

ZGSA SPRING RESEARCH SYMPOSIUM ABSTRACTS

Session 1: Cellular Biology

MSL 101 9:45 AM - 10:15

LC-MS/MS profiling of systemic and brain steroid levels in a songbird

Cecilia Jalabert, Chunqi Ma, Kiran K. Soma

Sex steroids regulate behaviour and the nervous system. High levels of circulating androgens are associated with aggression in breeding males. Interestingly, some species exhibit aggression in the non-breeding season, when the gonads are regressed and circulating levels of sex steroids are low. In such species, brain-derived steroids (“neurosteroids”) play a key role in the regulation of aggression. Here, we used liquid chromatography tandem mass spectrometry (LC-MS/MS), a cutting-edge technique for steroid quantification, to explore seasonal changes in a panel of 10 steroids. We examined steroids in the blood and brain areas that regulate social behavior, using wild territorial male song sparrows. In the breeding season, levels of the androgen 5 α -dihydrotestosterone are 20-fold higher in specific regions than in blood. In addition, 17 β -estradiol (E2) and estrone are detectable in the brain but not in the blood. In contrast to previous studies using immunoassays, we did not detect testosterone or E2 in the brain of non-breeding subjects suggesting that we need to further improve sensitivity of the method. Interestingly in breeding and non-breeding seasons progesterone levels varied across the different brain areas. These results together indicate that steroid concentrations are locally regulated across the brain and are not a simple reflection from levels in the circulation. These data suggest that steroid profiling by LC-MS/MS will be useful for comparative studies.

Expression of ACTH and ACTH receptor in mouse immune tissues

Melody Salehzadeh, Kiran K. Soma

The hypothalamic-pituitary-adrenal (HPA) axis is a critical stress response system in vertebrates. The hypothalamus stimulates the pituitary to secrete adrenocorticotrophic hormone, a 39 amino acid hormone (ACTH[1-39]). ACTH[1-39] binds to cognate receptors on the adrenal glands and stimulates secretion of glucocorticoids (GCs). Circulating GCs orchestrate changes in organismal physiology and are particularly important in immune function. GCs have been thought to be synthesized only in the adrenal glands. However, it is now clear GCs are also locally-produced within immune tissues, such as the bone marrow, thymus and spleen. It remains unclear what drives these immune tissues to produce GCs. Interestingly, there is evidence for a local HPA axis “homolog” in immune tissues, involving a truncated form of ACTH (ACTH[1-24]). ACTH[1-24] is biologically active, but is not produced by the pituitary. We hypothesized that mediators of the HPA axis are expressed within immune tissues, perhaps to regulate local GC synthesis. Here, we examined adult mouse bone marrow, thymus and spleen and performed qPCR to determine gene expression of ACTH and ACTH receptor. Preliminary data suggest that ACTH and ACTH receptor are expressed in the thymus and spleen. Future studies will investigate the form of ACTH using mass spectrometry. These data are a crucial first step for understanding how local GC production is regulated in immune tissues.

Session 2: Evolutionary Biology

MSL 102 9:45 AM - 10:15

During environmental change, cooperation can promote rescue or lead to evolutionary suicide

Gil J.B. Henriques, Matt M. Osmond

The adaptation of populations to changing conditions may be affected by interactions between individuals. For example, cooperative interactions may allow populations to maintain high densities, and thus keep track with moving environmental optima. At the same time, changes in population density alter the marginal benefits of cooperative investments, creating a feedback loop between population dynamics and the evolution of cooperation. Here we model how the evolution of cooperation is affected by, and in turn affects, adaptation to a changing environment. We hypothesize that changes in the environment promote the evolution of cooperation, and that this in turn helps the population keep up with the moving optimum. However, we find that the evolution of cooperation can have qualitatively different effects, depending on the life-cycle of the population. In many cases, cooperation indeed speeds adaptation by increasing population density; in contrast, in life-cycles where the benefits of cooperation increase reproductive variance, the evolution of cooperation may in fact slow adaptation down, leading to evolutionary suicide. Thus, we show that cooperation can either promote or, counter-intuitively, hinder adaptation to a changing environment.

