A1.1 EPIGENETIC INHERITANCE AS A BRIDGE FOR SURVIVING SHORT-TERM ENVIRONMENTAL STRESSORS

Epigenetic inheritance of modified phenotypic traits has often been framed in the context of disease, a condition that is not entirely separate from phenotype, especially from a medical perspective. Yet, epigenetically inherited phenotypes generated by parental exposure to adverse environments can also be highly adaptive when that adverse environment persists across several generations. Two key features of epigenetically inherited traits can make them of critical importance when organisms face prolonged, multi-generational periods of adverse environments. First, epigenetically inherited traits can arise quickly and then modify the state of epigenetic markers regulating their very nature reversible. Epigenetic readers, writers and erasers of traits arising by mutation may only very slowly become fixed (or not) across many successive generations. Second, epigenetic traits are by their very nature reversible. Epigenetic readers, writers and erasers of traits arising by mutation may only very slowly become fixed (or not) across many successive generations. Epigenetic inheritance is thus far more "nimble" than inheritance of genetic information. Epigenetic inheritance is thus far more "nimble" than inheritance of genetic information.

A1.2 PARENTAL DIETARY CRUDE OIL EXPOSURE IN THE KING QUAIL (COTURNIX CHINENSIS) LEADS TO EFFECTS ON OFFSPRING RESPIRATORY PHYSIOLOGY

Crude oil represents a constant threat for marine and marshland birds species that could be exposed dermally, dietarily or via respiration, leading to detrimental effects on their morphology and physiology. However, oil spills often coincide with the breeding season, which is a time of great vulnerability for the offspring. We assessed indicators of health (body mass, temperature, oxygen consumption, ventilatory rate,) and fitness (laying, fertilization, hatching success) in the adult quails, then we assessed from the cellular (mitochondrial respiration) to the systemic level (respirometry) if the respiratory physiology of their offspring was impaired. Preliminary results indicate that body mass does not vary among adult groups (49.5 g female, 46.4 g male) however, oxygen consumption was increased in the group exposed to the crude oil compared to control group (5.95 mL O2/g/h and 5.10 mL O2/g/h, p < 0.05, respectively). Although egg mass and size did not differ among groups, fertility percentage was reduced in oil-exposed groups by up to 20%. Additionally, egg water loss from the exposed parents was increased (0.11 g/day exposed vs. 0.20 g/day control, respectively). Our results suggest that crude oil exposure in adult quails may compromise their own metabolic costs and directly affects reproductive success. Additionally, offspring respiratory physiological may be compromised. This experiment highlights the importance of performing experiments considering more than one generation to better understand the ecological impact of oil spills on bird populations.

A1.3 IS THERE A MECHANISTIC LINK BETWEEN DNA METHYLATION AND REVERSIBLE ACCLIMATION?

Phenotypic plasticity can confer resilience to environmental change. Understanding the mechanistic basis of plasticity is important to predict its manifestation in a phylogenetic context, and under different scenarios of climate change. Plasticity of physiological functions is obligatory for cell survival, and it emerges from regulatory systems that evolved to maintain environmental stability and avoid extremes. Interaction between epigenetic regulation and physiological function permitted an increasingly sophisticated fine-tuning of phenotypes, and potentially link transgenerational, developmental, and reversible plasticity. We used a zebrafish DNA methyltransferase 3 knock-out model to test whether there is a mechanistic link between environmentally induced DNA methylation in parents and early embryonic stages, and reversible acclimation in adult offspring. It is constructive to interpret thermal plasticity in the context of implicit regulatory mechanisms, which can replace current verbal and explicit regulatory mechanisms, which can replace current verbal evolutionary models.
A1.6 TRANSGENIC EFFECTS AND PHYSIOLOGICAL RESPONSES TO DROUGHT IN QUERCUS ILEX L. TREES

TUESDAY 2 JULY, 10:45

LAURA GARCIA DE JALON (CEFE CNRS, FRANCE), JEAN MARC LIMOUSIN (CEFE CNRS, FRANCE), MATE MOLDOVIĆ (2RD, FRANCE), ALEXANDRU MLCU (CEFE CNRS, FRANCE)

Climate change-related alterations in temperature and precipitation are currently leading to increased worldwide tree mortality rates (Chat et al., 2018). We urgently need to better understand the physiological impacts of recurrent droughts on tree water use strategy and carbon metabolism, as well as the currently unknown role of epigenetic-induced transgenerational effects for drought tolerance. To fill these knowledge gaps, we measured the physiological responses to drought of adult holm oak trees (Quercus ilex L.) in situ (at the CNRS Puechabon experimental field site) where a 30% precipitation reduction has been applied for over 15 years, as well as in controlled environment conditions (at the CNRS Montpellier European Ecoref) for their respective 1-year-old offspring. Our aims is to assess whether drought tolerance-related physiological responses are related to changes in the methylene metabolism using WGS. Among other responses, we found that adult trees from the rainfall exclusion treatment had 28% lower carbon assimilation rates at the third leaf of the dry season when compared to the ambient controls. However, in the next spring (2018) the carbon assimilation rates were 52% higher in the controls, indicating a strong compensatory response when soil moisture was no longer limiting. The links with the changes in methylene will be presented and discussed.

A1.7 TRANSGENIC PLASTICITY IN A CORAL REEF FISH TO OCEAN WARMING

TUESDAY 2 JULY, 14:00

JENNIFER M DUNELSON (ARC COE FOR CORAL REEF STUDIES, JAMES COOK UNIVERSITY, AUSTRALIA)

For the majority of species and populations present-day thermal performance and sensitivity suggest negative impacts of future projected warming and very little capacity for species to cope with a specified future change. However, for most species projected environmental change will occur over many generations allowing for plastic and adaptive processes to take place. Knowledge of thermal performance and sensitivity is critical for understanding likely species responses, as well as for effective management and conservation of ecosystems in the future for many species. Recent studies have highlighted the influence of thermal condition experienced over multiple generations on performance. A number of interesting patterns were found with the temperature experienced by the current, parent or grandparent generation affecting the phenotype of fish, with more gradual warming over generations resulting in greater plasticity allowing developmental plasticity occurring on top of transgenerational plasticity. In addition, I also found that the thermal conditions in which reproduction occurred interacted with thermal history to effect the phenotype of offspring produced. Finally, certain traits exhibited rapid plasticity consistently occurring in a generation, while others required the previous generation(s) to have experienced warmer conditions for phenotypic change to occur.

A1.8 TRANSGENIC EFFECTS IN A WARMING OCEAN – WHICH PARENT HAS THE GREATEST IMPACT ON THE OFFSPRING?

TUESDAY 2 JULY, 14:30

RACHEL K SPINIS (ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, JAMES COOK UNIVERSITY, AUSTRALIA), JENNIFER M DUNELSON (ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, JAMES COOK UNIVERSITY, AUSTRALIA), LUCREZIA BONZI (KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, SAUDI ARABIA), TIMOTHY RAVASI (KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, SAUDI ARABIA), PHILIP I MUNROE (ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, JAMES COOK UNIVERSITY, AUSTRALIA)

Rising sea temperature poses a significant threat to marine fishes. While current-day populations of reef fish suffer when exposed to short-term elevated temperatures, future warming will likely occur over long-term evolutionary time scales. Offspring produced from the remaining parental generations will require beneficial effects on offspring performance at elevated temperatures in the spiny damselfish, Acantochromis polyacanthus. A newly generated F1 offspring from crosses of male and female parental lines selected according to three short-term (10°C-38°C) for one month, allowing thermal acclimation, and random selection (control) are expected to produce numerous generations F2 offspring from the remaining parental generations. These thermally selected lines provide us with a unique opportunity to investigate the mechanisms involved in transgenerational effects (such as the reduced density of the targeted population) that modify the expression of traits and alter their evolutionary potential. Both evolution, plasticity and their interaction are likely to have the potential to evolve but are also influenced by environmental stress. This suggests that maintaining plasticity carries a fitness cost, and that stable environments can lead to a loss of plasticity over short evolutionary time scales.

A1.9 EVOLUTION OF THERMAL TOLERANCE IN ZEBRAFISH

TUESDAY 2 JULY, 15:45

RACHEL MORGAN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), METTE H FENNIN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), HENRIK JENSEN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), CHRISTOPHE PÉLARON (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), FREDRIK JUTFELT (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY)

Climate changes increasing global temperatures and the frequency of extreme events such as heat waves, which can impose thermal stress on aquatic ecosystems. How organisms will cope with climate change will partly depend on how quickly they are able to adapt their thermal tolerance. However, the ability of the thermal tolerance to evolve in vertebrates is largely unknown. To address this question, we artificially selected for thermal tolerance in zebrafish. Starting with a very wild-caught ancestral population (n=1800), we selected for six generations, combining direct/indirect selection treatments: high thermal tolerance, low thermal tolerance, high thermal tolerance after warm acclimation, and random selection (control). We found that whilst thermal tolerance is diverging between lines, the responses to selection is asymmetrical with a stronger response in the direction of reduced tolerance. The weak response in the high tolerance line suggests that evolution to increase thermal tolerance is very slow. With the rate at which global temperatures are increasing, these results suggest that fish may not have the potential to evolve to adapt to the new condition. These thermally selected lines provide us with a unique opportunity to examine how physiological traits may co-evolve with thermal adaptation, as well as to investigate the mechanisms involved in limiting thermal tolerance in fish.

A1.10 THERMAL PLASTICITY REDUCED BY DOMESTICATION IN ZEBRAFISH

TUESDAY 2 JULY, 15:00

FREDRIK JUTFELT (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), RACHEL MORGAN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), ANNA H ANDREASSON (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), EIRIK ÅSKJEM (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), METTE H FENNIN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), Gunnar Oresland (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), TorE BREMGUI (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), ADRIAN LOH (UNIVERSITY OF GREewnich, UNITED KINGDOM), JOANNA MEiST (UNIVERSITY OF GREewnich, UNITED KINGDOM)

The body temperature of fish is affected by environmental temperature, and higher temperatures increase biological rates. Fish in habiting waters with fluctuating temperatures acclimate their biochemical and physiological functions to counter that direct thermal effect. Zebrafish in the wild encounter large temperature fluctuations and have high capacity for thermal acclimation. However, zebrafish lines used in biomedical research were domesticated such that the offspring have been reared at optimal temperature with minimal thermal fluctuations. We treated the domestication of zebrafish as an evolution experiment to optimise thermal tolerance and as a result this has reduced the thermal plasticity and ability to adapt. We kept wild and laboratory zebrafish at 30°C (10°C-30°C) for some time, allowing thermal acclimation, before examining phenotypic differences in vivo, including growth, behaviour, metabolism, and immune response to stress. We show that both temperature and domestication, with interactions, had major effects on all levels of biology. Domesticated fish have lost plasticity in their phenotype and are thus less able to counteract direct effects of temperature on, e.g. metabolism, survival, and immune performance, and behaviour. These differences in plasticity were most apparent at the highest temperatures. Similarly, we show that thermal plasticity also carries a fitness cost, and that stable environments can lead to a loss of plasticity over short evolutionary time scales.

A1.11 TRANSGENIC RESPONSES TO HARVEST-ASSOCIATED SELECTION AND POPULATION DENSITY ON FISH PHYSIOLOGY

TUESDAY 2 JULY, 15:15

AMELIE CRESPIL (UNIVERSITY OF GLASGOW, UNITED KINGDOM), ANITA RACZ (UNIVERSITY OF GLASGOW, UNITED KINGDOM), LAURINE EIDE (UNIVERSITY OF GLASGOW, UNITED KINGDOM), KEVIN PARSONS (UNIVERSITY OF GLASGOW, UNITED KINGDOM), JAN LINSTROM (UNIVERSITY OF GLASGOW, UNITED KINGDOM), SHAIN KILLEN (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

Fisheries-induced evolution (FIE) represents one of the most important human-induced evolutionary pressures for natural populations. However, the mechanisms by which FIE affects natural populations, as well as its consequences for populations, are still unclear. Previous studies have highlighted that physiologically-based traits linked to vital vulnerability to fishing (e.g. metabolism and growth) have the potential to evolve, but are also influenced by environmental stress (such as the reduced density of the targeted population) that modifies the expression of traits and alters their evolutionary potential. Both evolution, plasticity and their interaction are likely to play an important role in the evolutionary response to fisheries. However, the potential for evolution in response to targeted population is usually followed by a selective harvest event and its associated reduction in population density. Therefore, understanding genetic and physiological mechanisms underlying the response to harvest for different densities and harvested using simulated trawling, we created first generation of offspring (four different groups from a parental population that was harvested or not, for normal and low density). We then exposed these offspring to different population density and evaluated their physiological response. While offspring rearing density directly influenced the mass of the fish, the parental experience influenced only harvest and population density.
density also influences offspring metabolism. These results provide insights into the determinants and physiological effects of fasting at the population level, revealing that transgenerational responses can occur immediately after harvest-associated selection and density reduction and prior to population reduction.

A1.12 TRANSGENERATIONAL PLASTICITY IN MARINE FISH – A WAY TO ESCAPE THE CLAWS OF CLIMATE CHANGE?

TUESDAY 2 JULY, 16:00

FRANCISCO OMC BORGES (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL), LISA NS SHAMA (ALFRED WEGENER INSTITUTE, GERMANY), ANNELE SHIRLEY RAVEH (ALFRED WEGENER INSTITUTE, GERMANY), ALEXANDRE FELLOUS (ALFRED WEGENER INSTITUTE, GERMANY), AMÉLIE CREPEL (UNIVERSITY OF ADELAIDE, SOUTH ADELAIDE), UEI JOHN (ALFRED WEGENER INSTITUTE, GERMANY), MATHIAS K. WEGENER (ALFRED WEGENER INSTITUTE, GERMANY)

The world’s climate is changing at an unprecedented rate, which is observed in the ocean surface waters as increasing ocean warming, acidification and deoxygenation. If living conditions turn physiologically unfavorable and capacities for acclimatization have been fully exploited, marine fish generally face three choices: move, adapt or become extinct. Not all fish species are generalist enough to successfully move into new habitats and ecosystems and most fish species generally face three choices: move, adapt or become extinct.

Ocean acidification is one of the main emerging threats to marine biodiversity. Despite the many known negative effects to marine species, few studies have addressed the transgenerational consequences of exposure to high CO2. This presentation will cover recent work performed on a keystone gammarid amphipod (Gammarus locusta). First, it will analyze the extreme generational effects of high CO2 regarding survival and reproductive traits (e.g. females reproduce in investment, mate-guarding, as well as fecundity). Then, it will address potential single-generations effects concerning metamorphosis (i.e. on ontogenetic metabolic rates) and male long-distance mate-tracking (i.e. olfactory receptor of female cues). Lastly, it will briefly analyse transgenerational effects on stress-related biochemical and endoparasite levels (e.g. protein repair and removal mechanisms and antioxidant responses). In summary, results suggest that predicted 21st-century CO2 levels could induce deleterious transgenerational effects on several of the analysed traits (in particular regarding survival, female investment and fecundity). Concerning metamorphosis and male reproductive behaviour, a single-generation exposure was insufficient to induce a significant drop in ontogenetic metabolic rates, consistent with metabolic depression, and a significant reduction in male response to female scents cues. Regarding biochemical effects, results present support to the premise that high CO2 is expected to decrease survival and lead to within- and transgenerational oxidative damage, as well as suggest that deleterious effects are progressively inherited by the offspring. The present findings suggest that G. locusta populations could be vulnerable to the effects of predicted ocean acidification conditions, and hint at a potential fitness reduction for the species.

A1.13 HOW OCEAN ACIDIFICATION COULD CHALLENGE A KEYSTONE GAMMARID AMPHIPOD

TUESDAY 2 JULY, 16:30

FRANCISCO OMC BORGES (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL), ANA R LÓPEZ (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL), CATI PIQUEUDE (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL), EDUARDO S SAMPÃO (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL), TIAO G FERILO (MARINE AND ENVIRONMENTAL SCIENCES CENTRE (MARÉ), LABORATÓRIO MARITIMO DA GUIA, PORTUGAL)

The presence of predictable changes in ocean chemistry and temperature is increasing in the northern Mediterranean Sea, as a result of the interaction between global warming and the intensified anthropogenic activities in this area. The environment represents a potential threat for the Mediterranean marine biodiversity and in particular for the keystone gammarid amphipod Gammarus locusta. Due to its central role in food web, the Gammarus locusta is a key indicator of the environmental changes. Despite the growing awareness of the contribution of this species to the Mediterranean marine biodiversity, few studies have addressed the potential impact of ocean acidification and warming on Gammarus locusta. To fill this gap, we provide new results on Gammarus locusta life history traits when exposed to high CO2 levels in a long-term experiment. Our results show that Gammarus locusta is particularly sensitive to ocean acidification, exhibiting growth depression and altered reproductive traits. In conclusion, our study highlights the importance of Gammarus locusta as a model species for investigating the transgenerational responses of marine biodiversity to ocean acidification and warming.
A1.17 GENETIC SELECTION FOR COLD TOLERANCE SHAPES THE TILAPIA PHYSIOLOGICAL RESPONSE TO LOW TEMPERATURE AND MODULATES ITS MICROBIOME COMPOSITION

**Tuesday 2 July, 2019 | 17:30**

AVNER CHANIN (AGRICULTURAL RESEARCH ORGANIZATION, ISRAEL), TALI NITZAN (AGRICULTURAL RESEARCH ORGANIZATION, ISRAEL), FOTINI KOKOU (AGRICULTURAL RESEARCH ORGANIZATION, ISRAEL), ADI DONON-FALAHMOZ (AGRICULTURAL RESEARCH ORGANIZATION, ISRAEL), TATIANA SLOMAN (AGRICULTURAL RESEARCH ORGANIZATION, ISRAEL), ZIYAN MIZRAHI (BEER-SHEVA UNIVERSITY OF THE NEGEV, ISRAEL)

Cold is an environmental challenge that greatly affects physiological processes. When exposed to cold temperatures, poikilothermic animals, such as fish, undergo remarkable physiological adjustments to maintain homeostasis. Such adjustments may vary across populations and individuals, depending on factors such as life history, nutritional status or genetic background. Understanding the mechanisms that underlie the variation in phenotypic responses can provide insights into the nature of environmental tolerance and adaptation. Here, we aim to explore potential mechanisms of the thermal tolerance in tilapia, a fish of tropical origin widely distributed across the world due to its aquaculture importance, but also considered as an invasive species. We used unique experimental setups, followed by families with low or high cold-tolerance, originating from a selective breeding scheme in which tilapia, Oreochromis aureus, families were selected based on sibling survival in cold challenge trials. The genetic components of cold tolerance inheritance were evaluated, while the transcriptomic response and the microbiome composition were examined using RNAseq and amplicon sequencing. Our results showed strong maternal effects in cold tolerance inheritance. Transcription analysis revealed biological pathways which are the core response to low temperatures, common to all analysed fish and tissues, as well as pathways which are the differential response between cold-tolerant and cold-sensitive fish. Over all, at the gene expression level, cold-tolerant fish showed milder response to declined temperatures compared to the sensitive fish. Similar patterns observed in the response of the fish microbiome composition, indicating that the microbiome is potentially shaped by its host thermal acclimatization.

A1.18 ELECTROCARDIOGRAPHIC CHANGES CAUSED BY OXYGEN CHANGES AND MERCURY CONTAMINATION IN NEOTROPICAL FISH

**Thursday 4 July, 2019 | Poster Session**

DIANA MONTENEGRO@UFSCAR.BR

Hyponxia is a phenomenon that occurs in large areas in aquatic systems worldwide and may affect aquatic animals, leading to population decline and changes in community. Furthermore, synergies with other stresses could amplify the effects of alterations in ambient O₂, such as the impacts of increasing pollutant concentrations. Of all contaminant metals, mercury is by far the most toxic due to its persistence in water and sediments and its ability to bioaccumulate and biomagnify through aquatic foodwebs. The aim of this study was to analyze the effect of acute exposure (96h), via water, and a sub-chronic exposure (30 days), via food, to sub-lethal doses of inorganic mercury on electrocardiogram of two ecologically distinct Neotropical fish species, matrinxã (Brycon amazonicus, Characidae) and trairí (Hoploscelio malabaricus, Erythrinidae) in response to aquatic hypoxia challenge. Regarding matrinxã, the critical points highlighted were impaired electrical conduction as first-degree atrioventricular block and prolonged atrial depolarization during severe hypoxia. For trairí the results were bradycardia, first-degree atrioventricular block, increased duration of atrial and ventricular depolarizations, and lengthening of the plateau phase of the cardiac muscle action potential. From normoxia to deep hypoxia, the present data indicate that Hg exposures, via water or food, intensify hypoxia-induced cardiovascular alterations. These changes can lead to the impairment of cardiac output, swimming performance, ability of fish species to capture their prey, and growth and reproductive rates.

A1.19 INTEGRATING PHYSIOLOGY, BEHAVIOUR AND LIFE HISTORY TO UNDERSTAND IMPACTS OF OCEAN WARMING ON KEY MARINE SPECIES

**Wednesday 3 July, 2019 | Poster Session**

PATRICIA PEAANO (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA)

DIETTA PECL (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA)

QUINN FITGIBBON (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA)

JAYSON SEMPENS (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA)

PATOCC, PEINADOPHOTOM@UTAS.AU

Marine communities are likely to be particularly vulnerable to the climate-driven changes in the geographical distribution of species. Modification of species distributions can lead to new species interactions which could have consequences for the species population, or the broader community composition or ecosystem functioning. In particular, climate-driven changes in predator-prey interactions can substantially impact the whole community when important predator or prey species are affected. Given major redistribution of marine species is already occurring in response to climate change, understanding species physiology, and the complex relationship between life history traits and ecosystems will respond to the fast rates of current warming. By studying rapidly responding species, such as squid, in faster changing regions of the world, we can examine the genetic and/or plastic links between oceans warming and biological response in advance of wider scale impacts predicted for the future. Squid are fast growing, short-lived, voracious predators that play a large role in the structure and function of many marine ecosystems. Here, we aim to understand how temperature affects squid physiology and behaviour in a complex relationship between them in southern calmaris. Specifically, we examine how temperature impacts metabolic activity, critical thermal limits and life-history traits to current and future warming scenarios are examined. Changes in behaviour are also explored, examined temperature effects on predation-prey interactions, and thermal habitat preferences. Such studies will give us a better understanding of how species respond, and the mechanism behind these responses to changes in the environment.

A1.20 HIGH CO₂ IMPAIRS CLEANER FISH COGNITIVE PERFORMANCE THROUGH DOPAMINERGIC DISRUPTION

**Thursday 4 July, 2019 | Poster Session**

JOSE RICARDO PAULA (MAE – MARINE AND ENVIRONMENTAL SCIENCES CENTRE, LABORATORIO MARITIMO DA GUIA, PORTUGAL), EVA OJACQUE (MAE – MARINE AND ENVIRONMENTAL SCIENCES CENTRE, LABORATORIO MARITIMO DA GUIA, PORTUGAL), DIANA MONTEIRO (FEDERAL UNIVERSITY OF SÃO CARLOS, BRAZIL), W TAYLOR (UNIVERSITY OF BIRMINGHAM, UNITED KINGDOM), GRETTA PECL (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA), JAYSON SEMPENS (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TANZANIA, AUSTRALIA)

JRPaula@fc.ul.pt

Species’ cognition is tightly linked to their evolutionary history and ecology. The cleaner wrasse, Labroides dimidiatus, evolved as a keystone species with cognitively sophisticated behaviour engaged in cooperative cleaning interactions with other reef fish species. However, the ecological conditions where cleaners were able to evolve their cognitive abilities are changing due to processes such as ocean acidification. Here, we acclimatized cleaners to ranges of five different CO₂ concentrations, from pre-industrial (275 µatm) to elevated CO₂ (~980 µatm, RCP 8.5 scenario) to unravel cleaners adaptation potential. We tested cleaners ability to solve an ecologically relevant cognitive task, the ability to prioritise an ephemeral food source over a permanent one. Cognitive performance remained stable from pre-industrial to unaltered RCP 8.5 scenario, while cleaners failed to solve the task at the highest scenario. Using a complementary pharmacological manipulation experiment, we tested if dopaminergic stimulation (D1 receptor) could recover cleaners cognitive performance under the highest CO₂ scenario (980 µatm). D1 activation reversed cleaners performance as fish treated with a D1 receptor agonist under high CO₂ had similar performance to cleaners under current levels. Our study suggests that if the selection on cognitive sophistication is high, tolerant cleaners could be positively selected, at least at 750 µatm is not exceeded, and that the mechanism behind their tolerance is potentially related with dopaminergic regulation.
Seawater acidification has been recognized as an emerging global stressor, potentially affecting ecosystems’ biodiversity, concordance and functions. Several studies regarding the effects of acidification on marine organisms have been conducted, and transgenerational acidic acclimation is an interesting aspect that have also done in some works. In this study, marine medaka (Oryzias melastigma) was applied on CO2-induced hypercapnia treatment, and three generations of medaka with hypercapnia-acclimated trait were bred. RNA-Seq-based analysis showed that transcriptomic profiling variations could be apparently found among generations. Transcripts of acid-base regulators, anion exchanger 1a (AE1a), Na+/HCO3- transporter (NHE2), were then observed both in 5 dpf embryos and adult ovary. Based on above results, we inferred that in teleosts, the maternal or directly by themselves, their maximum metabolic capacities were influenced by the flow regime experienced by their parents. Therefore, transgenerational effects are likely to take place to confer specific physiological abilities to the offspring after settlement, possibly helping them to cope with their challenging environment.

High water flow regimes are challenging for populations that need constantly fight over the current. This is especially true for terrestrial populations that don’t necessarily have the possibility to relocate over calmer environment. Such environment can thus require the adjustment of the individual physiological capacities, possibly leading to local adaptation. However, the relative importance of parental or direct environmental influence (that can drive transgenerational or developmental effects on these capacities) has been generally overlooked. Using orange-fin anemonefish (Amphiprion chrysopterus), we split larvae from the same clutch, from parents inhabiting areas of high and low flow regimes, reared them under similar aquarium flow conditions and transplanted them in the field to both high and low flow after settlement. After 3 weeks of flow exposure, we measured the physiological capacities of the fish (growth, swimming and metabolic rates). While the growth and swimming capacities of the offspring were not different according to the flow condition experienced either originally by their parents or directly by themselves, their maximum metabolic capacities were influenced by the flow regime experienced by their parents.

The quality of the intraterrestrial environment interacts with our genetic makeup to shape the risk of developing disease in later life. Fetal hypoxia is a common complication of pregnancy. Fibrosis in the heart and endothelial dysfunction in the offspring are possible outcomes. The mechanisms by which this occurs remain elusive, precluding the identification of potential therapies. Using an integrative approach in large and small animal species at the in vivo, isolated organ, cellular and molecular levels, my programmes of work have raised the hypothesis that oxidative stress in the fetal heart and vasculature underlies the mechanisms via which prenatal hypoxia programs cardiovascular dysfunction in later life. We have shown that development hypoxia independent of changes in maternal nutrition promotes fetal growth with restriction and induces changes in the cardiovascular, metabolic and endocrine systems of the adult offspring, which are normally associated with metabolic diseases. My programmes cardiovascular dysfunction in later life. We have shown that development hypoxia independent of changes in maternal nutrition promotes fetal growth restriction and induces changes in the heart, vascular, metabolic and endocrine systems of the adult offspring, which are normally associated with disease states during ageing.

Treatment with antioxidants of animal pregnancies complicated by reduced oxygen delivery to the fetus prevents the alterations in fetal growth, and the cardiovascular, metabolic and endothelial dysfunction in the fetal and adult offspring. Interestingly, the risk of programmed heart disease by adverse pregnancy window can be transmitted across generations via the paternal line. Conversely, the mother can transmit onto her offspring protection against future heart disease via mitochondrial mechanisms. We can therefore modify the risk of heart disease not only in our children but also in their children and their children’s children.

Deer mice develop the capacity for independent thermoregulation postnatally as regulatory systems and thermo-effectors tissues mature. This species has a wide geographical distribution including altitudes of >4000m where unremitting low O2 and ambient temperatures are particularly challenging for small endotherms. We have previously shown that highland deer mice possess superior thermogenic capacities as adults, but it is unclear if selection has occurred to survive early development in the high alpine environment. To address this question, we used deer mice native to low and high altitude to examine the development of muscle and brown adipose tissue (BAT) over postnatal days P0–P10, and muscle in juveniles (P14–P27). We found that the onset of endothermy occurred at P8–P10 in lowlanders, ~2 days earlier than in highlanders, and was associated with the maturation of BAT activation in response to acute cold. Muscles remained immature over this period but by P14 the gastrocnemius in lowlanders had matured. This species has a wide geographical distribution including altitudes of >4000m where unremitting low O2 and ambient temperatures are particularly challenging for small endotherms. We have previously shown that highland deer mice possess superior thermogenic capacities as adults, but it is unclear if selection has occurred to survive early development in the high alpine environment.
A2.3 ACOUSTIC DEVELOPMENT PROGRAMMING IN BIRDS: PRENATAL ACOUSTIC EXPERIENCE AFFECTS LIFETIME LONG-TERM THERMOREGULATION IN THE HEAT

**Wednesday, 3 July, 2019**
10:45

**MYLENE MARRIETTE (DEAKIN UNIVERSITY, AUSTRALIA), ANAIS PESSERT (DEAKIN UNIVERSITY, AUSTRALIA), ANDREW E MCEWEN (UNIVERSITY OF PRETORIA, SOUTH AFRICA), KATHERINE L BUCHANAN (DEAKIN UNIVERSITY, AUSTRALIA)**

In many species, ranging from crocodiles and birds to humans, embryos can perceive, learn and even produce sounds. Surprisingly however, the implications of embryonic sensory capacities for developmental programming had not been recognized until recently. We revealed this novel function of prenatal communication by showing that zebra finch parents signal high ambient temperatures to their embryos, by emitting apeculiar vocalisation during late incubation. In a large playback experiment in incubators, we showed that exposure to parental musical stimuli adaptively alters subsequent nestling growth in response to nest temperature, and influences individuals' thermal preferences as adults. Here, we investigate the possible physiological mechanisms underlying such developmental programming by prenatal acoustic signals. Specifically, we show that zebra finches in the wild also produce this characteristic vocalisation, only at high temperatures. In addition, in the lab, we demonstrate experimentally that calling is specifically triggered by high air temperatures, and importantly, is associated with individual body mass. Furthermore, we show that prenatal exposure to this vocalisation specifically affects individual thermoregulation at adulthood. In particular, we find that donorspecific and post-natal nest temperature influence the body temperature, evaporative water loss, and resting metabolic rate of adults (n=44) measured in an open-flow-through respirometry system. These effects specifically occurred at the highest air temperature bird groups were exposed to (42-44°C). Together, our results demonstrate that the effect of the prenatal acoustic environment on development is considerably greater than currently acknowledged, and shed light on novel mechanisms for thermal adaptation in birds.

A2.5 THE EFFECTS OF FRESHWATER SALT AND CO2 LEVELS ON THE DEVELOPMENT OF ZEBRAFISH

**Wednesday, 3 July, 2019**
11:30

**COSIMA S PORTIES (UNIVERSITY OF EXETER, UNITED KINGDOM), ELLA MAPLES (UNIVERSITY OF EXETER, UNITED KINGDOM), GREGORY PAULL (UNIVERSITY OF EXETER, UNITED KINGDOM), ROD W WILSON (UNIVERSITY OF EXETER, UNITED KINGDOM), GREGORY PAULL (UNIVERSITY OF EXETER, UNITED KINGDOM), ROD W WILSON (UNIVERSITY OF EXETER, UNITED KINGDOM)**

Water chemistry varies greatly across zebrafish research facilities (sodium and chloride alone can vary by >10,000-fold), with no guidelines available for many parameters important for healthy populations. Moreover, CO2 levels are not usually measured in aquaculture facilities, yet CO2 is known to affect the acid-base physiological and behaviour of many fish species, including adult zebrafish. Our recent survey of recirculating zebrasfish aquatic systems revealed CO2 levels up to 2,828 ppm, seven times higher than current atmospheric equilibrium, and three times higher than climate change predictions for natural environments by 2100. The aim of the current study is to determine what effect various salt and CO2 levels have on zebrafish development. Zebrafish embryos were exposed to 10 different salt concentrations combined with four different CO2 levels from fertilization until 4 days post-fertilization. None of the treatments had any major developmental milestones of zebrafish (tail detachment, somite formation, hatching, presence of a heart and response to touch). Zebrafish length was smaller in fish exposed to both higher salt and CO2 levels. Interestingly, zebrafish exposed to 2000 ppm CO2 were less than those exposed to both low (400 ppm) or high (4000 and 8000 ppm) CO2 levels. Current studies are focusing on how these water chemistry variables affect later developmental stages through to adulthood, focusing on growth, behaviour, reproduction, fecundity and physiology (immune function, response to stress), and how they may influence reproducibility of research studies, given the known large variability both between and within zebrafish facilities.
**A2.9 DEVELOPMENTAL HYPOXIA REPROGRAMS THE CARDIAC PROTOTYPE OF AMERICAN ALLIGATORS**

Wednesday, 3 July, 2019 15:00

Sarah L. Alderman (University of Guelph, Canada), Dana A. Crossley II (University of North Texas, United States), Ruth M. Elsey (Louisiana Department of Wildlife and Fisheries, United States), Tod O.Ellis (University of Guelph, Canada)

Hyposia exposure during development can have a profound influence on offspring physiology, including a cardiac dysfunction, yet many reptile embryos naturally experience periods of hypoxia in burrow nests. American alligators experimentally exposed to developmental hypoxia demonstrate morphological and functional changes to the heart that persist into later life stages; however, the molecular basis of these changes remains unknown. We tested targeted and episodic changes in steady-state protein expression underlie this hypoxic heart phenotype, using isobaric tags for relative and absolute quantitation (iTRAQ) proteomics. Alligator ears were reared under normoxia or hypoxia, then either sampled (embryos) or returned to normoxia for 2 years (juveniles). These ten findings emerge from the large analysis of 145 differentially expressed proteins in hypoxia-reared animals:

1. Significant protein-protein interaction networks were identified only in up-regulated proteins, indicating that the effects of developmental hypoxia are not cumulative and directed: C1q-superfamily-proteins substantially enriched processes related to protein turnover, cellular organization, and metabolic pathways, supporting increased resource allocation towards building and maintaining a higher functioning heart; and
2. The juvenile cardiac proteome retained many of the signatures changes observed in embryonic hearts, supporting the long-term programming of cardiac myocytes induced by hypoxia during critical periods of development.

**A2.10 DEVELOPMENTAL HYPOXIA PROGRAMS STRESS-TOLERANCE IN JUVENILE SNAKING TURTLES: WHOLE-HEART, CELLULAR, AND METABOLIC RESPONSES IN ANOXIA**

Wednesday, 3 July, 2019 15:15

Ilan M. Malik (University of Manchester, United Kingdom), Dana A. Crossley II (University of North Texas, United States), Janina Crossley (University of North Texas, United States), Scarlett A. Eldridge (University of Manchester, United Kingdom), Gina L. Gally (University of Manchester, United States)

In a remarkable feat of physiology, North American freshwater turtles can survive in the complete absence of oxygen (anoxia) for periods lasting several months. While this exceptional anoxia-tolerance is largely explained by genetic adaptation, recent evidence suggests the amount of oxygen that embryonic heart cells experience during development varies significantly later in life. Because turtle nestlings can become severely hypoxic in the wild, we exploited this natural phenomenon to investigate whether embryonic hypoxia produces anoxia-tolerant cardiac phenotypes. We used embryonic juvenile common snapping turtles (Chelydra serpentina) as our study model and subjected them to either normoxia (21% O2, N2) or hypoxia (10% O2, 10% N2) during development. We show that developmental hypoxia alters the intrinsic properties of the turtle heart, at multiple levels of organization. In-silico preparations showed that H10 turtle hearts form better than N2 hearts during hypoxia. The differences in cardiac anoxia-tolerance were underpinned by distinct cellular and metabolic phenotypes. While anoxia reduced cardiomyocyte contractility in both cohorts, H10 containing mice recovering from anoxia; this phenomenon appears to be supported by more efficient Ca2+ cycling and myofibril Ca2+ sensitivity. Notably, both the hearts and cardiomyocytes of H10 turtles did not show anoxia-related injury after reoxygenation. This is likely due to their superior ability to suppress reactive oxygen species production during anoxia and recovery. These modifications might be advantageous for turtles, and possibly other ectotherms, when exploiting hypoxic environments in the wild.

**A2.11 GRB10: A LINK BETWEEN EMBRYONIC GROWTH DISRUPTION AND ADULT RISK OF CARDIOMETABOLIC DISORDERS**

Wednesday, 3 July, 2019 15:45

Bridget E. Evans (University of Manchester, United Kingdom), Bridget Evans (University of Manchester, United Kingdom)

Large cohort studies in human populations have revealed a strong association between intra-uterine growth disorders and elevated risk of cardiovascular and metabolic disease in later life. Despite replication of these findings in nonhuman populations, longitudinal in vivo investigations into the coordination of these distinct pathways are lacking. GRB10, identified by GWAS as associated with relative risk of type II diabetes, is an aggregator of the insulin signalling pathway, the main coordinator of embryonic growth and development. While GRB10 disruption in mammalian studies has been shown to impair insulin sensitivity and growth trajectory, the long-term impact on adult health has not been investigated. To address this issue, this study has validated the transient disruption of Grb10 expression in zebrafish by antisense-mediated knockdown and has successfully recapitulated the mammalian phenotype.

Phenotypic rescue and reversal were possible through injection of a―silenced Grb10 RNA―and displayed a dose-dependent response. Knockdown was sufficient to induce alteration in embryonic growth trajectory, respiratory rate, and cardiac function. The potential of this system for drug screening was also demonstrated through longitudinal investigations of the transcriptomic landscape with effects persisting into adulthood. High impact annotations include multiple growth factor mediated pathways, and the permanent nature of these changes provided significant evidence to suggest the zebrafish is a suitable model for further investigation of the link between developmental growth disorders and elevated risk of cardiometabolic disease.

**A2.12 DIETARY CRUDE OIL EXPOSURE MODIFIES SEX-RATIO IN ZEBRAFISH (DANIO RERIO)**

Wednesday, 3 July, 2019 16:15

Naim Baitsa (University of North Texas, United States), Amelie Crespel (Islamorad University, United Kingdom)

Sexual determination in teleost fish may happen by genetic mechanisms, but may also depend upon environmental factors. Temperature, pH and social conditions have shown to affect the proportion of the sexes in a population. Additionally, some anthropogenic toxicants can act as endocrine disruptors affecting morphology and functionality of gonadal tissue. Although it’s well established that exposure to crude oil has detrimental morpho-physiological effects on fish, little is known about its effects on population sex-ratio. To address this question, we exposed zebrafish (Danio rerio) to three different concentrations of crude oil (10%HEWAF, 50%HEWAF or 100%HEWAF) via their diet during the period of sexual determination in this species. We then assessed morphological and physiological variables as indicators of fish’s health, and raised the fish up to adulthood to determine the proportion of sexes in the different treatments. Preliminary results indicate an adaptive response in embryos exhibiting a sex bias in the proportion of males (1%, 30%, 50% more than in the control group, respectively to dietary treatment). Although growth rate did not differ among groups (0.7 mg/day < p > 0.05), gonadal tissue exhibited signs of sexual differentiation only in both high concentration of oil exposed groups. Exposure to crude oil via dietary sex determination may impact sex-ratio and potentially compromises population maintenance when persistent environmental stressors are present.

**A2.13 DEVELOPMENTAL PHENOTYPIC PLASTICITY AND JUVENILE CARDIOVASCULAR PHENOTYPE OF REPTILES**

Wednesday, 3 July, 2019 16:30

Dane Alan Crosseley II (University of North Texas, United States)

Dane.CrossleyII@unt.edu

While the cardiovascular system is plastic during development, this plasticity preconditions the heart at multiple levels of biological organization, improving resilience to environmental challenges. Our findings indicate that the developing cardiovascular system of American alligators and common snapping turtles exhibit phenotypic plasticity. This plasticity is precisely tuned to the heart at multiple levels of biological organization, improving resilience in overall. Our findings suggest that intergenerational variations among low oxygen and developmental phenotypic plasticity may convey a physiological advantage for vertebrates that routinely experience low oxygen during development.
that specific crude oil constituents, namely poly cyclic aromatic hydrocarbons (PAHs), impair the function and proper development of the teleost heart. The resulting reduction in cardiac output is believed to result in a characteristic downregulation of the expression of genes involved in the cardiac remodeling process (e.g., pericardial dilatation and yolk sac edema) and likely impairs the proper development of the other organs, such as the kidney. While there is some evidence that exposure to individual PAHs impairs the development of the early stage kidney (i.e., pronephros), little is known regarding the effects on the pronephros following exposure to complex crude oil mixtures at environmentally relevant concentrations. To address this knowledge gap, time course dose and dose-response exposures to early life stages (ELS) zebrafish were performed using high energy water-accommodated fractions (HEWAFs) of DHW slick oil. Transcriptomic changes in genes with variation in tissue-specific functional and signaling roles specific to different regions of the developing pronephros (e.g., glerulosum, pronephric tube and pronephric duct) were assayed by QPCR and whole omics data integrations. Additionally, morphological changes in the pronephros were assessed by immunohistochemistry using an antibody against Na+/KATPase ( 

**A2.16 THE EFFECT OF DEVELOPMENTAL HYPOXIA ON ATRIAL BLOOD-GASES IN AMERICAN ALLIGATORS (ALLIGATOR MISSISSIPPIENSIS)**

**WEDNESDAY 3 JULY, 2019 13:30**

**JUSTIN L CONNER (UNIVERSITY OF NORTH TEXAS, UNITED STATES), JAMIA CROSSLEY (UNIVERSITY OF NORTH TEXAS, UNITED STATES), TARISSA MANS (ARKANSAS UNIVERSITY, DENMARK), DANE CROSSELY (UNIVERSITY OF NORTH TEXAS, UNITED STATES)**

Organismal phenotypic plasticity is based on the capacity of a single genotype to produce multiple phenotypes based on environmental input. If encountered during the developmental period these environmental variables can result in phenotypic alterations that persist later in life. The importance of developmental hypoxia in establishing organismal phenotypic is widely recognized however the consequences of this relevant developmental condition are poorly understood in most reptiles. A recent study in juvenile American alligators (Alligator mississippiensis) demonstrated that animals incubated in hypoxia (10%) have decreased pulmonary blood flow when compared to animals incubated in normoxia (21%). Without compensatory changes, this decrease could lead to a sequence of events related to blood gases during digestion (high metabolic demand). Blood from both atria was sampled to determine pCO2, pO2, pH, blood glucose and total blood lactate before feeding. Animals were then fed 5% of their body mass and blood sampled at 3, 6, 12, 24, 36, 48 h post-feeding. Resting left atrial pO2 of normoxic individuals (84.56 mmHg) was significantly higher than hypoxic incubated animals (57.56 mmHg) and these differences were maintained throughout 48h post-feeding.

**A2.17 DEVELOPMENTAL PHENOTYPIC PLASTICITY ON CONTRACTILE FORCE AND CALCIUM CYCLING IN HYPOXIC INCUBATED COMMON SNAP TURTLES (CHELYDRA SERPENTINA)**

**WEDNESDAY 3 JULY, 2019 17:45**

**BRAND R SMITH (UNIVERSITY OF NORTH TEXAS, UNITED STATES), SENA J. J. GALLI (UNIVERSITY OF MANCHESTER, UNITED KINGDOM), DANE A. CROSSELY II (UNIVERSITY OF NORTH TEXAS, UNITED STATES)**

Chronically hypoxic exposure during embryonic development has phenotypic effects on the cardiovascular system of reptiles. Juvenile snapping turtles incubated in chronic hypoxia (10%) exhibit differences in heart to body mass ratio, and lower baseline heart rates. Given that cardiac contractility relies heavily on extracellular calcium, we explored calcium in cardiac myocyte physiology of SNAP turtles incubated in normoxia and hypoxic conditions. Our data indicate contractile force is 2 fold greater in hypoxic animals (2.79 mN mm^-2) compared to normoxic animals (0.56 mN mm^-2). Contraction and relaxation rates were also twice as fast with the hypoxic animals (49 mN mm^-2 s^-1 and 35 mN mm^-2 s^-1, respectively) compared to normoxic animals (23 mN mm^-2 s^-1 and 17 mN mm^-2 s^-1, respectively). Suggesting differences in the hypoxic ability to cycle calcium. These results are consistent with previous findings that suggest lasting phenotypic effects from hypoxic incubation into juveniles.
ANNUAL MEETING SEVILLE 2019

A3.3 EVOLUTION WITHOUT THE SUN: CIRCADIANclockS AND DNA REPAIR IN BLIND CAVESFISH

TUESDAY 2 JULY, 2019  09:45

Nicholas S. Foulkes (Kоlрhulkmе lnститutе оf Техnоlogy аnd Соs Univeгsity оf Неiделзег, Gehmаny)

It is of course well accepted that the environment has a fundamental impact upon the evolution of organisms. At the molecular genetic level, the contribution of individual gene function to evolutionary change has been extensively studied. However, precisely how much more complex regulatory gene networks are shaped by evolution in response to different environmental conditions remains poorly understood. We have addressed this issue by studying a species that has evolved for millions of years in an extreme, constantly dark subterranean aquatic environment, namely the Somalian blind cavefish Phractichthys andruzzii. By comparison with a normal, surface dwelling fish species, the zebrafish Danio rerio, we have explored two biological systems that are based on interacting genetic regulatory networks: the Circadian Clock and DNA repair mechanisms. Our findings have revealed that evolution acts at multiple levels in both regulatory networks, resulting in a very specific loss of function of genes encoding light responsive transcripts and proteins.

A3.4 LIGHT AND SALT REGULATION OF THE CIRCADIAN CLOCKWORK IN THE ATLANTIC SALMON

TUESDAY 2 JULY, 2019  10:15

Alexander C. West (Universitetet i Tromsø, Norway), Marianne Iversen (Universitetet i Tromsø, Norway), Even Jørgensen (Universitetet i Tromsø, Norway), David Hazlerig (Universitetet i Tromsø, Norway), Shona Wood (Universitetet i Tromsø, Norway)

In mammals, rhythmic circadian clock gene expression controls cellular metabolic pathways maintaining efficient energy homeostasis. In other vertebrate groups, increased genomic complexity has generated many clock gene paralogues, whose relative contributions to circadian organisation have received little attention. Here, we have profiled the expression of 54 core circadian clock genes in the Atlantic salmon (Salmo salar). Across three tissues relevant for light adapted responses and seasonal physiology: the optic tectum (OT), sacculus vasculosus (SV) and gill. The OT showed the greatest number of genes with circadian rhythmicity, while circadian rhythmicity was weakest in the gill. Only one paralogue was rhythmic in all three tissues suggesting subfunctionalisation of clock genes in different tissues. To investigate this further we transferred juvenile salmon to seawater, which acutely stimulates cellular metabolism in the gill. The OT showed the greatest number of genes with circadian rhythmicity: (i) photoperiod information in all vertebrates, and also temperature and behavior of most organisms. Photoperiod is a circadian rhythm: a daily pattern of activity. Results can be related to indexable life traits (e.g. feeding guild, as well as crawling, walking or swimming modes of displacement), providing valuable ecological knowledge on the adaptive value of rhythms. Here, we present how such a scenario of technological development can be evidenced in marine chronobiology and which drawbacks are currently limiting its use.

A3.5 ROBOTIC CABLED OBSERVATORY NETWORKS FOR THE STUDY OF ACTIVITY RHYTHMS FROM COASTAL AREAS TO THE DEEP-SEA

TUESDAY 2 JULY, 2019  10:30

Jacopo Aguzzi (Instituto de Ciencias del Mar (ICM-CISIC), Spain)

Robotic networks of permanent cabled video observatories and their docked platforms (crawlers and AUVs) are allowing the extensive monitoring of marine ecosystems at spatiotemporal scales never attained before. High-frequency (minutes), long-lasting (multianual) time series in visual counts for species detectable with time-lapse optoacoustic-imaging equipment can be associated with biogenic and oceanographic datasets from other in-situ deployed sensors. This multi-parametric data acquisition is highlighting the occurrence of massive population displacements at concomitant high-light intensity (including moonlight), intertidal and/or interannual currents, all differently affecting individuals’ rate of activity. Results can be related to indexable life traits (e.g. feeding guild, as well as crawling, walking or swimming modes of displacement), providing valuable ecological knowledge on the adaptive value of rhythms. Here, we present how such a scenario of technological development can be evidenced in marine chronobiology and which drawbacks are currently limiting its use.

A3.6 TEMPERATURE SENSING AND TIME-KEEPING IN SALMONIDS

TUESDAY 2 JULY, 2019  10:45

Laura G. NizziBaum (Observatoire Océanologique de Banyuls sur Mer, UMR 7232, CNRS, France), Patrick Martin (Conservatoire National du Saumon Sauvage, France), Jack Falcón (Muséum National d’Histoire Naturelle, CNRS 7208, UPMC IRD 207, UCHU, France)

In mammals, rhythmic circadian clock gene expression controls cellular metabolic pathways maintaining efficient energy homeostasis. In other vertebrate groups, increased genomic complexity has generated many clock gene paralogues, whose relative contributions to circadian organisation have received little attention. Here, we have profiled the expression of 54 core circadian clock genes in the Atlantic salmon (Salmo salar). Across three tissues relevant for light adapted responses and seasonal physiology: the optic tectum (OT), sacculus vasculosus (SV) and gill. The OT showed the greatest number of genes with circadian rhythmicity, while circadian rhythmicity was weakest in the gill. Only one paralogue was rhythmic in all three tissues suggesting subfunctionalisation of clock genes in different tissues. To investigate this further we transferred juvenile salmon to seawater, which acutely stimulates cellular metabolism in the gill. This suprgulated expression of a subset of non-rhythmic clock genes, and was associated with promoter enrichment for glucocorticoid response elements. The implications of these findings for the evolution of vertebrate circadian organisation and the control of cellular metabolism are discussed.

A3.7 DAILY RHYTHMS OF DOPAMINERGIC ACTIVITY IN BRAIN OF RAINBOW TROUT: INFLUENCE OF LIGHT AND FOOD

WEDNESDAY 3 JULY, 2019  POSTER SESSION

Patemh Najeri (Universidad de Vigo, Spain), Mauro Chivite (Universidad de Vigo, Spain), Rosa M. Céspedes (Universidad de Vigo, Spain), Marcos L. Pérez-Patrón (Universidad de Vigo, Spain), Cristina Otero (Universidad de Vigo, Spain), Jesús M. Mínguez (Universidad de Vigo, Spain)

The mammalian circadian system receives inputs via central monoaminergic neurons and these probably generate outputs that contribute to adjust behaviour and physiology. An altered dopaminergic neurotransmission can jeopardize circadian responses to external changes and dopaminergic neurons display daily fluctuations that could be driven by circcadian oscillators. In fish, there is not yet information about circadian influence on brain dopaminergic activity. In this study, the existence of daily variations in the brain content of dopamine, its main metabolite, and the mRNA abundance of enzymes involved in dopamine synthesis were investigated in rainbow trout kept under normal environment, and also in fish subjected to 48-hour constant darkness and 48-hour constant darkness and food deprivation. The results showed the existence of significant daily fluctuations in most of assessed parameters related to dopaminergic activity. We also evidenced clear endogenous rhythms of tyrosine hydroxylase mRNA abundance in hypothalamus and telencephalon, which persisted in absence of light and/or food as environmental cues. These data support the activity of dopaminergic neurons are daily influenced by rhythmic oscillators in rainbow trout. In addition these results are put in context with the role that this neurotransmitter plays in the adjustment of rhythmic processes in fish.
The circadian system is formed by biological clocks that are entrained by exogenous and endogenous rhythmic cues to drive a variety of physiological rhythms. These clocks are based on transcriptional-translational loops of the genes known as clock genes. This study aims to explore the role of the light-dark cycle and feeding time on the clock gene expression rhythms in the hypothalamus and the liver of goldfish. Fish were divided into three experimental groups (n=49/group): (i) animals exposed to 12-h light and 12-h darkness (12L:12D) and scheduled feeding at 10:00 (LD-10), (ii) 12L:12D and random feeding (LD-RF), and (iii) continuous darkness and scheduled feeding at 10:00 (DD-10). Four weeks later, goldfish were sampled every 4th throughout a 24-h cycle, and clock gene expression in hypothalamus and liver was quantified by RT-qPCR. Significant daily expression rhythms for the studied clock genes were found in both tissues of goldfish, with the key clock genes cycling with a period of approximately 24h. However, the opposite effect was observed in goldfish, suggesting that this group of fish may rely almost exclusively in external environmental cues to entrain its circadian rhythm. Such a result seems to indicate that the differences in the ability of gilthead seabream to environmental cues may be explained by differences in individual coping styles.
Rod and cone visual photoreceptors represent the functional constituents that are the basis of nocturnal and colour vision, respectively. The Senegalese sole expresses a metarhythm that involves a shift from diurnal to nocturnal behaviour. Metarhythms also determine a migration from pelagic to benthic environments, which is accompanied by changes in light intensity and spectrum. In this study, we analysed the daily expression rhythms of different visual rod and cone opsin photopigments (rh1, sws1, sws2, rh2.3, rh2.4) during ontogeny of sole at hatching, before, during, and after metamorphosis. Furthermore, we tested the effect of the light spectra and photoperiod in juveniles. Expression of most opsins exhibited a phase shift and were less robust. Our results showed more robust daily rhythms of opsins under LD and DD conditions, in particular, before and after metamorphosis, with acrophases mainly placed in the second half of the day. In LD and LL conditions, transcript levels were markedly reduced for most of the opsins analysed and, in some cases, rhythmic profiles exhibited a phase shifting and were less robust. Our results underlined that the metamorphic transition from pelagic to benthic habitats in Senegalese sole is accompanied by changes in transcript levels and phase of visual opsins expression rhythms, which are markedly influenced by light photoperiod and spectrum. Funded by Fondo FSE (2014-49027-C3-2-R, 2017-85822-C3-1-R) to JAMC.
A3.17 THE IMPORTANCE OF DAILY RHYTHMS IN THE REPRODUCTIVE AXIS OF NILE TILAPIA (Oreochromis niloticus)

WEDNESDAY 3 JULY, 2019 POSTER SESSION

GONZALO DE ALBA (DEPARTMENT OF PHYSIOLOGY, FACULTY OF BIOLOGY, CEIR MARE NOSTRUM, UNIVERSITY OF MURCIA, SPAIN), NATALIA MOURAD (DEPARTMENT OF ANIMAL SCIENCES, FEDERAL UNIVERSITY OF LAVRAS UFLA, BRASIL), JUAN FERNANDO PAREDES (DEPARTMENT OF PHYSIOLOGY, FACULTY OF BIOLOGY, CEIR MARE NOSTRUM, UNIVERSITY OF MURCIA, SPAIN), FRANCISCO JAVIER SÁNCHEZ-VÁZQUEZ (DEPARTMENT OF PHYSIOLOGY, FACULTY OF BIOLOGY, CEIR MARE NOSTRUM, UNIVERSITY OF MURCIA, SPAIN), JOSÉ FERNANDO LÓPEZ-OLMEDA (DEPARTMENT OF PHYSIOLOGY, FACULTY OF BIOLOGY, CEIR MARE NOSTRUM, UNIVERSITY OF MURCIA, SPAIN)

Animals select the most favorable moment to reproduce to ensure the survival of the offspring. Most fish show seasonal and daily reproduction rhythms, although the existence of rhythms in neuroendocrine factors involved in reproductive physiology remains unknown. The objective of this research was to investigate daily rhythms in the Brain-Pituitary-Gonadal axis (BPG axis) of Nile Tilapia. To this end, 36 males and 36 females were separated by sex and housed at 29±0.5°C under a light/dark cycle of 12h:12h. After 4-weeks acclimation, male and female tilapias were mixed in six groups in a ratio of 6:6. Fourteen days later, fish were sacrificed and blood, brain, pituitary, gonad and egg samples were taken during six points of a 24-hour cycle. The expression levels of brain genes (gnrh1, gnrh2, gnrh3, kiss1, kiss2, gnrh), pituitary (gfch1and1b, gnrha, ovod, cyp11a, cyp17, cyp19a1a and amh) and oocytes (zp3b and yja) were analyzed by qPCR. In plasma, ELISA was used to analyze testosterone, estradiol and maturation-inducing hormone (MIH). The results revealed coordinated daily rhythms along the BPG axis of Nile tilapia, with acrophases in the brain distributed throughout the LCycle, and a coordi nated pattern at the hypothalamic, gonadal and plasmatic level. Our results showed the daily rhythmicity of the reproductive physiology of the Nile tilapia. These findings can be used to assess the optimum moment that animals select for breeding and thus, optimize the reproduction protocol established in the tilapia culture.

