Eurypanopeus depressus food handling with and without parasitic barnacle infection in North Inlet Estuary, Georgetown, SC during 2012 (Variation in Metabolic Processes project)

Website: https://www.bco-dmo.org/dataset/638930
Data Type: experimental
Version: 2016-02-19

Project
» Linking Variation in Metabolic Processes as a Key to Prediction (Variation in Metabolic Processes)

Contributors	Affiliation	Role
Griffen, Blaine D.	University of South Carolina	Principal Investigator
Toscano, Benjamin J.	University of South Carolina	Student, Contact
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Dataset Description

This data set comes from experiments testing how a parasite influences the foraging behavior of a crab predator. Related data sets include foraging rate and a field survey of parasite prevalence in crabs.

Related Reference:
Toscano BJ, Newsome B, Griffen BD (2014) Parasite modification of predator functional response. *Oecologia* 175:345-352

Related Datasets:
E. depressus - parasite and feeding (Oecologia, 2014)
E. depressus - parasite study - field survey (Oecologia, 2014)

Methods & Sampling

We tested the effects of barnacle (Loxothylaccus panopei) parasite infection on the interaction between the flat-backed mud crab (Eurypanopeus depressus) and its prey, the scorched mussel (Brachidontes exustus). All animals used in experiments were collected from intertidal oyster reefs in tidal creeks throughout North Inlet estuary (33°20'N, 79°10'W), Georgetown, South Carolina, USA. North Inlet is a relatively pristine salt marsh consisting of ocean-dominated tidal creeks with a high average salinity (~34 ppt) and a diurnal tidal cycle (Dame et al. 1986). We ran experiments in the screened-in, outdoor wet laboratory at the adjacent Baruch Marine Field Laboratory. The field survey of parasite prevalence was also conducted in intertidal reefs throughout North Inlet. Experiments and field sampling were conducted from June through August 2012.

Handling and reaction time experiment:
During the functional response experiment, we noticed that the maximum consumption rate of infected crabs was substantially lower than that of uninfected crabs. In traditional functional response models, maximum consumption rate is equivalent to the inverse of handling time, or the time it takes to capture, subdue and

consume an individual prey (Juliano 2001). These models assume that predators forage continuously (Tully et al. 2005; Jeschke et al. 2002), and in such a situation, predators are only limited by handling time at high prey densities. Thus, the reduced maximum consumption rate of infected crabs suggested an increase in the handling time of infected crabs. To test this, we observed and compared the handling time of uninfected and infected crabs independently of the functional response experiment.

Crabs and mussels used in this experiment fell within the same size ranges used in the functional response experiment. We recorded the carapace width of each crab and length of each mussel before trials and crabs were starved for 24 h to standardize hunger levels. The handling time of crabs was observed in cylindrical glass containers (6 cm diameter × 5 cm height) with one crab and one mussel per container. Ten crabs were observed at once and the experiment was conducted over multiple nights. Handling time was observed at night (generally from 1900 to 2400 h) under a red light to minimize disturbance to crabs (Griffen et al. 2012). Crabs were allowed to acclimate for 5 min before exposure to a mussel. Once a mussel was introduced, we recorded the time it took for a crab to make contact with the mussel (reaction time), as well as the time it took to completely consume the mussel after the first contact (handling time). Crabs were given 1 h to begin handling mussels before the experiment was terminated. Crabs that did not begin handling mussels during this time were excluded from the analysis. The reaction time of uninfected and infected crabs was measured and compared to test whether a longer period of inactivity before reacting to mussel prey contributed to the decreased consumption of infected crabs.

After this experiment, we removed and weighed the parasite externae of infected crabs to test whether the externa mass relative to the crab's body mass influenced the handling or reaction time of infected crabs. This could be expected if the size of the externa is indicative of the level of parasite infection, or acts as a physical impediment to crab handling of mussels. We compared the dry weight of the externa to the dry weight of the remaining crab body to determine relative parasite mass. Both the removed externae and crab bodies were dried in an oven at 60 °C for 72 h before measurement of dry weight.