Epidemics and the maintenance of genetic diversity

Ailene MacPherson, Matthew Keeling, Sally Otto

A primary goal of evolution biology is to understand the mechanisms that generate and shape the vast diversity of life. From stable polymorphisms at susceptibility loci to the maintenance of sexual reproduction, pathogens are thought to play an important role in the maintenance of genetic diversity of their hosts. Indeed as evidenced by the death toll of the Plague in 14th century Europe to the decimation of African ungulates by Rinderpest, infectious pathogens can exert strong selective pressures on their hosts. Using methods from epidemiology, we modelled coevolution between hosts and their infectious pathogens. We explore how coevolution, epidemiology, and stochasticity interact to shape the genetic diversity of hosts.

Session 3: Ecology & Conservation

MSL 101 14:25 - 15:10

Covariance in spatial use properties and their relation to body size

Sam Straus

Movement is a key process that structures how organisms interact with each other and their environment, linking habitats in space and time. In biodiversity studies, movement has mainly been considered as synonymous with dispersal, but we need to consider other forms of movement to understand how communities are linked through both time and space. In this analysis we test how three forms of movement — dispersal, foraging, and migration — covary with each other and body size across taxonomic groups. We found that all three movement types covary positively with each other and with body size, but the strength of covariance differs across taxonomic groups. To understand the way that organismal movement couples populations and communities across space, we must place greater focus on differences in the scales at which individual species disperse, migrate, and forage, as well as the taxa to which they belong.

Effects of resource quality on the temperature dependence of ecosystem respiration

Sandra Emry, Joey Bernhardt, Mary O'Connor

Temperature affects the rates of fundamental metabolic processes in ecological systems. Ecosystem respiration varies more with temperature than primary production does, resulting in shifts in ecosystem-level metabolism and community structure with warming. This asymmetric thermal dependence of respiration and photosynthesis governs ecosystem response to temperature, yet how plant resource quality may modify these effects of warming on biomass and energy flux is still not known. Theory predicts that low quality leaf material, such as tissue high in lignin content, will have a greater temperature dependence due to the increased complexity of enzymatic breakdown during decomposition; some evidence supports this, however current research has focused primarily on terrestrial systems. This project experimentally tested these predictions by warming experimental aquatic communities and manipulating the type of leaf litter. I measured decomposition, community respiration and community structure in each treatment, to quantify the effects of temperature on ecosystem fluxes under different resource conditions. The results will inform the interpretation of field patterns of respiration rates associated with different litter qualities, as well as a general understanding of the influence of temperature on ecosystem function.

Ban? What Ban? Status of seahorse fisheries and trade in India.

Tanvi Vaidyanathan, Amanda Vincent, X. Zhang and B. Ramkumar

The incidental catch of marine organisms (bycatch) poses a significant threat to their conservation. However, most current fisheries measures are directed towards managing and conserving targeted species, while overlooking the needs of these incidentally caught species. Seahorses (*Hippocampus* spp.) are one such charismatic genus of fishes that are incidentally caught in fishing gear for which greater catch and trade data exists. Our study investigates the impact of a catch and trade ban on the exploitation and conservation of seahorses in India. We find that the ban has been ineffective for seahorse conservation and that extraction and trade continues, mostly from non-selective fishing gear. Nearly two decades after the imposition of the ban, fisher awareness about the ban remains low in most states of India. Our work emphasizes on the need to move away from bans as a conservation measure, and focus on actually managing operations of non-selective fishing gear in order to conserve seahorses and other incidentally caught marine organisms.

Session 4: Physiology

MSL 102 14:25 - 15:10

A field-based investigation of the cardiorespiratory and thermal physiology of migratory Arctic Char (*Salvelinus alpinus*) using a remote mobile laboratory

Matthew J. H. Gilbert, Brendan Malley, Les N. Harris, Jean-Sébastien Moore, Anthony P. Farrell

