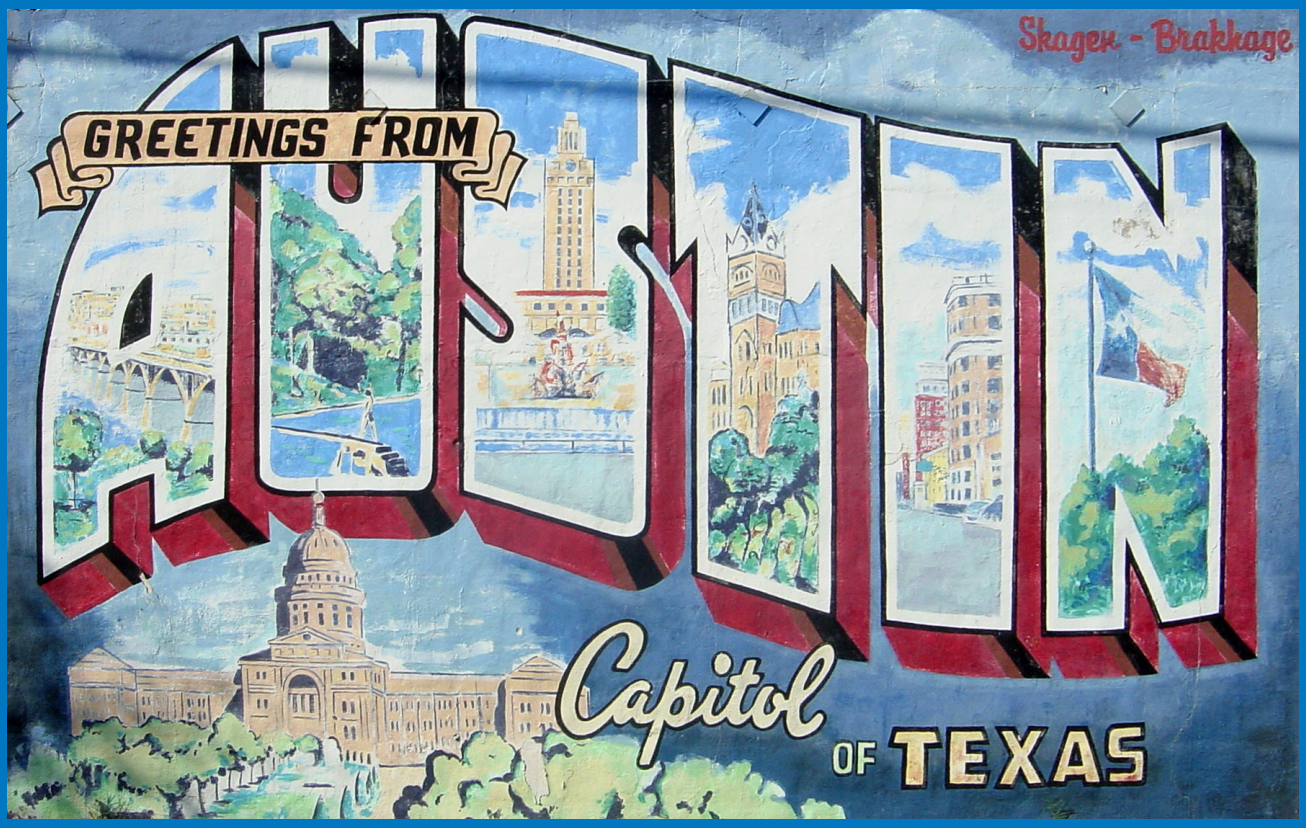
The Society for Integrative and Comparative Biology