Data Processing Description

We used linear mixed models (LMM) to test the fixed effects of parasite infection and the crab:mussel size ratio on handling and reaction time. Data were normally distributed, justifying use of a Gaussian distribution. We also used LMM to test the fixed effects of the crab:mussel size ratio and the parasite:crab mass ratio on the handling and reaction time of infected crabs. The day of observation was modeled as a random factor in all models to control for pseudoreplication. We fit models with and without fixed factors while retaining the random factor (day of observation) and compared models using Akaike's information criterion (AIC) to determine whether additional factors improved the fit despite increased model complexity.

BCO-DMO Processing:
- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- reformatted date from m/d/yyyy to yyyy-mm-dd

[table of contents | back to top]

Data Files

File
Edepressus_parasite_handling.csv (Comma Separated Values (.csv), 7.66 KB) MD5:97aa64df4b05545b0ac634f53de50c2b Primary data file for dataset ID 638930

[table of contents | back to top]

Parameters

Parameter	Description	Units
parasite	parasite presence (Yes) or absence (No)	unitless
crab	crab number	unitless
sex	crab sex: M=male; F=female	unitless
carap_width	carapace width	centimeters
claw_len	claw length	centimeters
claw_hgt	claw height	centimeters
claw_width	claw width	centimeters
mussel_hgt	mussel height	centimeters
mussel_len	mussel length	centimeters
mussel_wid	mussel width	centimeters
handling_time	time to completely consume the mussel after the first contact	minutes
time_start	time for crab to make contact with the mussel (reaction time)	minutes
externa_wgt	externa dry weight of parasite	grams
body_wgt	crab body dry weight	grams
date	observation date	yyyy-mm-dd

[table of contents | back to top]

Deployments

Griffen_lab

Website	https://www.bco-dmo.org/deployment/638572
Platform	Univ_S_Carolina
Start Date	2012-01-01
End Date	2016-12-31

[table of contents | back to top]

Project Information

Linking Variation in Metabolic Processes as a Key to Prediction (Variation in Metabolic Processes)

Description from NSF award abstract:
A major goal of biological and ecological sciences is to understand natural systems well enough to predict how species and populations will respond to a rapidly changing world (i.e., climate change, habitat loss, etc.). A population under any conditions will grow, shrink, or disappear altogether depending on how efficiently individuals consume resources (food), utilize that food metabolically, and eventually reproduce. However, making accurate predictions based on these metabolic processes is complicated by the realities that each species has different resource requirements and that no two individuals within a species are exactly alike. Rather, individuals vary and this variation, both within and across species, is central to many ecological and evolutionary processes. Developing the ability to predict responses of biological systems to a changing world therefore requires a mechanistic understanding of variation. The goal of this project is to improve this mechanistic understanding by examining variation within a metabolic context across a range of species that have a spectrum of commonly-seen resource requirements. Further, the work capitalizes on a unique biological characteristic of this group of species that allows control and manipulation of individual reproduction,

facilitating experimental study of the mechanistic links between variation in individual consumption, metabolism, and reproduction. The foundation this research is a combination of field measurements and laboratory experiments using both well-established and newly-developed techniques to quantify these links. The result will be a quantitative framework to predict how individuals will respond reproductively to changes in resource use. Because of the close link between individual reproduction and population dynamics, this research will contribute substantially to predictions in population dynamics under realistic conditions where individuals use more than a single resource, and improve the prediction of responses to current and future ecological changes.

The following publications and data resulted from this project:

Belgrad, B. and B. Griffen. 2016. Predator-prey interactions mediated by prey personality and predator identity.*Proc. Roy. Soc. B*: In Review. [2016-01-20]
P. herbstii mortality data: Mortality of crabs when exposed to either a single blue crab, toadfish, or no predator for a week
P. herbstii personality data: Refuge use of crabs when exposed to predator odor cues from either blue crabs, toadfish, or control of no cue
P. herbstii predator behavior data: Refuge use and mobility of blue crabs and toadfish while in mesocosms for a week - behavior measured during two days.