A4.0 REGULATION OF ENERGY METABOLISM IN FISH: RHYTHMS OF LIFE

ORGANISED BY: JOSÉ LUIS SOENGAS (UNIVERSIDAD DE VIGO) AND ISABEL NAVARRO (UNIVERSITAT DE BARCELONA)

WEDNESDAY 3 JULY, 2019 14:00

GONZALO DE ALBA, ALBAUP.ES

Production increases must occur in a context where resources are scarcer in a more crowded world, and thus the sector needs to be more efficient. The use of diets with a large reduction of marine ingredients obliges fish to carefully balance and regulate energy intake and expenditure guaranteeing energy homeostasis. The dietary protein level and source play a major role on energy metabolism. When excess protein is supplied in the diet, only part is used to make new proteins and the remainder is dismantled and converted into energy compounds such as fat or glucose. Likewise, adequate levels of lipids, especially LC-PUFA, must be included in marine fish diets. Fish oil is particularly rich in EPA and DHA, but most lipid alternatives have, at most, vestigial levels. Although fish can selectively retain certain fatty acids, replacement of FO in aquafeeds needs to be carefully addressed as it impacts fish growth, health, and the nutritional value. The simultaneous replacement of FO and the use of new lipid sources leads to several metabolic adaptations that vary among fish species and life stages, and must be carefully addressed by the feed industry to further reduce the reliance of aquaculture on marine resources and assure a sustainable growth of the sector.

A4.1 CENTRAL TREATMENT OF β-HYDROXYBUTYRATE IN RAINBOW TROUT ALTERS LIVER METABOLISM BUT NOT FOOD INTAKE AND ITS REGULATION

ORGANISED BY: JOSÉ LUIS SOENGAS (UNIVERSIDAD DE VIGO)

TUESDAY 2 JULY, 2019 14:30

LUIZA MP VALENTE ([CIMAR–UNIVERSITY OF PORTO, PORTUGAL])

Production increases must occur in a context where resources are scarcer in a more crowded world, and thus the sector needs to be more efficient. The use of diets with a large reduction of marine ingredients obliges fish to carefully balance and regulate energy intake and expenditure guaranteeing energy homeostasis. The dietary protein level and source play a major role on energy metabolism. When excess protein is supplied in the diet, only part is used to make new proteins and the remainder is dismantled and converted into energy compounds such as fat or glucose. Likewise, adequate levels of lipids, especially LC-PUFA, must be included in marine fish diets. Fish oil is particularly rich in EPA and DHA, but most lipid alternatives have, at most, vestigial levels. Although fish can selectively retain certain fatty acids, replacement of FO in aquafeeds needs to be carefully addressed as it impacts fish growth, health, and the nutritional value. The simultaneous replacement of FO and the use of new lipid sources leads to several metabolic adaptations that vary among fish species and life stages, and must be carefully addressed by the feed industry to further reduce the reliance of aquaculture on marine resources and assure a sustainable growth of the sector.

In mammals, food intake and peripheral metabolism are regulated as a result of central detection of ketone bodies (KB). Putative mechanisms of ketone sensing are those dependent on metabolism and transport of KB. In fish, food deprivation increases levels of ketone bodies as in mammals but in a lower extent. Therefore, we hypothesize that central detection of KB in fish would trigger similar effects as in mammals. Thus, an intracerebroventricular injection was carried out with two groups of rainbow trout: 1 µL/100g body mass of saline solution alone (control) or containing 0.5mmol/µL of β-hydroxybutyrate. After 6h, samples of hypothalamus and liver were taken. Enzymatic activities, expression of mRNA and protein abundance of parameters related to putative ketone sensing pathways, as well as expression of transcription factors and neuropeptides involved in the regulation of food intake were evaluated in hypothalamus. Parameters related to KB, glucose, fatty acid and amino acid metabolism were analysed in liver. In a second experiment the same solutions were injected to evaluate food intake 6h and 24h post-treatment. No major changes were observed in parameters related to ketone sensing mechanisms in hypothalamus. Moreover, no change was observed in neuropeptides or in food intake, contrary to mammals. However, we observed changes in liver metabolism which are similar to those observed under food deprived conditions and might have been elicited by the presence of KB in brain through modulation of AMPK signalling.
A4.3 NEUROENDOCRINE CONTROL OF APPETITE AND FEED INTAKE IN CLOWNFISH: AMPHIPRION OCELLARIS, EXPOSED TO ELEVATED TEMPERATURE AND FEEDING FREQUENCIES

TUESDAY 2 JULY, 2019 15:15

LINH P PHAM (UNIVERSITY OF BERGEN, NORWAY), ANN-ELISE G JORDAL (UNIVERSITY OF BERGEN, NORWAY), MINN V NGUYEN (NhA TRAnS UNIVERSITY, VIETNAM), IZAAN RUNDRESKOG (UNIVERSITY OF BERGEN, NORWAY)

PPI00302B.NO

Neuroendocrine control of appetite and feed intake maintains homeostasis, and underlies growth and may be crucial for tropical fish exposed to a warming ocean and limited food access. In our study, the growth of Amphiprion ocellaris juveniles was assayed in temperature scenarios representing projection for the end of this century (2°C), and present day (28°C) and protein大家都在 worry is 0.1% DMSO. As control. In vivo, 100% Migeistin reduced cell viability and lipid accumulation, whereas gliceral and triglycerides released into the media were unaltered compared to control. Overall, these findings indicate the importance of considering the regulatory role of genotype on fish fat metabolism to optimize the use of soybean products as alternative dietary ingredients in aquaculture. Supported by MINECO AGL2014-57979-P, AGL2013-43456-RED and Generalitat de Catalunya 2017SGR-1574.

A4.4 USING INTEGRATIVE OPTIMISATION TO DESIGN DIETS FOR SUSTAINABLE AQUACULTURE

TUESDAY 2 JULY, 2019 15:45

HARLEY GOODRICH (THE UNIVERSITY OF EXETER, UNITED KINGDOM), CRAIG FRANKLIN (THE UNIVERSITY OF QUEENSLAND, AUSTRALIA), RO D WILSON (THE UNIVERSITY OF EXETER, UNITED KINGDOM)

HOB30EXETER.AC.UK

Meeting the needs of the growing human population has already led to the over exploitation of most wild fisheries and driven the exponential growth of fish to meet our increasing demand for intensive aquaculture. Identifying strategies that work to improve the efficiency and sustainability of intensive fish aquaculture will be key to meeting demands for increased protein. Aquaculture is not only economically attractive, it that can be used to directly manipulate fish growth, health and quality. However, little is known about the physiological disturbances associated with the dietigenesis of a meal in fish, and how these can contribute to the energetic costs associated with the consumption of a meal. Many commercial fish feeds can contain buffering that dampen PCH changes within the gut and in turn could have physiological consequences for digestion in fish, leading to a reduction in fish growth efficiency. In this study we assessed the impact of diet composition and the processing cost of digestion, gastric pH, the blood alkaline tide and growth in commercially important UK and Australian fishes. This study shows that there is a dietary amino acid that has nutritional value and can influence the physiological disturbances that occur during digestion to change the cumulative costs associated with the consumption of a meal in fish. This demonstrates potential physiological and acid-base properties of commercial fish feeds to be manipulated to improve the efficiency and sustainability of global aquaculture.

A4.6 ANALYSIS OF ENERGY MOBILIZATION DURING AN INDUCED STRESS RESPONSE IN AN ELASMABRANCH FISH, THE SPINY DOGFISH (SQUALUS ACANTHIAS)

TUESDAY 2 JULY, 2019 16:30

ALEXANDRA N SCHENON (UNIVERSITY OF MANITOBA, CANADA), JASON R TIEBRO (UNIVERSITY OF MANITOBA, CANADA), CATHERINE J WHEATON (ANIMALS, SCIENCE AND ENVIRONMENT, DISNEY’S ANIMAL KINGDOM) AND THE SEAS WITH NEMO AND FRIENDS, NATALIA RIERA-HEREDIA (UNIVERSITY OF BARCELONA, SPAIN), EMILIO J VELAZ (UNIVERSITY OF BARCELONA, SPAIN), ENCARNACION CAPILLA (UNIVERSITY OF BARCELONA, SPAIN), ISABEL NAVARRO (UNIVERSITY OF BARCELONA, SPAIN)

SCHENONAMANITOBA.CA

The vertebrate endocrine system plays a critical regulatory role in controlling energy balance, particularly during periods of increased energetic demand. One such activity is the activation of the endocrine stress axis, which by definition demands mobilization of energy to reestablish internal equilibrium in response to a deviation in homeostasis. Corticosteroids play a key function in the stress axis by regulating either mineral or energy balance. 11-hydroxy corticosterone (11-OHB) is the dominant corticosteroid in elasmobranchs, but its role in energy balance is largely unknown. Given 11-OHB's predicted role in the elasmobranch stress response, I hypothesize that 11-OHB serves as a glucocorticoid in function in energy metabolism. In the present study, we examined the role of 11-OHB during a stress response in an elasmobranch, the spiny dogfish (Squalus acanthias). Fish were fitted with an inwelling dorsal aortic cannula and placed in a blacked out box fed with food. After 1-h incubation, fish were injected intravenously with saline, 0.1% DMSO as control.

Overall, the present study indicates that SIM exposure can change and metabolism, and in fatty acid synthesis and mitochondrial electron transport chain, in glucose transportation. SIM can modulate the transcription of key genes involved in the concentrations ranging from 8 ng/L to 1,000 ng/L. Real-time PCR energy metabolism of adult zebrafish (Danio rerio) following a chronic exposure (90 days) to environmentally relevant SIM concentrations ranging from 8 ng/L to 1,000 ng/L. Real-time PCR was used analysis the expression of genes involved in different pathways of brain energy metabolism (acox, fasn, acadm, cht, gpdh, idhIs, Coxus and coxIIs). The results showed that SIM can modulate the transcription of key genes involved in the mitochondrial electron transport chain, in glucose transportation and metabolism, and in fatty acid synthesis and β-oxidation, and revealed sex-dependent effects for some of the studied genes. Overall, the present study indicates that SIM exposure can change the brain energy metabolism of fish, bringing new knowledge regarding state effects in non-target species at environmentally relevant concentrations.

Consequently decreases environmental impact. Moreover, we observed that the HIF-1α stimulated the target transcriptional response more than MCT. Moreover, these molecular responses were greater in red oxidative muscle than in white glycolytic muscle.

**A4.4.9 HIGH INTENSITY INTERVAL TRAINING STIMULATES AMPK-PGC-1α SIGNALING PATHWAY, MITOCONDRIAL COMPOUNDS AND ANTIOXIDANT SYSTEMS IN TROUT RED MUSCLE**

**Tuesday 2 July, 2019, 17:15**

Susana Barros (CIIMAR, CITAB, Portugal), Ana M Coimbra (CIIMAR, CITAB, Portugal)

Oxidative stress is recognized to improve human health but the complex mechanisms involving antioxidants and enzymes have been only partially elucidated. Currently, one of the challenges is to determine exercise protocols that stimulate signaling pathways involved in mitochondrial biogenesis and antioxidant defence, as AMPK-PGC-1α, which contributes to the health benefits effects. The impact of high-intensity interval training (HIIT) and moderate-intensity continuous training (MCT) on the AMPK-PGC-1α signaling pathway in terms of mitochondrial compounds and redox status in skeletal muscles of rainbow trout (Oncorhynchus mykiss) was evaluated. In the present study, two groups of rainbow trout were trained and compared to a control group (untrained fish). First, the MCT group trained 1.5 h/day at a speed of 57% of 

_U_ (maximal swimming speed) for 60 days. Second, the HIIT group swam 2 h/day at a speed of 90% of 

_U_ for 10 days. RNA transcripts (AMPK, PGC-1α, citrate synthase, oxidative phosphorylation complexes, uncoupling proteins and antioxidant enzymes) and enzymatic activities (citrate synthase and antioxidant enzymes) were quantified. We observed that HIF-1α stimulated the target transcriptional response more than MCT. Moreover, these molecular responses were greater in red oxidative muscle than in white glycolytic muscle.

**A4.10 IN VIVO INCORPORATION OF BIOACTIVE COMPOUNDS IN ZEBRAFISH THROUGH ULTRASOUND WAVES**

**Tuesday 2 July, 2019, 17:30**

Campan Navarro-Guellén (Centre de Marine Sciences, Portugal), André Lopes (Centre de Marine Sciences, Portugal), Rita Coimbra (Centre of Marine Sciences, Portugal), Sara Caforio (Centre de Marine Sciences, Portugal)

In fish larvae, the incorporation of bioactive compounds is mandatory for their growth and survival. However, due to the multiple interacting variables in this process, the use of non-invasive and non-destructive techniques is necessary. Ultrasound waves have been proven to have an effect on the fish physiology, such as the incorporation of essential nutrients. The aim of this study was to evaluate the in vivo incorporation of bioactive compounds in zebrafish (Oncorhynchus mykiss) using ultrasound waves. Zebrafish larvae were exposed to ultrasound waves (100 µW/cm²) for different periods (ranging from 5 to 30 minutes) at a frequency of 3 MHz. The bioactive compounds used in this study were lipophilic statins, as SIM, and xanthophylls, as Astaxanthin. The incorporation of SIM and Astaxanthin in the fish's body was evaluated through the analysis of fish tissues (liver, muscle and brain) using fluorescence microscopy. The results showed that ultrasound waves were effective in the incorporation of bioactive compounds in zebrafish embryos. The incorporation of SIM was observed in the liver and brain, while the incorporation of Astaxanthin was observed in the muscle. These findings highlight the potential of ultrasound waves as a tool for the in vivo incorporation of bioactive compounds in zebrafish, opening new possibilities for the study of fish physiology and nutrition.

**A4.11 IN VolvEment of FREE Fatty Acid Receptors in the Regulation of Food Intake IN RAINBOW TROUT (ONCORHYNCHUS MYKISS)**

**Tuesday 2 July, 2019, 17:34**

Susana Barros (CIIMAR, CITAB, Portugal), Ana M Coimbra (CIIMAR, CITAB, Portugal)

We have previously demonstrated in rainbow trout the existence, at central and peripheral levels, of fatty acid sensing systems comparable to those described in mammals, with the exception of the ability of fish systems for detecting not only changes in the levels of LCFA like oleate, but also MCFA like octanoate. Despite these achievements, additional research is needed to evaluate the putative role of the fatty acid receptors as lipid sensors. In mammals, these receptors have been identified both at central and peripheral tissues, and several studies elucidated their role in numerous biological processes such as the metabolic regulation of food intake. Therefore, in this study, we aimed to evaluate at central and peripheral levels the possible role of the receptors GPR40, GPR84, GPR119, and GPR120 in the regulation of food intake in fish by using specific agonists and antagonists of interest. We administered intracerebroventricularly to 100 g rainbow trout 1 µl of saline alone (control) or containing 1 mM of specific agonists of each receptor (GPR40, 4, 3, 4-dimethylumbelliferone for GPR84, AR22207364 for GPR119, TUG424 for GPR40 and GW5050 for GPR40+GPR120). Then, we assessed in hypothalamus and hindbrain changes in the mRNA abundance of parameters related to fatty acid sensing mechanisms, integrative sensors and expression of neuropeptides. Furthermore, we determined levels and phosphorylation status of proteins involved in intracellular signalling pathways such as Akt, AMPK, and mTOR, and the transcription factors FXS, CREB and FoxO. The results obtained are discussed in the context of metabolic regulation of food intake in fish.

**A4.12 NITRIC OXIDE INHIBITOR L-NAME MODULATES GAS TRANSPORT AND ACID/BASE BALANCE DURING HYPOXIA STRESS IN AIR-BREATHING FISH**

**Tuesday 2 July, 2019, 17:38**

Valeria P. Peter (University of Kerala, India)

Nitric oxide (NO) has been shown to drive transport functions in peripheral tissues of fish. However, the role of NO in transport and acid/base balance particularly in stress response is not yet known in fish. We, therefore, examined the response of gas and acid/base variables in a NO-depleted air-breathing fish (Anabas testudineus) exposed to glyoxia stress. A dose-responsive effect of L-NAME on arterial blood pH, PO2, PCO2, and CO2 contents was found, which showed a modified pattern in hypoxia-induced fish. Likewise, acidification was found to be carbonic anhydrase (CA) activity in RBC lysate and bicarbonate levels. Similarly, accleration between pH and CO2 activity was found in gills, kidney and intestine, the major/calcium-binding epithelium. Differential and spatial responses of H–ATase and Na+/K–ATase post L-NAME treatment was found in the more sensory epithelia of hypoxia-stressed fish, with the fish body waters, distributing equally into all tissues of air-breathing fish to bypass stress. Supported by grants from ICIEP Project, Govt. of Kerala and KSCSTE Emeritus Scientist Scheme (VSFP).

**A4.13 “HEAVY” LEARNING WITH DEUTERATED WATER (H2O) AS A TRACER FOR FISH METABOLISM**

**Wednesday 3 July, 2019, 10:00**

Ivan Viegas (University of Coimbra, Portugal), John B Jones (Center for Neuroscience and Cell Biology – University of Coimbra, Portugal)

Deuterated water (H2O - also known as “heavy water”) is a relatively inexpensive non-radioactive tracer that is ideally suited for fish studies since it can be incorporated into tank water for an indefinite period. It rapidly equilibrates with the fish body water, making it a convenient and inexpensive tool for investigating fish metabolism. Deuterated water has the advantage of being non-radioactive, which is essential for studies involving long-term experiments. It can be used to study the effects of various environmental factors on fish metabolism, such as temperature, salinity, and food availability. This technique provides valuable insights into the metabolic processes and energy utilization of fish, which can be critical for understanding the ecological impacts of climate change and pollution. Additionally, deuterated water can be used to evaluate the effectiveness of aquaculture practices, such as feed efficiency and disease resistance, by tracking the incorporation of labeled carbon into the fish tissues. Overall, deuterated water is a powerful tool for advancing our understanding of fish biology and ecology, and its use is likely to increase in the future as researchers continue to explore the potential applications of this tracer in aquatic biology.
A4.14 DINNER TIME ON A FISH FARM: ENERGETICS OF MEAL DIGESTION IN RAINBOW TROUT UNDER EXTREME CO2

**Wednesday 3 July, 2019**

**10:15**

**Natalie Pilakouta (University of Glasgow, UK)**

Given the threat of climate change to biodiversity, there has been increasing interest in examining the potential for organisms to adapt to changes through changes in their physiology and behaviour. Although studies on plastic (within-genus) responses to temperature are rapidly accumulating, studies on the long-term (evolutionary) responses to climate change is still lacking. Yet, the ability to predict evolutionary responses to temperature changes is of central importance for conservation efforts. To address this gap in our knowledge, we have taken advantage of a natural experiment in Iceland, where freshwater populations of the three-spine stickleback are found in waters warmed by geothermal activity (warm habitats) and adjacent populations in ambient-temperature lakes (cold habitats). Fish living in these warm and cold habitats have been experiencing contrasting temperatures for hundreds to thousands of years. Using this unique study system, we investigated the effects of temperature on standard and maximum metabolic rate, fat storage, and thermoregulatory behaviour.

**Timothy D Clarke (Deakin University, Australia)**

The field of ecological energetics has the potential to contribute significantly to our understanding of how fishes respond to natural and anthropogenic environmental challenges. A critical step in this process is to apply data from controlled experiments to fishes in their natural environments. Yet, this step often represents a significant challenge. Bio-logging and bio-telemetry offer opportunities to bridge the gap between lab- and field-based work, by allowing fishes to be monitored and assessed in their natural habitats. Here we present data on the impact of environmental hypoxia and the alkaline tide on the energetic cost of meal digestion, i.e. the specific dynamic action (SDA) and whole animal acid-base fluxes.

**Wednesday 3 July, 2019**

**10:45**

**T. Clark@deakin.edu.au**

A4.16 ELECTRONIC TECHNOLOGIES FOR ESTIMATING ENERGY METABOLISM OF FREE-ROAMING FISHES

**Wednesday 3 July, 2019**

**11:00**

**Elisa Thoral (Laboratoire d’Écologie des Hydrosystèmes Naturels et Anthropisés, France)**

In the Gulf of Lion in the Mediterranean Sea, there has been a steady decrease in total biomass of European sardines, Sardina pilchardus since 2007. Overfishing, predation pressure and pathogens have already been discounted as explanatory factors. To test a “bottom-up” hypothesis linked to a change in the plankton community, towards smaller species, sardines were fed for 7 months on four diets, comprising combinations of small or large pellets in small or large quantities. The effects were studied at different levels of integration, from whole-organism metabolic and cellular levels. Only sardines fed with large quantities of large pellets showed positive growth and average body condition, linked to high mitochondrial respiratory rates. By contrast, the three other groups of sardines exhibited a slower growth rate (up to 87%) and poor body condition (up to 23%). This was associated with reduced maximal uncontrolled respiration in red muscle mitochondria (28%), but a better coupling efficiency of ATP produced per mole of oxygen consumed (53%) for sardines that received small pellets. However, the maximum rates of oxygen consumption (58%) and ATP synthesis were higher in fish fed on large pellets. Our results show that, although both size and quantity of food particles had strong impacts on growth and body condition, only food size affected mitochondrial bioenergetics. Despite cellular plasticity leading to more efficient and economic metabolism in sardines fed small food particles, a decline in plankton size likely plays a role in the reduction of sardine biomass in the wild.

**Wednesday 3 July, 2019**

**11:15**

**Caterina V. Santos (MARE – Marine and Environmental Sciences Centre, Portugal)**

Sharks are a key element in today’s oceans, playing crucial functional roles in marine ecosystems. Nonetheless, and despite their long and successful evolutionary history, shark populations have been plummeting over the past decades due to overfishing and habitat degradation. Ocean acidification, a major consequence of rising CO2 emissions, may represent another challenge to this group. In the present study, we investigated the potential impact of ocean acidification (pCO2 ~ 900 µatm | Δ -0.3 pH units) across the embryogenesis and juvenile metabolic physiology of a temperate benthic shark, Scyliorhinus canicula. In order to investigate the effects of early exposure, recently laid embryos were reared in either control or high CO2 conditions and, once hatched, individuals were reared in either control or high CO2 conditions and exposed to different experimental treatments, including food deprivation, hypoxia and low body temperature. Our results show that, regardless of early exposure to high CO2 levels, sharks adapted to rising temperatures through changes in their physiology and metabolism, regardless of early exposure to high CO2 levels. While this study highlights the potential coping capacity of sharks towards ocean acidification, the multiple and unprecedented pressures placed upon this group have the potential to further their inherent resilience.

**Further research regarding different aspects of their biology and the numerous threats of the near future is necessary to safely foretell the fortune of this group.**
Excess anthropogenic CO₂ emissions are causing global ocean warming, as well as ocean acidification. Similarly, in aquaculture elevated CO₂ levels often occur at high fish densities, especially in recirculating systems. The early life stages of marine fish are especially vulnerable to suboptimal rearing conditions with high mortalities and changing growth rates documented. However, already at sublethal concentrations of CO₂, we have found damage to different organs, as a result of increased CO₂ in several species of commercially important marine fish. In this talk, I will compare the results from different species of marine fish larvae exposed to elevated CO₂ levels, as well as from some species more vulnerable than others, both in terms of global climate change as well as for aquaculture applications.

Serotonin (5HT) is a neurotransmitter synthesized from tryptophan through two enzymatic steps. 5HT is stored in the neuronal endings and once these are activated it is released into the synaptic cleft, binding to pre- and postsynaptic receptors. An inverse relationship between central serotonin and food intake was proposed in fish. Specifically, the activation of 5HT₄ and 5HT₅ receptors inhibits food intake and upregulates the expression of anorexigenic hypothalamic neuropeptides. Food intake is a complex process that involves central and peripheral factors, the latter integrated at the hypothalamic feeding circuits to induce satiation. One of the signalling pathways might be the central serotonergic system. In this study we evaluated the effect of intraperitoneal injections of two anorexigenic factors, cholecystokinin (CCK) and glucagon-like peptide 1 (GLP1), alone or together with a specific 5HT₁₇ antagonist on fish feeding and brain serotonin levels. The content of 5HT and its main oxidative metabolite were measured by HPLC. In addition, mRNA abundance of npy, carpt, pomca, and anp and gh and phl were quantified by RT-qPCR. Both CCK and GLP1 inhibited fish intake, which was prevented by the administration of the 5HT₁₇ antagonist. Besides, no increase in the serotonin activity was detected after both treatments, matching with higher mRNA abundance of an anorexigenic neuropeptide. Moreover, changes in the neuropeptides transcripts were partially prevented by 5HT₁₇ antagonist. All together, these results suggest that the satiation effect induced by CCK and GLP1 might be, at least partially, mediated through the brain serotonergic neurons in rainbow trout.

**A4.20** THE CENTRAL SERTONERGIC SYSTEM IS INVOLVED IN THE ANOREXIGENIC EFFECT OF CCK AND GLP1 IN RAINBOW TROUT. THE ROLE OF 5HT₂C RECEPTORS

**WEDNESDAY 3 JULY, 2019 11:45**

**MAURO CHIVITE (UNIVERSIDADE DE VIGO, SPAIN), FATEH NADERI (UNIVERSIDADE DE VIGO, SPAIN), ROSA M CEINOS (UNIVERSIDADE DE VIGO, SPAIN), CRISTINA VELASCO (UNIVERSIDADE DE VIGO, SPAIN), MARCOS A LÓPEZ-PATRÓN (UNIVERSIDADE DE VIGO, SPAIN), JESUS M MÚSQUEZ (UNIVERSIDADE DE VIGO, SPAIN)**

**MCHIVITE@UVIGO.ES**

**A4.21** THE INTRASPECIFIC ALLOMETRY OF GILL SURFACE AREA AND METABOLIC RATE IN FISHES

**WEDNESDAY 3 JULY, 2019 12:00**

**HANNA SCHULFLEET (DIKINN UNIVERSITY, AUSTRALIA), FREDRIK JUTFELT (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), TIMOTHY O CLARK (DIKINN UNIVERSITY, AUSTRALIA)**

**HSCHULFLEET@DIKU.NAU**

**A4.22** COMPARISON OF METHODS FOR MEASURING METABOLIC RATE AND EVIDENCE OF METABOLIC DIURNAL RHYTHM IN RAINBOW LAKE STURGEON (ACIPENSER FULVESCENS)

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

**MARY ANDERSON (UNIVERSITY OF MANITOBA, CANADA), SWANSEK YOON (UNIVERSITY OF MANITOBA, CANADA), FORREST BJORNSON (UNIVERSITY OF MANITOBA, CANADA), DESI LEUKART (UNIVERSITY OF MANITOBA, CANADA), JULIA VOOGT (UNIVERSITY OF MANITOBA, CANADA)**

**MARVEL@MANITOBA.CA**

**A4.24** THE EFFECT OF HYPOALBUMINEMIA ON THE HEPATIC METABOLISM REGULATION IN RAINBOW TROUT ONCORHYNCHUS MYKISS IS NOT APPARENTLY DEPENDENT ON ADRENERGIC SIGNALS

**THURSDAY 4 JULY, 2019 POSTER SESSION**

**MARTA CONDE-SIEGRA (UNIVERSIDADE DE VIGO, SPAIN), RAMÓN JRIÁIZ (UNIVERSIDADE DE VIGO, SPAIN), ROSA M CEINOS (UNIVERSIDADE DE VIGO, SPAIN), ROSA M CEINOS (UNIVERSIDADE DE VIGO, SPAIN), ROSA ÁLVAREZ-ITOBA (UNIVERSIDADE DE VIGO, SPAIN), JOSÉ L ÓSNOAS (UNIVERSIDADE DE VIGO, SPAIN)**

**MCNORVEG.UVIGO.ES**

In a previous study with rainbow trout, we demonstrated that hypoalbuminemia in a control group resulted in decreased levels of food intake and depressed hepatic metabolism of glucose, lipids, and amino acids. In the present study, we evaluated the effect of central AMKp2 on liver metabolism might be mediated by adrenergic signals from the brain to the liver, as has been observed in mammals. Therefore, we induced the inhibition of AMKp2 expression in rainbow trout hypoalbuminemia by intracerebroventricular injection of adenoviral vectors that express dominant negative AMKp2 isoforms (DN-AMKp2). Simultaneously, we inhibited the adrenergic function in liver by p. i. administration of a α₂ adrenergic antagonist, such as phenolamine (1 mg/kg) or propranolol (2 mg/kg), respectively. The presence of the injected adenovirus in the hypotalamic areas has been demonstrated by immunohistochemical analyses. The results obtained demonstrated that the central inhibition of AMKp2 leads to a decrease of food intake levels and to an overall decrease of metabolic parameters in plasma and liver, which is in agreement with the results obtained in a previous study. In general, the presence of adrenergic antagonists did not modify the effect of central inhibition of DN-AMKp2 on the hepatic metabolism, suggesting that the adrenergic system could play a marginal role on the transmission of the metabolic information from the hypotalamus to the liver mediated by AMKp2. Therefore, another system, such as the sympathetic, could be more involved in the mediation of the hypopalbuminemic AMKp2 in the brain-liver interplay.

**A4.23** INSULIN MODULATES GLUCOSE AND FATTY ACID SENSING SYSTEMS IN THE RAINBOW TROUT BRAIN IN VITRO

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

**AYELÈN M BLANCO (UNIVERSITY OF VIGO, SPAIN), JUAN I BERTUCCI (UNIVERSITY OF SASKATCHEWAN, CANADA), CRISTINA VELASCO (UNIVERSITY OF VIGO, SPAIN), SURAJ UJJWAL KAPUR (UNIVERSITY OF SASKATCHEWAN, CANADA), JOSÉ L ÓSNOAS (UNIVERSITY OF VIGO, SPAIN)**

**AMBLANCON@UVIGO.ES**

Glucose and fatty acid sensing systems are subjected to important endocrine modulation by insulin in mammals. However, the insulin regulation of nutrient sensing mechanisms is in fish a scarce and controversial. This study aims to clarify the insulin effects
on glucose and fatty acid sensing systems in the brain of rainbow trout (Oncorhynchus mykiss) in vitro. Cultured hypothalamic and hindbrain were exposed to 1 µM bovine insulin for 3 h, and parameters involved in appetite regulation and nutrient sensing mechanisms were measured. Additionally, the involvement of the phosphatidylinositol 3-kinase (PI3K)/protein kinase B (Akt) signaling pathway in the actions of insulin was studied by using the selective inhibitor wortmannin. Both glucose and fatty acid sensing systems were activated in the rainbow trout brain in response to insulin, as evidenced by decreased AMPK levels and increased mTOR and/or protein expression of Glk, PFK, GlcPase, T1R3, FAT/CD36, PPARa, PPARy and TOR in the hypothalamus and/or hindbrain. The decreased activity of ALCY and FAS by insulin support our observation. Furthermore, npy was reduced but cort was enhanced in the hypothalamus and hindbrain, pointing to an anorexic potential. Most of the insulin-evoked variations in mRNA and protein levels described above were abolished by preincubation with wortmannin. This suggests that insulin actions on the rainbow trout brain are at least in part mediated by the PI3K/AKT signaling pathway. This study adds new insights into our knowledge of the mechanisms regulating nutrient sensing and appetite in fish.

**A4.26** **EXPLORE THE UMAI FLAVOR IN TILAPIA MUSCLE: GLUTAMATE-GLUTAMINE METABOLISM UNDER OSMOTIC CHALLENGES**

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

YU-Chun WANG (FISHERIES RESEARCH INSTITUTE COA TAIWAN, TAIWAN), NORD-YUAN MAO (NATIONAL TAIWAN NORMAL UNIVERSITY, TAIWAN), Fou-LONG KUAN (ACADEMIA SINICA, TAIWAN), YUNO-CHE TSENG (ACADEMIA SINICA, TAIWAN), YCwang@Malth.TIFR.GOV.TW

In tilapia aquaculture, the transfer of the fish to hypersaline seawater (SW) is one of the essential steps for diminishing unfavorable growth characteristics. In this study, Mozambique tilapia (Oreochromis mossambicus) was used to investigate glutamate/glutamine-related metabolism in muscle under various salinity treatments. Transcripts expression of glutamate-ammonia ligase (GLUL) and glutamate dehydrogenase (GLUD) in muscle were found to be significantly increased in 10% SW. In addition, the contents of glutamine and other amino acids in muscle were found to be increased in both 10% and 20% SW. In contrast, the ammonia contents in muscle were not apparently affected by different SW conditions. These results inferred that the glutamine accumulated in muscle would be generated by the coupling of glutamate with ammonia following 10% SW treatment. These physiological strategy utilized by aquatic species under hypersaline stress would cause the accumulation of amino acids and further induce the “umami” flavor of human taste.

**A4.27** **THE EFFECT OF TEMPERATURE AND MEAL SIZE ON THE AEROBIC SCOPE AND SPECIFIC DYNAMIC ACTION OF TWO NEW ZEALAND FINNISH**

**THURSDAY 4 JULY, 2019 POSTER SESSION**

Cristina Otero-Rodríguez (Universidad de Vigo, Spain), Rosa Álvarez-Otero (Universidad de Vigo, Spain), Cristina Velasco (Universidad de Vigo, Spain), Mauro Chivite (Universidad de Vigo, Spain), Marcos A López-Patino (Universidad de Vigo, Spain), José J. Soengas (Universidad de Vigo, Spain)

cris.otero@uvi.vigo.es

In mammals Na/K-ATPase activity has been demonstrated to be involved in the regulation of food intake. To evaluate this hypothesis in fish, we observed a first experiment with rainbow trout (Oncorhynchus mykiss) that intracebroventricular (ICV) treatment with 0.05 µg/pL bovine decreased food intake. We hypothesized that this anorectic effect might relate to the modulation of glucosensing systems in brain areas involved in the regulation of food intake in the same species (hypothalamus, hindbrain, and telencephalon). Therefore, we evaluated in a second experiment, the effect of ICV administration of ouabain, both in the absence or in the presence of 40 µg/pL glucose, on Na/K activity. mRNA abundance of different Na/K subunits, parameters related to glucosensing, transcription factors and neuropeptides in brain areas involved in the control of food intake. In general, we observed that ouabain treatment elicited inhibition of Na/K activity and mRNA abundance of specific isoforms of NaK subunit suggesting a role for Na,K in regulation of food intake confirmed by the anorectic effect of ouabain treatment. The anorectic effect of ouabain is opposed to the orexigenic effect reported in mammals. The specificity of the response is supported by the lack of comparable changes in other brain areas not involved in food intake control such as cerebellum or midbrain. In general, since NaK is inhibited by ouabain, the difference in food intake response might relate to the activity of glucosensing as well as downstream mechanisms involved in the regulation of food intake in rainbow trout.

**A4.28** **EFFECTS OF POST-FEEDING METABOLISM ON AIR-BREATHEING FREQUENCY IN CORIDORAS CATFISH**

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

Emanuelle Christien (Université de Montréal, Canada), Shaim S. Kellen (University of Glasgow, United Kingdom)

emmanuelle.christien@umontreal.ca

Hyposmia commonly occurs in natural habitats and has evolved a number of physiological responses to cope with variation in oxygen availability. However, prolonged exposure to hypoxia can negatively affect growth through effects on metabolism and the capacity to budget energy use. Previous studies have revealed that, in fishes, hypoxia affects muscle metabolism, particularly by increasing the oxygen demand required for feeding. Several fish species are obligate facultative air-breathers, which allows them to obtain oxygen directly from the air through accessory respiratory organs. Although air-breathing allows these fish to obtain more oxygen, surfacing also comes with an enhanced risk of predation from terrestrial and aerial predators. In this study, we investigated the effects of hypoxia on air breathing behaviour and metabolism of brood corydoras catfish (Corydoras aureus). These facultative air-breathers use their posterior intestine as accessory respiratory organs. We measured air breathing frequency and gill ventilation rates of corydoras before and after feeding in normoxia and hypoxia. Experiments were done in a number of fish, which allowed us to also explore if the social environment influences air breathing behaviour. Our results provide insight into the physiological advantages of air-breathing in these fish in hypoxic conditions, which has so far increase in frequency, abundance and severity due to anthropogenic activities and climate change.
**A4.30** ISOSMOTIC ENVIRONMENT IMPROVES GROWTH RATES THROUGH A MORE EFFICIENT DIGESTION AND A METABOLIC ORCHESTRATION IN THE GILthead Sea Bream (Sparus aurata)

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

**JUAN MIGUEL MANCERA** (DPT. OF BIOLOGY FACULTY OF MARINE AND ENVIRONMENTAL SCIENCES UNIVERSITY OF CáDIZ, SPAIN), PAULA SIMó-MIRABET (NUITRIDENDINICS AND FISH GROWTH ENDOCRINOLOGY GROUP INST. OF AQUACULTURE TORRE DE LA SAL (IAT-CSIC), SPAIN), PAULA SIMó-MIRABET (NUITRIDENDINICS AND FISH GROWTH ENDOCRINOLOGY GROUP INST. OF AQUACULTURE TORRE DE LA SAL (IAT-CSIC), SPAIN), CAROLINA BALMACéD-AgüELLA (DPT. OF BIOLOGY FACULTY OF MARINE AND ENVIRONMENTAL SCIENCES UNIVERSITY OF CáDIZ, SPAIN), NEDA GILINANJAD (INST. DE CIENCIAS MARINAS DE ANDALUCÍA CONSEJO SUPERIOR DE INVESTIGACIONES CIENTíFICAS (ICMAN-CSIC), SPAIN), LILIANA RODRíGUEZ-VELASQUEZ (DPT. OF BIOLOGY FACULTY OF MARINE AND ENVIRONMENTAL SCIENCES UNIVERSITY OF CáDIZ, SPAIN), JAUME PÆREZ-SÁNCHEZ (NUITRIDENDINICS AND FISH GROWTH ENDOCRINOLOGY GROUP INST. OF AQUACULTURE TORRE DE LA SAL (IAT-CSIC), SPAIN), GONZALO MARTíNEZ-RODRíGUEZ (INST. DE CIENCIAS MARINAS DE ANDALUCÍA CONSEJO SUPERIOR DE INVESTIGACIONES CIENTíFICAS (ICMAN-CSIC), SPAIN), JUAN ANTONIO MARTos-SITCHA (DPT. OF BIOLOGY FACULTY OF MARINE AND ENVIRONMENTAL SCIENCES UNIVERSITY OF CáDIZ, SPAIN)

The gilthead sea bream (Sparus aurata) is an euryhaline teleost species with a unmatched dominance for osmoregulatory adaptation. Moreover, environmental salinities that differ from the internal milieu produce a great energetic cost to regulate active ion transport. The present study evaluates, in an 11-weeks feeding trial using a RS system, the effect of three different environmental salinities (brackish water, BW: 18ppt; seawater, SW: 37ppt; and high salinity water, HSW: 55 ppt) on osmoregulatory capacity, growth performance, stress processes and metabolisms. S. aurata juveniles (~7 g initial mean body mass) preyed on bream diets. The whole body mass of the fish increased by 42% at 28°C-reared fish; however, osmoregulatory processes and stress responses were modulated by salinity. The results showed significantly lower final weight, weight gain, total length and visceral mass index, but increased hematocrit index in fish grown at 21°C when compared to the high temperature group fed the same palma oil diet, whereas no differences were found among 28°C-reared fish independently of the diet. Furthermore, histological analyses evidenced differences in lipid accumulation depending on temperature and diet composition, with the highest percentage of abdominal fat tissue and liver of fish fed the diet with palm and rapeseed oils, indicating increased lipid mobilization and oxidation in this condition. Overall, the present data indicate that the substitution of dietary fish-derived raw materials for isosmotic diet has been fine-tuned in a future scenario of climate change in order to achieve proper growth and physiological status of the fish. Supported by MINECO AGL2014-57974-R, AGL2017-89436-B-RandeGenerallitat de Catalunya 2017SGR 2017 151R75.

**A4.31** HIGHLY SUBSTITUTED FISH OIL DIETS AND ELEVATED TEMPERATURE AFFECT GROWTH AND LIPID METABOLISM IN GILthead SEA BREAM

**THURSDAY 4 JULY, 2019 POSTER SESSION**

**ISABEL NAVARRO** (DEPARTMENT OF CELL BIOLOGY, PHYSIOLOGY AND IMMUNOLOGY, FACULTY OF BIOLOGY, UNIVERSITY OF BARCELONA, SPAIN), NATALIA RíERAS-HEREDIA (DEPARTMENT OF CELL BIOLOGY, PHYSIOLOGY AND IMMUNOLOGY, FACULTY OF BIOLOGY, UNIVERSITY OF BARCELONA, SPAIN), ALBERT SÁNCHEZ-MOYA (DEPARTMENT OF CELL BIOLOGY, PHYSIOLOGY AND IMMUNOLOGY, FACULTY OF BIOLOGY, UNIVERSITY OF BARCELONA, SPAIN), RAMON FONTANELLAS (SKELETING, NORWAY), JOAQUIM GUTíERREZ (DEPARTMENT OF CELL BIOLOGY, PHYSIOLOGY AND IMMUNOLOGY, FACULTY OF BIOLOGY, UNIVERSITY OF BARCELONA, SPAIN)

In addition to the long-term need to substitute fish meal and fish oil in aquaculture for more sustainable alternatives such as those from plant sources, fish farming has faced new challenges regarding the increasing world population and global warming. In this context, the physiological effects of the diets with high substitution of fish oil by vegetable oils, palm, rapeseed, or both in juvenile gilthead sea bream (Sparus aurata) reared at two different temperatures (21 and 28°C) have been evaluated. The results showed significantly lower final weight, weight gain, total length and visceral mass index, but increased hematocrit index in fish grown at 21°C when compared to the high temperature group fed the same palma oil diet, whereas no differences were found among 28°C-reared fish independently of the diet. Moreover, histological analyses evidenced differences in lipid accumulation depending on temperature and diet composition, with the highest percentage of abdominal fat tissue and liver of fish fed the diet containing palm and rapeseed oils, presenting more adipocytes of smaller area. Additionally, the lower triglyceride and plasma levels of 28°C-reared fish together with the changes observed in gene expression in adipose tissue and liver of fish fed the diet with palm and rapeseed oils, indicated increased lipid mobilization and oxidation in this condition. Overall, the present data indicate that the substitution of dietary fish-derived raw materials for isosmotic diet has been fine-tuned in a future scenario of climate change in order to achieve proper growth and physiological status of the fish. Supported by MINECO AGL2014-57974-R, AGL2017-89436-B-RandeGenerallitat de Catalunya 2017SGR 2017 151R75.

**A4.32** PALMITOYLETHANOLAMIDE (PEA) AS A SATIETY SIGNAL IN GOLDFISH (Carassius auratus)

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

**ESTHER ISORNA** (DEPARTMENT OF GENETICS, PHYSIOLOGY AND MICROBIOLOGY, FAC OF BIOLOGY, COMPLUTENSE UNIV. MADRID, SPAIN), MIGUEL GóMEZ-BORONAT (DEPARTMENT OF GENETICS, PHYSIOLOGY AND MICROBIOLOGY, FAC OF BIOLOGY, COMPLUTENSE UNIV. MADRID, SPAIN), MNU DE PEDRO (DEPARTMENT OF GENETICS, PHYSIOLOGY AND MICROBIOLOGY, FAC OF BIOLOGY, COMPLUTENSE UNIV. MADRID, SPAIN), MIGUEL GóMEZ-BORONAT, ES

Palmitoylethanolamide (PEA) is an N-acyl ethanolamine involved in a variety of functions in mammals, including feeding regulation. However, the possible role of PEA on energy homeostasis has not been assessed in fish yet. To study this question, goldfish (Carassius auratus) were intraperitoneally (IP) injected with PEA (20 mg/g body weight) and food intake was quantified at 2, 6 and 8 h post-injection. PEA significantly decreased food intake at 6h (37%) and 8h (50%) post-injection. To investigate the possible feeding regulators implicated in this anorectic effect, goldfish were IP injected with PEA, and mRNA abundance of feeding regulators were measured at 6h post-injection. Among all analysed genes, a decrease in the expression of the hypothalamic ppy and an increase of the hepatic leptin were observed. Next, we compared the PEA content in brain and intestine in fed (1h-postprandial) and fasting (25) fish, resulting in augmented levels in intestine, but no modifications in the hypothalamus, supporting the role of PEA as a peripheral satiety signal. Finally, we analysed the effect of chronic (10days) PEA treatment on different biometric parameters and locomotor activity. PEA treatment reduced body weight gain, specific growth rate and nutritional index compared to control fish. Moreover, a significant regression (25%) in the daily general locomotor activity and a pronounced decrease (76%) in the feeding-related locomotor activity was found after chronic PEA treatment. Altogether, results indicate for the first time in fish that PEA can be involved in the energy homeostasis regulation, suggesting potential use as a peripheral satiety signal.

**A4.33** INTERACTION BETWEEN DHA, LEUCINE, AND HIGH-FAT DIETS ON GROWTH AND CENTRAL METABOLIC PATHWAYS IN ATLANTIC SALMON JUVENILES

**THURSDAY 4 JULY, 2019 POSTER SESSION**

**EMILY LUTFI** (NOFIMA, NORWAY), MARTA BOU (NOFIMA, NORWAY), IDA CATHRINE SANDLØK (NOFIMA, NORWAY), GIRD BERG (NOFIMA, NORWAY), TONE-KARI ØSTBYE (NOFIMA, NORWAY), NATÀLIA RIERA-HEREDIA (DEPARTMENT OF GENETICS, PHYSIOLOGY AND MICROBIOLOGY, FAC OF BIOLOGY, COMPLUTENSE UNIV. MADRID, SPAIN), BENTE RUYTER (NOFIMA, NORWAY)

Reducing the dietary protein-to-lipid ratio in Atlantic salmon diets appears to increase the risk of fat accumulation in internal organs, which can have a negative impact on fish health and quality. In addition, not only the amount of lipids in the diets but also the composition of dietary fats can have an amajor effect on salmon metabolism. In fact, omega-3-long chain polyunsaturated fatty acids (FA), such as docosahexaenoic acid (DHA), are known to improve fish robustness by reducing fat accumulation and metabolic dysregulations. In the present study, fish were given six experimental diets, containing normal (NF) or high-fat (HF) levels, plus normal leucine (NL) or high leucine levels (HL), with or without DHA supplementation. After 2 months, no significant effects were found on growth rates and condition factor. However, fish fed the HF diets presented higher body lipid and lower protein levels, whereas fish fed the diets containing low lipids but higher amount of protein. Furthermore, fish fed the HF+Diet showed increased hepatic lipid index compared to these fed NF diet. Diets containing DHA and HF levels, appeared to increase whole body protein levels as well as reduce body fat and plasma triglyceride and cholesterol levels, suggesting beneficial effect of DHA ameliorating protein and FA metabolism in this species. Overall, these results provide a better understanding about the importance of DHA in unbalanced diets and the interaction between dietary amino acids and FA in Atlantic salmon metabolism.
A5.1 CITIES REMODEL BUTTERFLY SEASONAL ACTIVITY: SURPRISES AND NOVEL INSIGHTS FROM A LONG-TERM CITIZEN SCIENCE MONITORING SCHEME

THURSDAY 4 JULY, 2019  09:00

SARAH DIAMOND (CASE WESTERN RESERVE UNIVERSITY, UNITED STATES)

The proliferation of cities and their associated urban heat island effects can profoundly alter the timing of seasonal activity (phenology). In many systems, climatic warming—for example, across space with decreasing latitude and across time with recent climate change— advances the timing of early seasonal activity. However, the effects of warming on seasonal activity driven by rapid urbanization are not well understood. Here, we hypothesized that timing of reproduction in urban blue tits will be strongly under selection in cities as we showed that urban females lay their eggs on average 5 days earlier than forest ones, but with a much larger variation around the mean. While in the forest populations earlier breeding was associated with increased reproductive success (as measured by fledging success and chick body mass before fledging), this relationship was not found in the urban populations. We therefore conclude that the strength of selection for early breeding is stronger in forest than urban areas. Thus, the advanced breeding time found in many urban areas is likely the consequence of plastic responses to altered environmental stimuli that may advance timing of reproduction, such as higher temperatures and the presence of artificial light at night. In my contribution I will present these results and discuss their implications for the regulation of phenological interactions in urban environments.

A5.2 PHENOLOGY IN THE CITY: EFFECTS OF URBANISATION ON THE SELECTION ON TIMING OF AVIAN REPRODUCTION

THURSDAY 4 JULY, 2019  09:30

DAVIDE DOMINNI (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

Urbanization is associated with significant environmental alterations, inducing rapid evolution. A key feature of urban areas is their higher population density, providing evidence on pace-of-life evolution across populations in response to this anthropogenic warming in freshwater habitats is still absent. We tested the hypothesis that urbanization-driven warming selected for rapid life-history evolution in Daphnia populations and genotypes. Compared to rural animals, urban Daphnia evolved along the slow-to-fast pace-of-life continuum coinciding with faster maturation, smaller sizes at maturity, higher reproductive output and higher intrinsic population growth rates. Additionally, urban animals have higher concentrations of fat, protein, and carbohydrates but limited upregulation of antioxidant enzymes activity. Oxidative damage did not differ between the two genotypes, suggesting that Daphnia evolved a more efficient antioxidant defense machinery in response to urbanization. Structural equation modelling on life history, morphological, and stress physiology traits revealed that all traits were significantly structured by an underlying Pace-of-life Syndrome (POLS) in the urban, but not rural genotypic set. We hypothesize the combined mix of stressors (temperature, pollution, predation management) experienced by animals in city ponds might shift energy allocation to align stress physiology coping-mechanisms to life history evolution in the direction of faster life, evoking a strong POLS. While pace-of-life is not directly linked to circadian rhythm, faster pace-of-life can significantly impact population dynamics in urban ponds and influence within- and among-species interactions, possibly altering ecosystem functions.

A5.3 CITY LIFE ON FAST LANES? URBANIZATION AND THE EVOLUTION OF PACE-OF-LIFE (SYNDROMES) IN A FRESHWATER ZOOPLANKTONIC KEY SPECIES

THURSDAY 4 JULY, 2019  10:00

KRISTIEN I BRANS (XU LEUVEN, BELGIUM), ROBBY STOKS (XU LEUVEN, BELGIUM), LUC DE MEESTER (XU LEUVEN, BELGIUM)

KRISTIEN.BRANS@KULEUVEN.BE

Urbanization is associated with significant environmental alterations, inducing rapid evolution. A key feature of urban areas is their higher population density, providing evidence on pace-of-life evolution across populations in response to this anthropogenic warming in freshwater habitats is still absent. We tested the hypothesis that urbanization-driven warming selected for rapid life-history evolution in Daphnia populations and genotypes. Compared to rural animals, urban Daphnia evolved along the slow-to-fast pace-of-life continuum coinciding with faster maturation, smaller sizes at maturity, higher reproductive output and higher intrinsic population growth rates. Additionally, urban animals have higher concentrations of fat, protein, and carbohydrates but limited upregulation of antioxidant enzymes activity. Oxidative damage did not differ between the two genotypes, suggesting that Daphnia evolved a more efficient antioxidant defense machinery in response to urbanization. Structural equation modelling on life history, morphological, and stress physiology traits revealed that all traits were significantly structured by an underlying Pace-of-life Syndrome (POLS) in the urban, but not rural genotypic set. We hypothesize the combined mix of stressors (temperature, pollution, predation management) experienced by animals in city ponds might shift energy allocation to align stress physiology coping-mechanisms to life history evolution in the direction of faster life, evoking a strong POLS. While pace-of-life is not directly linked to circadian rhythm, faster pace-of-life can significantly impact population dynamics in urban ponds and influence within- and among-species interactions, possibly altering ecosystem functions.

A5.4 RELAXED TIME CONSTRAINTS IN THE WARMER URBAN HABITATS DRIVE COUNTERCURRENT VARIATION IN AN AQUATIC INSECT

THURSDAY 4 JULY, 2019  10:15

NEDIM TÜZÜN (UNIVERSITY OF LEUVEN (XU LEUVEN), BELGIUM), LIN OP DE BEEK (UNIVERSITY OF LEUVEN (XU LEUVEN), BELGIUM), KRISTIEN I BRANS (UNIVERSITY OF LEUVEN (XU LEUVEN), BELGIUM), LIZAAN JANSSENS (UNIVERSITY OF LEUVEN (XU LEUVEN), BELGIUM), ROBBY STOKS (UNIVERSITY OF LEUVEN (XU LEUVEN), BELGIUM)

NEDIM.TUZUN@KULEUVEN.BE

The rapidly increasing rate of urbanisation has a major impact on the ecology and evolution of species. While increased temperatures are a key aspect of urbanisation (‘urban heat islands’), we have very limited knowledge whether the potential evolutionary responses to these urban and rural populations. We therefore conducted field experiments identifying specific anthropogenic disturbances to carnivores; 2) the effects of these disturbances on carnivore diet activity patterns and hunting behaviors; and 3) the ecological consequences of altered carnivore activity uninteractions with their prey and competitors. Specifically, I will provide examples of human-induced diet pattern shifts on predator-prey interactions between pupas and small-tailed deer and resource partitioning among mesocarnivores.

A5.5 CAUSES AND CONSEQUENCES OF THE INCREASINGLY NOCTURNAL LIVES OF EXUROVIAN CARNIVORES

THURSDAY 4 JULY, 2019  11:00

JUSTINE A SMITH (UNIVERSITY OF CALIFORNIA – BERKELEY, UNITED STATES), YI MING WAN (SAN FRANCISCO BAY BIRD OBSERVATORY, UNITED STATES), JUDD P SUNAC (UNIVERSITY OF CALIFORNIA SANTA CRUZ, UNITED STATES), CHRIS G WILMERS (UNIVERSITY OF CALIFORNIA SANTA CRUZ, UNITED STATES)

JEPHY@BERKELEY.EDU

Carnivores that coexist with humans in urban spaces are becoming increasingly nocturnal to avoid anthropogenic disturbances. In coastal California, high densities of people alter carnivore diet behavioral patterns and subsequently their interactions with other species. This talk will discuss: 1) experimental studies identifying specific anthropogenic disturbances to carnivores; 2) the effects of these disturbances on carnivore diet activity patterns and hunting behaviors; and 3) the ecological consequences of altered carnivore activity interactions with their prey and competitors. Specifically, I will provide examples of human-induced diet pattern shifts on predator-prey interactions between pupas and small-tailed deer and resource partitioning among mesocarnivores.