Society for Integrative and Comparative Biology

with the

Animal Behavior Society

American Microscopical Society

The Crustacean Society

Final Program

Hilton Austin

Austin, Texas

3-7 January 2014

Table of Contents

Future Meeting Dates

West Palm Beach, Florida, 3-7 January 2015

Portland, Oregon, 3-7 January 2016

New Orleans, Louisiana, 3-7 January 2017

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P2.133	DCPB	*Akuma DC, Piermarini PM, Gillen CM; Kenyon College, Ohio Agricultural Research and Development Center*	Tissue and developmental expression of three putative Na-coupled cation-chloride cotransporters in *Aedes aegypti*
P2.134	DCPB	*Lovett DL, Williams M, Pulido S, Goldfarb AM; The College of New Jersey, Ewing*	Effect of salinity on gene expression for enzymes in the methyl farnesoate synthesis pathway in the green crab *Carcinus maenas*
P2.135	DCPB	*Mitchell RT, Henry RP; Auburn University*	Functional evidence for neuroendocrine regulation of carbonic anhydrase in the blue crab *Callinectes sapidus*
P2.136		*Bollinger RJ, Bujak JK, Madsen SS, Tipsmark CK; University of Arkansas, Fayetteville, University of Southern Denmark, Odense*	Vivo-morpholino induced knock-down of gill Na,K-ATPase impairs seawater acclimation in rainbow trout
P2.137		*Zajic DE, Cramb G, Gotz M, Villasenor A, Yancey PH; Whitman College, University of St. Andrews*	Novel osmolyte in Atlantic salmon (*Salmo salar*) as a potential biomarker of freshwater-seawater transition
P2.138	DCPB	*Tipsmark CK, Breves JP, Rabeneck DB, Trubitt RT, Lerner DT, Grau EG; University of Arkansas, Fayetteville, University of Massechusetts, Amherst, University of Hawaii, Kaneohe*	Effects of salinity and cortisol on gill claudin-10c, -10e, -28a, -30 and occludin in tilapia
P2.139	DCE	*McCormick SD, Regish AM, O'Dea MF; USGS, Conte Anadromous Fish Research Center*	The evolutionary consequences of staying in freshwater: seawater performance, physiological and endocrine differences between landlocked and anadromous salmon
P2.140		*Mascarenhas FE, Mallery Jr. CS, Dzialowski EM; University of North Texas, Denton*	Physiology of the Pekin duck (*Anas pekin*) ductus arteriosus
P2.141	DCPB	*Hedrick MS, McNew KA; University of North Texas*	Does baroreflex gain vary with habitat in anuran amphibians?
P2.142	DCPB	*Slay CE, Hicks JW; University of California, Irvine*	Cardioventilatory responses to digestion in anemic American alligators (*Alligator mississippiensis*)
P2.143	DCPB	*Wehrle BA, Herrel A, Tadic Z, German DP; University of California, Irvine*	Testing the adaptive modulation hypothesis: physiological changes in in a newly herbivorous lizard
P2.144		*Chamberlain JD, Gifford ME; University of Arkansas, Little Rock*	The influence of prey size and abundance on patterns of energy allocation in watersnakes
P2.145	DCPB	*Wiessner G, Stewart JR, Heulin B, Ecay TW; East Tennessee State University, Johnson City, Station Biologique de Paimpont, France*	Developmental calcium uptake and chorioallantoic membrane expression of calbindin-D28K by viviparous *Zootoca vivipara* embryos under manipulated *ex utero* calcium provision
P2.146		*Hobensack MJ, Hood WR; Auburn University*	Increasing mechanical strain on the skeleton during reproduction does not reduce bone mobilization during reproduction in the mouse
P2.147		*Karratti-Abordo J, Nerurkar P; University of Hawaii at Manoa*	Anti-inflammatory mechanisms of tropical foods
P2.148		*Rodriguez LM, Aguilar AC, Castillo AO*; University del Valle, Cali - Colombia*	Leptin's promoter methylated in pregnant women with a low flow-mediated vasodilation

Reproduction and Sexual Selection

P2.149	DAB	*McKee A, Newton S, Carter A; California State University, Long Beach*	Influence of inbreeding on female mate choice in two species of *Drosophila*
P2.150	DVM	*Morris JS, Carrier DR; University of Utah*	Specialization for aggression in sexually dimorphic skeletal morphology in Carnivora
P2.151		*Donoviel ZS, Sirman AE, Hood WR; Auburn University*	Maternal dietary effects and age at first reproduction in the house mouse
P2.152		*Panhuis TM, Kwan L, Fris M, Tuhela-Reuning L, Rodd FH, Rowe L; Ohio Wesleyan University, University of Toronto*	Structural characterizations of the *Poeciliopsis* fish placenta

