



**NOAA  
FISHERIES**

**Alaska Fisheries  
Science Center**

# Ocean acidification and commercial crabs: Crab plan team update

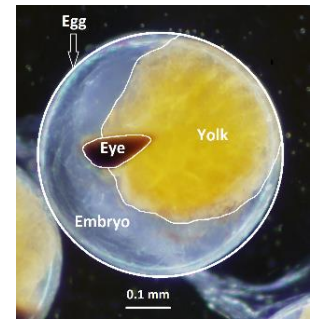
W. Christopher Long



NOAA OCEAN ACIDIFICATION PROGRAM

# Past Results: Crab Summary

Species	Life history stage	Growth	Mortality	Respiration	Feeding rate	Condition	Development
Red king crab	Embryo		=				Altered
	Larvae		Increased				
	Juvenile	Decreased	Increased	Increased	=	Decreased	=
	Adult						
Blue king crab	Juvenile	Decreased	Increased	Increased	=		=
Golden king crab	Juvenile	Decreased	Increased				
Tanner crab	Embryo		Increased				Altered
	Larvae		Increased			Decreased	
	Juvenile	Decreased	Increased			=	=
	Adult						
Snow crab	Embryo		=				=
	Larvae		=			=	
	Adult						



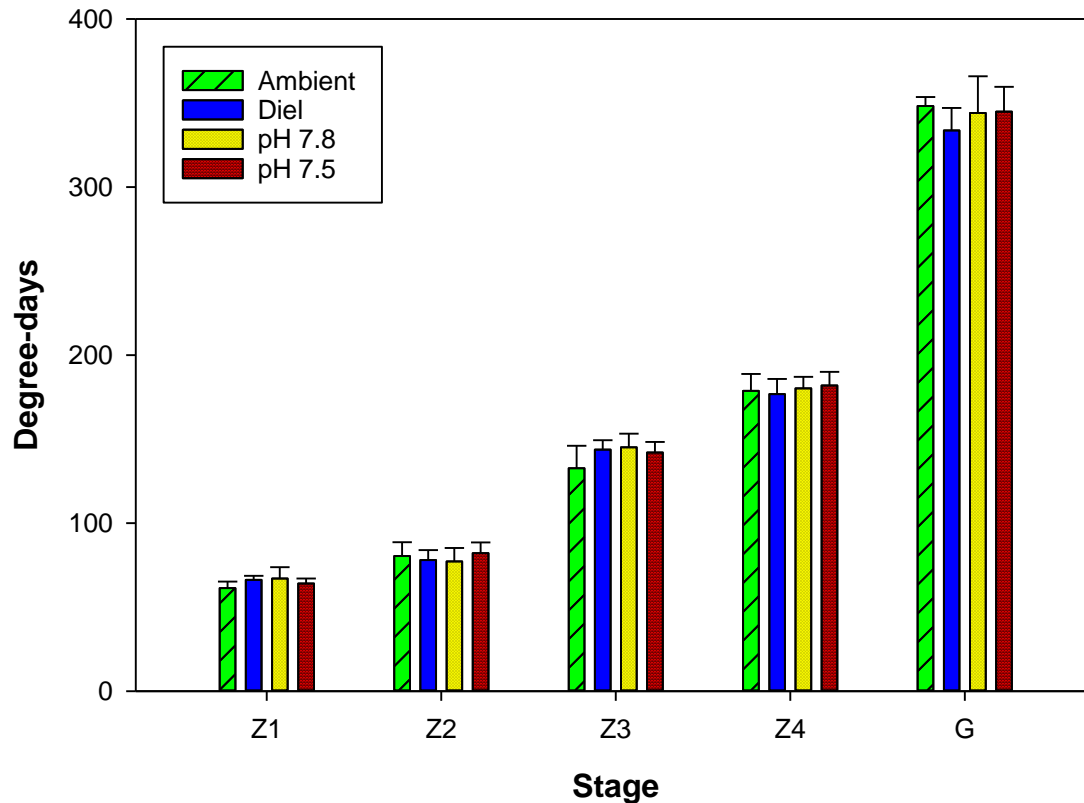
Species	Life history stage	Calcification	Exoskeleton hardness	Hemolymph pH	Immune system	Gene expression
Red king crab	Embryo					
	Larvae	Increased				=
	Juvenile	=	Decreased			Altered
	Adult	Increased				Altered
Blue king crab	Juvenile	Increased	Decreased			
Golden king crab	Juvenile					
Tanner crab	Embryo					
	Larvae	Decreased				
	Juvenile	Decreased				
	Adult	Decreased		=	Decreased	
Snow crab	Embryo					
	Larvae	=				
	Adult	Decreased	Decreased			

# Red king crab larvae

- 4 pH Treatments
  - Ambient, pH 7.8, pH 7.5, Diel (Ambient with 0.1 pH variation)
- RKC larvae
  - Reared to C1
  - Ambient temp (5-10 C)
- For each stage measured
  - Development time
  - Survival
  - Morphometry
  - Dry mass
  - Elemental composition

