Rapid adaptation to extreme temperatures

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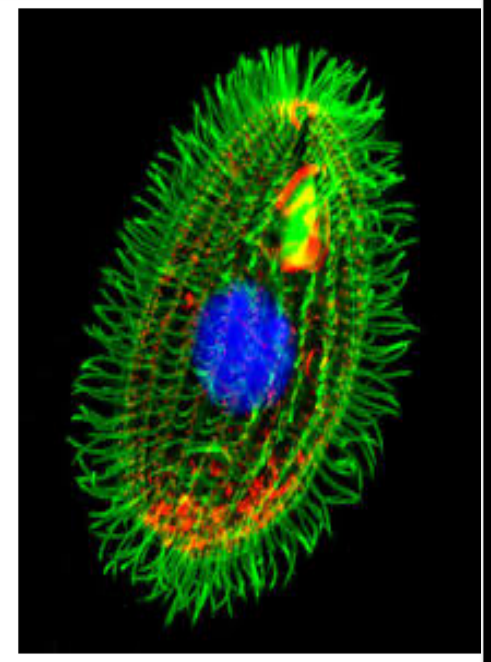
Question

Can microbial organisms adapt to rapidly increasing temperatures?

Background

- *Tetrahymena thermophila* is a microbial eukaryote that is a major part of the aquatic food web
- I am testing how *T. thermophila* will respond to increasing temperatures outside of which they normally grow
- This study will show us how *T. thermophila* will likely respond to global warming in their natural environment and subsequently, how the aquatic food web will likely be affected



Methodology

Overview

- First, I determined the highest temperature at which 4 different genotypes of *T. thermophila* were able to grow
- Then, 4 replicate populations of each genotype were allowed to evolve in progressively higher temperatures
- Finally, I tested whether there is a genetic basis to the ability to grow at elevated temperatures

Daily

- Count cell densities of each population by using dilutions and counting cells under microscope
- Calculate volume needed to transfer for a starting density of 10,000 cells/ml

Weekly

- Maintain populations at starting temperature for at least 4 days by doing serial transfers
- Attempt to move populations to higher temperatures after 4 days of evolution
- Repeat steps for each increasing temperature interval

Verification of genetic basis

- Grow evolved populations at room temperature for 2 days
- Transfer to new thermotolerance limit for a day
- Measure ending densities

Conclusions

- *T. thermophila* is able to adapt quickly to rapidly increasing temperatures (Fig. 1)
- Responses to rapidly increasing temperature are similar among the four genotypes tested (Fig. 2)
- Adaptations are due to genetic mutations rather than phenotypic plasticity (Table 1)
- Aquatic food chains that depend strongly on *T. thermophila* will not be significantly affected by increasing global temperatures
- Next steps:
  - Measure thermal performance curves
  - Sequence genomes to find cause mutation/s responsible for adaptation

Acknowledgments

I'd like to thank Jason Tarkington and Bandana Sharma for their help and ideas.

