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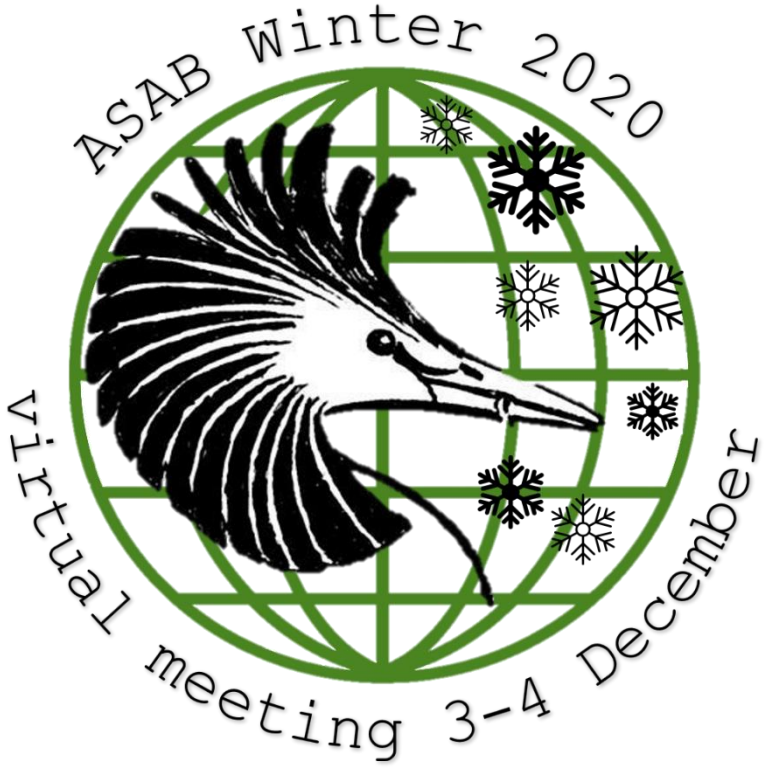

Talk and Poster Abstracts

ASAB WINTER VIRTUAL MEETING 2020

THE ROYAL SOCIETY PUBLISHING

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10:45-12:15 Talk Session 1: Cognition

10:45 Fanny-Linn H. Kraft (Deakin University, Australia)
Ondi L. Crino, David F. Clayton, Katherine L. Buchanan and Julia M. George

Developmental conditions have intergenerational effects on vocal learning and brain gene expression

Learning allows animals to adapt to local environmental conditions and forms a key aspect of developmental plasticity. However, very few have tested whether adverse events can have transgenerational impacts on cognitive traits. Vocal learning in songbirds is a condition-dependent trait that is affected by conditions during early development, and it is controlled by well-documented neural mechanisms. We tested whether developmental stress in one generation could have intergenerational impacts on vocal learning in the subsequent generation, by first exposing one generation of songbird nestlings to stress (corticosterone treatment), and then quantifying the ability of their offspring to copy and recognize tutor song. We assessed two behavioural measures of song copy accuracy. We also assayed immediate early gene expression in the auditory forebrain as an indicator of neural activity in response to tutor or novel song playback. We found that both song copying accuracy and brain gene expression during song playback were affected by whether their parents had experienced early developmental stress. Specifically, males reared by a corticosterone-treated mother and a control father sang song containing a higher percentage of non-parental sounds, compared to controls. In terms of brain gene expression, all treatment groups in the overall gene expression following song playback. To the best of our knowledge, these results are the first to demonstrate that there are impacts of parental developmental stress on offspring vocal learning and brain gene expression. Our findings suggest that adverse environmental conditions can have lasting effects on learning and its underlying neural processes. These results also have implications for the evolution of song as a criterion for mate choice and resource defence, which can have long-term consequences for population dynamics and speciation.

11:00 Joe Wynn (University of Oxford)
Oliver Padget, Henrik Mouritsen, Chris Perrins and Tim Guilford

Natal imprinting to the Earth's magnetic field in avian taxa

In migratory animals it is essential that there exists a mechanism by which an individual can both navigate to the wintering location and then back to the natal site. In birds, it has been suggested that navigation towards the wintering site is underpinned by an inherited vector (a direction and a distance in which to move), though the return migration back to the breeding site is less well understood. Here, using historic ringing data gathered over more than 50 years and secular variation in the Earth's magnetic field, we investigate whether birds of various taxa use magnetic cues when attempting to reach their breeding site. We find that small changes in the inclination ('dip angle') of the Earth's magnetic field between ringing and recovery correspond to probabilistic changes in the position at which birds are recovered, with the extent of these positional changes fulfilling a priori expectations. We suggest that birds may use the natal value for magnetic inclination, learnt prior to departure on first migration, as a cue targetable over long distances when returning to the natal site.

11:15 Johanna Eckert (Max Planck Institute for Evolutionary Anthropology)
Hannes Rakoczy, Shona Duguid, Esther Herrmann, Josep Call

The ape lottery: chimpanzees fail to consider spatial information when drawing statistical inferences

Humans and nonhuman great apes share a sense for intuitive statistics, making intuitive probability judgments based on proportional information. This ability is of tremendous importance, in particular for predicting the outcome of events using prior information and for inferring general regularities from limited numbers of observations. Already in infancy, humans functionally integrate intuitive statistics with other cognitive domains, rendering this type of reasoning a powerful tool to make rational decisions in a variety of contexts. Recent research suggests that chimpanzees are capable of one type of such cross-domain integration: The integration of statistical and social information. Here, we investigated whether apes can also integrate physical information into their statistical inferences. We tested 14 sanctuary-living chimpanzees in a new task setup consisting of two "gumball machine"-apparatuses that were filled with different combinations of preferred and non-preferred food items. In four test conditions, subjects decided which of two apparatuses they wanted to operate to receive a random sample, while we varied both the proportional composition of the food items as well as their spatial configuration above and below a barrier. To receive the more favorable sample, apes needed to integrate proportional and spatial information. Chimpanzees succeeded in conditions in which we provided them either with proportional information or spatial information, but they failed to correctly integrate both types of information when they were in conflict. Whether these limitations in chimpanzees' performance reflect true limits of cognitive competence or merely performance limitations due to accessory task demands is still an open question.

11:30 Anna Korzeniowska (University of Sussex)
Julia Simner, Holly Root-Gutteridge, David Reby

This sounds big! Domestic dogs are sensitive to audio-visual crossmodal correspondences between pitch and size

Crossmodal correspondences are non-arbitrary, intuitive associations between non-redundant features of a stimulus, such as acoustic pitch and visual illumination. These phenomena have been extensively studied in humans, and numerous crossmodal correspondences from all modalities have been discovered (e.g. dark colours are intuitively paired with low pitched sounds while bright colours are paired with high-pitched sounds). Currently, little is known about such associations in non-human animals, however there is emerging evidence that this phenomenon is not unique to humans. Here we explore whether domestic dogs associate high-pitched sounds with small objects, and low-pitched sounds with large objects - just as humans do. In a learning phase, we first trained dogs to approach an object after hearing a sound emanating from a speaker implanted within it. Subsequently, in a testing phase, we presented the dogs with two objects differing in size (small, large), one of which was playing a sound. The sound was either high- or low-pitched. We found that dogs were more likely to choose the correct object (i.e. the one that was emanating the sound) in congruent trials where pitch intuitively matched object-size (i.e. small=high pitch, large=low pitch), but not in the incongruent trials where the sound-pitch and object-size were mismatched. We also found that the objects the dogs looked at first after hearing the sound were subsequently more likely to be approached in congruent trials only, further suggesting that the congruency of the pitch-size pairing affected the dogs' choices. Our results suggest that the pitch-size crossmodal correspondence is not uniquely human and could be more universally shared by other mammalian species.

11:45 Paula Ibáñez de Aldecoa (University of Vienna)
Alice Auersperg, Sabine Tebbich

Tool use generalization in Goffin's cockatoos

Generalization (the transfer of a tool-use skill acquired in a certain situation to a new contextual setting) has been reported in birds such as New Caledonian crows and kea. We investigated whether this capacity is also present in another parrot species with high cognitive abilities, which uses tools in captivity: the Goffin's cockatoos. Performance of thirteen adult subjects divided into two groups (experimental or control) was compared in a two-stage experiment, where the learning component about the tool was manipulated by providing a more diverse training for the experimental group in stage one (trained to use tool in three different tasks instead vs one, in the control case) . We hypothesized that this broader learning of the tool's affordances would facilitate causal understanding of its physical properties, enabling to generalize its use to solve a novel task. Our results show that the experimental group outperformed the control group in stage two (higher success rate and lower latency to solve), which we interpret as a product of behavioural flexibility being enhanced during stage one: by operating the tool in more diverse contexts, tindividuals from the experimental group might have acquired an advantageous experience on its versatility, transferrable to tackle an untrained problem more efficiently.

12:00 Helen Lambert (Animal Welfare Consultancy)
Gemma Carder, Dr Neil D'Cruze

Searching for sentience in reptiles: A review of the current evidence for reptile sentience

Vertebrates are generally accepted as being sentient beings, capable of pain and suffering, and joy and pleasure. Most of us can see that our pet dogs or cats are emotional, feeling beings, but what about the cold-blooded reptiles who are popular pets around the world? Do we accept that they feel pain? Does their experience of suffering matter? Reptiles are often not given the same consideration when it comes to their welfare as their fluffier vertebrate counterparts. This has implications for their wellbeing in captivity, as many reptile owners may not credit their pets with the level of consciousness that they actually have. We searched the scientific literature to document evidence of, and investigations into reptile sentience. We used 168 keywords associated with sentience to search through four journal databases and one open-access journal. We documented reptile studies that explored sentience in reptiles and those that recognised sentience in their experiments. In our systematic review of the literature, we found that reptiles were assumed to be capable of anxiety, distress, excitement, fear, frustration, pain, stress, and suffering in 37 articles. We also found four articles exploring the capacity of reptiles to feel pleasure, emotion, and anxiety. These findings show that reptiles are considered to be able to experience a range of meaningful feelings and states. This has important implications for the millions of reptiles kept as pets around the world, often languishing in cramped, unstimulating and isolated tanks. These findings also have important implications for the commercial trade in reptiles, which can pose numerous challenges to reptile welfare.

10:45-12:15 Talk Session 2: Reproduction

10:45 Rachel Findlay-Robinson (University of Cumbria)
Volker Deecke, Andrew Weatherall, Davina L. Hill

Does weather affect the timing of reproduction in the hazel dormouse, *Muscardinus avellanarius*?

Hibernators face the challenge of fitting their annual lifecycle into a compressed active season whilst maintaining their fitness. Consequently, many hibernators mate immediately after emergence to maximize time available for offspring growth and weaning. However, dormice, the UK's only rodent hibernators and a species of conservation concern, do not generally follow this pattern across their UK range, and there is high variability in continental populations. In other hibernating species, delayed reproduction has been associated with reduced fitness, and consequent population declines. As dormouse activity levels are known to be affected by weather, we investigated the effects of weather conditions at different time throughout the year, as a proxy for climate, on the timing of reproduction in this species. We tested the effects of temperature and rainfall at weekly scaled on the timing of reproduction using the 25-year National Dormouse Monitoring Programme and Met Office HadUK Grid datasets across the dormouses' UK range. A sliding window climatic analysis was used to test climate windows for all periods for up to a year before reproduction occurred. Our results suggest that temperature and rainfall have complex effects on the timing of reproduction in dormice in both the long (up to 1 year) and short-term, and that the weather during the hibernation season may impact behaviour during the active season. As rapid environmental and climatic changes are predicted to occur in the coming decades, understanding the relationships between the weather, behaviour and dormouse demographic rates may be vital in producing future-proof conservation plans for this species.

