar response across replicates



- No strong signal of selection
- Very similar response across replicates
- with exceptions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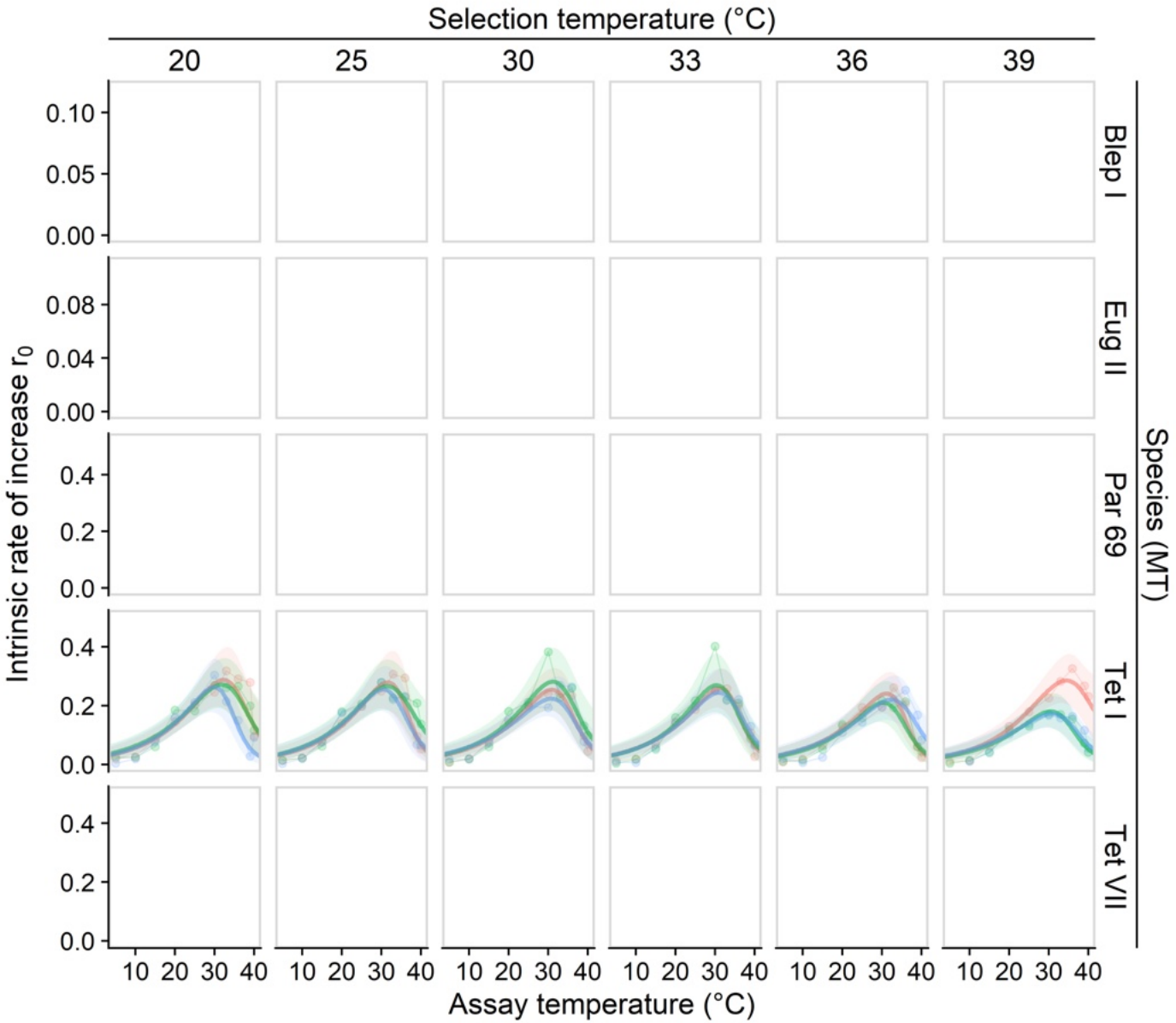
Assay temperature (°C)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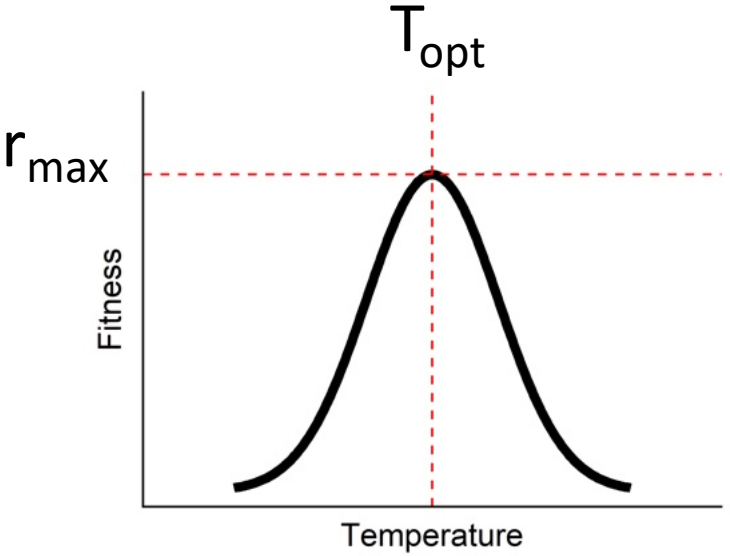
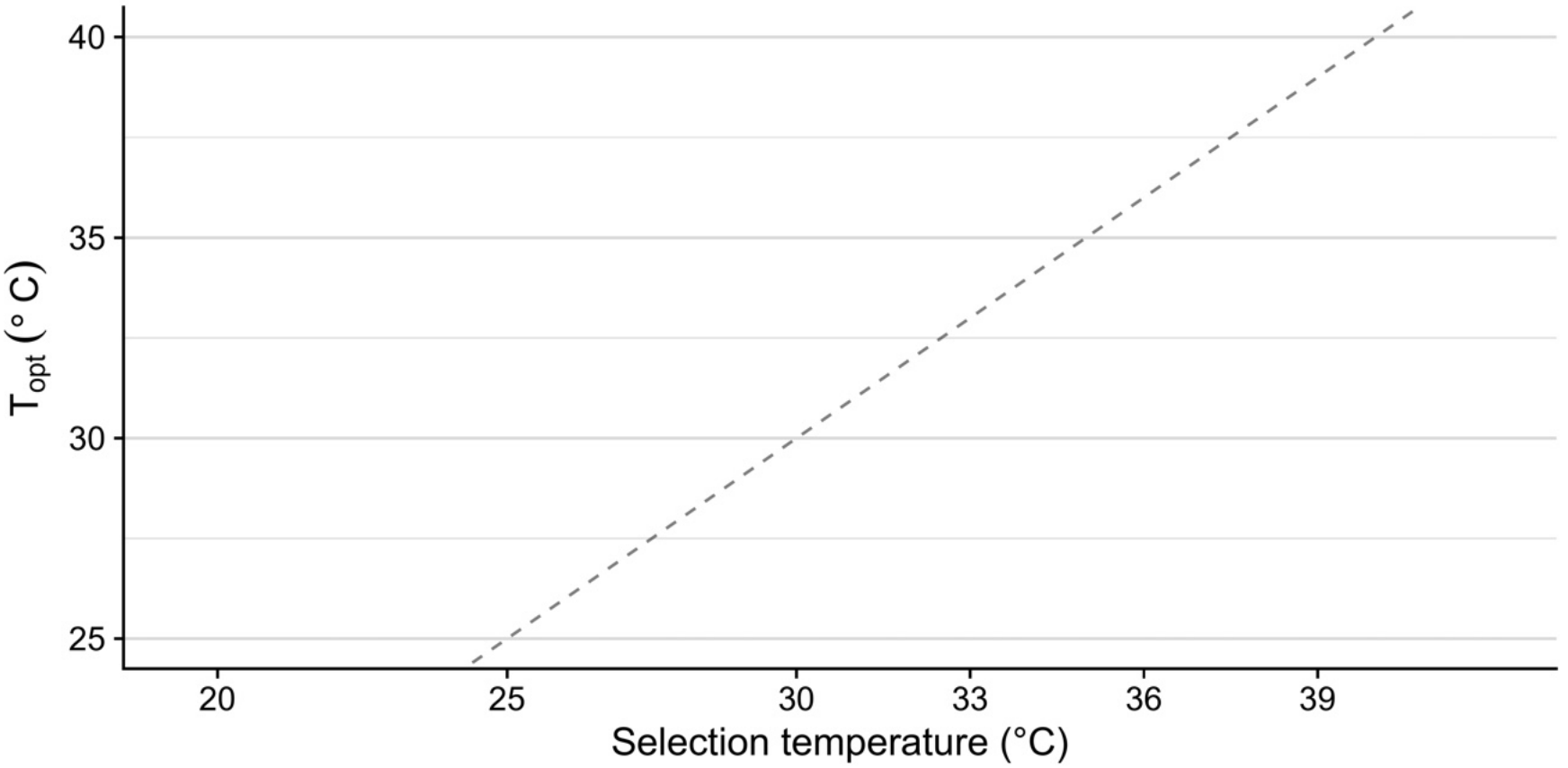

