Duke
UNIVERSITY PROGRAM IN ECOLOGY

Ecology Symposium 2016

Monday, December 5th

9 – 5, *reception to follow*

Field Auditorium, Environment Hall

Schedule of Events

8:15-9 Coffee and Registration

9-9:15 Welcome

9:15-10:30 Session 1 – Presentations

9:15-9:45 Faculty Speaker: Emily Bernhardt (Biology)

"The forest grows but the watershed leaks: surprising ecosystem responses to an acid rain mitigation experiment."

9:45-10:00 Matthew Zipple

"*Conditional Fetal and Infant Killing by Male Baboons"*

10:00-10:15 Aspen Reese

"Nitrogen limitation in the mammalian gut"

10:15-10:30 Vivienne Foroughirad

"Reconstructing pedigrees from genomic data in a wild polygamous species"

10:30-11:00 Break

11:00-12:00 Session 2 - Speed talks

11:00-11:30 Faculty Speaker: Dan Holstein (Duke University Marine Lab)

"Marginal environments, refuges, and the fates of metapopulations."

11:30-11:35 Cathy Chamberlin

"Formation of a Lowland Karst Landscape; A Mass-Balance Approach"

11:35-11:40 Gregory Larsen

"The Trinidadian guppy (Poecilia reticulata) as an integrative model of life history evolution"

11:40-11:45 Zachary Brecheisen

"Old-field succession, landuse legacies, and below-ground respiration"

11:45-11:50 Joanna Blaszczak

"*Effects of Urbanization on Stream Ecosystem Metabolism are Mediated by Streambed Stability"*

11:50-11:55 KC Bierlich

"The skin microbiome of Humpback Whales along the Western Antarctic Peninsula"

11:55-12:00 Anna Wade

"Impact of legacy sediments on floodplain dynamics: a novel biogeochemical system"

12:00-1:00 Lunch

1:15-2:15 Biology Superspeaker Seminar: Regina Baucom (U. Michigan) – FFSC 2231

2:30-4:30 Session 3 - Presentations

2:30-3:00 Faculty Speaker: Sönke Johnsen (Biology)

"Join now! The minor effects of schooling on visibility to potential predators."

3:00-3:15 Ruben Dario Palacio

"*San Antonio 100 years later and beyond: Bird Extinctions and Climate Change."*

3:15-3:30 Break

3:30-3:45 Sarah Loftus

"Cross-study analysis of factors affecting algae cultivation in recycled growth medium."

3:45-4:15 Faculty Speaker: Anne Pusey (Evolutionary Anthropology)

"Female relationships in a patrilocal society."

4:15-4:30 Closing Statement

4:30-6 Poster session and reception (First floor common area, Environment Hall)

Melissa Manus *"Environmental influences on the Malagasy skin microbiome"*

Gabriel Yapuncich *"Evidence of niche partitioning among sympatric primate species from the Eocene of Wyoming"*

Kendra Smith and Alexandra Stonehill *"Maternal traits mediate offspring health in wild meerkats"*

Mark River *"Particulate Phosphorus in Stormwater"*

William Cioffi *"Baleen (alpha-keratin) archives metabolic and endocrine individual life histories of mysticete whales."*

Hongjun Wang *"Climate change induced plant-microbe succession maintain carbon sink in peatlands"*

Abstracts

Presentations

Matthew Zipple "*Conditional Fetal and Infant Killing by Male Baboons"*

Sexually selected feticide—the killing of infants in utero by males— has only rarely been described or analyzed, although it is presumed to be favored by the same selective pressures that favor sexually selected infanticide. To test this hypothesis, we measured the frequency of feticide and infanticide by male baboons of the Amboseli basin in Kenya, and examined which characteristics of a male and his environment made him more likely to commit feticide and/or infanticide. We found a dramatic increase in fetal and infant death rates, but no increase in death rates of 1-2 year-old individuals, following the immigration of males who stood to benefit from feticide and infanticide. Specifically, fetal and infant death rates were highest following immigrations in which: (1) the immigrant male rapidly attained high rank, (2) that male remained consistently resident in the group for at least three months, (3) food availability and social group range overlap was relatively low, and (4) relatively many pregnant females and/or dependent infants were present. Together, these results provide strong evidence for the existence of both sexually selected feticide and infanticide in our population, and they indicate that feticide and infanticide are conditional male behavioral strategies employed under particular circumstances.

