

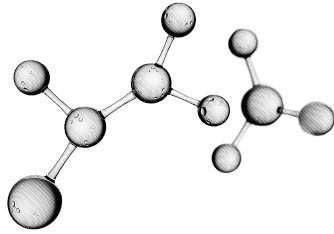
## OPEN ANIMAL ABSTRACTS LIST

### Reproductive Biology & Behaviour (Tue 09.00 – 10.30)

#### Why bitches copulate with more than one male?

**Sunil K Pal**

Seventeen oestrous female dogs (14 group-living and 3 non-group-living) were selected to investigate the benefits of multiple-male mating in relation to the frequency of successful copulation, litter size, pup survival and pup care. The focal animal sampling method was followed, and a total of 5130 hours were devoted to collecting data. The data were analyzed using a Pearsonian  $\chi^2$  model, Pearson's coefficient of correlation and paired and unpaired t-tests. A GLMM was used to determine the weekly variations between the males in relation to nursing activities. Among the focal females ( $n=17$ ), fourteen females were recorded as multi-male mating (MMM), and three females as Single-male mating (SMM). The frequency of successful copulation, litter size and pup survivability were greater among the MMM females than among the SMM females. The mean duration of copulatory ties was higher among the MMM females than among the SMM females. During weaning, male dogs (fathers) were observed to feed the pups by regurgitation and also to protect the pups as 'guard dogs', with a higher frequency among the MMM females than among the SMM females. Interestingly, predation of pups by another dog group was noticed in the case of SMM groups. From this study, it may be suggested that multiple mating may increase females' fertility, the whelping rate and litter size in bitches, offspring survival, protection from predators, and may provide food by regurgitation, active defense of the young at the den site, high-quality genes through sperm competition.



## **Competition with vertebrate scavengers' delays return to parental care in the burying beetle *Nicrophorus vespilloides***

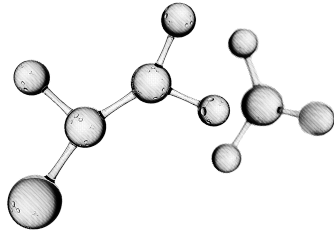
**Casey Patmore**, Georgia Lambert, Charlotte Noonan, Per T Smiseth

Competition over rare and limited resources is an important evolutionary driver of behaviour. One such resource found in nature are carrion carcasses, which the burying beetle *Nicrophorus vespilloides* depends on to breed. However, these carcasses are highly valuable and often bring these beetles into competition with other species, including opportunistic vertebrate scavengers. While we might predict the beetles should have some mechanism to deal with these encounters, little is known about how such interactions inform parental care decisions of *N. vespilloides*. Here, we test whether this includes facultative adjustments to parental care. We found that parents were slower to return to providing care when given cues that indicated vertebrate scavengers were present. Despite this, we found there was no difference in the overall amount of care parents provided, or in resulting larval fitness. Our results are consistent with previous work that shows while vertebrate competition does trigger a strong immediate response in these beetles, any long-term adjustments in parental behaviour are limited. This suggests that the selective pressure for long-term adjustments here is weak, and we find evidence that these beetles may instead rely on non-facultative behaviours such as concealing carrion to deal with asymmetric competition.

## **Semi-transparency: Strategic camouflaging technique in a freshwater prawn**

**Chayan Munshi**

Camouflaging strategies in animals primarily includes the efficient feature to merge with the background of the ecosystem. This physiological phenomenon is an evolutionary process regulated by specific genes and is effective in terms of prey-predation equation. The colouration mechanisms in animals comprehends sophisticated pigment physiology, which is exhibited in a proficient way on the body surface of the animal to conflate with the adjacent environment. This work uses a semi-transparent freshwater prawn species, *Macrobrachium lamarrei*, to elucidate the mechanism to camouflage in the aquatic medium thus using the light intensity underwater. *Macrobrachium lamarrei* has specific arrangement of pigment droplets on its exoskeleton. However, the exclusivity of camouflage exists within the semi-transparent appearance of the body, for which, the organism effectively becomes 'invisible' in the aquatic habitat. The accumulative effects of semi-transparency

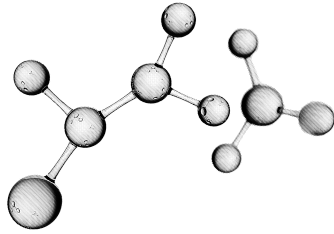


and pigment droplet distribution on the body surface, plays the crucial role in the hiding strategy. In fact, the degree of semi-transparency is regulated by the organism and the intensity of light plays a critical role in the reflection of the image of the prawns to the predator. This study is conceptualised on the interplay of light and transparency where we have used a semi-transparent aquatic organism as a reliable biophysical model to analyse camouflagic adaptation.

### **The effect of fish size on the escape responses of schooling shiner perch *Cymatogaster aggregata***

**Francesca Leggieri**, Chelsea B. Millward, Jasmine Reighard, Mabel Zhang, John F. Steffensen, Jacob Johansen, Paolo Domenici

Escape responses in schooling fish have been researched at length, though little is known regarding how responses may differ as schooling fish grow. To investigate this, we elicited escape responses in a subset of individuals from schools (consisting of 19-20 individuals) of different size ranges of shiner perch (*Cymatogaster aggregata*), by triggering a visual stimulus when 3-6 individuals were positioned within view of the stimulus, with their resulting reaction to a threat ensuing further responses across the rest of school which could not see the stimulus because of an opaque barrier that was suspended above the water level. We analysed individual turning rates, latencies, and the propagation of the reaction among individuals. Our experiments revealed distinct patterns in response behaviour: as expected, turning rate decreased with fish size, conversely, these smaller individuals exhibited longer latencies in initiating the escape response, suggesting a trade-off between speed of turning and reaction time across sizes. Furthermore, size was found to significantly affect the spread of information among individuals that detected the escape-triggering stimulus, with larger individuals facilitating faster propagation of the response throughout the school. These findings highlight the complex interplay between individual size and collective behaviour in fish schools, suggesting that size not only influences individual escape performance but also the efficiency of information transfer within groups. Our results contribute to a deeper understanding of the mechanisms underpinning escape responses in gregarious fishes, with implications for the study of predator-prey interactions and the evolutionary dynamics of schooling behaviour.