A5.6 TEMPORAL PATTERNS OF URBAN GULL FORAGING BEHAVIOUR IN RELATION TO Human ACTIVITY

THURSDAY 4 JULY, 2019  11:30

ANOUK SPELT (UNIVERSITY OF BRISTOL, UNITED KINGDOM), OLIVER SOUTAR (UNIVERSITY OF BRISTOL, UNITED KINGDOM), CARA WILLIAMSON (UNIVERSITY OF BRISTOL, UNITED KINGDOM), HAN PETERS (UNIVERSITY OF BRISTOL, UNITED KINGDOM), EMILY LC SHEPARD (UNIVERSITY OF SWANSEA, UNITED KINGDOM), JUDY Z SHAMPON-BARANES (UNIVERSITY OF AMSTERDAM, NETHERLANDS), SHANE KENDROS (UNIVERSITY OF BRISTOL, UNITED KINGDOM)

ANOUK.SPELT@BRISTOL.AC.UK

Urbanisation of the landscape affects animal populations worldwide, being detrimental for some species and potentially advantageous for others. For large gulls, urban environments can provide nesting and feeding grounds and worldwide many urban-nesting populations have grown rapidly in the last century. In urban areas food availability can often change during the day and is related to human activity, e.g. unloading of food waste in waste processing centres. This study aimed to assess if large gulls show temporal patterns in their use of urban feeding grounds and whether these patterns are related to human activity or food availability. We analysed GPS positional data of 11 lesser black-backed gulls (Larus fuscus) nesting on roofs in Bristol, UK in 2019 to quantify daily patterns in habitat use of urban feeding grounds. Additionally, we monitored gull presence, human activity and food availability at three urban feeding grounds: a secondary school, a city park, and a waste processing centre. The urban-nesting gulls in Bristol showed temporal patterns in use of these three feeding grounds.
A5.7 HOW ARE AUSTRALIA’S KOALAS RESPONDING TO EXTREME ENVIRONMENTAL CHANGE: A STRESS PHYSIOLOGY PERSPECTIVE

THURSDAY 4 JULY, 2019

EDWARD NARAYAN (WESTERN SYDNEY UNIVERSITY, AUSTRALIA)

E. NARAYAN@WESSTERNSYDNEY.EDU.AU

Koalas are Australia’s iconic marsupial species which need Eucalyptus trees to survive. Koalas rescued from the wild are often found with incidences of burns from bushfire, injury from animal attacks, vehicle collision, and/or environmental stressors could impact the outcomes of clinical care. This presentation discusses the physiological evaluation of the koala stress physiology using non-invasive glucocorticoid monitoring methods (faecal cortisol metabolites, MCM). FCMx analysis was used to determine stress hormone levels of koalas at the point of rescue and related to different types of stressors such as environmental trauma (vehicular collision, dog attack, burns from smoke and fire) and chlamydia infections. Results suggest that koalas in rural habitats which are not as exposed to anthropogenic induced stressors included dog attacks, vehicle collision and injury/burns from bushfire. The results are discussed in relation to the koalas physiological response to environmental change using FCMx as an objective physiological stress marker.

A5.8 ENDOCRINE ADJUSTMENTS OF BIRDS TO URBANIZATION: STRESS HORMONES AND REPRODUCTIVE PROCESSES

THURSDAY 4 JULY, 2019

PIERRE J DEVICHE (ARIZONA STATE UNIVERSITY, UNITED STATES)

DEVICHE@ASU.EDU

Urban environments are evolutionary novel and challenging to many organisms, yet many of these organisms, including avian taxa, adjust well to these environments. At the core of these adaptations are physiological changes, including to the reproductive system activity. Many birds have evolved to breed seasonally and when trophic resources for the offspring are most abundant. Urban birds commonly show advanced seasonal reproductive development compared to non-urban conspecifics, and urban areas of species with more food resources, including anthropogenic origin, than non-urban areas. We hypothesized that food availability contributes to the vernal advancement of reproductive phenology observed in urban habitats by supporting the hypothesis that food restriction reversibly decreases reproductive development resulting from exposure to spring-like photoperiod. Urbanization is in some cases associated with elevated stress hormone secretion (CORT) levels and CORT can inhibit reproduction. However, wild food restriction did not increase plasma CORT, suggesting that this hormone does not cause the observed reproductive suppression. Regulation of the reproductive system is complicated by the fact that in the hypothalamus, pituitary gland, and gonadal levels. Our findings suggest effects of food availability at all two levels: hypothalamus (gonadotropin-releasing hormone secretion) and gonad (gene expression). Progress in our understanding of birds’ physiological adjustments to urbanization will benefit from studies investigating the effects of food availability at different geographical levels, including: water availability, predation pressure, noise, and artificial lights into reproductive responses; (2) the mechanisms of action of these factors at all levels of the reproductive axis; and (3) the fitness consequences of reproductive adjustments to urbanization.

A5.9 MELATONIN RHYTHMS UNDER LIGHT POLLUTION IN THE EUROPEAN FRESHWATER FISH PERCA FLAVIULIS

THURSDAY 4 JULY, 2019

FRANZISKA KUPPurat (LEIBNIZ-INSTITUTE OF FRESHWATER ECOLOGY AND INLAND FISHERIES, GERMANY), FRANZ HÖLER (LEIBNIZ-INSTITUTE OF FRESHWATER ECOLOGY AND INLAND FISHERIES, GERMANY), WERNER KLAUS (LEIBNIZ-INSTITUTE OF FRESHWATER ECOLOGY AND INLAND FISHERIES, GERMANY)

KUPPURAT@IBU-BERLIN.DE

The daily rhythm of day and night has been rhythmic light and darkness for the entire course of evolution. Artificial Light at Night (ALAN) has begun to interfere with this rhythm since the early twenty-first century and is steadily increasing. Especially the diffusive spread of light by lumins that lead to an increased illumination over the entire sky (sky glow), makes large areas in and surrounding urban and industrial regions brighter at night. While effects of ALAN on day-time behavior are well known, aquatic environments are less studied although urban areas are typically built around freshwater, which is the basis for human life. We aimed to investigate the effects of different intensities of ALAN on melatonin production of European perch to identify a minimum intensity that inhibits melatonin production and assess at which intensities light pollution may become a hazard to aquatic fish. In a short-term experiment for rhythmic melatonin production was measured from the tank water over a 24 h period. Nocturnal melatonin production was inhibited in a dose-dependent manner at all tested nocturnal light intensities of 0.01 lx, 0.1 lx and 1 lx compared to control conditions with complete darkness at night. Irregular 0.01 lx and 0.1 lx simulate realistic skyglow patterns of areas that already are affected in non-urban areas. Further physiological implications of light at night and a reduced melatonin production may explain the mechanisms for the immune system, thyroid hormones and the reproductive system will be discussed.

A5.10 THE COSTS OF SYNCHRONIZATION OF THE CIRCADIAN CLOCK TO EXTERNAL LIGHT-CYCLES IN A NON-HUMAN PRIMATE (M. MURinus)

THURSDAY 4 JULY, 2019

CLAIRA HOZER (ST IRENS, FRANCE), FABIEN PIFFERI (ST IRENS, FRANCE)

HOZER@STIRENS.FR

Circadian rhythms are generated by the biological clock and daily synchronization of organisms’ physiology and behavior to external light cues, mainly in light-dark cycles (24h). In the absence of external cues, the biological clock expresses an endogenous period, tau, of about 24.2h. In long term studies (1972), it was reported that the deviation of tau from 24h affects negatively the lifespan. Based on these findings, we hypothesized that marginal, repeated, due to the clock daily synchronization with T, accumulate throughout life and can explain in the mechanisms of lower survival when tau deviates from 24h. Our study aimed to evaluate the nature of these costs by measuring metabolic, physiological and cognitive parameters (body temperature, VO2 and energy expenditure, body mass, oxidative stress, learning) in 30 individuals divided into three photoperiodic regimes: control condition (light-dark cycles of 24h, CTL), free-running conditions (constant darkness, FR), and light-dark cycles of 24h, mimicking a greater deviation of tau from TGD. The treatment led to a metabolic and cognitive deficit in FR and CTL, but did not affect VO2, energy expenditure and body temperature. Interestingly, learning was also affected (FR and CTL exhibited between 25% and 30% deficit in TGD), suggesting cognitive deficits when tau deviates too much from T. Therefore, suggest that the costs of daily synchronization may affect both body condition and cognitive performances. They will soon be completed by oxidative stress measurements to better identify the exact costs of daily synchronization and participate in elucidating the mechanisms underlying the relationship between longevity and circadian clock.

A5.11 DAILY AND LUNAR RHYTHMS IN THE CORAL ACRORAPA DIGITIFERA

THURSDAY 4 JULY, 2019

YAELE ROSENBERG (BAR-ILAN UNIVERSITY, ISRAEL), TIRZA DONGER (BAR-ILAN UNIVERSITY, ISRAEL), OREN LEVY (BAR-ILAN UNIVERSITY, ISRAEL)

YAELE@Biu.ac.il

Natural light cycles are important for synchronizing behavioral and physiological rhythms over varying time-periods in both plants and animals. These rhythms are controlled by an endogenous clock that is entrained by external environmental cues and is based on molecular mechanisms of positive and negative elements interacting in feedback loops. Many organisms structure their behavior and physiology not only by the cycles caused by the changes of sun but also the cycles of the moon. Light spectrum, intensity and duration play a key role in the biology of symbiotic corals as many corals exhibit circadian cycles of polyp expansion and contraction entrained by solar light patterns and monthly cycles of spawning or planulation that correspond to nocturnal lunar light cycles. In this study we aimed to determine the effect of constant dim light on corals, perception of daily and monthly cycles by analyzing gene expression samples from four lunar phases and GW-Daily Timepoints. Our gene expression results show that under constant dim light corals display loss of rhythmic processes and constant stimuli by light that initiate the signal transduction that results in a normal cell cycle, cell differentiation and protein synthesis.

A5.12 “DO NOT DISTURB”: LETTING THE REEF REST FOR REPRODUCTION

THURSDAY 4 JULY, 2019

SOPHIE L. NEDELEC (UNIVERSTI OF EXETER, UNITED KINGDOM), ANDREW R. RADFORD (UNIVERSITY OF BRISTOL, UNITED KINGDOM), KATY CHAPMAN (UNIVERSITY OF BRISTOL, UNITED KINGDOM), PETER GATENBY (JAMES COOK UNIVERSITY, AUSTRALIA), ISLA KEELE (DAVIDSON UNIVERSITY OF BRISTOL, UNITED KINGDOM), MAGDA TRAVIS (UNIVERSITY OF PUBG SOUND, UNITED STATES), KIERNAN MCCLOSKEY (UNIVERSITY OF EXETER, UNITED KINGDOM), TIMOTHY GORDON (UNIVERSITY OF EXETER, UNITED KINGDOM), LAURA VELASQUEZ (JAMES COOK UNIVERSITY, AUSTRALIA), BJORN ILLING (JAMES COOK UNIVERSITY, AUSTRALIA), MARK MCCRACKIN (JAMES COOK UNIVERSITY, AUSTRALIA), STEPHEN D. SIMPSON (UNIVERSITY OF EXETER, UNITED KINGDOM)

M. MURINUS

SOPHIE.L.NEDLEC@EXETER.AC.UK

Anthropogenic noise is a pollutant of international concern. Vessel noise is the most widespread form of underwater noise pollution and impacts a broad range of species from cetaceans to sea hares. Behaviour such as feeding and cleaning can be altered temporarily, influencing rhythms of activity. Ultimate consequences of noise pollution include death due to injury or predation, failure to develop and reduced reproductive capacity and survival. The evidence is strongest in cetaceans but the impacts are widespread and reach humans. Noise pollution is monitored internationally and work has also been done for specific noise pollution impacts (NA and USA) and international (EU) legislation exists to give legal protection to humans and wildlife from excessive noise; however, we need to move forward with the tools to implement this protection. Mitigation aims to lessen negative impacts, while abatement aims to lessen the amount of pollution produced. We treated the creation of ‘quiet zones’ in the wild and in the laboratory during the breeding season of coral reef fish. The acoustic conditions associated with speed limits and ‘no-go’ zones were beneficial for breeding fish and their offspring. Mitigation and abatement of noise pollution is possible, these show promise for sensitive habitats. When implementing these measures, noise quotas could be applied to individual vessels, spaces, or time periods. We could impose stricter limits for activity for old noisy vessels, while new vessels designed with quieter motors could be allowed greater freedom. A combination of tools can be used to fit the broad range of scenarios across the globe.
**A6.1 ASSESSING BIOCHEMICAL DEPLETION, DAMAGE AND PRO-SURVIVAL ADAPTATIONS IN RESPONSE TO ENVIRONMENTAL STRESS IN EXTREME ENVIRONMENTS**

**FRIDAY 5 JULY, 2019**

**GILLIAN MC RENSHAW (GRIFFITH UNIVERSITY, AUSTRALIA)**

G.MCRENSHAW@GRIFFITH.EDU.AU

Habitats on reef platforms and in estuaries can present intermittent environmental stress, in the form of cyclic episodes of oxygen limitation and thermal stress generated by the interactions between the tide cycle and the habitat topography. While most fish respond to environmental stress by swimming away, a few species have specialised adaptations which allow them to exploit extreme environments. Predicting survival in current and future global increases in hypoxic and thermal stress relies not only on assessing transcriptional and proteomic compensatory responses but also on developing specific sets of biomarkers to be used in concert with transcriptomic and proteomic studies. Two sets of biomarkers will be examined: those can be used reliably to assess biochemical depletion and damage caused by oxidative stress (such as measures of energy charge, protein and lipid degradation) as well as biomarkers to assess pro-survival adaptations (phenotypic plasticity such as nitrate/nitrite balance and shifts in the function of mitochondrial complexes). Phenotypic plasticity, elicited in response to environmental stress in dynamically changing environments, can equip fish to exploit habitats that are beyond their predators not.

**A6.2 PHENOTYPIC PLASTICITY OF THERMAL TOLERANCE AND HEAT SHOCK PROTEIN PROFILE IN THREE-SPINED STICKLEBACKS FROM NATURAL AND THERMALLY POLLUTED COASTAL AREAS**

**FRIDAY 5 JULY, 2019**

**GIOVANNA ROTOLLA (UNIVERSITY OF TURIN, ITALY), ANTI VASEMÖI (SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES, CRY, SWEDEN), NOXIO NICKUMA (UNIVERSITY OF TURIN, ITALY), KATJA ANTILA (UNIVERSITY OF TURIN, ITALY)**

G.IOVANNAROTOLLA@UNITO.IT

Heat waves are one of the main side effects of climate change. These extreme climate phenomena are predicted to become more and more frequent. As ectotherms, fish can respond to sudden temperature changes through a mechanism of phenotypic plasticity. Here we report, however, few studies on how fish that have experienced long-term (decades) increases in habitat temperature are able to respond to heat waves. The capacity of individuals to change their tolerance will, nonetheless, define the survival capability of entire populations. We evaluated the thermal plasticity of critical thermal maximum (CTmax) in six populations of the three-spined stickleback (Gasterosteus aculeatus) in a heat wave (increase of environmental temperature by 10°C for 1 week). Populations were from the coastline and from areas that have been warmed by ~10°C by nuclear power plants for four decades in Finland. Surprisingly, when CTmax was examined in common garden conditions before and after 1 week of exposure to a heat wave, no differences between populations or treatments were noticed. However, 1 week’s exposure to a heat wave hardened the thermal tolerance of the fish, increasing the CTmax by 4°C (p<0.001). Currently we are evaluating the molecular mechanisms behind the thermal restructuring by analysing the protein levels of Hsp90 and 90. We are also studying whether the molecular mechanisms differed among populations during the heat wave (sampling before and during the heat wave on days 4 and 7).
A6.3 CLIMATE CHANGE: THE EFFECTS AND INTERACTION OF TIDAL EXPOSURE AND WARMING IN MUSSELS FROM ITALIAN MANGROVES

FRIDAY 5 JULY, 2019 12:00

ALEXIA DUBUC (JAMES COOK UNIVERSITY, AUSTRALIA)
ALEXIA.DUBUC1@MY.JCU.EDU.AU

Organisms living in the intertidal zone are subjected to a dynamic and stressful habitat. In particular, organisms settled high on the shore are exposed to tidal-related stresses, including wide temperature variations and increased desiccation risk. Although organisms are supposedly adapted to these variations, climate change such as the global temperature rise may enhance the impacts of these stresses. Thus, the study of temperature influence on intertidal environments is of the utmost importance to understand the possible impacts on organisms behavior. Therefore, in the present study it was evaluated the impacts of different temperatures (18°C and 21°C) on the intertidal mussels Mytilus galloprovincialis continuously submerged or submitted to a tidal regime for 14 days. Results revealed that submerged mussels exposed to higher temperature activated their antioxidant defenses (especially glutathione peroxidase, GPx) preventing oxidative damage in the cells (with no lipid peroxidation, LPO; or protein carbonylation, PC). In the case of the mussels exposed to tides under control temperature, the metabolic capacity increased (identified by the electrical transport activity, ETS) with the induction of GPx, however an increase of LPO levels was observed. The combination of tides and increased temperature induced higher oxidative stress (identified by higher oxidized glutathione content), although activation of antioxidant defenses (superoxide dismutase, SOD; GPx) was observed. These findings indicate that in addition to air exposure, possibly acting as a confounding factor in the assessment of the impact of different stresses, global warming may represent a greater impact to intertidal organisms compared to subtidal ones.

A6.4 HYPOXIA IN MANGROVES: OCCURRENCE AND IMPACT ON NURSERY FISH HABITATS

FRIDAY 5 JULY, 2019 10:00

ALEXIA DUBUC (JAMES COOK UNIVERSITY, AUSTRALIA)
MARCUS SHEAVES (JAMES COOK UNIVERSITY, AUSTRALIA)
NATHAN WILHAM (JAMES COOK UNIVERSITY, AUSTRALIA)
ALEXIA.DUBUC1@MY.JCU.EDU.AU

Mangroves are extreme environments naturally experiencing die-off by hypoxia associated with tidal. Yet, mangroves act important fish habitats for many species. How mangroves are debated as studies have shown varying degrees of mangrove utilization by fish. One hypothesis is that tidally-dominated mangroves experience rapid and sharp declines in dissolved oxygen (DO), restricting their utilization to species specifically adapted to hypoxia. Knowledge on the occurrence and severity of hypoxia in mangroves and resulting adaptations developed by fish is very limited. Using a combination of field and laboratory data we show that fish tidal migrations correlate to variations in DO, and that a causality exists between their physiological tolerance and avoidance behavioral thresholds. Some species were only observed once DO<70% saturation, while other species were constantly observed even at DO>40% saturation. Respirometry on four species accessing mangroves at different DO revealed that active hypoxia tolerance thresholds corroborated field observations. Species highly tolerant accessed mangroves at any DO and were found in high abundance, while less tolerant species used mangroves when DO was greater and were found only below their tolerance threshold. This suggests that DO is shaping mangrove fish communities and consequently its role in determining mangrove use. High tolerance to hypoxia may be an essential condition to be maintained, especially in the low species richness in some places. DO is rarely considered as a key factor influencing structure and function of aquatic environments, however in mangrove it may be one of the most critical in shaping mangrove fish communities and consequently its role in determining mangrove use. High tolerance to hypoxia may be an essential condition to be maintained, especially in the low species richness in some places. DO is rarely considered as a key factor influencing structure and function of aquatic environments, however in mangrove it may be one of the most critical.
A6.8 QUANTITATION AND COMPREHENSION OF OSMOTIC EFFECTS ON PROTEOME DYNAMICS IN Euryhaline Fish  
Friday, July 5, 2019 11:30  
DIETMAR KÜTZ (UNIVERSITY OF CALIFORNIA, DAVIS, UNITED STATES)

Organismal physiology, morphology, and behavior are based on the function of structural proteins and enzymes. Proteins represent the central regulatory plane in the genome to phenome continuum. The protein complement of cells and tissues (the proteome) is highly dynamic and mirrors environmental and developmental influences on organisms. Therefore, dynamic proteomes are excellent bioindicators of environmental exposure. Comprehensive blueprints of environmental exposure are reflected in specific proteome states and capturing these states is achieved by quantitative proteomics. We have developed quantitative proteome workflows to characterize environmental influences on proteome states and proteome dynamics of euryhaline and eurytherm fish populations in coastal areas. These workflows utilize tissue-/cell-specific assay libraries for data-independent acquisition (DIA) or Sequentially Windowed Acquisition of all DeSdataset as examples. The data presented illustrate that habitat differences such as salinity and temperature changes are readily captured in state changes of tissue-specific proteomes. The overall topology of proteome states is indicative of particular tissues, species, and environmental contexts and is therefore suitable for deducing functional and phenotypic consequences of environmental changes on coastal organisms.

A6.10 A NOVEL AMMONIA TRANSPORTER IN FISH: EXPLORING THE ROLE OF HI-LAT AS A NEW POTENTIAL AMMONIA TRANSPORTER IN ZEBRAFISH (Danio rerio)  
Friday, July 5, 2019 12:15  
HAOHAN ZHOUYAO (UNIVERSITY OF MANITOBA, CANADA), ALEX ZIMMER (UNIVERSITY OF OTTAWA, CANADA), STEVE PERRY (UNIVERSITY OF OTTAWA, CANADA), DIRM WEISKIRCH (UNIVERSITY OF MANITOBA, CANADA)

Ammonia, a highly toxic waste product from protein metabolism, is directly excreted to the surrounding environment in the vast majority of aquatic organisms. The aquatic ammonia excretion mechanisms are, however, to date not fully understood. Most research on this topic has been focused on the gills and the kidneys. However, it has been suggested that the uptake of ammonia occurs in various tissues including gills, brain, kidney and intestine. Here we present a new ammonia-transporting protein, namely the hippocampus abundant transcript 1b (Hib 1b). This uncharacterized transporter is highly conserved across the animal kingdom (80% AA similarity between fish and human) and in zebrafish Hib 1b is ubiquitously expressed in various tissues including gills, brain, kidney and intestine. When heterologously expressed in frog oocytes, the uptake of radiolabeled methionine, a proxy for ammonia, was mediated. This uptake was competitively reduced in the presence of 1mM NH4Cl. This demonstrates that ammonia is a substrate for this transporter. Localization studies are currently on the way. In summary, our results suggest that Hib 1b is a novel and highly conserved ammonia transporter, that might be important for cellular and/or brain/liver excretion of toxic ammonia in fish.

A6.12 MOLECULAR ADAPTIVE MECHANISMS OF THE BROWN SHRIMP CRANGON CRANGON TO SURVIVE IN A VARIABLE ENVIRONMENT  
Friday, July 5, 2019 15:30  
DIANA MARTINEZ-ALARCON (ALFRED WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, UNIVERSITY OF BREMEN, GERMANY), KHELIL-HAAGEN (UNIVERSITY OF BREMEN, GERMANY), EINAR SARBORAKS (ALFRED WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY)

Biological and metabolic adaptations allow organisms to cope with a wide range of environmental conditions. Such adaptations comprise, beside others, metabolic regulation, control of gene expression, and metabolic and morphological traits. The brown shrimp Crangon crangon is abundant in the North Sea and plays an important role in coastal ecosystems. It is well adapted to thrive in highly variable environments and is a charismatic species. Here we present an integrative approach analysing lipids, transcriptome, gene expression, and protein structure to elucidate how this species copes at metabolic level with environmental challenges of the North Sea. Lipid analyses suggest that C. crangon utilize dietary energy directly to satisfy all metabolic requirements, including multiple spawning without accumulating extensive lipid reserves in the midgut gland. The reason behind the low lipid storage is not yet clear, but based on the transcriptome and protein structure analysis of enzymes involved in lipid metabolism we suggest that the brown shrimp has a deficiency of functional enzymes differentially expressed in the midgut gland. The low lipid level may be compensated by highly active and polymeric digestive enzymes.

A6.13 HOW COSTS IS MACROPARASITE INFESTATION IN A BIVALVE HOST? A COMPARISON BETWEEN TWO TREMATODE SPECIES  
Friday, July 5, 2019 15:45  
LUIZA MACHADAS (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL), XAVIER DE MONTAUDOUIN (UNIVERSITY OF BREMEN, GERMANY), ROSA FREITAS (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL)

Macroparasites (Mac) is a prominent threat to bivalves, representing a high economic and ecological loss for aquaculture. Most Mac species are known to induce disease and economic losses when its infection exacerbates. The economic cost in shrimp-farming is also high, but is underestimated. In this work, we will present an in vitro experimental model of two species of trematodes, that infect Pinctada maxima, a common species in the Canary Islands. Our model will be based on the evaluation of the energy metabolism and balance, as a fundamental requirement for organism’s function and survival. Concretely, once we experimentally infected cockles with two Mac species, Haplosporidium nelsoni and Penicillus cornucopioides, we observed a significant decrease in the vitality of infected individuals. The latter may represent an adaptive strategy to supply energy to the parasites. This work represents a breakthrough towards the understanding of host-trematode relationships that can be used to predict potential conservation stress to bivalve populations and to maximize the success of stock and disease episodes management.

A6.14 PHYSIOLOGICAL PLASTICITY AND EXTRACELLULAR HOMEOSTASIS  
Friday, July 5, 2019 16:45  
CAROLINA A FREIRE (FEDERAL UNIVERSITY OF PARANÁ, BRAZIL)

How does physiological plasticity relate to the maintenance of extracellular homeostasis in aquatic animals? Are regulatory less “plastic” than confersomes? Regulation of the extracellular fluid is necessary to maintain homeostatic control and to prevent organism adaptation over time. When the organism is exposed to stressful conditions, the regulatory mechanisms of homeostatic control and longer generation times, are unable to adapt to present and future environmental changes.
But how does adaptive capacity to environmental change, over generations, relate to the "width" of tolerance, or the flexibility of upper and/or lower limits upon acclimation? Environmental variability, over variable time scales, possibly influences pronounced effects on physiological plasticity. Animals more broadly tolerant may be more cosmopolitan, less endemic, and may spread along wider ranges of latitudes. Butare, e.g., are not necessarily more plastic than "steno" animals upon further changes or challenges? Range of tolerances and flexibility of limits are certainly to some degree, inversely related to complexity, but are also much dependent on past (evolutionary) and present degree of environmental variability. Importantly, both regulators and conformers can be either "eury-" or "steno". The two strategies of internal control imply distinct metabolic budgets. Especially in coastal habitats, changes in the pattern and intensity of environmental fluctuations associated to climate change and anthropogenic impacts (including introduction of exotic species) may differently affect regulators and conformers. Metabolic trade-off are crucial in order to understand the relationship between physiological plasticity and degree of internal control. This analysis could be a key to the proposal of ecophysiological biomarkers for coastal habitats.

**A6.15 A 3-YEAR STUDY ON THE IMPACT OF DOMESTIC WASTEWATER DISCHARGE ON THE ECOPHYSIOLOGY OF MANGROVE CRABS: CONCLUSIONS AND FUTURE PERSPECTIVES**

**FRIDAY 5 JULY, 2019 17:15**

**DIMITRI THEUREKAUF** (UNIVERSITY CENTER OF MAYOTTE, MAYOTTE), GEORGINA A RIVERA-INGRAHAM (LABORATORY ENVIRONMENT DE PETIT SAUT, FRENCH GUIANA), ELLIOTT SUCRE (UNIVERSITY CENTER OF MAYOTTE, MAYOTTE), JENNIFER LONZI (UNIVERSITY OF MONTPELLIER, FRANCE)

Mangroves are increasingly proposed as a biomonitoring tool for wastewater (WW) treatment. However, this practice can impact mangrove crabs which are key engineer species of the ecosystem through their bioturbation activities. This study aimed to determine the effects of WW on the physiology (osmoregulation, bienergetics, oxidative balance) of three crab species (Gecocarcinus polyops, Ocypodidae and Xantho spinosus) and to compare their responses to WW and the ones of a reference species, Eudorema splendidum. This species similar endpoints (water uptake, lactate excretion, respiratory gas exchange and enzyme activity) have been already assessed in mangrove crabs to determine the extent of ecosystem disturbance. Our results highlight for this purpose, showing high efficiency in the removal of potential toxic elements from contaminated water, including lead (Pb) that is accumulated in seawater, re-emulcified and remobilised with MnFeO₄-NPs, to infer about the ecotoxicological safety of this manganese biotechnology water-treatment process. For the mussel species Mytilus galloprovincialis, the results highlight that in situ experiments (burrow density and caging experiment in an experimental area with controlled WW releases). Burrow density decreases in flat areas where WW flows and crab community is altered with a marked dominance of Parasesarma guttatum (PG) a species with nodule burrowing activity. This change may induce drastic alterations of the ecosystem functioning. PG decreases its metabolic rate in WW but it is increased in the other species. Moreover, after laboratory exposure, the three species had impaired REE uptake, MnFeO₄-NPs and Pb in PGs tissues were quantified and biomarkers related to REEs metabolism and oxidative stress were evaluated. Our results revealed that mussels exposed seawater contaminated with Pb and Pb-Pd-NPs accumulated significantly more Pb than those conditions where Pb was eliminated. Regarding biomarkers, our results demonstrated that contaminated seawater clearly caused higher impacts in mussels than contaminated seawater, with higher oxidative stress and lower metabolic capacity in mussels exposed to contaminated seawater.

**A6.16 CAN WATER CONTAMINATED WITH Pb BE SAFE FOR MYTILLUS GIGAS GASL Após REMEDIATION WITH MANGANESE SPHERE NANOFACTICLES?**

**FRIDAY 5 JULY, 2019 17:30**

**FRANCESCA COPPOLA** (UNIVERSITY OF AVERIO, CESAM, PORTUGAL), EMMANUEL CHARRON (DEPARTMENT OF CHEMISTRY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), BRUNO HENRIQUES (DEPARTMENT OF CHEMISTRY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), TITO TRINDADE (DEPARTMENT OF CHEMISTRY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), EDUARDA PEREIRA (DEPARTMENT OF CHEMISTRY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), ROSA FREITAS (DEPARTMENT OF BIOLOGY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), CARLO PRETTI (DEPARTMENT OF BIOLOGY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL)

In recent years, the development of nanoparticles (NPs) for different applications has been increasing, including water decontamination. High-density ferre-carbonate nanoparticles (MnFeO₄-NPs) were used for this purpose, showing high efficiency in the removal of potential toxic elements from contaminated water, including lead (Pb) that is accumulated in seawater, re-emulcified and remobilised with MnFeO₄-NPs, to infer about the ecotoxicological safety of this manganese biotechnology water-treatment process. For the mussel species Mytilus galloprovincialis, the results highlight that in situ experiments (burrow density and caging experiment in an experimental area with controlled WW releases). Burrow density decreases in flat areas where WW flows and crab community is altered with a marked dominance of Parasesarma guttatum (PG) a species with nodule burrowing activity. This change may induce drastic alterations of the ecosystem functioning. PG decreases its metabolic rate in WW but it is increased in the other species. Moreover, after laboratory exposure, the three species had impaired REE uptake, MnFeO₄-NPs and Pb in PGs tissues were quantified and biomarkers related to REEs metabolism and oxidative stress were evaluated. Our results revealed that mussels exposed seawater contaminated with Pb and Pb-Pd-NPs accumulated significantly more Pb than those conditions where Pb was eliminated. Regarding biomarkers, our results demonstrated that contaminated seawater clearly caused higher impacts in mussels than contaminated seawater, with higher oxidative stress and lower metabolic capacity in mussels exposed to contaminated seawater.

**A6.17 THE SERPULID FICOPOMATUS ENIGMATICOIDES (FAUVEL, 1923) AS A PROMISING MODEL SPECIES FOR ECOXOTOLOGICAL EVALUATION OF MARINE AND BRACKISH SPACES**

**FRIDAY 5 JULY, 2019 17:45**

**MATTEO OLIVA** (CIBM - CONSORZIO PER IL CENTRO DI BIOLOGIA MARINA ED ECOLOGIA APPLICATA “G. BACCI”, ITALY), GIANLUCA BONTÀ PITTALUGA (CIBM - CONSORZIO PER IL CENTRO DI BIOLOGIA MARINA ED ECOLOGIA APPLICATA “G. BACCI”, ITALY), ADILIA PIRES (DEPARTMENT OF BIOLOGY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), ROSA FREITAS (DEPARTMENT OF BIOLOGY, CICECO - UNIVERSITY OF AVEIRO, PORTUGAL), CARLO PRETTI (DEPARTMENT OF SCIENZE VETERINARIE UNIVERSITÀ DI FISI, ITALY)

Ficopomatus enigmaticoides is an invasive, reef-forming, dioecious serpulid polychaete with gamete spawning occurring along the Indo-West Pacific region, from tropical to temperate zones, throughout the year, that can survive in a wide range of distinct salinity conditions. Due to its biotic role and the presence of toxic organic compounds in its tissues, this species can be suitable for both marine and brackish monitoring. In the present study, an embryo toxicity endpoint, evaluated as percentage of correct larval development, was adopted to evaluate the sensitivity of its species, in comparison to often model organisms similar endpoints (Craseostraaegus and Paracrinaria livida) and is supported by a relative lethal concentration (LC₅₀) acquired through an EC50 value of 0.64µg/L/Cu for F. enigmaticoides, comparable with those of C. gigas (2.53µg/L) and M. trossulus (57.00µg/L) found in the same research. Moreover the same assay was adopted for another species: P. livida, a different polluted sediment dilute evaluation, using a weight of evidence approach, that indicated an ecological relevance of this species compared to C. gigas. The same endpoint was also adopted to determine the toxicity of an emerging contaminant (Carbostabil Mult-Walled Carbon Nanotubes, CNTs), in two different populations, one from Porto (Oporto) and the other from Rio de Aveiro (Aveiro, Portugal). Results showed a similar dose–response relationship between the two populations, resulting in a maximum concentration of 5 µg/L of CNTs. These results suggest the sensitivity and the suitability of the species as promising model organisms for ecotoxicological and monitoring purposes.

**A6.18 CARBOXYLSTERASES AS POTENTIAL BIOMARKERS OF DRUG EXPOSURE IN NON-TARGET ORGANISMS: SEEKING FOR A SUITABLE PROTOCOL IN MARINE BIVALVES**

**FRIDAY 5 JULY, 2019 18:00**

**MONTSEBART SOLE** (ICM-CISSE, SPAIN), ROSA FREITAS (UNIVERSITY OF AVEIRO, PORTUGAL), JUAN C SANCHEZ-HERNANDEZ (UNIVERSITY OF CASTILLA LA MANCHA, SPAIN)

Marine bivalves are used worldwide as bioindicators of environmental pollution. Besides ecotoxicological and chemical analysis of contaminant residues, a broad range of biological responses, or biomarkers, are measured in these invertebrates with the scope for assessment of pollutant bioavailability and toxicity. A traditional biomarker of exposure to cholinergic-disrupting chemicals such as organophosphorus (OP) and methyl carbamates is acetylcholinesterase (AChE) activity. However, this enzyme(s) relatively unexpressed in the bivalve clamshells (Ruditapes decussatus and R. philippinarum). Conversely, these marine bivalves have high tissue esterase activity (N-Acetyl-β-D-glucosaminidase). Another serine esterase activity activated in the non-catalytic detoxification of OP pesticides. A recent in vitro study with the mussel species Mytilus galloprovincialis evidenced that CE activity is highly sensitive not only to OP pesticides, but also to other chemicals of current concern, such as pharmaceuticals, personal care products, and polybrominated flame retardants. Not only in vitro but also in vivo environmental exposures to pesticides and other anthropogenic chemicals reveal inhibition of CEs in several bivalve species (mussels, cockles and raux shells). Herein is compared the CE activity of two marine bivalves, M. galloprovincialis and R. philippinarum, exposed to the retroviral drug Oseltamivir® under lab exposures. Current procedures for CE determinations generally measure the total hydrolytic activity of multiple CE isoforms using several nitrophenyl- and naphthyl-derived esters. Results obtained revealed that bivalve CE activity preferentially hydrolysed long-chain butyrate substrates (1-naphthyl butyrate) over acetate-derived substrates. Altogether, results highlight the value of CEs as biomarkers of toxicity by these compounds.
A6.19 NOVEL FATTY ACID ELONGASE (BMFAE) FROM BRYERTHUSIS MAGISTER REVEALED BIFUNCTIONAL ACTIVITIES IN SYNTHESIS OF VERY-LONG-CHAIN POLYSATURATED FATTY ACIDS BY METABOLICALLY ENGINEERED SACCHAROMYCES CEREVISIAE

WEDNESDAY 3 JULY, 2019 POSTER SESSION

JOUNG-SOO PARK (NATIONAL INSTITUTE OF AGRICULTURAL SCIENCES, KOREA (SOUTH)), TAE-HO KIM (NATIONAL INSTITUTE OF AGRICULTURAL SCIENCES, KOREA (SOUTH))

JONJOSUKOREA.KR

To develop a sustainable system for the production of the very long-chain polyunsaturated fatty acids (VL-PUFAs), we focused on the action of a key enzyme, fatty acid elongase (BMFAE), which is a crucial enzyme for DHA and AδA synthesis. BMFAE encoding a 1888-bp full-length DNA was cloned from Bryanthys magister by PCR and cloning. The sequence contained disrupted ORF-puouol prospergionp (ORF). To investigate the enzymatic activity of BMFAE, the production of DHA in the presence of BMFAE was examined. In the presence of BMFAE, a significant increase in DHA production was observed. This result indicates the possibility of the de novo production of VL-PUFAs. Lipid analysis revealed that fatty acid elongase (BMFAE) could be a multifunctional enzyme that could catalyze both ω and δ elongation.

A6.20 DIVERGENT MITOCHONDRIAL PLASTICITY IN RESPONSE TO ANOXIA-REOXYGENATION AND ELEVATED SACcharINc IN TWO ANOXIA-TOLERANT TROPICAL SHARKS

THURSDAY 4 JULY, 2019 POSTER SESSION

GILLIAN RENSHAW (ANZFIELD UNIVERSITY, AUSTRALIA), JULES DE BUVAX (UNIVERSITY OF AUCKLAND, NEW ZEALAND), TONY J. HICKEY (UNIVERSITY OF AUCKLAND, NEW ZEALAND)

G. RENSHAW@ANZFIELD.EDU.AU

Exposure to anoxia rapidly depletes ATP, alters metabolic pathways and compromises cellular function. Saccharin accumulates in mitochondria of ischemic brains and is rapidly oxidised upon reoxygenation, which elevates electron leakage and increases deleterious ROS production. While the neuronal function of most vertebrates is compromised after anoxia-reoxygenation (AR), the eelapulate shark (ES) and grey carpet shark (GS) display different adaptive responses to prolonged anoxia: while the ES enters energy conserving metabolic depression, the GCS temporarily elevates its haematocrit, a haematological trait rarely observed in other species. High-resolution respirometry coupled with flurometry assays were used to investigate mitochondrial function in mitochonrion from the cerebellar, a highly metabolic area of the brain. High oxygen-sensitive and vulnerable to injury after anoxia/re-oxygenation (AR). Saccharin was titrated into cerebellar preparations in vitro, with or without pre-exposure to AR, then the activity of mitochondrial complexes was examined. Overall, GCS mitochondria significantly increased succinate oxidation rates, with impaired complex I function post-AR. In contrast, ES mitochondrial inhibited succinate oxidation rates and both complex I and II capacities were conserved, resulting in preservation of oxidative phosphorylation capacity post-AR. ROS production was mediated by accumulating succinate and was lower in ES compared to GCS. Mitochondrial plasticity elicited by elevated succinate post-AR mirrors the diverse physiological adaptations of these sympatric species: the absence of GCS and presence of metabolic depression (ES).

A6.21 TRACE ELEMENTS CONTAMINATION AND SALINITY CHANGES: IMPACTS ON POLYCHAETES

WEDNESDAY 3 JULY, 2019 POSTER SESSION

ADILIA PIRES (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL), ROSA FREITAS (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL), CARLA PATINHA (UNIVERSITY OF AVEIRO, BIOGEOTECH, PORTUGAL), EDUARDO FERREIRA DA SILVA (UNIVERSITY OF AVEIRO, BIOGEOTECH, PORTUGAL), ETELMA FIOQUE (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL)

ADILIA@UA.PT

Eutrophic sediments are the ultimate sink of contaminants, as trace elements (TEs). Salinity changes are expected to have intricate effects on elements geochemistry and on biota sensitivity, mainly in organisms living in sediments, like polychaetes. Therefore, this study examines the interactions of TEs and salinity changes on polychaetes performance. The species Ficophoma enigmaticus, Hediste diversicolor, and Arenicola marina were exposed to TEs contaminated sediments (median and fine sand, collected from contaminated areas in ria de Aveiro lagoon, Portugal) and salinities 10 (S12), 28 (S282 control) and 40 (S40), for 28 days. Biochemical, behavioral and physiological responses of polychaetes were evaluated. After exposure, both types of sediments presented lower TE levels (As, Cd, Cu, Ni, Pb, Sn, Zn), when compared to original sediments, mainly medium sand exposed at S21 with H.diversicolor, highlighting that the burying behavior of this species and salinity changes sediments TEs availability. Considering TEs accumulation in organisms, the three species accumulated more TEs at S21 and S40. Polychaetes biochemical response evidence that LP levels were higher at S40 for the three species for both sediments. An increase of the activity of antioxidant (SOD, CAT, GPx) and biotransformation enzymes (GST) was observed at S21 and S40 for both sediments. Electron transport system activity decreased in H. diversicolor and A. marina exposed at S40 for both sediments, which was accompanied by a decrease in these polychaetes burying capacity. D. neapolitana exposed at S21 and S40, for both sediments, exhibited lower capacity to regenerate their body when compared to S28.

A6.22 PHYSIOLOGICAL ADAPTATIONS OF THE BAMBOO SHARK, CHYLOSCLYMUS PUNCTATUM: GILL AND RECTAL GLAND RESPONSE TO OXYGEN FLUCTUATION

THURSDAY 4 JULY, 2019 POSTER SESSION

JEAN-HERVE LIONET (UNIVERSITY OF MONTPELLIER MARBE LABORATORY, FRANCE), MATILDE LEJEUNE (UNIVERSITY OF MONTPELLIER MARBE LABORATORY, FRANCE), GILLIAN RENSHAW (ANZFIELD UNIVERSITY, AUSTRALIA)

JEAN-HERVE.LIONET@MONTPELLIER.FR

The elasmobranch bamboo shark (Chylloscyllium punctatum) frequently experiences hypoxic conditions in tropical coastal waters. Hypoxia challenges ATP production and can induce oxidative stress leading to cell damage, especially when water reoxygenation occurs. Oxygen fluctuation can also impact organ integrity and osmoregulation, an energy-consuming function. This study aims to investigate specific adaptations of the gills and rectal gland, oxidative stress injuries and energetic imbalance in the bamboo shark. Animals experiencing 2h of hypoxia followed by 24h of reoxygenation were compared to sharks maintained in normoxia. Osmoregulation was assessed through a morphological analysis of the mitochondrion-rich cells (MRCs) in the gills and rectal gland. Na+/K+-ATPase activity was also quantified. After 24h of hypoxia, sharks that experienced hypoxia present a 2-fold increased A11 MRC number compared to sharks maintained in normoxia. However, Na+/K+-ATPase activity quantified (fluorescence labelling) decreased in the rectal gland but in both organs Na+/K+-ATPase activity was unchanged. Plasma osmotic balance was not affected by reoxygenation and no cellular damage induced by oxidative stress was observed in the gills after the hypoxic period. Therefore, gill hyperventilation was observed along with a significant decrease in gill mitochondrial ATP synthase. Therefore, gill of the bamboo shark present high plasticity when facing oxygen fluctuations. Two opposite physiological hypotheses can be proposed: gill MRC proliferation could be a functional response to altered acid/base blood regulation (rather than the osmotic imbalance one could expect), or inactive MRC proliferation could be an uncouplable physiological response to environmental stress.

A6.23 EFFECTS OF TRACE METALS EXPOSURE ON LARVAL DEVELOPMENT OF TWO POPULATIONS OF FICOPOMATUS ENIMATIGUS

WEDNESDAY 3 JULY, 2019 POSTER SESSION

MATILDE SANCHES (UNIVERSITY OF AVEIRO, PORTUGAL), ADILIA PIRES (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL), ROSA FREITAS (UNIVERSITY OF AVEIRO, CESAM, PORTUGAL), CARLO PRETI (CIBM, ITALY)

MATILDE.VIEIRA@UA.PT

Ficopomatus enigmaticus is a selerosteid polychaete with gamete spawning occurring along different seasons throughout the year and in a wide range of salinity conditions. Owing to these characteristics, in addition to the easy sample and identification, a previous study suggested the possibility of this species to be used as model organism for both marine and brackish waters monitoring, by the performance of sperm toxicity and larval development assays. The present study was focused on larval development, comparing the response of two populations of F. enigmaticus (San Rossore-Migliarino Regional Park - Pisa, Italy; and Ria di Aveiro, Portugal) after exposure to different trace elements. Individually, larval development was evaluated for a diverse number of elements. For the Portuguese population, while Cd (1 163.28 µg/L) and Pb (1 160.00 µg/L) showed the least toxicity, for the Italian population, As toxicity was observed. Therefore, the sensitivity and suitability of these organisms to be used in ecotoxicological bioassays and monitoring protocols.

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Overall, salinity changes influenced TEs availability and both parameters impacted the studied species.
**A6.24 PHYSIOLOGICAL EFFECTS OF WASTEWATER EXPOSURE ON A MANGROVE CRAB: A FOCUS ON THE GILLS AND HEPATOPANCREAS**

LaureaMegvand (Université de Montpellier, France), Diana Martínez-Alarcon (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany), Dimitri Theurkauff (Université de Montpellier Centre Universitaire de Formation et de Recherche de Mayotte, France), Georgia A. Rivera-Ingraham (Université de Montpellier Laboratoire Environnement de Petit Saut, Hydreco Guyane, France), Elliott Sucé (Université de Montpellier Centre Universitaire de Formation et de Recherche de Mayotte, France), Zainab Hervé Lignot (Université de Montpellier, France)

Mangrove crabs play a key role in the functioning of the ecosystem through their bioturbation activity. They can be used as bioindicators for health assessment of the mangrove ecosystem, especially when this ecosystem is used as a natural filter for wastewater (WW) treatment processes. For instance, regular discharges of low-salinity, ammonia-rich WW impact the community crab species but the key effects on the individual physiology are still under evaluation. Therefore, using the burrower crab Necora puber (Sesarmidae) exposed in laboratory conditions to WW and ammonia (NH₄Cl), concentrations, we took into account the functional difference between anterior and posterior gills. Finally, a morphological analysis has been conducted to characterize the different cell types in the hepatopancreas, with a specific focus on the secretory B-cell type. Results provide an integrated view of the effects of WW and ammonia exposure on the gills and digestive gland. These biomarkers in the two studied organs constitute additional tools that can be used for functional and mechanistic studies.

**A6.25 BIOACUMULATION AND BIOCHEMICAL PATTERNS OF Ruditapes philippinarum CLAMS FROM THE RIA DE AVEIRO (PORTUGAL): RESPONSES TO SEASONALITY AND CONTAMINATION LEVELS**

Silvana T. Costa (University of Aveiro, Cesam, Portugal), Francesca Coppola (University of Aveiro, Cesam, Portugal), Joel Lopes (University of Aveiro, Cesam, Portugal), Bruno Henriques (University of Aveiro, Cesam, Portugal), Rui Monteiro (University of Aveiro, Cesam, Portugal), Russel Holm (University of Aveiro, Cesam, Portugal), Jianfeng Zengjie (University of Aveiro, Cesam, Portugal), Eduarda Pereira (University of Aveiro, Cesam, Portugal), Rosa Freitas (University of Aveiro, Cesam, Portugal)

Shellfish farming and harvesting activities have been practiced for long time in the Ria de Aveiro (Portugal). Among several commercial bivalves, Manila clam Ruditapes philippinarum represents one of the most important species inhabiting this ecosystem. Introduced in Portugal in 1984, naturalized R. philippinarum clam populations have been subjected to several pressures that may threaten their sustainable management: illegal fishing, harvesting in chemically polluted sites with impacts on human health, lack of control in terms of carrying capacity, with a risk for progressive decline of the biomass. Funded by the ASARISAFE project, the environmental quality of Manila clam productive sites was assessed, focusing on inorganic pollution, namely health status of clams regarding bioaccumulation and risks to human consumption, and clam's biochemical performance. Seasonal sampling campaigns (summer, autumn, winter, spring) were conducted in six R. philippinarum harvesting areas evaluating inorganic pollution levels in clam's tissues, sediments and water. Clams' biochemical performance in terms of metabolism, energy reserves and oxidative stress was also assessed. Results highlighted mercury and arsenic (As) as potentially toxic elements with the highest BAF (Bioaccumulation factor) values, with pollutants levels in tissues and sediments varying among sampling areas and season. The lowest amount of clam consumed per week exceeded the provisional tolerable week intake (PTWI) was found for As, 0.05 kg fresh weight. Further correlation analyses demonstrated that clam's biochemical performance was not responding to tissues contamination levels but were closely related to inorganic pollution with distinct metabolic capacity and oxidative stress levels among distinct seasons.

**A6.26 TOXIC IMPACTS OF RUTILE (TIO₂, NPS) IN MYTILUS GALLAPOPROVINCIALIS EXPOSED TO WARMING CONDITIONS**

Carla Leite (University of Aveiro, Cesam, Portugal), Francesca Coppola (University of Aveiro, Cesam, Portugal), Rui Monteiro (University of Aveiro, Cesam, Portugal), Tanja Russ (Universita degli Studi di Napoli Federico II, Italy), Ioana Maria Puse (Universita degli Studi di Napoli Federico II, Italy), Maria Ada Giordano (University of Aveiro, Cesam, Portugal), Taylor Palmiere (Ciczico-Aveiro Institute of Materials, Portugal), Eduarda Pereira (University of Aveiro, Cesam, Portugal), Rosa Freitas (University of Aveiro, Cesam, Portugal)

Climate change is leading to a gradual increase in the ocean temperature, which can cause physiological and biochemical impairments in aquatic organisms. Furthermore, it is already reported that warming may change the properties and toxicity of pollutants. The presence of pollutants in the aquatic ecosystem has been continuously increasing, with special concerns on the growth of emerging pollutants such as nanoparticles (NPs). Due to the broad applications of TiO₂ NPs, the presence of these NPs have greatly increased in aquatic systems. With rutile being the most common polymorph of TiO₂, the rutile NPs are a good starting point to assess its interaction with organisms. Thus, this study aimed to assess the effects of rutile NPs in Mytilus gallaprovincialis, under actual and predicted warming conditions. Organisms were exposed to different concentrations of rutile NPs (0, 5, 30, 100 μg/L) for 24h, 72h and 144h at temperatures of 18 ± 1°C and increased (22 ± 1°C) temperatures. Histopathological and biochemical changes were evaluated. Histopathological results revealed enlarged impacts on gills and digestive glands with increasing exposure concentrations, with similar variations at both temperatures. Biochemical markers showed that exposed mussels have an unchanged metabolic capacity at 17°C. However, the metabolic capacity increased at 22°C. Although humantioxidant defences were not activated in contaminated organisms under increased temperature, the cellular damage occurred under these conditions. Overall, our findings showed that histopathological impacts occurred after rutile NPs exposure regardless the temperature, while biochemical alterations were only significantly noticeable when temperature is enhanced to 22°C.

**A6.27 SALINITY ACCLIMATION OF THREE-SPINED STICKLEBACKS LIVING IN A SOUTHERN HOT MARGIN: FROM GENE AND PROTEIN EXPRESSION TO FISH O2 CONSUMPTION**

Jean-Hervé Lifouït (University of Montpellier Marine Laboratory, France), Eva Blondeau-Bidet (University of Montpellier Marine Laboratory, France), Sandrine Crochoumore (University of Montpellier Marine Laboratory, France), Quentin Rodriguez-Bolico (University of Montpellier Marine Laboratory, France), Khalid Rind (Shaheed Benazir Bhutto University, Pakistan)

Out-of-range populations must withstand specific environmental conditions, especially for coastal aquatic species dealing with predictable or unpredictable temperature and salinity fluctuations. This is particularly relevant for fish living in a ‘hot margin’, such as three-spined sticklebacks (Gasterosteus aculeatus L.). In the Camargue area (South of France), the population of this species is still abundant. Salinity is a key parameter in this coastal environment with interconnected freshwater canals, mesohaline and euryhaline lagoons. The effects of salinity and salinity changes on osmoregulation and energy consumption were studied using gene and protein expressions of key ion and water transporters. Na/K-ATPase (NKA) activity in the gills was also evaluated along with O₂ consumption. Sticklebacks were kept in laboratory conditions for 2 weeks in freshwater (FW: 5‰), seawater (SW: 30‰) or brackish water (BSW: 15 ‰). Other acclimated fish were transferred from SW to FW and FW to SW for up to 72h. Expression of the branchial NKA (NK A α1a/b and NK A α1c paralogs), aquaporin-3 (AQP3), sodium/hydrogen exchanger 3 (NHE3) and sodium/potassium/2chloride transporter (NKCC) were analysed. Results revealed that sticklebacks sustain different salinities and salinity changes with very limited energy use, although the gene and protein expressions of some transporters in the gills are rapidly modified. The effect of transcriptional chlormore than euryhaline species was of salinity expressed and NK A α1a/bparalogy on its relative expression due to salinity changes is discussed. Altogether, this study reveals that Mediterranean coastal sticklebacks have a strong euryhalinity capacity. Further work should also focus on the combined effects of temperature and salinity.
A6.28 LONG-TERM EFFECTS OF FLUOXETINE, PROPRANOLOL AND DICLOFENAC EXPOSURE IN A TOP PREDATOR FISH

Pharmaceutical compounds are continuously released into the aquatic environment, resulting in their ubiquitous presence in many estuarine and coastal systems. These compounds are designed to produce effects at very low concentrations and target specific biological pathways, which in many cases are evolutionarily conserved. Hence, there is growing concern whether these compounds elicit deleterious effects on aquatic organisms. In this context, long-term effects of the exposure to three different pharmacological compounds on juvenile meagre Argyrosomus regius were studied. Fish were exposed for 28 days to environmental concentrations (0.001-3.00 μg/L) of one of the pharmacutical: fluoxetine (anti-depressant), propranolol (anti-hypertensive) and diclofenac (non-steroidal anti-inflammatory agent). Multiple biomarker responses were analyzed in liver, muscle, heart and brain tissues, namely antioxidant and biotransformation enzymes activity (CAT, SOD, EROD, GST), biomarkers of effects (DNA damage, LDH, IDH, ETS), and of neurotoxicity (CAT, SOD, EROD, GST), biomarkers of effects (DNA damage, LDH, IDH, ETS), and of neurotoxicity (CAT, SOD, EROD, GST). Results showed that ZF-L cells were exposed to a range of temperatures from 28 to 40°C for 2 to 6 h, before measuring cell viability, apoptosis induction and expression of genes involved in cellular stress and metabolic pathways. Cell viability was stable up to 38°C where a decrease started to be observed. At 40°C, cell viability was near 0%. Heat shock proteins, antioxidants and metabolic enzymes were upregulated with temperature, and heat shock proteins remained upregulated above 39°C. This suggests a breakdown of metabolic and antioxidant pathways near 38°C. An important finding is that the different environmental concentrations tested did not affect the responses observed. The results indicate that the exposure to these compounds can impact cellular response to temperature stress and therefore can have a potential impact on aquatic organisms.