11:00 Sara Raj Pant (University of Groningen)
Martijn Hammers, Jan Komdeur, Terry Burke, Hannah L. Dugdale, David S. Richardson

Age-dependent infidelity in Seychelles warblers

Extra-pair paternity (EPP) is often linked to male age in socially monogamous vertebrates; that is, older males are more likely to gain EPP and less likely to be cuckolded. However, whether this occurs because males improve at gaining paternity as they grow older, or because 'higher quality' males that live longer are preferred by females, has rarely been tested, despite being central to our understanding of the evolutionary drivers of female infidelity. Moreover, how extra-pair reproduction changes with age within females has received even less attention. Using 18 years of longitudinal data from an individually marked population of Seychelles warblers (*Acrocephalus sechellensis*), we found considerable within-individual changes in extra-pair reproduction in both sexes, i.e. an early-life increase and a late-life decline. Furthermore, males were cuckolded less as they aged. Our results indicate that in this species age-related patterns of extra-pair reproduction are determined by within-individual changes with age, rather than differences among individuals in longevity. These results challenge the hypothesis - based on longevity reflecting intrinsic quality - that the association between male age and EPP is due to females seeking high quality paternal genes for offspring. Importantly, EPP accounted for up to half of male reproductive success, emphasizing the male fitness benefits of this reproductive strategy. Finally, the occurrence of post-peak declines in extra-pair reproduction provides explicit evidence of senescence in infidelity in both males and females.

11:15 Jules Dezeure (Institution of Evolutionary Sciences of Montpellier)
Alice Baniel, Lugdiwine Burtchell, Alecia J. Carter, Guy Cowlishaw, Bernard Godelle, Elise Huchard

Evolutionary determinants of non-seasonal breeding in wild chacma baboons

Animal reproductive phenology varies from strongly seasonal to non-seasonal, sometimes among closely related or sympatric species. While the extent of reproductive seasonality is often attributed to environmental seasonality, this fails to explain many cases of non-seasonal breeding in seasonal environments. We investigated the evolutionary determinants of non-seasonal breeding in a wild primate, the chacma baboon (*Papio ursinus*), living in a seasonal tropical environment characterized by high climatic unpredictability. We tested three hypotheses, respectively proposing that non-seasonal breeding has evolved in response to (1) climatic unpredictability, (2) reproductive competition between females favouring birth asynchrony, and (3) individual, rank-dependent variations in optimal birth timing. We only found support for the reproductive asynchrony hypothesis: (i) birth synchrony is costly to subordinate females, lengthening their interbirth intervals, and (ii) females flexibly adjust their reproductive phenologies (fertility periods and conceptions) to other females in the group, in order to stagger conceptions. These results indicate that reproductive competition generates reproductive asynchrony and weakens the intensity of reproductive seasonality at the population level. This study emphasizes the importance of sociality in mediating the evolution and modalities of reproductive phenology in gregarious organisms, a result of broad significance to understand key demographic parameters driving population responses to increasing climatic fluctuations.

11:30 Venkatesh Nagarajan-Radha (The University of Sydney)
Paramanantha Swami Doss Devaraj

Surviving promiscuity: the evolution of male polygynous behaviours amid relaxed sexual selection in the fruit bat, *Cynopterus sphinx*

The fruit bat, *Cynopterus sphinx,* is thought to follow a polygynous mating strategy. Male bat constructs and defends foliage-roost that are occupied by females, forming harem-like social units within populations. Recent studies show that the number of females roosting in a harem is not indicative of male reproductive success, and the within-harem paternity is lower than the value expected for the polygyny threshold. These findings suggest promiscuous mating strategy in this species. If promiscuous, then the benefits of male polygynous behaviours remain poorly understood. We conducted several studies in a large population of *C. sphinx* located in South India for over six years. Our findings include: 1) Harem-males that exhibit resource (roost) defence maintains a larger harem size. 2) Harem-males with foliage-roost that have larger volumes benefit with larger harem size. 3) While most harem-males hold only one foliage-roost (main roost), some harem-males hold multiple foliage-roosts (alternate roosts). Nevertheless, holding multiple alternate roosts do not contribute to an increase in harem size. Moreover, 4) although there is sharing of alternate roosts among harem-males, there is no evidence for inclusive fitness in this species. Our results further confirm that male polygynous behaviours only affect harem size, but not male reproductive success. In conclusion, our results provide new evidence for social selection on male polygynous behaviours in this promiscuously-mating species.

11:45 Javier Abalos (University of Valencia)

Guillem Pérez i de Lanuza, Alicia Bartolomé, Océane Liehrmann, Hanna Laakkonen, Fabien Aubret, Tobias Uller, Pau Carazo, Enrique Font

Do colour morphs reflect alternative reproductive strategies in the European common wall lizard (*Podarcis muralis*)?

The adaptive value and persistence of local polymorphisms are often thought to be explained by the existence of alternative reproductive strategies wired up to the morphs. The European common wall lizard, Podarcis muralis (Lacertidae), which shows a striking orange-white-yellow ventral colour polymorphism, has attracted particular attention. Research on P. muralis has revealed several inter-morph differences in morphological, physiological and behavioural traits that might suggest the existence of these alternative strategies, but a coherent pattern remains elusive and no study has tackled the question experimentally. Here, we present preliminary results from an enclosureexperiment carried out in the spring of 2018, in which we performed behavioural observations in ten experimental populations of P. muralis balanced for their sex ratio (1:1) and morph frequencies (1:1:1). Each experimental enclosure consisted of a 7x7 m fenced area in which we installed six wood pallets carrying cinderblocks, stones, and bricks on top of them. By varying the number of cinderblocks and bricks, we created two types of sites that differed in their appeal to lizards. We found no significant differences between male colour morphs in male-male competition, spatial dominance or in the nature of their social interactions with females, as well as in mating and reproductive success. Instead, we found that dominance and pallet quality were the prime determinants of male reproductive success. Overall, our results argue against the traditional assumption that P. muralis colour morphs may function as a chromatic signals informing conspecifics about the signaller's reproductive strategy.

12:00 Ellie Chesterton (University of Leeds)

The effect of helping on offspring fitness in the cooperatively breeding Seychelles warbler (*Acrocephalus sechellensis*)

Cooperative breeding is when individuals forego their own reproduction to raise non-descendant offspring - something that, on the surface, appears to contradict natural selection. While kin selection theorises how cooperative breeding evolved, many of the fitness benefits that are believed to have driven the evolution of this complex social system are still yet to be quantified. For example, helped offspring may have higher fitness than non-helped offspring, however, there is little research exploring the impact of helping on offspring long-term fitness. Here, I use the long-term Seychelles warbler dataset to quantify the effect of helpers on offspring fitness at various life-history stages. Specifically, I will investigate how helping affects survival, age at first and last reproduction, annual reproductive success and associated reproductive senescence profile, lifetime reproductive success and grand-offspring production of offspring. Our study population on Cousin Island provides an excellent opportunity to answer questions about the evolution of cooperative breeding behaviour. There is virtually no emigration between islands. This closed system, paired with high resighting rates, allows death and dispersal to be separated and individuals tracked over their entire lives. In addition, the detailed, long-term pedigree spanning >11 generations provides a comprehensive account of individual variation in reproductive success. I predict that helping improves the survival and reproductive success of offspring. Quantification of the long-term fitness benefits of helping will improve understanding of the evolution of cooperative breeding.

Talk Session 3: Movement and Collective Behaviour

15:00 Laska Alicja (Adam Mickiewicz University)
Rector Brian, G., Kuczyński Lechosław, Skoracka Anna

How to begin? Analysis of behaviours preceding passive aerial dispersal in phytophagous mites

Dispersal is a fundamental biological process that influences population genetic structure and geographical species distributions. Moreover, the process involves many behavioural interactions that, if inefficient, could lead to starvation for individuals and serious fitness consequences for populations. Such costs can be particularly high for passively dispersing organisms, whose movement is determined by external forces. For example, an aerially dispersing organism can choose neither the direction of movement nor the distance. In this study, we investigated whether aerial dispersal depends on specific behaviours, morphology, or environmental factors (viz. wind speed and population density), using the phytophagous eriophyoid wheat curl mite (WCM), *Aceria tosichella*, as the study subject. For this purpose, we built a wind tunnel to generate wind speeds at intervals between 0.2 - 5.7 m/s, within which we observed mite behaviour and recorded dispersal events. Additionally, using video recordings, we measured basic morphological characteristics of resident and dispersing mites. We found that dispersal events were phenotype- and context-dependent with an important behavioural component. Chain formation among individuals significantly increased the likelihood of aerial dispersal from plant leaves and mites dispersing in chains were significantly more elongate compared to controls. The difference in shape significantly interacted with the wind speed but diminished at wind speeds above 4 m/s. Contrary to expectations, we found that an upright position did not increase likelihood of being blown away. The results indicate that WCM dispersal is influenced by interactions of collective behaviour, morphology and environment. Our study represents a step toward explaining WCM dispersal and colonization potential, with implications for other passively dispersing organisms in general.

15:15 Baptiste Garde (Swansea University)
Nik Cole, Adam Fell, Rory P Wilson, Emily LC Shepard

Peak breeding season coincides with low foraging costs and high foraging success in seabirds that breed year round

The idea that birds breed preferentially when food is most abundant was established by David Lack in 1968. Some tropical seabirds, however, breed all year-round, including outside the season of peak productivity. This raises the question of whether their breeding phenology is driven by seasonal changes in prey availability or the costs of accessing prey, which could be due to changing environmental factors such as wind. We equipped red-tailed tropicbirds (*Phaethon rubricauda*) on Round Island, Mauritius, with high-frequency GPS, accelerometer and barometric pressure loggers that enabled the quantification of rates of prey encounter (from aerial dives) and flight effort (from wingbeat frequency). Data were collected from 76 foraging trips across high (September-October) and low (February-March) season. Our results showed that prey encounter rates did not differ between seasons. However, in the high season there was a marked increase in flight effort with each prey encounter, suggesting that either fish mass or foraging success was greater than in low season. Foraging effort was higher in the low breeding season, despite birds experiencing lower wind speeds. The scale of the difference in effort was consistent with seasonal changes in air density; a factor that has not previously been considered as a key factor affecting the movement costs of birds that operate near sea level. Overall therefore, we show that birds breeding in the peak season appear to

benefit from greater foraging success as well as lower foraging costs, and we highlight that a range of environmental factors can influence foraging efficiency, and ultimately the benefits of breeding in a given season.

15:30 Tara Cox (University of Leeds)
Terry Burke, Hannah Edwards, David Richardson, Hannah Dugdale

Is natal dispersal dependent on animal personality in the Seychelles warbler?
Natal dispersal has important implications for evolutionary and ecological dynamics in wild populations. By facilitating range expansion, ecological invasions and gene flow, dispersal assists species in responding to unfavourable local conditions. Despite extensive efforts, the precise mechanisms dictating dispersal remain unclear. Recently, consistent between individual variation in behavioural traits (‘animal personalities') have been proposed as a driver through ‘personality-dependent-dispersal'. However, many studies on wild populations are limited to observing whether dispersal occurs, but are often unable to investigate dispersal distance or age at dispersal. In addition, study systems are typically open wild populations, where long-distance migration can be confounded with death. In this study, I will use long-term data from a closed island population of individually-marked Seychelles warblers to determine the importance of exploration–avoidance personalities on natal dispersal. To date, inbreeding avoidance, predation and spatial variation in territory quality have been ruled out as drivers of dispersal in the Seychelles warbler, but personality-dependent dispersal has not yet been tested. My data encompasses exploratory responses to a novel environment and novel object collected over nine years from 155 individuals, and has been shown to be repeatable and heritable. Specifically, I will investigate whether exploratory behaviour in the Seychelles warbler is associated with natal dispersal, dispersal age or dispersal distance. These results will help elucidate the drivers of natal dispersal in wild populations, as well as investigating the consequences of variation in exploratory behaviour on an individual's life history strategy, and ultimately their fitness.