Belgrad, B. and B. Griffen. 2016. The influence of dietary shifts on fitness of the blue crab, *Callinectes sapidus*. *PloS One. DOI: 10.1371/journal.pone.0145481.*
Blue crab activity: Activity of crabs fed different diets over a summer
Blue crab egg size: Volume of eggs for crabs fed different diets
Blue crab hepatopancreas index (HSI): Weight of hepatopancreas for crabs fed different diets
Blue crab hepatopancreas lipid content: Hepatopancreas lipid content of crabs fed different diets
Blue crab reproductive tissue analysis (GSI): Gonadosomatic index of blue crabs on various diets
Blue crab survival: Blue crab survival data during the dietary study

Knotts ER, Griffen BD. 2016. Individual movement rates are sufficient to determine and maintain dynamic spatial positioning within *Uca pugilator* herds. *Behavioral Ecology and Sociobiology* 70:639-646
Uca pugilator: behavior change with carapace marking: Search space behavior due to carapace treatment (control, nail polish, and food dye)
Uca pugilator: field spatial position: Assessment of individual's position within a herd at 3 min. intervals; for proportion of time found at edge of herd
Uca pugilator: herd position proportion: Individual's proportion of time spent in an edge/alone position among a herd
Uca pugilator: search space distribution: Search space that crabs traveled; to evaluate the sample's distribution of exploratory behavior

Belgrad, B. and B. Griffen. 2015. Rhizocephalan infection modifies host food consumption by reducing host activity levels. *Journal of Experimental Marine Biology and Ecology*. 466: 70-75.
E. depressus digestion time : Time taken for food to pass through gut of flat-backed mud crabs infected by a parasite
E. depressus metabolism: Respiration rate of infected/uninfected flat-backed mud crabs
E. depressus reaction time to prey: Time taken for infected/uninfected flat-backed mud crabs to react to the presence of prey

Blakeslee, A.M., C.L. Keogh, A.E. Fowler, B. Griffen. 2015. Assessing the effects of trematode infection on invasive green crabs in eastern North America. *PLOS One* 10(6): e0128674.(pdf)
Carcinus: hemocyte density: Counts of circulating hemocyte density in Carcinus maenas
Carcinus: parasites physiology behavior: Behavior and physiology of Carcinus maenas infected with trematode parasite

Griffen BD, Norelli AP (2015) Spatially variable habitat quality contributes to within-population variation in reproductive success. *Ecology and Evolution* 5:1474-1483.
P. herbstii diet: sampling site characteristics (Eco-Evo 2015)
P. herbstii diet: body measurements (Eco-Evo 2015)
P. herbstii diet & reproduction (Eco-Evo 2015)
P. herbstii: collection sites (Ecol-Evol 2015)

Griffen BD, Riley ME (2015) Potential impacts of invasive crabs on one life history strategy of native rock crabs in the Gulf of Maine. Biological Invasions 17:2533-2544.
Cancer consumption and reproduction (Bio.Inv. 2015): Lab experiment linking dietary consumption and

reproduction

Griffen BD, Vogel M, Goulding L, Hartman R (2015) Energetic effects of diet choice by invasive Asian shore crabs: implications for persistence when prey are scarce. *Marine Ecology Progress Series* 522:181-192.
Hemigrapsus diet 1 (MEPS 2015)
Hemigrapsus diet 2 (MEPS 2015)

Hogan and Griffen (2014). The Dietary And Reproductive Consequences Of Fishery-Related Claw Removal For The Stone Crab *Menippe* Spp. Journal of Shellfish Research, Vol. 33, No. 3, 795–804.
Stone crab: 052012-DietChoiceExp1: Prey choice for 2-clawed and 1-clawed Stone Crabs (Menippe spp.)
Stone crab: 052012-LongTermConsumption: Long-term consuption for 2-clawed and 1-clawed Stone Crabs (Menippe spp.), summer of 2012
Stone crab: 062013-DietChoiceExp2: Prey choice for 2-clawed and 1-clawed Stone Crabs (Menippe spp.)
Stone crab: 062013-PreySizeSelection: Prey Size selection ranking for 2-clawed and 1-clawed Stone Crabs (Menippe spp.)

