Eurypanopeus depressus feeding 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/638907
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
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Dataset Description

This data set comes from experiments testing how a parasite influences the foraging rate of a crab predator. Related data sets include foraging behavior 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 prey handling (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.

Functional response experiment:
We first measured the functional responses of uninfected and infected mud crabs (8-13.5 mm carapace width) foraging on the scorched mussel (4-7 mm shell length). Mussels in this size range are abundant in oyster clusters throughout the study site (Toscano and Newsome, personal observations). We identified

infected crabs by the presence of parasite externae, indicative of a mature stage of parasite infection (Alvarez et al. 1995). However, we cannot discount the possibility that uninfected crabs were actually in the immature, internal stage of infection. Mussels were offered to crabs in eight densities: 2, 4, 6, 8, 10, 16, 24 and 32 mussels per experimental chamber. Trials were run in a randomized complete block design and each treatment was replicated a total of 12 times (12 blocks). Individual crabs were used once in this experiment.

We ran functional response experiments in plastic chambers (15 cm length × 13 cm width × 7.6 cm height) containing oyster shells to simulate the structure of natural oyster reef habitat. Each chamber received five cleaned and dried oyster shells (7-10 cm shell length) to provide a relatively consistent substrate for mussels to attach to. The necessary number of mussels for a given treatment was evenly distributed over the shell throughout each chamber. Experimental chambers were then placed in a larger cylindrical flow-through seawater tank (97 cm diameter × 41 cm depth, water depth: 25 cm) and mussels were allowed to attach to oyster shells over a 12 h period. Crabs were starved for a 24 h period before placement in the chambers to standardize hunger levels. After starvation, crabs were allowed to forage for a 13 h period overnight, generally from 1900 to 0800 h. Chambers received a constant flow of unfiltered sea water from North Inlet throughout this period. After 13 h, the number of remaining mussels was recorded. All dead mussels showed signs of being preyed upon by crabs (cracked shells).

Data Processing Description

Functional response models were fit separately to uninfected and infected crabs, allowing us to examine the effects of parasite infection on the functional response. First, to determine the type of functional response (i.e. type I, II or III), we used polynomial logistic regression on the proportion of prey consumed as a function of prey density (Juliano 2001). For both uninfected and infected crabs, the first order term in this regression was significantly negative (i.e. declining proportion consumed at very low prey densities), indicative of a type II functional response (Juliano 2001). Because prey were depleted over the 24 h that crabs foraged and not replaced, a Rogers type II functional response model that accounts for prey depletion was fit separately to uninfected and infected crabs (Rogers 1972):

$N_e = N_o(1 - \exp(\alpha(N_e T_h - PT)))$ (1)

where Ne is the number of prey eaten, No is the initial prey density, a is attack rate, Th is handling time, P is the number of predator individuals (set to 1), and T is the experimental duration (set to 13 h). Equation 1 is a recursive function of Ne, and so we used the Lambert W function to implement the model (see Bolker 2008 for details):

$Ne = N_o(W(\alpha T_h N_o \exp^{-\alpha\ (PT - T_h N_o)})/\alpha T_h)$ (2)

where W is the Lambert W function and all other parameters are the same as in Eq. 1. This functional response model was fit to prey consumption data using maximum likelihood estimation with binomial errors in the statistical software R (package "bblme").

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

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Data Files

File
Edepressus_parasite_feed.csv (Comma Separated Values (.csv), 5.32 KB) MD5:0e721ee73c912475228cdadbac266f06 Primary data file for dataset ID 638907

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Parameters

Parameter	Description	Units
expt_block	id number for the time block for experimental work	unitless
date	observation date	yyyy-mm-dd
mussel_density	number of mussels in tank	mussels
prey_eaten	mussels eaten	mussels
carap_width	carapace width	centimeters
sex	crab sex: M=male; F=female	unitless
parasite	parasite presence (Yes) or absence (No)	unitless

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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

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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

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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

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