15:45 Daniel Strombom (Lafayette College)
Audrey Dussutour

Self-organized traffic via priority rules in ants
Ants and other social insects often form well-organized and efficient trails between different locations. While the microscopic traffic rules responsible for this organization and efficiency remain elusive in many cases some progress has been made. In particular, we recently confirmed that a set of local priority rules isolated in previous experimental studies with leaf-cutting ants (*Atta colombica*) are sufficient to reproduce key characteristics of the traffic observed on the trails using a modeling approach. More specifically, we established that the priority rules induce de-synchronization into clusters of inbound and outbound ants on a narrow trail, and that priority-type dependent segregated traffic emerges on a wider trail. The generic nature of these priority rules also suggested that they may be responsible for the traffic organization in a variety of other ant species and situations. In this talk I will introduce the priority rules, show that they induce traffic on narrow and wide trails that is consistent with that observed in experiments, and showcase ongoing work on adapting these priority rules to model traffic organization in other ant species and situations.

16:00 Matthew Hasenjager (Royal Holloway)
William Hoppitt, Ellouise Leadbeater

There's more on the dance-floor: how honeybee information networks combine to drive collective foraging

Honeybees show remarkable collective foraging reliant on communication along multiple pathways. These pathways — including not only the much-celebrated waggle dance, but also food-sharing interactions and antennal contacts — are well-studied in themselves, yet each offers potentially redundant information and assessing their relative contribution to colony foraging has not yet been possible. As a result, the adaptiveness of dance communication remains poorly understood, and recent work has questioned its importance for colony foraging. Here, we use network-based diffusion analysis to quantify information flow through dynamic multiplex networks of forager interactions within unmanipulated hives. We show that successful recruits to novel locations overwhelmingly rely on dance information rather than information gained concurrently via olfactory pathways pointing them to the same resource. However, during reactivation to known sites (a far more common occurrence in daily foraging), information gained through both dance and olfactory interactions jointly contribute in driving bees to food. By disentangling the simultaneous impact of multiple information routes, we show how accounting for these alternative communication systems can shed light on the selective pressures that may have shaped the dance's evolution.

16:15 Stefanie White (University of the West Indies)
Amy Deacon

Where one species goes another follows: interspecies processions in Neotropical caterpillars

Mixed species groups are fascinating models in animal behaviour, as they can shed light on both the proximate and ultimate causes of sociality. In June 2017, we observed a novel example of inter-species processionary behaviour in the Neotropical caterpillars, *Hylesia metabus* and *H. nanus*. In their intra-specific contexts both species perform a suite of highly coordinated group behaviours, maintaining physical contact when feeding, resting and moving between sites. During our observations, both species integrated seamlessly, performing these behaviours as a single group. Our research sought to characterise the underlying behavioural mechanism behind this intricate inter-species behaviour. We hypothesised that group cohesion relied on a combination of local chemical and tactile signals from other individuals. To test for shared chemical cues, we performed a series of binary choice experiments. Both species chose arms laced with conspecific pheromone over controls, demonstrating the presence of chemical signals in this system. Further, both species chose heterospecific pheromone over controls, demonstrating mutually attractive chemical signals. Next, we performed experiments on conspecific and heterospecific processions, holding back sections of processions and replacing followers with tactile manipulation. We found a characteristic “start-stop” response in both species in response to tactile cues. Finally, we tested the relative importance of chemical and tactile signals, by providing contradictory chemical and tactile cues to individuals in procession. We found that *H. nanus* consistently responded to tactile cues, irrespective of the presence of chemical cues, while *H. metabus* showed a more variable response, often ignoring tactile cues in the presence of chemical trails. This demonstrated a subtle difference in the hierarchy of signals between the species. We conclude by relating these findings to the emergent group behaviours in both species.

Talk Session 4: Parental behaviour, decision making

15:00 Stephanie McLean (University of Hull)
Lesley J. Morrell

Laterality and parental care in three-spine sticklebacks

Laterality, the partitioning of information processing into specific brain hemispheres, is widespread across animal taxa. Despite identified advantages of lateralisation, including an enhanced neural capacity and ability to multi-task, substantial unexplained variation persists in this trait particularly between the sexes. The underlying causes of such variation are poorly understood, with few studies considering the influence of fitness related behaviours that vary between the sexes including parental care, which is associated with a high cognitive demand and ability to simultaneously perform offspring care and functions necessary for survival. Here, we investigated the effect of reproduction on variation in laterality, specifically testing the hypotheses that in a species with uniparental care i) the caring sex should be more strongly lateralised than the non-caring sex, and ii) that laterality is linked to the requirement to perform parental care behaviour. Within a single reproductive event, we measured behavioural laterality following the completion of reproductive behaviours in both sexes by assessing the turning biases of individuals detouring around a barrier. We demonstrate a relationship between behavioural laterality and parental care: the caring sex (males) was more strongly lateralised than the non-caring sex (females) during reproduction and males that had cared for offspring were more strongly lateralised than their non-caring counterparts. Thus, fitness related behaviours that vary between the sexes represent a key, yet overlooked, source of variation in laterality that could affect performance in other ecologically relevant behaviours especially those tightly associated with fitness.

15:15 Tom Ratz (University of Edinburgh)
Katerina Kremi, Lyndon Leissle, Jon Richardson, Per Smiseth

Availability of resources shifts the balance between cooperation and conflict between caring parents

In species where both sexes provide care, each parent has to coordinate its behaviour with its partner in order to best respond to offspring needs. Given that the costs of care are shared between the two parents, whereas parents receive equal indirect benefits of care, each individual parent is expected to reduce its own care at the expense of the other parent. In addition, parents should also adjust their care to environmental changes that affect the costs and benefits of care. One key environmental variable is resource availability as it influences both the investment in the current brood and in future reproduction and survival. We investigated the impact of resource availability on biparental care using the burying beetle *Nicrophorus vespilloides* as a study species. Burying beetles breed on the carcass of a small vertebrate, which is also the sole food source for parents and offspring during breeding and can easily be manipulated. We provided breeding pairs with mouse carcasses from a broad range of sizes and subsequently monitored parental care, parental food consumption, weight change over breeding, and larval traits related to offspring performance. As predicted, we found that male parents breeding on a larger carcass increased the duration of care more than female parents, while parents did not change their food provisioning and own food consumption with carcass size. Furthermore, both parents gained more weight and produced more and heavier offspring on larger carcasses. Our findings provide additional support for sex-specific parental responses and suggest that the resource availability reduces sexual

conflict over care, which might have important implications in other processes such as intrasexual competition.

15:30 Rebecca Goldberg (University of Oxford)
Philip Downing, Ashleigh Griffin, Jonathan Green

The costs and benefits of paternal care in fish
Male-only parental care is a rare strategy in most animal groups but is highly prevalent among teleost fish. Lower investment in parental care by males than females in other animals is usually explained by sexual selection acting more strongly on males to increase re-mating rates, yet in many fish species with male-only care, males are also under stronger sexual selection (as judged by high sexual dimorphism and dichromatism). The high prevalence of male-only care in fish may reflect unique features of fish biology that act to reduce the costs of care to fathers while generating substantial benefits in terms of improved reproductive success. Here, we present the results of a phylogenetic meta-analysis quantifying the costs and benefits of paternal care across 48 teleost species. We find that, on average, care of offspring imposes little cost on males in terms of loss of body condition. Surprisingly, however, we also find little evidence for a benefit of care in terms of offspring survival. Instead, our results show that investment in paternal care increases male reproductive success through attraction of additional mating partners. Thus, across fish species, there is evidence that male-only care has evolved in part through sexual selection arising from female preference for caring males and that in fish, unlike in many other animal groups, male investment in care does not necessarily trade-off against mating success.

15:45 Elisa Fernández Fueyo (University College London)
Alecia Carter

Primates' reactions to death: why do mothers carry the corpses of their dead infants?
The carrying of dead infants by non-human primate mothers (CDIM) is the most reported response to the death of a conspecific. Despite its prevalence, quantitative analyses of this behaviour is scarce and inconclusive. Drawing on published records, we compiled the largest database of cases of primate mothers' responses to their infants' deaths to test hypotheses proposed to explain between- and within-species variation in the duration of the CDIM behaviour. We used Bayesian phylogenetic regressions to analyse 416 cases across 50 different primate species. Three factors were found to possibly affect CDIM duration: infant age, habitat conditions and the infant's cause of death. These results may provide support for two hypotheses suggested to explain CDIM: the mother-infant bond strength hypothesis and the infant-dependency hypothesis, both of which suggest that CDIM is a by-product of a strong mother-infant bond. The results are discussed in the context of the evolution of emotion and the awareness of death.

16:00 Nicholas Moran (Technical University of Denmark)
Alfredo Sánchez-Tójar, Holger Schielzeth, Klaus Reinhold, Andre Visser, Jane Behrens

Why risk it? Linking diet, nutrition and risk-taking behaviour through meta-analysis and experimental study
The food an animal eats is one of the most intimate and influential interactions that they will have with their environment. Here I explore: (1) how an animal's diet can influence of their behavioural phenotype, specifically in relation risky situations such as predator and novelty

responses; and, (2) how individual differences in risk-taking traits (e.g. boldness traits) correlate with diet variation in the wild. Theory makes contrasting predictions that animals in better physical condition (i.e. nutritional- or energetic-state) should either take greater risks (state-dependent safety) or fewer risks (asset protection principle). A preregistered meta-analysis systematically quantified the effects of diet variation (e.g. high versus low quality or quantity diet treatments), on a wide range of risk-taking behaviours. Phylogenetic multilevel meta-analyses of mean effects (126 studies, 1297 effect sizes) revealed that animals with poor diets overall showed on average a 26% greater tendency towards risky behaviours, but this was influenced by an animal's life stage and the experimental context. Meta-analysis of variance (120 studies, 1241 effect sizes) instead did not show an overall effect of diet on behavioural variation, but also showed life stage- and context-specific effects of diet on phenotypic variance. Following this, an experimental study is exploring state-behaviour covariation in the invasive round goby (*Neogobius melanostomus*) in the Baltic Sea. This combines behavioural analysis with food-web analysis via stables isotopes, to directly quantify the impacts of intraspecific behavioural differences on diet interaction in the wild. Together, this work highlights the interactive effects of diet and nutrition on individual's behavioural choices, as well as the benefits of combining theoretical and empirical approaches in behavioural ecology.

16:15 Aileen MacLellan (University of Guelph)
Agustina Resasco, Miguel Ángel Ayala, Lindsey Kitchenham, A. Michelle Edwards, Sylvia Lam, Stephanie Dejardin, Georgia Mason

Validation of a novel mouse judgement bias task and its application in biomedical research
In humans, emotional states can bias responses to ambiguous information. Such ‘judgement biases' (JB) have great potential for assessing animal welfare. In animals, relative optimism or pessimism can be detected by training individuals to perform operant responses to one cue to receive a reward, and another cue to avoid punishment, before assessing responses to intermediate, ambiguous cues. If a task has construct validity, then similar to humans, animals in positive affective states will respond ‘optimistically' when presented with ambiguous stimuli (as if expecting reward), while animals in negative affective states will instead behave ‘pessimistically' (as if expecting punishment or no reward). New animal JB tasks always require construct validation. However, for laboratory mice (*Mus musculus*), the most widely used vertebrate in research, successful validation of a JB task has proved elusive. We first validated a novel mouse JB test, a Go/Go task in which subjects were trained to discriminate between odour cues and dig for high- or low-value food rewards. In female C57BL/6 and Balb/c mice, responses to ambiguous odour cues were sensitive to housing-induced changes in affective state: environmentally enriched animals demonstrated relative optimism, through shorter latencies as if expecting high-value rewards ($p=0.014$, Cohen's $d=1.148$). Having achieved construct validation, we then tested for ‘pessimism' in mice bearing subcutaneous lung adenocarcinomas (using a shortened protocol). Tumour-bearing males (albeit not females) treated ambiguous cues more pessimistically than did healthy controls ($p=0.005$, Cohen's $d=1.425$). To our knowledge, this is the first validation of a JB task for mice, and the first potential evidence of pessimism in tumour-bearing animals. Refinements to improve its sensitivity are still needed, but this new JB task has great potential for assessing mouse welfare and addressing fundamental questions about how state affects decision-making.