Aspen Reese *"Nitrogen limitation in the mammalian gut"*

Resource limitation is a fundamental factor governing the composition and function of ecological communities. I will present evidence that gut microbiota confront nitrogen limitation in the large intestines of 18 mammal species spanning 5 orders of magnitude in body mass, regardless of diet or digestive physiology. Colonic nitrogen limitation results from hosts' absorption of dietary nutrients, producing a stoichiometric gradient along the intestine. However, using stable-isotope labeling, we show that animals mitigate nitrogen limitation of gut microbes via internal secretions. These secretions are dynamic and diminish when bacterial loads are reduced. Single-cell spectrometry suggests select members of the phylum Bacteroidetes are the primary foragers of nitrogen in the colon, and we find that these taxa, in particular, are depleted when secretions are reduced. Together, our findings indicate

that nitrogen limitation arises from preferential host utilization of dietary nutrients and subsequently enables hosts to selectively regulate microbial communities in the large intestine. Host control of nutrient availability presents a metabolic cost, but provides mammals with a mechanism for maintaining a mutualistic gut microbiota.

Vivienne Foroughirad *"Reconstructing pedigrees from genomic data in a wild polygamous species"*

The decreasing cost of sequencing is enabling large numbers of individuals to be typed at many thousands of loci, increasing our potential to accurately estimate both pedigree and genomic relatedness in wild populations. Information about kinship derived from pedigree reconstruction is especially important for answering questions regarding such phenomena as inbreeding avoidance, kin recognition, and kin selection. However, for non-model organisms with polygamous mating systems and overlapping generations, deriving accurate relationship category assignments can be challenging even with large amounts of data. Here I present a combination of simulations and empirically derived estimates of relatedness for a population that exhibits these characteristics, the resident Indo-Pacific bottlenose dolphin community in Shark Bay, Western Australia. We use a combination of genomic data including single nucleotide polymorphisms, presence/absence markers, and mitochondrial haplotypes in conjunction with field observations of age and maternal relatedness to derive kinship estimates among a sample of 185 individuals. Correct classification rates are presented for various categories of relatedness, and we explore the relative efficiency of using pedigree vs genomic relatedness to predict social relationships.

Cathy Chamberlin *"Formation of a Lowland Karst Landscape; A Mass-Balance Approach"*

Karst landscapes are highly soluble, and are vulnerable to biological acid production as a major driving factor in their development. Big Cypress National Park (BICY) is a low-lying karst landscape in southern Florida displaying a distinctive morphology of isolated depressions likely influenced by biology. The goal of this study was to constrain timescales of landform development in BICY, as we hypothesized that these domes are formed by biological dissolution and should therefore be of recent origin. We used soil and vegetation surveys and long-term surface water flow and chemistry to generate Ca and P budgets for the BICY landscape. Estimated soil pools of 20 kg Ca/m2 and annual hydrologic export of 12 g Ca/m2 indicate that wetland basins would have taken ~15000y to achieve their current excavated volume assuming constant export. Landscape-wide P stocks averaged 264 g P/m2 but were concentrated in depression soils; other P stocks were negligible. Atmospheric deposition of 0.036 g P/m2 and hydrologic export of 0.003 g P/m2 lead to an estimated age of ~8000y. Overall, we conclude that Ca and P mass balance are consistent with the hypothesis that the BICY landscape is geologically young and results from biologically-controlled rates of dissolution.