27.2 WEBSTER, M.R.*; SOCHA, J.J.; DE VITA, R.; Virginia Tech; *mwbstr@vt.edu*

Nonlinear Elasticity of Tracheal Tubes in the American Cockroach

In some insect species, diffusion−based respiration is supplemented with convection. For insects that use rhythmic tracheal compression, convective ventilation is produced by the periodic collapse and re−inflation of various tracheae in the respiratory system, a phenomenon that is dependent on the unique structure and material properties of the tracheal tissue. To understand the underlying mechanics of this method of gas transport, we are studying the microstructure and material properties of the primary thoracic tracheal tubes in American cockroaches. In previous tensile tests, we found that these tracheae sustain large strains and exhibit a nonlinear elastic behavior. Although these tests provided crucial information about the mechanical behavior of the tracheal tubes, they were insufficient to fully describe the complex three−dimensional loading conditions experienced *in vivo* by these tubes. Inflation−extension tests, in which the trachea is pressurized while being stretched in the longitudinal direction, provide mechanical data that are more physiologically relevant. For this reason, we design and built an inflation−extension testing system that is able to measure low axial forces, internal pressures, and surface deformations of tracheal tubes of ~500 µm diameter. Images collected with two synchronized CCD cameras were analyzed using the digital image correlation method to compute the strain field. In addition, we also developed a constitutive equation that can capture the finite strains and nonlinear elasticity of the tracheal tubes. Our ultimate goal is to formulate a three−dimensional model that can be implemented into finite element methods to reproduce the complex mechanical response of tracheal tubes under *in vivo* loading conditions. Supported by NSF 0938047.

P2.18 WEDEMEYER, KR*; BERNARDO, J; PLOTKIN, PT; Texas A and M University; *kwedemeyer@bio.tamu.edu*

Ecological niches as underlying mechanisms of L. olivacea female alternative reproductive tactics

Alternative reproductive tactics are well studied in males, but poorly known in females. An important but understudied question is: What selection pressures cause divergent female behavior and/or morphology? We hypothesize that *Lepidochelys olivacea* (olive ridley sea turtles) female alternative reproductive tactics (solitary vs. mass−nesting behaviors) relate to an ecological dimorphism − differential foraging strategies (neritic vs. pelagic). We are investigating this idea using morphometrics, stable isotopes and satellite tracking.

P2.143 WEHRLE, BA*; GERMAN, DP; Univ. of California, Irvine; *bwehrle@uci.edu*

Testing the Adaptive Modulation Hypothesis: Physiological Changes in in a Newly Herbivorous Lizard

Few studies of diet incorporate analyses of what an animal is actually digesting. Knowing what an animal digests (as opposed to only what it ingests) allows us to understand if its physiology and morphology are optimized for its nutritional source. According to the Adaptive Modulation Hypothesis, dietary specialization should lead to gut specialization. We investigated potential digestive specializations in a lizard species that has shown rapid evolution of feeding and digestive tract morphology. A population of the Italian Wall Lizard (*Podarcis sicula*) in Croatia has become primarily herbivorous and morphologically distinct from its insectivorous source population in <30 generations. Though some morphological changes have been documented, it is unknown if gut function has shifted with this diet change. We compared the gross morphology of the intestines of both groups of lizards, compared their diets, and measured performances using digestive enzyme activities and concentrations of fermentation end products (short chain fatty acids, SCFAs). In a common garden experiment, we measured digestive efficiency of lizards from the herbivorous and source populations on different diets. Experiments are in progress, but we expected that the plant−eating population would have more plant material in their guts and a hindgut chamber in their distal intestines. Moreover, we expected to find differences in enzymatic activities among the populations, with the herbivores showing elevated carbohydrase activities. We also anticipated that the plant−eating population will have slower food transit times, increased microbial fermentation, and increased digestibility of a plant diet than the insectivorous population. Overall, this study will test whether rapidly evolving morphological features can translate into changes in animal performance.

S7.1−1 WEINERSMITH, K.L.*; HANNINEN, A.F.; SIH, A.; EARLEY, R.L.; University of California Davis, University of Virginia, University of Alabama; *klsmithbio@gmail.com*

Euhaplorchis californiensis, a brain−infecting trematode parasite, is associated with changes in physiology and behavior in its killifish second intermediate host