Talk Session 5: Collective behaviour and social networks

10:15 Charlotte Christensen (Swansea University)
Anna Bracken, Justin O'Riain, Michael Heistermann, Andrew King, Ines Fürtbauer

Quantifying grooming budgets in wild chacma baboons (*Papio ursinus*) using tri-axial accelerometers

Non-human primates spend a considerable part of their day grooming. These sociopositive interactions have been linked to both social benefits (increased tolerance, coalition support) and physiological benefits, e.g. lower physiological stress levels through modulation of hypothalamus-pituitary-adrenal (HPA)-axis activity. Accurately quantifying the total time invested in grooming simultaneously for multiple individuals in a group, throughout day- and night-time is an impossible task for a human observer. Hence, studies have relied on rates of grooming from focal observations to approximate grooming budgets. Here, we present grooming data from n=13 chacma baboons (*Papio ursinus*) on the Cape Peninsula, South Africa obtained from tri-axial accelerometers, recording continuously 24 hours/day (40 Hz). Using machine learning (random forest models), we identify the receiving and giving of grooming with high accuracy (>79%) and recall (>78%). Whilst self-grooming has been identified from acceleration data in other species, this is the first time social grooming (allogrooming) has been successfully identified and quantified. Using absolute grooming budgets, we investigate temporal patterns of grooming related to different ecological (day length and weather), physiological (reproductive state) and social (dominance rank) factors. Quantification of individual grooming budgets in combination with non-invasive hormone sampling will allow testing of hypotheses on the proximate mechanisms underpinning the link between sociality and HPA-axis activity.

10:30 Kareemah Chopra (University of Essex)
Holly R. Hodges, Zoe E. Barker , Jorge A. Vazquez Diosdado, Jonathan R. Amory, Thomas C. Cameron, Darren P. Croft, Nick J. Bell, Edward A. Codling

Proximity interactions in a permanently housed dairy herd: network structure, consistency, and individual differences

Understanding the herd structure of housed dairy cows has the potential to reveal preferential interactions, detect changes in behaviour indicative of illness, and optimise farm management regimes. This study investigates the structure and consistency of the proximity interaction network of a permanently housed commercial dairy herd throughout October 2014, using data collected from a wireless local positioning system. Herd-level networks were determined from sustained proximity interactions (pairs of cows continuously within three metres for 80 seconds or longer), and assessed for social differentiation, temporal stability, and the influence of individual-level characteristics such as lameness, parity, and days in milk. We determine the level of inter-individual variation in proximity interactions across the full barn housing, and for specific functional zones within it (feeding, non-feeding). The observed networks were highly connected and temporally varied, with significant preferential assortment, and inter-individual variation in daily interactions in the non-feeding zone. We find no clear social assortment by lameness, parity, or days in milk. Our study demonstrates the potential benefits of automated tracking technology to monitor the proximity interactions of individual animals within large, commercially relevant groups of livestock.

10:45 Camille Bordes (Bar-Ilan University)
Rosanne Beukeboom, Yael Goll, Eli Geffen, Lee Koren, Amiyaal Ilany

Day vs. Night: How rock hyraxes go through the day.

Multiple factors drive the structure and dynamics of animal social networks. But because most studies are based on daytime observations of identifiable individuals, resulting social networks are limited spatially and temporally, and neglect the nocturnal activity of social species. As a consequence, our understanding of social networks in wild populations is almost exclusively based on interactions taking place during the day. Here, I investigate night-time sociality of a wild population of rock hyraxes and how it affects daytime interactions. I use proximity loggers to continuously record social interactions and compare proximity-based social networks between day and night. I also explore how individual and group traits affect individual changes in centrality measures. I show that night-time and daytime networks do not consistently predict each other. Group size, degree centrality and network density vary less than expected by chance, suggesting that hyraxes retain similar levels of sociality and maintain their social environment constant over day-night transitions. Continuously varying social environments bring animals to always reassess social outcomes, which is potentially detrimental for their fitness. Social differentiation varies greatly but inconsistently over time, meaning that hyraxes change the way they allocate social contacts between social neighbours over day-night transitions. Results revealed that group composition affects how individual centrality vary daily, whereas individual traits have little effect. It implies that the composition of the social environment is the main determinant of individual changes in sociality on a daily scale, raising the question of influential group members. Tracking social interactions over natural gradients can unravel social processes at stake in animal societies. It therefore helps fill a substantial gap in our understanding of nocturnal networks of social species and the daily dynamics of mammalian societies.

11:00 Dominic Cram (University of Cambridge)
Jessica van der Wal, David Lloyd-Jones, Claire Spottiswoode

Produce or scrounge? Correlates and consequences of cooperating with humans for the greater honeyguide

In both ecosystems and economies, individuals can produce something of value or scrounge from the value produced by others, but the factors that determine which approach an individual adopts are rarely investigated empirically. In a unique mutualism, greater honeyguides (Indicator indicator) lead human honey-hunters to bees' nests, where the human harvests the honey and rewards the guiding bird with beeswax. Scrounging honeyguides also eat this wax without guiding, but the basis for individual differences in guiding, and the rewards of each strategy, are unknown. Here, we present empirical evidence of the correlates and consequences of producing and scrounging in wild greater honeyguides. We show that individuals in the best condition are more likely to guide humans, but that this strategy is flexible and birds that guide have often scrounged on other occasions. We then show that guiding results in greater pay-offs than scrounging: the guiding bird was typically first to arrive at the reward, and was more likely to feed on the wax before a large nocturnal mammal entirely depleted it. Our findings suggest that higher pay-offs of guiding make this system robust to cheating scroungers, but that declining honeyguide condition could depress guiding behaviour and jeopardise this ancient mutualism, impacting future generations of honeyguides and honey-hunters. More broadly, our results suggest that the total value created in complex systems is influenced by the number of good-condition individuals that opt to produce, and the pay-offs they receive for doing so.

11:15 Camille Troisi (University College Cork)
Josh Firth; Michael Reichert; John Quinn

Experimental evidence for transient and persistent effects of resource distribution and social familiarity on social stability in the wild

Social structure impacts a wide variety of behavioural and ecological processes. However, the causal factors that affect individuals' social stability and variation in social structure within natural populations are poorly known. By applying automated experimental treatments to RFID-tracked wild great tits (*Parus major*) in a large-scale experiment, we examined how social structure varies with experimental manipulations of: i) spatial patterns of resource availability (i.e. dispersed or clustered); and ii) social group stability (i.e. forced stable groups or forced unstable groups). We found that between individual differences in social phenotypes (their flock size and social network centrality) were consistent, and maintained across the experiment despite the manipulations, as were dyadic association preferences between individuals. Furthermore, average flock size and individuals' social centrality scores were higher when the food was clustered, and this effect persisted even when the resource returned to the dispersed state. We also show that manipulating social group stability has varied effects, whereby birds assigned to the stable social group treatment showed a decrease in average flock size and in their own social connections (‘weighted degree'), while birds assigned to the unstable group treatment showed an increase in overall social centrality (‘eigenvector centrality'). As such, we provide direct experimental evidence for the effects of environmental factors on sociality, while simultaneously demonstrating that individual social behaviour can remain relatively resilient in wild social systems exposed to external changes.

11:30 Alex Morris (University of Edinburgh)
Dr Lesley Smith, Dr Giles Innocent, Dr Emma Cunningham and Prof Mike Hutchings

Social modulation of behavioural responses to parasitism

Parasitism can have a major impact on animal health and altered behavioural responses may be one way to mitigate the effects of infection. These sickness behaviours were previously assumed simply as a result of debilitation, but it is now thought may be an adaptive response to reallocate energy to fight infection. However, an individual's behavioural response may be altered by their external environment, including their social environment. Here we test firstly, whether parasitism reduces the activity behaviour of infected lambs, and secondly whether the infection status of other individuals in their social group affects the degree to which these behaviours are expressed. Parasite naïve lambs were separated into social groups within three treatments (n=4 groups of 5 individuals per treatment), Parasitised; all lambs in a group were dosed with parasitic nematode *Teladorsagia circumcincta*, Non-parasitised; all lambs within a group were dosed with water, and Partially-parasitised; part of the group were experimentally dosed and part of the group were dosed with water. Lambs were fitted with an activity monitor that continuously recorded their step count, motion index and transition rate. Groups were put onto pasture in individual group plots and monitored for 1 week pre-infection, 6 weeks during infection and 2 weeks post infection after all lambs were treated with anthelminthic. Overall, we found infected lambs reduced activity levels following infection but increased it again following anthelmintic treatment. Parasitised groups had lower activity levels when infected than control groups but infected animals in partial groups did not display the same drop in activity. These findings show how parasitism can change the behaviour of infected animals and how the infection profile of an individual's social group can shape an individual's behavioural response to parasitism.

Talk Session 6: Sexual selection and conflict, Genetics and Genomics

10:15 Náyade Álvarez-Quintero (University of Vigo)
Alberto Velando, Sin-Yeon Kim

Cognitive performance and mate preference in the three-spined stickleback
Cognitive abilities may be crucial to respond appropriately to social and environmental information, and hence on individual fitness. However, the role of cognitive traits on sexual selection has received attention only recently. In this study, we test (1) whether females choose more cognitively skilled mates, and (2) whether female's cognitive skills affect their mate preferences in the three-spined sticklebacks (*Gasterosteus aculetaus*). For this, we first evaluated the problem solving ability of sexually mature individuals in a detour-reaching task. Then, female preference was repeatedly assessed in a dichotomous-choice test where the female was exposed to two males with contrasting scores (relatively high and low) in the detour-reaching task. Overall, we found that more skilled males were preferred, but this preference was affected by female cognitive ability. Thus, females with relatively low ability to solve the task preferred males with higher ability (i.e. better problem-solvers) than females with high ability that showed no preference. In addition, we explored how cognitive ability of males correlated with their performances used by females to choose mates. We found that males with high cognitive skills built a more elaborated nest, but expressed a significantly smaller area of red nuptial colouration. To our knowledge, this is among the first results that illustrate how cognitive traits of the both sexes influence female mate preference, which has implications for the strength and direction of sexual selection.

10:30 Natalie Pilakouta (University of Aberdeen)
Anais Baillet

Effects of temperature on mating behaviour and mating success: a meta-analysis
In light of global climate change, there is a pressing need to understand how populations will respond and adapt to rising temperatures. Because animal behaviour is particularly labile, there is a growing body of literature investigating the effects of temperature on a wide range of behavioural traits. Understanding how temperature changes might affect mating behaviour is particularly important, given its link to population viability and performance. A number of studies have already shown that strong sexual selection can increase population fitness and reduce the risk of extinction. Sexual selection could therefore play a major role in the capacity of populations to cope with climate change. Here, we performed a meta-analysis of 53 studies to examine how temperature changes influence mating latency, choosiness, and mating success. If higher temperatures make mate searching and mate assessment more costly, this might lead to a reduction in mating latency and cause females to be less choosy, thereby indirectly increasing overall mating success. Alternatively, if it becomes more beneficial to mate with a high-quality mate under warmer (and potentially harsher) conditions, we might expect an increase in mating latency and choosiness, along with a decrease in mating success at the population level. Overall, our results show the absence of a consistent directional effect of temperature on mating latency, choosiness, and mating success. This suggests it may be difficult to predict changes in the strength of sexual selection in natural populations in a warming world.