A6.29 ESTABLISHING UPPER THERMAL LIMITS AND MECHANISMS OF TEMPERATURE TOLERANCE IN AN IN VITRO FISH MODEL

It is well established that rising temperatures influence the physiology of aquatic animals. Several in vivo studies have established upper thermal limits (Tcrit) in various fish species and how these can accelerate changes in environmental temperatures. The factors that determine upper thermal limits and acclimation capacity in fish remain vague relating from systemic factors such as oxygen transport limitations to cellular aspects such as mitochondrial function. It is often difficult to tease apart the cellular mechanisms from the systemic response. We therefore aimed to establish in vitro model to study cellular temperature physiology. Using a zebrafish liver cell line (ZF-L), we aimed to investigate the temperature tolerance profile of this in vitro system, and 2) elucidate the cellular mechanisms that contribute to upper thermal limits. We exposed ZF-L cells to a range of temperatures from 28 to 40°C for 2 to 6 h, before measuring cell viability, apoptosis induction and expression of genes involved in cellular stress and metabolic pathways. Cell viability was stable up to 38°C where a decrease started to be observed. At 40°C, cell viability was near 0%. Heat shock proteins, antioxidants and metabolic enzymes were upregulated with temperature. The expression of genes involved in cellular stress and metabolic pathways suggest a breakdown of metabolic and antioxidant pathways near 38°C. The results suggest that ZF-L cells can be used as a model to study thermal limits and give indications about the pathways involved in setting Tcrit.

A7.1 CIRCADIAN RHYTHMICITY OF HEAT BALANCE AND BODY TEMPERATURES OF HAIR COAT SHEEP RAISED UNDER A TROPICAL-SEMI ARID ENVIRONMENT

The circadian rhythm is an adaptive mechanism of the animal, which synchronizes a wide range of physiological and behavioral functions to counter with the possible offensive environmental conditions. This research was designed to assess the circadian rhythmicity of body temperatures and sensible heat balance of Morada Nova sheep raised under a tropical-semi-arid region. Twelve healthy non-lactating Morada Nova ewes (3 ± 1.2 years old, body mass 32.7 ± 3.7 kg) were assigned in two 12 × 12 Latin square designs (from 07:00 to 19:00 and from 19:00 to 07:00, respectively) for 14 days. Results revealed the presence of an explicit monophasic rhythm in the overall ambient temperature circadian rhythm, which ranged between 22 and 37°C. The sensible heat loss (i.e., long-wave radiation and surface convection) of Morada Nova sheep exceeds the heat produced by metabolism between 20:00 and 05:00. The reduced rhythm of body temperatures (i.e., rectal, skin, and hair coat surface of ewes gradually increased (p < 0.05) from 05:00 to 19:00 with zenith value of 39.3, 30.3, 37.3, and 36.0°C, and nadir value of 37.90, 34.40, and 31.00°C, respectively. In conclusion, the Morada Nova sheep can have some difficulties in conserving their body heat not only on a circadian but also on a seasonal basis. Furthermore, this study explains the observed circadian changes in rectal temperature. Perhaps, behavioral adjustments such as huddling would help these animals to avoid substantial body cooling during nocturnal periods.

A7.2 COOKED OR EATEN? HIGH TEMPERATURES FORCE INCUBATING BIRDS TO TRADE-OFF INCREASED PREDATION RISK AGAINST MAINTENANCE OF OPTIMAL INCUBATION CONDITIONS

Ground-nesting birds can increase clutch survival by nesting in exposed locations that allow early detection and flight from an approaching predator. By isolating camouflaged eggs, this reduces the likelihood of nest being discovered, and thus predated. However, such nests provide little protection from the sun, and at our Zambian study site, unattended eggs can experience lethal temperatures. We hypothesised that high temperatures constrain laying birds to safely leave eggs unattended, such that at higher temperatures, birds are forced to reduce their flight initiation distances (FID)—a measure of how close an incubating bird can be approached before they fly the nest—in order to minimise exposure to lethal temperatures in six lower and seven species, while measuring FID across a range of ambient temperatures. At higher temperatures, birds reduced FID.
and returned to shade in response to overheating even though
it was consistently warmer at such times than during
the previous week. These results suggest that the
heat exposure and overheating even though
dealt with situations that were more stressful.

A7.4 THE ROLE OF PHENOTYPIC PLASTICITY IN THERMOREGULATORY CAPACITIES ON THE LEAF-EARED MOUSE GEGRAPHIC DISTRIBUTION UNDER CLIMATE CHANGE

**THURSDAY 4 JULY, 2019**

**KARIN MALDONADO** (FACULTAD DE ARTES LIBERALES, UNIVERSIDAD ADOLFO IBÁÑEZ, CHILE), GABRIELA PIRÍZ (DEPARTAMENTO DE CIENCIAS ECOLÓGICAS, FACULTAD DE CIENCIAS, UNIVERSIDAD DE CHILE, CHILE), ALEJANDRO CARO (DEPARTAMENTO DE CIENCIAS ECOLÓGICAS, FACULTAD DE CIENCIAS, UNIVERSIDAD DE CHILE, CHILE), PAUL JERÓNIMO (DEPARTAMENTO DE CIENCIAS ECOLÓGICAS, FACULTAD DE CIENCIAS, UNIVERSIDAD DE CHILE, CHILE), DANIÉL FIGUEIREDO (CENTRO DE INVESTIGACIÓN APLICADA DE CHILE (CIACH), CHILE)

There is good evidence that terrestrial and aquatic species distributions are shifting in response to climate change. Moreover, it has been shown that several temperature-related shifts are in the way expected due to their physiological responses to temperature. Accordingly, some hypotheses have focused on the idea that animals’ plasticity traits are the main factors limiting species geographic ranges. In this context, phenotypic plasticity in physiological thermoregulatory capabilities has been proposed as a key mechanism to deal with future environmental changes. To evaluate the role of phenotypic plasticity in the animal’s distribution, we examined some thermoregulatory capacities (TC; metabolic rates, thermal conductance and critical thermal limits) and flexibility in two rodent populations (Phyllotis darwini) from the northern and southern limits of their geographical distribution. This information was then incorporated into species distribution models (SDMs). In order to project the potential distribution of P. darwini in four climate change scenarios. Contrarily to our expectations, we found no small differences in phenotypic plasticity in P. darwini. In the future species distribution, the P. darwini distribution area only 2-3% higher in comparison with the SDMs that contained animals’ TC without considering its plasticity. Funded by CONICYT/ FONDECYT 1151341 to KM.

A7.5 RESPIRATORY AND CUTANEOUS HEAT LOSS IN ZEBRA FINCHES ACCLIMATED TO DIFFERENT THERMAL AND WATER REGIMES

**THURSDAY 4 JULY, 2019**

**ANNA KOWALCZEWSKA** (DEPARTMENT OF VERTEBRATE ZOOLOGY, NICHOLAS COPERNICUS UNIVERSITY, POLAND), MALGORZATA JEFIMOW (DEPARTMENT OF ANIMAL PHYSIOLOGY, NICHOLAS COPERNICUS UNIVERSITY, POLAND), MICHAŁ S. WOJCIECHOWSKI (DEPARTMENT OF VERTEBRATE ZOOLOGY, NICHOLAS COPERNICUS UNIVERSITY, POLAND)

When ambient temperature exceeds body temperature, the only way to dissipate heat is to evaporate water from the skin and respiratory tract surfaces. However, this brings about a significant loss of water, which may help to trigger hot and dry conditions. We asked whether prolonged exposure to hot and dry conditions results in adjustments in cutaneous and respiratory heat loss. To answer this question we used 40 male zebra finches (Taeniopygia guttata) that were accustomed to different thermal and water conditions. Ten out of 20 birds exposed to 23°C were water-deprived for half of the daylights. The remaining 20 birds were exposed to 40°C for the duration of the day and half of them was also water-deprived for 6 h/day. After a 3-month acclimation we measured cutaneous (CEHL) and respiratory (REHL) evaporative heat loss by open-flow respirometry. The results show that, overall, acclimation to hot or water restriction did not affect CEHL or REHL. In all birds measured at 25°C, CEHL was ~50% greater than REHL, while at 40°C REHL markedly increased and was ~3 times higher than CEHL. During exposure to 40°C, REHL increased ~2.5 times compared to 25°C. Results support the theory that passerines REHL is the main method of energy dissipation under heat stress. The study was supported by the National Science Center grant 2017/24/B/NSB/00541.

A7.6 BEHAVIOURAL THERMOREGULATION AND METABOLIC RECOVERY AFTER EXHAUSTIVE EXERCISE IN BROOK TROUT (Salvelinus fontinalis)

**THURSDAY 4 JULY, 2019**

**LAUREN E. ROWSEY** (UNIVERSITY OF NEW BRUNSWICK, NEW BRUNSWICK, CANADA), BEN SPERRY-ROEDICH (UNIVERSITY OF NEW BRUNSWICK, NEW BRUNSWICK, CANADA), JAMES D. KIEFFER (UNIVERSITY OF NEW BRUNSWICK, NEW BRUNSWICK, CANADA)

The effects of temperature on post-exercise recovery in fishes are widely studied, but questions remain about how metabolic processes are most important in driving temperature-dependent recovery and whether fish prioritize certain processes through thermal preference. For example, is it more advantageous to recover oxygen debt faster or cool the body faster to remove lactate quickly at warm water temperatures? We examined the influence of temperature on recovery processes and behavioural thermoregulation following a topical acclimation to and exercised at 15°C, then allowed to recover at either 15°C or 10°C while their excess post-exercise oxygen consumption (EPOC) was measured. Additionally, post-exercise metabolite levels were analyzed in fish assigned to one temperature recovery regimen. Results showed that EPOC were completed more rapidly at 10°C compared with 15°C, but 10°C the trade-off in hindering the recovery of plasma lactate and osmolality levels. Specifically, post-exercise plasma lactate and osmolality remained significantly different between the two temperature recovery groups, with a 10°C treatment group having significantly lower plasma lactate at 10°C, whereas these were recovered fully by 6 h in fish from the other two recovery groups. However, fish did not exhibit behavioral thermoregulation, with an average 53% of time spent in 15°C and 47% of time spent in 10°C, suggesting the physiological recovery processes measured here are not prioritized by the fish.

A7.7 LONG TERM SURFACE TEMPERATURE RESPONSES TO RECURRENT ACUTE STRESSORS

**THURSDAY 4 JULY, 2019**

**KATHERINE A. HERBORN** (UNIVERSITY OF PLYMOUTH, UNITED KINGDOM), BENJAMIN WILSON (NEWCASTLE UNIVERSITY, UNITED KINGDOM), MARGARET MITCHELL (BRUH, UNITED KINGDOM), ALAN MCELLODITT (UNIVERSITY OF ROXBROATH, UNITED KINGDOM), LUCY ASHER (NEWCASTLE UNIVERSITY, UNITED KINGDOM)

Stress elevates body core temperature, are poised termed ‘stress-induced hyperthermia’. In laboratory studies, body surface cooling is simultaneously observed: vasoconstriction in the peripheral shunts blood and hence warm to the core. Depending on stressor magnitude, with recovery a short term surface warming may also be observed as core heat is dissipated. Little is known about the impact of recurrent acute stress exposure on long term surface temperature. Chickens (Gallus gallus domesticus)emit a repetitive, high-energy ‘distress call’ when acutely stressed. Pharmacological studies have shown that chicks in an ‘anxiety-like’ state distress call continuously, while chicks in a ‘depression-like’ state call intermittently, at half the total rate. Using cognitive blast tests, we found that exposure to artificially generated stimuli that mimicked these natural call distributions put chicks in comparable emotional states, suggesting emotional contagion. Comb surface temperature was measured in the same chick using an overhead thermal camera. In trial 1 (30 chicks × 12 calls), one bird ‘recurrent exposure to bouts of ‘depression-like’ calls (15 min/bout) increased basal surface temperature by 1°C within the day. In trial 2 (127 individuals), exposure to bouts of ‘anxiety-like’ calls in early life (days 3-7) was associated with a greater surface temperature response to acute stress -30 days later. Treatment effects on growth rate and feed intake were also observed. We discuss surface temperature increase as a potential long term physiological cost of emotional state.
**A7.8 ASSESSMENT OF PHYSIOLOGICAL STATE IN FREE-LIVING BIRDS USING INFRARED THERMAL IMAGING**

**THURSDAY 4 JULY, 2019**

PAUL JEREM (UNIVERSITY OF SUSSEX, UNITED KINGDOM), DOMINIC MCCAFFERTY (UNIVERSITY OF GLASGOW, UNITED KINGDOM), DOROTHY MCKEEGAN (UNIVERSITY OF GLASGOW, UNITED KINGDOM), RIEDE NAGER (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

Assessment of physiological state in natural environments generally requires subjects to be trapped and handled, to sample blood or tissues, or for measurement devices to be attached/implanted. Such methods limit research to species and individuals that can be caught, restricting the generalisability of findings. Also, natural behaviors are interrupted, and subsequent physiology, behaviour and performance can be affected. One alternative strategy is to examine traits that can be measured without invasive sampling, which relate to underlying physiological processes in a predictable way. Body temperature is promising in this context, being linked with many multiphysiological functions, including metabolism and stress state. Nonetheless, relationships between physiological state and body temperature remain poorly understood in free-living species, principally as measuring body temperature also used to be more difficult and time consuming. Recently, however, low-cost, highly-portable thermal imaging cameras have opened up new opportunities to remotely measure body surface temperature ($T_s$), which is a non-invasive proxy for core temperature ($T_c$). This allows the study of the thermal landscape and the interplay between physiological state and environment, independently of environmental conditions, within the range we measured. Combined, these results suggest thermal imaging could provide an alternative, non-invasive method for inferring both short-term and longer-term physiological state in free-living organisms.

**A7.10 THERMAL AND METABOLIC RESPONSES TO DISEASE IN BIRDS**

**THURSDAY 4 JULY, 2019**

ANDREAS NORD (LUND UNIVERSITY, DEPARTMENT OF BIOLOGY, SECTION FOR EVOLUTIONARY ECOLOGY, SWEDEN)

In endotherms, infection by pathogens triggers secretion of immunological molecules, increased metabolic rate, and fever. In birds, collectively development of disease can make an animal hyperthermic and reduce its daytime activity. Although immunological responses are crucial to the host protective response, they may also cause metabolic costs. Here, we examine the thermal responses of birds to acute experimental infections caused by various pathogens. We assess the thermal responses of birds to both acute and chronic infections, and how these responses may affect the metabolic costs of disease and the general fitness of infected birds.

**A7.11 EFFECTS OF WINTER FOOD AVAILABILITY ON THE ENERGY BUDGET OF A WILDERNESS**

**THURSDAY 4 JULY, 2019**

SACHIN ANAND (LUND UNIVERSITY, SWEDEN), HANNAH WATSON (LUND UNIVERSITY, SWEDEN), JOHAN NILSSON (LUND UNIVERSITY, SWEDEN), JAN-ÅKE NILSSON (LUND UNIVERSITY, SWEDEN)

Birds living in temperate regions face an energetically demanding period in winter, when food availability becomes reduced and unpredictable. To conserve energy, wintering passerines reduce their metabolic rate (MR) and body temperature ($T_b$) during the cold night. However, this must be balanced against increased locomotor costs. The development of novel methods to measure food availability on the energy budget of birds is not fully understood. Therefore, we studied the energy budget of birds using an integrated taxa (Parus major) by concurrently measuring MR and $T_b$ during the night in the

**A7.7 PLUMAGE DEVELOPMENT AND ENVIRONMENTAL FACTORS INFLUENCE SURFACE TEMPERATURE GRADIENTS IN WANDERING ALBATROSS (DIOMEADA EXULANS) CHICKS**

**THURSDAY 4 JULY, 2019**

DAVID & STONE (INSTITUTE OF BIODIVERSITY ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM), CARRIE GULL (BRITISH ANTARCTIC SURVEY, UNITED KINGDOM), ANDREAS NORD (DEPARTMENT OF BIOLOGY, LUND UNIVERSITY, SWEDEN), RICHARD A PHILLIPS (BRITISH ANTARCTIC SURVEY, UNITED KINGDOM), DOMINIC J MCCAFFERTY (INSTITUTE OF BIODIVERSITY ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM)

Surface temperature gradients are critical for thermoregulation in the extreme environments in which albatrosses (Diomedea exulans) breed. These birds inhabit some of the most remote and inhospitable places on Earth, with wind speeds often exceeding 100 km/h and temperatures dropping below freezing. Understanding the factors that influence surface temperature gradients is crucial for the conservation and management of these species. This talk will explore the role of plumage development and environmental factors in shaping surface temperature gradients in wandering albatrosses.

**A7.12 SURFACE, PERIPHERAL AND INTERNAL TEMPERATURE WARMING AFTER HYPOTHERMIA: AN UNEXPECTED STRATEGY**

**THURSDAY 4 JULY, 2019**

ANDREAS NORD (DEPARTMENT OF BIOLOGY, SECTION FOR EVOLUTIONARY ECOLOGY, LUND UNIVERSITY, SWEDEN), MANUEL CAMPOS STRASBOURG, FRANCE, YVES HANDRICH (ECOSYS-CNRS STRASBOURG, FRANCE), DOMINIC J MCCAFFERTY (SCOTTISH CENTRE FOR ECOLOGY AND THE NATURAL ENVIRONMENT, UNIVERSITY OF GLASGOW, UNITED KINGDOM)

In endotherms, infection by pathogens triggers secretion of immunological molecules, increased metabolic rate, and fever. In birds, collectively development of disease can make an animal hyperthermic and reduce its daytime activity. Although immunological responses are crucial to the host protective response, they may also cause metabolic costs. Here, we examine the thermal responses of birds to acute experimental infections caused by various pathogens. We assess the thermal responses of birds to both acute and chronic infections, and how these responses may affect the metabolic costs of disease and the general fitness of infected birds.

**A7.7 PLUMAGE DEVELOPMENT AND ENVIRONMENTAL FACTORS INFLUENCE SURFACE TEMPERATURE GRADIENTS IN WANDERING ALBATROSS (DIOMEADA EXULANS) CHICKS**

**THURSDAY 4 JULY, 2019**

DAVID & STONE (INSTITUTE OF BIODIVERSITY ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM), CARRIE GULL (BRITISH ANTARCTIC SURVEY, UNITED KINGDOM), ANDREAS NORD (DEPARTMENT OF BIOLOGY, LUND UNIVERSITY, SWEDEN), RICHARD A PHILLIPS (BRITISH ANTARCTIC SURVEY, UNITED KINGDOM), DOMINIC J MCCAFFERTY (INSTITUTE OF BIODIVERSITY ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM)

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A7.14 THERMAL CHALLENGES DURING FORAGING SUGGEST AN ENERGETIC BOTTLENECK FOR JUVENILE KING PENGUINS DURING THEIR EARLY LIFE AT SEA

THURSDAY 4 JULY, 2019  15:25

MANFRED R ENSTIPP (IZP-DEPE-CNRS AND CENTRE D’ETUDES BIOLOGIQUES DE CHERZI CNRS, FRANCE), CHARLES-ANDRE BOST (CENTRE D’ETUDES BIOLOGIQUES DE CHERZI CNRS, FRANCE), CELINE LE BIHOEC (IZP-DEPE-CNRS AND CENTRE SCIENTIFIQUE DE MONACO, FRANCE), CAROLINE BOST (CENTRE D’ETUDES BIOLOGIQUES DE CHERZI CNRS, FRANCE), YVON LE MAHO (IZP-DEPE-CNRS AND CENTRE SCIENTIFIQUE DE MONACO, FRANCE), HENRI WESERSEKER (CENTRE D’ETUDES BIOLOGIQUES DE CHERZI CNRS, FRANCE), YVES HENDRICH (IZP-DEPE-CNRS, FRANCE)

MANFRED.ENSTIPP@CNRS.FR

The early life at sea of marine top predators, like deep diving king penguins (Aptenodytes patagonicus), is likely a critical phase. Apart from finding favourable foraging sites, they have to develop effective prey search patterns as well as physiological capacities that enable them to capture sufficient prey, often at great depth, to meet their energetic needs. To investigate the trajectory of their thermoregulatory responses at sea, we imputed 30 juvenile king penguins and eight adult breeder with a small data logger that recorded pressure and subcutaneous temperature continuously until 2.5 years. We found important changes in the development of peripheral temperature patterns of foraging juvenile king penguins throughout their first year at sea. Peripheral temperature patterns during foraging trips, when peripheral vasodilatation leads to a thermal gradient between the warmer body core and the cooler shell, fell to increasingly lower levels during the first 6 months at sea, after which it stabilized. Most importantly, these changes re-occurred during their second year at sea, after birds had fasted for 4-6 weeks on land during their 2nd molt. Furthermore, similar peripheral temperature patterns were also present in adult birds during foraging trips throughout their breeding cycle. We suggest that these seasonal temperature changes mainly reflect differences in thermal insulation, associated with modifications of the subcutaneous fat layer. Heat loss estimates for juveniles at sea were initially high but declined to half, after 6 months at sea, indicating that juvenile king penguins face a strong energetic challenge during their early oceanic existence.

A7.15 ANIMAL SURFACE TEMPERATURE AND EVAPORATIVE HEAT TRANSFER

THURSDAY 4 JULY, 2019  15:40

DUNCAN MITCHELL (SCHOOL OF PHYSIOLOGY, UNIVERSITY OF THE WITWATERSRAND, SOUTH AFRICA), ROBYN S HETY (SCHOOL OF ANIMAL PLANT AND ENVIRONMENTAL SCIENCES, UNIVERSITY OF THE WITWATERSRAND, SOUTH AFRICA), EDWARD P SNELLING (DEPARTMENT OF ANATOMY AND PHYSIOLOGY, UNIVERSITY OF PRETORIA FACULTY OF VETERINARY SCIENCE, SOUTH AFRICA), SHANE K MALONEY (SCHOOL OF HUMAN SCIENCES, UNIVERSITY OF WESTERN AUSTRALIA, AUSTRALIA), VINICUS FC FONSECA (INNOVATION IN ANIMAL BIOMETERICAL GROUP, SÃO PAULO STATE UNIVERSITY, BRAZIL), ANDREA FULLER (SCHOOL OF PHYSIOLOGY, UNIVERSITY OF THE WITWATERSRAND, SOUTH AFRICA)

DUNCAN.MITCHELL@WITS.AC.ZA

Until recently, active sweating was considered essential for controlled surface evaporative cooling, but controlled evaporative cooling occurs also by passive diffusion across the skin, independent of subcutaneous water. Surface temperature plays a modulating role on skin blood flow, but probably a more direct role on diffusion rate. Dolic chronic mammals are an at advantage because the evaporative heat transfer coefficient is higher for narrow body parts. However, our recent data suggest that there is a need to take account of the surface area necessary for high evaporative and evaporate a smaller proportion of their body water pool per Watt of cooling. In spite of relative humidity being the psychrometric variable identified in the same analyses of evaporative heat transfer, the rate of evaporation depends on surface and atmospheric water vapour pressure, not atmospheric relative humidity. It is possible for an animal to cool evaporatively in an atmosphere with a relative humidity of 100%. For psychrometric reasons, the gradient for surface evaporative cooling increases steeply when surface temperature increases. However, because the phase change of water from liquid to vapour is isothermal, surface temperature remains constant during further increases in surface evaporative cooling once the surface is fully wet, and then the measurement of surface temperature provides no information on the rate of evaporative cooling. In environments where radiation and convection impose heat gain on mammals, predicted to be increasingly common under climate change, maintaining body temperature will depend on sustained evaporative cooling and consequently access to water, diminishing resource in and regions.

A7.16 HOW DOES WINTER FOOD SUPPLY MODULATE THE FEVER RESPONSE IN A SMALL BIRD?

THURSDAY 4 JULY, 2019  15:55

HANNAH MASON (LUND UNIVERSITY, SWEDEN), JAN-ÅKE NILLSON (LUND UNIVERSITY, SWEDEN), JOHAN NILLSON (LUND UNIVERSITY, SWEDEN)

HANNAH.MASON@LUSE.LU.SE

Invertebrates, fever-ally regulated increase in body temperature -is integral to the acute phase response to an invading pathogen. While beneficial in fighting pathogens, fever is energetically costly, and mounting a fever response is thus likely to trade off against competing energetic demands for e.g. reproduction, thermoregulation, and foraging. During winter, in cold temperate regions, small vertebrates are likely to be even more constrained in respect of energy available for mounting an immune response. Furthermore, during the long winters nights, a fever response may be odd with the simultaneous restriction in body temperature and metabolic rate that small birds typically employ in order to conserve energy reserves. We have previously shown that the predictability of food resources, and therefore the acquisition of energy, influences the depth of rest-phase hypothermia in wild birds in winter. Similarly, we expect that food availability is likely to influence the magnitude of the nocturnal fever response. We manipulated food availability in the wild for great tits Parus major wintering in southern Sweden. In late winter, birds exposed to both ‘predictable’ and ‘unpredictable’ food availability were expected to an immune challenge, via injection of lipopolysaccharide (LPS), continuous recording of body temperature throughout the night, via subcutaneous temperature-sensitive PIT tags, which enabled detailed quantification of the thermoregulatory response to an immune challenge under different levels of predictability. These findings will shed light on the trade-offs associated with food acquisition, the thermoregulation and immune function in small birds.

A7.17 SEASONAL VARIATION IN USE OF NET BOXES AS ENERGY SAVING STRATEGY OF BLUE TITS (CYANISTES CAERULEUS) IN WINTER

THURSDAY 4 JULY, 2019  16:57

ANNA HUXTABLE (INSTITUTE OF BIODIVERSITY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM), ANDREAS NORD (DEPARTMENT FOR BIOLOGY, LUND UNIVERSITY, SWEDEN), DOMINIC J MCCAFFERTY (INSTITUTE OF BIODIVERSITY, ANIMAL HEALTH, COMPARATIVE MEDICINE, UNIVERSITY OF GLASGOW, UNITED KINGDOM)

ANNA.HUXTABLE@GLASGOW.AC.UK

Roosting in a sheltered site is often reported to have thermal advantages for small endotherms, by minimising heat exchange with the environment and thermal benefits from favourable microclimates. Many species of birds choose to roost in nest boxes in winter but the extent to which this behaviour is influenced by weather and the thermal advantages of roosting is often poorly understood. We investigated the seasonal variation in the occupancy of nest boxes by blue tits (Cyanistes caeruleus) in a temperate oak woodland in the west of Scotland during winter 2018-19. The aim was to assess how temperature, precipitation, photoperiod and changes in population size determine winter occupancy. We also investigated how location (exposure and aspect) influenced microclimate and probability of occupancy across the study area. Overall, we found woodland nest boxes occupied through the winter (2-10%) and our results suggest a negative correlation between photoperiod and occupancy, with more birds occupying a day-length increased. However, occupancy did not appear to be correlated with weather or nest box temperature. These findings suggest nest box occupancy is linked to changes in local population size that decrease at the start of winter and increased in later winter/early spring. Results from our study in a relatively warm-temperate location, complement previous studies in harsher, continental climates and add to our understanding of overwintering strategies of small passerines.

A7.18 THE EFFECTS OF WINTER WEATHER ON ANVAN ENERGETICS IN A CHANGING CLIMATE

THURSDAY 4 JULY, 2019  16:59

HEATHER REILLY (UNIVERSITY OF GLASGOW, UNITED KINGDOM), ANNA-HORTALED (UNIVERSITY OF GLASGOW, UNITED KINGDOM), DOMINIC J MCCAFFERTY (UNIVERSITY OF GLASGOW, UNITED KINGDOM), ANDREAS NORD (LUND UNIVERSITY, SWEDEN)

HEATHERREILLY66@GMAIL.COM

Winter is an energetically demanding season for small birds as low temperature reduces the thermoregulatory costs that coincide with low food availability. To better understand the effects of winter climate, e.g. increasing temperature and precipitation, and higher frequency of extreme weather events, is likely to have energetic consequences for these birds. The aim of this study was therefore to determine the thermoregulatory costs during winter in three species of sympatric passerines of different body sizes and with different foraging ecology, and used these data to predict future climate shifts that will impact energetic responses to extreme events. We undertook weekly thermal imaging of blue tits (Cyanistes caeruleus) and great tits (Parus major) wintering in the west of Scotland, UK, to obtain body surface temperatures in active birds during daylight periods. These data were used in a biophysical heat transfer model incorporating bird morphometric and meteorological data, to estimate metabolic heat loss. The metabolic cost of the thermoregulation was strongly correlated with environmental conditions throughout the winter, showing variation in costs was species-specific. Our study suggests that metabolic savings due to elevated winter temperatures may be offset by increasing precipitation and wind during severe weather events, with possible consequences for energetics of these small resident birds.
A7.19 USING DRONES WITH THERMAL INFRARED SENSORS FOR ANIMAL CONSERVATION

THURSDAY 4 JULY, 2019 16:40
SERGE MICH (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), STEVE LONMORE (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), CLAIRE BURKE (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), MALISE RASHMAN (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), OWEN MCARIE (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), PAUL MCHIRTER (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM), JOHN VESTCHY (LIVERPOOL JOHN MooRES UNIVERSITY, UNITED KINGDOM)

S. A. WICH@LJMU.AC.UK

Land-cover change and hunting are leading to major declines in tropical biodiversity. The fast changes occurring in the tropics place urgent need on rapid and affordable techniques to monitor wildlife and its habitats. Recently the use of drones in conservation has increased markedly. Drones allow for the acquisition of data with a variety of sensors. The majority of research has been conducted with visual spectrum sensors but these have limitations in terms of their spectral bandwidth and observations during times when daylight is available. Here we focus on the use of thermal infrared sensors for the detection and classification of animals and poachers. We will provide results from studies on orangutans in Sabah, poachers in Tanzania, spider monkeys in Mexico and orangutans in the United Kingdom. These results indicate that thermal infrared sensors can facilitate animal detection, but that time of day and vegetation influences detection. We provide some preliminary results on the use of machine learning to detect and classify animal thermal footprints. We will end with some thoughts on future plans.

A7.21 WET-BULB TEMPERATURE IS NO GOOD AT PREDICTING HUMAN RESPONSES TO HOT ENVIRONMENTS AND EASY-TO-USE ALTERNATIVES EXIST

THURSDAY 4 JULY, 2019 17:25
SHANE K MALONEY (THE UNIVERSITY OF WESTERN AUSTRALIA, AUSTRALIA), DUNCAN MITCHELL (UNIVERSITY OF THE WITWATERSRAND, SOUTH AFRICA), MICHAEL R KEARNEY (THE UNIVERSITY OF MELBOURNE, AUSTRALIA)

Because heat exchange between humans and the environment depends on factors in addition to the temperature of the air, many indices have been developed that attempt to incorporate the effect of those other factors on human responses to heat. For example, convective heat exchange depends on the air temperature and also on the wind speed, radiant heat exchange depends on the surface temperature of every object that the body can "see" (the mean radiant temperature), and evaporative heat exchange depends on the ambient water vapour pressure and the wind speed. In many studies of human responses to heat, wet-bulb temperature, which depends on only air temperature and water vapour pressure, has been used as a single index to predict how human activity (including labour productivity) will be impacted in a climate-changed future. We show that the wet-bulb temperature correlates poorly with the upper limit of the prescriptive zone for active humans. An alternative to a simplified index is to embrace the complexity and employ rational heat balance modelling to estimate each route of heat exchange, to sum the outcomes to estimate overall heat balance, and to use heat balance to predict responses to heat. Several such models have been developed and employed with varying success. The rise in computer power and ease of use of software platforms, such as R, has made the implementation of such models less arduous. We use one such model to show the hazards of using wet-bulb temperature for predicting labour productivity in a climate-changed future.
A8 HOW DO ANIMALS MANAGE THEIR ENERGY EXPENDITURE? ENERGETICS: FROM MOLECULES TO ORGANISMS

ORGANISED BY: LEWIS HALSEY (UNIVERSITY OF ROEHAMPTON) AND VINCENT CAREAU (UNIVERSITY OF OTTAWA)

A8.1 CONSTRAINTS ON TOTAL DAILY ENERGY EXPENDITURE AFFECT HEALTH, ECOLOGY, AND EVOLUTION IN HUMANS AND OTHER ANIMALS

FRIDAY 5 JULY, 2019  09:00

HERMAN PONTZER (DUKE UNIVERSITY, UNITED STATES)

A8.2 FLEXIBILITY, VARIABILITY AND CONSTRAINT IN ENERGY MANAGEMENT PATTERNS ACROSS VERTEBRATE TAXA REVEALED BY LONG-TERM HEART RATE MEASUREMENTS

FRIDAY 5 JULY, 2019  09:30

VINCENT CAREAU (UNIVERSITY OF OTTAWA, CANADA), LEWIS HALSEY (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), JOHNNY GREEN (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM)

V CAREAU@UOTTAWA.CA

A8.4 ENERGY MANAGEMENT AND LACTATION PERFORMANCE ENVELOPES: A NOVEL FRAMEWORK FOR ASSESSING TRADE-OFFS AND RESILIENCE IN A WILD PINNIPED

FRIDAY 5 JULY, 2019  10:00

COURTNEY R SHUKERT (DURHAM UNIVERSITY, UNITED KINGDOM), LEWIS HALSEY (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), PATRICE P POMEROY (UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), SEAN D T WISS (DURHAM UNIVERSITY, UNITED KINGDOM)

A8.3 DOES REGRESSION DILUTION AFFECT INTERPRETATIONS OF ENERGY MANAGEMENT PATTERNS?

FRIDAY 5 JULY, 2019  09:45

LEWIS HALSEY (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), ANGELA PERNA (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM)

L. HALSEY@ROEHAMPTON.AC.UK

A8.5 CAN CONTAMINANT LEVELS IN THE WILD ALTER ENERGY BALANCE? LINKING IN VITRO EXPERIMENTS WITH MASS CHANGE TRAJECTORIES IN GREY SEALS

FRIDAY 5 JULY, 2019  10:15

KIMBERLEY A BENNETT (ABERTAY UNIVERSITY, UNITED KINGDOM), KELLY J HOBSON (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), HOLLY C AMSTRONG (ABERTAY UNIVERSITY, UNITED KINGDOM), SIMON EN NAY (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), GEORGES SCHOLL (UNIVERSITÉ DE LIEGE, BELGIUM), GAUTHIER EPPE (UNIVERSITÉ DE LIEGE, BELGIUM), JEAN-PIERRE DE LIEGE, BELGIUM, CATHY DEBAR (UNIVERSITÉ CATHOLIQUE DE LOUVAIN, BELGIUM), ALJA J HALL (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM)

K. BENNETT@ABERTAY.AC.UK
A8.6 ENERGY BALANCE EFFECTS OF PERSISTENT ORGANIC POLLUTANTS: EXPERIMENTAL EXPOSURE TO PCBs ALTERS BLUBBER GLUCOSE UPTAKE SENSITIVITY TO T3 IN VITRO

FRIDAY 5 JULY, 2019 10:30

KELLY J ROBINSON (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), AILSA J HALL (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), GUTHRIE EPPE (UNIVERSITY OF LIEGE, BELGIUM), KIMBERLEY A BENNETT (ABERTAY UNIVERSITY, UNITED KINGDOM)

Thyroid hormones (T) are involved in energy balance regulation through effects on metabolic rate, and are a valuable exposure tool to discern disruptors such as persistent organic pollutants (POPs) and plasticisers, including benzyl butyl phthalate (BBP). T are vital in initiating and maintaining Blair puffins' high body temperatures. We investigated changes in T cycling during moult, where different birds were at different stages. We found that T3 sensitivity was lower in young than in adults, which may disrupt fat storage and energy balance in a similar way in other species. POPs also affected the uptake of glucose in response to T3 treatment (LME: T = 1.97; p = 0.05; n = 45, n(animals) = 16). There was a positive relationship between glucose uptake and T3 (LME: p = 0.0330). Glucose uptake did not change in response to moulted state, overnight blubber temperature or exposure area. Our data show that T3 is important in the regulation of blubber function in juveniles.

A8.7 ENERGY BALANCE REGULATION IN JUVENILE GREY SEALS: T3 AFFECTS BLUBBER GLUCOSE UPTAKE

FRIDAY 5 JULY, 2019 10:45

HOLLY C ARMSTRONG (ABERTAY UNIVERSITY, UNITED KINGDOM), KELLY J ROBINSON (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), SIMON EW MOSS (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), AILSA J HALL (SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, UNITED KINGDOM), KIMBERLEY A BENNETT (ABERTAY UNIVERSITY, UNITED KINGDOM)

Fattiregulation is a vital component of energy balance. Marine mammals store fat as blubber, which also provides insulation. Blubber reserves fluctuate radically throughout the annual cycle in relation to life history events and food availability and are the site of accumulation of lipophilic contaminants. The regulation of blubber tissue function is poorly understood. Thyroid hormones (T) are involved in energy balance regulation through effects on metabolic rate and are a valuable exposure tool to discern disruptors such as persistent organic pollutants (POPs) and plasticisers, including benzyl butyl phthalate (BBP). T are vital in initiating and maintaining Blair puffins' high body temperatures. We investigated changes in T cycling during moult, where different birds were at different stages. We found that T3 sensitivity was lower in young than in adults, which may disrupt fat storage and energy balance in a similar way in other species. POPs also affected the uptake of glucose in response to T3 treatment (LME: T = 1.97; p = 0.05; n = 45, n(animals) = 16). There was a positive relationship between glucose uptake and T3 (LME: p = 0.0330). Glucose uptake did not change in response to moulted state, overnight blubber temperature or exposure area. Our data show that T3 is important in the regulation of blubber function in juveniles.

A8.8 (CO-)VARIATION BETWEEN ENERGY ACQUISITION, STORAGE AND USE IN A MIGRATORY SHOREBIRD: WHAT CAN WE DISCOVER FROM TRANSMITTERS?

FRIDAY 5 JULY, 2019 11:30

KIMBERLEY MATHOT (UNIVERSITY OF ALBERTA, CANADA), EVA MA KOX (NOIZ ROYAL NETHERLANDS INSTITUTE FOR SEA RESEARCH AND UNIVERSITY OF GRONINGEN, NETHERLANDS), THEUNIS PIERSMA (NIOZ ROYAL NETHERLANDS INSTITUTE FOR SEA RESEARCH AND UNIVERSITY OF GRONINGEN, NETHERLANDS)

In this study, we present a long-term monitoring of a group of Bar-tailed godwits (Limosa lapponica) using transmitter data. We found a positive relationship between total energy acquisition and T3 (LME: p = 0.0330). Glucose uptake did not change in response to moulted state, overnight blubber temperature or exposure area. Our data show that T3 is important in the regulation of blubber function in juveniles.

A8.9 THE SLEEP DILEMMA OF NOCTURNAL MIGRANTS

FRIDAY 5 JULY, 2019 12:00

ANDREA FERRETTI (UNIVERSITY OF VIENNA, AUSTRIA), NIELS RATTENBORG (MAR PLANET INSTITUTE, GERMANY), MASSIMILIANO CARDINALE (SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES, SWEDEN), LEONIDA FUASNI (VETERINARY UNIVERSITY OF VIENNA, AUSTRIA)

During migration, many birds must balance sleep and other important activities in order to survive their journey. In this study, we investigated the effects of sleep deprivation on the energy budget of nocturnal migrants. We found that sleep deprivation leads to a decrease in energy intake and an increase in energy expenditure. This suggests that sleep is essential for energy balance and survival during migration.

A8.10 ENERGY MANAGEMENT AND LOCOMOTOR ACTIVITY IN LABORATORY MICE DIVERGENTLY SELECTED FOR BASAL METABOLIC RATE

FRIDAY 5 JULY, 2019 12:15

Paweł Brzez (UNIVERSITY OF BIALYSTOK, POLAND), Piotr Selewski (UNIVERSITY OF BIALYSTOK, POLAND), Andrzej Dobczynski (UNIVERSITY OF BIALYSTOK, POLAND), Jan Niedergaard (STOCKHOLM UNIVERSITY, SWEDEN), Marek Koninzenzki (UNIVERSITY OF BIALYSTOK, POLAND)

Basal metabolic rate (BMR) represents unavoidable costs of body maintenance and obligatory heat production. Thus, variation in BMR can potentially affect the composition as well as constrain flexibility of energy expenditure in endotherms. The effects of selection on energy metabolism (RMR) were measured in two strains of laboratory mice selected towards either high (HBMR) or low (LBMR) BMR. Both strains selected for high RMR show higher energy expenditure but this difference disappeared when ambient temperature was reduced. Compared to LBMR mice, HBMR mice had higher spontaneous locomotor activity but lower capacity of non-shivering thermogenesis, and lower total amount of UCP! (major thermogenic protein) in brown adipose tissue. All these responses can be linked directly to between-line differences in BMR. Although ambient temperature affected most of studied traits, this effect was usually similar across both lines. Thus, elevated voluntary heat production does not seem to constrain energy budget of HBMR mice at higher ambient temperature.

A8.11 MANAGING ENERGY TO SURVIVE ON THE TIBETAN PLATEAU: THE PLATEAU PICA

FRIDAY 5 JULY, 2019 15:00

John Speakman (University of Aberdeen, United Kingdom, Chinese Academy of Sciences, China)

Averaging 4500m in altitude the Tibetan plateau presents many physiological challenges to its fauna, including low precipitation, low oxygen partial pressure, and temperatures routinely dropping below -40°C in winter. Yet it is home to many endemic mammalian species, including the plateau pika (Lagomorpha: Ochotona curzoniae). How these small mammals are capable of such adaptations remains a challenge for biologists. In this study, we evaluated the potential for the plateau pika to survive in a low temperature environment.
Liver were measured with the Soxhlet method. The results from fat reserves were then compared to the actual energy demands (mean 1698g/day). The overall scaling for the lean tissue and white adipose tissue (WAT) was found to be 0.832 and 0.42, respectively. In the end, total energy reserves were overlaid on the relation between energy expenditure and body mass to construct the fasting endurance curve. Our results showed that pika weighing less than 1.3 kg had insufficient fat reserves to last 1 day without food. As mass increased above 1.3 kg the pika could survive for increasingly longer periods with the largest pika able to live 3-5 days with no food supply. The assumptions of the Bergman model of body size based on greater potential fasting endurance of larger animals are therefore supported in this species.

A8.13 ROLE OF PREVIOUS PARASITE EXPOSURE IN ROUTINE METABOLIC RATE AND BRAIN SEROTONIN DYNAMICS FOLLOWING ACUTE INFECTION

FRIDAY 5 JULY, 10:30

LAUREN E. NADEL (NORWEGIAN UNIVERSITY OF LIFE SCIENCES, NORWAY), HELENE LE MIDTTUN (NORWEGIAN UNIVERSITY OF LIFE SCIENCES, NORWAY), SHAILA S. KULLEN (UNIVERSITY OF GLASGOW, UNITED KINGDOM), MARCO A. VINDAS (NORWEGIAN UNIVERSITY OF LIFE SCIENCES, NORWAY), TIJEVAN EVERLI (NORWEGIAN UNIVERSITY OF LIFE SCIENCES, NORWAY), IDA B. JOHANSEN (NORWEGIAN UNIVERSITY OF LIFE SCIENCES, NORWAY)

Moderators: LAUREN. LAUERKHAU. NO

Hosts incur energetic and often fitness-related costs from harboring parasites. Parasite infection typically stimulates an immune response in the host, the energetic cost of which can create a potential tradeoff between immediate survival and body condition, foraging, reproduction and other important processes. However, this response varies greatly among and within hosts, depending on the pathogenicity of the parasite, the condition of the host, and ambient environmental conditions. While studies of often focus on the long-term costs of infection, we know relatively little about how host energetics are altered during a and immediately following parasite exposure, and the relative importance of acute and long-term infection costs to the host’s energy budget. Here, we examined the effects of brain-infecting microsporidian parasite (Pseudoloma neurophilia) on its host fish, the zebrafish (Danio rerio). We measured how the acute infection process alters metabolic rate in naive versus previously infected hosts, and whether these effects are accompanied by changes in brain neurochemistry (particularly serotonergic activity) which can be interpreted as the 'stress' response to infection. To do so, we injected naïve and infected zebrafish, and examined the impact of parasite infection on baseline metabolic rate and brain serotonin dynamics. Our results suggest that brain serotonin levels are depressed by acute infection and that the degree of depression is related to the number of parasites infecting the host brain. These findings support the hypothesis that brain serotonin levels may be a useful tool for assessing the impact of infection on host energetics.

A8.14 CORTICOSTEROIDE LEVELS REFLECT VARIATION IN METABOLIC RATE, INDEPENDENT OF 'STRESS'

FRIDAY 5 JULY, 15:45

SIMON VERKULST (UNIVERSITY OF DORDRECHT, NETHERLANDS), BLANCA M. HERNANDEZ (UNIVERSITY OF DORDRECHT, NETHERLANDS), MICHAELA HAU (MAX PLANCK INSTITUTE FOR ORNITHOLOGY, SEEBESEN, GERMANY)

Moderators: S. VERKULST/NU, HR

Variation in glucocorticoid hormones (GCs) is often interpreted as reflecting 'stress', but this interpretation is subject of debate. GCs induce gluconeogenesis, and we hypothesize thereby that the GC variation can be explained by changes in acute and anticipated metabolic rate (MR). Alternatively, GC levels may respond to psychological stress' over and above effects on metabolic rate. We tested these hypotheses in captive zebra fish, by inducing an increase in MR through surgical stressor (no), and comparing its effect on corticosterone (the primary avian GC) with the effect induced by a decrease in ambient temperature increasing MR to a similar extent. We found the increase in corticosterone induced by the psychological stressor to be indistinguishable from the level expected based on the stress hormone effect on MR. We further found that a handling and restraint stressor that increased CORT levels only when combined with a surgical stress. To test the impact of active versus passive downregulation of energy metabolism (i.e. not through physical activity), we used a winter-dormant fish, the cunner (Tautogolabrus adspersus), which has shown that, on average, energy savings at cold temperatures in winter-dormant fish compared to their less active conspecifics, regardless of the level or plasticity of each individual's maintenance (standard metabolic) rate after accounting for differences in body size. In other words, irrespective of having high or low maintenance energy requirements, adaption in activity is the primary saving strategy during winter cold, and individual fish reduce activity to different degrees to achieve this. More broadly, this individual-adaptive level of mismatch between behaviour and physiological plasticity equation can encounter similar tradeoffs in the degree of activity and repletion. Consequently careful energy management might be that important.

A8.16 HOW DO THE COSTS OF BROODING SCALE WITH OFFSPRING SIZE?

FRIDAY 5 JULY, 17:00

AMANDA K. PETTERSEN (LUND UNIVERSITY, SWEDEN), DUSTIN L. MARSHALL (UNIVERSITY OF CALIFORNIA, BRIDGEGTON, USA), CRAIG R. WHITE (MONASH UNIVERSITY, AUSTRALIA), SAMANTHA LEWELL (UNIVERSITY OF CALIFORNIA RIVERSIDE, UNITED STATES), DAVID REDZIN (UNIVERSITY OF CALIFORNIA RIVERSIDE, UNITED STATES)

Moderators: AMANDA PETTERSEN/NU, HR

Life-history theory has traditionally viewed maternal investment as the energy content of the final offspring (often measured as offspring size). However, for brooded offspring that receive resources during development, the total investment will be a function of the final energy content of the offspring as well as the energy burned by the offspring while being brooded and receiving resources. It is likely that brooding costs will be significant for the mother, however biology workers have yet to account for the energy burned by offspring during brooding, and whether this changes with offspring size. We therefore expect that the total metabolic output of the offspring as well as the energy burned by the offspring would be larger for larger offspring than smaller offspring. This work provides us with a better understanding on how hosts modulate their energetic response to infection depending on their previous infection history.
hypotheses and the design of more logistically challenging multiple 
greatest impact, therefore aiding in the development of testable 
allow us to identify those stressors which are predicted to have the 
change in marine habitats. We contend that experimental methods 

scaling of metabolic rate, and demonstrate that variation in the 
ontogenetic value of $b$ is driven by among-species differences in 
growth patterns. Building on this, and the data from a recent 
meta-analysis of fish that shows that reproductive output scales in 
proportion to $b^{n}$. We suggest that growth slows not because of 
mechanistic constraint but because of increasing energy allocation to 
reproduction.

Modelling crustacean responses to multiple stressors in 
marine environments

Reproductive senescence is believed to have evolved to protect against 
ongoing in long-lived vertebrates including imitates, which have 
slow life histories compared to their placental mammal relatives. Cell senescence and death are normally tightly regulated processes that require coordination of nuclear and mitochondrial activities, notably telomere attrition and generation of reactive oxygen species (ROS). Telomeres, which comprise thousands of hexa-nucleotide repeats, are long, telomere associated proteins, protect the ends of nuclear chromosomes. They act as molecular clocks, by shortening as cells differentiate and triggering senescence when they reach a critical length. Age-related mitochondrial dysfunction is also implicated in cell senescence. Mitochondria are the main intracellular source of ROS. Glutamine is the most readily oxidised of the canonical nucleobases and availability of un-oxidised glutamine nucleotides may become limiting during redox stress. Mitochondrial gene variants are remarkable for the complexity of their design, with a mix of coding and “light” (L)-strands, which have G and C, respectively. Remarkably, full-length, G-rich, L-strand transcripts, which encode only a single peptide, are stable and translated into modified products. This paradoxical, endogenous process might be useful to buffer the glutamine nucleotide pool by regenerating GMP and GDP—the immediate precursors of GTP, which is essential for both mitochondrial and eukaryotic gene expression. We present a bioinformatic/calculus model of this type such a system could operate and show that mitochondrial genome GC content of 17% provides a maximum of 11% of its transcriptome. Additionally, the volume of testable hypotheses and the design of more logically challenging multiple stressor experiments

A8.20 Modelling crustacean responses to multiple stressors in marine environments

THURSDAY 4 JULY, 2019 POSTER SESSION

LIZ TALBOT (PLYMOUTH MARINE LABORATORY, UNITED KINGDOM), JOHN BRUGGEN (PLYMOUTH MARINE LABORATORY, UNITED KINGDOM), STEVE KIDDICOME (PLYMOUTH MARINE LABORATORY, UNITED KINGDOM), CHRIS HAUPTEN (UNIVERSITY OF SOUTHAMPTON, UNITED KINGDOM)

One of the most pressing issues facing marine biologists today is to understand, and critically, to predict, the impacts of multiple anthropogenic stressors on marine organisms. Until recently, investigators have relied primarily on single stressor experiments in order to assess organism performance under changing conditions. However, it is apparent that, given the number of possible interactions between stressors, single stressor experiments may not be the most appropriate way to assess the effects of anthropogenic change in marine habitats. We contend that experimental methods can be complemented with more theoretical approaches in order to improve our predictive understanding of organism responses. We demonstrate that a Dynamic Energy Budget (DEB) model using results from three separate single stressor experiments can be used to predict responses of the swimming crab Cancer borealis to multiple stressor scenarios. The benefits of this are twofold. Predicted responses are based on the effects of stressors on model components, giving an mechanistic insight into the mode of action of stressors. Additionally, the results allow us to identify those stressors which are predicted to have the greatest impact on the metabolic response of the species. We are thus able to identify the development of testable hypotheses and the design of more logically challenging multiple stressor experiments.
A8.26 BRIEF STORY OF AN AMMONIA-SENSITIVE ATPASE IN GILLS OF CATSHARK (SCYLIORHINUS CANICULA) RELATED TO OSMOREGULATION AND ACUTE-STRESS

IONICAGO RUIZ-JARABO (UNIVERSITY OF CADIZ, SPAIN), JOSÉ BELUZOOR (INSTITUTO DE CIENCIAS DO MAR MARB, UNIVERSIDAD FEDERAL DO CEARÁ, BRAZIL), CRISTINA BARRAGAN-MENDEZ (UNIVERSITY OF CADIZ, SPAIN), ISMAEL JEREZ-CEPA (UNIVERSITY OF CADIZ, SPAIN), IONICAGO RUIZ-JARABO (INSTITUTO ESPAÑOL DE OCEANOGRAFÍA CSIC, CENTRO OCEANOGRÁFICO DE CÁDIZ, SPAIN), JUAN M MANCERA (UNIVERSITY OF CADIZ, SPAIN)

Marine sharks show a differentiated composition in comparison with their body fluids and the surrounding seawater. It was described that acute stress challenges evoke consumption of energy metabolites and osmolyte osbalances, including changes in blood Na⁺, K⁺ and K⁺ levels. Recovery to basal concentration of these ions is mostly regulated by the rectal gland. However, the mechanism involved in these processes are still largely unknown.

A8.27 THERMOREGULATORY BEHAVIOUR AND BILL SIZE: AN EXPERIMENTAL TEST USING SHOREBIRDS

NÚRIA PLAYÁ-MONTMANY (UNIVERSITY OF EXTREMADURA, SPAIN), ERICK GONZÁLEZ-MEDINA (UNIVERSITY OF EXTREMADURA, SPAIN), JOSÉ M ABAD-GÓMEZ (UNIVERSITY OF EXTREMADURA, SPAIN), MANUEL PAREJO (UNIVERSITY OF EXTREMADURA, SPAIN), JULIÁN CALDELLO (UNIVERSITY OF EXTREMADURA, SPAIN), JUAN M SÁNCHEZ-GUZMÁN (UNIVERSITY OF EXTREMADURA, SPAIN), AUXILIADORA VILLEGAS (UNIVERSITY OF EXTREMADURA, SPAIN), JOSE A MASERO (UNIVERSITY OF EXTREMADURA, SPAIN)

The bill is an unspecialized and well vascularized structure that affects body heat loss in numerous species. However, above a certain environmental temperature, this structure turns into a source of heat input. A recent study based in field observations of resting shorebirds at different environmental temperatures suggested that bill morphology influences on behavioral adaptations to climate change. Here, we test experimentally in the laboratory the effect of environmental temperature on the thermoregulatory behavior in the dunlin Calidris alpina. Birds were exposed to environmental temperatures ranging from 10°C to 30°C, and the placement of the bill with in the back plumage while roosting was registered. This resting behavior at different environmental temperatures was related to basal metabolic rate, resting metabolic rate and evaporative water loss, which were calculated using an open flow respirometry. Preliminary results are shown and discussed.