## **A multimethod approach to study the behavioral utilization of spider silk glands.**

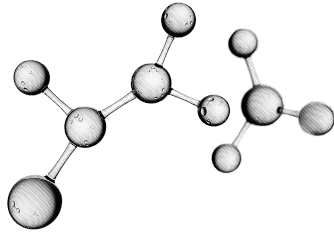
**Maitry M Jani**, Paula Heinz, Siripanyo Promnil, Jonas O Wolff

In recent years, research on spider silk has advanced, uncovering an enormous variation of its mechanical properties, both interspecifically and intraspecifically between different types of silk glands. However, understanding the ecological roles and behavioral utilization of distinct silk types and their ecological functions remains limited. Moreover, there is a notable gap in methodologies to identify the use of spider silk glands in different behavioural contexts. This study focused on the synanthropic cellar spider *Pholcus phalangioides* that is known to combine the construction of three-dimensional webs with unique prey capture behaviours. We tested the utility of multiple experimental approaches for the identification of which glands are active in which behavioural context. Methods included (a) the polarised light microscopy to measure different fibre diameters from collected silk samples, (b) morphometric analysis of spigot pore and fibre diameters, (c) the freezing of spinning behaviour followed by microscopical investigation, and (d) the blocking of silk spigots. We found that the combination of approaches a-c was suited to determine the ecological function of the different fibre producing silk gland types in *P. phalangioides*. Major ampullate, minor ampullate and aciniform silk was often used in combination, however the single-use silk threads for locomotion usually consisted only of a single silk material. This data provides a new perspective beyond the prevalent focus on orb weavers, offering insights into lesser-known species. Furthermore, the study highlights the limitations of single techniques, emphasizing the need for a multi-method approach to understand the biological function of morphological features.

## **Adaptive modifications in the thoracic appendages of a freshwater prawn, *Macrobrachium lamarrei***

**Swapnanil Mondal**, Chayan Munshi

Analysis of morphological adaptations is crucial in evolutionary biology research. *Macrobrachium lamarrei* is a freshwater prawn species which was considered as a model organisms to investigate the fundamental morphological development in the thoracic appendages of this species. Scanning Electron Micrographic (SEM) analyses validated the intricate modifications in the key appendages, where finer microscopic structures demonstrated infinitesimal geometrical complexities, thus manifesting efficacy of the appendicular functions. This study was fundamentally conducted to evaluate the appendage efficiency in performing several activities in correlation with the abundance



of specialised morphometric microstructures. Analysis of the geometric morphometrics was done to substantiate evolutionary success of the grooming appendage, with respect to the array of the microstructures. *Macrobrachium lamarrei* is a reliable model to study morphological adaptive modifications. Our findings revealed diversity of structural uniqueness and convolutions on the thoracic appendages which is certainly well designed to have specific geometric pattern. We conceptualise mathematical formulations, which can explain the arrangement of the micro-morphological adaptations in this organisms thus creating a space for comparative analysis among several other species in different ecological niche.

### **Stress Physiology (Wed 15.00 – 16.30)**

**Thermal effects on tissue telomere length in a colour polymorphic ectotherm, the role of thermal geographic variation.**

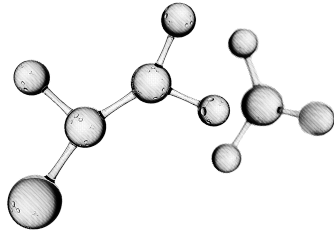
**Daniel Ritchie**

No abstract

**Effects of environmental challenges on physiological and life-history performance of a small marine copepod, *Calanus finmarchicus*.**

**Sidonie E Rousseau**, Elise Thiebaut, Justine Hienne, Wassim Dhifallah, Tamer H Abdelaziz, Dag Altin, Bjørn Henrik Hansen, Kang Nian Yap

To cope with environmental challenges due to global change, organisms must modulate their physiology to survive. Various environmental stressors like heat and pollution have been suggested to cause increased oxidative stress in animals. However, in many organisms with multiple life-stages, like the Calanoid copepods, how different life-stages respond to environmental stressors remains unclear. The planktonic marine copepod *Calanus finmarchicus* is a low trophic species, an important food source to several commercially important fish, and a keystone species in the ocean. Therefore, it is important to understand how they respond to stress. To investigate the physiological and life-history effects of critical life-stages of *C. finmarchicus* to heat stress and oxidative stress, we exposed fertilised eggs and adult males and females to graded doses of paraquat, an oxidative stress inducer,

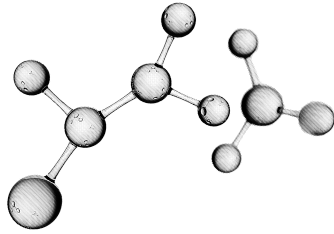


at different temperatures. We measured the eggs' hatching rate, defined the 96 hours LC50 of paraquat, and examined antioxidant mechanisms by measuring the transcription level of biomarkers genes involved in oxidative damage such as superoxide dismutase in both eggs and adults in response to both heat stress and paraquat treatments. Preliminary results showed no additive nor synergistic effects of heat and oxidative stress on the metabolic response of adult females. We hypothesised that early life stages and adult males are more sensitive to oxidative stress and temperature change than adult females. A better understanding of how copepods respond to environmental changes and the physiological mechanisms underpinning these responses will help us predict marine ecosystem dynamics in relation to global change.