10:45 Judith Janisch (University of Veterinary Medicine Vienna)
Cliodhna Quiqley, Elisa Perinot, Leonida Fusani

A new method to analyse a complex courtship display in 3D

Courtship displays are complex behaviours that evolved through sexual selection. The courtship dance of golden-collared manakins (*Manacus vitellinus*) is one of the most elaborate displays in the animal kingdom. Males form leks where they compete to attract females by performing displays in their courtship arenas located on the forest ground. Researchers have started only recently to study and understand their behaviour in more details thanks to advances in video recording technology. A further challenge was the application of 3D motion capture systems to analyse animal movements to understand behaviour or biomechanics. These systems work very well under laboratory conditions but are still challenging for field research. As the display of manakins can only be observed in the wild, our group participated in the development of a 3D-high speed recording system for use in the field and an image processing system that includes an automated tracking software. With this method we acquired 3D coordinates of our birds' movements during their dances. First we performed an evaluation of the automated image processing system followed by a post-processing procedure of the raw data. The subsequent analysis of the 3D coordinates revealed a better understanding of males' performance in relation to the spatial arrangement of their arenas and that individual males perform on a very consistent level without much variation across different displays. Next steps will include the comparison of the performance between individuals related to their courtship success to understand which traits are selected by female choice.

11:00 Gonçalo S. Faria (Institute for Advanced Study in Toulouse)
Andy Gardner, Pau Carazo

Kin discrimination and demography modulate patterns of sexual conflict

Recent years have seen an explosion of interest in the overlap between kin selection and sexual selection, particularly concerning how kin selection can put the brakes on harmful sexual conflict. However, there remains a significant disconnect between theory and empirical research. Whilst empirical work has focused on kin-discriminating behaviour, theoretical models have assumed indiscriminating behaviour. Additionally, theoretical work makes particular demographic assumptions that constrain the relationship between genetic relatedness and the scale of competition, and it is not clear that these assumptions reflect the natural setting in which sexual conflict has been empirically studied. Here, we plug this gap between current theoretical and empirical understanding by developing a mathematical model of sexual conflict that incorporates kin discrimination and different patterns of dispersal. We find that kin discrimination and group dispersal inhibit harmful male behaviours at an individual level, but kin discrimination intensifies sexual conflict at the population level.

11:15 Stotra Chakrabarti (University of Minnesota)
V. Kolipakam, JK Bump, YV Jhala

Selfish Partners or Comrades in Arms? Effects of kinship and demography in shaping male alliances in lions

Male coalitions in Asian lions are linearly hierarchical, wherein resources are appropriated disproportionately by the partners. Current understanding of coalitionary dynamics is contingent upon fitness indices of individual lions based on behavioural observations alone, and demonstrates how low ranking males in large coalitions fare similarly in fitness to that of single males. To investigate how kinship affect coalitionary dynamics, using a panel of microsatellites and long-term pedigree information, we computed relatedness between

coalition partners (n=23 males in 10 coalitions) of free-ranging lions in India. Large coalitions (>2 males) had higher likelihood of having sibling partners, while pairs were typically unrelated. By incorporating relatedness between coalition partners to fitness computations, we show that low ranking males in large coalitions had ultimate fitness higher than single males. This shows the indirect fitness benefits of related males in such coalitions. Dominant males were found to %u2018lose less' if they lost mating opportunities to related partners versus unrelated males. From observations on territorial conflicts, we conclude that proximate cooperation between male lions is likely driven by mutualism, while kin-selected benefits are essential for the maintenance of large coalitions. Although large coalitions had the highest fitness as a group, demographic constraints limit their prevalence by restricting the availability of related partners. Such constraints on evolutionary optimality have resulted in two-male coalitions being the most attainable compromise for Asian lions. By incorporating novel genetic analyses coupled with long-term behavioural and demographic data, we show that the optimal group size in male lions is not the most prevalent in nature.

11:30 Sara D. Cardoso (University of Saint Joseph)
Andreia Ramos, Bruno Louro, Adelino V. M. Canário, David Gonçalves

Divergent neurogenomic response to aggression in male and female Siamese fighting fish
In many species, both males and females engage in agonistic encounters. However, the proximate mechanisms (i.e. genetic, hormonal and neuronal) mediating sex differences in the display of aggression are not yet well understood. To address this problem, we took advantage of a long-term natural experiment of artificial selection for aggression undergoing in southeast Asia with the Siamese fighting fish *Betta splendens*. In this species, males were selected for winning paired-staged contests for more than six centuries, originating short-fin varieties known as “Plakat Morh” (fighter strain). Here, we compare the behavioural and neurogenomic response of males and females to an intrasexual contest in both wild-type and fighter strains. As expected, when presented to an aggressive challenge, either a mirror image or an interacting conspecific, fighter males were more aggressive than wild-type males. Interestingly, these differences also occurred for females, although only males have been directly subjected to artificial selection. Whole-brain gene expression analyses revealed that the selection for aggression induced a markedly different neurogenomic baseline state and response to the challenge in fighters, as compared with wild-types. The study provides evidence on brain gene regulation associated with the expression of aggression and presents the first comparison of males and females for *B. splendens* strains, a promising species for the investigation of the proximate and ultimate mechanisms of aggression in vertebrates.

Talk Session 7: Behavioural choice and plasticity

15:00 Chloe Fouilloux (University of Jyväskylä)
Lutz Fromhage, Janne K. Valkonen, Bibiana Rojas

Size-dependent tradeoffs in aggressive behavior towards kin
Aggression between juveniles can be unexpected, as larvae's primary motivation is to survive until their reproductive stage. However, instances of aggression, which may escalate to cannibalism, can be vital for larval survival, although the factors (e.g. genetic or environmental) leading to cannibalism vary across taxa. While cannibalism can greatly accelerate individual growth, it may also reduce inclusive fitness when kin are consumed. As a solution to this problem, some cannibals demonstrate kin discrimination and preferentially attack unrelated individuals. Here, we used both experimental and modeling approaches to consider how physical traits (e.g. size in relation to opponent) and genetic relatedness mediate aggressive behavior in dyads of cannibalistic *D. tinctorius* tadpoles. We paired sibling, half-sibling, and non-sibling tadpoles of different sizes together in an arena and recorded their aggression and activity. We found that the interaction between size and relatedness predicts aggressive behavior: large non-siblings are significantly more aggressive than large siblings. Unexpectedly, although siblings tended to attack less overall, in size mismatched pairs they attacked faster than in non-sibling treatments. Ultimately, it appears that larval aggression reflects a balance between relatedness and size where individuals are trading-off the benefit of kinship with the cost of attack.

15:15 Alexander E. Hausmann (Ludwig-Maximilians-Universität München)
Richard M. Merrill, Chi-Yun Kuo, Marília Freire, Nicol Rueda-M, Mauricio Linares, Carolina Pardo-Diaz, Camilo Salazar

Butterfly mating behaviours affected by light environment during early stages of divergence
Species divergence is facilitated when traits under divergent selection also act as mating cues. However, the strength of behavioural barriers involving these cues may be influenced by the immediate, and perhaps rapidly changing, sensory conditions. Such fine scale variation in the local environment can alter signal perception independently of adaptation to contrasting sensory environments - but how this affects behavioural isolation has received less attention, especially in terrestrial organisms. The warning patterns of *Heliconius* butterflies are under selection for aposematism and act as mating cues. In choice experiments, we presented males of the putative hybrid species *H. heurippa* (red-yellow patterned), its close relative *H. timareta linaresi* (yellow patterned) as well as their hybrids to dead mounted females of the two phenotypes. Using computer vision, we extracted behavioural data from 1481 hours of video footage for hundreds of male butterflies. We show that *H. heurippa* and *H. timareta linaresi* males differ in their response to divergent warning patterns, and that these differences are strengthened with increased local illuminance at the red-yellow female, suggesting red patterns are more conspicuous to *Heliconius* males when presented in bright sunlight. Trials with live individuals reveal low-level assortative mating, which is sufficiently explained by differences in visual attraction. Finally, our data from hybrid butterflies underlines the importance of local light environments and is consistent with linkage between a major warning pattern gene and the corresponding behaviour, though the differences in behaviour we observe are unlikely to cause rapid reproductive isolation as predicted under a model of hybrid trait speciation. Overall, our results highlight that the role of ecological mating cues for behavioural isolation may depend on the immediate sensory conditions during which they are displayed to conspecifics.

15:30 Cammy Beyts (The University of Edinburgh)

Tadpoles stuck in Traffic: The effect of traffic disturbance on tungara frog (*Engystomops pustulosus*) tadpole behaviour

Human disturbed environments are often more unpredictable than natural ones due to frequent disruption caused by human activity. From a behavioural perspective, certain traits (e.g. increased exploratory and risk-taking behaviours) may be beneficial to promote resource acquisition within areas of high human activity. Individuals may also behave more flexibly so they can respond to immediate changes in local conditions. Consequently, populations in high disturbance areas are likely to show altered mean expression of certain behavioural traits and greater within individual behavioural variation compared to those in low disturbance areas. We investigated the effect of human disturbed environments on behaviour using tadpole larvae in Trinidad. Tungara frog (Engystomops pustulosus) adults spawn in temporary water bodies in roadside locations across Trinidad, exposing tadpoles to varying degrees of traffic disturbance. To investigate whether tadpoles showed local adaption to traffic disturbance, we collected 121 tadpoles across 19 high and 13 low traffic disturbed sites and raised all individuals under common conditions. We were interested in the overall difference in three behavioural traits (activity, neophobia and exploration) and the variability of these behaviours among and within individuals between disturbance regimes over six trials. Traffic disturbance did not have an effect on the overall level for any measured behaviour and all three behaviours showed a reduction in level over the course of six trials. However exploratory behaviour was found to decline at a faster rate ($p = 0.048$) for tadpoles in the high disturbance regime. Furthermore, there were among individual differences in tadpole exploratory ($p = <0.001$) and neophobia ($p = 0.039$) behaviours over the six trials, whereby tadpoles that were initially high in exploratory or neophobic behaviour showed a steeper decline in behaviour over time.

15:45 Jennie Crawley (University of Turku)
Oceane Lierhmann, Diogo dos Santos, U Kyaw Nyein, Htoo Htoo Aung, Win Htut, Zaw Min Oo, Martin Seltmann, Jonathan Webb, Virpi Lummaa, Mirkka Lahdenperä

Influence of handler relationships and experience on the health, stress response and behaviour of semi-captive Asian elephants

Declining wild populations combined with accumulating captive populations of e.g. livestock, pets, draught and zoo animals, have resulted in some threatened species with a substantial proportion of their populations in captivity. The interactions animals have with humans within captivity considerably impact their wellbeing, and effects depend on the familiarity and quality of the relationship. Asian elephants have been managed by humans for millennia, and >25% live in captivity today, mostly in their range countries with one or more handlers (mahouts) almost entirely responsible for their care. Few studies have investigated these relationships, or the impact of recent shifts seen in handling systems across Asia. Here, I will talk about a study on a population of semi-captive Asian elephants with detailed handling records and veterinary management, involving assessment of multiple welfare indicators in relation to mahout-elephant relationship lengths and mahout total experience. We measured elephants' physiological stress (Faecal glucocorticoids, Heterophil:Lymphocyte ratio), muscle damage (Creatine Kinase/CK), immunological health (Total White Blood Cell count/TWBC), and behaviour (response to simple commands) in response to mahout-elephant relationship measures. An elephant's CK, and to some extent TWBC, increased logarithmically with their

mahout's total experience, indicating muscle damage and inflammation. The effect of relationship length on CK was age dependent, declining with longer mahout-elephant relationships after the age of 18. Elephants also showed behavioural distinctions, responding more to familiar mahouts and faster to mahouts they had known for longer. Our results suggest little evidence of the mahout-elephant relationship impacting physiological stress but mahout experience is linked to physiological responses, and elephants require behavioural adjustment periods following mahout changes.