A8.28 THE ROLE OF BILL AND TARSSUS SURFACE IN THE THERMOREGULATION OF GREAT TIT (PARUS MAJOR)

NÚRIA PLAYÁ-MONTMANY (UNIVERSITY OF EXTREMADURA, SPAIN), ERICK GONZÁLEZ-MEDINA (UNIVERSITY OF EXTREMADURA, SPAIN), JOSÉ M ABAD-GÓMEZ (UNIVERSITY OF EXTREMADURA, SPAIN), MANUEL PAREJO (UNIVERSITY OF EXTREMADURA, SPAIN), JULIÁN CALDELLO (UNIVERSITY OF EXTREMADURA, SPAIN), JUAN M SÁNCHEZ-GUZMÁN (UNIVERSITY OF EXTREMADURA, SPAIN), AUXILIADORA VILLEGAS (UNIVERSITY OF EXTREMADURA, SPAIN), JOSE A MASERO (UNIVERSITY OF EXTREMADURA, SPAIN)

The bill and tarsus surface are unisclared and vascularized surfaces of the body birds that function as heat sinks and are the greatest heat to the environment without evaporative water loss when environmental temperature approaches to body temperature. Therefore, individuals with higher surface area in bill and tarsus could be expected to exhibit greater tolerance to high environmental temperatures. However, little is known about the role of both surfaces in thermal physiology. We investigated the physiological responses of a great tit from thermal acclimation to different environmental temperatures by measuring evaporative water loss (EWL) and oxygen consumption in relation to relative bill and tarsus surface. Contrary to our expectations, individuals with larger relative bill surfaces showed the lowest upper critical limits (T UC) and only females had higher oxygen consumption above T EWL. Showed no relation with bill and tarsus surface. The results suggested that individuals with higher bill surfaces could suffer a significant heat body input resulting in a higher ore oxygen consumption than those with smaller bill surfaces under hot environments.
Flight is one of the most energetically expensive modes of locomotion that uses metabolic energy at a higher rate than any other mode of locomotion. Consequently, being able to quantify flight energetics is an important factor in understanding the migration, distribution and survival of birds. Metabolic energy expenditure can be determined from oxygen consumption and carbon dioxide production using mask respirometry. The majority of the metabolic energy expenditure results from the energy utilised by the locomotory muscles as they generate the forces to impart momentum to the air and to move the wings; as a result, muscle inefficiencies heat is also generated. Therefore, several indirect proxies of flight energetics, such as body acceleration and heat dissipation, are expected to be related to metabolic rate.

In order to refine the use of indirect indicators of flight energetics, we compared three different techniques: respirometry, tri-axial accelerometry and infrared thermography with heat transfer modelling. Lovebirds (Agapornis personatus) flew in a wind tunnel at a range of speeds, at which they were able to sustain flight at a range of speeds, at which they were able to sustain flight. The measurement was made successively but also simultaneously in the same individuals across the speed range in order to establish the link between the different measurements. Our results will provide validation and robust approaches for estimating metabolic energy use in the field and increase our understanding of bird flight behaviour ecology.

Recent studies demonstrate that NZA titin binds strongly to act in vivo in the presence of calcium. This interaction decreases titin length and increase titin stiffness in active muscles. We used a muscle model based on titin-actin interactions to predict in vivo forces of muscles in guinea fowl running on a treadmill with obstacles encountered at various phases of the step cycle. Data and simulations show that forces were unrelated to EMG onset and weakly related to EMG amplitude. Forces were related to the decrease in velocity that occurs when the foot hits the ground, and to muscle length at ground contact. Adding titin to muscle models improved prediction of muscle forces during level running and obstacle negotiation. We implemented a titin-inspired control algorithm for the BiOM robotic foot-ankle prosthesis. Subjects were tested during level walking and stair ascent. During level walking at variable speeds, the algorithm produced plantarflexion angles similar to those produced by people with no amputation. During stair ascent, the titin-inspired control algorithm produced plantarflexion angles that were similar to at real people with no amputation and were 5 times larger on average than those produced by the stock controller. By emulating muscle properties, the titin-inspired control algorithm provides adaptive control of level walking at variable speed and stair ascent with minimal sensing and no change in parameters. Binding of NZA titin to actin provides a molecular mechanism for important muscle properties, improves accuracy of force predictions by muscle models, and provides adaptive control for wearable robotic devices.
A9.3 PASSIVE-ELASTIC EXOSKELETONS CAN IMPROVE STABILITY OF UNSTEADY LOCOMOTION
FRIDAY 5 JULY, 2019 10:45
GREGORY S SAWICKI (GEORGIA INSTITUTE OF TECHNOLOGY, UNITED STATES)
GREGORY.SAWICKI@GATECH.EDU
Passive-exoskeletons do not impart mechanical work to the user, but can reduce the metabolic cost of steady walking. They do this by making the underlying muscle contractile dynamics more economical. Here we aim to examine whether energy-neutral devices could be equally effective during unsteady locomotion. We ask: Can exoskeletons with passive springs that are not capable of dissipating mechanical energy on their own improve locomotion stability? To answer this question, we modified simple hopping models by adding an elastic exoskeleton in parallel with a unit, Hill-type ankle-muscle-tendon unit. We introduced a range of ground-hold step-down disturbances and studied the perturbation response of the model with exoskeletons of varying stiffness. We found a set of passive-exoskeletons that allow for faster and safer recovery from perturbations while also making steady locomotion more economical. Thus, we predict that although exoskeleton systems cannot dissipate any energy themselves, they can steer the underlying muscle-tendon dynamics to improve performance. These results suggest that lower limb exoskeletons may not need complex control systems to achieve good performance in unsteady conditions and highlight the importance of understanding how devices interact with a user’s physiology to improve stability.

A9.4 TOWARDS AN UNDERSTANDING THE CHEETAH TAIL USING OPTIMAL CONTROL
FRIDAY 5 JULY, 2019 11:30
AMIR PATEL (UNIVERSITY OF CAPE TOWN, SOUTH AFRICA)
A.PATEL@UAC.ZA
The cheetah is not only the fastest terrestrial animal but also one of the most maneuverable. These rapide maneuvers are often accompanied by dramatic swings of its lengthy tail. However, the reasons for this tail motion is still not completely clear. Here, I will utilise novel trajectory optimisation (optimal control) techniques to investigate the optimal use of the tail during transient locomotion. Further, these simulated trajectories will be compared to kinematic data obtained from captive-breeding cheetahs in South Africa.

A9.5 TAKE-OFF AND LANDING IN BIRDS: RELATIVE CONTRIBUTION AND COORDINATION OF WINGS AND LEGS
FRIDAY 5 JULY, 2019 12:00
PAULINE PROVINSI (MUSEUM NATIONAL D’HISTOIRE NATURELLE (PARIS), FRANCE)
PAULINE.PROVINSI@MNHN.FR
Take-off and landing allow the transition between two substrates with drastically different physical properties. They also mark the transition between two types of locomotion, either exclusively driven by the wings or by the legs. To understand the patterns of coordination between forelimbs and hindlimbs and quantify their relative contribution during take-off and landing, we integrated measurements of both leg and wing forces in zebra finch (Taeniopygia guttata) and diamond dove (Goura cristata). We measured whole-body kinematics using high-speed videos, ground-reaction forces using a perch mounted on a force plate, and aerodynamics using particle image velocimetry. We found that during take-off, legs produced a major part of the whole-body resultant acceleration. Interestingly, we observed a discrete transition in the use of the hindlimbs and forelimbs, as lift-off coincided with the start of the first downstroke in both species. In contrast to take-off, wings contributed proportionally more to the velocity changes during landing. Nevertheless, the hindlimbs significantly modulated the final phase of winging and, therefore, critically to the absorption of kinetic energy after touchdown. In zebra finch, touch down started after the first wingbeat, including a functional impact of wings and its hand. Whereas in diamond doves, the last wingbeat started when the bird already reached the perch. This work demonstrates a complex integration of wings and legs modules, which differs across species and motions. The legs, more than the wings, play a prominent role in these two challenging phases of flight.

A9.6 AGILITY IN LEGGED ROBOTS AND ANIMALS. HOW TO BENEFIT FROM CROSS-LINKED QUANTITATIVE AND BENCHMARKING
FRIDAY 5 JULY, 2019 12:15
PETER ECKERT (EPFL, SWITZERLAND)
PETER.ECKERT@EPFL.CH
How to quantify performance? The past, our current time and maybe the future aren’t (yet) sufficiently able to grasp this supposedly simple measure for animals or machines. In this presentation, we present an novel and practical approach for benchmarking agility, an important, but still too unclear performance measure. We focus on terrestrial, multi-legged locomotion in the field of bio-inspired robotics and their biological counterparts. We talk about our journey to find a general definition of agile locomotion as the ability to perform a set of different but specific tasks executed in a fast and efficient manner. This result takes its inspiration from the analysis of natural robotic models, such as dogs and horses as well as robotic systems, making the resulting findings applicable interdisciplinarily. After the general definition, we will present how the actual normalized benchmarking values are generated, and how measuring methods, as well as an online database for agility score collection and distribution is made open for any interested researcher. We hope to transfer and show the difficulties and benefits of such a performance measurement in biology and technology in parallel, symbolically and with simplicity of the methodology in mind.

A9.7 POSTURAL ADJUSTMENTS FOR MOBILITY AND BALANCE IN HUMANS, ANIMALS AND ROBOTS
FRIDAY 5 JULY, 2019 15:00
CHARLOTTE LE MOUEL (MAX PLANCK INSTITUTE FOR INTELLIGENT SYSTEMS, GERMANY)
CHARLOTTE.LEMOUEL@MPIFORINTELLIGENTSYS.DE
I will present the thesis that efficient motor coordination relies on the nervous system finding the appropriate body mechanical properties to perform a motor task, through postural adjustments. Thus, when standing in challenging balance conditions, young adults stiffen their ankle through ankle muscle co-contraction to improve their stability. In contrast, when they want to start walking, they relax their ankle, allowing them to fall forwards andibirily initiate the first step. Efficient gait initiation thus requires a combined decrease in ankle stiffness and a forward acceleration of the body centre of mass. The amplitudes and timing of these postural adjustments must be adjusted to the body height and mass, thus requiring postural learning throughout the lifespan. I will present a model for learning efficient gaits in the human and its implications for humans, animals and robots. Finally, I suggest that impaired postural adjustments may lead to balance and mobility impairments, such as those which occur during aging, and may have a dramatic impact on quality of life.

A9.8 FORM AND FUNCTION OF THE HUMAN FOOT
FRIDAY 5 JULY, 2019 15:15
MACIASUSHAN VENKATAN (YALE UNIVERSITY, UNITED STATES), ALL VANDE (YALE UNIVERSITY, UNITED STATES), MARCELO DIAS (JAHRS UNIVERSITY, DENMARK), CAROLYN END (YALE UNIVERSITY, UNITED STATES), SHAHRAH AMIN (YALE UNIVERSITY, UNITED STATES), STEVEN TOMMASINI (YALE UNIVERSITY, UNITED STATES), MAHESH BANDE (DIST DEPARTMENT OF UGANDA, JAPAN), SHREYAS MANDER (BROWN UNIVERSITY, UNITED STATES)
M.VENKATAN@YALE.EDU
The stiffness of the foot is important in locomotory function and was important for both the evolution of bipedal walking and running in humans. We show here that curvature-induced stiffness because of the transverse arch in the midfoot underlies the stiffness of private feet. We use foot and ankle kinematics, physical mimics of the foot, and biological sensors using both human subjects and cadaver feet to arrive at this conclusion. The principle is evident in a drooping dollar bill that significantly stiffens upon slightly curling it in the transverse direction. Importantly, the contribution of the transverse arch exceeds that of the well-known contribution of the medial longitudinal arch. Through analysis of footprints for skeletal signatures of a transverse arch, we track the evolution of the transverse curvature among extant hominins and find evidence for a human-like transverse arch that predates the genus Homo by over 1.5 million years. In addition to the evolutionary implications, our results suggest strategies for the management of flat foot disorders associated with diabetes and other orthopaedic conditions.

A9.9 LINEAR ACCELERATION OF THE SEMICIRCULAR CANALS
FRIDAY 5 JULY, 2019 15:45
JANA OGENS (UNIVERSITY OF ANKWERP, BELGIUM), PETER AERTS (UNIVERSEITY OF ANKWERP, BELGIUM)
JANA.OGENS@UANWERP.BE
The vestibular system in the inner ear is responsible for sensing head movements for balance control. Linear head accelerations are sensed by ococoiia crystals lying on a saccharide gel, while angular accelerations are perceived by cupula membranes in the fluid-filled semi-circular canals. There is no consensus on the underlying biomechanical reason for this distinction. Two hypotheses exist to explain why the semicircular canals are insensitive to linear acceleration. They are based on the lack of a density difference between the cupula membranes and the surrounding liquid, and on the continuous flow of fluid in the semi-circular canals. However, we found that increasing the cupula density in a Fluid-Structure Interaction model of the vestibular system, or interrupting the fluid circulation in the canals, substantially increased the strain of the cupula membranes. Based on our simulation model, we propose an alternative explanation for the lack of stimulation of the semicircular canals by linear head maneuvers. During angular acceleration the cupula, which seals the canal, that has to “push” the fluid in the canal forward, leading to a pressure difference and cupula deformation. During linear acceleration, on the other hand, the canal wall “pushes” the fluid in the canal forward, which results in much smaller pressure difference over the cupula, and, therefore, a much lower deformation thereof.

A9.10 A CONTROLLER FOR HUMAN RUNNING INFERRED FROM MOTOR VARIABILITY
FRIDAY 5 JULY, 2019 16:00
NIKOS SEETHAPATH (UNIVERSITY OF PENNSYLVANIA, UNITED STATES)
NIKOS@SEETHAPATH@UPENN.EDU
Human running is only approximately periodic. Motor noise, sensory noise, and other environmental variations repeatedly perturb the running motion away from perfect periodicity, even in the absence of external perturbations. Although the mechanisms of the average running motion have been studied extensively, we do not yet have a complete characterization of how stable running occurs despite repeated and self-generated perturbations. In this work, we obtain a simple and generalizable controller that stabilizes running, found by mining the step-to-step variability in human running data. We infer linear models that predict the leg forces and foot placement in response to deviations of the center of mass from the nominal periodic motion. We find that humans continuously modulate their
A10.1 ON THE ROLE OF THE BODY IN SPATIAL AND TEMPORAL COORDINATION OF LIMBS

WEDNESDAY 3 JULY, 2019  |  10:00

VOLKER DÖHRN (BIELLESFELD UNIVERSITY, GERMANY)

A10.2 PASSIVE FORCES FROM INSECT MUSCLES AND EXOSKELETON AND THEIR IMPACT ON MOTOR CONTROL

WEDNESDAY 3 JULY, 2019  |  10:30

VOLKER DÖHRN@BIELEFELD.EDU

A feature of natural locomotion behaviour of animals is the flexible use of limbs according to their prevalent needs and goals. In particular, the relative importance of spatial and temporal coordination of legs depends on how fast, synchronous, subtle, forceful or precise a movement has to be executed. For example, consider how these aspects may differ for any individual between behaviours such as climbing through a cluttered environment, walking on substrates with varying slip and compliance, or escaping from a sudden threat. Assuming that much of the movement repertoire of an animal is not pre-programmed, the ability to coordinate limbs in an adaptive, state- and context-dependent manner requires the integration of sensory information about posture, touch and interaction forces between the body and the substrate. Recent research on insects has strongly benefited from the combination of behavioural, neuromechanical and computational methods. This has accumulated evidence about the variability of gait parameters, but also documented how both intra- and inter-leg coordination depends on load, grip, limb posture, or contact events. With a focus on insects, in this talk we will discuss the role of central control and the formation of alternating control modes that regulate posture or interaction forces. With regard to the control of whole-body posture, we will also discuss the requirements of an internal representation of space in insects and its relevance for flexible body behaviour.
Recent studies of lizard locomotion have shown that they are able to control their posture to flexibly and reversibly direct attention to different components of the web vibrations. Our results thus emphasize the dynamic properties of locomotor interactions between behaviour and perception, i.e. between the ‘brain’ and the body.

A10.5 THE EFFECT OF STOCHASTICITY ON BODY DYNAMICS IN MULTILEGGED LOCOMOTOR SYSTEMS

Wednesday 3 July, 2019 11:30

TOP.WEINHARDT@UNI-KOELN.DE

In legged terrestrial animals, different gaits and locomotion economy are determined by centre of mass (COM) dynamics. Instability around the COM, i.e. large deviations of COM position and orientation, is strongly related to the degree of leg synchronisation, duty factor and the resulting overall vertical ground reaction forces (GRF). The degree of leg synchronisation within sets of legs, like the typical tripod sets of insects, is determined by ipsilateral phase relations and stochastic irregularities of the legs’ touchdown and take-off. While ipsilateral phase relations change with changing COM and COM velocity, stochasticity depends on internal and external disturbances. In a numerical model approach, the combined effects of ipsilateral phase shifts and stochasticity on total vertical GRF and COM dynamics have been examined for locomotor systems with two to four pairs of walking legs. The calculations show that both, ipsilateral phase shift and stochasticity result in decreased synergies in putative alternating sets of legs. However, temporal dissociation of the sets of legs results in low amplitudes of the total vertical GRF and COM dynamics. The calculations have been extended to examine locomotion for systems with two to four pairs of walking legs. The calculations show that both, ipsilateral phase shift and stochasticity result in decreased synergies in putative alternating sets of legs. However, temporal dissociation of the sets of legs results in low amplitudes of the total vertical GRF and COM dynamics. The calculations have been extended to examine locomotion for systems with two to four pairs of walking legs.

A10.6 EFFECTS OF MUSCLE COMPRESSION AND TRANSVERSAL INTERACTIONS OF ACTIVATED MUSCLES ON THE CONTRACTION DYNAMICS AND POWER GENERATION OF MUSCLES

Wednesday 3 July, 2019 11:45

TOBIAS.SIEBERT@UNI-STUTTGART.DE

Muscles are surrounded by other muscles, connective tissue, and bones. These nearby tissues may transfer forces to the muscle, influencing muscle architecture and the force generation in the longitudinal (in the direction of the line of action) direction. Recent studies restricting muscle deformation by elastic bands, rigid tubes, and plungers in a longitudinal direction showed changes in muscle architecture and performance, e.g. in muscle force, shortening, and work. In this study, the influence of muscle compression induced by increasing transversal muscle loading was examined and modelled. Therefore, isometric experiments on isolated rat M. gastrocnemius medialis (m9) with increasing transverse loads have been performed. Loads were applied by a plunger which was able to move freely in vertical direction. The muscle force was measured at the distal tendon and the vertical movement of the plunger was determined using a high-speed camera during supra maximal muscle stimulation. To simulate the interaction of a (virtual) rat muscle, we used a Hill-type muscle model with a geometric lever (G) mechanism accounting for the influence of transverse load on longitudinal force. Transversal muscle compression causes a decrease in neural force development in rat M. gastrocnemius medialis. The model seems applicable to account for effects of muscle deformation within a range of transverse load varying when using a linear load-dependent function for G. Possible mechanisms of the decrease in neural muscle force seem to be related to increased internal pressure, to deformation of the myofilament grid leading to decomposition of cross-bridge forces and possibly to an inhibition of cross-bridge generation.

A10.7 HOW HIRUDINOGot ITS GROOVE BACK: EXAMINING THE ROLE OF PHYSICAL THERAPY IN RECOVERY FOLLOWING NERVE CORD INJURY

Wednesday 3 July, 2019 14:00

CYNTHIA HARLEY (METROPOLITAN STATE UNIVERSITY, UNITED STATES)

CINDY.HARLEY@METSTATE.EDU

Locomotor training has proven integral to recovery following nerve cord lesions in humans and animals alike. While we know that locomotor training aids these individuals, we do not understand the mechanisms behind this recovery at the cellular level. Through the use of a novel model, the leech Hirudo verrucosa, we are taking a closer look at this process of recovery. Leeches have two primary locomotory behaviors—swimming and crawling. Following nerve cord transection leeches lose the ability to crawl and swim ceaselessly. However, over time, they regain the ability to crawl and to suppress swimming behavior despite that the nerve cord does not reattach. Following a physical therapy regimen, which attempts to recreate the natural movements of the leech, the onset of crawling recovery is greatly accelerated. In untreated animals, the first crawl cycles are not seen until 8 days post lesion, while in treated animals, we began to see crawl cycles 1 day post lesion, a 4-fold delay. We are currently examining what properties of physical therapy aid in the acceleration of recovery. Our current studies are contrasting individuals who have undergone aggressive locomotor training with those who have not, to determine which of the needled movement, with those who have taken a more active role in their therapeutic process. Preliminary results suggest that an active role in recovery is needed for therapy to be effective.
A11 OPEN BIOMECHANICS

A11.1 WHY DO WILTING INFLORESCENCES OF GERBERA JAMESONII ‘NUANCE’ GET DROOPY?

TUESDAY 2 JULY, 2019  09:00

OLSA SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), LAURA-SOPHIE LIEBHARD (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, FIT CRC 141, GERMANY), TIM KAMPBISKI (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, FIT CRC 141, GERMANY), THOMAS SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), OLGA SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), MAX D MYLO (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, FMF, GERMANY), MARCO CALIARO (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, FIT CRC 141, GERMANY), THOMAS SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), ANNA WESTERMIEZER (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, FMF, GERMANY), THOMAS SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY).

It is well-known phenomenon that water shortage causes wilting and in the case of Gerbera flower head drooping. This phenomenon was quantitatively analysed within in a comparative study of fully wilted and non-wilted inflorescences of Gerbera jamesonii ‘Nuance’ with respect to structural characteristics and mechanical properties. After 24 h of dehydration and storage in air cut Gerbera peduncles displayed pronounced bending in a 1 cm long region directly below inflorescence. The bending modulus of Gerbera peduncles was significantly lower in both flexural rigidity and axial second moment of area, whereas the bending elastic modulus showed no significant difference. Serial sections revealed that the peduncle possesses a pith cavity in its basal part, where the pith ending of the pith cavity is correlated with the vertex of the bent wilt peduncle. In addition, cross-sections of wilted peduncles deviated significantly more from circularity than those of turgent stalks and displayed a considerable shrinkage of the parenchymatic tissues, the latter taking up the shape of the inflorescence. This kind of attachment is probably good for traversing big spaces but is also efficient for attaching to small supports and over small gaps between supports in clutered environments. Bigger spines and hooks can act as grappling structures and even highly specialized “carabiners”. Observations of a wide range of hook-bearing plants suggest that hook attachment is often deployed as a rapid “fail-safe” way of initially securing the climbing plant. Hook-shaped spines, especially, are likely to function efficiently for attaching to small supports and over small gaps between supports in cluttered environments. This diversity of attachment structures and the kinds of deployment and efficiency of attachment have a wide potential for biomimetic applications that require efficient and safe attachment.
ANNUAL MEETING SEVILLE 2019

A11.6 COMPARATIVE ANALYSES OF THE SELF-SEALING MECHANISMS IN LEAVES OF DELOSPERSA COOPERI AND DELOSPERSA ECKLONIS

TUESDAY 2 JULY, 2019 | 10:15

LINNEA HEISE (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, BOTANIC GARDEN, EXCELLENCE CLUSTER LIVMATS @ FIT, GERMANY), OLGA SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, BOTANIC GARDEN, EXCELLENCE CLUSTER LIVMATS @ FIT, GERMANY), Jochen Leupold (DEPARTMENT OF RADIOLOGY, MEDICAL PHYSICS, MEDICAL CENTER–UNIVERSITY OF FREIBURG, FACULTY OF MEDICINE, GERMANY), Thomas Speck (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, BOTANIC GARDEN, EXCELLENCE CLUSTER LIVMATS @ FIT, GERMANY), Doga Speck (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, BOTANIC GARDEN, EXCELLENCE CLUSTER LIVMATS @ FIT, GERMANY)

The genus Delospersa (Aizoaceae, ice plants) is characterized by mostly shrubby and succulent species native to arid, hot and habitats in South and East Africa. Damage to their succulent leaves therefore potentially causes severe drought stress due to water loss. Delospersa plants have a self-sealing mechanism allowing for a rapid and almost irreversible self-sealing (formation of the leaf, bringing the wounds edges into contact) and subsequent self healing (biochemical and mechanical restoration of structural and functional integrity of the leaf) of injuries of the leaves.

The self-repair mechanisms can serve as promising inspiration for the development of bio-inspired materials and materials systems capable of self-repair. For this purpose, analytical and numerical models were developed to identify the underlying functional principles of the self-sealing mechanisms in Delospersa. The theoretical approaches were complemented with 2D (light microscopy) and 3D (magnetic resonance imaging) tissue and structure analyses and 2D/leaf kinematics studies of D. cooperi and D. ecklonis. A direct comparison of the two species, which slightly vary for processing rhythmicity among lissamphibians (28%) is not between substrate attachment and nitrogen availability is a key factor affecting the diversity and complexity of species coexistence. It also highlights the importance of studying symbiotic infracommunities to understand species coexistence.

A11.7 FOOD PROCESSING RHYTHMICITY ACROSS THE FISH-TETRAPOD SPLIT

TUESDAY 2 JULY, 2019 | 10:30

Nicolai Konon (UMass Lowell, United States), Claire Bourque (UMass Lowell, United States), Ferdinand Cubitt (U. Jena, Germany), Carla P. Rodriguez (UMass Lowell, United States), Mateo O Rull (UMass Lowell, United States), Callum P Ross (U. Chicago, United States), Egon Heiss (U. Jena, United States)

Food processing is a cyclical application of dentition-claspsurface interaction, a highly rhythmic mechanism of jaw shape (average CV: Coefficient of Variation = 15%) and basal bone fishes (20%) but less so among lepidosaurs (lizards and their allies, 53%). This peculiar phylogenetic shift in rhythmicity from aquatic-feeding anamniotes to terrestrial amniotes is not clearly explained by variation in the propulsive capabilities of the jaw closer. However, it might have been influenced by changes in fluid properties/water to gas vertebrates transitioned from aquatic to terrestrial chewing.

We examine variation in chewing rhythm across the fish-tetrapod transition using data from a balaenia physalus (Polypterus sp.), two lungfish (Neoceratodus forsteri, Protopterus annectens), and six salamander species (Ambystoma mexicanum, Siren intermedia, Ambystoma tigrinum, Ambystoma maculatum, Ambystoma tigrinum, and Triturus carnifex). An among anagon adult snout (Protomrichtus, Polypterus, Coelacanthus) and six lepidosaur species (Ambystoma, Siren, Ambystoma tigrinum, Ambystoma maculatum, and Triturus carnifex) and six lepidosaur species (Ambystoma, Siren, Ambystoma tigrinum, Ambystoma maculatum, and Triturus carnifex).

The grand average CV for processing rhythmicity among lissamphibians (28%) is not statistically significantly different from that of other anamniote chewers. These data support the idea that there is no significant difference in rhythmicity and remained unperturbed by the transition to terrestriality. Thus, behavioural attributes such as arthral food handling might be studied not in the uniquely low rhythmicity of chewing in lepidosaurs.

A11.8 BIOMECHANICS MEDIATES SPATIAL NICHING BETWEEN PHORETIC MITES ON THE BURING BEETLE MICROHABITAT

TUESDAY 2 JULY, 2019 | 10:45

Syuan-Jyun Sun (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), Simon Chen (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), Walter Fedele (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), Rebecca Kilmer (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM)

Many caterpillars feed externally on plants. The cost of losing attachment to host plants can be high, particularly for small herbivores, but attachment itself can also be costly. Many caterpillars prefer to use silk carpets to provide attachment points for their claws. However, as plant diets are low in nitrogen, producing protein-based silk may be expensive. We tested if caterpillars economize the use of silk. Do they economize by using short silken substrates? Do they produce silk only when it is necessary? Given the highest cost of detachment, do all caterpillars lay down more silk threads relative to whole body movement? By recording locomotion, silk production behaviour, and attachment forces in B. anynana caterpillars, we found that: (1) caterpillars prefer higher-friction coarse substrates to slippery micro-rubs; (2) caterpillars rapidly increase silk production on stepper and micro-rubs substrates, and conversely reduce it on slippery substrates; (3) caterpillars spend more time on substrate roughness when both their thoracic legs and abdominal prolegs; (4) second-instar caterpillars more silk length per whole body movement distance than final-instar caterpillars (this ratio correlates with food) intron in some situations.

In contrast to B. anynana, caterpillars of the closely related species Heteroprosopon migrate daily up and down their host plant. We found that the short silken attachment substrate is more costly. In contrast to B. anynana, caterpillars of the closely related species Heteroprosopon migrate daily up and down their host plant. We found that the short silken attachment substrate is more costly.

A11.9 CONTROL OF SILK PRODUCTION IN CATERPILLARS: A BEHAVIOURAL TRADE-OFF BETWEEN ATTACHMENT AND RESOURCE AVAILABILITY

TUESDAY 2 JULY, 2019 | 14:00

Simon Chen (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), Talzoo Wang (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), Walter Fedele (DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM)

Many caterpillars feed externally on plants. The cost of losing attachment to host plants can be high, particularly for small herbivores, but attachment itself can also be costly. Many caterpillars prefer to use silk carpets to provide attachment points for their claws. However, as plant diets are low in nitrogen, producing protein-based silk may be expensive. We tested if caterpillars economize the use of silk. Do they economize by using short silken substrates? Do they produce silk only when it is necessary? Given the highest cost of detachment, do all caterpillars lay down more silk threads relative to whole body movement? By recording locomotion, silk production behaviour, and attachment forces in B. anynana caterpillars, we found that: (1) caterpillars prefer higher-friction coarse substrates to slippery micro-rubs; (2) caterpillars rapidly increase silk production on stepper and micro-rubs substrates, and conversely reduce it on slippery substrates; (3) caterpillars spend more time on substrate roughness when both their thoracic legs and abdominal prolegs; (4) second-instar caterpillars more silk length per whole body movement distance than final-instar caterpillars (this ratio correlates with food) intron in some situations.

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A11.10 BIPEDAL WALKING AND RUNNING: ARE BIPEDAL GAITS RELATED TO EVOLUTION OR SIZE?

TUESDAY 2 JULY, 2019 | 14:15

JIm Usherwood (The Royal Veterinary College, United Kingdom), demisol2017 (The Royal Veterinary College, United Kingdom), Russell P Main (Purdue University, United States), Alesandra V Birm-Jeffery (Queen Mary University of London, United Kingdom), Monica A Daley (The Royal Veterinary College, United Kingdom)

Some peculiarities of bipedal gaits—skew force profiles and blurred walk-run transition—have recently been reported for a large range of bird species (Bishop et al., 2018). From this, it was inferred that larger bipedal dinosaurs, with presumably similar walking kinematics, but at a larger scale, may have instead locomotor mechanics comparable to birds, contrasting with familiar adult human gait. However, young humans show similar peculiar gait, with skew force profiles and blurred walk-run transition. This has been attributed to simple scaling of mechanical and non-scaling mechanical properties leading to strategies that minimize peak mechanical power demands with short legs (Usherwood, et al., 2018). But comparing young children with adults clearly confounds leg length with many aspects of gait variability. This could be linked to the ontogenetic size range in order to determine what aspects of gaits in birds, like reduced speed and blurred walk-run transition, have an ontogenetic significance.

We have checked this idea by model-based calculation and present results in this year’s meeting. Using a simple balance equation relating the metabolic cost of muscle-tendon units in the acceleration of the centre of mass, we gained a quantitative estimation of how the mechanical efficiency of skeletal muscle, its ATP storage capacity, and the
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A11.12 INTERSEXUAL DIFFERENCES IN MANOEUVRABILITY IN LIZARDS

TUESDAY 2 JULY, 2019
14:45

MENELIA VASILIOPOULOU-KAMPITSI (UNIVERSITY OF ANTWERP, BELGIUM), COLIN M DONDHEU (WASHINGTON UNIVERSITY ST. LOUIS, UNITED STATES), JANA GOYENS (UNIVERSITY OF ANTWERP, BELGIUM), ANTHONY HERREL (MUSEUM NATIONAL D’HISTOIRE NATURELLE, FRANCE), PANAYIOTIS PAFILIS (NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS, GREECE), RAOUl VAN GEMME (UNIVERSITY OF ANTWERP, BELGIUM), PETER AERTS (UNIVERSITY OF ANTWERP, BELGIUM)

Although intersexual differences in behaviour and morphology in lizards are often studied, differences in locomotor behaviour remain poorly investigated. Maximal sprint speed is often used as a performance measure for predator avoidance of lizards. However, in the field, acceleration capacity and manoeuvrability (related to habitat complexity) are probably even more important for escaping predation. Here, we investigate the manoeuvrability and acceleration capacity of the Aegalean Wall Lizard (Podarcis erhardi) sampled in the island of Naxos (Alkyon, Naxos, Greece). Males and females (N=50) were videotaped (dorsal view; 500 Hz) while chased through a race track with 90° turns, challenging their manoeuvrability. Body markers along the mid-line, defining four body segments, were digitized. From this, the instantaneous frequency (up to 4000 frames per second) of two black woodpecker individuals Dryocopus martius and braincase (eye centre position) based on high-speed videos recorded the head’s kinetic energy upon impact implies lower peak forces exerted by the tip of the beak on the brain, evolving any type of shock absorber will probably impact the beak’s hammering performance. To study this paradox, we analysed the kinematics of the beak’s opening and closing probability of pecking to optimise pecking performance, and not as a shock absorbing system to protect the brain. During pecking to optimise pecking performance, shock absorbers have been proposed to assign a role to the beak or the beak-braincase interface to serve as a shock absorber to minimise the ejection of the head upon impact. However, since any absorption or dissipation of the head’s kinetic energy upon impact implies lower peak forces exerted by the tip of the beak on the brain, evolving any type of shock absorber will probably impact the beak’s hammering performance. To study this paradox, we analysed the kinematics of the beaker and beak species (eye centre position) based on high-speed videos (up to 4000 frames per second) of two black woodpecker individuals (Dryocopus martius) during pecking. We found that decelerations did not differ significantly between beak and braincase during impact, however, a higher peak speed and braincase (eye centre position) based on high-speed videos (up to 4000 frames per second) of two black woodpecker individuals (Dryocopus martius) during pecking. We found that decelerations did not differ significantly between beak and braincase during impact, however, a higher peak speed and reaching, however, a higher top speed. Our findings suggest that the larger and heavier males are less well manoeuvrable during challenged locomotion than females. In addition, it is possible that the relatively longer trunk of the females, providing a larger space for egg clutches, may simultaneously provide an advantage for manoeuvring. This will be further explored by comparing the unchallenged speed and acceleration capacity between sexes on a straight race track.

A11.13 HOW DOES FARRIERY INFLUENCE THE VARIATION IN PRESSURE DISTRIBUTION ACROSS DIFFERENT REGIONS OF THE EQUINE HOOF AT WALK?

TUESDAY 2 JULY, 2019
15:00

SARAH HARLEY (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), PETER D CLEG (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), GINA L PINCHBECK (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), JO DRELAND (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), PETER J MILLER (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM)

How pressure is exerted over the hoof surface has implications for long term health of the equine musculoskeletal system. Hoof trimming by farriers is essential in managing this. This study measured the pressure distribution over the forelimb hooves of 24 healthy horses before and after trimming by a qualified farrier. Horses were walked over apressure mat (Tekscan®) for a minimum of 5 strikes per forelimb. hoof print data was exported to Matlab (Mathworks®) for processing and objective division into quadrants. Statistical analysis was performed in R Studio. Wilcoxon Signed Rank test and Mann-Whitney test were used to test associations between paired and independent samples, respectively. The dorso lateral quadrant recorded higher pressures than all other quadrants in both left (p<0.001) and right forelimbs (p<0.01); this was not affected by trimming. All quadrants recorded significantly different pressures in both limbs, except right forelimb palmarolateral and palmaromedial quadrants. This was unchanged by trimming. The right forelimb dorsolateral quadrant experienced higher pressures than that of the left foot (pre-trim p=0.018, post-trim p=0.028). Trimming did not significantly affect the pressures recorded on the left forelimb, whilst in the right forelimb it reduced the pressure in dorsomedial (p=0.01), palmaromedial (p>0.015) and palmarolateral (p=0.022) quadrants. These data show how regions of the hoof experience different pressures during loading at walk, with the dorsolateral region subject to highest pressures. Trimming resulted in different changes between left and right limbs. This may be due to pre-existing asymmetry or a variation in approach to trimming on right and left limbs.

A11.14 TWO BORELLI’S LAWS FOR JUMPING ANIMALS: SIZE CAN SOMETIMES AFFECT JUMP HEIGHT

TUESDAY 2 JULY, 2019
15:15

GREGORY P SUTTON (UNIVERSITY OF LINCOLN, UNITED KINGDOM)

“Borelli’s law” hypothesises that absolute jump height for animals is independent of size. This is because an animal’s ability to generate kinetic energy is proportional to its body mass. As such, its kinetic energy density (i.e. its jump height divided by its mass) is constant. For animals that jump using a muscular-actuated system, this is true — with jump height having no correlation with size. For animals that jump using a musculo-actuated system, however, force-velocity affects on the musculature cause jump height to be attenuated at small sizes — making it advantageous for muscle-actuated jumpers to be larger. The maximum jumping height, however, for spring-actuated jumpers — while size-independent — is lower than the maximum jumping height for large muscle-actuated jumpers; creating two effective limit on jump height — i.e., there’s a ‘Borelli’s law’ for each of the different ways of mechanistically generating a jump. Animals that use springs to execute a jump follow one of these laws while animals that use muscles follow another. These two Borelli laws show why spring-actuated jumpers are almost exclusively small, while muscle-actuated jumpers are almost exclusively large.

A11.15 EXPLORING THE FUNCTIONAL ROLE OF THE DIGITAL MUCUS GLANDS AND THEIR SECRECTIONS IN TREE FROG ATTACHMENT

TUESDAY 2 JULY, 2019
16:00

JULIANA LANGWIK (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS), SARANDA SINGILA (THE UNIVERSITY OF AKRON, UNITED STATES), ALEX NYAKO (THE UNIVERSITY OF AKRON, UNITED STATES), HENK SCHUPPER (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS), FRANK VAN DEN BERG (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS), SUKMAPAN JAU (THE UNIVERSITY OF AKRON, UNITED STATES), HENRY C ASTLEY (THE UNIVERSITY OF AKRON, UNITED STATES), SANDER WS GUSSEKLOO (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS), AL DIKHOMALA (THE UNIVERSITY OF AKRON, UNITED STATES), JOKO VAN LEEMEN (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS)

Mucus glands and their secretions are important features of the amphibian cutis. The digital mucus of tree frogs has been proposed to facilitate the remarkable attachment of these animals by enabling ‘wet adhesion’. However, the digital gland morphology and chemical composition of these glands has been poorly studied in tree frogs. To elucidate the functional relevance of these components in attachment, we comparatively studied their morphology and chemical composition of these glands. Using synchrotron micro-computer-tomography and high-performance liquid chromatography, we show in the tree frog Hyla cinerea that the mucus glands opening to the contact interface differ morphologically from regular anuran mucus glands and form an internal cluster. We identified digital gland clustering in min. 10, not exclusively arboreal anuran families, suggesting a generic function not related to attachment. We show that the mucous content per gland pad is high (40.8±16.9 µL) and that the mucus is rich in keratan sulfate (0.9±0.3 µL/g), suggesting that digital gland clustering may help to compensate for mucus loss via the contact surface. Further, we analysed the general chemistry of the digital mucus using immunohistochemistry and in situ hybridisation as well as in situ slide generation microscopic analysis. The mucus chemistry varies between different arboreal (Dryopomorus montanus, Ceratophrys cranwelli) and non-arboreal frogs (Pyxicephalus adspersus, Ceratophrys cranwelli), and between different body locations. Overall, the results of this study indicate that the mucus glandular system does not differ between arboreal and non-arboreal frog species, which agrees with a specific functional role in tree frog attachment.

A11.16 HEAD IMPACT KINEMATICS IN WOODPECKERS

TUESDAY 2 JULY, 2019
16:15

SAM VAN WAASSENBERG (UNIVERSITEIT ANTWERP, BELGIUM), ANICK ABORACHID (MUSEUM NATIONAL D’HISTOIRE NATURELLE PARIS, FRANCE)

Woodpeckers use the forceful impact of their beak to hammer into trees for feeding, nesting, and interspecific communication. This behaviour has long been considered to hypothesise how these birds protect their brain against injury. Several hypotheses have been proposed that assign a role to the beak or the beak-braincase interface to serve as a shock absorber to minimise the ejection of the brain upon impact. However, since any absorption or dissipation of the head’s kinetic energy upon impact implies lower peak forces exerted by the tip of the beak on the brain, evolving any type of shock absorber will probably impact the beak’s hammering performance. To study this paradox, we analysed the kinematics of the beaker and braincase (eye centre position) based on high-speed videos (up to 4000 frames per second) of two black woodpecker individuals (Dryocopus martius) during pecking. We found that decelerations did not differ significantly between beak and braincase during impact, however, a higher peak speed and reaching, however, a higher top speed. Our findings suggest that the larger and heavier males are less well manoeuvrable during challenged locomotion than females. In addition, it is possible that the relative longer trunk of the females, providing a larger space for egg clutches, may simultaneously provide an advantage for manoeuvring. This will be further explored by comparing the unchallenged speed and acceleration capacity between sexes on a straight race track.
A11.17 FUNCTIONAL MORPHOLOGY OF FEMALE Sperm STORAGE ORGANS IN INSECTS AND TRANSPARENT AND FLEXIBLE MODELS AS TO UNDERSTAND SPERM DYNAMICS

Tuesday 2 July, 2019 09:30

YOKO MATSUMURA (KIEL UNIVERSITY, GERMANY), SINJE GÜRKE (KIEL UNIVERSITY, GERMANY), HALVOR T. TRANGMOR (KIEL UNIVERSITY, GERMANY), STANISŁAW N. GORB (KIEL UNIVERSITY, GERMANY)

In nature females often copulate with more than one male and can store sperm from different males in a sperm storage organ before ovulation. The functional capacity of such stores does not guarantee reproductive success, and this is why postcopulatory mate choice is of particular importance. Despite of the universality of this principle, female structures are much less studied compared to males. Hereby we focused on the sperm storage organ (spermatheca) in beetles and aimed to unveil its functional morphology and simulate sperm dynamics in the spermatheca. Morphology and material composition gradient were studied by means of micro-computed tomography and confocal laser scanning microscopy. We found the surface diversity of the spermatheca among studied species is not only in internal structures but also in internal ones. Despite of the structural diversity, all species possess a similar pumping structure, the spermatheca is surrounded by muscles in a structured way, and the wall is divided into an enriched region. Focusing on one species, which shows a relatively high level of internal atrial pumping, we established a method of designing a transparent, flexible, low cost models. Our fluid dynamics tests with and without the inner projection showed quite different results. Our approach demonstrated that structural variations in the spermatheca affect fluid dynamics, which suggests that shape differences in the spermatheca among species can reflect postcopulatory mate choice strategies in females. Based on our results we discuss new aspects of our experimental approach in understanding the postcopulatory mate choice.

A11.18 BODY SURFACE DEFORMATION OF SPOTTED SEAL IN A RAPID SWIMMING

Tuesday 2 July, 2019 16:45

YOSHINOBU INADA (TOKAI UNIVERSITY, JAPAN), SHINICHIRO IT0 (TOKAI UNIVERSITY, JAPAN), CHIHARU KAI (TOKAI UNIVERSITY, JAPAN), FUKITO TAKASHA (ENOSHIMA AQUARIUM, JAPAN)

innadatokai@lmp.com

Spotted seal (Phoca largha) is the widely distributed species of pinnipeds. They have a stout and spindle-shaped body with a thick blubber layer under the skin. When they swim rapidly, the body surface is deformed to make way a shape that is supposed to have some kind of fluid dynamic function and drag reduction. To investigate this function, the body surface deformation of spotted seal was observed at Enoshima aquarium, Japan. As a result, it was clarified that the way the pinniped surface appeared only when the swimming speed exceeded the threshold value. The amplitude and the wave length of the surface wave also showed the correlation with the swimming speed. Both of them gradually decreased as the swimming speed increased, indicating the possibility of the water drag reduction effect for the rapid speed swimming.

A11.19 BIOMECHANICAL AND MORPHOLOGICAL-ANATOMIC CHARACTERIZATION OF INTACT, DAMAGED AND HEALED BRANCHES COMPARING TWO SPECIES OF OPUNTIOIDEAE

Tuesday 2 July, 2019 16:48

MAX D. MYLO (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), FRIDERICKE KRIEGER (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY), THOMAS SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141 FFM, GERMANY), OLGA SPECK (UNIVERSITY OF FREIBURG PLANT BIOMECHANICS GROUP, EXCELLENCE CLUSTER LIVMATS @ FIT CRC 141, GERMANY)

Max.Mylko@bioLOGie.unifr.de

Plants have a high selective pressure on the evolutionary development of an efficient system of wounds, induced e.g. by environmental impacts. The first repair step, a fast wound sealing (within minutes to hours after injury), does not only impede infections by germs, but also protects the plant from dehydration. Additionally, wounded stems may be functional for xerophytes. During the subsequent wound healing (within several days to weeks after injury) the plant region at least in part its morphological/ anatomical integrity and mechanical stability are lost to the undamaged state. In the present study wound reactions in terms of morphology, anatomy and mechanics after artificial ring incisions are investigated in Opuntia ficus-indica and Opuntia pugilistica, two closely related species of the subfamily Opuntioideae. The two species show a very different attachment of the lateral branches: very stable C, fice-indica versus very fragile C, angiogelovii, whose side branches serve for vegetative propagation. Bending tests are performed successively on the same lateral branches being still attached to the plant to investigate their flexural rigidity in the intact, damaged and healed (21 days after wounding) state. To compare the flexural rigidity, the self-healing efficiency is calculated taking into account all three aforementioned states. Morphological and anatomical studies are performed via macroscopic and microscopic analyses of the wounded lateral branches and tissues during different stages of the repair. Our studies will not only help for a better understanding of self-repair mechanisms in xerophytes but also for the transfer into biomimetic materials systems.

A11.20 A MECHANICAL COMPARISON OF THE EXTENSOR DIGITORUM LONGUS (EDL) MUSCLE IN C57-BLACK AND FVB MICE

Tuesday 2 July, 2019 16:55

RACHEL HS TIAN (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), JAMES R USHERWOOD (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), J. B. BALABAN (UNIVERSITY OF LEEDS, UNITED KINGDOM), SIMON WALKER (UNIVERSITY OF LEEDS, UNITED KINGDOM)

rbalan@leeds.ac.uk

The C57-black strain is most commonly used to elucidate muscle function. Anxiety exhibited in C57-black and their lack of running wheel usage (Ben Smith, RVC, personal communication) indicates that this strain is a poor model of wild mouse locomotory behaviour. In contrast, the Friend leukemia virus (FVB) mouse strain is a hyperactive phenotype with locomotory patterns and muscle mechanics that may mimic those of a wild mouse more closely. In this study, we measured, of particular interest, we assume that the fast-twitch components of the force-speed and force-velocity curve. Furthermore, the mechanical properties of the fast-twitch fatigue-sensitive EDL muscle (p<0.001). The kinetics of the two strains were also explored by synchronising running wheel data and wheel-foot contact time stamps (n=440 total). Significant higher power was found in FVB mouse than C57-Black (38.5%, p<0.005), whereas changes in force, velocity and running speeds were not significant (p>0.05). These results suggest other differences in muscle properties presumably relating to the shape of the force-velocity curve. Thus, the evidence of FVB’s superior performance suggests that the use of the C57-black strain as an appropriate animal model may have to be re-evaluated to elucidate the mechanics of muscle performance.

A11.21 MORPHOMETRIC MEASUREMENTS OF THE EQUINE HOOF; HOW IS HOOF SHAPE ALTERED BY TRIMMING?

Tuesday 2 July, 2019 16:54

SARAH L. HARLEY (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), JAMES RUSHERWOOD (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), SARA H. L. PINE (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), GINA L. PINCHBECK (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), JO L. IRVINE (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), PETER J. MULER (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM)

Hoof shape is associated with lameness in horses; this study aimed to evaluate the effect of hoof trimming on hoof shape. Digital photographs were taken of dorsal, lateral, medial and solar views of the forefoot of 40 healthy pleasure horses before and after trimming by qualified farriers. Measurements were made in ImageJ and calibrated to a 5cm scale in each photograph. Comparisons were made using Wilcoxon signed rank test or Mann-Whitney U test for paired and independent samples as appropriate. Increases in medial rotation-frangapex (p<0.001), centre of rotation-circle of pressure (p<0.001) and heelbottom-centre of pressure (p<0.001) were associated with trimming in both limbs. Comparisons: pre-trimming-frangapex, tax-distance to (p=0.001), solar width (p=0.001) and medial solar width (left p=0.016, right p=0.03) were reduced post-trimming, whilst the medial hoof wall angle was increased post-trimming (left p=0.017, right p=0.004). The difference between dorsal hoof wall angle and heel angle was greater (p=0.01) on the medial side than on lateral side across both limbs. Medial hoof wall angle was significantly more acute (p<0.001) than lateral hoof wall angle is both pre- and post-trimming conditions of the forelimb, but not the right forelimb. Hoof trimming increases the pain sensation and reduction in length at the toe. Differences in trimming and angulation of medial and lateral walls of the hoof may indicate differing growth and have implications for medicinal/straddle of the hoof. Any asymmetry within forelimb pairs may result from different loading or trimming and affect conformation and long-term orthopaedic health.
**A11.23 SOPHISTICATED SUCTION ORGANS FROM INSECTS LIVING IN TORRENTIAL STREAMS: MORPHOLOGY AND ULTRASTRUCTURE OF THE ATTACHMENT ORGANS OF NET-WINGED MIDGE LARVAE (DIPTERA: BLEPHARICERIDAE)**

**THURSDAY 4 JULY, 2019**

**VICTOR KANG (UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM), ROBIN WHITE (CARL ZEISS X-RAY MICROSCOPY, UNITED STATES), RICHARD JOHNSTON (MIANSAKE UNIVERSITY, UNITED KINGDOM), THOMAS VAN DE KAPP (KARLSRUHE INSTITUTE OF TECHNOLOGY, GERMANY), TOMAS FARAGO (KARLSRUHE INSTITUTE OF TECHNOLOGY, GERMANY), WALTER FEDELE (UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM)**

Use webs for many purposes, one of which, and perhaps the most important one, is for hunting because of their perfect structure. However, the mechanical properties and behaviours of spider webs are far from being completely understood, due to the complex interaction among all its components. In this work, we show the mechanics of two different spider webs: a net web produced by Nuctenea umbratica and the tangle web produced by spiders of the Theridiidae family. The orb web acts like a filter, selecting specific prey and discarding possible big prey that could destroy the whole web. In contrast, what will be explained is the mechanism of each single component of the web, with a special focus on the mechanics of the different junctions (produced by different silk glands) that occur within the web. The tangle web, instead, is the main supporter for the lifting-hunting mechanism. This allows spiders to lift heavy prey making them unable to grip on surfaces and thus escape. We showed that this hunting behaviour could be modeled mechanically for both the Steatoda triangulosa and Steatoda pallidians species. In particular, we showed how the nonlinear mechanics associated to the spider silks is essential in this mechanism in order to have better lifting efficiency.

**A11.25 REPAIR OF MICRODAMAGE IN INSECT CUTICLE**

**THURSDAY 4 JULY, 2019**

**DAVID TAYLOR (TRINITY COLLEGE DUBLIN, THE UNIVERSITY OF DUBLIN, IRELAND), MAEVE O’NEILL (TRINITY COLLEGE DUBLIN, THE UNIVERSITY OF DUBLIN, IRELAND)**

It is well known that mammalian bone develops microdamage in the form of sub-micrometer cracks during normal in vivo loadings, and that it is capable of repairing this damage, thus extending bone’s durability. Here we showed that insect cuticle is also capable of repairing microdamage. We applied bending loads to the hind tibiae of Schistocerca gregaria – a desert insect that lives in torrential alpine waterways – to produce microdamage. We found an increase in elastic stiffness after each successive jump, indicating the presence of microdamage. After a period of time, up to 1 day, the stiffness remained low, but when restested after 1 week and 4 weeks it had returned to normal, indicating that repair had occurred. In previous work we demonstrated that insect cuticle can repair macroscopic damage (cuts and punctures) but this is the first indication that it is capable of detecting and repairing microdamage.

**A11.27 MECHANICAL WORK LOOPS OF THE MUSCLE-TENDON-COMPLEX IN LOW INTENSITY IMPACT CONDITIONS**

**THURSDAY 4 JULY, 2019**

**KASPER CHRISTENSEN (UNIVERSITAT STUTTGART, GERMANY), MICHAEL GÜNTHER (UNIVERSITAT STUTTGART, GERMANY), SYN SCHMIDT (UNIVERSITAT STUTTGART, GERMANY), TORIAS SIEBERT (UNIVERSITAT STUTTGART, GERMANY)**

For any type of terrestrial locomotion the common working condition is active contraction of skeletal muscles that generates high mechanical power. For mammals locomotion propulsion requires repulsion from a surrounding solid that in turn induces shock-wave-like accelerations (impact) to the system via bones muscles and joints. In former isolated muscle contractions experiments, we had emulated shock waves that propagate through muscle in response to impacts in Wistar m. gastrocnemius medialis and lateralis (GAS), at optimal length and with an impact force corresponding to a rat running at 1 m/s. Due to the relatively high strains in the muscle belly at high impact intensities the part of the muscle-tendon-complex (MTC) that absorbed most of the energy was supposed to be the most relevant location for in vivo experiments. Therefore, we reduced the strains in follow up experiments by reducing the impact intensities. With these reduced intensities, we could estimate the mechanical properties of the fibre material solely across the whole isometric force range. In the low intensity conditions with now having determined the properties of the fibre material across the whole isometric force range, we calculated mechanical work loops of the MTC centre of mass during one damped oscillation period and the damping coefficients. We found that the dissipated energy decreases with isometric force, and the damping coefficient increases with isometric force. We shortly discuss the significance of our findings in relation to state of the art mechanical models for fibre tissue contraction.
A11.29 LEARNING HOW TO SWIM: LESSONS FROM MUSCULAR VELOCITY PATTERNS
THURSDAY 4 JULY, 2019 11:00

JOHAN L VAN LEEUWEN (EXPERIMENTAL ZOOLOGY GROUP, WAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS), GEN LI (JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY, JAPAN), FLORENTI J MULJES (EXPERIMENTAL ZOOLOGY GROUP, WAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS), JONATHAN ST EDSLOE (EXPERIMENTAL ZOOLOGY GROUP, WAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS)

Most species of fish with swim with body undulations, also in their larval stages. These undulations are the result of fluid-structure interaction between the internal tissues of the fish and the surrounding water. Although the governing physics are complex, just-hatched larvae can already swim effectively. Despite their presumably limited neural capacity for muscle control and lack of swimming experience, they can produce fast starts followed by prolonged swimming at 2 days post fertilization (dpf). To examine how these larvae swim, we calculated spatiotemporal distributions of the net bending moment, that includes active and passive contributions, along the body-free-swimming zebrafish larvae from 3–12 dpf. To make the data accessible for analysis, we extracted from a large data set of video-recorded 3D motion, 3D computational fluid dynamics, and a large-amplitude deformation model. These data show that the bending moment patterns of each half-beat are similar across larvae throughout early development, as well as for different speeds and accelerations. The pattern changes mainly in amplitude and duration, depending on the combination of speed and acceleration. In our combinations with high amplitudes and/or short durations support swimming at high speeds, or with strong accelerations. Although the patterns are similar, the envelope of possible amplitudes increases considerably in the first days of development, allowing older larvae to swim at higher speeds and accelerations. The similarity of the bending moment patterns suggests that muscle activation patterns are also comparable. This development may imply that fish larvae control their swimming relatively simply, despite the complex physics.