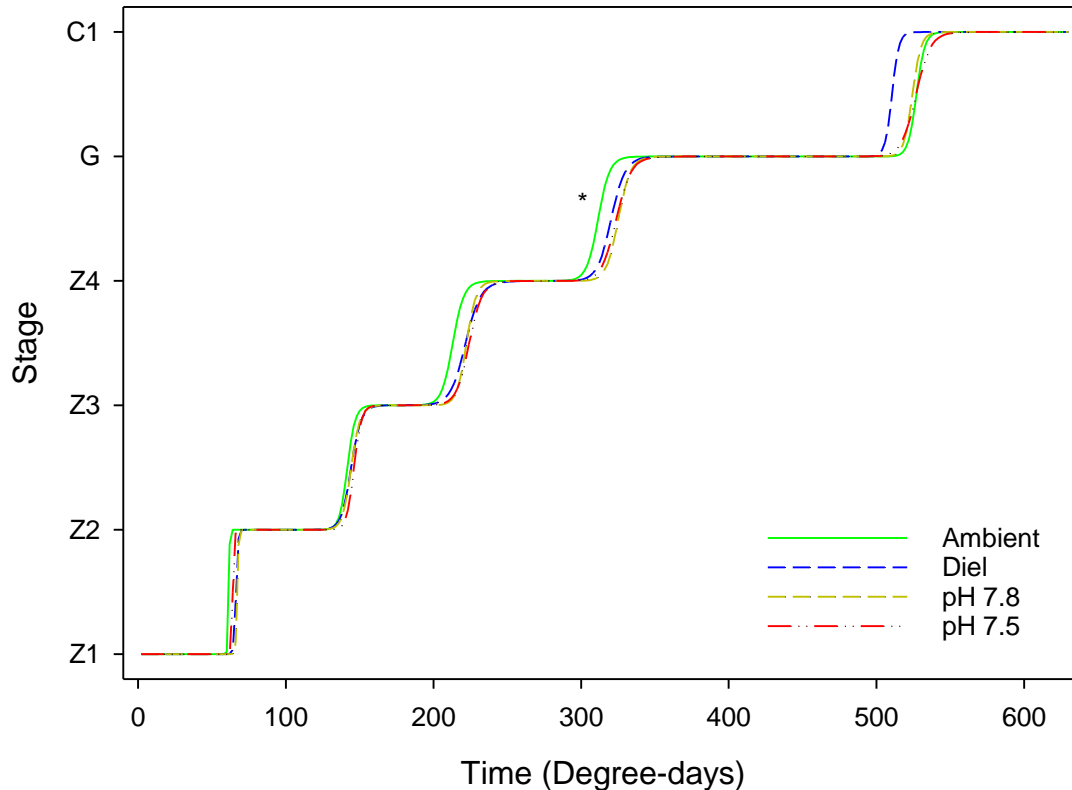


# Developmental time



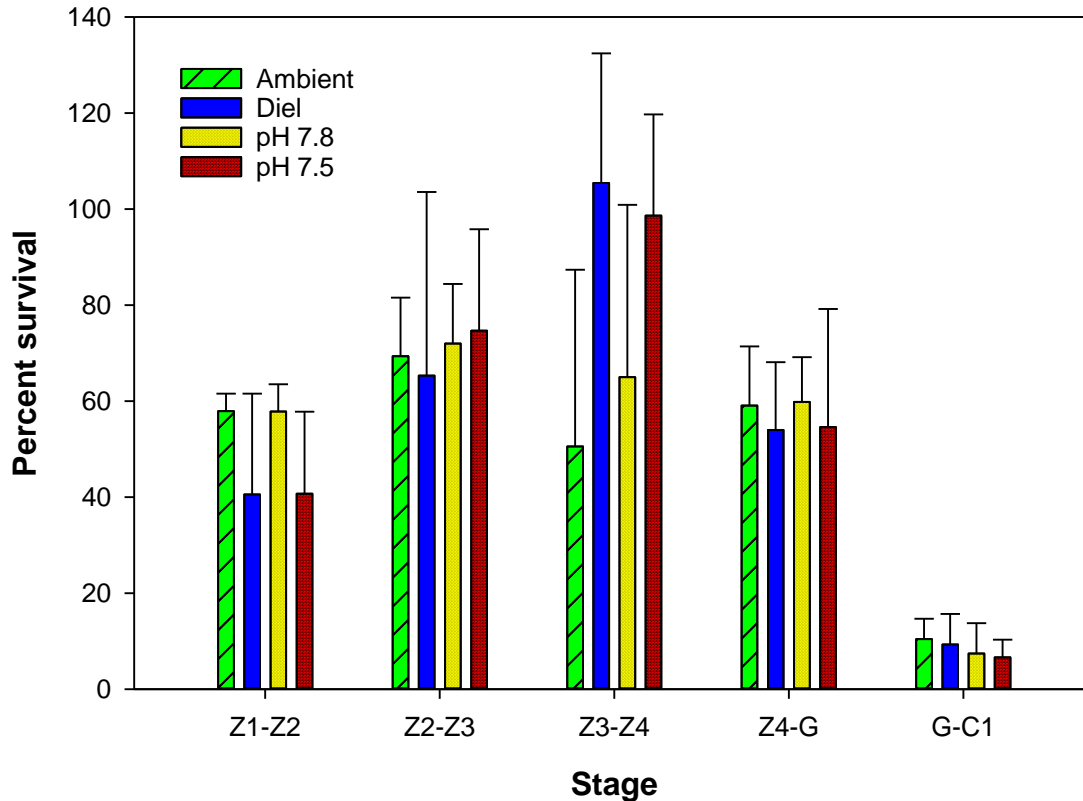
- No differences among treatments

# Cumulative development time



- Slight difference at molt to G
  - Ambient differed from Diel and pH 7.8
  - No difference at molt to C1

# Survival

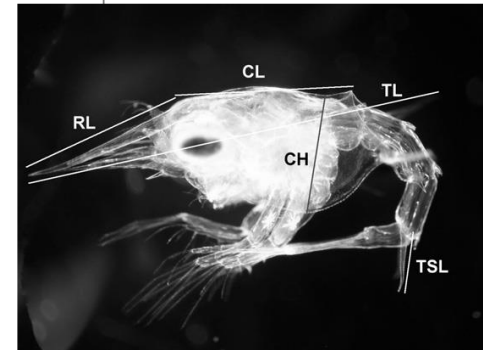
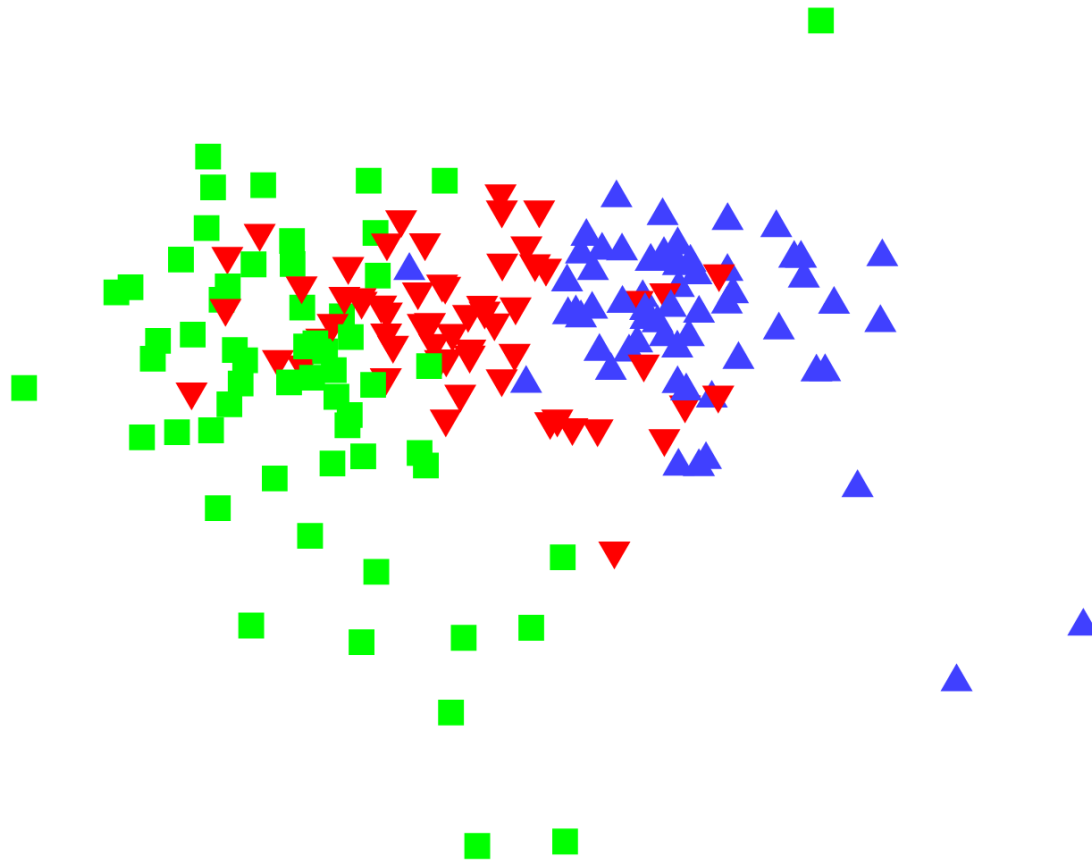