### **Evaluating stress and mortality during trap and transport in the European eel**

**Josefin Sundin**, Rob Van Gemert, Birgitta Jacobson, Jacob Reiff, Albin Gräns, Andreas Ekström, Philip Jacobson

Many water systems suffer from reduced or completely disrupted connectivity due to human activities, causing negative effects for species and ecosystems. Artificial transport past migration barriers, so called trap-and-transport, can be used as a management tool to mitigate fish population declines. The efficiency of trap-and-transport is, however, rarely evaluated, in particular for downstream transport of catadromous species such as the European eel. In this study we analysed seven years of trap and transport data (2016-2022), encompassing more than 65 000 transported eels, to evaluate stress and mortality during all steps of the trap and transport process. We found that average mortality rate was generally low but could be as high as 10%. Mortality during all steps of the trap and transport procedure was affected by temperature, with higher temperatures leading to higher mortality. We also found that when mortality in the fishing gear had been high, mortality during holding was also high. Mortality during transport was additionally affected by transport time, with longer transport time causing higher mortality. In addition to mortality rates, we also evaluated stress during trap and transport by surgically implanting biologgers measuring heart rate, which was used as a proxy for stress. Similar to mortality, stress was affected by temperature, with higher temperatures causing higher stress levels, in particular during transport. We conclude that although trap-and-transport, fishways, and other alternatives aiming at reducing negative impacts, can reduce



mortality, such measures require maintenance and human interference, wherefore removal of migration barriers should be the long-term goal.

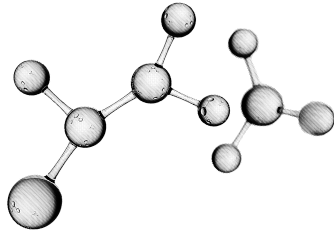
### **Linking individual cortisol responsiveness with chronic stress, cortisol regulation and growth of Atlantic salmon (*Salmo salar*)**

**April Grace R Opinion**, Marine Vanhomwegen, Gudrun De Boeck, Johan Aerts

Fish initiate stress responses with the activation of the hypothalamic-pituitary-interrenal (HPI) axis resulting in the secretion of cortisol, of which the magnitude is subject to extensive inter-individual variation. The link of this variation with the susceptibility of individuals to the maladaptive effects of chronic stress underlain by the long-term upregulation of cortisol is generally limited. This study revealed the association between cortisol responsiveness and chronic stress using scale cortisol as a biomarker in Atlantic salmon (*Salmo salar*). Individuals exposed daily to unpredictable chronic stress protocol for 8 weeks were categorized into low-, mid-, and high cortisol-responsive groups based on their plasma cortisol response to 2-hour confinement stress. Scale cortisol, growth, and expression of key HPI axis genes were compared among groups to differentiate fish performance and cortisol regulation of these individuals under prolonged stress. Although high cortisol-responsive individuals generally accumulated higher cortisol in scales, a temporal downregulation of cortisol levels was observed in both plasma and scale. The downregulated cortisol levels corresponded with the temporal upregulation of cortisol receptors (glucocorticoid and mineralocorticoid receptors), which were generally elevated in higher cortisol-responsive individuals. This suggests the differential role of these cortisol receptors under acute and chronic scenarios. Interestingly, higher cortisol-responsive individuals were bigger and grew faster, implying the adaptive influence of cortisol response on growth performance when exposed to unpredictable long-term stress. Overall, this study demonstrated the plasticity of cortisol responsiveness under chronic stress conditions, which was dynamically reflected in scale cortisol and influenced the growth performance of Atlantic salmon.

### **Zebrafish: A Reliable Model to Study Cognitive Neuroscience**

**Upama Das**, Chayan Munshi



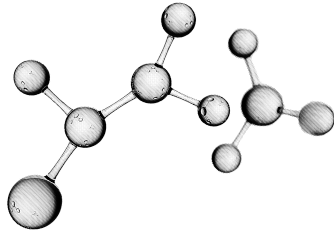
Zebrafishes (*Danio rerio*) locomotion is widely used as a reliable marker in ecotoxicological, pharmacological, neurotoxicological research. Alteration in the surrounding ecosystem or microenvironment of the organism can induce significant variation in the behavioural patterns which is highly regulated by the underlying neuronal mechanisms. The zebrafish exhibits high sensitivity in respect to any trivial environmental perturbation underwater. However, such quick change in the environment is effectively adapted but the notable change in the locomotory pattern fundamentally helps researchers to understand the alteration in the environment. In this study, we are establishing the said organism as a reliable model (based on the analysis of locomotion pattern and movement trajectory) to study cognitive neuroscience. We have conducted behavioural experiments to assess the sensitivity cognition in this fish. Additional to locomotory pattern, collective locomotory decision-making in zebrafishes is regarded to gain indebt knowledge on zebrafish movement neurobiology. Future perspectives of our study involves study of the influence of environmental pollutants impairing cognitive ability.

### **Insights into the in-vivo physiological energetics of juvenile Atlantic bluefin tuna**

**David J McKenzie**, John F. Steffensen, Patricia Reglero, Edurne Blanco, Vincent Kerzerho, Tristan Rouyer, Fernando De la Gandara, Aurelio Ortega

The Atlantic bluefin tuna *Thunnus thynnus* (ABFT) is an extremely valuable marine fish, a pelagic predator with physiological adaptations to a lifestyle of ceaseless swimming, notably partial endothermy and obligatory ram ventilation. Very little is known about ABFT energetics but, by comparison to 'normal' teleosts, they are expected to have elevated standard and routine metabolic rates (SMR and RMR) and aerobic metabolic scope (AS), and high aerobic swimming performance. We used swim tunnel respirometry to investigate this in age 0+ juveniles (mass ~550g, forklength ~30cm) held at 19 °C. The tuna did not enjoy the tunnel, they lost equilibrium and became agitated below 1.4 bodylengths per second (BL s<sup>-1</sup>), refused to swim faster than 2.2 BL s<sup>-1</sup>, and had their highest metabolic rates when agitated. Their SMR was about 1.5 times those of other Mediterranean fishes at similar sizes and temperatures, whereas their AS was two to threefold higher. Video analysis of the juveniles in their rearing tank revealed they were actually cruising spontaneously at speeds between 2.5 and 3.5 BL s<sup>-1</sup>. Extrapolation of respirometry data to 3 BL s<sup>-1</sup> indicated an RMR about fourfold higher than direct measures, by tank respirometry, in other Mediterranean species. These





preliminary observations would confirm longstanding predictions about the comparative energetics of ABFT but more work is clearly needed and some is ongoing.