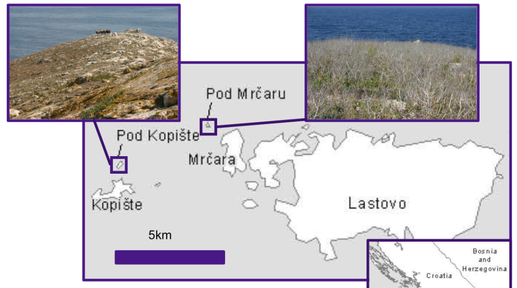
The trematode parasites *Euhaplorchis californiensis* (EUHA) and *Renicola buchanani* (RENB) infect California killifish (*Fundulus parvipinnis*) as second intermediate host. Infected killifish exhibit conspicuous behaviors, and infection is associated with a 10−30 times increase in predation rates by birds, the parasites' shared definitive host. EUHA is also associated with changes in neurotransmitter activity, which could result in downstream changes in steroid hormone release rates. In this study we explore associations between stress hormones (cortisol) and sex hormones (11−ketotestosterone and estradiol) and EUHA and RENB density in wild−caught California killifish. We find that the interaction between duration of handling stress and the density of EUHA influences release rates of cortisol and 11−ketotestosterone. We discuss the implications of these findings, and plans to further explore these relationships using controlled infections.

Abstract

Few studies of diet incorporate analyses of what an animal is actually digesting. Knowing what an animal actually digests allows us to understand if its physiology and morphology are optimized for its nutritional source. According to the Adaptive Modulation Hypothesis, dietary specialization should lead to gut specialization. We investigated the mechanisms through which these specializations arise in a lizard species that has shown rapid evolution of feeding and digestive tract morphology. A population of the Italian Wall Lizards *Podarcis sicula* in Croatia has become primarily herbivorous and morphologically distinct from its source population in <30 generations. Though some morphological changes have been documented between the populations, it is unknown if gut function has shifted with this diet change or if there has been any effect on performance and fitness. We compared the gross morphology and histology of the intestines of both groups of lizards, compared their diets, and measured performances using analyses of gut histology, and digestive enzyme activity. We expected that the plant-eating population will have partitioned hindguts and greater intestinal surface area compared to the source population. We also anticipated plant-eating population will have slower food transit times and increased microbial fermentation, as is found in other herbivorous lizards. Additionally, we compared digestibility of plant and insect diets in both groups and measured metabolic rates to investigate differential effects of diet and diet specialization on performance and, ultimately, their effects on fitness.

Introduction

- Adaptive Modulation Hypothesis:
  - Digestive tract expensive
  - Structure and function should match diet
  - Dietary specialization → gut specialization
- *Podarcis sicula* experimentally moved from Pod Kopište to Pod Mrčaru, Croatia in 1970. In <30 generations, Pod Mrčaru population fed mainly on plants while the Pod Kopište population remained insectivorous.[1]



- Pod Mrčaru population:
  ↑ bite force, gut nematodes, hindgut chambers[1]
- Expected that with change in diet and structure of gut, there should be functional changes with performance implications. Thus in Pod Mrčaru lizards we predicted:
  - **Morphology**: longer guts, ↑ gut surface area, valves present
  - **Physiology**: ↑ activity of enzymes for digesting plants
  - **Performance**: ↑ digestive efficiency of plant diet

Testing the Adaptive Modulation Hypothesis: Physiological Changes in a Newly Herbivorous Lizard

Beck A. Wehrle[1], Anthony Herrel[2], Zoran Tadić[3], & Donovan P. German[1]

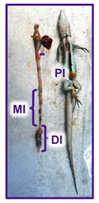
[1]University of California, Irvine; [2]CNRS/Muséum National d'Histoire Naturelle, Paris; [3]University of Zagreb

Methods & Results

Morphology

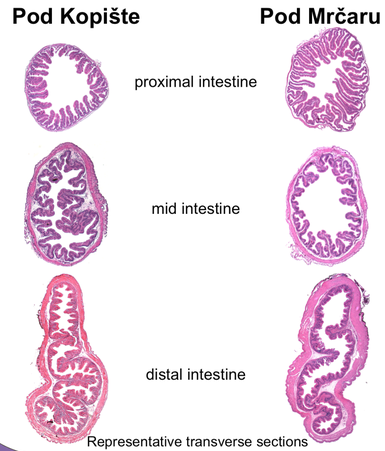
We dissected *P. sicula* from each island:

- Measured total mass, SVL, and gut length (*N*=13)
- Divided gut into proximal (PI), mid (MI), and distal intestine (DI)
- Weighed gut sections (*N*=4)
- Histology: ratio of mucosa to serosa perimeters for comparison of surface area