Gregory Larsen *"The Trinidadian guppy (Poecilia reticulata) as an integrative model of life history evolution"*

Since 1982, the Trinidadian guppy (Poecilia reticulata) has been the subject of research on life history evolution and its role in shaping natural ecosystems. Many aspects of the Trinidadian guppy's physiology and natural habitat make the species well suited to scientific research, and today there is a wide body of published work on the species that includes field studies, captive laboratory experiments, and common garden experiments that bridge the two settings. The Trinidadian guppy has become a model organism for evolutionary biology, effectively demonstrating how life history can shape physiology, behavior, and ecology. Within just the past three years, published literature has explored how predator-induced changes in guppy life history can influence metabolism and growth, exploratory behavior, and nutrient cycling. As still more studies continue in distinguished laboratories and established field sites the Trinidadian guppy will undoubtedly continue to yield new discoveries that refine our understanding of life history evolution and its integral role in the biological sciences.

Zachary Brecheisen *"Old-field succession, landuse legacies, and below-ground respiration"*

In order to investigate the effects of ~80 years of old-field succession in the SC Calhoun Critical Zone Observatory (CCZO) regarding soil biogeochemistry, chronosequence landuse history plots at the CCZO have been instrumented and studied. Chronosequence plots consist of 3 reference hardwood forest plots, 3 plowed agriculture plots, and 3 old-field secondary forest plots. In this framework, reference hardwood soil profiles are minimally-impacted in terms of erosion, soil structure, and soil biogeochemistry. Plowed agricultural plots represent degraded, non-regenerated states, while old-field forest plots are expected to be intermediately degraded. This investigation seeks to determine how different landuse histories and above ground ecology among continuously cultivated, old-field secondary forests, and reference hardwood plots are reflected in soil profile metabolic/biogeochemical gas concentrations? Each landuse history comparison plot has four 750ml gas reservoirs buried at 0.5m, 1.5m, 3m, and 5m with sampling ports at the surface for in situ CO2 and O2 analyses as well as soil gas collection for laboratory analysis. One of three landuse history replicates has all 3 treatments in close proximity on a 4th order interfluve and has sensors installed at 0.5m and 1.5m logging real-time soil moisture, temperature, CO2, and O2 data. Soil gas samples are analyzed at Duke generating N2O and CH4 data and verify field CO2 measurements via gas chromatography. Previous research and preliminary data show that CO2 concentrations increase and then decline with depth below ~2-3m under forested conditions. Reference hardwood forest soil CO2 concentrations have the highest maxima (>7% CO2) and high seasonal variation thought to be linked to leaf-on vs. leaf-off changes in forest metabolism. Cultivated fields have low CO2 concentrations but are also range seasonally between ~0.5-2% CO2. Old-field forests having re-established root-networks and root-respiration have CO2 concentrations comparable to reference hardwoods with lower maxima and less seasonality likely due to old-field forest plot communities being dominated by evergreen loblolly pine.

Joanna Blaszczak "*Effects of Urbanization on Stream Ecosystem Metabolism are Mediated by Streambed Stability"*

Stream metabolism provides an integrative metric of biological activity in streams. It is sensitive to light availability, physical habitat characteristics, chemical conditions, and disturbances related to floods, all of which are altered by urbanization. The relative importance of intensified hydrologic disturbance

regimes in urban streams for metabolism is partially dependent on channel geomorphology since streambed habitats vary in their susceptibility to perturbation. We selected two groups of 3 urban streams in Durham and Raleigh, NC that each spanned a gradient in hydrologic flashiness, with one group having 'unstable' beds in the study reach and the other with 'stable' beds. Since November 2015, we have been measuring gross primary productivity (GPP). We expected that average GPP would be negatively correlated with hydrologic flashiness and lower overall in sites with unstable beds. Daily GPP ranged from 0.10 to 5.83 mg O2 L-1 d-1 across all sites. Average GPP was consistently lower in sites with unstable beds and negatively associated with increasing hydrologic flashiness. We found that the relationship between light as the primary driver of GPP breaks down with increasing hydrologic flashiness. Our study shows that the instability of streambeds and frequency of hydrologic disturbances can be major factors for determining the metabolic regimes of urban streams.