A11.30 AN OPTIMAL SWIMMING STRATEGY OF THE ANIMAL (MOLA MOLA)
THURSDAY 4 JULY, 2019 11:15

OIL IDISIEVSKI (TECHNOLOG, ISRAEL), ILIUSTECHNOL.AI.CC

A predator’s swimming speed represents a compromise between maximizing energy gained from prey and minimizing the energy spent on capture. A pelagic predator, for example, an oceanic white tip shark, that feeds on high-energy-density prey, spreads most of its time in search for it; its feeding events are short and rare. Consequently, its optimal swimming speed is practically the speed that minimizes the cost of transport. An ocean sunfish that feeds on low-energy-density prey, stops on average, every few tens of seconds to feed. In this study we theoretically derive an optimal swimming strategy for a feeding oceanic sunfish: a maximal acceleration in the optimal cruise speed, followed by a powerless glide; the optimal cruise speed and the time duration of each speed, depend on the distance between the stops. Regardless of the distance between the stops, however, the average swimming speed will be smaller than the speed that would have minimized the cost of transport of the fish when swimming at constant speed. Bio-logging data from three animals show good agreement between the theoretical predictions and actual swimming behavior.

A11.31 DRAUGHT DUALITY IN UNDULATORY SWIMMERS GOVERNS OPTIMIZATION STRATEGIES
THURSDAY 4 JULY, 2019 11:30

GEN LI (JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY, NETHERLANDS), KAO LIU (CHBEA UNIVERSITY, NETHERLANDS), ULRIKE MULLER (CALIFORNIA STATE UNIVERSITY FRESNO, UNITED STATES), JOHAN VAN LEEUWEN (WAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS)

Dr. Gen Li (DOI:10.1001/0001-0001.35.14.19) and colleagues

Dr. Gen Li is a leading expert in aquatic biomechanics, particularly in the context of fish swimming. In this study, she explored the duality of swimming strategies in undulatory swimmers, such as larval fish, which can exhibit different behaviors depending on the conditions. By analyzing the patterns of swimming, she found that the transition between feeding and cruising is not just a matter of speed but also depends on the amplitude and duration of these behaviors. This work contributes to our understanding of how fish optimize their swimming strategies under varying conditions, which is crucial for their survival and success in the ocean environment.

A11.32 FLUID DYNAMIC FUNCTIONS OF SMALL TURBULENCE BASED ON FINLESS PINPOISE
THURSDAY 4 JULY, 2019 11:45

YOSHIKUNI SHIDOKA (OKA UNIVERSITY, JAPAN), KIYOSATO TANAKA (OKA UNIVERSITY, JAPAN), MIKUNI KAWAMURA (OKA UNIVERSITY, JAPAN), YASUHIRO TANAKA (OKA UNIVERSITY, JAPAN), INADAKA KU-JP

Finless pinpoise (Neophocaena phocaenoides) has many small tubercles on its dorsal ridge at the centerline of the back. These tubercles generally have conical or hemispherical shape with a cupule of millimeter height. Their function is supposed to reduce the water surface turbulence when the pinpoise enters into the water for the first time but also on the other side of the body meets at the dorsal ridge and generates the water turbulence like waves or splashes. The water entry experiments were done to confirm this function using a streamlined and finless pinpoise model equipped with small tubercles on its surfaces. As a result, the finless pinpoise model showed a distinct wave reduction and the streamlined model also showed a sound reduction during the water entry, showing the marked fluid dynamic functions to inhibit the water surface turbulence.

A11.33 BIRDS AND BALLOON WAKES: OPTIMISING FOR MORE THAN JUST ELLIPTICAL LOADING AND JUST INDUCTED DRAG
THURSDAY 4 JULY, 2019 14:10

JANE A CHEYEN (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), JAEIL SONG (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), JONATHAN P STEVENSON (UNIVERSITY OF BRISTOL, UNITED KINGDOM), NICHOLAS E DURSTON (UNIVERSITY OF BRISTOL, UNITED KINGDOM), SHANE P WINDSOR (UNIVERSITY OF BRISTOL, UNITED KINGDOM), JORDAN J BOMPHREY (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), JORN A CHENEY (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), RICHARD J BOMPHREY (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), SHANE P WINDSOR (UNIVERSITY OF BRISTOL, UNITED KINGDOM), JORN A CHENEY (ROYAL VETERINARY COLLEGE, UNITED KINGDOM), RICHARD J BOMPHREY (ROYAL VETERINARY COLLEGE, UNITED KINGDOM)

J. Cheyney@rvc.ac.uk

This talk introduces the aerodynamic forces and moments acting on birds and small flying mammals, such as bats. The forces generated by the wings of birds and bats are critical for their flight and energy efficiency. By understanding the aerodynamic principles underlying these forces, researchers can optimize flight performance for various tasks, such as maneuverability or energy conservation. This knowledge is valuable in various fields, including avian ecology, ornithology, and even the design of small unmanned aerial vehicles.
**A11.36 A BIO-INSPIRED ROBOTIC FLAPPER REVEALS THAT FLIES USE TORQUE COUPLING IN ESCAPE MANEUVERS**  
**THURSDAY 4 JULY, 2019**

**FLORIAN P MUIJRES (WAGENINGEN UNIVERSITY, NETHERLANDS), MATEI KARÁKÉ (DELTU UNIVERSITY OF TECHNOLOGY, NETHERLANDS), CHRISTOFFE DE WAGTER (DELTU UNIVERSITY OF TECHNOLOGY, NETHERLANDS), BART DE REMES (DELTU UNIVERSITY OF TECHNOLOGY, NETHERLANDS), GUIDO CHE DE CROON (DELTU UNIVERSITY OF TECHNOLOGY, NETHERLANDS), FLORIAN P MUIJRES@WUR.NL**

The banked turn performed by escaping flies is among the most rapid flight maneuvers in nature. Flies control such maneuvers by modulating slow muscle contractions using small adjustments in their wingbeat pattern. It is suggested that these torque modulations are controlled using a proportional-integral (PI) controller based on haptor feedback, and that yaw is not controlled at all, resulting in large sideslip at the end of the turn. We tested these hypotheses, by replaying banked turns of fruit flies, and found that the flies changed their tailplane angle during the turn, reducing the sideslip that was still large. We deduce that an inertial mechanism, followed by aeroelastic aileron, is at work. We discuss the interplay between non- and structural ailerons, and how these combine to reduce body motion.

**A11.37 WING KINEMATICS AND AERODYNAMICS OF SIDE-SLIP MANEUVERING IN BLUE-TAILED DAMSELFIES (ISCHNURA ELEGANS)**  
**THURSDAY 4 JULY, 2019**

**ZIV KASMINER (TEL AVIV UNIVERSITY, ISRAEL), FLORIAN P MUIJRES (WAGENINGEN UNIVERSITY RESEARCH, NETHERLANDS), GAIL RIBAK (TEL AVIV UNIVERSITY, ISRAEL)**

Damselsflies catch flying insects in air while navigating through dense vegetation. We previously showed that contralateral damselflies, chasing manoeuvring targets, tend to minimize changes in body yaw by flying sideways (hereafter ‘side-slip’). This behaviour can enhance transmission gain and stabilize and tracking of objects moving against a stationary panorama. Here, we examined how damselflies coordinate their four wings to achieve controlled sideways flight during the side-slip manoeuvre. An artificial target was oscillated horizontally at 1 Hz (amplitude=0.12 m) within a flight arena. Free-flying male damselflies were filmed chasing the target using high-speed camera to extract kinematic data. During the side-slip manoeuvre, as damselflies changed flight direction, the forewing that is opposite to the initial flight direction had the highest vertical-stroke–reversal point and deviation angle relative to the thorax and body plane. Higher flapping amplitude was also observed in the same wing, compared with the opposite wing. We found that the asymmetries in these rotational angles and differences between wings in wing phase, stroke plane angle and wingbeat frequency were insignificant throughout the manoeuvre. A quasi-steady kinematic model of contralateral wings was used to simulate flapping kinematics. We found that contralateral wings of damselflies coordinate their four wings to achieve controlled sideways flight during the side-slip manoeuvre. Asymmetry in flapping kinematics has a mitigating effect on the asymmetry in the kinematics of contralateral wings.

**A11.38 BODY FLEXION IN HAWKMOTH PLAYS A CRUCIAL ROLE IN HOVERING FLIGHT STABILITY AND MANEUVERING**  
**THURSDAY 4 JULY, 2019**

**RU XU (CHIBA UNIVERSITY GRADUATE SCHOOL OF ENGINEERING, CHIBA UNIVERSITY, JAPAN), HAO LIU (CHIBA UNIVERSITY, JAPAN), CAIXUEFEI@SJTU.EDU.CN**

Hawkmoths are an important model in insect aerodynamics. We developed a bio-inspired hawkmoth model of the insect body, in which a flexible joint was introduced between abdomen and thorax. Our results indicate that the effects of body flexion in terms of abdomen oscillation on aerodynamic performance is a margin compared with that of variation in wing kinematics. In contrast, the inertial torque owing to large abdomen oscillation plays a critical role in primarily altering the pitch angle of thorax, which leads to large pitch-up and/or -down and hence variation in aerodynamic force direction. Moreover, it is found that some small oscillation in abdomen in phase with wing flapping enables marked suppression of the thorax oscillation. Therefore, our study points to the importance of the body flexion in hawkmoth hovering that the abdomen motion likely plays a crucial role in enhancing the pitch stability and maneuvering actively and/or passively.

**A11.39 ACTIVE BODY CONTROL OF FRUIT FLY IN EVASIVE MANEUVER: A COMPUTATIONAL MODEL**  
**THURSDAY 4 JULY, 2019**

**XUEFEI CAI (CHIBA UNIVERSITY, JAPAN), TOSHI NAKATA (CHIBA UNIVERSITY, JAPAN), ZIVKASSNER@GMAIL.COM**

While subtle wing kinematics adjustment has long been considered as the control strategy for insects during sharp turns as a rapid evasive maneuver, whether the body plays an active role in maneuvering and how active body control facilitates maneuvering are still unknown. To uncover the novel mechanisms associated with the active body control in evasive maneuver of insects, we built up an integrated computational model to couple a CFD model of fruit fly flapping flight and a simplified dynamic model of the body that accounts for the flapping-wing aerodynamic torque, active body twist torque and flapping counter-torque. Our simulation results indicate that the evasive maneuver in fruit fly flight can be classified in three-fold: 1) using active body control to achieve quick production of evasive velocity; 2) adjusting wing kinematics for fine-tune the evasive flight; 3) utilizing the flapping counter-torque to efficiently reach a new trimmed (balanced) flight. Our study points out the key role of the active body control in dominating the evasive maneuver, which may bring a new perspective on understanding the flight-control strategies in flapping flight of insects. The novel flight-control mechanisms built in active body control can be an innovative biomimetic design for insect-inspired flapping-wing microair vehicles.

**A11.40 ELASTIC WING DEFORMATIONS DURING FREE-FLIGHT MANEUVERS DAMPEN FLAPPING ASYMMETRY BUT INCREASES TORQUES IN ROSE CHAFERS (PROTETIA CUPREA)**  
**THURSDAY 4 JULY, 2019**

**YOKOTA MEMERES (TEL AVIV UNIVERSITY, ISRAEL), GAIL RIBAK (TEL AVIV UNIVERSITY, ISRAEL), MERMESMAN@MAIL.TAU.AC.IL**

Manoeuvrability sets upper limits on flight performance. Turn in air creates asymmetric flapping between contralateral wings. This flapping asymmetry leads to asymmetry in force production, generating torques that rotate the animal in air. While manoeuvrability includes both natural and induced, insect wings are rigid skeletal structures that prevent active control of wing shape. However, insect wings elastically deform due to the forces associated with the flapping motion. The link between insect flapping kinematics, wing deformations, and aerodynamic manoeuvrability are poorly understood. Here, using high-speed videography, we measured how contralateral wings deform during free-flight manoeuvres in rose chafers (Protetia cuprea). We supplemented the indirect observations with quantitative measurement of wing flexibility during air and/or ground activity. We found that during aerial turns, wing deformations of the left and right wings were asymmetric. The highest asymmetry occurred at the stroke reversal due to a contralateral wing deformation that is relatively larger than the contralateral wings, but asymmetry was also evident during mid-strokes, when inertial flapping forces are minimal. Elastic wing deformations and inertial flapping forces show that wing asymmetry in chafers is not a consequence of elastic deformations, but rather is a result of the passive elasticity of contralateral wings. Nevertheless, wing flexibility increased wing pitch (in both wings) leading to larger quasi-steady torques to rotate the body. The measurement of wing flexibility revealed that subtle differences in body deformation lead to substantial differences in the deflection of the trailing edge. These, in turn, alter wing pitch that changes both turning dynamics. Consequently, wing compliance is an important factor affecting aerial manoeuvrability.
by the much larger inertial forces due to their own acceleration. This is believed to achieve beating in a perfect plane, that allows the orthogonal component of the Coriolis forces to be detected in isolation from the pressure fields. However, this has not been confirmed experimentally. Here, we use time-resolved microtomography to visualise the halteres in tethered blowflies, Calliphora vicina, using induced roll manoeuvres. We used the measured 3D haltere kinematics to calculate the corresponding dynamics. Surprisingly, we found large primary forces acting in the same plane as the Coriolis forces. These were caused by significant out-of-plane motions at the haltere base, and may be a factor of tethering. Furthermore, this base motion produces a force that matches the Coriolis forces that would be produced by a constant pitching motion. Flies will therefore be sensing an fictitious force during tethered flight that could result in changes to their behaviour and requires careful consideration when designing such experiments.

A11.42 \textbf{SURFACE STRUCTURES PROVIDE STEALTH ACOUSTIC CAMOUFLAGE TO MOTHS}

\textbf{THURSDAY 4 JULY, 2019} \hspace{1cm} \textbf{16:55}

Thomas R Neil (University of Bristol, United Kingdom), Zhiyun Shen (University of Bristol, United Kingdom), Daniel A Veitch (University of Lincoln, United Kingdom), Marc W Holderied (University of Bristol, United Kingdom), T.Neil@lincollin.ac.uk

Intense predation pressure from echolocating bats has led to the evolution of a host of anti-bat defences in nocturnal moths. Some have evolved ears to detect the ultrasonic biosonar of bats, yet there are many moth species that are completely deaf. To enhance their survival chances, deaf moths must instead rely on passive defences. Here, we explore the surface structures of moths and show that the acoustic properties of the scales give moths passive acoustic stealth by reducing their echoes from bats. Using acoustic tomography, we show that echolocation frequency can be tuned to enhance or reduce acoustic stealth by changing the cavity frequencies in the moth body. We investigated the acoustic stealth of a range of moths from different body surface adaptations employing a variety of sound ultrasonic frequencies. The surface structures that adorn moths provide substantial acoustic stealth at all ecologically relevant frequencies.

A11.43 \textbf{THE NUMERICAL INVESTIGATION OF THE AUDITORY MECHANICS INVOLVED IN THE PROPAGATION OF SOUND ALONG THE ACOUSTIC TRACHEA OF A BUSH CRICKET}

\textbf{THURSDAY 4 JULY, 2019} \hspace{1cm} \textbf{17:10}

Emine Celiker (University of Lincoln, United Kingdom), Daniel A Veitch (University of Lincoln, United Kingdom), Sarah Aldridge (University of Lincoln, United Kingdom), Christian Pulver (University of Lincoln, United Kingdom), Fernando Pontealegre-Z (University of Lincoln, United Kingdom), Ecelyr@lincollin.ac.uk

The outer ear of the bush-cricket Copiphora gorgonensis consists of an air-filled tracheotome, the acoustic trachea (AT), which transfers sound from the propodeum into the tympanum. The velocity of sound propagation and the acoustic driving forces of the tympanum (the ear drum) can be calculated from the tympanic pressures. However, the mechanism responsible for this change in sound pressure level and velocity remains elusive. In this study, we investigate the mechanical processes behind the change in sound pressure gain by numerically modeling the tracheal acoustic behaviour with the use of the finite element method. Taking into account the thermoviscous acoustic-shell interaction on the propagation of sound, we analyze the effects of the viscosity of the fluid, adhesive processes and the elasticity of the tracheal wall on the change in sound pressure level in the AT. Furthermore, we demonstrate the importance of the mechanical impedance of the tympanic membranes on the pressure gain through numerical simulations. The possible mechanism at work in the AT responsible for the decrease in propagation velocity and pressure gain is further elaborated through varying the numerical values of the material properties in the simulations.

A11.44 \textbf{CONFORMITY IN SPEED: A HIDDEN ENERGETIC COST WITHIN MOVING ANIMAL GROUPS}

\textbf{THURSDAY 4 JULY, 2019} \hspace{1cm} \textbf{17:25}

Lucy H Cotorro-Gome (Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, United Kingdom), Jolles Jolles (Max Planck Institute of Ornithology, Germany), Grant Hofcroft (Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, United Kingdom), Colin Torney (School of Mathematics and Statistics, University of Glasgow, United Kingdom), Em Hinze-Mayer (School of Mathematics and Statistics, University of Glasgow, United Kingdom), Zhiyuan Shen (University of Glasgow, United Kingdom), SHaun Killen (Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, United Kingdom), l.cotorro-gome@sgl.ac.uk

Group living is ubiquitous among taxa and comes with costs and benefits associated with predator avoidance, foraging and reproduction. There is increasing evidence that individual variation in physiology may drive collective behaviour, however, the potential costs of such heterogeneity within groups have rarely been explored. Animals that move together may have different movement profiles and must converge on some common speed in order to maintain their group status. Individual group members may thereby be deviating from their own optimal speed in terms of cost of transport. Using a Black-type swim tunnel respirometer, the oxygen consumption of individual zebrafish (Danio rerio) was measured at different swim speeds to repeatedly determine their optimal swim speed (Uopt). Individuals were then filmed in an open field arena to determine whether the voluntary swim speed, when unconstrained by a current, matched their predicted optimal swim speed. Fish were then tested in pairs and in groups of four to determine how their swim speed changed depending on their conspecifics, and whether fish of a certain optimal swim speed (low, medium or high) would show the greatest compromise (and thus greatest energetic costs per unit distance travelled) to remain part of the group. We also observed how leadership within a group was related to optimum swim speed, providing new insights into the energetic costs of social behaviour and how individuality plays a role in and alters collective movement.

A11.45 \textbf{SPEED CONSENSUS AND THE "GOLDILocks PRINCIPLE" IN FLOCKING BIRDS (COLUMBA LIVIA)}

\textbf{THURSDAY 4 JULY, 2019} \hspace{1cm} \textbf{17:40}

Daniel W Sankey (Royal Holloway University of London, United Kingdom), Emily L Shepard (Smanssea University, United Kingdom), Dora Bird (University of Oxford, United Kingdom), Steve J Portal (Royal Holloway University of London, United Kingdom), Daniel.Sankey.2016@live.rhul.ac.uk

The evolution of group-living transformed the history of animal life on earth, yielding unprecedented selective benefits. Yet, without overcoming fundamental challenges such as how to coordinate movements with conspecifics, animals cannot maintain cohesion, and coordination thus forms a prerequisite for the evolution of sociality. Although bats have been considered to animal groups use different strategies to coordinate the timing, and direction of movements, additionally, coordinating speed is essential to prevent group splitting. We investigated speed consensus in homing pigeons flying at high-resolution GPS. Despite marked differences in solo speeds (predicted by bird mass), compromise was reached in flocks at an average of observed solo speeds. Speed-averaging – by virtue of minimising extreme compromises – can maximise selective benefits across the group, suggesting shared consensus for group speeds could be ubiquitous across taxa. Nonetheless, despite group-wide advantages, contemporary flight models suggested unequal energetic costs in favour of individuals with intermediate body-mass/preferred-speed (hence the "Goldilocks principle").
A11.47 EXPLORING THE EFFECTS OF FREE SURFACE ENERGY VARIATIONS ON TREE FROG ATTACHMENT

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

LISA NIEUWBOER (WAAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS), JULIAN KA LANGOWSKI (WAAGENINGEN UNIVERSITY AND RESEARCH, NETHERLANDS)

LISA.NIEUWBOER@WUR.NL

Tree frogs are able to attach to different substrates in their natural habitat using adhesive digital pads. A mucous meniscus is present at the pad-substrate interface, which is proposed to enable wet adhesion (i.e. capillary forces). However, the extent to which capillary adhesion contributes to tree frog attachment is not resolved. To explore the role of capillary adhesion in tree frog attachment, we quantified the adhesion of the digital pads as a function of the substrate free surface energy (γ) on seven substrates with differing γ (Teflon, PMMA, glass, coated glass, stainless steel, Musca leaves and Alocasia leaves with a range of γ = 14.8-63 N/m) using a rotation table setup. The newly built set-up is nearly vibrationless, has easily exchangeable substrates, and allows for the dynamic measurement of the pad contact area by frustrated total internal reflection as well as for dynamic recordings of the body kinematics. As a high pressure reduces the contact angle of the mucous meniscus and accordingly enhances capillary adhesion, one would expect that tree frog generates stronger adhesion forces on high-γ-substrates than on substrates with low 𝛾. However, this was not observed in our experiments. To explore this effect we studied the role of the mucous meniscus in enhancing the pitch stability and maneuvering actively and/or passively.

**A11.48 RIGTING MECHANISM OF THE INDIAN STICK INSECT**

**THURSDAY 4 JULY, 2019 POSTER SESSION**

PHILIPP H. SUNCKE (DEPT. OF BIOMICROSCOPIC, HOCHSCHULE BREMEN – CITY UNIVERSITY OF APPLIED SCIENCES, GERMANY), DAVID LABORTE (DEPARTMENT OF BIOMEDICAL ENGINEERING, EMPIRAL COLLEGE LONDON, UNITED KINGDOM), SUSANNA LABSCH (BIOMICROSCOPIC-INNOVATION-CENTRE, HOCHSCHULE BREMEN – CITY UNIVERSITY OF APPLIED SCIENCES, GERMANY), JAN-HENNING DIRKS (BIOMICROSCOPIC-INNOVATION-CENTRE, HOCHSCHULE BREMEN – CITY UNIVERSITY OF APPLIED SCIENCES, GERMANY)

PHILIPP.SUNCKE@GMAIL.COM

Although insects possess very reliable adhesive organs, any climbing insect can fall down. Previous studies have shown that air-righting mechanisms allow insects to control their fall to some extent. However, there is still a chance for an unfortunate landing on the back. Having a fast and efficient righting strategy is thus important for the survival of any climbing insect. Do climbing insects show characteristic righting mechanisms when lying on their back? In this study we investigated the righting mechanisms of two Indian stick insects (Carausius morosus), typical model organisms for locomotion biomechanics. Adult female stick insects were placed on their dorsal side on a smooth glass plate. Eight characteristic markers were defined along the long axis and tracked from the lateral and dorsal view. Tracking data was used to calculate (1) the angle between the mesothorax and the ground (2) the angle of rotation around the roll axis and (3) the overall curvature of the animal’s body. Based on our data we identified a characteristic righting behavior of the insects which could be divided into four main phases: initial phase (dorsal flexion begins), lateral phase (maximum curvature, falling on the ipsilateral side), straightening phase (contralateral legs swinging around, straightening of the ipsilateral leg) and final phase (declining curvature, lifting of the body). Experiments with removed adhesive organs show that ground contact is essential during the straightening phase. Based on our results we propose a simplified, bio-inspired rotation mechanism forbionics, involving only four legs and four segments.

**A11.49 MICROPHYSICS OF THE ANTENNAL OLFCTION OF SAMIA CYNTHIA (LEPIDOPTERA, SATURNIIDAE)**

**WEDNESDAY 3 JULY, 2019 POSTER SESSION**

MOURAD JAFFAR-BANDJEE (THE UNIVERSITY OF TOURS, FRANCE)

MOURAD.JAFFAR-BANDJEE@ETU.UNIV-TOURS.FR

Olfaction is an important sense for insects and antennas are usually the main organs dedicated to smelling. Silk moth antennas composed of one rami and the sensilla it supports. We combined an experimental measurement of the airflow signal between the substrates of the antenna instead of flowing around, with a modeling approach used to determine the mass transfer between the air and the surface of the antenna. We then calculated the capture efficiency of the antenna. In the experimental approach, we used a Particle Image Velocimetry (PIV) system on an artificial antenna built with additive manufacturing processes, also called 3D-printers. The modeling part was adapted from a model developed for heat transfer in the case of a similar geometry. We found that the capture efficiency of the antenna is either limited by a low leakiness and low velocities or a low efficiency of the heating of sensilla at high velocities. We found that the antenna has a constant capture efficiency over a large range of fluid speeds. Our models also give a mechanistic explanation of the phenomenon of olfactory illusion described on pectinate antennae.
Aquatic pHs below 5.0 are toxic to most freshwater animals. This toxicity arises largely through the perturbation of ion homeostasis — low pH disrupts epithelial integrity and compromises ion uptake machinery. Despite these challenges, many aquatic organisms can survive and reproduce in naturally occurring, low pH environments. One of these acid-adapted species is the Scarlet-sided pobblebonk, Limnodromytes terraearenae, a frog whose larval range can tolerate waters as low as pH 3.5. The mechanism that allows L. terraearenae to live in these extreme environments is poorly understood. This study explored the mechanistic basis for the tolerance of low pH water by L. terraearenae larvae using a combination of whole animal, pharmacological and molecular tools. We found that larvae reared at pH 3.5 maintained similar body Na uptake capacity as larvae reared at pH 6.5. Acute exposure of acid-naïve larvae to low pH resulted in a small, transient loss of body Na+ associated with an inhibition of Na+ uptake. However, uptake capacity was restored within 48h. Using RNA-seq and pharmacological tools we found that branial Na+ uptake transporters were upregulated in low-pH acclimated larvae, as were genes associated with the detection of Na+ by osmosensing antennae (od glands). Our findings highlight the importance of low-pH sensing mechanisms and control of Na+ loss in the maintenance of epithelial integrity.

**A12.2 SYNERGISTIC EFFECTS OF OCEAN ACIDIFICATION AND WARMING ON THE THERMAL TOLERANCE AND LOCOMOTION OF A SEA URCHIN**

**THURSDAY 4 JULY, 2019  09:15**

STEFANO MARRASSI (NATIONAL RESEARCH COUNCIL (CNR), ITALY), LEONARDO VENERUS (CONSEJO NACIONAL DE CIENCIA Y TECNOLOGIA (CONICET), ARGENTINA), ANDREA SATTA (NATIONAL RESEARCH COUNCIL (CNR), ITALY), LEONARDO VENERUS (CONICET, ARGENTINA), PATRICIO MANRIQUEZ (CENTRO DE ESTUDIOS AVANZADOS EN ZONAS ÁRIDAS (CEAZA), CHILE), RODRIGO TORRES (CENTRO DE INVESTIGACIÓN EN ECOSISTEMAS DE LA PATAGONIA (CIEP), CHILE), FABIO MARINO (NATIONAL RESEARCH COUNCIL (CNR), ITALY), STEFANO MARRASSI (CNR-ITA), IAN A BOUYOCOS (AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, AUSTRALIA), SUE-ANN MATSON (AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, AUSTRALIA)

Recent studies have shown that ocean acidification and warming, driven by anthropogenic carbon dioxide (CO2) emissions, can affect the behaviour and physiology of aquatic animals. While each isolated stressor has been studied extensively, the synergistic effects of low pH and high temperature are known to be more severe. Here we tested the combined effect of medium-term (30 days) exposure to elevated CO2 and different temperatures on the thermal tolerance and locomotion of the sea urchin Paracentrotus lividus. Individuals exposed to four treatments (two CO2 levels, 400 and 1000 µatm and two temperatures, 14 and 24°C) were tested for their critical maximal (CTmax) and minimal (CTmin) temperature, the highest temperature for self-righting behaviour (Tb), and their horizontal and vertical locomotion. We found that high temperature had a positive effect on all the variables measured compared with the combined exposure to elevated CO2 and high temperature or the independent effect of elevated CO2. Exposure to high temperature led to an increase in CTmax and Tb, and the locomotor performance during horizontal and vertical displacement. By contrast, we observed a little influence of elevated CO2, suggesting that thermal tolerance and locomotion were robust to this environmental stressor. Knowledge of how these traits may change as a result of concurrent exposure to elevated CO2 and high temperatures represents an important step to predict the responses of this species to climate change.

**A12.3 A TROPICAL MESOPREDATORY SHARK IS RESILIENT TO SIMULATED WARMING AND END-OF-CENTURY ACIDIFICATION LEVELS**

**THURSDAY 4 JULY, 2019  09:30**

IAN A BOUYOCOS (AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, AUSTRALIA), SUE-ANN MATSON (AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, AUSTRALIA), ILISHA L WINDLE ( środowisko Institute of Marine Sciences, United States), ANDREW SIMPFENDORFER (CENTRE FOR SUSTAINABLE TROPICAL MARINE ECONOMIES IN A Changin World, Australia), SANDRINE HUGHES (IGFL ENS LYON, FRANCE), STEVEN D MELVIN (ENVS RESEARCH LABORATORIES IAEA, MONACO), ANUTA CHINDRIS (INTERNATIONAL MARINE CENTRE INVERNESS, SCOTLAND), COLIN SENEGAL (INTERNATIONAL MARINE CENTRE INVERNESS, SCOTLAND), MARGARET BESSON (ENVIRONMENT LABORATORIES IAEA, MONACO), FABIO MARINO (NATIONAL RESEARCH COUNCIL (CNR), ITALY), BENJAMIN GILLET (IGFL ENS LYON, FRANCE), HUGO JACOB (ENVIRONMENT LABORATORIES IAEA, MONACO), MARC METIAN (ENVIRONMENT LABORATORIES IAEA, MONACO), STEFANO.MARRAS@CNR.IT

The combined effects of climate change stressors on the physiology and behaviour of marine ectotherms are equivocal. However, understanding species’ responses across a range of ecological niches is vital for managing and protecting imperiled populations. The purpose of this study was to determine how a tropical mesopredatory shark responds to ocean warming and acidification. Specific objectives were to (i) test the effects of warming (28 and 31°C) and acidification (600 and 1000 µatm CO2) in laboratory seawater stressor (hypoxia), behaviour (activity and lateralisation), physiological status (acid-base status and haematology), and aerobic performance (scope and recovery) in neonatal blacktip reef sharks (Carcharhinus melanopterus). Although haematocrit was elevated in sharks at 31°C and minimum oxygen uptake rate was elevated under high CO2 at 31°C, we did not observe changes in any other variable measured relative to ambient (28°C and 600 µatm) conditions. This species has previously demonstrated resilience to warming (28 vs 33°C) and elevated CO2 (600 and 1000 µatm) in isolation, but this is the first study to investigate these combined stressors. Improvements in oxygen transport (i.e., haemoglobin-oxygen affinity) and the excellent plasma buffering capacity that is characteristic of elasmobranch fishes may have allowed these sharks to maintain a physiological function despite the challenges associated with elevated temperatures and CO2. Our data suggest the current phenotype of the target population – at least in this early life stage – is capable of enduring end-of-century temperature and CO2 conditions, possibly preserving this mesopredator’s ecological function.

**A12.4 EFFECTS OF MICROPLASTICS ON GILTHAD SEABREAM JUVENILES (SPARUS AURATA) USING A MULTI-DIAGNOSTIC APPROACH**

**THURSDAY 4 JULY, 2019  09:45**

MARC BESSON (ENVIRONMENT LABORATORIES IAEA, MONACO), HEIJO JACOB (ENVIRONMENT LABORATORIES IAEA, MONACO), FRANÇOIS OBERRAENHOLZ (ENVIRONMENT LABORATORIES IAEA, MONACO), ANTONIO TAVARES (ENVIRONMENT LABORATORIES IAEA, MONACO), SANDRINE HUGHES (IGFL ENS LYON, FRANCE), STEVEN D MELVIN (AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES, AUSTRALIA), BESSONMARCLUC@GMAIL.COM

Microplastic (MP) pollution is a global major concern, particularly in aquatic ecosystems where the amount of MPs continues to rise as plastic production increases worldwide. Given their ubiquitous nature and small dimensions, MPs can be ingested by aquatic organisms, transferred along the food-web, and translocated in internal tissues, the hazards of which are yet to be fully understood. While this concern has led to a substantial amount of experimental studies, there is still a need for better decipher the effects of MP pollution on aquatic organisms. Here, we developed a multi-diagnostic approach involving impact assessment at multiple levels of biological organization (from atoms to organisms) to detect the impacts of MPs on marine fish. More precisely, we exposed Gilthead seabream juveniles (Sparus aurata) to virgin 10-250 µm polyethylene microspheres through food (Artemia salina; exposed at 5 mg/L) for 45 days and looked at their (i) liver, stomach and intestine histology; (ii) intestinal microbiome; (iii) brain, liver and muscle metabolite profiles (NMR); (iv) assimilation of 15N and 13C; (v) carbon and nitrogen stable isotopes profiles in muscle; and (vi) acetylcholinesterase stress and hunger, and satiety hormones levels. This variety of endpoints allowed us to develop a comprehensive and representative framework of the impacts of MPs in a fish species, revealing subtle to profound biological changes.
A12.5 Glass Eel (Anguilla anguilla) Riverward Migration Could Be Challenged by Projected Climate Change

Thursday, July 4, 2019, 10:45

Francisco PMC Borges (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal), Catarina P Santos (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal), Eduard S Sampaio (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal), José A Paula (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal), Carlos Antunes (Interdisciplinary Centre of Marine and Environmental Research, Portugal), Rui Rosa (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal), Tiago F Brilho (Marine and Environmental Sciences Centre (MARE), Laboratory Marítimo da Guia, Portugal)

franciscomcborges@gmail.com

Little is known about the potential vulnerability of European eel’s (Anguilla anguilla) early stages concerning projected future environmental changes, a concern with the dramatic decline in this critically endangered species’ populations over recent decades. In this study, we investigated, for the first time, the potential effects of combined ocean warming (Δ1.4°C) and ocean acidification (Δ0.4pH) on the survival and migratory behaviour of A. anguilla glass eels, specifically regarding their preference towards riverine (i.e. osmotic and freshwater). Over 100 days, glass eels were exposed to the experimental treatments, adjusting for the salinity gradients associated with upstream migration. Mortality was monitored daily, and migratory activity and potential shifts in preference were assessed using a two-choice test. In summary, warming was responsible for decreasing survival and increasing migratory activity, while ocean acidification induced a hindered migratory response by reducing preference for riverine cues. These results suggest that future ocean conditions could reduce the survival and migration of this migratory species, and potentially favour an early settlement of glass eels. It is paramount that further research into the effects of climate change on eel migration and habitat selection is conducted, if efficient conservation plans are to be implemented.

A12.6 The ‘Decline Effect’ Characterizes a Decade of Ocean Acidification Research on Fish Behaviour

Thursday, July 4, 2019, 10:15

Jeff C Clements (Norwegian University of Science and Technology, Norway), Joseph N Sunjio (Norwegian University of Science and Technology, Norway), Timothy D Clarke (Deakin University, Australia), Frederik Jutfelt (Norwegian University of Science and Technology, Norway)

jeff.clements@ntnu.no

Innovative scientific discoveries are followed by attempts to replicate and build upon the groundbreaking works. In many instances, however, follow-up studies fail to replicate initial effects and, consequently, are unable to build upon those pioneering results. This tendency for initial scientific findings—which typically show outstanding effects— to lose strength over time is referred to as the ‘decline effect’. Using a meta-analysis, we provide a striking and textbook example of the decline effect over a decade of research on ocean acidification and fish behaviour. While early studies reported outstandingly strong effects, the effect size has not been significantly different from zero. This trend of declining effect size cannot be explained by an increasing number of studies or different methodologies. We encourage further exploration of the decline effect in the context of other biological phenomena, and in a wider array of scientific disciplines, with an aim to rectify the underlying drivers.

A12.7 New Insights from Genomics and Proteomics in Intestinal Carbohydrate Digestion

Thursday, July 5, 2019, 11:00

Enrique Caviedes-Vidal (Consejo Nacional de Investigaciones Científicas y Técnicas, Universidad Nacional de La Plata, Argentina), Bruno Antonio (Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina), Daniel Méndez-Abranda (Max Planck Institute for Ornithology, Germany), Melisa Mallainas Alba (Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina), William Karanav (University of Wisconsin - Madison, United States), Carlos Martinez del Rio (University of Wyoming, United States), Maude Baldwin (Max Planck Institute for Ornithology, Germany)

enrique.caviedes@gmail.com

Present knowledge presumes that in vertebrates, the enzymes sucrase-isomaltase (SI) and maltase-glucosamylase (MGAM) are responsible for the digestion oligo- and disaccharides (e.g., maltose, sucrose, etc.) at the small intestine apical membrane. Such knowledge has its origins in mammalian studies where those two orthologs perform these functions. We tested if this hydrolytic system is conserved in all vertebrates by searching databases for SI and MGAM sequences. Surprisingly, we found that only SI was conserved and that all clades and just some (amphibians, some fishes and birds) exhibited both sequences. Phylogenetic inference revealed the ancestral condition of SI and that MGAM appeared in different evolutionary events along clades. We tested this finding using a phylogeny coupolyed to protomics assay binding brush-border membrane of rats, mice, chickens, zebras, and house sparrows. In the first three species, a genomic study produced sequences of SI and maltase-glucosamylase, while in the passerine species, only SI was found. Maltose, sucrose and isomaltose were used as substrates for the phylogeny. Glycose assay on the phylogeny yields produced bands in all species’ livers revealing alpha-glucosidase and enzyme activity. These bands were cut and assayed for proteins. Proteomics confirmed our genomics findings: SI and maltase-glucosamylase were responsible for the hydrolysis in mammals and chickens and only one enzyme, SI, accounted for all alpha-glucosidases activity in passerines. Findings suggest greater diversity and different evolutionary history of the brush-border membrane alpha-glucosidases than previously presumed, with widespread implications for our understanding of the digestive physiology of the majority of vertebrates. Supported by NS 0501554983.

A12.8 Peptide Transporters in the Primary Gastrointestinal Tract of the Pre-Feeding Mozambique Tilapia Larva

Thursday, July 4, 2019, 11:15

Pazit Con (Hebrew University of Jerusalem, Israel), Tal Nitaz (Ari, Israel), Taitana Sloman (Ari, Israel), Sheinman Harpaz (Ari, Israel), Avner Cmani (Ari, Israel)

ppazaph@gmail.com

Fish larvae differ greatly from the adult form in their morphology and organo functionality. The functionality of the gastrointestinal tract depends on the expression of various pumps, transporters, and enzymes responsible for feed digestion and absorption. During the larval period, the gastrointestinal tract develops from a simple closed tube, into its complex form with differentiated segments, crypts and villi, as found in the adult. In this study, we characterized the expression of three peptide transporters (PepT1a, PepT1b, PepT2) in the gastrointestinal tract of the Mozambique tilapia (Oreochromis mossambicus) larvae along 12 days of development, pre-hatching to the completion of yolk sac absorption. Gene expression analysis revealed differential and complimentary temporal-expression of the PepT1 variants and PepT2 along the larval period. Immunofluorescence analysis showed differential protein localization of the three PepTs along the gastrointestinal tract and its respective functions and role of the gastrointestinal tract and its transporters during the larval period.

A12.9 It’s a Shark-Eat-Shark World: Nitrogen Movement Along the Gastrointestinal Tract of the Spinny Dogfish (Squalus acanthias) Suckling Following the Urea-Rich Meal

Thursday, July 4, 2019, 11:30

J. Lisa Hodgenboom (University of Manitoba, Canada), W. Gary Anderson (University of Manitoba, Canada)

j.lisa.hodgenboom@umanitoba.ca

Marine elasmobranchs retain high plasma urea levels (>350 mM) as a metabolic strategy. Research into the synthesis and retention of urea has previously focused on post-prandial metabolic processes that follow the consumption of marine teleosts (containing negligible urea concentrations). However, some marine elasmobranchs prey upon other elasmobranch species necessitating the integration of an elimination of excess prandial urea. To determine the movement of excess nitrogen (as ammonia or urea) across the gastrointestinal tract, North Pacific spinny dogfish (Squalus acanthias) were force-fed and Atlantic herring (Clupea harengus) with 800 mM urea added; control animals were fasted for 7 days or force-fed herring only. Caudal sinus plasma and mesenteric arterial plasma were taken pre- and post-feeding; ammonia was highest in mesenteric arterial plasma post-feeding, suggesting the movement across the gastrointestinal tract. To determine if ammonia concentration was significantly higher than the background bath concentration (p<0.001), while ammonia concentrations were significantly higher compared to the food (p= 0.001). In vitro gut sac preparations of the stomach and the intestinal fluids were incubated for 3 h in ammonia-free Elasmobranch Ringer’s; a ammonia ion concentrations in the intestinal lumen were significantly greater than the surface bath (p<0.001), while ammonia ion concentrations did not differ. These data indicate excess prandial urea may be converted to ammonia within the gastrointestinal tract, likely by intestinal urease activity.

A12.10 Recycling Urine When You’re in Trouble: Acid–Base Balance Upon Emersion in the Semi-Cylindrical Thick-Minnow Gobius, Helice Formosensis (Grapsidae)

Thursday, July 4, 2019, 11:45

Garrett JP Allen (University of Manitoba, Canada), Yoon-Chie Tseno (Marine Research Station Institute of Cellular and Organismic Biology, Sinica, Taiwan), Dirk Weihrauch (University of Manitoba, Canada)

allen@emapm.ca

Grass carp are keystone species within many as they are significant primary producers, and geographical influence are major contributors to benthic environment’s nutrient cycle. Helice formosensis, the thick-crab, is a small ballowishing species which regularly
**A12.12 METABOLIC RATE, CELL SIZE AND TEMPERATURE: A COMPARISON BETWEEN DIPLOID AND TRIPLOID ZEBRAFISH**

**THURSDAY 4 JULY, 2019** 14:25

IRIS LE VAN DE POL (Radboud University, NETHERLANDS), ADRIAN HENDERSHOT (UNIVERSITY OF REALYST, POLAND), WILCO CEP VERBRUK (Radboud University, NETHERLANDS)

Being composed of small cells may carry an energetic cost as smaller cells have a larger surface area to volume ratio, which would result in higher energetic costs to maintain electrochemical gradients. Conversely, a benefit of smaller cells could lie in a greater capacity to transport oxygen to the mitochondria, owing to relatively larger surfaces and shorter diffusion distances. Evidence suggests that these costs and benefits of cell size at temperature depend. To study the consequences of cell size for whole-organism metabolic rate across different temperatures we used diploid and triploid zebrafish differing in cell size. Fish were reared to 5 dpf in a full factorial design combining three different rearing and testing temperatures (23.5, 26.2, 29.5°C). Individual oxygen consumption rates and oxygen-regulatory capacity was measured. We hypothesized that triploids should have lower rates of oxygen consumption and a lower oxygen-regulatory capacity at higher water temperatures in which oxygen availability is lower due to metabolic demands and lower. We found that triploids had significantly lower metabolic rates at the highest test temperature, but higher metabolic rates at the lowest test temperature. This difference was particularly pronounced in fish reared at 29.5°C. Triploids also deviated less from experimental oxygen consumption levels, although the difference was very small. Our results largely support our hypotheses, suggesting that costs and benefits at the level of the cell have consequences for whole-organism oxygen consumption.

**A12.13 TEMPERATURE VARIATION MAKES AN ECOTHERM MORE SENSITIVE TO THE WARMING UNLESS THERMAL EVOLUTION OCCURS**

**THURSDAY 4 JULY, 2019** 14:40

JULIE VERHEYNEN (KU LEUVEN, BELGIUM), ROBBY STOKS (KU LEUVEN, BELGIUM)

In a recent study, global warming impacts on species were shown to be greater in colder regions. In this study, we aimed to understand species’ sensitivity to temperature changes, body-size-activity of flies over five generations and after two generations under common garden conditions (control diet) at 25°C. We found that the evolutionary response of metabolic rate to changes in temperature, we are undertaking a long-term experimental study in Drosophila melanogaster in which larvae were reared at 18, 25 or 28°C on either a control diet, a low-calorie diet, or a low-protein diet. In each of these nine selective environments, we are assessing fly longevity and changes in metabolic rate, body size, activity of flies. We found that flies reared at 25°C displayed a higher metabolic rate, body size, and activity of flies than flies reared at 18°C or 28°C. In contrast, flies reared at 28°C displayed a lower metabolic rate, body size, and activity of flies than flies reared at 18°C or 25°C. These results suggest a negative effect of temperature on the evolutionary response of metabolic rate to changes in temperature.
type II cells and ultimately, petrosal excitability. DA applied directly evoked intracellular Ca(2+)-responses in type II cells when grown together with type I cells in rat CB cultures. This in contrast to type I cells, a effect prevented by the D2/3 blocker, sulpiride (0.1-10 μM). Interestingly, sulpiride, or roserpine-induced DA depletion, antagonised P2Y2R-mediated Ca(2+) -transients predominantly during hypercapnia or high K+ exposure. Finally, in CB-petrosal neuron co-cultures, sulpiride potentiated (DA+)-responses in both type II cells and petrosal neurons during hypercapnia. Further, selective P2Y2R stimulation evoked rapid triggered (DA+)-responses in nearby petrosal neurons. Our results suggest that type II cells may contribute to the DA inhibitory pathways in the CB and, however, they may communicate directly with sensory endings via purinergic mechanisms. Supported by NSERC and CHIR.

A12.18 THE FUNCTIONAL ROLE OF T-TYPE Ca2+ CHANNELS IN THE TURTLE (Trachemyx scripta) HEART IS AFFECTED BY ANOXIA EXPOSURE AND COLDD-ACCLIMATION

THURSDAY 4 JULY, 2019 15:55

JOHANNA K STEYK (UNIVERSITY OF ALASKA ANCHORAGE, UNITED STATES), GUS BARBER (UNIVERSITY OF ALASKA ANCHORAGE, UNITED STATES)

I. Introduction - Hypoxia and cold-acclimation improve heart function in cold-blooded animals. Type I and II cardiac cells of cold-acclimated turtle hearts are more sensitive to changes in external conditions compared to controls. This project examines whether cold-acclimation affects the functional properties of T-type Ca2+ channel (CICR) is known to thereby affect anemonefish (M. aenetus) metabolism. We observed repeatedly to quantify the strength and the number of connections among individuals with each group. Our findings suggest that group connectivity is affected by temperature change and provide insight into how individual physiological traits affect social dynamics.

A12.19 DO THERMAL CONSTRAINTS ON PHYSIOLOGICAL PERFORMANCE DRIVE WINTER DORMANCY IN FISH?

THURSDAY 4 JULY, 2019 16:40

LAUREN R WORSLEY (UNIVERSITY OF NEW BRUNSWICK SAINT JOHN, CANADA), CONNOR REEVE (UNIVERSITY OF NEW BRUNSWICK SAINT JOHN, CANADA), BEN SPEERS-ROEHEC (UNIVERSITY OF NEW BRUNSWICK SAINT JOHN, CANADA)

We measured the thermal sensitivity of fitness-linked physiological performance (burst swimming, metabolic rate, aerobic scope, metabolic levels, and enzyme activity) in winter-acclimated versus standard (non-acclimated) individuals during both acute hypoxia and colddomancy below ~7°C. Performance was measured after acclimation exposure to 2-2°C C and after acclimation exposure (5 weeks) to 12-14°C. Exposure to hypoxia and cold phenotype decreased with cooling below the Fm, independent of exposure group. In acutely exposed fish, the thermal sensitivity of performance was greater below the colddomancy threshold temperature, above suggesting a major constraint of cold. However, at 2°C, acclimated cunner had a greater performance at lower thermal sensivity compared to acutely exposed cunner (Fm of 1-1.2 vs. 3.9-4.3 between 2-2°C, respectively). This, dormant cunner showed partial compensation of swimming and aerobic performance in winter cold temperatures, similar to cold-active species. Additionally, compensation of metabolic enzyme activities did not underlie the whole-organism performance compensation. We conclude that thermal constraint on anaerobic exercise and aerobic performance are not major drivers of winter dormancy in cunner.

A12.20 WHAT ARE THE EFFECTS OF TEMPERATURE ACCLIMATION ON THERMAL AND HYPOXIA TOLERANCE IN RAINBOW TROUT

THURSDAY 4 JULY, 2019 15:40

NICHOLAS R STROWBRIDGE (UNIVERSITY OF BRITISH COLUMBIA, CANADA), MATTHEW J JERIBERT (UNIVERSITY OF BRITISH COLUMBIA, CANADA), JESSICA MCKENZIE (UNIVERSITY OF BRITISH COLUMBIA, CANADA), ANTHONY F PARRELL (UNIVERSITY OF BRITISH COLUMBIA, CANADA), PATRICIA M SCHULT (UNIVERSITY OF BRITISH COLUMBIA, CANADA)

STROWSBIOLOGY.UBC.CA

Integrative studies assessing the acclimation response across multiple levels of biological organization will provide a better understanding of how organisms may respond to environmental changes associated with climate change. We assessed the effects of thermal acclimation (12°C, 18°C, 24°C) on critical thermal maximum (CTmax), hypoxia resistance, induced loss of algal symbiont (zooxanthellae), and metabolic activity. Cardiovascular and metabolic responses were measured in juvenile rainbow trout at elevated temperatures. Temperature acclimation increased CTmax, Fm, and Gmax, with increased CO2-induced inhibition on thermal acclimation and CTmax at 21°C in normoxia, indicating a reduced functional role of the T-type Ca2+ channel under these conditions. The finding highlights an additional mechanism through which cold acclimation prepares the turtle heart for prolonged anoxia exposure in winter. How animals interact within social groups is a vital part of understanding animal social behaviour. Connections among individuals within social groups are important for group foraging behaviour, predator avoidance, information transfer, and mating. It is currently unknown, whether variation in environmental temperature affects the stability of social networks in ectothermic species. We also know little about how individual physiological traits relate to position within a social network. We measured standard metabolic rate and social network in groups of the social fish corydoras catfish (Corydoras aeneus) after acclimation to temperatures that increase (2°C) or decrease (2°C) the speed of swimming (f(max)) and intrinsic heart rate (Fm). Our results suggest that increased swimming is linked to increased CTmax and Gmax and decreased intrinsic heart rate (Fm), Isabelle Arago (ISABEL@TEAMSUNDIN.SE)

How animals interact within social groups is a vital part of understanding animal social behaviour. Connections among individuals within social groups are important for group foraging behaviour, predator avoidance, information transfer, and mating. It is currently unknown, whether variation in environmental temperature affects the stability of social networks in ectothermic species. We also know little about how individual physiological traits relate to position within a social network. We measured standard metabolic rate and social network in groups of the social fish corydoras catfish (Corydoras aeneus) after acclimation to temperatures that increase (2°C) or decrease (2°C) the speed of swimming (f(max)) and intrinsic heart rate (Fm). Our results suggest that increased swimming is linked to increased CTmax and Gmax and decreased intrinsic heart rate (Fm), Isabelle Arago (ISABEL@TEAMSUNDIN.SE)

A12.21 PHYSIOLOGICAL AND BEHAVIOURAL EFFECTS OF ANEMONE BLEACHING ON SYMBIONT ANEMONEFISH

THURSDAY 4 JULY, 2019 16:55

ISABEL ARAGO (UNIVERSITY OF GLASGOW, UNITED KINGDOM), MAR PINEDA (UNIVERSITY OF GLASGOW, UNITED KINGDOM), DAPHNE CORTESE (CRIOBE, FRENCH POLYNESIA), TOMEY NORN (DTU, DENMARK), JONATHAN AW STECYK (UNIVERSITY OF ALASKA ANCHORAGE, UNITED STATES), ANDERS BERGLUND (UPPSALA UNIVERSITY, SWEDEN), RICARDO BELLADE (CRIOBE, FRENCH POLYNESIA), SHAUN KILLEN (UNIVERSITY OF GLASGOW, UNITED KINGDOM), SUZANNE MILLIS (CRIOBE, FRENCH POLYNESIA)

DAPH.CORTESE@GMAIL.COM

Increased ocean temperatures are causing mass bleaching of anemones and corals in the tropics worldwide. While this heat-induced loss of algal symbiont (zooxanthellae) directly affects anemones and corals physiologically, this damage may also cascade to affect other animal symbionts. We investigated how bleaching of the magnificent sea anemone (Stichodactyla m农民) may indirectly affect key energetic traits of juvenile orange-fine anemonefish (Amphiprion perideraion) over short and long timescales. We first measured the effect of residing short-term (2 weeks) in bleached vs unbleached sea anemone on anemonefish metabolic rate. We then investigated the potential metabolic acclimation to life in bleached anemones, as well as the growth and behavioural responses, after long-term exposure (2 months) of wild juvenile anemonefish to bleached anemones. Short-term exposure of anemonefish increased the standard (baseline) metabolic rate of anemonefish significantly by 8.2%. Compared to fish residing in unbleached anemones. Although the short-term exposure of anemonefish did not significantly affect fish growth, preliminary results show that long-term residence in bleached anemones reduces growth rates of juvenile anemonefish. Physiological and behavioural analyses from our long-term experiment will provide insight into whether anemonefish are able to metabolically adjust to their new environment, including the potential for acclimation, and increase our understanding of how organisms associated with coral reefs are impacted by rapid global changes.

A12.22 INTRA-SEXUAL COMPETITION OVERRIDES MATE CHOICE DECISIONS IN A SEX ROLE REVERSED PIPEFISH

THURSDAY 4 JULY, 2019 17:25

JOSEFIN SUNDIN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), GUNILLA ROSENVEDT UPPSALA UNIVERSITY, SWEDEN), ANDERS BERGLUND (UPPSALA UNIVERSITY, SWEDEN), TONI ARNASD (UNIVERSITY FOR NATURE RESEARCH, NORWAY)

JOSEFIN@TEAMSUNDIN.SE

Mate choice can be defined as the process that occurs whenever the effect of sexual selection on offspring fitness is different when two sexes mate by directly assessing the individuals based on physical characters or other criteria, or by observing competitive
A12.24 EFFECTS OF A TRINOMIAL METAL MIXTURE OF CU, ZN AND Cd ON BIOACCUMULATION AND INOREGULATION IN COMMON CARP, Cyprinus carpio

**Thursday 4 July, 2019**

**MARIAN PILLET (UNIVERSITY OF ANTEWERP, BELGIUM), GIOVANNI CASTALDO (UNIVERSITY OF ANTEWERP, BELGIUM), BART SLOOTMOCKERS (UNIVERSITY OF ANTEWERP, BELGIUM), LIEVEN BERVOETS (UNIVERSITY OF ANTEWERP, BELGIUM), ROBBIE BLOHM (UNIVERSITY OF ANTEWERP, BELGIUM), GUDRUN DE BOECK (UNIVERSITY OF ANTEWERP, BELGIUM)**

The development of industry, mining activities and agriculture supported an increase of metal pollution in the aquatic system. Therefore a wide occurrence of mixtures of metals exists in the aquatic environment. When looking at individual metal exposures, 10% of the LC50 is often considered relatively safe, near the NOEC (No Observed Effect Concentration) or LOEC (Lowest Observed Effect Concentration). With this study we try to answer the question: “Can 10% of this LOEC for Cu, Zn and Cd still be considered as a safe concentration when applied in a mixture?” Common carp were exposed to mixture of 4, 8, 48, 128, 480, 880 and 1280 µg/L of Cu, Zn and Cd during 1020°C for 1 week and we looked at fish survival, bioaccumulation, ionoregulation and metallothionein induction. Our results show a rapid increase in copper and cadmium in gills and liver with adverse effects on iono-homeostasis. A sodium drop was reported in the gills, liver and muscles. The loss in sodium content affected the whole body iono-homeostasis, while a decrease in potassium levels was only observed in the liver. An increase in the pH of the water was observed in the gills, liver and muscles. A sodium drop was observed after 1 day of exposure. We hypothesize that this increase in pH is a ‘H+-ATPase and the subsequent recovery of the Na+K+-ATPase ’ which could influence the uptake of copper and cadmium at the uptake site. In addition a strong stimulation of metal homeostasis expression was reported during the whole experiment.

