Does Climate Change Promote Antibiotic Resilience?

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Introduction

•Climate change: rising temperatures and environmental stressors impact global health.
•Antibiotic resistance (AMR) poses a significant threat, potentially leading to 10 million deaths annually by 2050[1].
•Climate change may exacerbate this issue by influencing bacterial evolution.

This study examines how climate change stressors affect *Pseudomonas stutzeri* by evaluating the fitness of antibiotic-resilient(ABR) mutants under these stressors.

•We hypothesize that climate change stress will afford fitness advantages to mutants that show high fitness in antibiotics. (AKA antibiotic resilient mutants)

Methods

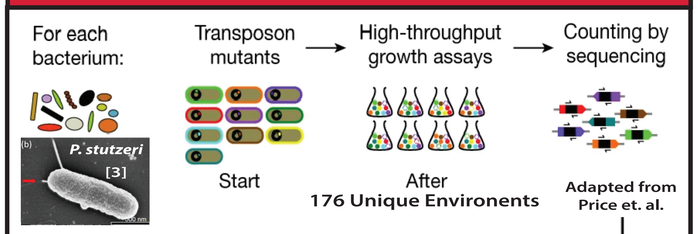

Figure 1

Figure 1: Overview of experimental procedure performed by Arkin Lab

Mutant phenotypes

Gene fitness = average (strain fitness)

$$\text{Strain fitness} = \log_2\left(\frac{\text{abundance after}}{\text{abundance at start}}\right)$$

Figure 2: Summary of experiments analyzed

The following stressors were chosen to simulate several effects of climate change on our model organism.

Condition	Treatment	Control	Num of Experiments
Heat Stress	30C in Glucose Defined media, LB	26C in Glucose Defined media, LB	8
Salinity Stress	400 mM Chloride in RCH2 Defined Media	RCH2 Defined Media	2
Metal Stress	Copper Stress in Lactate	Lactate	3
Antibiotic Stress	Vancomycin Cephalothin, many more	RCH2 Defined Media	23

Figure 2

END PRODUCT OF EXPERIMENTS: A dataset with **3.5k gene knockouts and their fitnesses** in **176 unique conditions**

Results

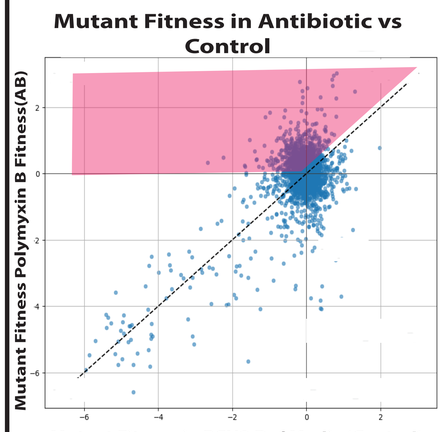

Figure 3

Figure 3: Mutant fitnesses in AB vs Control. Note in the red region mutants that have fitness. adv. in AB do not have same extent of advantage when no AB present. i.e, they see a fitness cost with their ABR mutations.

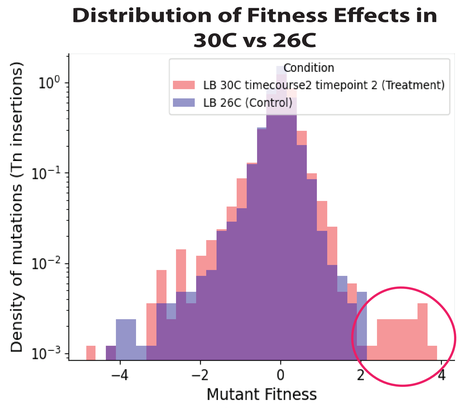

Figure 4

Figure 4: DFE with mutants in 30C vs 26C. There exists a large denisty of mutants that gain strong fitness advantages in the warmer condition.

Figure 5: Mutant Fitnesses in 30C vs 26C. Colored points are AB Resilient, a lighter color denotes a higher AB fitness. Points above the dotted line are mutants that have higher fitness in warmer temperature. Note the cluster of strong AB mutants in the upper right that gain fitness advantages in 30C vs 26C.