16:00 Jessica van der Wal (University of Cape Town)
Pietro D'Amelio, Celestino Dauda, Brian Wood, Claire Spottiswoode

A micro-geographic mosaic of mutualism between honeyguides and humans
When two species interact, behavioural variation in traits of one species affect the other, likely leading to differential local dynamics of coevolution. Greater honeyguides (Indicator indicator) are birds that cooperate with humans to gain access to bees' nests, from which humans get honey and honeyguides gain wax. In those parts of Africa where this mutualism still thrives, there is geographical variation in the calls 'honey-hunters' use to attract honeyguides to lead them to bees' nests, both among and within different human cultural groups. We studied the signalling calls that Yao and Macua honey-hunters (n = 141) use to communicate with honeyguides, in 13 remote villages across the Niassa Special Reserve (42,000 km2) in Mozambique. We hypothesised that honey-hunter signals vary arbitrarily (analogously to linguistic divergence), and that despite this, the human-animal communication is still successful. We investigated what drives the signal variation by testing three hypotheses: (i) isolation by environment (calls are shaped by the signaling environment); (ii) isolation by distance (cultures are more similar with geographical proximity); and (iii) isolation by origin (individuals born closer together are more similar in their signals). We found that certain call elements were common to all villages, but that honey-hunters also used a diversity in trills, grunts, whoops and whistles. Despite this variation, the mutualism still thrives throughout the Reserve. Geographical distance between villages best explained the signal variation, and we found no evidence that calls are shaped by the environmental factors measured, or by where people were born. This indicates that human-animal signals evolve in the same way as human-human signals do. Recognising how and why honey-hunter signals differ will help understand how cultural variation maintains this fascinating and rapidly disappearing mutualism.

16:15 Nicole Walsek (Radboud University)
Willem Frankenhuis, Karthik Panchanathan

An evolutionary model of sensitive periods when the reliability of cues varies across ontogeny
Sensitive periods are widespread in plants and animals, but their evolution is not well understood. Recent mathematical modeling has shed light on the conditions that favor the evolution of sensitive periods early in ontogeny. However, sensitive periods also exist at later stages of ontogeny, such as adolescence. Here, we present a mathematical model that explores the conditions that favor sensitive periods at later developmental stages. Our model assumes that organisms use environmental cues to incrementally construct a phenotype that matches their environment. Unlike in previous models, the reliability of cues varies across ontogeny. We use stochastic dynamic programming to compute optimal policies for a range of evolutionary ecologies and then simulate developmental trajectories to obtain mature

phenotypes. We measure changes in plasticity across ontogeny using paradigms often employed in empirical work: adoption and cross-fostering. Our results show that sensitive periods only evolve later in ontogeny if the reliability of cues increases across ontogeny. The onset, duration, and offset of sensitive periods - and the extent to which plasticity is elevated - depend on the specific parameter settings. If the reliability of cues decreases across ontogeny, sensitive periods are favored only early in ontogeny. These results are robust across different paradigms. Therefore, empirical research may study these patterns using a variety of experimental and observational designs.

Talk Session 8: Communication, Learning and Culture

15:00 Lies Zandberg (Royal Holloway)
Robert F. Lachlan, Luca Lamoni, Luke E. Rendell, Ellen C. Garland

Inferences about vocal learning in a species that can't be kept in captivity: the mechanics of revolutions in humpback whale song.
Humpback whale song is a striking example of vocal cultural behaviour, with one of the most complex transmission patterns among vertebrates. All males within a population conform to a common song, which slowly evolves over time. In certain populations however, also periodic revolutions occur, during which the current song in a population is rapidly replaced by a novel song adopted from a neighbouring population. The mechanisms underlying these patterns of cultural transmission are not currently understood: the whales' exceptional size and long-distance migration, make it implausible to study development experimentally. Instead, here we used individual-based models of the global humpback whale population in combination with empirical data to infer these processes of vocal learning and cultural evolution. We simulated processes of song innovation, biases in song learning and patterns of contact among populations. We compared our model outcomes with a unique long-term empirical dataset using Approximate Bayesian Computation to infer the parameter values most consistent with this data. We found that a tendency to learn novel songs, in combination with a song memory and rare interactions with neighbouring populations, was sufficient to create a pattern of constant song evolution, as well as rapid song revolutions, spreading horizontally across populations, as observed in populations in the southern hemisphere. This study demonstrates how cultural evolutionary approaches can be used to make inferences about the processes underlying cultural transmission.

15:15 Gabriel Melo-Santos (BioMA/UFRA (Biology and Conservation of Amazonian Aquatic Mammals/ Federal Rural University of the Amazon); IDSM/GPMAA (Mamirauá Sustainable Development Institute/Research Group in Amazonian Aquatic Mammals))
Samuel Walmsley; Volker Deecke; Heloíse Pavanato; Braulio Leon-Lopes; Alexandre Azevedo; Diogo Barcellos; Hector Barrios-Garrido; Amandine Bordin; Camila Carvalho de Carvalho; Marta Cremer; Kareen De Turris ; Maria Claudia Diazgranados; Camila Domit; Luciana Duarte de Figueiredo; José Lailson-Brito; Miriam Marmontel; Dalila Teles Leão Martins; Angélica Lúcia Figueiredo Rodrigues; Israel Maciel de Sá; Marcos César de Oliveira Santos; Sheila Simão; Rodrigo Hipólito Tardin; Marie Trone; Luz Helena Rodriguez Vargas; Maria Luisa da Silva; Vincent Janik; Laura May-Collado

Unexpected diversity of *Sotalia* dolphin whistle repertoires at a continental scale

The size and composition of vocal repertoires can reflect key aspects of biology such as cognition, social complexity, and population dynamics. Here we quantify and compare the whistle repertoires of 16 populations in the genus Sotalia, belonging to two sister species: the Guiana dolphin (*Sotalia guianensis*) and the tucuxi (*S. fluviatilis*), both endemic to Latin America. We extracted whistle contours and used an adaptive resonance theory neural network combined with dynamic time-warping (ARTwarp) to categorize whistles into types. Applying recent methods from community ecology, we then determined the size of each population's repertoire and estimated β-diversity between populations while accounting for differences in sampling effort. Our analysis included a total of 1,817 whistles from 16 populations (10 from *S. guianensis* along the Latin American Coast and 6 from *S. fluviatilis* in the Amazon Basin) distributed throughout the range of the genus Sotalia. Contrary to previous studies comparing more general acoustic characteristics, we found significant differences in the composition of each population's repertoire, with 21% of whistle types being unique to a single population (permutation test; $p = 0.001$). This variation was partially explained by geographic distance between populations (Mantel test; $R = 0.173$, $p = 0.03$). We also identified surprisingly large variation in repertoire size, estimating some populations to have up to 20-times more whistle types than others. Our findings highlight the importance of scale when measuring vocal repertoires and open the door for further exploration of the evolutionary and ecological factors driving vocal diversity in delphinids.

15:30 Satyajeet Gupta (Indian Institute of Science)
Anusha L. K. Kumble, Kaveri Dey, Jean-Marie Bessière, Renee M. Borges

The scent of life: Intraspecific vehicle discrimination in phoretic nematodes based on physiological state of a vehicle

Phoresy is a phenomenon where one organism (traveler) attaches to another organism belonging to a different species (vehicle) for dispersal to suitable habitats. Organisms that show such interactions can become tightly associated with their vehicles if they occupy specialized habitats which show ephemerality, i.e. appear stochastically in time and space. In phoretic systems that need to cope with the constraint of habitat ephemerality, getting on to the correct vehicle forms a crucial step. Phoretic organisms are known to use various cues ranging from visual to chemical to locate their vehicles but so far no studies have investigated if they can differentiate between the physiological status of their vehicles, i.e. whether they are dead or alive. The brood site pollination mutualism involving figs and fig wasps provides an excellent opportunity to conduct such studies. This represents an ancient co-evolved, species-specific, obligate mutualism which show associations with phoretic nematode communities and that utilize pollinating wasps as vehicles for dispersing from one fig syconium (closed urn-shaped inflorescence) to another. We study the pollinating fig wasp species and the phoretic nematode community (consisting putative plant- and animal-parasite) associated with the *Ficus racemosa*, a wide-spread, common tropical fig species. We use behavioral assays to demonstrate that nematodes choose ‘live' over ‘dead' vehicles. We also investigate the role of wasp volatiles especially carbon dioxide concentrations in nematode differentiation between different physiological state of the wasp vehicles. We further use chemical (GC-MS analysis of volatiles) and metabolic (estimation of carbon dioxide released) analysis for thus determining the scent of life.

15:45 Marc Gilles (Bielefeld University)
Leanne Grieves, Elizabeth MacDougall-Shackleton, Barbara Caspers

Sex and seasonal information is encoded in the preen oil of birds: a meta-analysis

When studying chemical communication in birds, one should first determine what information is encoded in avian body odour. Preen oil is the main source of odour in birds. Studies have found that the chemical composition of preen oil could differ according to a number of parameters, notably sex and season. Sex and seasonal differences are of particular interest to interrogate a function of preen oil for chemical communication, especially for reproduction. We performed a systematic literature search and found 47 studies investigating sex and/or seasonal differences in preen oil composition, comprising 66 species. Seasonal differences were reported in almost all species studied whereas sex differences were not as common. We conducted a meta-analysis using Bayesian logistic models (MCMCglmm) to investigate the determinants of sex and seasonal differences. We show that 1) sex differences are more frequent during the breeding period (compared to the non-breeding period) and in species with uniparental incubation (compared to species with biparental incubation), and that 2) seasonal differences are more frequent in the incubating sex, but only in species that nest on the ground. These results suggest that preen oil could be an olfactory cue used for reproduction for non-ground nesting species, while it could be used for olfactory crypsis for ground nesting species. This study provides a comprehensive review of studies on preen oil composition and aims to give guidelines for future research in avian chemical ecology.

16:00 Matthew Steele (University of St Andrews)
Linda E. Neaves, Barbara C. Klump, James J. H. St Clair, Joana R. S. M. Fernandes, Vanessa Hequet, Phil Shaw, Peter M. Hollingsworth, & Christian Rutz

DNA barcoding identifies cryptic animal tool materials

A diverse range of animal taxa engage in tool use and/or construction behaviour. The properties of the raw materials an animal uses determine the properties of its final tool or construction, which in turn have important consequences for the animals' fitness. However, the effects of raw material properties are under-studied, in part due to the difficulty involved in identifying raw materials in the first place. We recently used DNA barcoding to identify the plant source of highly modified New Caledonian crow (*Corvus moneduloides*) hooked stick tools – a mystery which had puzzled our team for a number of years. This is the first time, to our knowledge, that DNA barcoding has been employed in this field. New Caledonian crows show distinct regional variation in tool types and raw material use, the origins of which are not currently well understood, so this discovery represents an important step forward in our research on the species. My talk will tell the story of this discovery, contrasting DNA barcoding with other approaches our team used in attempting to solve this problem, and outline the ways in which we believe DNA barcoding could be useful in the study of other behaviours, from nest building in birds to tool manufacture in chimpanzees.

