Relationship between leaf herbivory, tree characteristics, and refuge availability in a Belize mangrove forest during 2013 (Variation in Metabolic Processes project)

Website: https://www.bco-dmo.org/dataset/639335
Data Type: experimental
Version:
Version Date: 2017-08-03

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 is part of a project exploring the impact of niche construction on current plant-animal interactions. Data were collected February 2013.

Related Datasets:
A. pisonii: egg size
A. pisonii: fecundity
A. pisonii: fitness and diet
A. pisonii: larval starvation resistance
A. pisonii: latitudinal body size
A. pisonii: predation
A. pisonii: range expansion
A. pisonii: reproductive effort
A. pisonii: mangrove tree survey

Related Reference:
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.

Methods & Sampling

We established three random 10 m x 10 m plots within a dwarf *Rhizophora mangle* stand in Twin Cays, Belize. In each plot, we established the X, Y coordinates of each tree within the plot by determining the position of its central trunk. We measured morphological tree characteristics for each tree, including length (m, long axis of the tree), width (m, short axis of the tree), and height (m). Additionally, we categorized all trees into one of three categories: (1) no refuge, (2) adjacent to refuge, (3) refuge. Trees categorized as “no refuge” did not

contain a tree hole resulting from previous herbivory by the beetle *Elaphidion mimeticum* (Cerambycidae) or other wood-boring insects. Trees categorized as “adjacent to refuge” did not contain a tree hole, but were physically in contact with a tree that did contain a tree hole. Trees categorized as “refuge” contained a tree hole.

Within each of the three experimental plots, we randomly selected five trees from each of the three tree categories (except plot 3, in which there were only four “adjacent to refuge” trees). For each of these trees (n=44), we randomly collected 10 green leaves from a basal position on a twig (i.e. fourth or fifth leaf pair from the twig terminals). Leaves were transported to the field station on Carrie Bow Cay and pinned flat. We then digitally photographed all 10 leaves from each tree in one frame, along with a size reference for use in subsequent leaf image analysis.

In order to analyze the proportion of leaf area damaged or removed by herbivory, we used the digital analysis software ImageJ 1.49u (U.S. National Institutes of Health). For each image, which included the 10 leaves collected from a single tree, we first set the scaling factor using the size reference. We outlined the total area of a single individual leaf to quantify total leaf area (cm^2), and then proceeded to outline each individual area (cm^2) on the leaf surface that showed evidence of complete herbivory (sections of leaf completely removed) or damage from herbivory (partial removal of leaf, such as scraping or brown areas). For each of these instances of leaf damage, we used recognizable leaf damage signatures of the three herbivores that damaged leaves in this study ((1) the mangrove tree crab *Aratus pisonii*, (2) the mangrove periwinkle snail *Littoraria angulifuera*, and (3) larvae of the bagworm moth *Oiketicus kirbii*) to categorize which was responsible for each piece of leaf damage. After determining the total area of all spots damaged by herbivory on a single leaf, we calculated the percentage of leaf area that was damaged or consumed by herbivory for each of the three herbivores, as well as the total percentage of leaf area damaged or consumed by all herbivores. We then repeated the process for the nine remaining leaves in the image, beginning with the outline of the next leaf’s total leaf area.

Data Processing Description

Once we had calculated the proportion of herbivory for all of the leaves collected from a single tree, we also calculated the mean total herbivory and herbivory by each herbivore for each particular tree.

BCO-DMO Processing:
- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard
- replaced spaces with underscores; removed commas
- added site, latitude and longitude for mapping purposes
- reordered columns
- no longitude data were supplied; added longitude = -88.10 as given in mangrove tree survey dataset
- version 2017-08-03 replaced version: 2016-02-25: latitude corrected from 16.78 to 16.83

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Data Files

File	
Apisonii_herbivory.csv	(Comma Separated Values (.csv), 4.28 KB) MD5:92091f16fcccbd88300ab60842bae750
Primary data file for dataset ID 639335	

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Related Datasets

IsRelatedTo

Griffen, B. D. (2016) **Aratus pisonii survey in native mangrove and novel salt marsh habitats in**

South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project). Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 2016-02-25) Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639205 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Comparing egg size in Aratus pisonii populations from mangrove and salt marsh habitats in South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-03-01 http://lod.bco-dmo.org/id/dataset/639282 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Comparing larval quality in Aratus pisonii populations from mangrove and salt marsh habitats in South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639320 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Comparing predation pressure on Aratus pisonii in mangrove and salt marsh habitats South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639301 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Experimental results determining fecundity of Aratus pisonii populations in mangrove and salt marsh habitats in South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639229 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Impact of diet variation on physiological and reproductive condition of A. pisonii in South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 2016-02-25) Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639095 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Mangrove tree distribution and characteristics in a dwarf mangrove systems in the South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-03-01 http://lod.bco-dmo.org/id/dataset/639360 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2016) **Survey comparing Aratus pisonii reproductive effort in native and novel habitats in South Eastern US mangrove forests during 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2016-02-25 http://lod.bco-dmo.org/id/dataset/639267 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

Griffen, B. D. (2017) **Survey examining latitudinal body size patterns in Aratus pisonii collected from South Eastern US mangrove forests in 2013 (Variation in Metabolic Processes project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2017-08-03 http://lod.bco-

dmo.org/id/dataset/639250 [view at BCO-DMO]
Relationship Description: Aratus pisonii dataset collected as part of the same study "Habitat-specific differences alter traditional biogeographic patterns of life history in a climate-change induced range expansion" Riley & Griffen (2017).

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Parameters

Parameter	Description	Units
site	Site identification	unitless
lat	Latitude; north is positive	decimal degrees
lon	Longitude; east is positive	decimal degrees
plot	Mangrove plot number	unitless
site_descrip	plot contains refuge; is adjacent to refuge; or not a refuge for A. pisonii	unitless
tree	Tree identification number	unitless
total_herbivory	Total herbivory	proportion of leaf area cm^2
A_pis_herbivory	A. pisonii herbivory	proportion of leaf area cm^2
L_ang_herbivory	L. angulifuera herbivory	proportion of leaf area cm^2
O_kir_herbivory	O. kirbii herbivory	proportion of leaf area cm^2
X_coord_tree	X coordinate of tree	meters
Y_coord_tree	Y coordinate of tree	meters
tree_len	Tree length	meters
tree_wid	Tree width	meters
tree_hgt	Tree height	meters
dist_refuge	Minimum distance to a tree inside the plot with a refuge	meters

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Camera
Dataset-specific Description	Digital still camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

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Deployments

Griffen_mangroves

Website	https://www.bco-dmo.org/deployment/639093
Platform	Univ_S_Carolina
Start Date	2013-06-01
End Date	2015-12-31
Description	Aratus pisonii (Mangrove Tree 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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