Dietary intake by the crab Hemigrapsus sanguineus and its energy storage: GSI, HIS in North Inlet Estuary, Georgetown, SC during 2012 (Variation in Metabolic Processes project)

Website: https://www.bco-dmo.org/dataset/648272
Data Type: experimental
Version:
Version Date: 2016-06-03

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
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Laboratory experiment used to examine the link between dietary intake by the crab *Hemigrapsus sanguineus* and its energy storage. This dataset reports gonadosomatic index (GSI), or the proportion of body weight comprised of the ovary and hepatosomatic index (HIS), or the proportion of body weight comprised of the hepatopancreas.

Related Reference:

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. doi: 10.3354/meps11160

Related Dataset: Hemigrapsus diet 1 (MEPS 2015)

Methods & Sampling

General experimental methods – We conducted an experiment to determine the effect of food type (algae vs. animal) and amount of food consumed on the energetic state of the Asian shore crab. We chose to use the most commonly consumed and preferred food types in invaded habitats. For animals, this is the mussel Mytilus edulis, and for algae it is the abundant red alga Chondrus crispus. We collected female crabs from Odiorne Point, NH, USA in early May 2011. To standardize reproductive state of experimental crabs as far as possible, we only collected gravid females. Crabs were taken immediately to the University of South Carolina where they were held at elevated temperatures (20°C, which falls within the range of natural summer temperatures for seawater at the site where these crabs were collected, but is higher than temperatures that commonly occur) for 5 d to stimulate egg hatching. All crabs used in the experiment had therefore recently produced and released a clutch of eggs.

The experiment was conducted in a closed, recirculating aquarium (salinity 34 psu) at water temperatures that mimicked summer temperatures on the New Hampshire coast (15°C), and with a 18 h light: 6h dark cycle. Each crab was housed in its own experimental chamber (1 l volume). Each chamber was supplied with water so that flow occurred through each chamber within the recirculating system. Chambers were designed to capture all feces and unconsumed food particles so that these could be precisely quantified for each crab. Algae fed to crabs during the experiment were collected at the same time and place as crabs. However, given the scarcity of mussels at the site at the time of collection, we purchased live mussels from Cape Cod Shellfish & Seafood (Boston, MA) and froze them until they were used in the experiment. Only mussel mantle tissue was used. No crabs died or molted during the 10 wk experiment.

Feeding and consumption – Each crab was fed a constant diet 3 times per week throughout the experiment. These experimental diets differed in the total amount of food offered at each feeding (0.1, 0.2, 0.4, 0.8 g wet weight) and the percent of that food that was mussel or algae (ratios used were 0:100, 25:75, 50:50, 75:25, 100:0), yielding a total of 20 different quantitative × qualitative diet combinations. Crabs were fed on Monday, Wednesday, and Friday throughout the 10 wk experiment and were given 24 h to consume the provided food before any uneaten food was removed, dried at 70°C for 48 h, and weighed (mussel and algae separately) to determine the precise amount of each food type remaining. Initial dry weight of food offered was calculated from measured wet weights using the percent water content of each of the different food types (mussel: 82.5 ± 1.6%; algae: 70.0 ± 0.3%; mean ± SD), determined independently using the mean difference in mass of wet and dry replicate samples (n = 30) of each food type. Additionally, a nonconsumption control (mussel tissue and algae submerged within the experimental chamber, but not accessible to a crab) was included on each feeding day to determine any nonconsumptive changes in food mass.

Absorption – After removing uneaten food in each feeding cycle, crabs were then given 24 h for gut clearance before being fed again (except on weekends where food was removed on Saturday and feeding did not occur again until Monday). Experimental chambers were designed with a mesh subfloor so that feces fell through to a collection chamber where they were isolated from the crab to prevent reingestion. Feces were collected by filtration onto a Whatman Qualitative No. 1 filter, and were weighed after drying for 24 h at 70°C. We used the ratio of the dry weight of feces produced and the dry weight of food consumed as the absorption efficiency (termed Assimilation in the data file).

Metabolic rate – In the 9th week of the experiment we also measured the metabolic rate of each crab to determine whether diet-induced differences in metabolic rate could be responsible for any differences in physiological condition seen at the end of the experiment. Rates were measured using a YSI dissolved oxygen meter (model no. 52CE) in a closed volume chamber. Measurements were made after the gut clearance period (so at least 24 h after crabs had eaten). Crabs were placed into a closed chamber filled with water at the same salinity and temperature as the experimental water. They were allowed 15 min after introduction into the respirometry chamber to acclimate before the initial oxygen reading was taken. The final reading was then taken 15 min later and the metabolic rate was calculated as mg O2 consumed per gram dry weight of crab per hour. Following the metabolic rate measurement, the crab was then returned to its experimental chamber and the regular feeding schedule continued as des cribed above.

Physiological condition – At the conclusion of the experiment, each crab was dissected and the hepa topancreas was removed. The hepatopancreas and the rest of the crab were then each dried for 72 h at 70°C and weighed. As a second estimate of physiological condition, we measured the percent lipid of the hepa to pancreas tissue. Bulk lipids were extracted using a modified Folch method where chloroform is replaced with hexanes.

Data Processing Description

Raw data are presented.

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
Hemigrapsus_diet_2.csv (Comma Separated Values (.csv), 2.35 KB) MD5:364cb646f1bf598bbc02f35301386add Primary data file for dataset ID 648272

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Parameters

Parameter	Description	Units
crab	unique identification number for each crab	unitless
carap_width	carapace width of crab	millimeters
diet	dietary treatment fed to individual crabs: All – all diet types offered Animal – all animal food types offered Plant – all algal food types offered Barancle – only barnacles offered (Semibalanus balanoides) Crab – conspecifics offered (Hemigrapsus sanguineus) Snail – only snails offered (Littorina littorea) Chondrus – only the alga Chondrus crisups offered Fucus – only the alga Fucus vesiculosus offered Mastocarpus – only the alga Mastocarpus stallatus offered	unitless
gonadosomatic_index	gonadosomatic index: the proportion of body weight comprised of the ovary	unitless
hepatosomatic_index	hepatosomatic index: the proportion of body weight comprised of the hepatopancreas	unitless
days_feces	number of feeding days out of 21 possible where feces was produced (used as a proxy to know when crabs had consumed food	days

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	scale or balance
Generic Instrument Description	Devices that determine the mass or weight of a sample.

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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

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