- No difference among treatments
  - Except Z3-Z4
  - No significant post-hoc differences
- No difference in cumulative survival at any stage

# Morphometrics- Zoeal stages

2D Stress: 0.1

Stage  
▲ Z2  
▼ Z3  
■ Z4



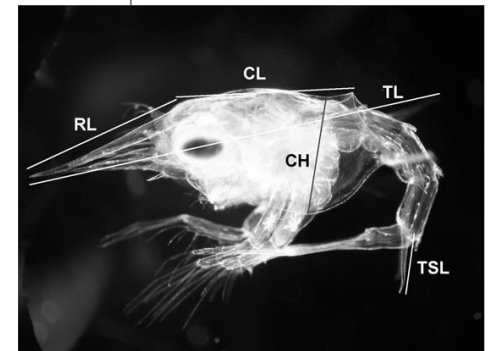
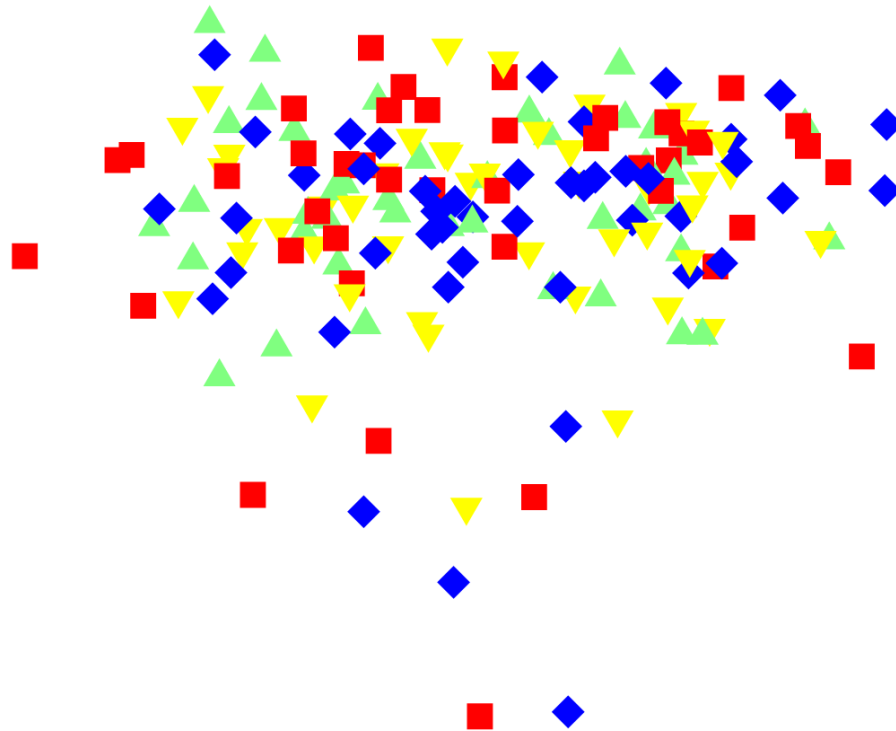
- All stages different

# Morphometrics- Zoeal Treatment

2D Stress: 0.1

## Treatment

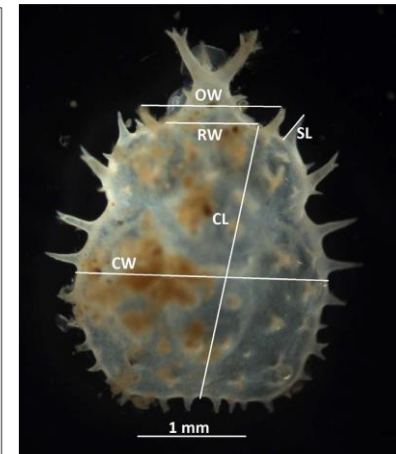
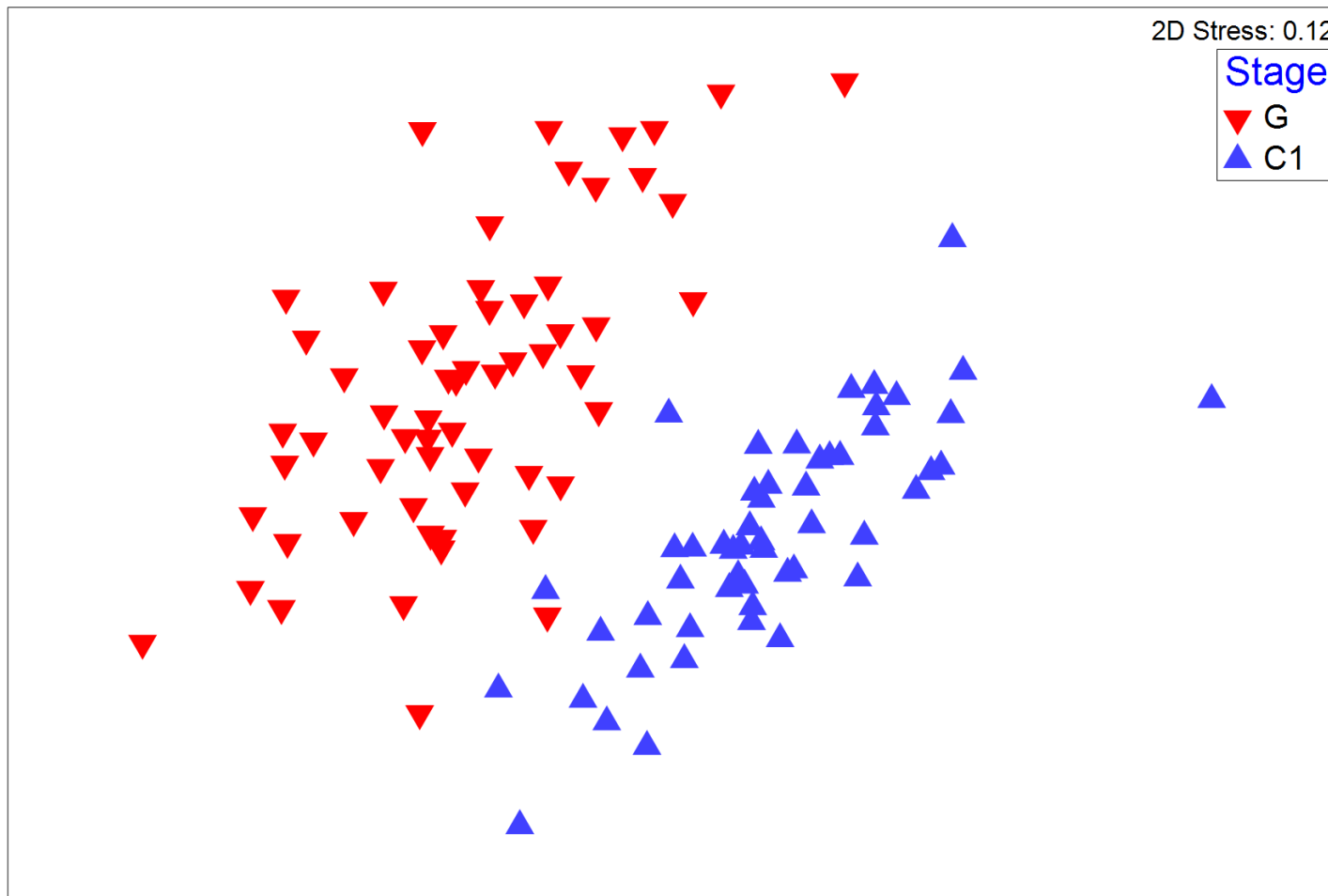
- ▲ Ambient
- ◆ Diel
- ▼ pH 7.8
- pH 7.5