T_{opt}
r_{max}
Fitness
Temperature


40
35
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25
T_{opt} (° C)
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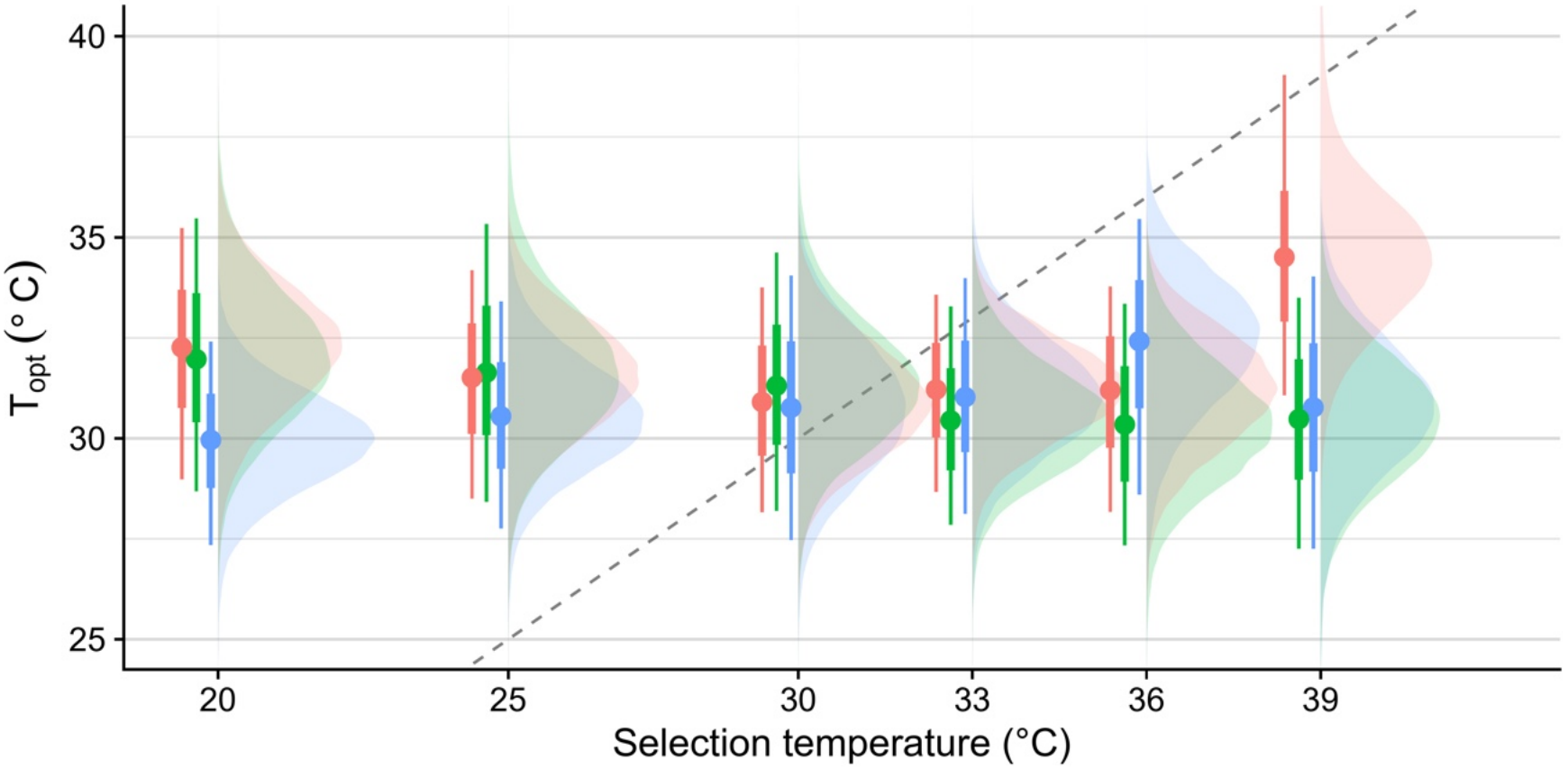
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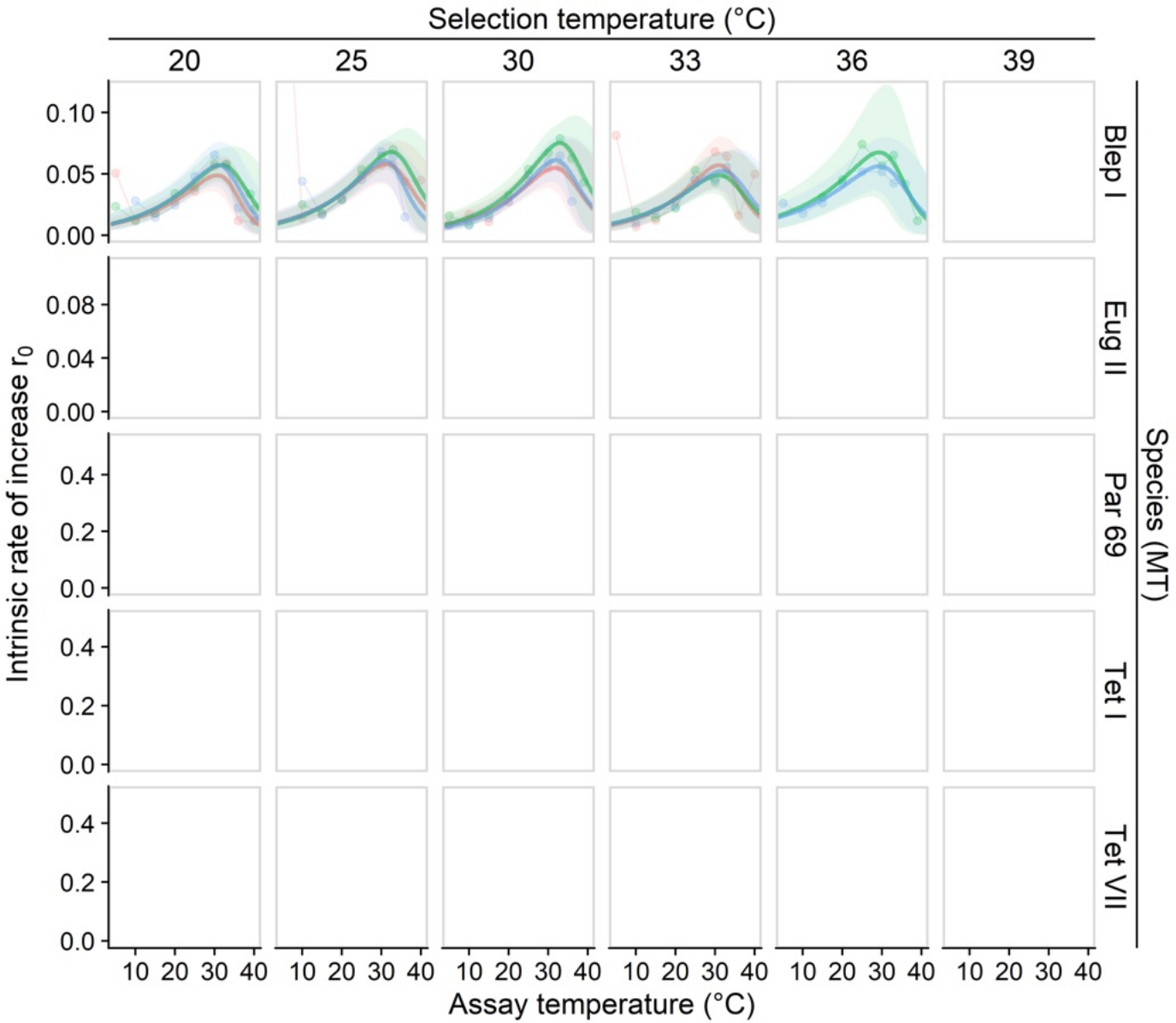
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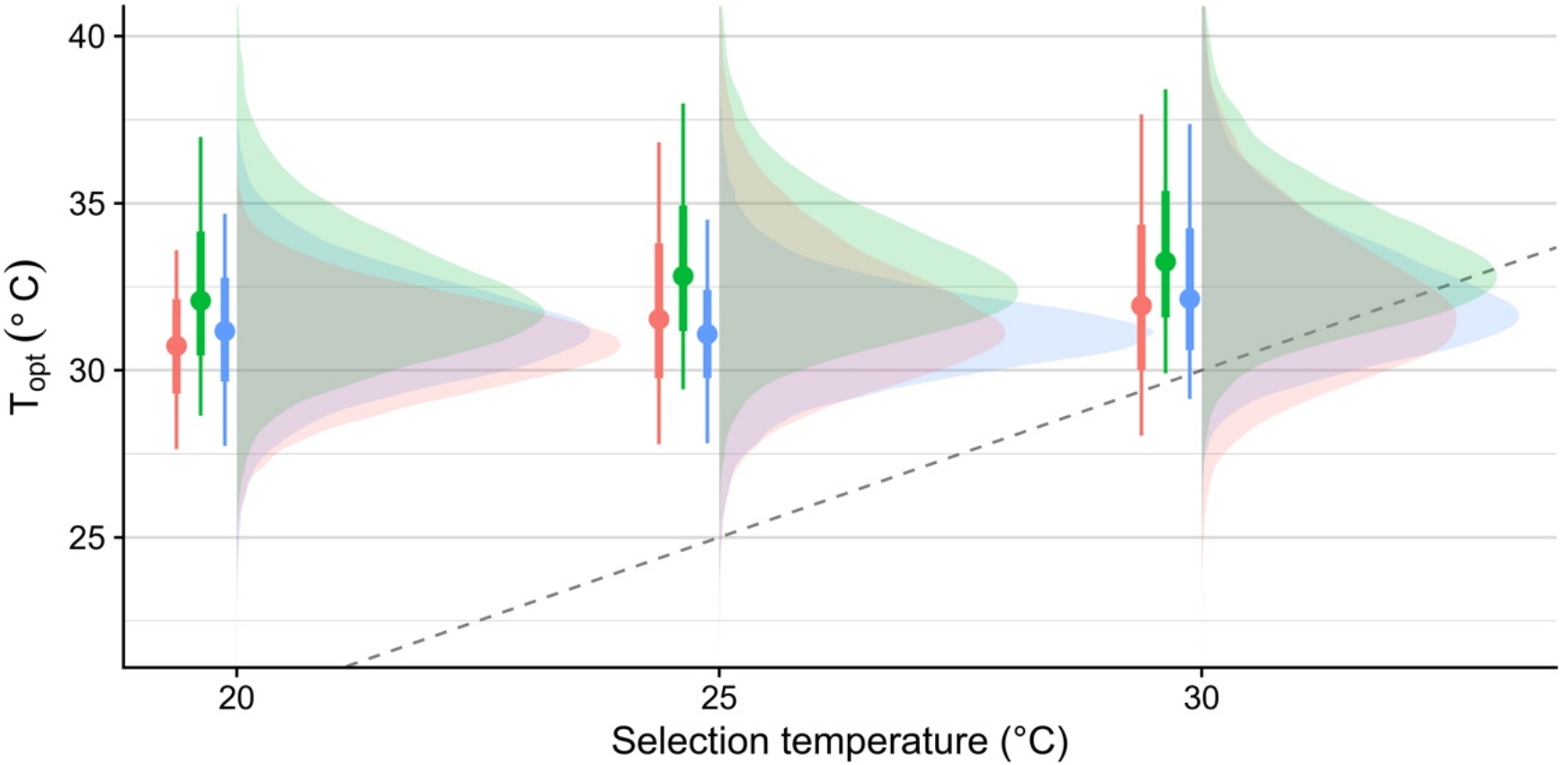
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35
30
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T_{opt} (° C)
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25
30
Selection temperature (°C)

Conclusions

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  - Standing genetic variation and recombination

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- Potential implications for climate change
  - Speed of climatic change vs evolutionary change
  - More reliance on dispersal?
- However,
  - Standing genetic variation and recombination
  - Speed of adaptive response

Acknowledgments


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Claire Gougat-Barbera


Emanuel A. Fronhofer

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ANR

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Institut des Sciences de l'Evolution-Montpellier

cnrs

MEME

iain.moodie@evobio.eu irmoodie.com @irmoodie

Get in touch!

Questions?

For more information on the ongoing project:

emanuelfronhofer.net