## Climate & Environmental Change (Thu 11.00 – 12.30)

### Mechanisms of climate warming impacts on fish

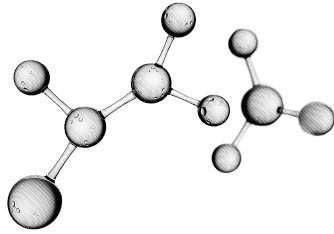
**Fredrik Jutfelt**, Anna H Andreassen, Robin H J Leeuwis, Timothy D Clark, Rasmus Ern

Warming has diverse effects on fish through a multitude of interacting mechanisms. How heat in the environment translates into higher-level biological effects has been studied for over a century, yet much of it remains obscure and subject to enthusiastic debate. Here we review the leading physiological ideas regarding the impacts from both acute and chronic warming. At a fundamental level, heat exerts its effects through three main molecular pathways by directly affecting reaction rates, protein structure, and membrane fluidity. By creating a conceptual model, we trace these molecular effects and their interactions through cellular-, tissue- and organ-level impacts. Because of the various interactions, it is difficult to disentangle the contributions of each pathway. In situations of rapid warming, fish can die from loss of physiological homeostasis and motor function, and the brain has been implicated as one of the most sensitive organs of failure. The role of oxygen availability in determining tolerance to acute and chronic warming has often been overstated, but can sometimes be a limiting factor, such as during aquatic hypoxia or a high level of simultaneous aerobic activities. We conclude that the mechanisms involved in climate warming impacts are dependent on many factors including intensity and duration of heat exposure, species and lifestyle, and ecological interactions.

### Physiological response to acute warming of reproducing male and female polar cod (*Boreogadus saida*) using MRI

**Nicole Vogt**, Jasmine M. Nahrgang, Daniela Storch, Christian Bock

Climate change is causing rapid warming of Arctic regions threatening the ecosystem and their species such as the polar cod (*Boreogadus saida*). Polar cod is considered the most abundant forage fish species linking lower and higher trophic levels in the Arctic food web. In particular, the thermal

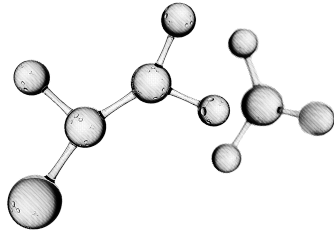


tolerance of sensitive life stages, such as reproducing adults, is important for an assessment of biodiversity changes in the context of global warming. Here, a non-invasive experimental approach using magnetic resonance imaging (MRI) is presented to investigate the physiological performance of reproducing male, female and non-reproducing polar cod during acute warming. Inside the MRI scanner, 0°C pre-acclimated polar cod were exposed to a temperature ramp from 0°C to 8.5°C at a rate of 1.5°C every two hours. A set of physiological performance parameters of the cardio-vascular system and energy status were continuously determined during the temperature ramp. In particular, flow-weighted MRI techniques were used to quantify blood flow in the head and in the abdomen, respectively, and the ventilation rate was assessed using CINE MRI. The energy status was determined by in vivo <sup>31</sup>P-NMR spectroscopy. A preliminary data analysis showed a similar blood flow at the control temperature of 0°C for all three animal groups, whereas blood flow increased remarkably in the head of reproducing males during warming, which was more pronounced in comparison to non-reproducing individuals. These initial results could indicate a higher energy requirement of the reproducing males, leading to a higher sensitivity to future warming conditions.

### **Interactive effects of density and elevated temperature on foraging efficiency of aquatic predator**

**Mateusz Augustyniak**, Jarosław Kobak, Bálint Preiszner, István Czeglédi, Tomasz Kakareko, Tibor Er's, Ross N. Cuthbert, Țukasz Jermacz

Predator-prey relationships are an important factor shaping ecological communities. Functional response (FR) describes the relationship between the food resource density and amount of food consumed by a single predator and is commonly used to study the role of predator-prey interactions in population dynamics. Elevated temperature related to global change is likely to modify consumer-resource interactions. Another important factor is predator density, as hunting individuals can be positively or negatively influenced by nearby conspecifics. Higher energy expenditure in elevated temperature requires greater foraging activity (enhancing foraging efficiency), which in turn may increase the competitive pressure between multiple predators and lead to predator interference (reducing foraging efficiency). This underlies the need to include predator density as a factor affecting foraging efficiency when studying effects of rising temperatures. Here, we performed a laboratory experiment using three densities of a fish predator (pumpkinseed, *Lepomis gibbosus*) (1, 2 and 4

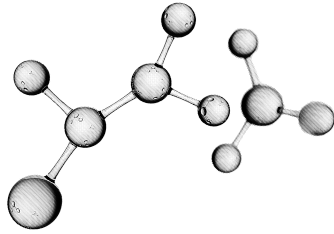


specimens), two temperatures (25 and 28 °C) and 6 prey densities. Using FR approach, we showed the effect of temperature on foraging efficiency of single and 2 predators, but not on foraging of a group of 4 predators. Moreover, increased conspecific presence strongly reduced predator efficiency at a lower temperature, whereas, at a higher temperature, conspecific effect was totally absent (2 individuals) or lower (4 individuals). Our study indicates that predator density is an important factor that should be considered in experiments on the effects of environmental change on foraging efficiency. This research was supported by National Science Centre, Poland (Grant No. 2020/39/D/NZ8/01226)