- No differences among treatments

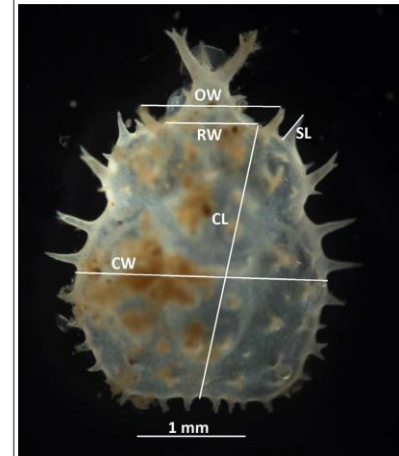
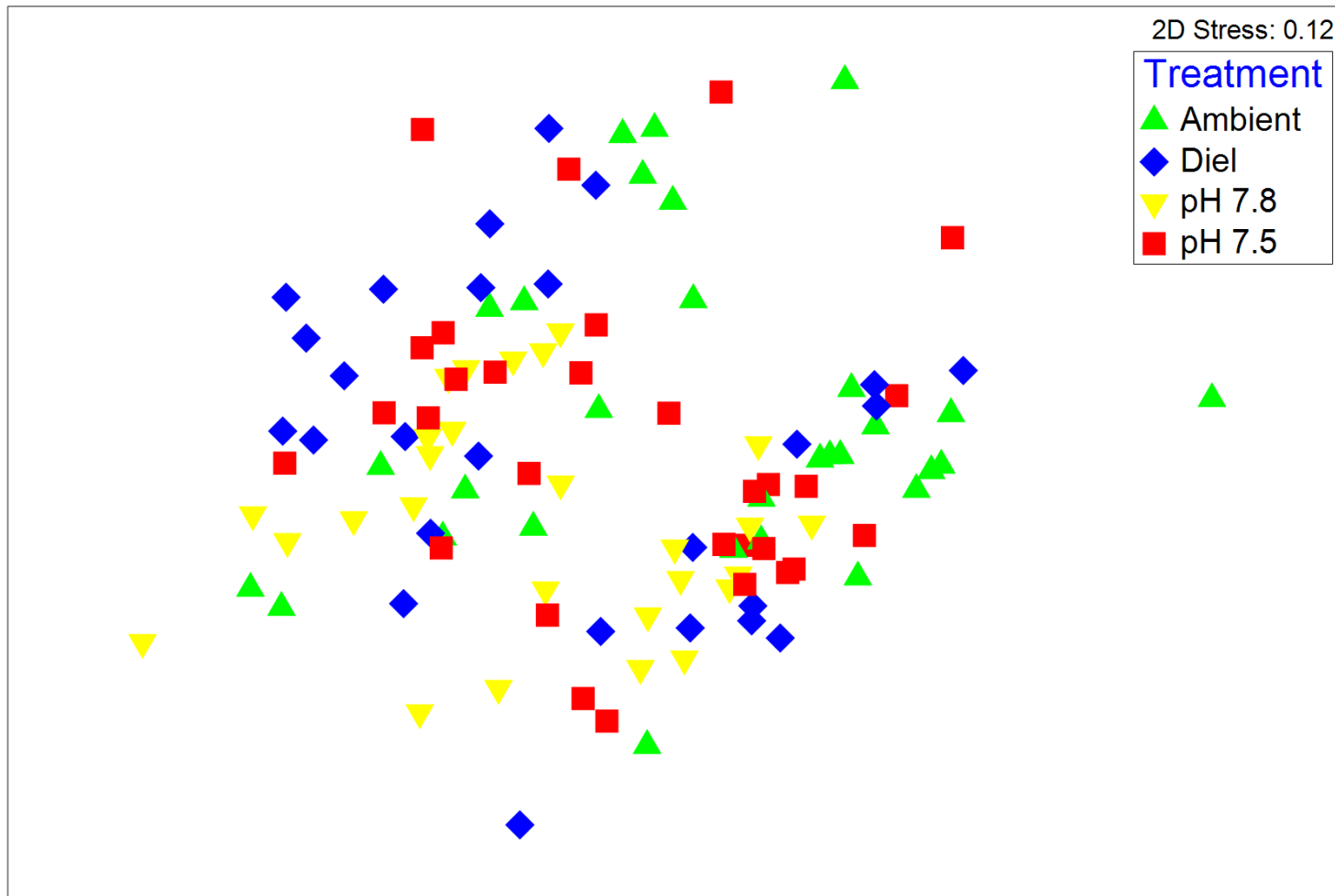