Riley M, Johnston CA, Feller IC, and Griffen B. 2014. Range expansion of *Aratus pisonii* (mangrove tree crab) into novel vegetative habitats. *Southeastern Naturalist* 13(4): 43-38
A. pisonii: range expansion: Aratus pisonii survey in native mangrove and novel salt marsh habitats

Riley M, Vogel M, Griffen B. 2014. Fitness-associated consequences of an omnivorous diet for the mangrove tree crab *Aratus pisonii*. *Aquatic Biology* 20:35-43, DOI: 10.3354/ab00543
A. pisonii: fitness and diet: Impact of diet variation on physiological and reproductive condition of A. pisonii

Toscano BJ, Newsome B, Griffen BD (2014) Parasite modification of predator functional response. Oecologia 175:345-352b
E. depressus - parasite and feeding (Oecologia, 2014): Feeding with and without parasitic barnacle infection
E. depressus - parasite and prey handling (Oecologia, 2014): Food handling with and without parasitic barnacle infection
E. depressus - parasite study - field survey (Oecologia, 2014): Parasitised field survey

Toscano BJ, Griffen BD (2014) Trait-mediated functional responses: predator behavioural type mediates prey consumption.*Journal of Animal Ecology* 83:1469-1477
P. herbstii - activity and feeding (JAE, 2014): Activity level and feeding with and without predator cue

Toscano BJ, Gatto J, Griffen BD (2014) Effects of predation threat on repeatability of individual crab behavior revealed by mark recapture. *Behavioral Ecology and Sociobiology* 68:519-527
P. herbstii - recapture behavior (BESB, 2014): Mud crabs refuge use and activity level - initial measurements
P. herbstii - refuge use (BESB, 2014): Effect of predation threat on repeatability of individual crab behavior revealed by mark-recapture

Griffen BD, Altman I, Bess BM, Hurley J, Penfield A (2012) The role of foraging in the success of invasive species. Biological Invasions. 14:2545-2558
Hemigrapsus seasonal diet (Bio.Inv. 2012): Percent herbivory and gut fullness for Hemigrapsus sanguineus at different times of year

Griffen BD, Toscano B, Gatto J (2012) The role of intraspecific trait variation in mediating indirect interactions. Ecology 93:1935-1943
P. herbstii refuge use (Ecology, 2012): Proportion of time that Panopeus herbstii spent using refuge habitats in a lab experiment
P. herbstii: Field personality distribution (Ecology, 2012): Field distribution of personality types in the mud crab Panopeus herbstii relative to tidal height
P. herbstii: Trait mediated indirect effect (Ecology, 2012): Influence of refuge use by the mud crab Panopeus herbstii on consumption of bivalves

Riley ME, Griffen BD (2017) Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion. PLOS One 12(5):e0176263
A. pisonii: egg size: Comparing egg size in Aratus pisonii populations from mangrove and salt marsh habitats
A. pisonii: fecundity: Determining fecundity of Aratus pisonii populations in mangrove and salt marsh habitats
A. pisonii: larval starvation resistance: Comparing larval quality in Aratus pisonii populations from mangrove and salt marsh habitats
A. pisonii: latitudinal body size: Survey examining latitudinal body size patterns in Aratus pisonii
A. pisonii: predation: Comparing predation pressure on Aratus pisonii in mangrove and salt marsh habitats
A. pisonii: reproductive effort: Survey comparing Aratus pisonii reproductive effort in native and novel habitats

A. pisonii: herbivory: Relationship between leaf herbivory, tree characteristics, and refuge availability
A. pisonii: mangrove tree survey: Mangrove tree distribution and characteristics in a dwarf mangrove system

Cannizzo ZJ, Dixon SR & Griffen BD (2018). An anthropogenic habitat within a suboptimal colonized ecosystem provides improved conditions for a range-shifting species. Ecology and Evolution, 8(3):1524-1533.
A. pisonii: behavior: Proportion of time the mangrove tree crab Aratus pisonii spent in different behaviors related to diet and energy storage
A. pisonii: dock-marsh thermal: Thermal readings from under a dock and in a nearby salt marsh
A. pisonii: sun-shade: Proportion of time that mangrove tree crab Aratus pisonii spent in sun and shade in three habitats, 2015-2016.
A. pisonii: thermal picture: Thermal condition of A. pisonii in three habitats: under dock, mangroves, saltmarsh

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1129166
Slocum-Lunz Foundation	Lerner Grey Memorial Fund of the American Museum of Natural History

[table of contents | back to top]