Results

- Confirmed Pod Mrčaru lizards more massive (*P*=0.004) and have greater SVL (*P*=0.0002) than Pod Kopište population
- No differences in relative total gut length
- Preliminarily, no differences in mass of each gut section, or surface area of each gut section between populations
- No qualitative differences in distal intestine morphology detected thus far



Representative transverse sections

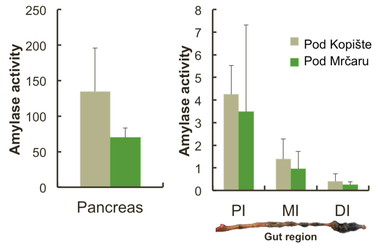
Enzyme Activity

We dissected out the pancreas, PI, MI, and DI from 7 *P. sicula* per island immediately post capture:

- Contents removed from PI, MI, and DI for future analyses
- Amylase assays (pancreas, PI, MI, DI) and aminopeptidase assays (PI, MI, DI) at 25°C (*N*=4 completed)

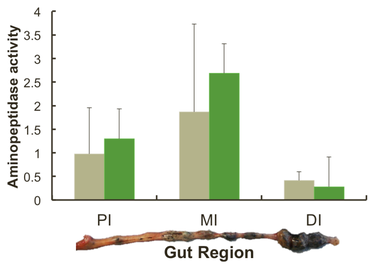
Results

- No differences in amylase activity by population
- Amylase activity higher in pancreas than in DI (*P*=0.005)



Amylase activity in tissues in nmol of sugar liberated g^{-1} min^{-1}. Values are mean ±SD.

- No differences in aminopeptidase activity by population



Aminopeptidase activity in tissues in nmol of p-nitroaniline liberated g^{-1} min^{-1}. Values are mean ±SD.

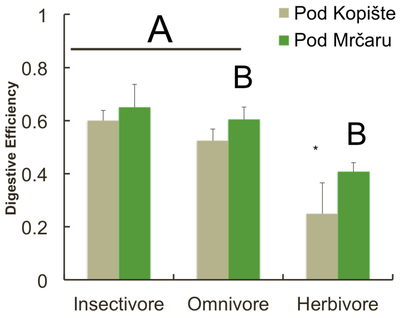
Digestive Efficiency

We kept 15 *P. sicula* from each island in the lab:

- Fed experimental diet daily for 11-31 days
  - Insectivore, Omnivore, Herbivore
- All produced feces collected
- Carmine dye mixed with food mid-trial to determine transit time

Results

- Pod Mrčaru lizards digest herbivore diet more efficiently (*P*<0.05)
- Both populations less efficient digesting plant diet compared to insectivorous or omnivorous diets (*P*<<0.001)



Digestive efficiency by diet treatment with standard deviations. **A** are not significantly different from each other. **B** are not significantly different from each other. The * denotes significantly different from all other groups.

- No differences in transit time
  - By population (*P*=0.577)
  - Nearly significant by diet (*P*=0.056)

Conclusions

Digestive performance differences of plant diet not due to gut surface area or increase in amylase activity. Other mechanisms warrant exploration.

Contrary to expectations, no significant differences in amylase activity. Pod Mrčaru lizards may accommodate their plant diet with higher activity of other enzymes.

As expected, no differences in aminopeptidase activity, supporting no differences in digestion of substrates (i.e., protein) common to the two populations

Future Work

- Diet and stable isotope analyses
- Other enzyme activities in tissues and produced by endosymbionts:
  α & β-glucosidases,cellulase, cellobiohydrolase, xylanase, β-xylanase, chitinase, NAG, trehelase, trypsin, lipase
- Gut ultrastructure
- Fermentation analysis
- Microbial endosymbiont gene expressions
- Metabolic and fitness effects of diet
- Modulation with seasonal diet changes

Acknowledgments

Thanks to K. Chernoff , A.-C. Fabre, and Lastovsko otočje for help the field and K. Chernoff, M. Krajnovic, A. Kokanoutranon, and R. Agnihotri for assistance in the lab. Institutional support was provided by the University of Zagreb. This project was funded by NSF CNIC grant number 1318059. Methods were approved by UC Irvine IACUC, protocol 2013-3096-0.

Literature Cited

[1]Herrel, A., et al. 2008. Rapid large-scale evolutionary divergence in morphology and performance associated with exploitation of a different dietary resource. Proceedings of the National Academy of Sciences. 105: 4792-4795.