16:15 Maria C Tello-Ramos (University of St Andrews)
Guillette Lauren M & Healy Susan D

Architectural traditions of birds: social learning in building behaviour

Bird nests, as ubiquitous as they are, still lack a predictive framework in animal behaviour research. Amounting evidence shows that nest building behaviour in birds is the result of learned behaviours depending on previous experience and the environment. Similarly, social learning and culture in animals is more common and taxonomically widespread that previously thought. Little is known however, about the role that social learning has in building

behaviour. In the laboratory the use of social information by birds building a nest has been shown as juveniles copied the type of material a familiar bird had used before. In order to test whether birds in the wild also use social information when building, we have compared the size and shape of the roosts built by 42 colonies of the white-browed sparrow weavers (*Plocepasser mahali*), living at the Kalahari Desert in South African. The sparrow weavers are cooperative breeders that build different purpose structures, a single nest for the dominant female to lay the eggs and several individual roosts that are used by a single bird. Each roost is shaped as an inverted "U" with an entrance and an exit. Despite of the spatial proximity between colonies, we found that the shape and size of the roosts are repeatably similar within colony and consistently different between colonies. The length of the entrance, the total width of the roosts as well as the angle between the entrance and the exit tubes differ between colonies and thus, these roosts not only look different but may also be the result of differences in the decision making process of the colonies. The relatedness and life history of each of > 200 individuals as well as the environmental conditions at the territory of each colony are known and thus, the contribution of all these factors to the differences in the morphology have been included in the study to explain the "architectural traditions" of these birds.

Poster Session One

Jonas Verspeek (Antwerp University) Room 1. Poster 1
Edwin JC van Leeuwen, Nicky Staes, Jeroen M. G. Stevens

Preference and paradigm: Bonobos show some evidence of prosociality in two free choice group experiments

Human society has evolved into an exceptional cooperative system founded on extended levels of prosociality: any behaviour performed by one individual that results in a benefit for another individual. To understand the uniqueness and evolutionary origins of prosocial tendencies, our closest living relatives, bonobos (*Pan paniscus*), have been studied with prosocial tasks, yet leading to mixed results. Part of these inconsistencies might be due to the fact that different studies have used different task designs with different benefits for the test subjects. The most widely used test of prosociality in nonhuman animals is the prosocial choice task in which a subject can choose between a prosocial and a selfish option. In the present study, we implemented three variants of the prosocial choice task in a captive bonobo group (N=14) in Zoo Planckendael in Belgium: group service paradigm (GSP); juice-box paradigm (JBP); and group prosocial choice task (PCT). Like in the standard prosocial choice task, in all of these tasks the bonobos could freely choose to provide food to another individual or not. However, the three tasks differed in the amount of benefit the subject would obtain when providing food to a recipient (GSP<JBP<PCT). In the GSP, subjects never received a reward when providing food to a recipient. In the JBP, subjects could obtain a limited benefit from providing juice to another individual by means of scrounging. In the PCT, subjects would always obtain the same high value reward as the recipient for choosing any option. Analyses show that overall prosocial tendencies in bonobos were low; infants and subadult bonobos behaved more prosocially than adults; and more prosocial choices were made in the tasks with higher benefits for the subject, which may help to explain previous inconsistencies between studies. In conclusion our study shows that the bonobos were motivated to obtain rewards for themselves but less to provide benefits for group members.

Rafael Ayala Lara (University of Saint Joseph) Room 1. Poster 2
Raquel O. Vasconcelos

Evaluating noise-induced stress in larval zebrafish: insights into anxiety and sensory loss.

Noise pollution is now widely present in most aquatic soundscapes; however, very limited information is known on how this relevant environmental stressor impacts fish behaviour especially in early ontogeny. Zebrafish (*Danio rerio*) has become an important vertebrate model for high-throughput screening of environmental stressors, ototoxic drugs, and genetic modulators of embryonic development. In this study, we performed a split-brood experiment to assess the effects of increasing ambient noise level (lab silent conditions versus 150 dB re 1 µPa continuous white noise) on behavioural patterns and hearing abilities in larval zebrafish (5 days post fertilization).Recently laid eggs from multiple zebrafish breeding tanks were randomly chosen and split into custom-made net-boxes that were suspended above underwater speakers placed in the bottom of acoustic treatment tanks. We found that exposure to increased noise level led to increased dark avoidance behaviour (scotophobia) in an anxiety-related dark/light preference arena. Noise-exposed animals also displayed impaired spontaneous alternation behaviour (SAB), an exploratory and mnestic-related behaviour. Electrophysiological assessment of hearing sensitivity based on field potentials measured from the inner ear saccular hair cells population revealed significant increase in auditory thresholds in noise-treated animals. Our work provides first evidence of anxiety-driven and innate exploratory behavioural alterations, as well as a significant impact in sensory capabilities of larval zebrafish due to noise exposure at moderate and ecologically relevant levels.

Isabella J. M. Tortora-Brayda (The University of St Andrews) Room 1. Poster 3
Sophie C. Edwards, Alice Fouillouze, Susan D. Healy

Piecing together nest building: Blue Tit nest building through time

Many aspects of avian reproduction are well described. Perhaps surprisingly, a key aspect of reproduction for most birds, nest building, is not. Nearly all our understanding comes from examination of nests following fledging of chicks and it is assumed that the nest allows us to see the decisions birds took when they built the nest. To assess whether observations of building itself could add to our understanding of builders' decision making, we video recorded nest-building by female blue tits, *Cyanistes caeruleus*, at a site in St Andrews, UK. We found that these birds built most actively in the morning and afternoon, and less in the evening. However, as the day on which they laid their first egg approached, females brought material more frequently than they did when they first started building, with this increase more pronounced in the evenings. Blue tits tended to build less in windy conditions, but when birds built, during the day or over the nest-building period, was not affected by ambient temperature. Which material birds deposited, however, was related to temperature: on warmer days birds brought more feathers and grass. As grass is typically found in the nest base, I had expected birds to bring grass less often as they got closer to laying their first egg, however they continued to steadily collect grass until this date. This result suggests that more manipulation of material occurs within the nest after materials are deposited, contrary to current inferences based on deconstruction of the final nest artefact. We suggest that data on the actual building behaviours is necessary for us to understand decision making in builders.

Dishari Dasgupta (University of Calcutta) Room 1. Poster 4
Arnab Banerjee, Arnab Banerjee, Rikita Karar, Debolina Banerjee, Shohini Mitra, Srijita Karmakar, Aparajita Bhattacharya, Swastika Ghosh, Pritha Bhattacharjee, Manabi Paul.

Reassessing feeding preference in the urban-adapted grey langurs in West Bengal, India.

For the last few decades, urbanization has imparted a profound effect on the ecosystem. Urban encroachment has not only pulled down the green cover from the earth, but also altered human-animal movements and their interactions. While some animals fail to adapt to their new surrounding, few have managed to thrive within urban settlements by altering their preference for resources. Folivorous colobines such as grey langurs (also known as Hanuman Langur, *Semnopithecus entellus*), who usually feed on plant parts, are now approaching high calorie urban food sources. However, such a generalized feeding pattern does not go with their tripartite gut physiology, thereby making them an excellent example of Liem's paradox which needs to be studied further. Our study locations cover various parts of West Bengal, India. They range between urban to rural, where these free ranging langur troops are being followed for long-term field based behavioral observations. The feeding census has shown that langurs residing in the urban area are more dependent on the anthropogenic food sources in contrast to their wild brethren. Observing a tentative altered feeding habit, we decided to test it with a choice-based field experiment. Here we allowed them to choose between 'urban' and 'natural' food options in 83 experimental trials, of which 74 has been considered for the final analysis. We recorded langurs' attempts and delays in food selection, aggression and rejection received by the food items, which were then contemplated to a multivariate model. The model reveals a clear preference towards urban food options which langurs have selected being independent of food scarcity and human interferences. Therefore, it can be interpreted that these free ranging Hanuman Langurs have not only learned to approach human-provisioned 'urban' food items but also acquired preferences for some of it despite being mostly known to be folivorous in nature.

Ørjan Røkkum Brandtzæg (Norwegian University of Science and Technology) Room 1. Poster 5
Robert Biegler

The secret to a long life is knowing when it's time to stop. Using signal detection theory to define optimal information gathering in a sequential sampling problem.

When distinguishing categorically different situations, signal detection theory defines an optimal decision threshold, given any evaluation of the possible outcomes and knowledge of how well the situations can be distinguished. It conventionally assumes that all relevant information is available at the time of decision. In sequential sampling problems, an organism can choose how much information to gather. The decision process has been modelled with drift diffusion models and race models, which can account for how speed is traded off against accuracy given parameters of the process. Yet they do not specify how speed *should* be traded off against gathering more information. We show how signal detection theory can be applied to sequential sampling to calculate how much information should ideally be sampled. We find that optimal sampling as a function of base rate is defined by the ratio of sampling cost to the importance of outcomes, and that for high and low base rates, it is often not worth gathering any information beyond the absolute minimum.

Oceane Liehrmann (University of Turku) Room 1. Poster 6
Jennie Crawley, Martin W. Seltmann , U Kyaw Nyein , Win Htut , Htoo Htoo Aung, Léa Lansade, Virpi Lummaa

Working elephants are less likely to respond to unfamiliar handlers

The nature of relationships between people and animals has been of interest for many centuries. However, the experimental study of these interactions is a relatively recent development, despite the suggestion that Human-Animal interactions may have consequences for animal welfare. Intriguingly, although the Human-Animal relationship is an important factor to take into account in animal management, researchers have to date overlooked some animals: the working animals for hard labor known as draught animals. To investigate the Human-Draught Animal relationship,87 Myanmar timber elephants were asked to respond to the call of their own mahout or the call of another mahout and 52 of them were asked to walk on a novel surface. These tests aimed to assess if a long-lasting relationship between handlers and animals affects the quality of the response to work orders in a usual context or a disturbed context (confronted with novelty). The analysis revealed that most of the elephants responded only to their own mahout and elephants responded were less disturbed by the novel surface when they had a long-lasting relationship with the mahout calling. The success rate was also driven by the age of the elephant in interaction with the mahout's identity, indicating the importance of training and for the animal and handlers to know and understand each other. On the contrary, when novelty was involved, the older elephant trend to failed more following the common theory of young individuals being less neophobic than older ones. This study is the first to experimentally assess the relationship between handlers and draught animals, highlighting its importance in improving work quality and performances. Further research is needed to investigate the role of the Human-Draught Animal relationship in terms of animal welfare and handlers' security.

Alex Lancaster (University of Chester) Room 2. Poster 1
Tomas Fernández, Sergio Radic, Claudio Moraga, Paulo Corti, Achaz von Hardenberg

Behavioural modifications by wild guanaco (*Lama guanicoe*) to domestic sheep in Southern Patagonia, Chile.

Throughout large parts of the Patagonian Steppe, Southern Chile, the highly social ungulate, guanaco (*Lama guanicoe*) share much of their habitat range with domestic sheep and have seen large declines in population and habitat range due to overhunting and apparent competition with livestock. Guanaco-sheep competition has been readily investigated, primarily in Argentine Patagonia, however has focused primarily on habitat or dietary overlaps. Comparatively few studies have examined the effect of resource competition on the behaviour of coexisting ungulate species. Here, using focal and scan samples amassed from four different study sites over nine consecutive field seasons, we analyse the likelihood of individuals within guanaco social units to adapt their behaviour according to the presence of domestic sheep. We also present the effects of sheep presence on the bite (foraging) and step (selectivity) rates of guanaco, in an effort to further understand whether the relationship between the two species is competitive, or if there is a level of resource partitioning or facilitation at play.