# Morphometrics- G/C1 stages



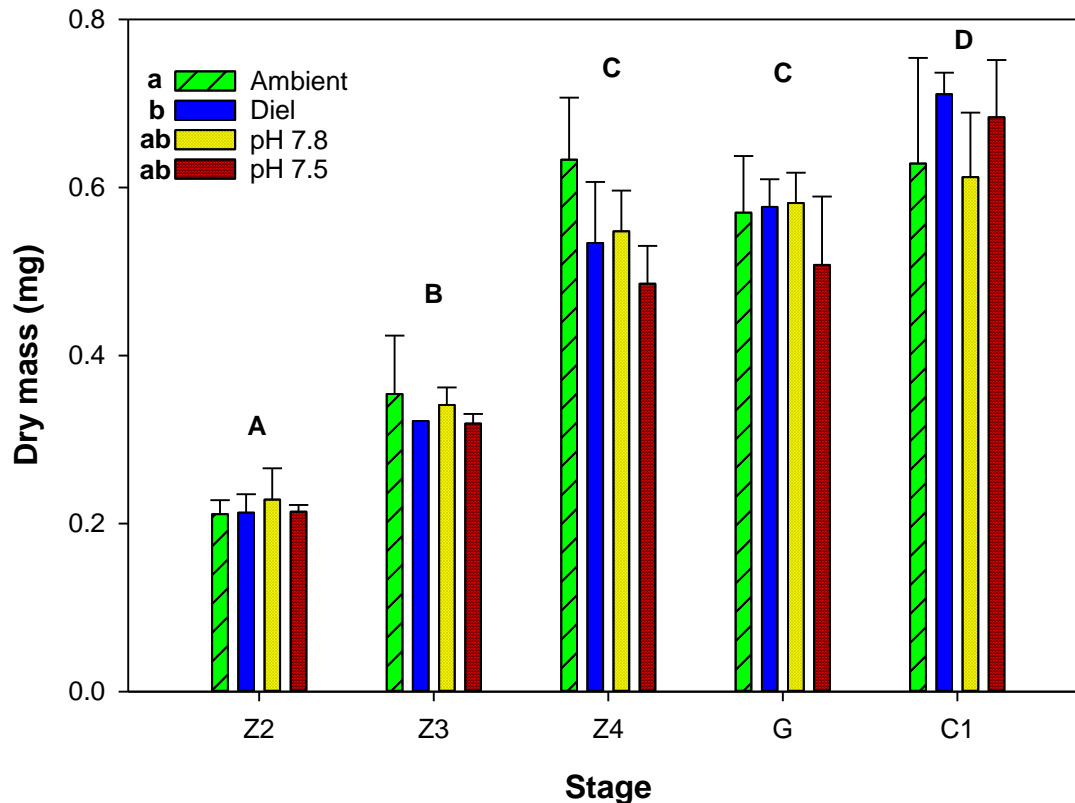
- Stages different

# Morphometrics- G/C1 Treatment



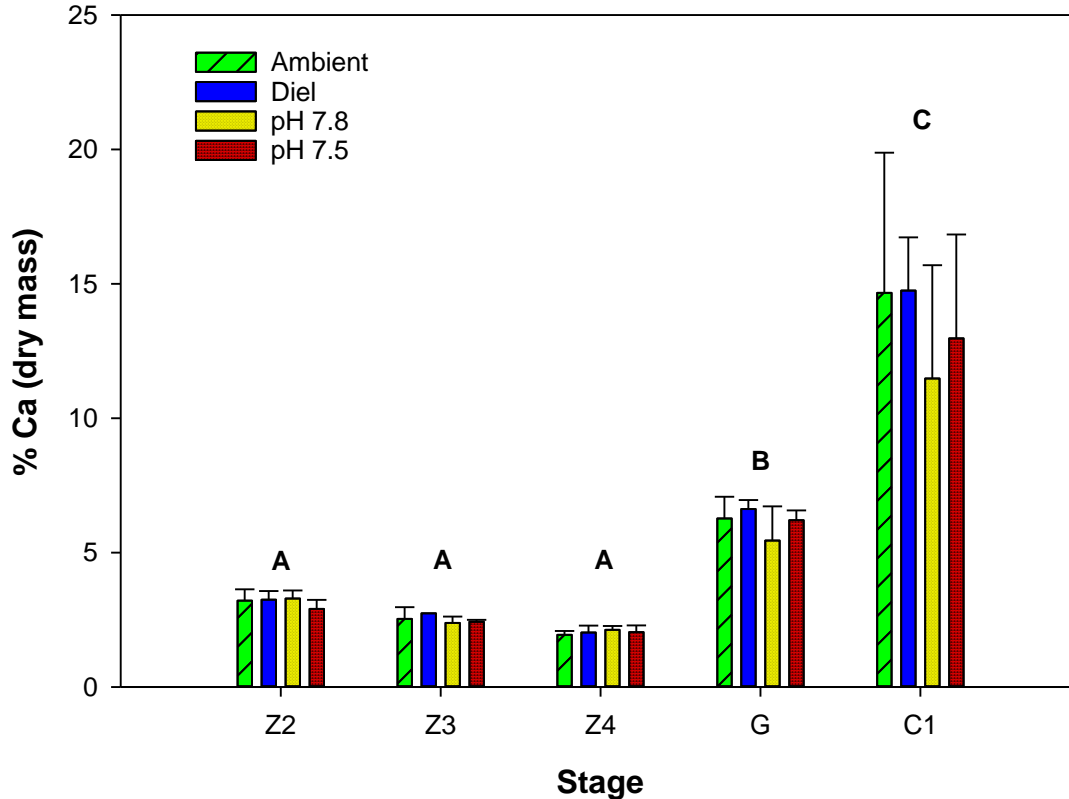
- Ambient slightly different from pH 7.8 only

# Larval mass



- Mass increases with stage
- Small difference between Ambient and pH 7.8
  - Mean effect size 2%
  - Range -8 to 13%

# Calcification



- Increases with stage
- No treatment effect

# RKC larvae summary

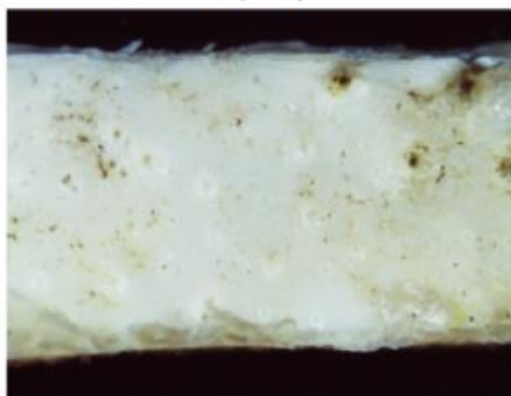
- No effects on survival or development
- No effects on size or mass
- No effects on calcium content
  
- RKC larvae are pretty well adapted to a range of pH conditions



# Adult Tanner crabs- Cuticle properties



Ambient pH (8.1)