## **Keep on pumping: Cold tolerant *Drosophila* resist hypothermic depolarization of muscle membrane potential**

**Johannes Overgaard**

Chill sensitive insects risk neuromuscular dysfunction in cold environments due to a mismatch between active and passive membrane ion transport. This is particularly critical for muscle cell function where hypothermic loss of Na<sup>+</sup>/K<sup>+</sup>-ATPase activity may cause depolarization due to loss of ion balance and decreased electrogenic polarization. To investigate this further we examined 10 *Drosophila* species with varying cold tolerances to quantify if chill-tolerant species defend membrane polarization better at low temperature through enhanced Na<sup>+</sup>-K<sup>+</sup>-ATPase activity. Muscle membrane potential measurements were measured in all species at 21°C and 0°C, with and without ouabain (a Na<sup>+</sup>-K<sup>+</sup>-ATPase blocker). At benign temperature all species had similar muscle membrane potential of ~ -55 mV and in accordance with our hypothesis cold sensitive species exhibited a larger hypothermic depolarization. Measurements of membrane potential with ouabain revealed that the cold induced depolarization in chill sensitive species was predominantly caused by a loss of Na<sup>+</sup>/K<sup>+</sup>-mediated electrogenic polarization. Subsequent measurements of whole animal standard metabolic rate at high and low temperature showed that the improved preservation of membrane in cold tolerant species came at a low cost as the more cold tolerant species were characterized by a lower mass specific metabolic rate at low temperature despite the fact that these species maintained membrane polarization and the ability to move at low temperature.



## **Does cerebral blood vessel phenotype represent and adaptive response to repeated hypoxia in the southern elephant seal?**

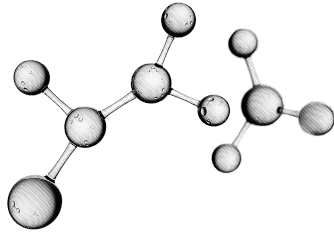
**Erwan Piot**, Christophe Dubois, Lea Hippauf, Ambre Rudo, Mathilde Malinconi, Laura Charlanne, Baptiste Picard, Christophe Guinet, Caroline Gilbert, Jerome Badaut

Repeated hypoxic events are reported in various brain pathologies. Mammal brain is highly vulnerable to hypoxia, because brain functions require high oxygen and energy demands. Marine mammals, such as pinnipeds, were naturally selected to cope with daily repeated hypoxic events during foraging dives, when human brain can only cope with minor repeated hypoxia. How do pinnipeds cope with repeated severe hypoxic events at the blood-brain interface? We performed a comparative physiological approach using for model the Southern Elephant Seal (SES), which is the most extreme diver of all seals and being exposed to severe peripheral hypoxia. Immunolabelling of various blood-brain interface markers (endothelium, astrocytes, neurons) were performed on brain cortical slices from freshly dead post-weaning pups (n=4) and reproductive adults (n=5) collected at Kerguelen Island. Immunolabelling were visualised using confocal microscope and images were analysed using ImageJ. Cerebral vascularisation exhibits significant differences between pups and adults: 1) in the grey matter, the vascular volume fraction was  $\approx 62\%$  higher in adults than in pups; 2) the vessels were significantly more ramified and tortuous in adults (e.g. 6% more tortuous in the white matter); 3) some large blood vessels exhibited abnormalities in adults suggesting blood-brain interface dysfunctions. Interestingly, adult SES vessels share similar phenotypes to pathological cerebral-blood vessels described in human neurodegenerative diseases. Then, abnormal vessel-morphologies raise the question of the potential pathological situation for adult SES. To study blood-flow velocity in brain-vessels and premature aging in SES, biomechanical fluid modelling, additional staining for neurodegenerative landmarks and blood-biomarkers are currently performed.

## **The interplay between fish sleep and ecophysiology, behaviour and responses to environmental change**

**Helena Norman**, Amelia A Munson, Daphne Cortese, Barbara Koeck, Shaun S Killen

Sleep is nearly ubiquitous across animal taxa; however, current knowledge on the behaviour, neurophysiology and ecophysiology associated with sleep is concentrated on mammals and birds. Fish are a hugely diverse group that can offer novel insights into a variety of sleep-related behaviours



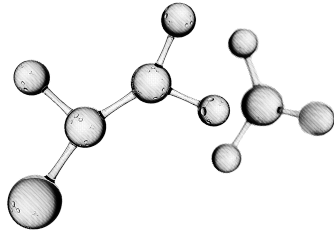
across environments, but the ecophysiological relevance of sleep in fish has been largely overlooked. Here, we systematically review the literature to assess the current breadth of knowledge on fish sleep, and survey the diverse physiological effects and behaviours associated with sleep. We also discuss possible ways in which unstudied external factors may alter sleep behaviours. For example, predation risk may alter sleep patterns, as has been shown in mammalian, avian and reptilian species. Other environmental factors, – such as water temperature and oxygen availability – have the potential to alter sleep patterns in fish differently than for terrestrial endotherms. Understanding the ecological influences on sleep in fish is vital, as sleep deprivation has the potential to affect waking behaviour and fitness due to cognitive and physiological impairments, possibly affecting ecological phenomena and sensitivity to environmental stressors in ways that have not been considered.