KC Bierlich *"The skin microbiome of Humpback Whales along the Western Antarctic Peninsula"*

Assessing the health state of wild marine mammals and their populations is challenging, and there is a growing need to develop reliable proxies for health determination. Climate change and other anthropogenic factors are influencing disease prevalence and virulence in the marine environment and there is a need to improve tools and techniques for monitoring the health status of wild marine mammals that are listed as threatened or endangered. The skin is the largest mammalian organ and serves as the first line of defense between the host and their external environment. Most research has focused on human health and has found that the skin microbiome can serve as a protective mechanism by adding to the skin's defense against colonization of potential pathogenic bacteria. The skin is relatively well-sampled in marine mammals and may serve as a useful proxy for health status, as demonstrated in humans. However, before skin microbiomes become useful health diagnostic tools for marine mammals, more information is needed about the factors influencing variability within the skin microbial community. This study analyzed the skin microbiome of 94 samples collected from humpback whales along the Western Antarctic Peninsula to see if there is a core or common group of bacteria shared.

Anna Wade *"Impact of legacy sediments on floodplain dynamics: a novel biogeochemical system"*

Fluvially deposited legacy sediments persist as legacies of upland erosion in the floodplains of southeastern forests. At the Calhoun Critical Zone Observatory, we are measuring the repercussions of these legacy sediments on the biogeochemistry of the Holcombe's Branch floodplain. Rapid erosion buried approximately 4.6 kg carbon per square meter. Newly deposited sediment contains an additional 2.5 kg carbon per square meter. Having characterized these sediments for their texture, color, and chemistry, we are now seeking to explore how this large mass of transported sediment has altered groundwater flow and respiration rates of belowground carbon. We are doing this using a combination of 14C measurements, carbon mineralization tests, groundwater modeling, and tree ring dating. Altogether, this gives us a first-order estimate of a novel biogeochemical system derived from some of the most weathered soils in the world.

Ruben Dario Palacio "*San Antonio 100 years later and beyond: Bird Extinctions and Climate Change."*

With maximal elevations of 2200 m, San Antonio is a cloud forest on a truncated mountain summit in the Colombian Andes, for which multiple avian surveys dating back to 1911 are available, a rare scenario for a tropical site. We document changes in this bird community over a 100-year period and provide a first assessment of its vulnerability to climate change. In 2015-2016 we surveyed birds with point counts and complemented our list with data from eBird. During the first 80 years, forest fragmentation caused the extirpation of 32 species from an original avifauna of 150 forest birds. Thanks to conservation programs, at least 11 species have reestablished populations in the last 20 years and there are no further extinctions. The original core avifauna has remained relatively intact at a control site in a nearby protected area with continuous forest in higher elevations. In the face of ongoing global warming, we found that even in a worst-case scenario of a temperature increase of 3°C for the area, no mountaintop extinctions are expected for San Antonio, because there are few highland birds near their lower elevational limit. However, 52 species have narrow elevational ranges (≤1500m) and are mountain specialists with low abundances, thus being vulnerable to climate change. Our study provides long-term baseline information for a single montane tropical community that will allow future assessments and the evaluation and calibration of models made at larger spatial operating scales.

Sarah Loftus *"Cross-study analysis of factors affecting algae cultivation in recycled growth medium."*

Algae derived biofuel production holds great promise, but current high costs of commercial-scale production prevent its widespread implementation as a renewable fuel source. One approach to reduce algae cultivation costs is to reuse the cultivation water after biomass harvesting, thereby reducing water pumping and treatment costs. However, dissolved compounds or other microorganisms remaining in the water could affect subsequent generations of algae growth. Previous studies demonstrate a wide variety of effects of recycled medium on algae growth, yet their results have not been collectively analyzed. Here we integrate data across 86 studies to present the first meta-analysis that determines the relative importance of different factors in influencing algae growth in recycled medium. We found that algae taxa can have the greatest influence, while the harvesting method and culture age influences are more limited. This report identifies favorable taxa and thus provides a tool for algae cultivation decision-making when medium reuse is an important driver. Results can also aid in estimating algae yield and growth rates for technoeconomic assessments that incorporate water recycling.