1 mm

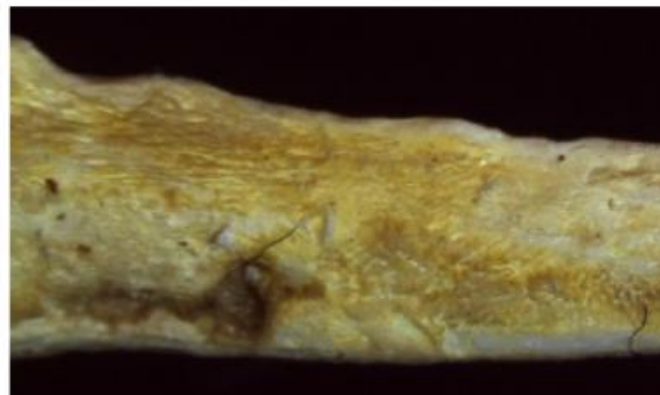


0.5 mm

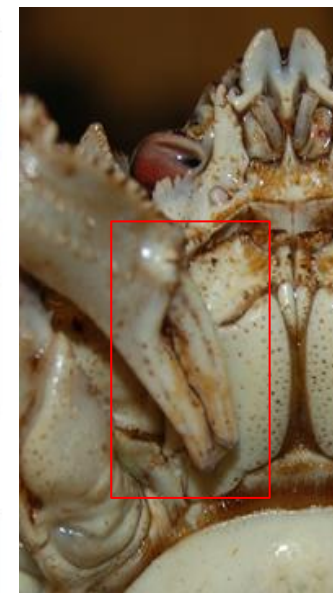
Reduced pH (7.5)