A12.26 THE INFLUENCE OF PARENTAL ISOLATION ON OFFSPRING PROACTIVE-REACTIVE PERSONALITY AXIS

**Thursday 4 July, 2019**

**TIFFANY A ARMSTRONG (UNIVERSITY OF OSLAND INSTITUTE OF BIOBIOGRAPHY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNITED KINGDOM), MIA LUNG (UNIVERSITY OF OSLAND INSTITUTE OF BIOBIOGRAPHY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNITED KINGDOM), JAN LINSTROM (UNIVERSITY OF OSLAND INSTITUTE OF BIOBIOGRAPHY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNITED KINGDOM), SHAN S KILLSIN (UNIVERSITY OF OSLAND INSTITUTE OF BIOBIOGRAPHY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNITED KINGDOM), KEVIN J PARSONS (UNIVERSITY OF OSLAND INSTITUTE OF BIOBIOGRAPHY, ANIMAL HEALTH AND COMPARATIVE MEDICINE, UNITED KINGDOM)**

Parental investment is known to increase growth and survival of offspring among many taxa. Recent evidence has suggested that the involvement of both parents in rearing can influence the development of social and aggressive behaviours in offspring. However, the role of biparental care in development and coevolution of offspring behaviours with the sex of the individual is currently understudied. Neolamprologus brevis is a shell-dwelling African cichlid that provides biparental care to its offspring. Dominant males of this species tend to be large and aggressive, while subordinate males resemble females in size and behaviour. This study investigated the role of biparental absence during early development on boldness, exploration and aggression in offspring. Further, correlations among these behaviours were examined based on offspring sex. We found that male offspring reared without parents were significantly more aggressive than those reared with parents. However, female offspring did not show an effect of parental presence on aggression, but showed a weak effect of parental presence on early exploration. These results suggest that parental presence results in the development of suites of correlated behaviours in this species and behavioural integration. These results also indicate that parental absence during development has a stronger influence on male than on female offspring, which could influence mate acquisition and territory defence later in life.
energetics will be of ecological significance, many studies argue against a bottom-up versus a top-down driven ecosystem, wherein fossil fuel energy inputs are the major source of energy flux to the higher trophic levels. This study suggests that the alternative hypothesis of a top-down driven ecosystem, wherein fossil fuel energy inputs are the major source of energy flux to the higher trophic levels, should be re-evaluated. The results of this study provide new insights into the functioning of top-down driven ecosystems and highlight the importance of considering the interactions between different trophic levels.

The study was conducted in collaboration with the University of Michigan, the University of California, and the University of Minnesota. The research was supported by a grant from the National Science Foundation and the Environmental Protection Agency. The data used in the study were collected from field observations made in Lake Michigan, a large freshwater lake located in the Great Lakes region of the United States.

The findings of this study are expected to have a significant impact on our understanding of ecosystem functioning and the role of different energy sources in driving trophic dynamics. The results will be used to inform future research and policy decisions regarding the management of freshwater ecosystems.
A12.35 GENE-BY ENVIRONMENT INTERACTIONS ON SOCIABILITY IN THREESPINE STICKLEBACKS

WEDNESDAY 3 JULY, 2019 POSTER SESSION

NATALIE PILAKOUTA (UNIVERSITY OF GLASGOW, UNITED KINGDOM), AMELIE CREPIEL (UNIVERSITY OF GLASGOW, UNITED KINGDOM), MARIE LEVET (UNIVERSITY OF GLASGOW, UNITED KINGDOM), MARION CLAIREAUX (INSTITUTE OF ENVIRONMENTAL SCIENCES CENTRE, UNIVERSIDADE DE LISBOA, PORTUGAL), JÓHANN BULLET (HÓLAR UNIVERSITY COLLEGE, ICELAND), SKÜL SKULASON (HÓLAR UNIVERSITY COLLEGE, ICELAND), NEIL METCALFE (UNIVERSITY OF OXFORD, UNITED KINGDOM), JAN LINDSTRÖM (UNIVERSITY OF GLASGOW, UNITED KINGDOM), MARIE LEVET (UNIVERSITY OF GLASGOW, UNITED KINGDOM), KEVIN PARSONS (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

Group-living is associated with costs and benefits that vary with environmental conditions. For example, animals in groups may benefit from improved predator detection and avoidance, but they can also suffer costs in the form of increased competition for food or other resources. Temperature is an important factor influencing the balance of these costs and benefits by altering food availability, predator abundance, and other ecological parameters. Variation in temperature may therefore drive within-individual variation in sociability, directly or through other factors due to associations with conspecífics for non-aggressive interactions. There may also be between-population variation in sociability under a common temperature, raising due to genetic interactions with cleaning organisms, like shrimps or fishes, where they benefit from the ectoparasite reduction and thus stress relief.

On the Great Barrier Reef, gastropods are known as one of the most common fish ectoparasites, having substantial effects on settlement-stage larvae or very young juveniles, and repeated attacks also affect fish growth. In order to cope with these ectoparasites, reef fishes have evolved cooperation in interactions with cleaning organisms, like shrimps or fishes, where they benefit from the ectoparasite reduction and thus stress relief.

Ocean acidification is known to pose a range of threat to marine invertebrates, yet the potential effects of ocean acidification on fish populations remain unknown. We exposed cultured gymnophionoid to high CO2 in single vials and measured their survival rate under isolation. Our results showed that high CO2 did not have any effect on the gymnophionoid survival rate at any life stage. We advocate that, as these populations would not be affected by ocean acidification, cleaner fish communities would still play a significant role in coral reefs and thus, future studies are necessary to assess the effects of ocean acidification in such organisms.

A12.36 OCEAN ACIDIFICATION DOES NOT AFFECT FISHECTOPARASITE SURVIVAL

THURSDAY 4 JULY, 2019 POSTER SESSION

EVE OTJACQUES (MARE - MARINE AND ENVIRONMENTAL SCIENCES CENTRE, UNIVERSIDADE DE LISBOA, PORTUGAL), JOSÉ RICARDO PAULA (MARE - MARINE AND ENVIRONMENTAL SCIENCES CENTRE, UNIVERSIDADE DE LISBOA, PORTUGAL), COURTNEY KILLIBRAND (UNIVERSITY OF WOLLONGONG, AUSTRALIA), ALEXANDRA GUTRER (UNIVERSITY OF QUEENSLAND, AUSTRALIA), RUI ROSA (MARE - MARINE AND ENVIRONMENTAL SCIENCES CENTRE, UNIVERSIDADE DE LISBOA, PORTUGAL)

The nerite snail Theodoxus fluviatilis (Linnaeus, 1758) has formed regional subgroups in northern Germany and appears in both freshwater (FW) and brackish water (BW). In these waters, distinct ecotypes can be found that show a clear grouping of FW or BW collection sites in terms of tolerance towards hyperosmotic stress and in terms of underlying mechanisms of osmotic stress accumulation as a means of dealing with hyperosmotic stress. Thus, it stands to reason that the protein expression between the ecotypes is different as well. Considering the salinity in the natural habitat of Theodoxus fluidius, BW snails not only have to deal with a higher basinal salinity than the FW snails, but also cope with frequent fluctuations of the salinity that occur after heavy rains or severe evaporation caused by extended periods of intense heat and sunshine. Therefore, the protein expression pattern in the five collection sites including FW and BW habitats were analysed using 2D SDS-PAGE, mass spectrometry and sequence comparisons based on Theodoxus transcriptome database. The results of this study revealed 23 differently expressed proteins between the five collection sites, of which many were proteins related to stress responses. The difference in the expression can be explained by phenotypic plasticity, but also by genetic differences. Nine of the differently expressed proteins seem to be special interest as they may be involved in mediating the higher tolerance of BW animals towards hyperosmotic stress compared to FW animals.

A12.37 DIFFERENCES IN PROTEIN EXPRESSION IN FRESHWATER AND BRACKISH WATER INDIVIDUALS OF THE EURYHALINE SNAIL THEODOXUS FLUVIATILIS

WEDNESDAY 3 JULY, 2019 POSTER SESSION

AMANDA WIESENTHAL (UNIVERSITY OF OREGON, USA), CHRISTIAN MÖLLER (UNIVERSITY OF OREGON, USA), KERK ALBRECHT (UNIVERSITY OF GERMANY, GERMANY), JAN-PETER KILLIBRAND (UNIVERSITY OF GERMANY, GERMANY)

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A12.38 APPLICATION OF GROWTH FACTORS AFTER OPTIC NERVE CRUSH INCREASES MACROPHAGES AND PHAGOCYTIC ACTIVITY

WEDNESDAY 3 JULY, 2019 POSTER SESSION

ROSA E BLANCO (UNIVERSITY OF PUERTO RICO, UNITED STATES), GIAM S VEGA-MELÍNDEZ (UNIVERSITY OF PUERTO RICO, UNITED STATES), VALEDA DE LA ROSA (UNIVERSITY OF PUERTO RICO, UNITED STATES), HAAVARAH@STUD.NTNU.NO (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), CLARE STAWSKI (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), JOSÉ RICARDO PAULA (MARE - MARINE AND ENVIRONMENTAL SCIENCES CENTRE, UNIVERSIDADE DE LISBOA, PORTUGAL), JAN-PETER KILLIBRAND (UNIVERSITY OF OREGON, USA)

We have previously shown that a single application of the growth factors ciliary neurotrophic factor (CNTF) or fibroblast growth factor 2 (FGF2) to the crushed optic nerve of the frog, Rana pipiens, increases the number and variety of macrophages and microglia in the lesioned eye. Using immunohistochemistry and transmission electron microscopy, we have found that macrophages and microglia are present in the lesioned eye at different stages after injury, and that the number of macrophages and microglia increases over time. However, the number of macrophages and microglia decreases after 2 weeks. In control PBS treated eyes, many macrophage-like cells are present 100 μm distal to the crush site at 1 week after injury, and their numbers increase to a maximum at 2 weeks. In eyes that received a single application of FGF2 or CNTF at the time of injury, the number of macrophages and microglia increases at 2 weeks and remains high for at least 4 weeks. We hypothesize that the increase in macrophage influx seen after growth factor application is beneficial for the regeneration of axons, probably due to the microglia in the lesioned eye.

A12.39 SEASONAL GLUCOCORTICOID PROFILE OF TWO SPECIES OF NORWEGIAN BATS

THURSDAY 4 JULY, 2019 POSTER SESSION

HÅVARD Å HAMALIAK (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), CLARE STAWSKI (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY)

Physiological stress is known to impact multiple aspects of life for animals in the wild, notably the capacity for growth, reproduction and immunological response. This phenomenon, previously referred to as the General Adaptation Syndrome, is triggered by adverse environmental or social conditions, and is facilitated among other things by an increased secretion of glucocorticoids from the adrenal gland. While many studies have established stress profiles for a multitude of animals, often in the context of human encroachment or other forms of anthropogenic disturbance, few studies have attempted to quantify stress levels in bats. However, such information is vital, as many bat species can often be found living in close proximity to humans, and frequently use human-made structures and light sources as roost sites and hunting grounds, respectively. We therefore aimed to establish seasonal profiles of stress in two species of Myotis bats in a rural area of Norway, by measuring the levels of free glucocorticoid (cortisol) in faecal samples by enzymeimmuno assay. Our results indicate that the amount of free cortisol is heightened in pregnant and nursing females, while it drops off towards original values later in the season (though variability late-season is considerably higher than in the early season). Therefore, reproductive individuals are likely at greater risk when faced with external disturbances than their conspecifics. This suggests a redirection of future conservation efforts, with the primary concern being the protection of maternity roosts, and limitation of human disturbance in critical reproductive phases.
ANNUAL MEETING SEVILLE 2019

A12.40 IMPACT OF CRUDE OIL EXPOSURE ON TELOEST PERSONALITY BEHAVIOURS

THURSDAY 4 JULY, 2019 POSTER SESSION

ALEXIS J KURSIORGA (THE UNIVERSITY OF TEXAS AT AUSTIN MARINE SCIENCE INSTITUTE, UNITED STATES), ANDREW E EBASHU (THE UNIVERSITY OF TEXAS AT AUSTIN MARINE SCIENCE INSTITUTE, UNITED STATES)

AKURSIORGA@UTA.EDU

While the cardio toxic effects are the most highly discussed impacts of oil exposure in fishes, evidence suggests that neurological function is also impaired and may be just as sensitive. Transcriptomic data from exposed larval fish showed that pathways related to neurological and cognitive function were severely disrupted; this was accompanied by a significant reduction in brain size in these fish. The few studies that have examined the effects of oil on personality traits have shown that acute exposure to low concentrations of oil can reduce sociability and increase aggressive behaviour. Yet much remains to be understood regarding the scope and significance of these observations. The purpose of this study was to explore the potential of oil exposure to result in a behavioural syndrome that may affect ecological performance using the model species, Danio rerio. Fish were acutely exposed to a range of oil concentrations after which they were tested for exploration, activity, boldness, aggression and sociability behaviours. Preliminary evidence suggests that oil exposure promotes a proactive phenotype coincident with reduced antiredictive behaviour. Discussion will include historical and gene expression analysis of brains sampled from the respective treatments.

A12.41 GENOTYPE EXPRESSION IN TURTLE BRAIN: IMPORTANCE OF COLD AND INCREASED GABAERGIC ACTIVITY AND THE INCREASE IN GABAERGIC ACTIVITY OBSERVED AT CELLULAR LEVELS

THURSDAY 4 JULY, 2019 POSTER SESSION

SUE ANN WATSON (QUEENSLAND MUSEUM, JAMES COOK UNIVERSITY, AUSTRALIA), PHILIP MUNDAY (JAMES COOK UNIVERSITY, AUSTRALIA)

SUEANN.WATSON@JCU.EDU.AU

As biologists we need to quantify what the contribution of carbon dioxide (CO₂) in seawater during ocean acidification experiments. However, equipment to measure CO₂ directly can be costly, time consuming and invasive, but has been shown to be a practical approach. As result, other parameters of the carbonate system, such as pH and total inorganic carbon (TIC), are often used and measured to calculate the partial pressure of CO₂ (pCO₂) in seawater. We compared four methods of pCO₂ determination, as often used in ocean acidification experiments: 1) Versatile Instrument for the Determination of Total inorganic Carbon and pH in Water (VINDA) measurement of dissolved inorganic carbon (DIC) and pCO₂, 2) spectrophotometric measurement of pH, CO₂ (μatm) and TIC, 3) electrode measurement of pH and CO₂, and 4) the direct measurement of CO₂ using a portable CO₂ equilibrator equipped with non-dispersive infrared (NDIR) gas analyser. All methods produced very similar pCO₂ estimates, and the three methods often suited to highly replicated biological experiments or biological fieldwork (spectrophotometric pH, electrode pH and CO₂ equilibrator) produced estimated measurement uncertainties of 3.4–4.6% for pCO₂. We are not advocating the replacement of established methods to measure seawater carbonate chemistry, particularly for high-accuracy quantification of carbonate parameters or to measure very small changes in pCO₂. Instead, measurement of biological CO₂-manipulation experiments measuring differences of over 100 μatm pCO₂ among treatments, the four methods described here can produce similar results with careful use.

A12.42 MEASURING SEAWATER pCO₂ IN BIOLOGICAL EXPERIMENTS: GETTING THE BEST RESULTS WITH A CO₂ EQUILIBRATOR, SPECTROPHOTOMETER OR PH ELECTRODE

THURSDAY 4 JULY, 2019 POSTER SESSION

CHRISTINE S COUTURIER (UNIVERSITY OF ALASKA ANCHORAGE, UNITED STATES), JONATHAN A STECK (UNIVERSITY OF ALASKA ANCHORAGE, UNITED STATES), STAN ELLEFSEN (INLAND NORWAY UNIVERSITY OF SCIENCE, NORWAY), GURU K SANDWIK (UNIVERSITY OF OSLO, NORWAY), SARAH L MILTON (FLORIDA ATLANTIC UNIVERSITY, UNITED STATES), HOWARD D PILSTON (FLORIDA ATLANTIC UNIVERSITY, UNITED STATES), OLEANNA E NILLSON (UNIVERSITY OF OSLO, NORWAY)

CSCOUTURIER@ALASKA.EDU

We investigated six transcriptomic responses consistent with the arrest of synaptic activity in the nontoxic turtle (Trachemys scripta) brain. Thirty-nine genes of olfactory receptors, transporters, enzymes and regulatory proteins of phosphatidylinositol 3-kinase (PI3K) pathway were partially cloned and their expression in the telencephalon of 21°C and 5°C-acclimated normoxic, anoxic (24 h at 21°C, 14 days at 3°C) and oxygenated (24 h at 21°C, 15 days at 5°C) turtle (classified by electrotachyphagist or by the level of noradrenalin) were cloned and expressed in cells with different levels of noradrenaline in the olfactory epithelium and olfactory bulb of seabream during exposure to high pCO₂-water.

A12.43 EFFECTS OF SEAWATER ACIDIFICATION ON EXPRESSIONS OF OXYTANIA MELASTIGMA

WEDNESDAY 3 JULY, 2019 POSTER SESSION

YI AN CHEN (DEPARTMENT OF LIFE SCIENCE, NATIONAL TAIWAN UNIVERSITY, TAIWAN), TJH-YUN LU (MAREINE RESEARCH STATION INSTITUTE OF CELLULAR AND ORGANISCIC BIOLOGY, TAIWAN), DOONG NT AU (DEPARTMENT OF BIOLOGY AND CHEMISTRY, CITY UNIVERSITY OF HONG KONG, HONG KONG), MING-YU CHOU (DEPARTMENT OF LIFE SCIENCE, NATIONAL TAIWAN UNIVERSITY, TAIWAN), YUNG-CHIE TSAI (MARINE RESEARCH STATION INSTITUTE OF CELLULAR AND ORGANISCIC BIOLOGY, TAIWAN)

KRIS15048165001@GMAIL.COM

Seawater acidification acts as a primary environmental perturbation that is accelerated in response to the increase in atmospheric CO₂. This is a result of both direct and indirect effects on marine organisms. Indirect effects include ocean warming and hypoxia, which can further drive ocean acidification. Direct effects include changes in ocean chemistry due to changes in carbonate chemistry, which can affect pH, pCO₂ and thus CO₂-water. The decrease in ocean pH levels has been shown to strongly affect the physiology and gene expression of marine teleosts. Here, we report the effects of ocean acidification on the expression levels of the β-subunit of the ionotropic glutamate receptor, from O. m. m. The results show that in every tissue and step of the olfactory system, the gene expression levels were significantly increased in response to ocean acidification. These results are consistent with previous studies showing that changes in pH affect the expression of genes involved in synaptic activity and that acidification affects the expression of genes involved in neurosensory function. The results also show that the changes in gene expression of these genes are consistent with the increase in GABAergic activity observed at cellular and whole organism levels. Moreover, at 21°C, the alterations in gene expression with a noxicia induced a distinct gene expression pattern compared to normoxia and reoxygenation. Strikingly, the alterations in gene expression from 2°C to 5°C-acclimated normoxic, anoxic (24 h at 21°C, 14 days at 3°C) and oxygenated (24 h at 21°C, 15 days at 5°C) turtle were qualitatively distinct compared to that of 2°C-anoxic turtles. Overall, this study highlights that key transcriptional responses are consistent with the decrease in glutamatergic pathways and increase in GABAergic activity observed at cellular and whole organism levels.
Antioxidants levels play a key role in protein turnover by reducing the oxidative damage in the skeletal muscle, and hence promoting growth performance in the long-term. In the present study, Senegalese sole post-larvae were reared in three experimental diets, a control (CTRL) and two supplemented with natural antioxidants: curcumin (CC) and grape seed (GS). Trials spanned for 25 days and growth performance, muscle cellularity and the expression of muscle growth-related genes were assessed at the end of the experiment. The dietary inclusion of CC and GS resulted in significantly larger fish compared to CTRL. This enhanced growth was associated with muscle cross-sectional area, although only fish fed CC were significantly different from CTRL. Sole fed the CC diet had the highest number of muscle fibres indicating that the CC promoted muscle hypertrophic growth. The mean fibre diameter did not differ among treatments, however, the proportion of large-size (>25μm) increased, suggesting that CC diet can also improve hypertrophic growth. Such differences in the phenotype were associated with a significant up-regulation of the myogenic differentiation 2a and myoD transcripts involved in muscle development and differentiation and myofibrillar organization during larval development. In conclusion, these results demonstrate that curcumin supplementation in diet can positively modulated muscle development in sole post-larvae by hypoxia and peroxynitrite of muscle fibres.

Current, hotly-debated ecophysiological theory predicts climate warming will cause ectotherms such as fish and invertebrates to ‘shrink’, that is reach a smaller maximum body size. This has implications for ecosystem functioning, ecological interactions and body size and oxygen availability. To examine this possibility, acute (48h) mortality bioassays were performed for different life stages of D. magna (neonates and adults) using high exposure in normoxia and hypoxia. Chronic (21d) lethal bioassays were also performed in normoxia and hypoxia to assess various sublethal endpoints, including reproductive output, Hb concentrations, lead bioaccumulation and oxygen consumption rates.

Somatic growth is a balance between protein synthesis and degradation that is largely influenced by nutritional cues. Dietary antioxidants play a key role in protein turnover by reducing the oxidative damage in the skeletal muscle, and hence promoting growth performance in the long-term. In the present study, Senegalese sole post-larvae were reared in three experimental diets, a control (CTRL) and two supplemented with natural antioxidants: curcumin (CC) and grape seed (GS). Trials spanned for 25 days and growth performance, muscle cellularity and the expression of muscle growth-related genes were assessed at the end of the experiment. The dietary inclusion of CC and GS resulted in significantly larger fish compared to CTRL. This enhanced growth was associated with muscle cross-sectional area, although only fish fed CC were significantly different from CTRL. Sole fed the CC diet had the highest number of muscle fibres indicating that the CC promoted muscle hypertrophic growth. The mean fibre diameter did not differ among treatments, however, the proportion of large-size (>25μm) increased, suggesting that CC diet can also improve hypertrophic growth. Such differences in the phenotype were associated with a significant up-regulation of the myogenic differentiation 2a and myoD transcripts involved in muscle development and differentiation and myofibrillar organization during larval development. In conclusion, these results demonstrate that curcumin supplementation in diet can positively modulated muscle development in sole post-larvae by hypoxia and peroxynitrite of muscle fibres.

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A12.53 THERMAL TOLERANCE NOT AFFECTED BY SALINITY IN ZEBRAFISH (Danio rerio)

On the other hand, it was observed that Octocystene reduced hatching success at 46°C. Cardiac frequency was reduced by Benzenophene and increased by Ethylxylaceticisolate at 56°C in larvae. Preliminary results regarding aerobic metabolic scope suggest that this may not be affected by Benzenophene.

A12.54 THE EFFECT OF NONOCYTOID PESTICIDES ON THE INSECT CLOCK AND SLEEP

THURSDAY 4 JULY, 2019 POSTER SESSION

KIAH TASMAN (KIAH TASMAN, UNITED KINGDOM), OJAM HODIE (UNIVERSITY OF BRISTOL, UNITED KINGDOM)

KIAH@KIAHTASMAN.COM

A12.55 ANTI-OXIDANT AND METAL HOMEOSTASIS IMBALANCE IN FRESHWATER BIVALVE (Culcula fluminia) EXPOSED TO MICROPLASTICS, CADMIUM AND THEIR MIXTURES

THURSDAY 4 JULY, 2019 POSTER SESSION

SUSANA PARRA (CENTRE FOR THE RESEARCH AND TECHNOLOGY OF AGRO-ENVIRONMENTAL AND BIOLOGICAL SCIENCES CITAB UTAD, PORTUGAL), LUIS M FELIX (INSTITUTE FOR RESEARCH AND INNOVATION IN HEALTH LABORATORY ANIMAL SCIENCE IBPC CITAB, PORTUGAL), SUSANA PARRA (CENTRE FOR THE RESEARCH AND TECHNOLOGY OF AGRO-ENVIRONMENTAL AND BIOLOGICAL SCIENCES CITAB UTAD, PORTUGAL), JESUS SAINZ (INSTITUTO ESPAÑOL DE OCEANOGRAFÍA IEO, SPAIN), SANDRA MONTEIRO (CENTRE FOR THE RESEARCH AND TECHNOLOGY OF AGRO-ENVIRONMENTAL AND BIOLOGICAL SCIENCES CITAB UTAD, PORTUGAL)

SUSANAPARR@UTAD.PT

In fish, upper thermal tolerance varies between species and individuals, but the underlying mechanisms explaining this variation remains unknown. Studying how variation in thermal tolerance is affected by other environmental stressors could give clues to these underlying mechanisms, as well as valuable insights into cost-effective, targeted approaches to environmental protection. In this study, we investigated the effect of temperature on the thermal tolerance of Danio rerio, a freshwater fish known to be tolerant to high temperatures. We performed experiments to determine the critical thermal maximum (CTMax), the highest temperature at which an organism can maintain its metabolic processes. Our results showed that thermal tolerance is not affected by salinity in Danio rerio, which is consistent with previous studies. However, further research is needed to understand the mechanisms underlying this lack of effect, as well as their implications for conservation and management of these species in the wild.
ANNUAL MEETING SEVILLE 2019

A12.60 IN VIVO AND IN VITRO APPROACHES TO UNDERSTAND THE CARBONATE MINERAL PRODUCTION IN THE MARINE FISH INTESTINE

THURSDAY 4 JULY, 2019

POSTER SESSION

ALEX BERRY (UNIVERSITY OF EXETER, UNITED KINGDOM), MICHAEL SALTER (UNIVERSITY OF EXETER, UNITED KINGDOM), CHRIS PERRY (UNIVERSITY OF EXETER, UNITED KINGDOM), ROB WILSON (UNIVERSITY OF EXETER, UNITED KINGDOM)

AB782EXETER.AC.UK

Fish represent a significant contribution to marine carbonate production. However, many areas relating to carbonate production can be difficult to study directly due to the presence of marine biota. In vivo small animal experiments using ultrasensitive micro-XRF (X-ray fluorescence spectroscopy) enable the analysis of elemental distribution within coral tissue. This has enabled the investigation of carbonate production in the spiny lobster (Palinurus elephas) native to the UK, with significant differences in metabolic capacity and carbonate production identified between species and sexes. The in vivo small animal experiments and high resolution imaging techniques are proving to be a great tool for investigating carbonate production within marine organisms with minimal disturbance to the sample.

A12.61 ADAPTATION OF SWIMMING KINETICS IN THE WORLD’S WARMEST REEF SYSTEM

WEDNESDAY 3 JULY, 2019

POSTER SESSION

DANIEL R KREPLY (THE UNIVERSITY OF MANCHESTER, UNITED KINGDOM), JACOB W JOHANSON (UNIVERSITY OF HAVANA, CUBA), MICHAEL STEMMEN (UNIVERSITY OF MANCHESTER, UNITED KINGDOM), HOLLY A SHELS (THE UNIVERSITY OF MANCHESTER, UNITED KINGDOM), JOHN BURT (NEW YORK UNIVERSITY ABU DHABI, UNITED ARAB EMIRATES)

AB768EXETER.AC.UK

Coral reefs in the Persian/Arabian Gulf are exposed to some of the world’s most extreme ocean temperatures, ranging annually from 26-36°C. The only coral reef system experiencing temperatures of 22-32°C, similar to other coral reef systems worldwide. Separately by several thousand years of evolution, populations in the Arabian Gulf and the Gulf of Oman provide a system to explore adaptation to elevated temperatures.

A12.62 IN SEARCH OF PERFORMANCE CONSEQUENCES OF MORPHOLOGY DIFFERENCES IN GALAXIAS MACULATUS, A NATIVE FISH IN SOUTHERN PATAGONIA

THURSDAY 4 JULY, 2019

POSTER SESSION

CHRISTEL LEFRANCOIS (LIENSIS-UNIV. LA ROCHELLE, FRANCE), QUINTIN TEMNON (LIENSIS-UNIV. LA ROCHELLE, FRANCE), ANDREW ROB JONES (CADO-CONECIT, ARGENTINA), MAXIMILIANO RUBEL (CADO-CONECIT, ARGENTINA), CLAUDIA BOY (CADO-CONECIT, ARGENTINA), FELIPE BROCCO@GMAIL.COM

Understanding the mechanisms involved in the organism’s adaptation to their environment is a challenging question in ecology and evolutionary biology. The first preliminary results of a broad study regarding functional and energetic consequences of morphometric differences are presented. The native Galápagos giant goby shows a remarkable intra-specific variation: Acroydromus argus (AN), diadromous population and Laguna Negra (LN, landlocked) both in the Parque Nacional Tierra del Fuego. Individuals from AN and LN are characterized by a thinner/elongated and a robust/shorter caudal peduncle respectively, phenotype being involved in locomotor performance. The fast/slow muscle fibers ratio and swimming/metabolic performance were investigated in these populations. Histological sections of caudal peduncle were made and stained with Haematoxylin-Ensin (n=20 individuals/population). The fast muscle metabolic rate (AMR) was significantly higher AN than LN. We are currently working on a critical thermal maximum (CTmax) protocol, which involves a constant rate of warming to hypoixa and acute warming.

A12.63 IMPACT OF CLIMATE CHANGE ON GROWTH POTENTIAL OF NORTH ATLANTIC COD

WEDNESDAY 3 JULY, 2019

POSTER SESSION

NADEZHDA.SOKOLOVA@AWI.DE

Various studies show that climate change dramatically impacts marine ecosystems (Messers et al., 2016). Rising temperatures affect individual marine organisms, as well as the abundance and distribution of species in the environment (Peeler and Knust, 2007; McKenzie et al., 2016). Our study shows how North Atlantic cod respond to a warming climate. We assessed North Atlantic cod maximum growth potential using highly resolved modelled ocean temperature data and growth model. The growth model was designed by Butz and Peeler (2017). The data set included observations from the North Atlantic cod, but the geographical range was restricted to the southern margin of the North Sea. Our study reveals the potential to develop an ecological approach that can be used for strategic ecosystem assessments on longer time scales.

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Felipe Brocco et al.
A12.65 POTENTIAL MECHANISMS FOR FISHERIES-INDUCED SELECTION ON SOCIOABILITY IN A SIMULATED FISHERY

WEDNESDAY 3 JULY, 2019 POSTER SESSION

TOBY FR MILLER (UNIVERSITY OF GLASGOW, UNITED KINGDOM), AMELIE CREPEL (UNIVERSITY OF GLASGOW, UNITED KINGDOM), SHAUN S KILLER (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

MILLERTWE.LV.UL.E

Human exploitation of fish species is both widespread and intensive, impacting upon population abundance in marine ecosystems. In addition to a reduction in biomass of fish within an ecosystem, highly exploitative fishing can potentially override natural selection through a process known as fisheries-induced evolution (FIE). Fishing gear could selective with respect to a range of phenotypic traits and potentially by the genetic basis in which those traits are determined. We examined the selective potential of active fishing practices and also the plastic changes in phenotype that may be caused by a reduction in population density due to fishing. Zebras (from 36 families were raised at two densities (normal: 6 fish/L and low: 3 fish/L). These individuals were passed through an individual solubility assay, and then through a thawing simulation, allowing us to quantify measures of social behaviour and vulnerability to harvest. Population density had no effect on sociability while the overall length of the fish population. It was also observed that there was a partial correlation suggesting that any selection by fishing could cause evolutionary change in this trait. Further work will use quantitative genetics and trans-generational studies to confirm whether FIE is taking place.

A12.67 NITROGENOUS WASTE PRODUCTION IN GREY TIGER SALAMANDER (AMBYSTOMA TIRGINUM) TADPOLES INHABITING SALINE WETLANDS IN SASKATCHEWAN, CANADA

WEDNESDAY 3 JULY, 2019 POSTER SESSION

JASON S BYSTRIANSKY (DEPAUL UNIVERSITY, UNITED STATES), KIMBERLY BOYLE (DEPAUL UNIVERSITY, UNITED STATES), IAIN D PHILLIPS (SASKATCHEWAN WATER SECURITY AGENCY, CANADA), R MODAVOK M LAMKOVIC (LOYOLA UNIVERSITY, UNITED STATES)

JBYSTrianSky@illinois.edu

Population of grey tiger salamanders (Ambystoma tigrinum) have been observed living in saline wetlands in the prairie pothole region of Saskatchewan, Canada. To survive in elevated salinity these salamanders must have evolved mechanisms to deal with this osmotic challenge. Typically juvenile amphibians are known to find freshwater and produce ammonia as their primary nitrogen waste product. In this study we examined the capacity of tiger salamander tadpoles to produce urea. A total of eight post-embryonic stages were collected and each stage was divided into two replicates. Salamander tadpoles were found in all ponds surveyed and appeared to be healthy with robust populations regardless of water salinity. Excretion rates were determined for individuals at each of the 10 stages of development, regardless of acute test temperature. Membrane and calcium handling abilities were induced by intraperitoneal injections of atropine and isoproterenol. ECG recordings were taken from fish acclimated to 18°C, 23°C or 28°C. The heart rate was determined using a calibrated probe to measure contraction rate. Understanding the mechanisms underlying cardiac function of fish is critical for predicting how animal populations will respond to climate change. Here we show that zebras (Danio rerio), a common fish species, is a robust model for exploring the reactivity of behaviour in wild zebrafish as well as unexplained with individual variance (heterogeneous residuals). Heterogeneous residuals seem to be common ‘statistical issue’ and aren’t well integrated into evolutionary theory. We specifically tested whether the heterogeneous residuals were caused by (1) non-linear relationship (i.e., non-linear plasticity), (2) passive plasticity where physical processes change plasticity and environment, (3) a non-linear plasticity, or (3) non-linear physiological trait, where individuals are not sensitive to environmental change at the extremes of the environmental factor. An organisational error suggests that at temperatures outside of a specific range, the behaviour level varies considerably, giving rise to ‘limited plasticity’. Individuals are further able to express their optimal level of a behaviour, leading to positive plasticity. Thus, the ecological organism may be expressed at the level of a behaviour during fluctuations in the environmental temperature as long as the temperature remains within the organism’s range. It is likely that other species may have different thresholds for expressing their optimal level of a behaviour, thereby making it more difficult to identify the optimal level of a behaviour in other species.

A12.69 BEHAVIOURAL PLASTICITY AND REPEATABILITY ACROSS A 12°C RANGE IN WILD ZEBRAFISH (DANIO RERIO)

WEDNESDAY 3 JULY, 2019 POSTER SESSION

METTE H FINNØEN (NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, NORWAY), JAMES L MARCHANT (UNIVERSITY OF BRITISH COLUMBIA, CANADA), ANTHONY P FARRELL (UNIVERSITY OF BRITISH COLUMBIA, CANADA)

MARCHANTJZOOLOGY.U.CA

Fish thermal tolerance is of growing concern due to climate change. Understanding the mechanisms underlying thermal performance of the heart is vital for predicting how animal populations will respond to climate change. Here we show that zebrafish (D. rerio), a common model organism, does not respond to thermal acclimation mechanisms and (2) that heart rate is dependent upon our approach to measuring heart rate – the heart rate determined using uniform heart rate regardless of acute test temperature. Membrane and calcium clock mechanisms were tested for their relative contributions to pacemaking under the same thermal challenge by blocking HCN channels (zatbradine) on D subtypes and SERCA activity (ryanodin receptors and SERCA pumps). The results of this study help us understand the heart rate in wild zebrafish and suggest that future work should have implications for the conservation of this species in this range.
**A12.71 A GENOMIC INVESTIGATION OF THE STOMACH PHENOTYPE IN TELEOSTS**  
**WEDNESDAY 3 JUNE, 2019 POSTER SESSION**

LOUIS J PFEFFER (WILFRID LAURIER UNIVERSITY, CANADA), GABRIEL MORENO-HAGELSIEB (WILFRID LAURIER UNIVERSITY, CANADA), LUIS FILIPE C CASTRO (UNIVERSITY OF PORTO, PORTUGAL), JONATHON M WILSON (WILFRID LAURIER UNIVERSITY, CANADA)

LOUIS@PALAULOS.CA

The vertebrate stomach, which is distinguished by acid-peptic digestion, has been independently lost more than once (15) during the evolution of the teleost fishes. This phenomenon seems counterintuitive given the advantages of acid-peptic digestion such as extending the variety of digestible dietary protein sources. This gastric function is conferred by acid (HCl) secreted by gastric proton pumps encoded by the genes ATPMA and ATPMB, and the enzymes of peptidases encoded by PAG, PGB, PGC and CYM.

Although this agastric phenomenon is not limited to teleosts and has been observed in other vertebrates, the teleosts represent an interesting group given the multitude of independent loss events. A strong correlation has been established between gastric gene presence and stomach development where the gastric genes are absent from the genome the stomach is absent. However, this correlation is based on a limited number of gastric and agastric vertebrates. Thus, this correlation analysis is limited to these groups to provide better confidence. The goal of my thesis is to have an in-depth characterization of the relationship between the gastric genes and the stomach in teleosts. This analysis is achieved through a two-pronged approach involving both molecular genetic and bioinformatics. This survey will expand our understanding of stomach development and the occurrence of a stomach loss throughout teleost evolution, providing critical insight to the phenomenon of the evolution of the agastric behavior. This characterization will also provide direction for future attempts to genetically reinduce the stomach through genetic knock-in.

**A12.73 EFFECTS OF THE INHIBITION OF GASTRIC ACID SECRETION WITH OMEPRAZOLE ON GROWTH AND SPECIFIC DYNAMIC ACTION IN THE NILE TILAPIA**  
**WEDNESDAY 3 JUNE, 2019 POSTER SESSION**

JONATHON WILSON (WILFRID LAURIER UNIVERSITY, CANADA), KELSY MOFFATT (WILFRID LAURIER UNIVERSITY, CANADA), MARK ROSS (WILFRID LAURIER UNIVERSITY, CANADA), EDWARD PARK (WILFRID LAURIER UNIVERSITY, CANADA)

J-WILSON@WLU.CA

The presence of an acid-secreting stomach provides many selective advantages to higher vertebrates. Phenotypic stomach loss is linked to loss of expression of both the gastric proton pump and its inhibitor. Cytosolic activity is the only known key function in acid-secreting stomach development and the metabolic costs of digestion (specific dynamic action, SDA) will help provide information about the metabolic expense of acid production. Omeprazole, a gastric proton pump inhibitor, was used to simulate the gastric phenotype in Nile tilapia by ‘knocking-out’ acid production. Agrowth trial was performed feeding both control and omeprazole-supplemented feed with a manipulation of 15% of Nile tilapia per group over a 38-day period. Fish were fed 2% body mass (BM)/day. The dose of omeprazole was 25 mg/kg BM/day. Stop flow respiration was used to determine standard metabolism (SMR) and SDA in Nile tilapia fed either a control or omeprazole meal of 2% BM of pellets. Data were analyzed according to D. Chabot and R. Data are used comparing paired t-tests. The data from this study showed that the specific growth rate of Nile tilapia was negatively affected by the addition of omeprazole in the feeding trial (p<0.001).

The feeding of omeprazole was shown to decrease expression (p<0.001) of H+, K+ ATPase (alpha) and beta) as well, suggesting a decrease in digestion and assimilation of the meal. In separate feeding trials we confirmed that omeprazole inhibited stomach acidification.

Since the industrial revolution humans have placed a heavy reliance upon synthetic materials to facilitate modern life. This extensive utilization has caused exponential growth of the world's plastics production from 1.7 million tonnes during the 1950s, to over 5 million tonnes in 2018. There is a growing concern that plastics pose an increased threat to marine life. It is estimated that 10% of plastic waste will enter the world oceans. Plastics that enter these oceans are subject to mechanical and chemical processes that progressively degrade them into smaller fragments called microplastics. Microplastic is found in the stomachs of many marine animals, readily accumulates in body tissues and microplastic toxicity is expected to have negative fitness costs. The present study aims to identify how microplastic exposure and/or ingestion impacts key fitness traits, in Noreis diversicolor, sampled in the Humber estuary (N=1200), FTIR analysis will be performed to identify microplastic content of body tissues and deduce a geographical origin. The effects of microplastic toxicity on overall fitness will be tested by exposing N. diversicolor (N=500) to similar types of microplastic found in the Humber, using a series of behavioral assays. The overall goal of the study is to highlight fitness costs associated with microplastic toxicity and is expected to inform the relationship between the gastric genes and microplastic exposure.

**A12.74 EVALUATION OF ESTROGENIC POTENTIAL OF GENISTEIN ADMINISTRATION IN INDIAN FRESHWATER CATFISH, HETEROPNEUSTES FOSILIS**  
**THURSDAY 4 JULY, 2019 POSTER SESSION**

PREETI KHANDELWAL (UNIVERSITY OF DELHI, INDIA)

PREETIKHANDELWAL.SVGHOMAIL.COM

Aromatase is a terminal enzyme in steroid biosynthesis and hence a potential target of endocrine disrupting compounds (EDC). Its enzyme consists of two isoforms: E2C and E2B. E2C is expressed in various sources and Fish species are at high risk of exposure. Genistein is an isoflavone with the potential to disrupt endogenous estrogen signals by competitively inhibiting CYP19A1 and inducing vitellogenin (vit) synthesis in male fish. Its abundant in soy-derived foods. The present study was undertaken to study the effect of different concentrations of genistean administration in Heteropneustes fossilis and to evaluate its potency as an estrogen-mimicking compound taking estradiol-17β as a positive control. Expression of vit and estrogen receptor (er) genes in liver and aromatase in ovary and brain was quantified. Biochemical parameters such as [Ca+2] in plasma was determined. Aromatase isoenzyme expression in ovaries of fish was upregulated while in the brain it was downregulated. The results of the study show that genistein induces male phenotype in vitro and had estrogenic/anastrozolic activity in catfish, but its effect varies in either sex and dose with.

**A12.76 CHARACTERIZING THE RELATIVE ROLES OF PLASMA ACCESSIBLE AND TOTAL CARBONIC ANHYDRASE IN RELEASE OF POST HYPERCAPNIC HAGFISH**  
**THURSDAY 4 JULY, 2019 POSTER SESSION**

UUG0005 (UNIVERSITY OF ALBERTA, CANADA), JENNA DRUMMOND (UNIVERSITY OF ALBERTA, CANADA), ALEX CLIFFORD (UNIVERSITY OF ALBERTA, CANADA), CLAUDI TRANDAFIR SUPURAN (UNIVERSITY OF FLORENCE, ITALY)

UUG0005@UALBERTA.CA

As scavengers that hagfish (Eptatretus stoutii) are known to feed on (and in) decay in carriage such as large marine mammals and are thus highly tolerant of noxious environmental stresses including extreme by marginal factors. Indeed, hagfish entering into a mammalian carcass can tolerate extreme by marginal factors (≥5% CO2) by rapidly building up plasma HCO3, up to >24–48% of exposure, attaining the highest plasma HCO3, [HCO3] (higher than observed any organism (~70 mM HCO3, [HCO3]) Thus exiting the hagfish can be an advantage a low metabolite and that rapidly excrete HCO3 from their gills at some of the highest HCO3 fluxes measured. The goal of this study is to characterize the release of plasma accessible carbonic anhydrase (CA) versus total CA in in vivo and in vitro hagfish recovery. We exposed hagfish to either control conditions (0.03% CO2) or hypercarbia (9% CO2) for 48h. To induce severe hypercarbia. We used a recently developed in situ hagfish dual perfusion/ perfusion with perfusion of radiolabeled C-18 HCO3, into the plasma space and measurement of release into the perfusate (water space). Under control conditions, perfusion of the plasma space using both membrane impermeable (C18) and membrane permeable (Acetazolamide) carbonic anhydrase inhibitors showed that >40% of HCO3, flux was accompanied by plasma accessible CA while another 30% reduction occurred after sequential acetazolamide inhibition. In the post-hypercarbic period, there was an increased capacity for plasma accessible CA with plasma accessible CA activity. This research demonstrates that plasma accessible CA is a major factor for generating HCO3, release.
A12.77 PHYSIOLOGICAL EVIDENCE FOR MITIGATION OF CATIONIC POLYMER FLOCCULATION TOXICITY

EDITA JASINSKA (UNIVERSITY OF ALBERTA, CANADA), GREG OSSIE (UNIVERSITY OF ALBERTA, CANADA), ALEXANDER CLIFORD (UNIVERSITY OF ALBERTA, CANADA), G HANNA (CLEARFLOW GROUP, CANADA), JESSE MEINTS (CLEARFLOW GROUP, CANADA)

Industrial operations such as coal mining, road building and aggregate washing result in high concentrations of suspended particles (total suspended solids; TSS) in effluent waters. To promote sedimentation of TSS, industry uses a number of cationic chemical coagulants/floculants. Cationic chemical floculants are known to cause acute toxicity at very low concentrations (0.3-0.5 mg/L) resulting in failure of bioassays. Current environmental management practices do not allow discharge of water containing active cationic polymers given this high toxicity. We hypothesized that treating cationic contaminated waters with anionic polymers would bind the cationic polymers and render the tailings water non-toxic. Fish exposed to cationic polymer WL800 alone had impaired oxygen uptake by 12% and were dying by 24h with ~50% mortality by 48h. However, addition of a neutralizing polymer (CN369) at the WL800 dose restored oxygen uptake. The CN369 also eliminated the clogging of the gills and eliminated the toxicity. Finally, similar to the oxygen transport, the cationic polymer treatment resulted in elevated stress hormones (e.g., epinephrine and plasma lactate) while treatment with either CN369 alone or WL800:CN369 at a 1:1.5 ratio eliminated these sub-lethal indications of toxicity. These results support the hypothesis that use of a neutralizing agent (CN369) may be an effective mean to mitigate cationic polymer toxicity and is a promising new technology for mine wastewater management.

A12.79 TEMPERATURE-MEDIATED BEHAVIOURAL VARIATION IN THE BEADLET ANEMONE, ACTINIA EQUINA

WEDNESDAY 3 JULY, 2019 POSTER SESSION

Jack S Thomson (University of Liverpool, United Kingdom), Daniel K MacKay (University of Liverpool, United Kingdom), Kathryn Arnold (University of York, United Kingdom), Bob Beynon (University of Liverpool, United Kingdom), Lynne U Sneddon (University of Liverpool, United Kingdom)

Personality profiles in animals vary systematically with stress response profiles: among vertebrates, more aggressive, bolder animals tend to fibrinogen c ontent and stress response to stress compared to less aggressive, shyer animals. The connection between stress response and personality in invertebrates is, however, less well understood. Here we used a proteomic method to explore how protein regulations varied between anemones, Actinia equina, with different personality profiles (bold or shy) and under different stressors (chronic: graduated increase in temperature from 11-23 °C over 13 days; acute: response to perturbation, the “startle response” used to identify personality among these animals). Protein expressions were subsequently examined bynicotine. A variety of proteins were differentially expressed between treatments; principal component analysis was therefore used to determine groups of proteins with related function. Under temperature stress structural proteins were upregulated while those involved in nucleotide/protein turnover were downregulated. In contrast, under acute stress proteins involved in stress mitigation and nucleotide/protein turnover showed an increased expression, with reduced expression of those involved in catalysis. These data are a first step in assessing how biodiversity of Actinia equina individuals vary according to personality; however, more detailed examination of these processes and the timescale over which they operate is necessary.

A12.80 BIG MOONS: ARE MOON JELLYFISH EFFECTED BY CLIMATE CHANGE?

THURSDAY 4 JULY, 2019 POSTER SESSION

Lynne U Sneddon (University of Liverpool, United Kingdom), Daniel Goodyer (University of Liverpool, United Kingdom), Charlotte Birt (University of Liverpool, United Kingdom), David CC Wolowick (Blue Planet Aquarium, United Kingdom)

Anthropogenic climate change is a significant problem for many marine species, however, it is predicted that changes in the environment will increase jellyfish populations. Currently, jellyfish populations are growing globally due to an increase in ‘bloom’ events, possibly fuelled by climate change. The aim of this study was to investigate how three environmental variables linked to climate change affected the growth rate of two life stages of the moon jellyfish, Aurelia aurita. T reating groups were set up to assess the impact of increased temperature (16-19 °C), salinity (35-35.5 ppt) and acidification (pH7.8-8.0) on the polyp and ephyrae stage of jellyfish. Temperature change had no significant impact on polyp growth. Ephyrae growth was however found to be higher at low salinity compared with high salinity. Additionally, lower pH resulted in lower polyp growth. Temperature change was significantly affected by temperature changes of 16–19 °C, with an increase in temperature causing a higher growth rate, but conversely decreasing pH caused a reduction in growth rate. Overall, the implications of climate change on A. aurita appear complex. Decreasing pH had the biggest negative impact on both the polyp and ephyrae life stage of A. aurita, yet, increasing temperature had a positive impact on ephyrae growth. Thus, climate change can influence temperatures in environments to result in large moon jellyfish populations, while other species should be investigated in future to obtain a fuller picture of the impact of climate change on jellyfish.

A12.3P THE INFLUENCE OF PARENTAL ISOLATION ON OFFSPRING PROACTIVE-REACTIVE PERSONALITY AXIS

WEDNESDAY 3 JULY, 2019 POSTER SESSION

Tiffiny A Armstrong (University of Glasgow Institute of Biodiversity Animal Health and Comparative Medicine, United Kingdom), Mia Leng (University of Glasgow Institute of Biodiversity Animal Health and Comparative Medicine, United Kingdom), Jan Lindstrom (University of Glasgow Institute of Biodiversity Animal Health and Comparative Medicine, United Kingdom), Shaun S. Kline (University of Glasgow Institute of Biodiversity Animal Health and Comparative Medicine, United Kingdom), Kevin J. Parsons (University of Glasgow Institute of Biodiversity Animal Health and Comparative Medicine, United Kingdom)

Parental investment is known to increase growth and survival of offspring across many taxa. Recent evidence has suggested that the involvement of both parents in rearing can influence the development of social and aggressive behaviours in offspring. However, the role of biparental care in development and covariation of offspring behaviours with the sex of the individual is currently understudied. Neolamprologus brevis is a shell dwelling African cichlid that provides biparental care to its offspring. Dominant males of this species tend to be large and aggressive, while subordinate males resemble females in size and behaviour. This study investigated the role of biparental care and sex on boldness, exploration and aggression in offspring. Parental investment was varied from high to low, with high parental investment sen t to each male with half the offspring. Parental investment was varied from high to low, with half the offspring sent to each male with half the offspring. The results showed that male offspring reared without parental investment were almost twice as big as those reared with high parental investment. Female offspring showed no effect of parental investment. This study supports the suggestion that biparental care can influence offspring development. Current evidence has suggested that the involvement of both parents in rearing can influence the development of social and aggressive behaviours in offspring. However, the role of biparental care in development and covariation of offspring behaviours with the sex of the individual is currently understudied. Neolamprologus brevis is a shell dwelling African cichlid that provides biparental care to its offspring. Dominant males of this species tend to be large and aggressive, while subordinate males resemble females in size and behaviour. The results showed that male offspring reared without parental investment were almost twice as big as those reared with high parental investment. Female offspring showed no effect of parental investment. This study supports the suggestion that biparental care can influence offspring development.

A12.4P ASSESSING THE IMPACT OF UNUSUAL CARBONATE CHEMISTRY IN RECIRCULATING AQUACULTURE SYSTEMS ON LUMPFISH PHYSIOLOGY, BEHAVIOUR AND GROWTH

THURSDAY 4 JULY, 2019 09:45

Jennifer A Finlay (Jennifer Finlay, United Kingdom), Cosima Porteus (University of Exeter, United Kingdom)

Lumpfish (Cyclopsetrus lumpus) are a new aquaculture species that is increasingly being farmed within recirculating aquaculture systems (RAS). These cleaner fish are deployed in salmon pens as biocontrol against sea lice, a parasite that causes substantial losses. Little is known about lumpfish, so it is impossible to assess what impacts intensive farming are having on productivity and welfare. Within RAS, due to the recirculation of water, CO2 respiration builds up to levels which can detrimentally impact growth and physiology. Because this acidifies water, an alkaline buffer is typically added to return pH to a ‘normal’ range within RAS. To assess the impacts of RAS condition on physiology and growth, water chemistry data from the U.K.’s largest lumpfish RAS facility were used to form a growth trial. Control fish were exposed to mesocosm CO2 and alkalinity, while experimental treatments included high CO2, high alkalinity, and combination of those treatments. Initially, growth was reduced in all experimental treatments, but the differences compared to controls declined with time. As expected, blood pH CO2 was almost doubled in fish exposed to both high CO2 treatments; but fish in both these groups compensated by accumulating a carbonic anhydrase that changed in expression which produced the unexpected result of a higher blood pH than control fish. This makes lumpfish rather unusual compared to other teleosts exposed to hypercapnia. Our data should help optimise water chemistry within RAS, to improve productivity. We also aim to assess its effect on lumpfish behaviour.
A13.1 THE EFFECT OF 30 YEARS OF SELECTION ON THE CHICKEN EMBRYO’S RESPONSE TO HYPOXIA

Wednesday 3 July, 2019 15:00

AMIT HARON (HEBREW UNIVERSITY, ISRAEL), SHELLEY DHURAN (AND THE VOLCANO CENTER, ISRAEL)

AMIT.HARON@HEBREW.ILAC.AC.IL

Selection of modern broilers for rapid growth has been leading to modifications in mechanisms of development and growth, with elevated CO2 levels for practical reasons. However, insufficient development and growth resulted in low capability to maintain adequate dynamic steady-state mechanisms for energy balance expenditure, as well as for coping with sub-optimal environmental conditions. The aim of this study was to compare between the effects of hypoxic exposure (17% O2) from E16 to E18 (the oxygen consumption plateau period), for 12 h per day, on the embryos of modern broilers vs broilers that did not undergo selection since 1986. Both lines exhibited a similar adaptive response of the embryos, was significantly lower compared to 1986 embryos. Consequently, the adaptive mechanisms for energy balance expenditure, as well as for coping with sub-optimal environmental conditions, are logical adaptations of lines under conditions of increased predation. To reduce this risk, some species perform group airbreathing. Temperature may also affect the frequency of air breathing behavior, as well as the risk of predation. To reduce this risk, some species perform group air breathing. Temperature may also affect the frequency of air breathing behavior, as well as the risk of predation. This study investigated the mechanism of a high-adaptive response of individuals to hypoxic conditions. Our results show that hypoxic exposure combined with crude oil exposure results in significantly reduced aerobic scope, which was additive compared to the reductions caused by each stressor alone. Interestingly, our results also showed changes to hypoxic exposure with respect to crude oil exposure levels and a reduction in the additive effects. We are currently investigating parameters such as hematocrit, mitochondrial enzyme content, and blood oxygen binding affinity in the combination of stressors driving these additive effects. These data will offer insights into strategies to target and prevent the additive effects of environmental stressors.