## Pollution (Fri 09.30 – 11.00)

### **Now you see me, now you don't: artificial light at night alters predation on colour-polymorphic camouflaged prey**

**Emma Moyse**, Louise B Firth, Tim Smyth, Svenja Tidau, Thomas W Davies

Artificial light at night (ALAN) is a globally pervasive sensory pollutant that disrupts biological processes across taxa and at all levels of organisation, but its impact on colour-guided processes remains largely unexplored. This is especially concerning given the rapid and ongoing transition away from narrow-spectrum lighting and towards broad-spectrum technologies like white LEDs, which are rich in the short wavelengths of light to which many taxa are especially sensitive. Camouflage is particularly likely to be disrupted by broader ALAN spectra due to changes in the conspicuousness of background matching prey altering prey recognition in visually guided predators. We simulated natural intensities of moonlight with and without ALAN, using both broad-spectrum ALAN and ALAN filtered to remove the characteristic short wavelength peak of white LEDs to test how exposure to these light treatments impacted predator-prey interactions between the intertidal crab *Carcinus maenas* and contrasting morphs of the colour-polymorphic snail *Littorina obtusata*. Exposure to broad-spectrum ALAN reduced overall predation by more than half and reversed the pattern of colour-based prey selection observed under control conditions. Exposure to filtered ALAN removed any significant difference in attack likelihood between colour morphs. Our results demonstrate that

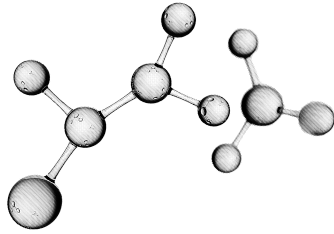


spectral composition is a crucial aspect of ALAN as a sensory pollutant, capable of instigating profound changes in predator-prey interactions that could drive changes in population demography and increase morphological homogeneity in species that depend on colour polymorphism for camouflage.

### **Understanding the North: The physiologic repercussions of chronic nickel exposure to the Arctic Char (*Salvelinus alpinus*)**

**Connor Stewart**, Anne Cremazy, Patrice Couture, Eva Enders, Emily Garman, Christian Schlekat, Ellie Middleton, Daniel Alessi, Tamzin Blewett

Global climate change is one of the most significant threats to biological diversity and survival. Coupled with increasing anthropogenic outflows and environmental devastation, temperate species must adapt or move north to maintain temperature homeostasis. Polar areas are the most critically impacted, with the Arctic warming several-fold faster than other areas. This alters ice coverage and permafrost depth, revealing deposits of critical minerals, including those used in battery technologies, such as zinc, cobalt, and nickel (Ni). In response to the growing demand for green energy technologies, significant extraction efforts have led to increased aquatic metal concentrations in the Arctic. Exploitation of these mineral resources allows for increased transport of these metals into Arctic waters, yet insufficient data exists regarding the impacts they may have on Arctic biota. This study aimed to address some of these knowledge gaps, with a particular interest in the impacts of Ni on Arctic char (*Salvelinus alpinus*). Arctic char are an important salmonid species in Arctic ecosystems, but the physiological responses of these fish to chronic Ni exposure remains unstudied. To address this, we exposed juvenile Arctic char to environmentally relevant Ni concentrations for sixty days to investigate the physiologic consequences of exposure and the mechanisms of toxic action. This work evaluated impacts on growth, survival, the respiratory system, and ionoregulation, finding significant impacts on both survival and growth, among other effects. These results provide insight into the physiological consequences of Ni exposure on Arctic char and the risk posed to these fish in their native environments.



## **The effects of polyethylene microplastic exposure on amphibian larval development and health physiology**

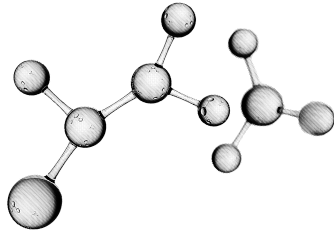
**Colette A Martin**, Katharina Ruthsatz, Ivan Gomez-Mestre, Pablo Burraco

Microplastics (MPs; defined as plastic debris smaller than 5mm) have emerged as one of the fastest-growing forms of pollution across habitats. Environmental pollutants are contributing to the global decline of natural populations, with MPs representing a particularly widespread and persistent threat. The extent to which MPs affect the growth and health of animals remains unclear across various taxa, notably among amphibians, which represent the most endangered group of vertebrates. Here, we used the African clawed frog (*Xenopus laevis*) to investigate the effects of polyethene MPs on the development and health of its filter-feeding larvae. *Xenopus* larvae were exposed to an environmentally relevant concentration of MP particles in the absence or presence of exogenous stress hormone corticosterone (CORT), the latter to induce a neuroendocrine stress response. To assess the physiological consequences of MP exposure, our study quantified markers of stress (CORT), or health and ageing (oxidative stress levels and telomere length) in larvae. MP exposure was found to reduce the larval body mass but it did not include changes in the skeletal growth (body length). CORT levels, oxidative stress, and telomere length remained unaltered in larvae exposed to MPs. Our results confirm that environmentally relevant concentrations of MPs reduce body mass but suggest that such effects might not have major consequences for the stress status, health, and ageing rates of filter-feeding amphibian larvae.

## **A systematic evidence map and bibliometric analysis of the behavioural impacts of pesticide exposure on zebrafish.**

**Kyle Morrison**

Pesticides in natural environments can cause many negative impacts on aquatic species, ranging from mortality to sub-lethal physiological and behavioural changes. The complex sub-lethal impacts of pesticides are routinely tested on model species, with zebrafish (*Danio rerio*) being regularly used as a behavioural model. Although behavioural ecotoxicology research using zebrafish is increasing rapidly, we lack quantitative evidence to support which pesticides have been tested and how study designs are carried out. To provide quantitative evidence of what pesticides are currently studied and what study designs are used, we combined a systematic evidence map approach and bibliometric analysis.