1 mm

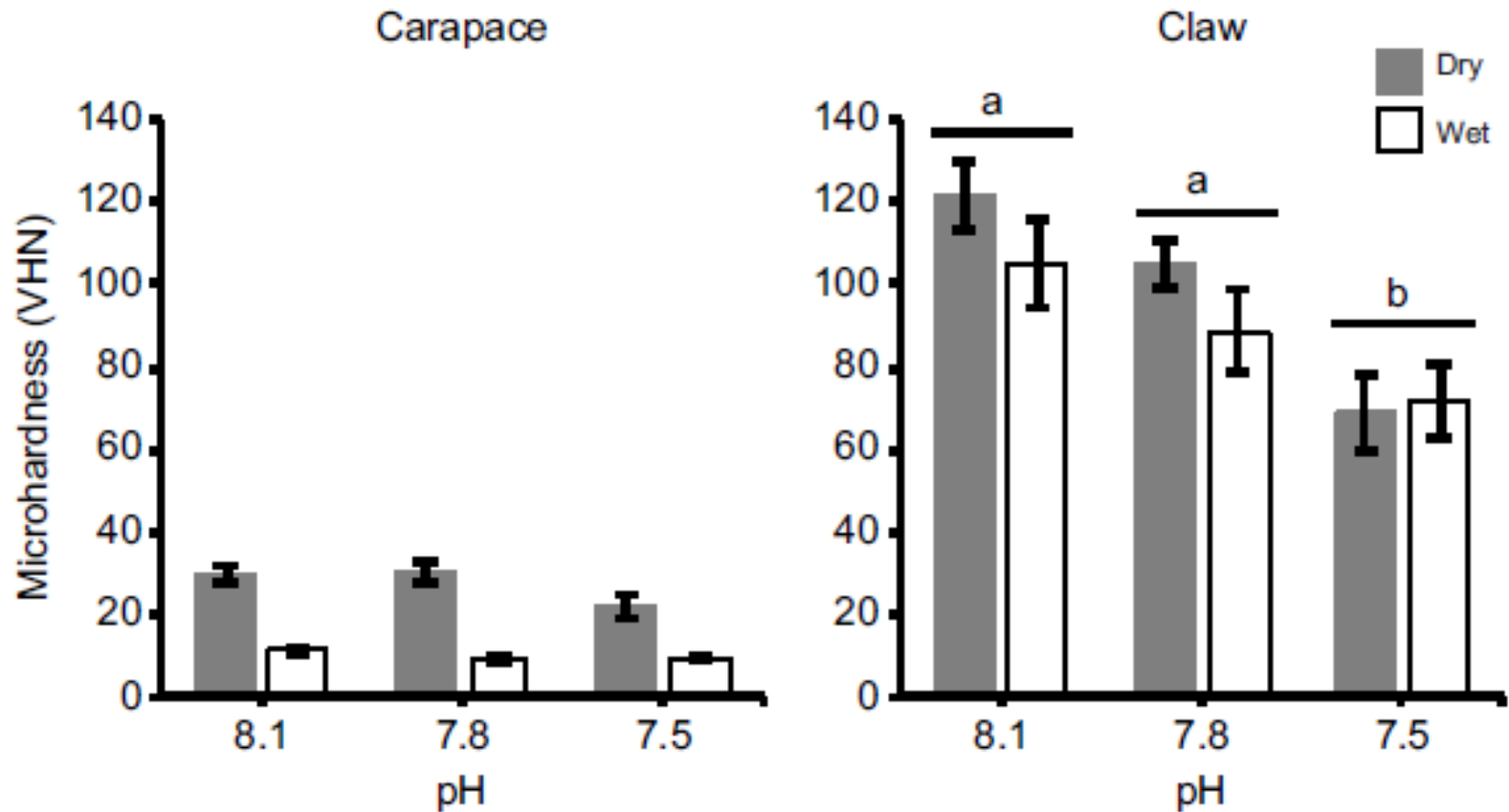


0.5 mm

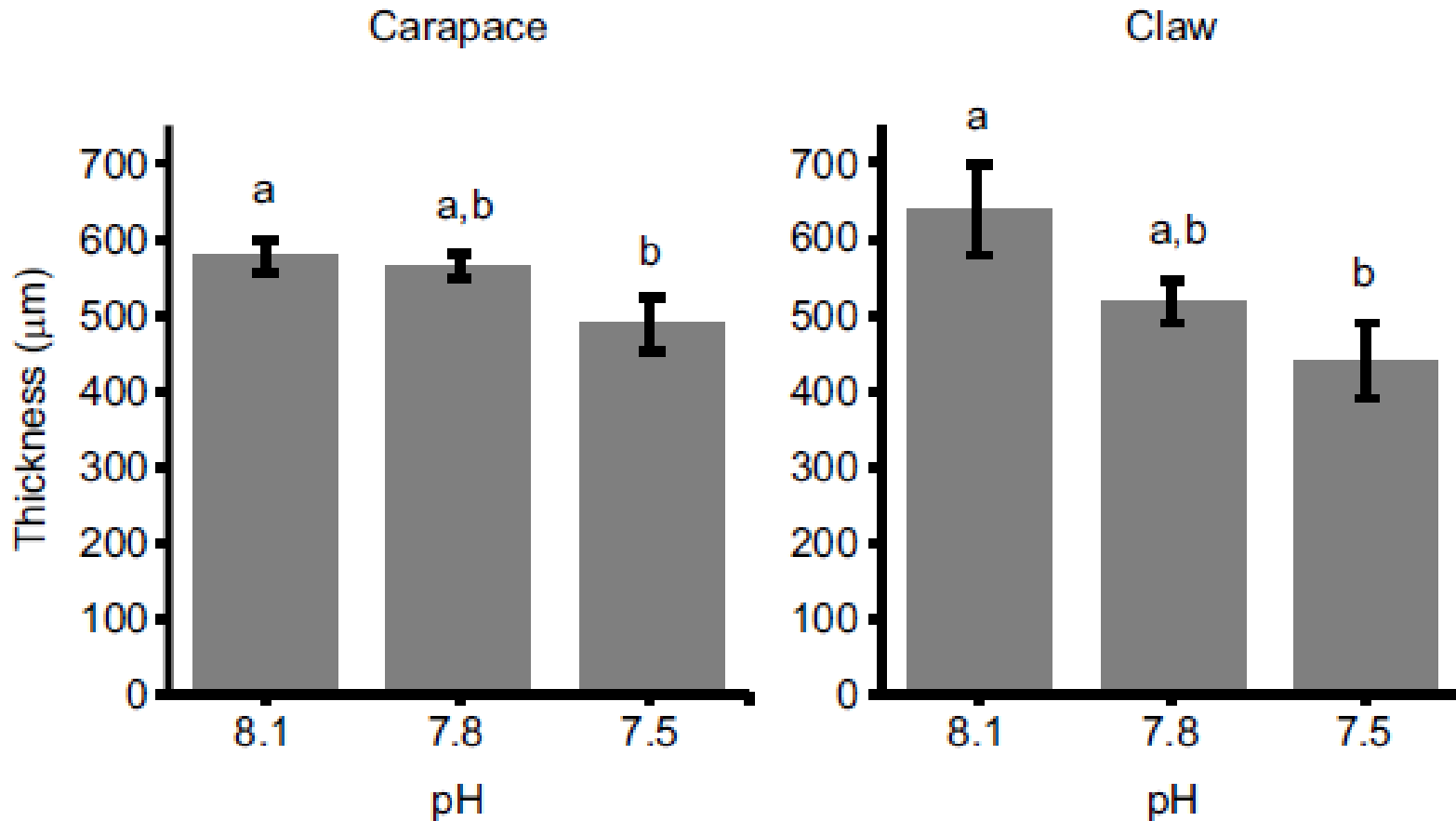


Dickenson, G. H., Bejerano, S., Salvador, T., Makdisi, C., Patel, S., Long, W. C., Swiney, K. M., et al. in press. Ocean acidification alters exoskeleton properties in adult Tanner crabs, *Chionoecetes baridi*. *Journal of Experimental Biology*.