There is a paucity of environmental-physiological research on valuable northerly-distributed fish, such as migratory Arctic char, despite the fact that the Arctic is warming much faster than the global average. This knowledge gap persists largely due to logistical challenges associated with conducting sensitive physiological techniques in remote arctic field settings. In this study, we utilized innovative mobile research infrastructure developed by the Arctic Research Foundation to conduct a field-based assessment of the thermal limits to cardiorespiratory performance in Arctic char. Maximum heart rate in migratory Arctic char captured between 10 and 13°C was constrained below 4°C and above ~18°C, with the heart beat becoming arrhythmic at ~21°C. In agreement with the heart rate data, aerobic capacity was not impaired between 4 and 16°C, although the ability of fish to recover following handling and exercise stress may be. The observed thermal tolerance breadth encompasses the river temperatures migrating Arctic char would commonly encounter in the central Canadian Arctic. However, some Arctic char bearing rivers do occasionally exceed these temperatures during the migration period. We are currently investigating the prevalence of supra-optimal temperatures during migration, the thermal acclimation potential of Arctic char, and population specific differences in thermal physiology

Does piscine orthoreovirus (PRV) harm the respiratory capability of infected Atlantic salmon (*Salmo salar*) smolts? An assessment that uses physiology to characterize phenotype.

Yangfan Zhang

The recent ubiquitous detection of PRV among salmonids has sparked international concern about the cardiorespiratory performance of infected wild and farmed salmon. Piscine orthoreovirus (PRV) has been shown to create substantial viremia in salmon by targeting erythrocytes for principle replication. In some instances, infections develop into heart and skeletal muscle inflammation (HSMI) or other pathological conditions affecting the respiratory system. Critical to assessing the seriousness of PRV infections are controlled infection studies that measure physiological impairment to critical life support systems. Respiratory performance is such a system and here multiple indices were measured to test the hypothesis that a low-virulence strain of PRV from Pacific Canada compromises the cardiorespiratory capabilities of Atlantic salmon. Contrary to this hypothesis, the oxygen affinity and carrying capacity of erythrocytes were unaffected by PRV despite the presence of severe viremia, minor heart pathology and transient cellular activation of antiviral response pathways. Similarly, PRV-infected fish had neither sustained nor appreciable differences in respiratory capabilities compared with control fish. The lack of functional harm to salmon infected with PRV in this instance highlights that, in an era of unprecedented virus discovery, detection of viral infection does not necessarily imply bodily harm and that viral load is not always a suitable predictor of disease within a host organism.

High temperature, hypoxia, and fish in the intertidal

Derek Somo

Increasing temperatures and decreasing oxygen content in the ocean pose a challenge to marine organisms and communities, potentially forcing individuals and populations to either move to more hospitable conditions, adapt, or die. Recent efforts to forecast changes in marine organism distributions with predicted changes in temperature and oxygen have based their projections on laboratory-based measurements of the acute effect of temperature on hypoxia tolerance. This approach to modelling species responses to climate change has been criticized for ignoring potentially key processes such as evolutionary adaptation. To investigate the evolution of temperature effects on hypoxia tolerance, I measured the effect of acute temperature increase on a key aerobic metabolic trait, the critical oxygen tension for resting oxygen uptake (P_{crit}), in 9 species of cottid fishes from temperature- and oxygen-variable or stable habitats. Several of the species in the study appear to have evolved increased capacities for oxygen uptake in hypoxia at high temperature, and thermal tolerance may be an important determinant of this trait. Surprisingly, there was no clear correlation between the temperature sensitivity of P_{crit} and environmental variability in the native habitat. Though evolutionary changes in temperature-hypoxia tolerance relations are difficult to predict, incorporating thermal tolerance may improve projection performance.

Poster session

Biodiversity Research Centre 17:00 - 18:00

Parallel genetic evolution and speciation from standing variation

Ken A. Thompson, Matthew M. Osmond, Dolph Schluter

How does the degree of genetic parallelism—adaptation using the same alleles in allopatric populations—depend on the differences in the direction of natural selection acting on two populations, from parallel (0°) to divergent (180°)? And how does adaptation from standing variation affect progress toward speciation, and does its effect depend on the direction of natural selection? We develop theory to address these questions. We first find that small differences in the direction of selection (angle) can largely preclude genetic parallelism. Second, we find that adaptation from standing variation has implications for speciation that change along the continuum from parallel to divergent selection. Under parallel selection, high genetic parallelism causes interpopulation hybrids to have high mean fitness when their parents adapt from standing variation. As selection tends toward divergent, adaptation from standing variation becomes less beneficial for hybrid fitness and under completely divergent selection causes interpopulation hybrids to have lower mean fitness than when adaptation was from new mutation alone. Our results provide general insight into patterns of genetic parallelism and speciation along the continuum of parallel to divergent natural selection.