This novel method has been coined research weaving and allows us to elicit gaps and clusters in our evidence base, whilst showing connections between authors and institutions. The methodology can be summarised in five primary steps: literature searching, screening, extraction, data analysis and bibliometric analysis. We identified four areas where research on the sub-lethal effects of pesticide exposure on zebrafish is lacking. First, some widely used pesticides, such as neonicotinoids, are understudied. Second, most studies do not report important elements of the study design, namely the sex and the life-stage of the zebrafish. Third, some behaviours, such as impacts of pesticide exposure on zebrafish cognition, are underexplored. And last, we revealed through the bibliometric analysis that most of the research is conducted in developed countries and there is limited cross country co-authorships.

### **Consequences of chemical pollution on eel reproduction after a 6000+KM spawning migration**

**Marko Freese**

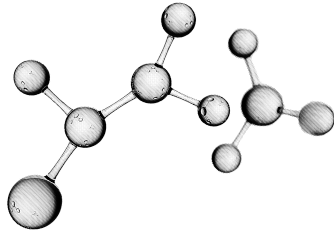
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### **Impact of electromagnetic fields from offshore windfarm submarine electric cables on the development, biology and behavior of *Scyliorhinus canicula***

**Julie Lucas**, Damien Einsargueix, Laure Lailheugue, Antony Fortin, Emilie Portefin, Marie-Caroline Husset, Alexandre Carpentier, Thomas Trancart

Among marine renewable energy (MRE) producers, offshore wind farms are currently booming and are seen as a key energy source for energy transition. Wind farm can induce noise, vibrations, interruptions to ecological continuity and generate electromagnetic fields at the level of submarine electric cables. They can affect behavior of electro- and magneto- sensitive species which use natural electromagnetic fields to move and feed. The increasing number of offshore windfarms is likely to amplify these effects, while existing information on their impact on ichthyological communities remains patchy. Studies have been limited to a few species of commercial interest and exposure to electromagnetic fields is relatively short-lived. Submarine electric cables can transmit alternating current (AC) or direct current (DC), depending on the function, power, length of the wind turbine





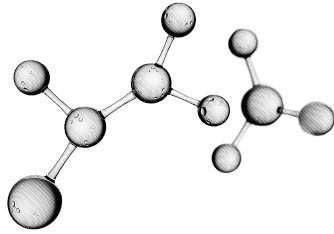
transmission line. Currently, wind farms located less than 50km from the coast use AC current whereas future more powerful wind farms will be located more than 50 km away and will use DC current. In this context, our study aims to identify and evaluate the effects of magnetic fields in AC and DC current on the survival, development, growth and behavior of elasmobranchs, an elero-sensitive species at conservation risk. The results will enable us to understand how elasmobranchs react to electromagnetic fields, depending on their intensity and the type of current, and thus the type of offshore wind farm (fixed or floating). They will provide managers and decision-makers information they need to meet the challenges of developing MREs without harming marine biodiversity.

## **Diseases, Parasites & Nutrition (Fri 11.30 – 13.00)**

### **Immune Boosting Against SARS CoV-2 Infection: An Approach to Traditional Medicine**

**Mihieka Bose**, Aishee Chakravorty, Chayan Munshi

In recent years, the COVID-19 virus pandemic has threatened public health globally. In several nations, the pandemic's aftermath is still affecting the human population. Numerous mutant strains of SARS CoV-2 spreading caused several waves of infection. These variants were linked to high infectivity or high mortality. But in the face of such assaults, human immune system developed a defence mechanism of its own against the infection to deal with cytokine storm, antibody neutralization escape and multiple organ failure. In order to boost the defence mechanism and SARS CoV-2 broadly being a respiratory disorder was targeted with multiple remedial strategies procured from traditional knowledge of medicinal plants. A survey was conducted to surmise the usage of such medicinal plants with therapeutic properties during the pandemic in a random population in West Bengal, India. Our data demonstrates the most often utilized raw traditional medicines. To deal with clinical manifestations associated with SARS CoV-2 (such as cough and cold) and boosting immunity, Tulsi (*Ocimum tenuiflorum*) was the most widely used plant which is easy to manage in kitchen gardens and have a high growth rate on the Indian subcontinent. This survey-based study is done to correlate with the efficacy of Tulsi in combating infectious diseases from common cough and cold to COVID-19. Regulated long-term use of these medicinal plants will also help avoid a number of prevalent illnesses and be advantageous for household healthcare.



## **Modelling SETBP1 Haploinsufficiency Disorder (SETBP1-HD) in Zebrafish (*Danio rerio*)**

**Katherine M Ullrich**, Jordan A Diaz, Maria J Aristizabal, William Andrew Thompson, Alexander G Little

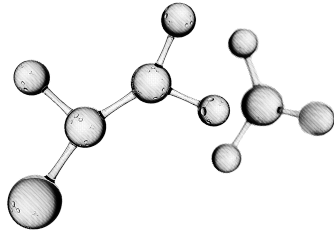
SETBP1 haploinsufficiency disorder (SETBP1-HD) is a rare human genetic disorder (currently only 131 known cases) that affects development —particularly neurodevelopment. Individuals carry a hemizygous deletion or loss of function in the SETBP1 region, which results in insufficient production of SET binding protein 1. Typically, SET binding protein 1 alters histone methylation to regulate the expression of target genes. When SETBP1 expression is low, key developmental genes are underexpressed, leading to developmental delay phenotypes. Symptoms include childhood hypotonia, motor development delay, intellectual and learning disabilities, anxiety, autism spectrum disorder, and attention-deficit/hyperactivity disorder. The aim of this study is to establish whether zebrafish represent a useful biomedical model for SETBP1-HD. Specifically, we deleted a single copy of SETBP1 via CRISPR transgenesis to investigate whether zebrafish SETBP1 hemizyosity induces the behavioral syndromes characteristic of human patients. Social and cognitive behaviours were assessed through larval behavioural assays; including thigmotaxis, startle response, and light dark response. A zebrafish model of SETBP1-HD will increase pathophysiological understanding of the disease and help to determine the molecular underpinnings of disease-linked variants, including Schinzel-Giedion syndrome and leukemia. Zebrafish represent a great model for high-throughput drug screening, which means that our transgenic SETBP1-HD lines may aid in the screening and development of potential SETBP1-HD therapies.

