Tigriopus californicus Copepod Acclimation and Adaptation to Low pH

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Introduction

Daily fluctuations of conditions in rocky intertidal pools cause *Tigriopus californicus* copepods to experience variable environmental acidity. Previous studies have demonstrated *T. californicus* tolerance to changes in pH[1], temperature[2], and dissolved oxygen[3]. We investigated acclimation ability and existing adaptation of two distinct *T. californicus* populations to low pH.

We hypothesized that copepods exposed to low pH shocks beforehand would have lower frequencies of knockdowns (a state of immobility) and shorter recovery times compared to controls after all were exposed to same extreme low pH shocks. We predicted, as others have[4], that pH tolerance may be correlated to thermal tolerance trends[2], therefore hypothesizing that the more southern population from Abalone Cove (AB) would react to the extreme shocks with fewer knockdowns and differential recovery times than the more northern population from Bodega Bay (BB).

Results

- The control wells had high KD fraction and a longer recovery time than the treatment wells (Fig. 1).
  - The AB population was less likely to be knocked down, but had longer recoveries than the BB population (Fig. 1, 2)
- Based on p-values from the ANOVA analyses, no variables were significantly correlated and therefore random variation cannot excluded as a cause of the trends.

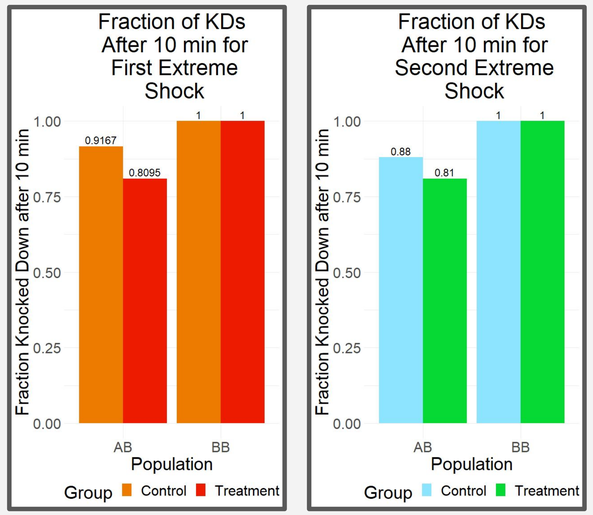

Fig. 1: KD fractions by group after the first extreme shock and second extreme shock.

Population and Treatment	First Acclimation Shock pH	Second Acclimation Shock pH	Number Copepods Before Shock	First Extreme Shock pH	Number Copepods Before Shock	Second Extreme Shock pH
AB Control	8.01	8.01	24	4.81	16	4.95
AB Treatment	6.01	5.99	21	4.81	16	4.95
BB Control	8.01	8.01	3	4.81	3	4.95
BB Treatment	6.01	5.99	8	4.81	7	4.95

Fig. 3: pH shock data for each trial performed.

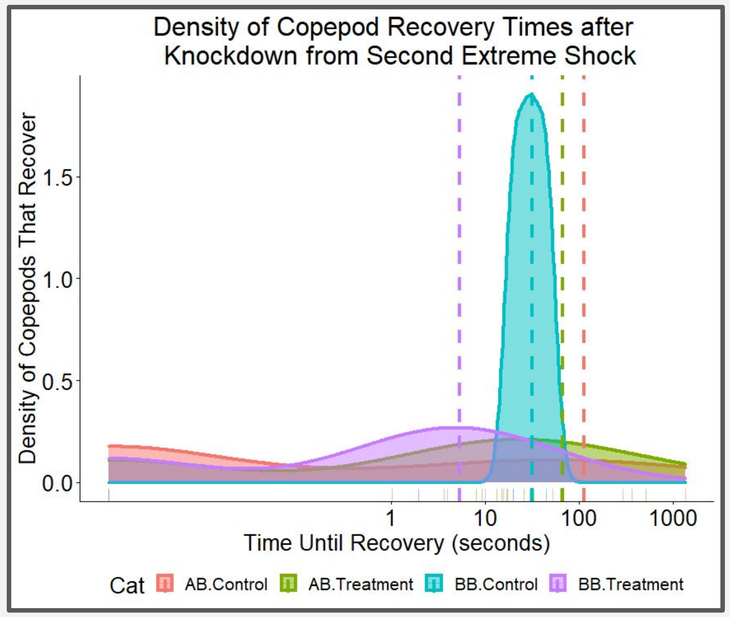

Fig. 2: Density plot, with x log scale, showing the density of copepod recovery time after knockdown for each group. The vertical dashed lines indicate the mean recovery time of each group. Copepods that did not knockdown were given a recovery time of 0 seconds.

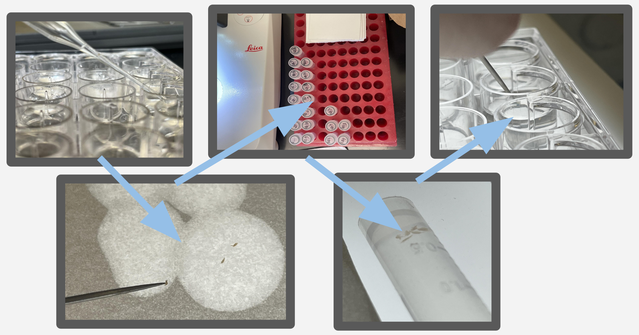

Fig. 4: Shock Procedure. Copepods are pipetted from wells onto filter paper, transferred by needlepoint to micro test-tube, left for 10 minutes, pipetted back onto to filter paper, and transferred into new wells of normal ~8 pH ASW via needlepoint.

Discussion

- Our first hypothesis is supported by the treatment copepods having a shorter recovery time than the control copepods, pointing to exhibited acclimation.
- The second hypothesis is supported by the AB control having shorter recovery times and a lower KD percentage than the BB control, supporting differential adaptation to pH conditions between populations.
- Results from both populations suggest that pH acclimation takes the form of pH sensitivity which may explain why each population treatment group has higher KD percentages and quicker recovery times than its control. This may help the copepod cope in its tidepool environment.
- Though the results appear to support the hypotheses, the data is not statistically significant, indicting that population and prior exposure to low pH may have no effect on copepod extreme pH tolerance.
- For future direction, we suggest testing pH acclimation by raising treatment copepods in constant low pH conditions. Similar to previous studies testing heat tolerance,[5] we are also interested in exploring gene regulation of copepods in response to changing pH conditions.

Materials and Methods

- Four groups were created from egg sacs: AB Control, AB Treatment, BB Control, BB Treatment. Females were removed throughout experiment when identified.
- At age ~21 days, all copepods received a 10 minute acclimation shock. All received another acclimation shock around 7-10 days later:
  - Treatment added to ~6 pH artificial seawater (ASW); Control added to normal ~8 pH ASW
- At age ~40 days, all copepods received a 10 minute extreme shock. Because of unpreparedness for unexpectedly fast recovery times, all copepods received a second extreme shock of 20 min 22 hours after the first. KDs and recovery times were recorded for each extreme shock.
- Statistical analyses performed using ANOVA of lm models in RStudio.

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References

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