Acute stress increases local corticosterone levels in lymphoid organs of neonatal mice: analysis using LC-MS/MS

Jordan E. Hamden, K. M. Gray, M. Salehzadeh, C. Ma, Kiran K. Soma

Glucocorticoids (GCs) are steroids produced by the adrenal glands and by lymphoid organs such as bone marrow, thymus, and spleen. Corticosterone is the active GC in mice. During early development (postnatal day (PND) 2 to 12), mice show decreased adrenal GC secretion, termed the stress hyporesponsive period (SHRP). Lymphoid organs locally-produce GCs, particularly during the SHRP, suggesting that these organs might increase local GC production in response to stress. Here, using PND1, PND5, PND9, and PND13 mice, we administered 5% isoflurane (an anesthetic) in oxygen as an acute stressor, oxygen as a vehicle control, or neither (baseline). We then measured a panel of 7 steroids in the blood and lymphoid organs using liquid chromatography tandem mass spectrometry. At PND1, corticosterone levels were high in both blood and lymphoid organs and did not differ with treatment. At PND5, corticosterone levels were generally very low, but increased with stress in a tissue-dependent fashion. At PND9, baseline corticosterone levels were very low, but increased in both blood and lymphoid organs in response to a stressor. At PND13, corticosterone levels were higher in blood than in lymphoid organs for all treatments and increased with stress. These data support the exciting possibility that mouse lymphoid organs can locally-produce corticosterone, even when little is produced by the adrenal glands.

Linking spatial use properties and body size with the IUCN Red List

Danielle Main, Samantha Straus, Rachel M. Germain, & UBC Trophic Metacommunity Group*

Anthropogenic climate change continues to impact ecosystem functions and services through habitat loss, fragmentation, and barriers to movement, thus leading to loss in biodiversity. The field of movement ecology has become ever more important in wildlife management and conservation. Understanding the multiple types of movement (dispersal, home range and migration) is crucial to planning successful conservation and mitigation strategies. This study uses a meta-analysis to examine the links between spatial use properties and body size (mass) with the International Union for Conservation of Nature (IUCN) Red List, determining if these traits covary. We found that there is a strong covariance between body size and IUCN Red List status; however, no significant relationship was detected for the three spatial use properties. Overall, further research needs to be conducted across all taxa as numerous intrinsic and extrinsic factors must be considered to efficiently allocate limited funds and resources for targeted species conservation.

Coming in hot: Community-level responses to changes in heat wave intensity and herbivore density

Cassandra A. Konecny and Christopher D.G. Harley

Climate change is a major threat to ecosystem function and biodiversity. Increases in global average temperatures and the magnitude and frequency of thermal extremes have the potential to impact the physiology, behavior and performance of organisms, ultimately driving species range shifts and altering community composition across scales. While chronic exposure to high temperatures can be detrimental to organismal performance, acute exposure can be benign or even benefit organisms through increased activity rates. To better understand how heat-wave intensity influences tidepool community structure and composition, we conducted a field experiment in Vancouver, British Columbia. Using a novel heating system, The SAUTÉ (Seaside Array for Understanding Thermal Effects), we simulated weekly heating events of different intensities (ambient, $\pm 2^\circ\text{C}$, $\pm 4^\circ\text{C}$) in artificial tidepools. In addition, we manipulated herbivore density to determine if there is an interaction between herbivore pressure and heat wave intensity. After two months, we measured the relative chlorophyll concentration (proxy for microalgal cover) in each pool as well as the abundance of invertebrates. We found that although there were no differences in Shannon diversity between treatments, there were differences in average species richness. There was no effect of heating intensity but there was higher richness in the presence of increased herbivore pressure. Average chlorophyll-a content per slide strongly decreased by the experimental addition of limpets, although this effect was more pronounced in the high temperature treatment with a significant interaction between heating intensity and herbivore pressure. Further, the abundance of barnacles was higher in treatments with increased herbivore pressure. This study suggests that herbivore pressure and biotic interactions may be more important than predicted increases in heatwave intensity in shaping tidepool communities found in Burrard Inlet, BC.