# Tanner claws are softer

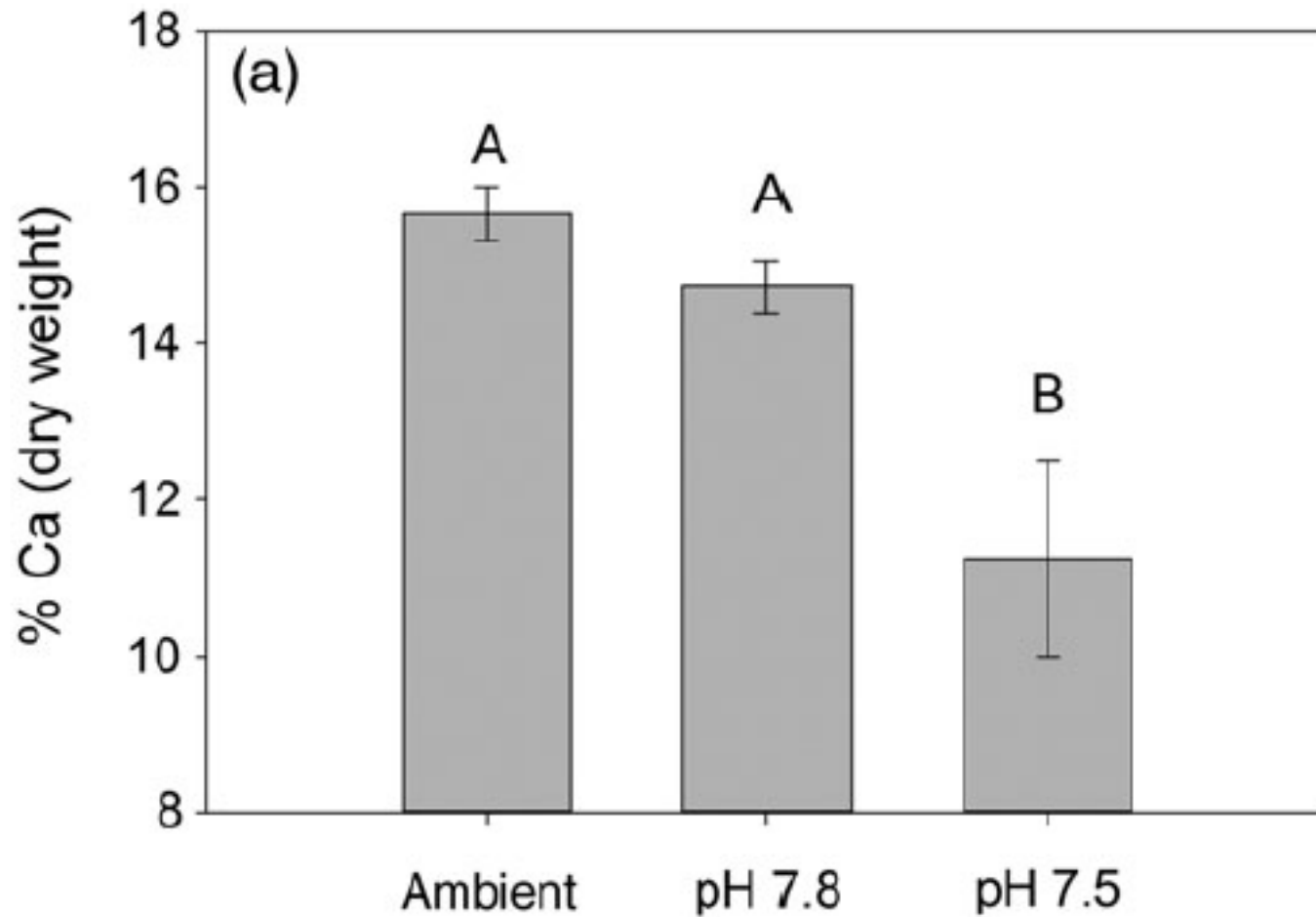


# Cuticle is thinner





# Carapace is less calcified

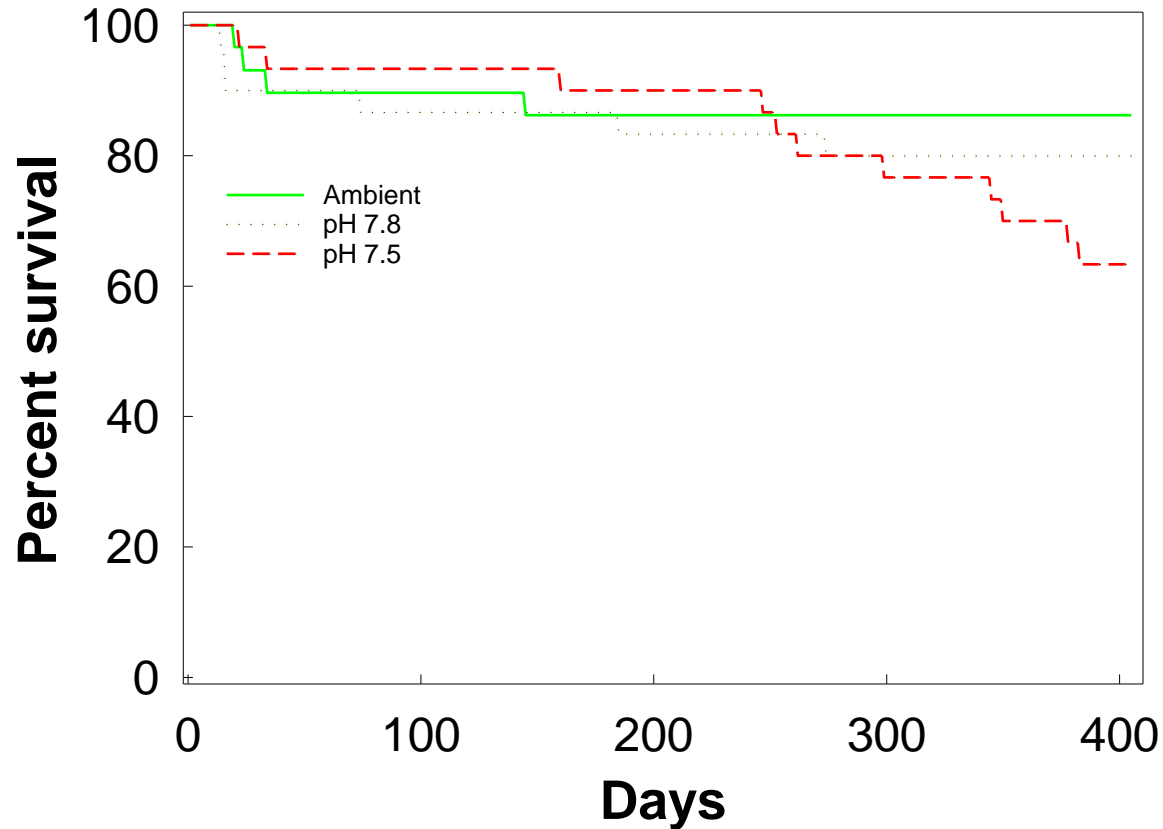


# Snow crab juveniles- Very initial results

- 3 pH treatments
  - Ambient, pH 7.8, pH 7.5
- Held at 3C
- 405 day exposure
- Measured
  - Survival
  - Growth
  - Morphology

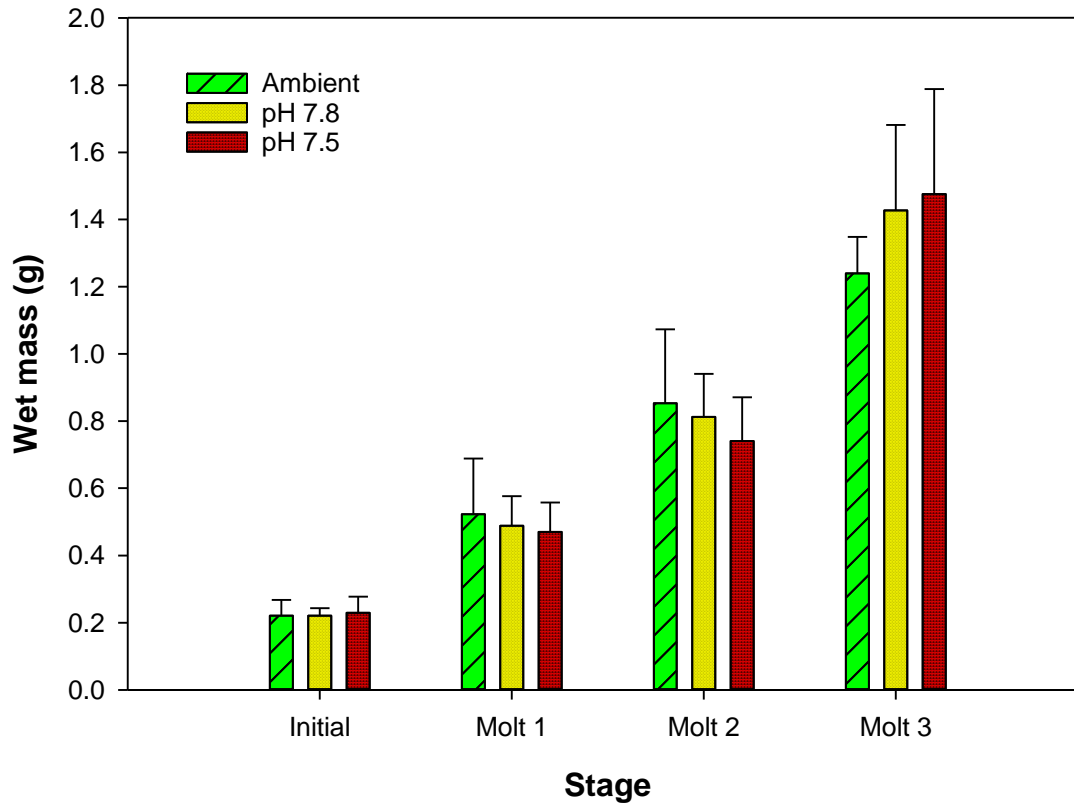


# Survival



- Slightly higher rate at pH 7.5 later in experiment

# Growth- Wet weight



- No difference among treatments for any molt

# Some Crabby Observations

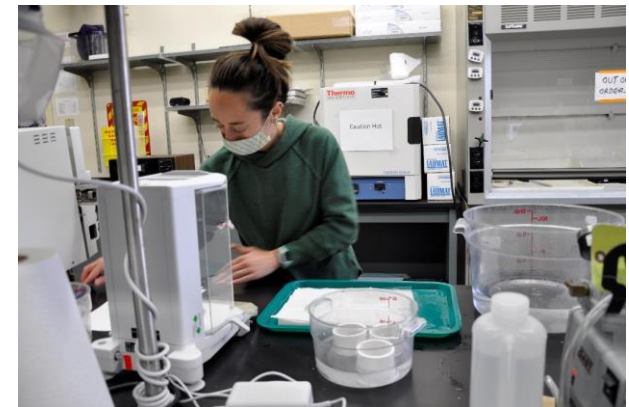
- Red king crab and Tanner crab are more sensitive to OA than snow crab and blue king crab
- Larvae are pretty resistant to OA
- Juveniles are the most sensitive
- There's a lot of differences among species
- Some species can adapt



# Thanks



NOAA OCEAN ACIDIFICATION PROGRAM



## What do you want next?

## Kodiak Lab Staff