Posters

Melissa Manus *"Environmental influences on the Malagasy skin microbiome"*

The skin is continuously exposed to the outside environment, resulting in microbial transfer between the humans, animals, and environment with which an individual comes into contact. Most research on the skin microbiome has focused on Western populations living in largely hygienic conditions, yet these populations have vastly different patterns of environmental contact than the majority of people on the planet who live in low- and middle-income countries or rural settings. We studied the skin microbial communities of humans and domesticated cattle (zebu) living in rural Madagascar to investigate how zebu ownership affects microbial transfer, and to characterize human skin communities more generally.

We sampled the backs of zebu and four sites on humans (ankle, forearm, hand, and armpit). The V3 region of the 16S rRNA gene was sequenced, and microbial taxonomic analyses were run in QIIME and R. Zebu owners' ankles harbored fewer taxa than non-owners' ankles and zebu. Unweighted UniFrac distances revealed that human and zebu samples segregate from one another, yet humans do not separate based on zebu ownership. These data suggest that humans share a skin microbial community that is not influenced significantly by zebu ownership, but there were clear differences in microbial communities among human body sites. Overall, our findings are similar to previous research showing distinct microbial communities across body sites in Western populations. In contrast to Western populations, however, we failed to find evidence for sharing between individual humans and their domesticated animals, likely due to profound lifestyle differences between rural Malagasy and Western populations.

Gabriel Yapuncich *"Evidence of niche partitioning among sympatric primate species from the Eocene of Wyoming"*

Since body mass covaries with many aspects of a species' ecology, body mass prediction is a frequent goal of paleontologists. For example, niche partitioning by body mass (as predicted from tooth size) is often invoked in mammalian paleocommunities. However, tooth size can vary independent of body mass, and this variation has ecological implications. The lack of fossil specimens preserving associated dental and postcranial elements has confounded evaluation of hypotheses of niche partitioning in fossil species. Here we predict body masses of seven sympatric primate species from the Eocene of Wyoming: Notharctus tenebrosus, Notharctus cf. pugnax, Notharctus cf. robustior, Smilodectes gracilis, Omomys carteri, Washakius insignis, and Hemiacodon gracilis. All specimens include associated dentitions and postcrania except H. gracilis (a composite of two specimens). Body masses are predicted using equations relying on molar area (based on primate and strepsirrhine reference samples) and equations based on postcranial elements. Postcranial variables predict similar body masses, while dental predictors often deviate from each other and postcrania. For S. gracilis and O. carteri, postcranial predictions are most concordant with values generated by the "primate" dental equations. In all other species, postcranial predictions are more similar to the values generated by the "strepsirrhine" equations. The dental/postcranial proportions of S. gracilis and O. carteri were likely more similar to non-strepsirrhine taxa of the "primate" sample (i.e., anthropoids), while other taxa had proportions similar to extant strepsirrhines. As anthropoids tend to have smaller molars than similarly sized strepsirrhines, S. gracilis and O. carteri likely had small molars relative to their postcranial dimensions. A multi-proxy approach to body mass prediction indicates that among these fossil primates, relative molar size likely reflects exploitation of different dietary resources.

Kendra Smith and Alexandra Stonehill *"Maternal traits mediate offspring health in wild meerkats"*

Androgens underlie a well-known tradeoff between reproductive benefits versus health costs in males. Despite substantial variation in female androgen production and the potential for transgenerational effects, this tradeoff is underappreciated in females and their offspring. In the cooperatively breeding meerkat (Suricata suricatta), dominant females benefit from raised androgens through increased competitive abilities, particularly during pregnancy, but suffer from androgen-mediated

immunosuppression (Smyth and Drea 2016; Smyth et al. 2016). Here, we ask if exposure to raised prenatal androgens produces a comparable trade-off in meerkat pups. From 2012-15, we measured parasite burdens and innate immune responses in pups derived from dominant and subordinate control dams, and from dominant dams treated with an androgen-receptor blocker. Offspring from normative dominant and subordinate dams did not differ in their parasite burdens or immune responses; however, blocking prenatal androgens improved pup health and survival. Thus, despite the reproductive benefits of hormonal masculinization for certain female meerkats, the consequences for offspring survival represent an unanticipated cost of sexual selection operating in females.