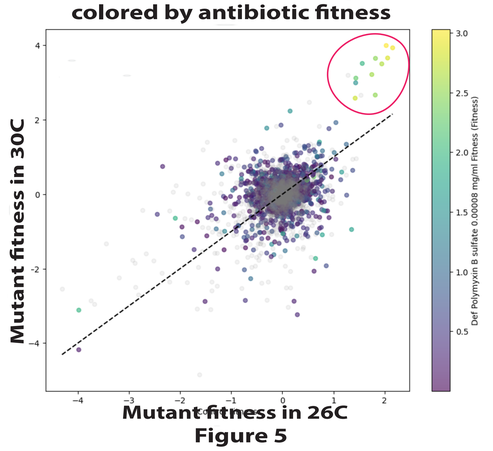

Figure 5

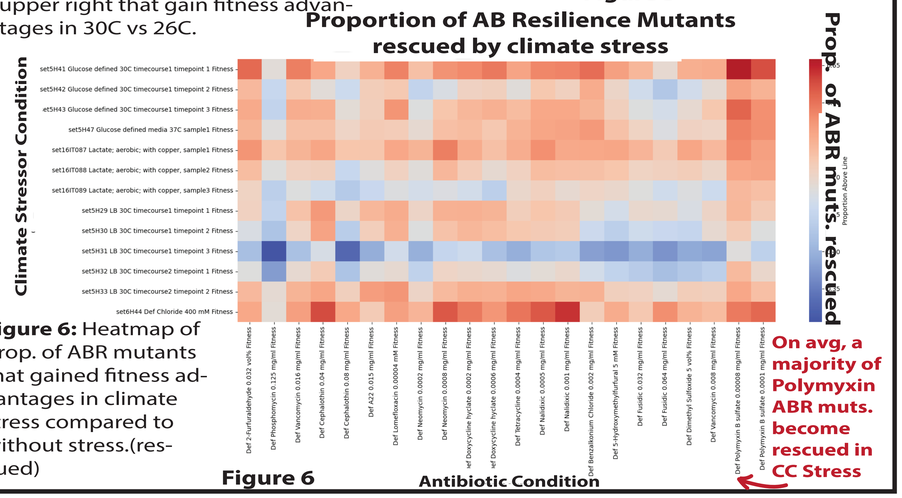

Figure 6

Figure 6: Heatmap of prop. of ABR mutants that gained fitness advantages in climate stress compared to without stress.(rescued)

Results (cont.)

Figure 7: Scatterplot of mutant fitness in Salinity vs AB Stress, with lighter colored points indicative that mutant recieved stronger fitness advantage in climate stressor.

Mutants in the top right quadrant have fitness advantages in both AB and Salinity Stress. Examining mutants in this region can give us insights into cellular mechanims involved in ABR enchanced by CC. Stress

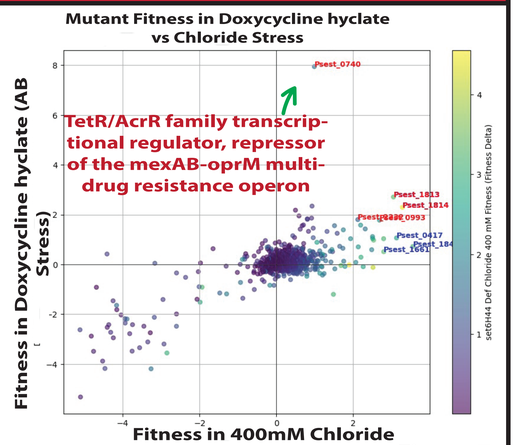

Figure 7

Conclusions

There exist many gene mutations that are given fitness advantages in a climate change stressor. Of these, many of the mutations also confer a fitness advantage in certain antibiotics.

If a mutation confers resilience/resistance to an antibiotic, this can have an associated fitness cost. (See Fig 3)
From Figure 5 it is evident that many of these AMR mutations fitness costs are reduced in the presence of a climate change stressor.

These results suggest climate change stressors allow for these antibiotic resilient mutants to more readily take root in a microbial populations by providing these ABR mutants fitness advantages.

Acknowledgements

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References

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