## **Saposin-like proteins in *Caenorhabditis elegans*: Unveiling substantial functions of a multidomain protein beyond antimicrobial activity.**

**Christine Blurton**, Matthias Leippe

The saposin-like protein (SAPLIP) family exhibits noteworthy diversity. Nonetheless, most members of this family share a structural feature: the characteristic SAPLIP fold. This fold is composed of four to five alpha helices interconnected by a conserved pattern of three disulfide bonds. Proteins containing a SAPLIP domain have been identified in organisms ranging from the most primitive levels of eukaryotes to mammals.

The nematode *Caenorhabditis elegans* possesses 28 saposin-like proteins (SPPs), which could



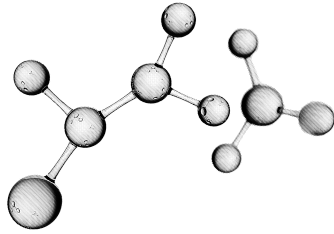
potentially give rise to 34 peptides with a SAPLIP domain. The characterization of selected *C. elegans* SPPs revealed antimicrobial activity. This activity is probably achieved through interaction of the cationic peptide with the negatively charged bacterial membrane, followed by membrane permeabilization. Functional analysis of SPP genes from *C. elegans* has been primarily limited to those with a single SAPLIP domain.

Therefore, conducting a functional analysis of SPP genes from *C. elegans* with more than one SAPLIP domain may unveil novel insights into the multifaceted family of SAPLIPs. The gene *spp-10* in *C. elegans* is predicted to encode for at least two SAPLIP domains. The absence of the second SAPLIP domain, *spp-10b*, resulted in mutants with diminished efficiency in the intestinal degradation of ingested *E. coli*. Unexpectedly, the reduced fitness of this mutant was not primarily attributed to proliferating bacteria but also to non-proliferating bacteria. Remarkably, we successfully restored the diminished fitness of *spp-10b* deficient mutants by supplementing coenzyme B12. This finding indicates substantial functions associated with each SAPLIP domain of *spp-10*.

### **Temperature preference in immune-stimulated and parasite-infected sunfish**

**Marie Levet**, Shaun S Killen, Ellycia Manata, Maryane Gradito, Sandra A Binning

Ectotherms can regulate their body temperature by moving between cooler and warmer environments. The choice of a thermal environment can be driven by different parameters, including an individual's health status. For instance, disease and parasite infection can cause some species of fish to increase their body temperature by spending more time in warmer waters, presumably to maximise their immune defences and, thus, the chance to fight off the infection, a phenomenon known as behavioural fever. Most studies on fish thermoregulation do not consider how the immune response to disease and/or parasite infection can shape a fish's thermal choice. Yet, the severity of the parasite infection (load), the presence of multiple parasite species (co-infection) and the timing of the infection (acute vs. chronic) can change temperature preference. Here, we measured the preferred temperature of wild-caught pumpkinseed sunfish using a shuttle-box system. Fish were separated into three groups: 1) chronically co-infected by parasite, 2) acutely exposed to parasite, and 3) immune-stimulated via injection of lipopolysaccharide (LPS) endotoxin. We observed that preferred temperature did not increase with parasite load and co-infection. Fish acutely exposed to LPS preferred warmer temperatures. This suggests that activation of the immune system leads fish to



display behavioural fever, translating to more time spent in warmer environments. This combination of groups with different infection status allowed us to tease apart the role of the immune system in thermal choice and deepen our understanding of animal movement. Ultimately, this helps our comprehension of how ectotherms fight disease in nature.

### **Can reduced growth in cod having high infection loads with the liver worm *Contracaecum osculatum* be alleviated by ample food?**

**Jane Behrens**

No abstract

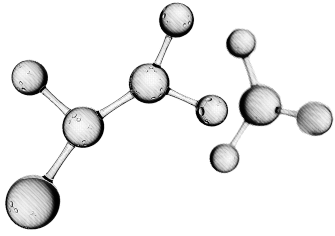
### **Sea urchin larval digestion – the role of laminarin for larval fitness**

**Smilla L. Tetzlaff**, Marius Ortjohann, Christine Blurton, Meike Stumpp

Laminarin, one of the main storage polysaccharides of brown algae and diatoms, was recently found to be an important molecule in the world's oceans by accounting for up to  $26 \pm 17\%$  of the particulate organic carbon. While digestive enzymes breaking down laminarin (laminarinases) have been intensely studied in a number of adult marine invertebrates, data on larval stages remain scarce. Abundantly inhabiting kelp forests as ecosystem engineers, especially sea urchins are found in laminarin-rich areas, suggesting that laminarin digestion plays a significant role throughout their life cycle. Considering the high laminarin abundance in microalgae, i.e. the food source of echinoderm larvae, digestive degradation might be beneficial, if not crucial, not only in adult sea urchins but also for larval performance within plankton.

To disentangle the ecological and physiological role of laminarin for sea urchin larvae we conducted perturbation experiments with different laminarin concentrations and food sources (laminarin-rich and -poor microalgae) to evaluate the impact onto larval nutrition and performance. We analyzed (I) growth, survival and settlement success, as well as (II) laminarinase activity and expression patterns during larval development of the painted sea urchin *Lytechinus pictus* in response to the feeding regimes.

The results contribute to a better understanding of laminarin dependent digestive dynamics in the



early life stages of echinoderms, potentially affecting the recruitment of these important ecosystem engineers.