Mark River *"Particulate Phosphorus in Stormwater"*

In many watersheds worldwide, particulate phosphorus (PP) in stormwater dominates the annual phosphorus (P) load. Fine-resolution measurement of the size, chemistry, and minerology of stormwater particles can improve our understanding of PP transport and aid in the design of stormwater BMP's.

William Cioffi *"Baleen (alpha-keratin) archives metabolic and endocrine individual life histories of mysticete whales."*

Whales in the order Mysticeti are highly intractable study subjects since individuals spend most of their obscured from view, range across entire ocean basins, and require expensive equipment to locate and track. Nevertheless these species are of high interest due to their unique place in marine food webs, extreme morphology, and history of commercial exploitation. Baleen, the keratinized plates that make up the feeding structure that characterizes mysticete whales, can be used to reconstruct multiyear metabolic and endocrine histories for individual animals. Baleen plates grow continuously during an animal's life from the upper gumline and slowly wear away at the distal end. A single plate may consist of material from the last 1-10 years depending on species and individual. Metabolic information is preserved in material of the plate itself as it grows and can be investigated through stable isotope analysis. This matrix also preserves steroid hormones and may represent the systemic fluctuations in hormone levels associated with pregnancy and stress at a given time. Recent studies have demonstrated the validity of these methods in detecting pregnancy and here we further investigate the efficacy of these techniques using tissue from several species. We present a biological validation showing cortisol levels increase during pregnancies in an animal with a known history. We compare levels of steroid hormones found in baleen to values from blubber, which is often collected in the field from living animals. We also investigate inter plate and within plate variation in hormone levels, delta13c, and delta15n values to assess the consistency and reliability of the measured signals. Finally, we present a pilot study using specimens of baleen from collected over the last 140 years in the North Atlantic to assess the applicability of these methods in identifying long term patterns in feeding and endocrine ecology across a time period of heavy commercial exploitation.

Hongjun Wang *"Climate change induced plant-microbe succession maintain carbon sink in peatlands"*

Peatlands have stored 600–700 gigatonnes of carbon, which is close to the atmospheric carbon content as CO2 and exceeds that of global vegetation. Many short-term studies have shown that climate change, especially drought and warming, may decrease C sequestration and increase C loss in peatlands, thus

producing a global-concern for a positive feedback on climate change (e.g. Dorrepaal et al., 2009; Fenner and Freeman 2011). However, peatlands that are broadly distributed may have adaptive mechanisms other than anoxia to maintain C sequestration during drought and warming. We conducted a series of field and lab experiments in shrub peatlands to document how previously unrecognized mechanisms regulate the buildup of anti-microbial phenolics, which protects stored carbon directly by reducing phenol oxidase activity during short-term drought, and indirectly through a shift from low-phenolics Sphagnum/herbs to high-phenolics shrubs after long-term moderate drought (Wang et al., 2015). We found along with high-phenolic plant shifts a symbiotic succession of slow-growing fungi which decreased the temperature sensitivity of decomposition and stabilized the stored peat. We suggest that shrub expansion induced by climate change in boreal peatlands is a long-term self-adaptive mechanism not only by increasing carbon sequestration, but also by biogeochemically protecting soil C. Therefore, the projected "positive feedback loop" between carbon emission and climate change in peatlands may not occur as rapidly in the future. Peatlands, especially those found in southern latitudes have been found to be self-stabilizing in which the symbiotically adaptive succession of plant-microbe triggered by persistent climate change likely can acclimate southern peatlands to water and temperature stress and thus maintain their carbon sequestration function and processes.