Experimental results describing the activity of crabs fed different diets during a summer (Variation in Metabolic Processes project)

Website: https://www.bco-dmo.org/dataset/630014
Data Type: experimental
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Project
» Linking Variation in Metabolic Processes as a Key to Prediction (Variation in Metabolic Processes)

Contributors	Affiliation	Role
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Dataset Description

Related Reference:

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*.

Treatments:
FL = crabs fed large portions of fish
FS = crabs fed small portions of fish
ML= crabs fed large portions of mussels
MS = crabs fed small portions of mussels
SL = crabs fed large portions of seaweed
SS = crabs fed small portions of seaweed

Related Datasets:

Blue crab egg size
Blue crab hepatopancreas index (HSI)
Blue crab hepatopancreas lipid content
Blue crab reproductive tissue analysis (GSI)
Blue crab survival

Methods & Sampling

We collected 60 mature fully intact female Callinectes sapidus (carapace width = 12.5 – 16.5 cm) using baited

crab traps from the National Estuarine Research Reserve, North Inlet (33°20'N, 79°10'W, Georgetown, South Carolina). Crabs were obtained during early May 2014 over the course of a week, one month prior to the peak spawning season. We started the experiment in blocks (5 total) as crabs were captured so that no crabs were held longer than 24 hours before commencing the study and being fed.

Crabs were transported to the Baruch Institute wet lab (situated on North Inlet) where they were placed into individual plastic containers (length 29.8 cm, width 19.7 cm, height 20.3 cm) submersed within seven flow-through tanks supplied with seawater directly from North Inlet. Water temperature matched environmental conditions and varied between 25.4 – 34.5 °C throughout the experiment. Individual containers were filled with a 1.5 cm layer of sediment collected from the field and continuously received water at a rate of ~1.3 L/min. Once a week the containers were cleaned with an aquarium vacuum and the substrate layer was replenished with new sediment. This sediment was provided because sediment is required for development of normal egg masses in this species. Sediment may also have served as an additional source of food. Crabs that died before the end of the experiment were frozen and stored at -20 °C for later dissection. Any egg masses produced by the crabs were stored in the freezer for later analyses. The experiment was terminated after 12 weeks, on 30-Jul-2014.

Throughout the duration of the experiment, crabs were fed either exclusively ribbed mussels (Geukensia demissa), mummichogs (Fundulus heteroclitus), or seaweed (Ulva lactuca), with all crabs having access to sediment. Because consumers are known to compensate for low-quality diets by increasing the amount of food consumed we fed crabs either a satiating amount of food (4 ribbed mussels, 25.2 g mummichog, 3.7 g seaweed) or approximately one-quarter this amount (1 ribbed mussel, 5.8 g mummichog, 1.3 g seaweed). The quantities of food offered depended on food type. Food was weighed to the nearest 0.0001g using an analytical scale (HR-120) While mummichog weight corresponded to the average weight of the soft tissue within 4 or 1 mussels, seaweed weight related to the volume of 25.2 or 5.8 g of mummichog because U. lactuca is substantially less dense than mummichog and the amount of food blue crabs can consume is dependent on their stomach capacity. Thus, this study had a 3x2 factorial design with ten crabs randomly assigned to each of the six different experimental diets.

Crabs were fed a constant experimental diet every other day and any excess food was removed after 24 h. Food was collected from North Inlet daily and, to prevent decomposition, was never refrigerated longer than 48 h prior to use. Mussels were cracked open prior to being fed to the crabs in an effort to make handling effort more similar across food types, and only soft tissue weights of mussels were used.

We assessed individual crab aggression levels daily to determine if diet influenced behavior. To reduce biases in behavior originating from previous feeding history we did not begin measuring behavior until two weeks after capture. Behavior was measured by slowly lowering a metal prong into each container, stopping approximately three cm from the mouth of the crab, and observing the crab response. The container sides were opaque to help prevent the crab from reacting to stimuli outside of the container and the observer was careful to never appear directly over the container. Crab behavior was categorized as aggressive if the crab approached or raised its chelipeds towards the prong, while stationary crabs or crabs that moved away from the prong were labeled as docile. Crab behavior was measured once each day between the hours 1200–1330 prior to feeding to help control for any behaviors associated with the crab circadian rhythm and to prevent changes in behavior associated with consuming food. Individual crab aggression was expressed as the proportion of days it acted aggressively.

Data Processing Description

A generalized linear model with a binomial distribution was employed to determine if either the food type (mussel, fish, or seaweed) or amount of food offered (large or small portions) influenced crab mortality. Statistical Software: R v. 3.0.3 (R Development Core Team, Auckland, New Zealand)

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard

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Data Files

File
behavior.csv (Comma Separated Values (.csv), 176.61 KB) MD5:14642d1c429230b5875566f34a06ec5e Primary data file for dataset ID 630014

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Parameters

Parameter	Description	Units
block	time block for experimental work	unitless
lat	latitude of sample collection; north is positive	decimal degrees
lon	longitude of sample collection; east is positive	decimal degrees
year	year	YYYY
time_local_zone_diff	difference between GMT and local time	hours
foodtype	type of food: fish mussels seaweed	unitless
portionsize	relative portion size: small or large	unitless
individual	crab identification for behavior study	unitless
treatment	two letter code for food type and portion size: M=mussel; S=seaweed;F=fish; L=large portion; S=small portion	unitless
tank	tank identifaction	unitless
day	day of month	dd
month	month	unitless
time_gmt	GMT time	HHMM
crab_fed_today	whether crab was fed or not on each day	unitless
temp	temperature	degrees Celsius
activity_flag	activity flag: 0=docile; 1=aggressive	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	scale or balance
Dataset-specific Description	Analytical scale (A & D, model HR-120)
Generic Instrument Description	Devices that determine the mass or weight of a sample.

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Deployments

Griffen_2014

Website	https://www.bco-dmo.org/deployment/629829
Platform	Univ_S_Carolina
Start Date	2014-05-31
End Date	2014-10-25
Description	Blue crab studies

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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

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