A13.2 THE EFFECT OF TEMPERATURE AND HYPOXIA ON SYNCHRONISED AIR BREATHING IN CORYDORAS CATFISH

Wednesday 3 July, 2019 16:45

MAR PINEDA (UNIVERSITY OF GLASGOW, UNITED KINGDOM), ISABEL ARAGAO (UNIVERSITY OF GLASGOW, UNITED KINGDOM), DAVID BENNETT (UNIVERSITY OF MONTPELIER, FRANCE), SHAUN KILLEN (UNIVERSITY OF GLASGOW, UNITED KINGDOM)

2302889BY@student.lslu.ac.uk

Group living is found throughout the animal kingdom and has a variety of costs and benefits. One of the benefits of living in a group is maximising resource acquisition, such as food territory. Another reason that is vital for survival, yet often overlooked, is oxygen. In some fishes, the ability to breathe air is evoked to overcome constraints in hypoxic environments but comes at a cost to stability and predation. To reduce this risk, some species perform group air breathing. Temperature may also affect the frequency of air breathing behavior, and recorded air breathing frequency of individuals and group air breathing behavior is under different oxygen concentrations (100%, 50%, 40%, 20%) and two acclimation temperatures (25°C & 30°C). The repetitive flow of respiration was found to be correlated with oxygen demands of individuals. The results from this study increase our understanding of how individuals balance their oxygen demands with the risk to the group or self to take risks and acquire resources.

A13.3 AMPHIBIOUS FISH SEEK HYPOXIC MICROENVIRONMENTS TO ACCENTUATE METABOLIC DEPRESSION OUT OF WATER

Wednesday 3 July, 2019 17:00

DUILLA S ROSSI (UNIVERSITY OF QUEBEC, CANADA), PATRICIA A WEIGHT (UNIVERSITY OF QUEBEC, CANADA)

GROSSIU@DUGUHEL.CA

Amphibious fishes that survive weeks out of water without food often depress metabolic rate to slow the depletion of endogenous energy stores. Microhabitat selection with O2 levels may augment metabolic depression. Thus, we hypothesised that air-exposed amphibious fishes choose microhabitats that maximally depress metabolic rates below endogenous energy stores and conserve the integrity of critical tissues, including skeletal muscle. Using lesioning strategies, we tested whether hypoxic microhabitats with low dissolved oxygen levels and aerobic scope, which was additive compared to the reductions caused by each stressor alone. Interestingly, our results also showed changes to hypoxic exposure with respect to crude oil exposure levels and a reduction in the additive effects. We are currently investigating parameters such as hematocrit, mitochondrial enzyme content, and blood oxygen binding affinity in the combination of stressors driving these additive effects. These data will offer insights into strategies to target and prevent the additive effects of environmental stressors.

A13.4 ADDITIVE EFFECTS OF OIL EXPOSURE AND HYPOXIA ON AEROBIC PERFORMANCE IN RED DRUM (SCIAENOPS OCELLATUS)

Wednesday 3 July, 2019 17:15

KERRI LYNN ACKERLY (THE UNIVERSITY OF TEXAS AT AUSTIN MARINE SCIENCE INSTITUTE, UNITED STATES), ANDREW J ESBAUGH (THE UNIVERSITY OF TEXAS AT AUSTIN MARINE SCIENCE INSTITUTE, UNITED STATES)

KLECKEREY@TEXAS.EDU

Cardiac performance is gauged by evaluating principle cardiopulmonary indices that regulate cardiac output. Cardiac output, the product of heart rate and stroke volume, is essential for sustaining the convective transport of oxygen and substrate effects on the transport of oxygen will impact organismal fitness. Cardiac output is reduced by 30% and 36%, respectively. Based on our data, the fish’s comprehensive physiological response to hypoxia and crude oil exposure results in a reduction of cardiac performance in fish at late stages of life remains limited. Given our limited understanding we conducted two investigations. The first focused on the consequence of crude oil exposure on the heart rate and stroke volume and the second focused on evaluating cardiovascular function during a combined stress of crude oil exposure and acute hypoxia surgically recovered red drum (Sciaenops ocellatus). Our findings indicate that crude oil exposure increases dorsal aortic pressures by 28% and reduces cardiac output by at least 25%. The reduced cardiac output was the result of a diminished stroke volume while heart rate was constant. When oil exposure was combined with hypoxia (1.5mg/L), cardiac output and stroke volume were reduced by 30% and 36%, respectively. Based on our data, the fish’s comprehensive physiological response to hypoxia and crude oil exposure allows the synergistic interaction between the two stressors to drastically compromise cardiac performance and could consequently impact the animal’s fitness in the wild. This study is ongoing and is supported by the GoMRI RECOVERYIITN Consortium to A. R., and D.C. II.
A13.6 THE CARDIAC RESPONSE OF THE GOLDFISH (CARASSIUS AURATUS) TO HYPOXIA: A ROLE FOR BETA-ADRENOCETORS?

WEDNESDAY 3 JUNE, 2019 3:45 AM

SANDRA UMBRASIO (UNIVERSITY OF CALABRIA, ITALY), ROSA MAZZA (UNIVERSITY OF CALABRIA, ITALY), MARIACRISTINA FILICE (UNIVERSITY OF CALABRIA, ITALY), ALFONSO DI VITTO (UNIVERSITY OF CALABRIA, ITALY), MARIA C CERRA (UNIVERSITY OF CALABRIA, ITALY)

Low oxygen availability is a limiting factor for “free life”. It occurs in cardiovascular fragility associated to a poor quality of life, and often fatal outcomes. Several animal species tolerate prolonged periods of reduced O2 availability. Among fish, cyprinids of the genus Carassius (teleost) such as the goldfish Carassius auratus, survive hypoxia for days to months thanks to compensative mechanisms, still under investigation. By using an in vivo preparation, we showed that, under hypoxia, the goldfish heart increases its performance and sensitivity to hemodynamic regulation, this representing a putative component of hypoxia tolerance. However, the mechanisms that sustain this hypoxic increase of cardiac contractility have not been elucidated. Since in teleost hypoxia is often associated with an increased sympathetic tone, we aimed to evaluate the role of adrenergic receptors (ARs) in modulating cardiac response to hypoxia. We first characterized the expression of β1, β2, β3 and β4 ARs in the goldfish heart in terms of contractility and signal transduction. Then, we analysed their role in the hemodynamic response of the goldfish heart exposed to hypoxia. We also found that β3 ARs expression is affected by hypoxia. Our data suggest that the activation of β3 ARs contributes to the increased contractility which characterizes the hypoxic goldfish heart.

A13.7 MULTI-OMICS ANALYSIS OF ACCLIMATION RESPONSES TO COLD IN THE COMMON CARP

THURSDAY 4 JUNE, 2019 9:00 AM

ANDREW R COSSING (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), DARIL WILLIAMS (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), YONGXIAN FANG (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), JENNI PROKOLI (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), MARK CAIDICK (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM)

Global methods of molecular analysis, led by transcriptomics, have revolutionised approaches to understanding physiological mechanisms. These focus on identifying responses on the regulation of transcription abundances and, regulation of gene expression can equally be regulated at the level of protein expression. We have combined global transcript screening with the phenomenon of “isoforms”

A13.8 CONTRASTED THERMAL REACTIONS NORMS AMONG SOUTHERNMOST POPULATIONS OF A COLD WATER SALMONID

THURSDAY 4 JUNE, 2019 9:15 AM

LISANDRINA MARQUES (UNIVERSITY OF STRASBOURG, FRANCE), JULIEN DAFRENS (UNIVERSITY OF LAUSANNE, SWITZERLAND), EMILIAN LASNE (UNIVERSITY OF GENEVA, SWITZERLAND)

In the current global change context, cold water stenotherms are most at risk to face the detrimental effects of warming. Arctic char (Salvelinus alpinus) populations found in the alpine and peralpine region are located at the Southernmost limit of the species distribution range, and can be considered as sensitive species of climate change. Char early life stages (eggs and fry) are a particularly vulnerable to temperature increases, and the persistence of Southern populations will be determined by the capacity of these critical life-stages to respond adaptively to external conditions. In this study, we used a common garden approach to test the hypothesis of local adaptation of char populations from the Southernmost regions of their distribution. We used eggs originating from four thermally contrasted lakes at an either optimal (10 °C) or sub-optimal (5 °C) temperature for the species, reared them in constant temperature chambers and subsequently moved them to a thermally variable environment (2-4°C). We tested thermal reaction norms of larval growth and survival. We found significant differences between populations of different origin, with the Southernmost populations showing the higher plasticity in terms of thermal tolerance. Furthermore, iTRAQ proteomics analysis identified key proteins and metabolic pathways involved in the response to temperature acclimation. This study confirms that local adaptation can play a major role in determining the response to warming in this species and opens the possibility in the future to utilize this high plasticity to better interact with the changing climate.
A13.12  Gonadal transcriptomic analysis in the oyster Crassostrea gigas - how to unravel the locks of a sequential hermaphrodite in order to identify potential male and female sex-determining genes

**THURSDAY 4 JULY, 2019  10:15**

CORALIE BROQUARD (LOMPH-IMRENE (LA TREMBL ADE), FRANCE) and BOERA (CAEN, FRANCE), SUKAW-SANSAI SAMAROW (GENDECOLOGY RESEARCH CENTRE UEC (QUEENSLAND) and DEPARTMENT OF ANATOMY MACHOLSOL, AUSTRALIA), LIONEL DEGREGORY (LOMPH-IMRENE (LA TREMBLADE), FRANCE), JEAN-BAPTISTE LAMY (LOMPH-IMRENE (LA TREMBL ADE), FRANCE), BENJAMIN MORGA (LOMPH-IMRENE (LA TREMBL ADE), FRANCE), ABGAL ELIZUR (GENDECOLOGY RESEARCH CENTRE UNIVERSITY OF THE SUNSHINE COAST (QUEENSLAND), AUSTRALIA), ANNE-SOPHIE MARTINEZ (BOERA (CAEN), FRANCE)

The oyster Crassostrea gigas is one of the most valuable molluscs of the international market. As an irregular sequential hermaphrodite, its sex may change several times during its life time, making it difficult to identify precisely the sex-specific genes. To better identify the sex-determining genes as well as their temporal dynamics during the time-frame of sex determination along the gametogenic cycle, gonadal samples were collected for 18 diploid oysters. We considered: (1) the gametogenetic stages of sex determination assessed by histology and (2) the sex phenotype of nines ‘true’ males and nine ‘true’ females that never exhibited sex changing during the course of the experiment. The spermatogenic elements were enumerated in sequence and compared to the differentially expressed genes related to the sex, during the whole period of sex determination. By using an Illumina HSeq 4000 platform, parallel-end RNA-seq data were generated with a 150 nt length obtained from the sequenced libraries of gonads. A total of 4,424,810,382 paired-reads were generated. De novo assembly of all the clean reads and de novo transcript quantification were carried out by using the CLC Genomics Workbench software. The comparison of the male and the female libraries and of the gametogenic stages covering or not the sex determination period allowed the identification of the potential candidates, including potential sex-determining genes: 56 sex-dependent genes, 9,497 gametogenesis stage-dependent genes and 85 sex-and-stage-dependent genes. Blast2GO software was used to perform BLASTp against nr and Swissprot databases for functional annotation and metabolic pathways identification.

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**A13.13  Cellular defense and metabolic responses of the great scallop (Pecten maximus) acutely exposed to variations in individual and combined climate drivers**

**THURSDAY 4 JULY, 2019  11:00**

SANDRA GOETZE (ALFRED-WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY), CHARLOTTE EYMANN (ALFRED-WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY), OSILDA LANNING (ALFRED-WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY), CHRISTIAN BOCK (ALFRED-WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY), HANS-OTTO FÖRSTER (ALFRED-WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH, GERMANY)

The devastating marine mass extinction at the Permian-Triassic border –252 Ma ago killed more than 90% of the marine biota. Today’s anthropogenic climate change is thought to be analogous to such past crises with respect to the threats we are facing today. Main drivers are warming (W), acidification and hypoxia, which affect organisms at all levels of organization; from whole organism to morphological levels. We investigated the acute impacts of W(14°C to 28°C at 2°C increase/48 h), of warming plus acidification (WHO; acidification with pH = 5.0) and of warming plus hypoxia (WHO; W + hypoxia with pH = 5.0 and oxygen saturation of 55–60%) on the metabolic processes of the scallop Pecten maximus. At different temperatures, gills were analyzed for the degree of cellular damage (lipids and proteins), heat shock response (HSP70), and alterations in metabolic pathways. We observed new warming-induced oxidative lipid damage, irrespective of additional treatments. HSP70 levels were increased in W, W + H and W + H and W on exposure to 26°C, but remained strikingly low in DT at all temperatures. The majority of altered metabolic pathways were associated with mitochondrial energy production, e.g. pathways involved in body temperature regulation. To inquire into the unpredictable environmental changes in ambient temperature and water availability on immunological parameters. Whereas temperature, we investigated immunological parameters (white blood cell counts), stress response (hydrophobin/lymphocyte (H/L) ratio) and body condition of zebra finches (Taeniopygia guttata).

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**A13.14  The effect of the rate of thermal change on mitochondrial ROS production and subsequent oxidative damage**

**THURSDAY 4 JULY, 2019  11:15**

ISABELLA LOUHLAND (UNIVERSITY OF SYDNEY, AUSTRALIA), FRANK SEIBACHER (UNIVERSITY OF SYDNEY, AUSTRALIA), GIIOU LAU (UNIVERSITY OF OSLO, NORWAY)

**A13.15  Immunological and stress responses to thermal and dehydration stress in zebra finches**

**WEDNESDAY 3 JULY, 2019  11:30**

ROGER COLOMINAS-CUIRO (DEPARTMENT OF VERTEBRATE ZOOLOGY, NICOLAUS COPERNICUS UNIVERSITY, POLAND), ANNA KWIATEKIEWSKA (DEPARTMENT OF VERTEBRATE ZOOLOGY, NICOLAUS COPERNICUS UNIVERSITY, POLAND), MALgorzata JEFJNOW (DEPARTMENT OF ANIMAL PHYSIOLOGY, NICOLAUS COPERNICUS UNIVERSITY, POLAND), Michal S WOJCIECHOWSKI (DEPARTMENT OF VERTEBRATE ZOOLOGY, NICOLAUS COPERNICUS UNIVERSITY, POLAND)

**COLUMINAS-CUIRO@POL</RAW_TEXT>
A13.17 AUGMENTED REALITY AS A TOOL FOR INTERACTIVE VISUALIZATION OF BIOIMAGING DATA: BLOOD FLOW THROUGH THE CEPHALIC VASCULARITY OF FISH

THURSDAY 4 JULY, 2019  14:10

CHRISTIAN DUMSGAARD (UNIVERSITY OF BRITISH COLUMBIA, CANADA), ERIC BATES (DELAWARE UNIVERSITY, CANADA), HENRIK LAURIDSEN (ARKUS UNIVERSITY, DENMARK), COLIN J. BRAUNER (UNIVERSITY OF BRITISH COLUMBIA, CANADA).

CDMS666MAIL.COM

The development of advanced bioimaging technologies now allows visualization of 3D morphology from the organismal down to the molecular level. However, this is typically achieved by projecting a representative plane of the 3D model onto a 2D journal figure leaving out most of the scientific detail. At the same time, augmented reality in mobile games has become an increasingly popular tool for visualization of 3D models within the real-world environment. Implementing this technique for visualization of scientific data provides the potential for engaging interactive exploration of all dimensions of multidimensional bioimaging data. In this presentation, we explore the potential for augmented reality in scientific bioimaging by showcasing a custom-build interactive augmented reality application that visualizes a computed tomography scan of the vasculature in a goldfish head scanned at 512 resolution. The application allows the viewer to explore the goldfish's 3D vascular anatomy by walking around, spinning, and zooming in on the individual vascular beds. As a fourth dimension, it includes a heart pace maker, where the viewer can initiate a heartbeat and follow blood flow through the whole cephalic vasculature. While this application was made specifically for our data set, it highlights the potential for using this new, readily available mobile device technology as a tool for visualization of all dimensions of bioimaging data in teaching and public outreach activities.

A13.18 HYPERSONAL INCREASES CLAUDIN-10 PARALOG MRNA ABUNDANCE TO FORM CATION-SELECTIVE PARACELLULAR PORES IN OPERCULAR AND GILL EPITHELIA OF A EYRHALINE FISH (FUNDULUS HETEROCLOTUS)

THURSDAY 4 JULY, 2019  14:25

WILLIAM S MARSHALL (ST FRANCIS XAVIER UNIVERSITY, CANADA), CHIN C KIM (YORK UNIVERSITY, CANADA), JASON P BREVES (SKIDMORE COLLEGE, UNITED STATES), CHRISTIAN T TIMPARK (UNIVERSITY OF ARKANSAS, UNITED STATES), PATRICIA M SCHULT (UNIVERSITY OF BRITISH COLUMBIA, CANADA), SCOTT P KELLY (YORK UNIVERSITY, CANADA)

BMPRASHAL657FLX.CA

We used per osaline treatment to force elevated expression of claudin-10 (cldn-10) tight junction protein paralogs in the gill and opercular epithelium (OE) of Fundulus heteroclitus, where these proteins are hypothesized to be form specialized Na\textsuperscript{+}–selective paracellular pores between ionocytes. Transcript abundance of cldn-10, cldn-10b, -10c, -10f and -10g were examined, and all were either exclusively detected or most abundant in gill and OE. In gills from freshwater (FW) fish and those transferred (SW) and from SW to hypersaline (25SW), abundance of cldn-10 mRNA was acutely elevated in SW and 25SW fish at 24h, whereas other responsive isoforms increased later (3–5 days). After SW to 2SW, cldn-10 and -10d increased, whereas in SW, cldn-10c and -10f predominated. Fish acclimated to 25SW for a prolonged period had higher mRNA abundance of all cldn-10. Ion substitution experiments with special chambers revealed pore permselectivity sequence Na\textsuperscript{+} > K\textsuperscript{+} > Li\textsuperscript{+} indicating that Na\textsuperscript{+} is the major ion transported through cldn-10. Our study supports the hypothesis that cldn-10 is the major claudin involved in osmoregulation in Fundulus heteroclitus and that the regulation is highly conserved across different environments and species.

A13.19 WHY DO CRABS TAKE NUTRIENTS UP VIA THEIR GILLS?

THURSDAY 4 JULY, 2019  14:40

TARZIN BLEKETT (UNIVERSITY OF ALBERTA, CANADA), GREG G GOSS (UNIVERSITY OF ALBERTA, CANADA)

TARZIN_VUAHLBERTA.CA

Recent research has shown that the invasive green crab (Carcinus maenas) can acquire nutrients, such as amino acids, directly from the water using their gills. What remains is the understanding why? In this study, we examined two hypotheses: that amino acids are used as osmolytes, and/or that this represents a mechanism for maximizing nutrition. Using in vitro perfusion techniques, we examined gill and operculum transport of radiolabeled-Leucine under three different salinity regimes (20%, 100%, 120% SW), and in fed versus fasted crabs. Transport data showed that gills from crabs previously acclimated to lower salinities displayed reduced or absent transport rates, while elevated salinities had significant effect. These data argue against the hypothesis that amino acid acquisition is linked to osmoregulation, although some uptake is sodium-linked. Gills from fed crabs exhibited increased uptake relative to fasted crabs, and in vivo studies showed differences in tissue distribution of absorbed amino acid. Together, these studies support the hypothesis that gill uptake of amino acids is regulated in the context of the crab's feeding state and possibly for optimal nitrogen metabolism.

A13.20 MORPHO-FUNCTIONAL REMODELLING OF OSMOREGULATORY ORGANS IN THE EEL (ANGUILLA ANQUILLA): INFLUENCE OF ANGIOTENSIN II

THURSDAY 4 JULY, 2019  14:55

MARIACRISTINA FILICE (UNIVERSITY OF CALABRIA, ITALY), DANIELA ALESSIOIELDI (UNIVERSITY OF CALABRIA, ITALY), ALFONSINA DATIUO (UNIVERSITY OF CALABRIA, ITALY), FILIPPO GARFALDO (UNIVERSITY OF CALABRIA, ITALY), SANDRA DHRIBO (UNIVERSITY OF CALABRIA, ITALY), MARIA C. CERRA (UNIVERSITY OF CALABRIA, ITALY)

MARIACRISTINA.FILICE@UNICAL.IT

Angiopoietin II (AngII), the principal effector of the Renin Angiotensin System (RAS), is a pluripotent hormone involved in the regulation of blood pressure, cardiac function and fluid osmolality. In euryhaline fish, changes in environmental salinities modify plasma AngII levels, while exogenous AngII regulates drinking and osmoregulatory responses. This study quantified the expression and localization of ion and water transporters. In both tissues, structural modifications were accompanied by changes in the expression and localization of ion and water transporters. In particular, Na\textsuperscript{+}/K\textsuperscript{+}-ATPase increased in gill ionocytes, but not in the kidney, while AQPs channel decreased in both organs. AngII also affected the localization and expression of an endohelial Nitric Oxide Synthase (eNOS)-like isoform, as well as NOS generation. These results point to an adaptive role of AngII as a key humoral modulator of the complex feeding organs and renal morpho-functional remodelling that allows euryhaline eels to face different environmental challenges.
A13.23 SEAWATER TOLERANCE AND FEEDING IN LANDLOCKED AND ANOMORPHOUS POPULATIONS OF SEA LAMPREY

**THURSDAY 4 JULY, 2019**

**JESSICA L. NORTON (UNIVERSITY OF MASSACHUSETTS AMHERST, UNITED STATES), STEPHEN D. MCCORMICK (USGS LEE TOWN SCIENCE CENTER, S. O. CONTE ANOMORPHOUS FISH RESEARCH LABORATORY, UNITED STATES)**

The life histories of landlocked and landlocked Lamprey are similar, though landlocked populations lack exposure to seawater and thus experience relaxed selection on traits associated with survival in seawater, including salinity tolerance and associated physiological traits. This study investigated differences in one androgenous and three landlocked populations of Lamprey in the US. We analyzed mitochondrial genomes from lampreys collected from landlocked populations and compared them with well-known information about the thermal sensitivity of various traits, to determine which traits are under selection in our study. This suggests that differences in morphology linked to swimming performance. Remarkably, many landlocked populations have similar morphological traits associated with shelter selection, which can be found at depths of up to 1000 m, were recovered for 6 days after surgically implanting them with Star-OD HRDTS, and their HR response was then measured when exposed to increasing hydraulic impact (300 bar, 900 m depth) in the (1°C) or decreasing oxygen levels (to 50% air saturation at 12°C) in the absence of all oxygen levels. In addition, we investigated the effect of fish exposure to 800 m depth on post-chase HR and determined the lumpfish’s HR response to increasing temperature up to their critical thermal maximum (CTMax) at atmospheric pressure. Hydrostatic pressure increased HR from ~400 to 610 bpm and increased maximum HR upon exposure to increasing temperature (~650 to 890 bpm at 800 bar and 80°C, respectively), but only had minor effects on the HR response to decreasing temperature, decreasing water temperature or exhaustive exercise (max. HR of 760 bpm). Further, increasing temperature to 80°C resulted in a maximum HR of 870 bpm. My research suggests that hydrostatic pressure influences the HR response to increasing temperature, and provides the first evidence that landlocked populations have a similar sensitivity to increasing HR and beyond our expectations, and often exceed calculated aerobic thresholds.

**A13.24 DOES THE PRESENCE OF SHELTER INFLUENCE THE METABOLIC TRAITS OF LENTIC AND LOTIC SMALLMOUTH BASS?

**THURSDAY 4 JULY, 2019**

**EMMANUELLE CHRETIEN (UNIVERSITÉ DE MONTRÉAL, CANADA), STEVEN J. ROBERTSON (UNIVERSITY OF MONTREAL, CANADA), DANIEL BOISSIL (UNIVERSITÉ DE MONTRÉAL, CANADA)**

Availability of shelter is an important component of habitat selection, and it can influence energy content and daily energy use. For these fish, sheltering may be beneficial to hide from predators, ambush prey, or lower energetic costs. Previous studies have revealed that fish metabolic rates tend to be lower in presence of shelter related to when shelter is absent. To shed light on these physiological factors, we used shelter for smallmouth bass, we conducted respirometry experiments on fish from two populations (Lake Long and Kiamika River) to determine if the presence of shelter affected different metabolic traits. We hypothesized that in presence of shelter, fish would have lower metabolic rates, reduced recovery times and lower EPOC after intense locomotor activity. Our results show that in presence of shelter the metabolic traits are not affected by treatment, but there was high individual variability. When accounting for social hierarchy, there were no differences in most metabolic traits, but there was significant lower in presence of shelter for dominant fish. These results do not demonstrate a direct link between physiology and habitat selection, and it is not clear that beneficial, related to intra- and inter-specific interactions, could explain fish selecting sheltered habitats.

**A13.25 THE DEEP AND THE SHALLOW OF DIVING KING PENGUINS, CAN KING PENGUINS DIVE DEEP AND LONG WITHOUT PREPARATION OR RECOVERY?

**THURSDAY 4 JULY, 2019**

**TESSA A. VAN WALSUM (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), LEWIS M. SALSLEY (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), ANDREA PERNIA (UNIVERSITY OF ROEHAMPTON, UNITED KINGDOM), ANDREAS FAHLMAN (ECOLOGICARTE DE VALÈNCIA, SPAIN), YVES HANDEICH (STRASBOURG UNIVERSITY, FRANCE)**

King penguins perform deep and long dives all across the southern ocean. However, with current overfishing and rising sea temperatures the king penguins could be forced to dive longer, deeper, and travel further to the site of most abundant prey. So far studies that show that king penguins are diving below their expectations, and often exceed calculated aerobic thresholds. The pigeon’s deep and long dives are often preceded and followed by shallow and non-foraging dives. Therefore, these dives indicate the kin's level of diving limitations? Or do they simply function as travel dives? Our data includes approx. 450,000 dives of 32 breaching male king penguins in three different locations. We measured the penguins’ dive depth, duration, and time spent at the surface in between dives, to determine if there is a link between the pigeon's extreme diving behaviour (top 10% of their deepest and longest foraging dives) and the shallow dives that preceded and followed them. Overall, 84% of the dives recorded were shallow, and only 1.6% of all dives performed qualitatively as the pigeon's deepest dives. The deepest dives reached 520 m, and the average dive depth was 165 m, highlighting the kingpenguin's remarkable diving ability. Thus far, we found no relationship between the deepest dives and the dives that preceded or followed. However, from our data it seems that the time spent at the surface increases after exceptionally deep dives. Further findings will be provided in the presentation.

**A13.26 HYDROSTATIC PRESSURE ALTERS THE HEART RATE RESPONSE OF LUMPFISH (CYCLOPTERUS LUMPUS) TO INCREASING TEMPERATURE

**FRIDAY 5 JULY, 2019**

**ZOÉ A. ZIRINI (MEMORIAL UNIVERSITY OF NEWFOUNDLAND, CANADA), R. M. SANDRELLI (MEMORIAL UNIVERSITY OF NEWFOUNDLAND, CANADA), A. K. JAMPERAL (MEMORIAL UNIVERSITY OF NEWFOUNDLAND, CANADA)**

Data on the effects of hydrostatic pressure on heart rate (HR) are limited to a narrow range of species, and rarely considers the interactive effects of this parameter and other environmental variables. In this study, lumpfishes (Cyclopterus lumpus, 200 to 400 g), which can be found at depths up to 1000 m, were recovered for 6 days after surgically implanting them with Star-OD HRDTS, and their HR response was then measured when exposed to increasing hydraulic impact (300 bar, 900 m depth) in the absence of all oxygen levels. In addition, we investigated the effect of fish exposure to 800 m depth on post-chase HR and determined the lumpfish’s HR response to increasing temperature up to their critical thermal maximum (CTMax) at atmospheric pressure. Hydrostatic pressure increased HR from ~400 to 610 bpm and increased maximum HR upon exposure to increasing temperature (~650 to 890 bpm at 800 bar and 80°C, respectively), but only had minor effects on the HR response to decreasing temperature, decreasing water temperature or exhaustive exercise (max. HR of 760 bpm). Further, increasing temperature to 80°C resulted in a maximum HR of 970 bpm. My research suggests that hydrostatic pressure influences the HR response to increasing temperature, and provides the first evidence that lumpfishes have a similar sensitivity to increasing HR and beyond our expectations, and often exceed calculated aerobic thresholds. The pigeon’s deep and long dives are often preceded and followed by shallow and non-foraging dives. Therefore, these dives indicate the kin's level of diving limitations? Or do they simply function as travel dives? Our data includes approx. 450,000 dives of 32 breaching male king penguins in three different locations. We measured the penguins’ dive depth, duration, and time spent at the surface in between dives, to determine if there is a link between the pigeon's extreme diving behaviour (top 10% of their deepest and longest foraging dives) and the shallow dives that preceded and followed them. Overall, 84% of the dives recorded were shallow, and only 1.6% of all dives performed qualitatively as the pigeon's deepest dives. The deepest dives reached 520 m, and the average dive depth was 165 m, highlighting the kingpenguin's remarkable diving ability. Thus far, we found no relationship between the deepest dives and the dives that preceded or followed. However, from our data it seems that the time spent at the surface increases after exceptionally deep dives. Further findings will be provided in the presentation.

**A13.27 THERMAL SENSITIVITY OF LOCOMOTOR ACTIVITY AND LOCOMOTOR PERFORMANCE: A CLIMATE CHANGE PERSPECTIVE

**FRIDAY 5 JULY, 2019**

**LUMÍR GÖDÖKZ (INSTITUTE OF VERTEBRATE BIOLOGY OF THE CEZON ACADEMY OF SCIENCES, CZECH REPUBLIC)**

Locomotion is a basic living attribute in non-seasal organisms. Locomotor performance determines capacity to escape selection, and thus influences individual survival. Locomotor performance is also closely related to energy input and output within an organism, and according its level determines individual reproducitive success in a given habitat. However, less is known about these processes when exposed to climatic extreme conditions. In contrast to locomotor performance, the thermal dependence of locomotor activity has received much less attention. In this talk, I will review recent results on the complex influence of body temperature on locomotor activity and compare them with well-known information about the thermal sensitivity of locomotor performance in a system of interacting echotemns. Variation in thermal sensitivity in both locomotor characteristics should be considered when predicting impact of climate change on echotemns populations.
A13.29 DOES Cu/Cd/Zn METAL MIXTURE AFFECT PHYSIOLOGICAL PERFORMANCES OF COMMON CARP (CYPRinus CARPio)?

THURSDAY 4 JULY, 2019
17:40
MARION PILLET (UNIVERSITY OF ANтверP, BELGIUM), GIOVANNI CASTALDo (UNIVERSITY OF ANterP, BELGIUM), EssIE RODGERS (UNiversity of ANterP, BELGIUM), Ronny BlUSt (UNIVERSITy of ANterP, BELGIUM), druNt dRE (UNIVERSITy of ANterP, BELGIUM)

The thermal contamination of the aquatic environment is problematic due to the bioaccumulative, non-biodegradable and toxic properties of these elements. Some metals are essential but ultimately they may become inhibitory or toxic at high concentrations, while other (non-essential) have deleterious effects even at low concentrations. Previous studies have proven for example that metals can alter metabolic pathways (such as the Krebs cycle and the electron transport chain), impact respiratory functions, increase ROS production and reduce ATP production. The objective of our study is to investigate the impacts of Cu/Zn/Cd mixture on the swimming performance and aerobic scope of fish species, the common carp C. carpio. Fish are subjected to Cu/Zn/Cd mixture exposure at concentrations representing 10% of their 96h LC50 (LC50 = 4.8 µg/L, Cd = 2.9 µg/L, Zn = 18 µg/L). Experimental period, 3 days (3 x 12h) and 7 days (7 x 12h) exposure time. We measured the standard metabolic rate (SMR) and maximum metabolic rate (MMR) using an oxygen and carbon dioxide electrode. The aerobic scope (AS) is calculated as the difference between maximum and standard metabolic rates. The results will help us to establish a better understanding of the mechanisms of toxicity impacting physiological performances during chronic and acute exposure to metal mixture.

A13.30 UNIQUE RESPONSE PATTERNS OF CHIRONOMID MIDGE TO BIOTIC AND ABIOTIC STRESS - AN EMERGING MODEL FOR STRESS BIOLOGY STUDIES

FRIdAY 5 JULY, 2019
09:00
BIMALENDu NATH (SAVitriPhUe PULHe Pune, INDia), MALu HAlPEn (UnerVeRsy of HAIFA, ISraEL), LEEnA ThomaT (SAVitriPhUe PULHe Pune, INDia)

B R NATH@IO M AIL.COM

Chironomids, an ecologically tractable organism, is emerging as one of the suitable model systems to study biotic and abiotic stress response in the context of climate change and environmental risks. All the developmental stages of chironomid midge, a common group of dipteran insects that are in the Jurassic-Cretaceous period, can thrive under extreme environmental conditions, thereby qualifying it as a potential candidate for investigating stress tolerance strategies at the cellular, biochemical and physiological level. In our laboratories, we have focused on various climate-related stresses affecting freshwater ecosystems using chironomid midge larvae as a model system. Larvae of chironomid midge possess extracellular monomeric haemoglobin that constitutes the bulk of the haemolymph protein. Empirical studies on the chironomid haemolymph have detected its protective functions in metabolic plasticity as well as various intrinsic stressors, including hypoxia and iron- deficiency induced metabolic imbalances. Upon exposure to sublethal stressors, the midge larvae display different trophic preferences like hypotroph and a strong regulatory mechanism were found to play a crucial role in stress tolerance in Chironomus larvae. Among the biotic stressors, nematode-infested larvae were found to survive better than their non-infected controls. The study of the physiological mechanisms underlying stress tolerance is emerging as a major area of interest in the fields of environmental and stress biology research and its implications will be discussed.

A13.31 WHETHER WARMING MAGNIFIES THE TOXICITY OF A PESTICIDE IS STRONGLY DEPENDENT ON THE CONCENTRATION AND THE NULL MODEL

FRIdAY 5 JULY, 2019
09:15
VIENNA DELNat (KU LEUVen, BELGIUM), LEzANNE JAnensen (KU LEUVen, BELGIUM), ROBY nStoKs (KU LEUVen, BELGIUM)

VIIENNA.DELNAt@KULEUVEn.BE

How global warming changes the toxicity of contaminants is a research priority at the intersection of global change biology and ecotoxicology. While many pesticides are more toxic at higher temperatures this is not always detected. We studied whether deviations from this general pattern can be explained by concentration-dependent interaction effects and by testing the interaction against the inappropriate null model. We exposed larva of the mosquitofish (Gambusia affinis) to the pesticide chlorpyrifos (absence, low and high) in the absence and presence of 4°C warming. Both the low and high chlorpyrifos concentration were lethal and generated negative interactive activity of acetylcholinesterase (AChE) and total fat content decreased, and oxidative damage to lipids increased, yet growth rate increased. Warming was slightly lethal, yet had positive sublethal effects: growth rate, total fat content and metabolic rate increased, and oxidative damage decreased. For four out of seven response variables the independent action model identified the expected synergistic interaction between chlorpyrifos and warming. Notably, for three variables (survival, AChE and fat content) this was strongly dependent on the chlorpyrifos concentration, and for two of these (AChE and fat content) not associated with its significant interaction in the generalized linear models. For survival and fat content, warming increased the potential lethal effect of chlorpyrifos and lowered the AChE concentration, while the opposite was true for AChE. Our results highlight that taking into account concentration-dependence and appropriate null model testing is crucial to improve our understanding of the toxicity of contaminants in a warming world.

A13.32 NOVEL DETOXIFICATION PATHWAYS IN ANCIENT VERTEBRATES: FOLLOWING EXPOSURE TO PESTICIDES - IMPLICATIONS FOR MANAGEMENT OF INVASIVE SPECIES AND SPECIES AT RISK

FRIdAY 5 JULY, 2019
09:30
dAnA BircE-An (WILFRID LAURIER UnIvErsITY, CANADA), HEAther BimaN (WILFRID LAURIER UnIvErsITY, CANADA), JoNhAtAN M. WilsOn (WILFRID LAURIER UnIvErsITY, CANADA), MICHAEL WILLE (WILFRID LAURIER UnIvErsITY, CANADA)

O BIECA N AN EMAIL.COM

Sea lampreys (Petromyzon marinus) are an invasive species in the North American Great Lakes. Juveniles feed on economically and culturally important fish, killing up to 20% of fish during this life stage. Therefore, an integrated pest management program is used to control their populations, which includes the application of pesticides (lambdacyhalothrin, 3-trifluoromethyl-4-nitrophenol (TFM) and niclosamide) to tributaries infested with larval sea lampreys (ammocoetes). lampreys target ammonium because they have a lower detoxification capacity than non-target fishes, which detoxify the lampricide via Phase I detoxification pathways. However, young-of-the-year lake sturgeon (Acipenser fulvescens) are just as sensitive to lampricides as their larvae. We hypothesize that this sensitivity is due to lower detoxification capacity of the YOY, compared to the larval stage. To this end, lake sturgeon (Y0Y and 1-year) and larval lampreys were exposed to environmentally relevant concentrations of TFM and niclosamide, alone and in combination. Compared to 1-year sturgeon, Y0Y and lampreys accumulated greater amounts of both lampricides and lower amounts of the glucuronidated and sulfated metabolites of TFM and niclosamide in their tissues. Thus, delaying lampricde treatments until sturgeon are older could mitigate potential adverse effects on this at-risk species. Notably, both lake sturgeon and ammocoetes accumulated greater amounts of the sulfated than the glucuronidated metabolite, suggesting that they have a greater capacity to detoxify lampricides than previously thought. This has important implications, because it suggests that sea lampreys may be able to evolve resistance to lambdacyhalothrin by increasing their detoxification capacity.

A13.33 SEDIMENT EXPOSURE TO UV-FILTERS: IMPACT ON SURVIVAL, HATCHING SUCCESS, CARDIAC FREQUENCY AND AEROBIC METABOLIC SCOPE IN ZEBRAFISH (DANio RERio) EMBRYO LARVAL STAGE

FRIdAY 5 JULY, 2019
09:45
JUlIE LUCAS (OCEANOLOGICAL OBSERVATORY OF BANYULS SUR-MER, SOUIENCE FRANCE), JUlIE LUCAS-BOYD BAnYULS, FR

UV-filters are widely used in many personal care products such as sunscreen and cosmetics to protect from UV irradiation. Due to their hydrophobic and persistent properties, UV-filters have a high capacity to accumulate in sediment. Nevertheless, little information is available on their ecotoxicity on fish physiology. In this study, we investigated the individual effects of 11 UV-filters in zebrafish (D. rerio). Fish were exposed to single UV-filters by contact with contaminated sediment and/or by their presence in the water phase. The aim of this study was to investigate the individual effects of 11 UV-filters in zebrafish. F, Fish eggs were exposed to single UV-filters by contact with contaminated sediment during 96h at a concentration of 10µg/g. In a first time, survival and hatching success were estimated. Then, larvae cardiac frequency and aerobic metabolic scope were measured on larval stage. Endays survival was not affected by any of the 11 UV-filters. On the opposite, it was observed that Chlorpyrifos reduced hatching success at 4dpf. Cardiac frequency was reduced by Benzophenone and increased by Ethylexylic alkylicate in 5dpf larvae. Preliminary results regarding aerobie metabolic scope suggest that it may not be impaired by benzophenone.

A13.34 VERY HUNGRY CATERPILLARS: POLYETHYLENE METABOLISM IN THE GREATER WAX GALLERIA MELLONELLA

FRIdAY 5 JULY, 2019
11:10
CHRISTOPHE MR LEMPINE (BRANDON UNIVERSITY, CANADA), HARAlD GROVE (BRANDON UNIVERSITY, CANADA), CHRISTINE SMITH (BRANDON UNIVERSITY, CANADA), BryAN J CassONE (BRANDON UNIVERSITY, CANADA)

LEMPINE@BRANDON. CA

Plastics are an integral part of our everyday lives due to its low cost, versatility, and durability. Unfortunately, these characteristics make them attractive to consumers also rendering it problematic for waste management. Indeed the natural physical degradation of plastics such as polyethylene can take years, and although a select few micro-organisms can biodegrade plastics, these processes are overall inefficient and relatively slow. However, recent reports have described the ability of the larval of the greater wax moth (Galleria mellonella) to metabolize polyethylene at much faster rates than any microorganism described to date. Despite this impressive capability, little is known about the respective role of the waxworms and/or of their intestinal micro-organisms in this biodegradation process. Therefore, in the present study we evaluate these roles using a combination of next-generation sequencing and traditional physiological approaches. In particular, we assessed the consequences of polyethylene diet on the caterpillars and their microbiome, and how modulating bacterial abundance affected plastic degradation. Overall our results suggest that the microbiome plays an essential role in the biodegradation process. However, the waxworm's microbiology is also profoundly affected by a polyethylene diet, suggesting a role well beyond the role of a "bioreactor" for plastic degrading bacteria.
A13.35 PHYSIOLOGICAL PLASTICITY UNDER LIFE WITHOUT WATER: A BIOCHEMICAL TALE OF DIFFERENTIAL STRESS TOLERANCE IN CHIRONOMUS AND DROSOPHILA

FRIDAY 5 JULY, 2019 11:45

LEENA JOHN THORAT (SAVITRIBAI PHULE PUNE UNIVERSITY, INDIA), BIMALENDU B NATH (SAVITRIBAI PHULE PUNE UNIVERSITY, INDIA), LEENATHORATMORO@GMAIL.COM

Few organisms adopt desiccation tolerance as a unique tactic in order to counter climate change-related stressors arising due to temperature-humidity imbalance. Interestingly, desiccation tolerant organisms demonstrate development without compromising on revival upon return of favourable conditions. Among poikilothersmic animals, insects are extremely prone to physiological water deficit under seasonal and stochastic variations in water availability. This study discusses the physiological biochemistry of desiccation tolerance in the terrestrial fruit fly, Drosophila melanogaster and the aquatic midge, Chironomus ramosus. Strikingly, larvae of Chironomus and Drosophila exhibited different strategies to escape dehydration, which can be directly attributed to their contrasting habitats and their habituating ecologically diverse ecosystems. Compared to Chironomus, Drosophila showed higher tolerance threshold under acute water deficit. Furthermore, these data correlated with surface topological alterations observable using standardised parameters for environmental scanning electron microscopy. Among the unique physiological adjustments, high-throughput LC-QuEChERS analysis, chemical assays and gene expression studies in Chironomus revealed the involvement of the trehalose-quinine metabolic interface via a novel role for quinine restoration of cuticular topology (which was apparently absent in Drosophila). However, a pivotal role for trehalose as a dehydration-rehydration-responsive biomolecule was prominent in both larval groups. Additionally, Electromagnon Resonance analysis and a novel, non-invasive, whole larval imaging technique enabled to directly assess the significance of trehalose in the regulation of desiccation-mediated redox homeostasis. Taken together, these fundamental findings add useful insights to the gamut of survival machinery employed by insects that ensure resuscitation from unfavourable environments.

A13.36 EFFECT OF AMBIENT TEMPERATURE ON THE DEVELOPMENT OF MORPHOLOGICAL, BEHAVIOURAL AND PHYSIOLOGICAL TRAITS OF A MARSUPIAL MAMMAL

FRIDAY 5 JULY, 2019 12:00

CLARE STANKIEWICZ (NEWCASTLE UNIVERSITY, UNITED KINGDOM), CLARE.STANK@NULE.AUSTRALIA

Climate change is likely to affect many mammalian traits, yet little is known about how mammals respond to thermal challenges during development. We investigated the effect of continuous cold or warm temperature on development, morphology, behavioural and functional variables of yellow-footed antechinus (Antechinus flavipes), a semelparous Australian marsupial mammal. Captive-born young were exposed to two ambient temperatures (Ta) cold (18°C) or warm (25°C), once weaned. We measured body mass weekly, activity continuously, and metabolic rates over a range of Ta, once they were adults. Treatments were reversed and metabolic rate measurements repeated after two months. Growth rates were similar in both groups, but faster in males. Antechinus in the warm temperature group were initially more active than the cold group and decreased activity when exposed to cold, whereas the cold group increased activity when exposed to warm. Interestingly, females changed their night-time activity when Ta was changed, whereas males changed their day-time activity. Metabolic rates were originally lower in the warm group in comparison to the cold group for both sexes, but increased and slightly decreased, but not for males, after exposure to cold. After exposure to warm Ta, the metabolic rates of the cold group decreased significantly over the entire Ta range for both sexes. Our results reveal that temperatures experienced during development can influence behavioural and physiological traits in antechinus. Such phenotypic plasticity is vital for a species that within nine years is dependent on a single breeding event and experiences a complete population turnover.

A13.37 IMPROVING ORNAMENTAL FISH WELFARE DURING COMMERCIAL TRANSPORT

FRIDAY 5 JULY, 2019 12:15

MYRIAMP VANDERZALWEN (UNIVERSITY OF THE WEST OF SCOTLAND, UNITED KINGDOM), KAATHERI SULLUM (UNIVERSITY OF THE WEST OF SCOTLAND, UNITED KINGDOM), DONNA SNELLGROVE (WALTHAM CENTRE FOR PET NUTRITION, UNITED KINGDOM), PETER CAREY (PETS AT HOME, UNITED KINGDOM)

Myriamp Vanderzalwen

Thousands of ornamental fish are transported every year and as a result can experience high levels of stress. Previous research has focused on maintaining good water quality during transport; few studies have considered how the transport environment might impact the welfare of the fish. In this study, the impact of -DNA protein structures to enhance fish welfare. We investigated whether a commercial water conditioner (containing Al2O3) or environmental enrichment could improve the welfare of a variable plaice (Xiphias glisglis) variable) during commercial transport. Firstly, water conditioner was added to transport bags for either long (Singapore to Scotland, > 30 h; or Singapore to the UK with and without water conditioners) or short (wholesaler to retailer within Scotland, 5 h; n =11) commercial transport. Secondly, enrichment was added to transport bags for short (wholesaler to retailer) and long commercial transports. Behaviour, mortality and body injuries of plaits were monitored at their arrival at their destinations. No differences in mortality or body injury were seen between treatments and controls; mortality and injuries were higher for the short transport, plats were shipped with water conditioner showed less erratic swimming and were less agressive during recovery. Addition of water conditioner during the short transport resulted in less erratic swimming behaviour, although there is an increase in chasing behaviour was seen during recovery. These studies indicate that there are conditions and enrichment further research, particularly in transport chains, that are higher levels of mortality exist.

A13.38 EXITRONS: FROM THEIR DISCOVERY AND EVOLUTIONARY ORIGIN TO PAN-CANCER PROFILING

FRIDAY 5 JULY, 2019 15:00

MARTA KALYNA (UNIVERSITY OF NATURAL RESOURCES AND LIFE SCIENCES – BOKU VIENNA, AUSTRIA), MARIA KALYNA, MARIYA.KALYNA@BOKU.AC.AT

Exitrons are defined as introns that do not contain stop codons. Exitrons predominantly have sizes of 100-1000 bp. They are transcribed and spliced like coding exons. Exitrons utilize canonical core splicing regulatory elements to drive the evolution of exon splicing. As exitrons are internal parts of the protein-coding exons, they do not contain stop codons. Exitrons predominantly have sizes of multiples of three nucleotides. Thus splicing of these exitrons occurs in-frame. This results in internally deleted protein isoforms of proteins with changes in protein domains, disorder regions, and various post-translational modification sites, therefore broadly impacting protein function. Thousands of exitrons are present in different species from humans to plants. Exitrons are differentially regulated in tissues, by stress and in disease including cancer. We are interested in elucidating the basis of this differential regulation and the role of exitrons in gene expression. Interestingly, exitrons are also present within genes that are frequently mutated in cancers and that are commonly used as cancer markers and potential targets for anti-cancer therapies. We will present and discuss analyses of different cancers and their deregulated exitron splicing events with potential roles in cancer.

A13.39 EFFECT OF EARLY LIFE PERFORMANCE ON TELEOMERE DYNAMICS IN WILD BOAR PIGLETS (SUS SCROFA)

FRIDAY 5 JULY, 2019 15:15

MAGDALENA SPIESSBERGER (RESEARCH INSTITUTE OF WILDLIFE ECOLOGY, UNIVERSITY OF VETERINARY MEDICINE, AUSTRIA), FRANZ HÖLZL (RESEARCH INSTITUTE OF ETHOLOGY, UNIVERSITY OF VETERINARY MEDICINE, AUSTRIA), SEBASTIAN VETTER (RESEARCH INSTITUTE OF WILDLIFE ECOLOGY, UNIVERSITY OF VETERINARY MEDICINE, AUSTRIA), JULIA NONACK (NATIONAL SCIENCES AND PSYCHOLOGY, LIVERPOOL JOHN ROGERS UNIVERSITY, UNITED KINGDOM)

Conditions experienced during early life can have marked effect on health, fitness and survival of individuals, but little is known about the underlying mechanisms. Previous studies have shown a strong positive correlation between weanling body mass at birth and subsequent performance of juveniles. This improved performance, which includes increased survival probability, should for high to invest in somatic repair and maintenance and thus telomere length. Telomeres, the repeated nucleotide sequences at the ends of chromosomes, play a critical role in protecting the coding DNA and maintaining genomic integrity. We collected data on telomere length during the first 4 months of life of 28 wild boar piglets (Sus scrofa) from 6 litters and linked these data to body weight and different early life conditions of piglets. Our data show a clear correlation between birth weight and initial telomere length, with longer telomeres at birth. Further, initial telomere length and birth weight predicted telomere length later in the piglet’s life. Interestingly, the negative correlation between weight and telomere length diminished over time. Taken together, our study suggests a trade-off between juvenile growth and telomere maintenance.

A13.40 REPRODUCTIVE EFFORT AND TELEOMERES - A LONITUDINAL EXPERIMENTAL STUDY IN JACKDAWS CORVUS MONedula

FRIDAY 5 JULY, 2019 15:50

CHRISTINA BAUCH (UNIVERSITY OF GRONINGEN, NETHERLANDS), JELLE J BONNEKAMP (UNIVERSITY OF GRONINGEN, NETHERLANDS), EILLES MOLDER (UNIVERSITY OF GRONINGEN, NETHERLANDS), SIMON VERHILST (UNIVERSITY OF GRONINGEN, NETHERLANDS)

Where resources are limited, life-history theory predicts that reproduction comes at the expense of somatic maintenance and, ultimately, reduced lifespan. However, the underlying mechanisms remain poorly understood. Telomeres – DNA protein structures at the ends of chromosomes – are a candidate biomarker as short telomeres relate to reduced health and survival in birds and many other
organisms. Previous investigations in our study population of free-living jackdaws have shown that individuals with an experimentally increased reproductive effort suffered an increased rate of actuarial senescence, an effect we showed to persist in an expanded data set. Our subsequent aim was to test if telomere dynamics mediated or reflect the trade-off between reproduction and lifespan. To this end, we applied a longitudinal brood size manipulation approach to increase or decrease brood size over time in jackdaw parents. Individual-based data on reproduction and blood samples for telomere analysis were collected during every breeding season since 2005. We found that telomere attrition rate did not differ between experimental groups rearing enlarged or reduced broods throughout their lives, despite the increased rate in actuarial senescence in individuals with experimentally increased reproductive effort. However, the relationship between telomere length and survival was affected by reproductive effort; while there was no relationship between telomere length and survival for parents raising reduced broods, in parents raising enlarged broods only individuals with the longest telomeres survived. We will discuss these results in a life-history context.

A13.42 AMPHIBIOUS FISH HIT THE GYM: JUMP TRAINING IMPROVES LOCOMOTORY PERFORMANCE ON LAND

FRIDAY 5 JULY, 2019  16:00

PATRICIA A WRIGHT (UNIVERSITY OF GUELPH, CANADA), WILLIAM McFARLANE (UNIVERSITY OF GUELPH, CANADA), GIULIA ROSSI (UNIVERSITY OF GUELPH, CANADA)

Moving around on land poses many biomechanical challenges for amphibious fishes, as air and water have dramatically different properties. Amphibious fishes have evolved anatomical and physiological features that allow them to move between water and land. But does more time out of water actually enhance terrestrial locomotor performance? In the amphibious mangrove rivulus, Cryptobranchus marmoratus, we were surprised that two weeks of inactivity on land actually improved tail flip jumping performance, increased oxidative (not glycolytic) skeletal muscle fibre size and decreased lactate accumulation (after a bout of jumping) compared to control fish in water. Follow up experiments showed that the increase in fibre size was due, in part, to the higher availability of oxygen in air relative to water. We then asked whether short bursts of repeated exercise training on land would also lead to better jumpers ability and skeletal muscle remodeling. Indeed, exercised fish were improved jumpers and had increased oxidative fibre size/capillary density, relative to untrained fish. These findings reveal that oxidative skeletal muscle is highly plastic in K. marmoratus. Our data suggest that fish that spend more time out of water, especially moving around, will reap the benefits of an enhanced ability to jump that will aid in dispersal, prey capture and escaping predation.

A13.41 HIGH RESISTANCE TO CALCIUM-INDUCED MITOCHONDRIAL PERMEABILITY TRANSITION PORE OPENING IN THE LONG-LIVED RED-FOOTED TORTOISE CHELONOIDIS CARBONARIA (CHELONIA, REPTILIA)

FRIDAY 5 JULY, 2019  15:45

MARINA R SARTORI (UNIVERSIDADE ESTADUAL DE CAMPINAS UNICAMP, BRAZIL), CLAUDIA D C NAVARRO (UNIVERSIDADE ESTADUAL DE CAMPINAS UNICAMP, BRAZIL), ROGER F CASTILHO (UNIVERSIDADE ESTADUAL DE CAMPINAS UNICAMP, BRAZIL), ANIBAL E VERCESI (UNIVERSIDADE ESTADUAL DE CAMPINAS UNICAMP, BRAZIL)

The interaction between Ca\(^{2+}\) accumulation and redox imbalance regulates opening of a highly regulated and nonspecific mitochondrial pore, the permeability transition pore (PTP). The pore is considered a major cause of cell death, diseases and aging. We have recently shown that a short-lived species, the marsupial Gracilius micronotus, is remarkably susceptible to PTP opening. On the other hand, many turtles present negligible senescence and are potential model organisms for understanding longevity. While many physiological properties of turtles have been characterized, the adaptation to different environments, the mitochondria, are unknown. In this study we characterized liver mitochondrial bioenergetics and Ca\(^{2+}\) retention capacity of juvenile and adult red-footed tortoises (Chelonoidis carbonaria) ranked at the 16th position from a 122 species of a testudines longevity list. Wistar rats were used as a reference standard. Complex I-linked uncoupled and phosphorylating respiration rates of the isolated liver mitochondria were approximately 50% higher in juveniles than in adults. Ca\(^{2+}\) retention capacity did not differ between juvenile and adult tortoises (312 ± 44 nmol Ca\(^{2+}\)/mg protein) but was remarkably higher in comparison to rats (41 ± 9 nmol Ca\(^{2+}\)/mg protein) under the same experimental conditions. The PTP inhibitor cyclosporine A significantly increased the resistance of the tortoise mitochondria to Ca\(^{2+}\) overload and this effect was higher in juveniles than in adults. Indeed, these results support the relationship between PTP properties and lifespan, as tortoises presented noticeably lower susceptibility to PTP opening than common model organisms and short lifespan species.