Results

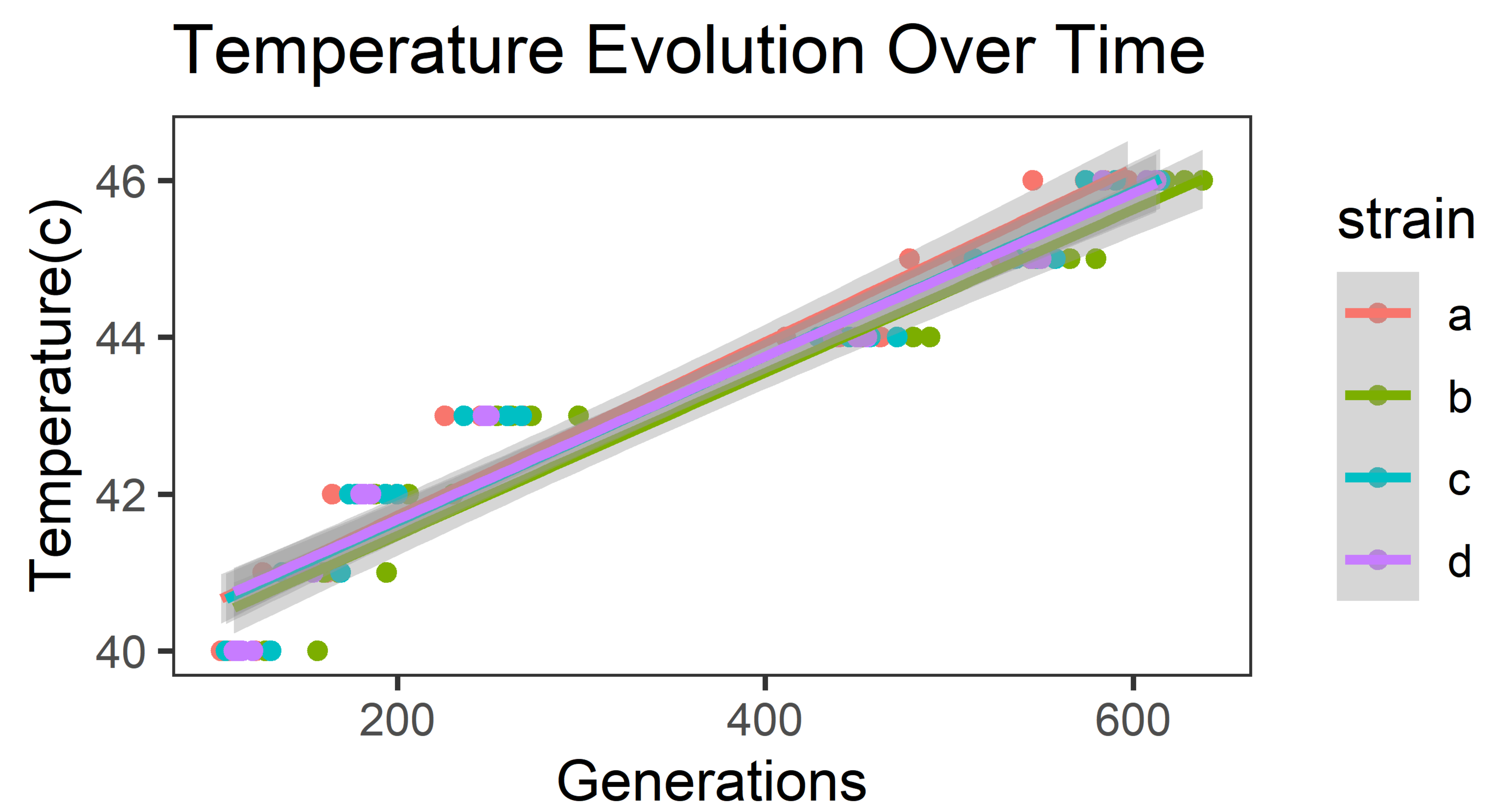


Fig 1. Maximum temperature at which *T. thermophila* can grow increases over 600 generations. Each dot represents the generation at which each strain was moved to the next temperature in the evolution experiment. The shaded gray region represents 95% confidence intervals.

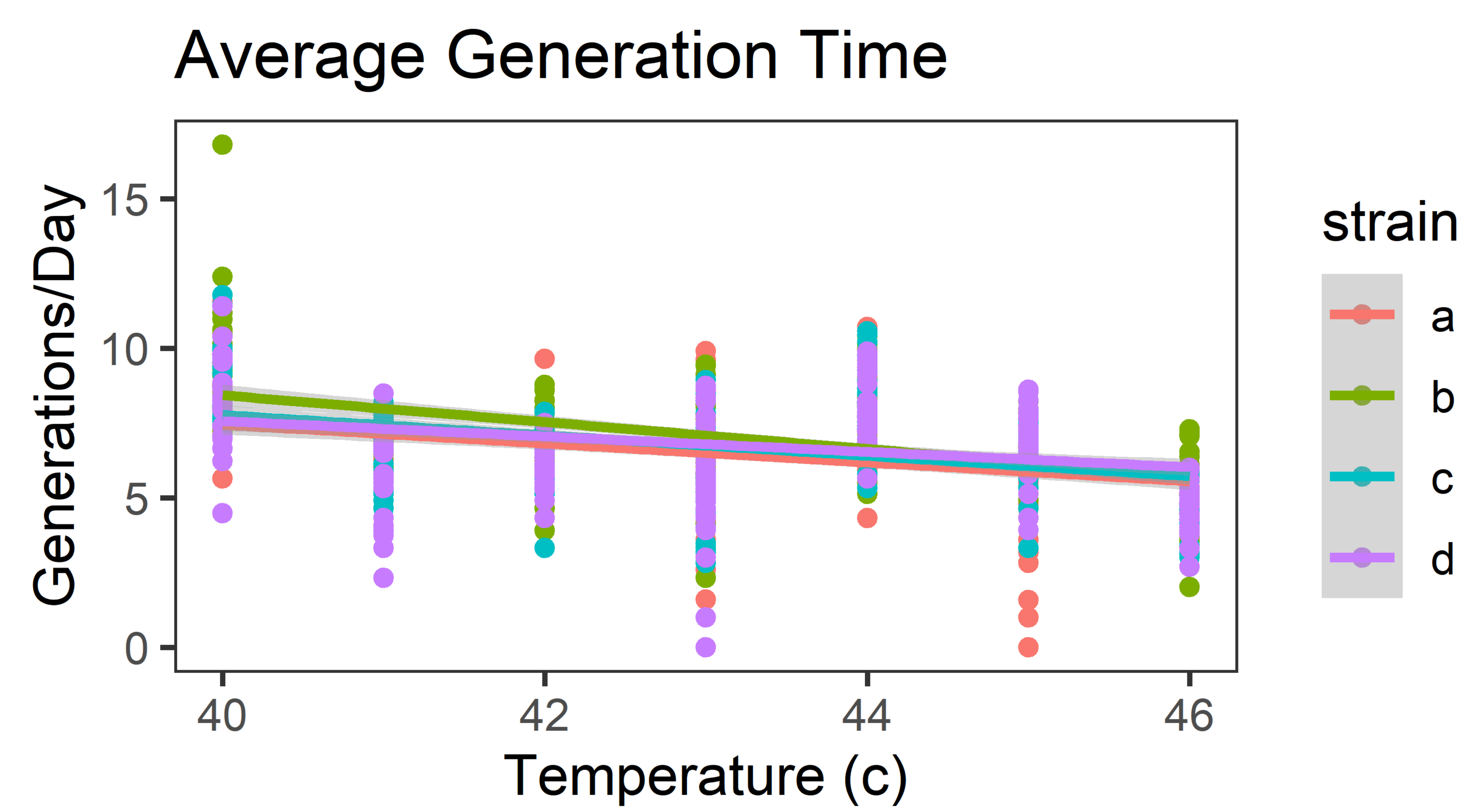


Fig 2. Different genotypes of *T. thermophila* evolve similar growth rates at elevated temperatures. Each dot represents the average generation time of a specific genotype at a given temperature. The shaded gray area represents 95% confidence intervals.

Temperature (C)	Ancestor	Evolved
24	Growth	Growth
40	Growth	Growth
46	No Growth	Growth

Table 1. Verification of genetic mutation. Evolved populations were able to grow at room temperature, intermediate temperature and elevated temperature, while ancestral strains were only able to grow at room and intermediate temperatures.