Melissa Peignier (University of Bern) Room 2. Poster 2
Max Ringler, Eva Ringler

Exploring links between personality and environmental traits in wild poison frogs

Animal personality is widespread across the animal kingdom, yet we lack empirical support for the theoretical concepts how variation in personality traits can persist within animal populations over time. The selective pressures induced by the natural and social environment have been proposed to play a key role in producing and maintaining various life-history strategies across individuals of a population. In the present study, we examined a wild, free ranging population of *Allobates femoralis* for the existence of personality types. We focused on three personality axes (aggressiveness, exploration and boldness) that we considered most relevant based on the known ecological features of our study species, and examined how these traits correlated with their age and the natural and social environment. We used acoustic playbacks to evoke territorial defense behavior in focal males to assess individual levels of aggressiveness. Exploratory tendency and boldness of males and females were assessed via a Novel Environment Test. We found evidence for personality along the three axes and evidence for a positive behavioral correlation between exploration and boldness. The data also suggested that a behavioral syndrome between exploration, boldness and aggressiveness might exist. We did not find a difference in the personality trait of young and old individuals. It suggests that personality is probably fixed and transcend life stages instead of changing with life stages based on the main selective pressures acting. We did not find a link between the natural and social habitat and any personality trait, which suggests that personality traits were randomly distributed through space. While amphibians have been largely overlooked in animal personality research, this study is one of the first comprehensive study of animal personality in amphibian in the wild, and offers empirical insights on the potential mechanisms playing a role in the arisen and maintenance of animal personality.

Christopher Pull (University of Oxford) Room 2. Poster 3
Irina Petkova, Ellouise Leadbeater

Benefits of memory use depend upon forage availability in bumblebees

Enormous variation in cognitive abilities is evident within animal populations, yet we currently understand little of the ecological selection pressures that shape the evolution of learning and memory. Here, we capitalize upon the unique tractability of a social insect system to quantify the relationship between cognitive performance and resource availability in the natural environment. We assayed the short-term memory (STM) of 132 individual bees from 26 parasite-free colonies in the laboratory, using a radial arm maze (RAM) - a classical psychological apparatus used historically to

assess working memory in rodents. Following cognitive testing, we gave colonies unrestricted access to the surrounding environment (a university parkland campus) and monitored the lifetime foraging efficiency of each tested worker. Using a continuous, staggered design that encompassed the entire foraging season (early spring to late autumn) over two years, we were thus able to assess how changes in floral resources affect memory use. In contrast to our expectation that cognitive abilities might be most important when forage availability is low, we found that the benefits of memory performance emerged in weeks when forage was richest. Our preliminary results are the first to link memory performance with ecological selection pressures, opening the door to a link between environmental complexity and selection on cognitive performance that invites further exploration.

Danita K Daniel (Indian Institute of Science Education and Research Kolkata) Room 2. Poster 4
Anuradha Bhat

Daring to Learn: Effect of Habitat on Correlates of Personality and Cognition in Populations of Wild Zebrafish

From climatic conditions to vegetation cover, the environment is continually being modified across spatial and temporal scales, more so now, due to anthropogenic disturbances. In such fluctuating circumstances, it becomes essential to understand how certain traits that are inherent in organisms, affect the adaptability of individuals to different habitat conditions. To test this, we studied how personality affects learning and memory in wild-caught zebrafish from habitats that differed in various environmental factors, such as flow regime, water turbidity, predator presence and human pollution. We measured the performance of individuals from three different habitats in a spatial task, based on feeding latencies in a maze over repeated trials, to assess their learning and memory abilities. We found differences between males and females for measures of boldness, as well as learning and memory in certain populations. We also found that personality affects both measures of learning and memory and although bolder fish are better learners, they show poorer retention of memory. The correlation between personality and cognitive ability also seems to vary, depending on how dynamic the native habitat of the population is likely to be. Boldness is an essential personality trait for an organism that helps it to optimize its performance efficiency for tasks that are necessary for its survival, such as foraging and seeking mates. Improved spatial cognitive abilities can help individuals to respond quickly to environmental changes and increase their survival chances. Studying these in wild fish, helps predict performance efficiencies among individuals and also explains how fish adapt to extremely dynamic environments, and also whether the difference in the environment leads to differences in the correlation between personality and cognition.

HaDi MaBouDi (University of Sheffield) Room 2. Poster 5
James A.R. Marshall, Andrew B. Barron

Honey bees calculate the probability of reinforcements as an effective cognitive strategy to solve multi-choice tasks

A honey bee's foraging ecology presents a prodigious cognitive challenge. Bees must gather concealed pollen and nectar from many cryptic and variable flower species, all of which vary moment by moment in the quality and amount of reward. Although this is established that bees are effective foragers, how bees solve this type of complex multi-choice task is unknown. In this study, we challenged honey bees with a controlled learning task that offered five options differing in the probability of offering reward and punishment to examine what bees learned and how they solved this type of multiple-comparison task. Our data show honey bees rapidly learned to match their choices in tests to the reinforcement history of each colour (probability matching strategy). Rather than comparing or ranking stimuli, bees simply aligned their likelihood of choosing a colour to their history of reinforcement with each colour.

We developed a neural network model inspired by the bee brain to explore the feasibility of probability matching in a five-arm bandit task for an insect brain. The model suggests a structure like the honey bee mushroom body with reinforcement-related plasticity at both input and output was sufficient for this cognitive strategy. The model reveals that the bees need nothing to solve this task more than associating each colour with the probability of the reward/punishment. We further analysed bees' inspection behaviours to understand their visual sampling strategy. The results gathered from the bees' paths exhibit that bees scanned the stimuli with more uncertainty for a longer time and with lower speed compared with the stimuli with a higher probability of the reward. This demonstrates the bees' scanning behaviours were influenced by their expectation of receiving the reward from the stimuli that were developed by the probability of being rewarded or punished during training. Our results suggest a simple cognitive strategy for foraging animals.

Victor Ajuwon (University of Oxford) Room 2. Poster 6
Andres Ojeda, Robin Murphy, Alex Kacelnik

Paradoxical Choice in Rats: Curiosity or Conditioned Reinforcement?

The acquisition of information is valuable because better informed decision-makers can behave more efficiently. However, recent experiments in pigeons, starlings, and rats have shown that subjects prefer an alternative that provides them with useless information - in the sense that it cannot be used to alter outcomes - over one that does not, even though this preference can lead to reward losses. One plausible mechanism is that acquiring information (reducing uncertainty) is rewarding per se, which might suggest that animals are 'curious'. Another, more parsimonious, is based on conditioning: signals that predict food or no food acquire secondary reinforcing properties that are opposite in sign and different in strength, with signals for good news having greater conditioning influence than signals for bad news. We contrast these theoretical explanations experimentally. Rats chose between two options of equal average profitability, that delivered food probabilistically a fixed delay after being chosen. In the informative option (Info), the outcome (food/ no food) was signaled as soon as the option was chosen, whereas in the non- informative option (NoInfo) cues were not correlated with reward outcomes. Subjects preferred the informative option, even when one of the signals (either S+ or S-) was omitted, which is consistent with the information hypotheses but precludes conditioning as the sole determinant of choice. Cue manipulation did influence the rate of acquisition, but not the asymptotic preferences, supporting the view that while signals are important, information per se ("curiosity") is a sufficient incentive to generate preference.

Laure Cauchard (University of Aberdeen) Room 3. Poster 1
Jennifer Morinay, Pierre Bize, Blandine Doligez

The role of cognition in social information use for breeding site selection: experimental evidence in a wild passerine population

In spatio-temporally variable environments, individuals are known to use information for making optimal decisions regarding where and when to breed. Optimal decision making can be complex when relying on multiple information sources with varying levels of reliability and accessibility. To deal with such complexity, different cognitive abilities such as learning might enable individuals to optimally process and use information but this remains unexplored in natural populations. We investigated whether learning performance on a problem-solving task was related to the use of an experimentally manipulated source of social information for nest site selection in wild collared flycatchers (*Ficedula albicollis*). Collared flycatchers are known to use heterospecific information from their main competitors, the great tits. We created a local apparent preference by tits for an artificial nest site feature (a geometric symbol attached to nest boxes) and recorded whether flycatcher pairs chose to

settle in nest boxes displaying the same feature as tits (copied tit apparent preference). Using a problem-solving task requiring opening a door temporarily blocking the nest box entrance, we then measured flycatchers' learning performance during nestling rearing as the number of entrances required to solve the task (i.e. open the door) twice in a row below a given efficiency threshold. We found that fast learning females copied tit preference, while slow learning ones rejected it. Male learning performance did not affect copying behavior. Our results showed that learning performance might play an important role in the ability to optimally use information for nest site selection in females: both fast and slow learning females could process this heterospecific information source but used it differently. This could partly explain the link between cognitive abilities and reproductive success reported in previous studies.

Lucrezia Lonardo (Messerli Research Institute) Room 3. Poster 2
Christoph Völter, Claus Lamm & Ludwig Huber

Dogs follow human misleading suggestions more often when the informant has a false belief

1. Having a theory of mind implies attributing mental states to others and being able to predict their behaviour based on those. The comparative study of theory of mind seeks to assess whether non-human animals represent others´ minds. Although recent studies have shown that great apes, just like human infants, can pass non-verbal false belief tasks, the possession of a theory of mind by non-human animals remains a highly controversial topic. 2. In this preregistered experiment, we briefly accustomed pet dogs (*Canis familiaris*, N=120) to a hiding-finding game in which they had the possibility to retrieve food from one of two opaque buckets (one baited, the other empty). During this familiarisation phase, one experimenter (the hider) would always hide food in one bucket while a second experimenter (the communicator) would watch carefully the hiding procedure and then help the dog by ostensibly suggesting the location of food. We compared the performance of dogs tested in one of two conditions (between-subjects design) of a change of location test, where food was displaced from one container to the other either in the presence (true belief condition) or in the absence (false belief condition) of the communicator. In both conditions, dogs witnessed the initial hiding and the subsequent displacement of food but, unlike in the familiarisation, the communicator suggested to them the empty container. If dogs attribute a false belief to the communicator, they should be less inclined to follow her hints to the empty container than dogs in the true belief condition. Instead, we found that dogs in the false belief group chose the suggested (empty) container significantly more often than dogs in the true belief group. As this finding goes in the opposite direction relative to what would be predicted by a theory of mind account, we discuss different mechanisms that can possibly explain this behaviour.

Poncet Lisa (Normandie Université) Room 3. Poster 3
Roig Anthony, Billard Pauline, Bellanger Cécile, Jozet Alves Christelle

First indications of future-planning abilities in the common cuttlefish

Over the recent years, the cognitive abilities of the common cuttlefish (*Sepia officinalis*), in particular its memory, have been the subject of several studies. As memory is thought to be intrinsically directed toward the future, cuttlefish may possess the ability of foresight. However, some claims that animals cannot anticipate their future needs as they cannot escape their present state. To challenge this hypothesis, we conducted an experiment on 18 wild-caught adult cuttlefish. Each cuttlefish was tested in a Y-maze, where they were first fed until satiety. Afterwards they were proposed a choice between two arms: one with a shelter, but without any prey, and the other one without a shelter but with preys. They were confined inside the chosen arm overnight. Whereas the test group did not get any food when choosing the shelter, the control group was given food during the night inside the shelter.

The following day, after being fed until satiety, the same choice test was undertaken. If cuttlefish were bound to their current needs, they should choose the shelter on the two tests. However, if they anticipated their future needs (hunger during the following night) irrespective of their current needs (hiding), they should prefer the arm with the food on the second day. All cuttlefish went to the shelter on the first day, a choice consistent with their current state of motivation. On the second day, whereas control cuttlefish still chose the shelter, half of the test cuttlefish preferred the arm with the food. Although the number of individuals was too low to reach statistical significance, these results provide the first indication of an ability of cuttlefish to plan for their future.

Annebelle Kok (Scripps Institution for Oceanography) Room 3. Poster 4
Kelly Bishop, Ella Kim, Tetyana Margolina, John Joseph, Lindsey Peavey, Leila Hatch, Simone Baumann-Pickering

Ending the day with a song: patterns of calling behaviour in a species of rockfish

Similar to birds, fish produce sound to attract mates and repel rivals. At the height of the mating season, these calls can be so intense that they form a significant part of the marine soundscape. Even though this phenomenon is widespread in fish species, not much is known about fish calling behavior. We investigated the seasonal, lunar and diel patterns of calling behavior of bocaccio (*Sebastes paucispinis*), a species of rockfish, in the Channel Islands National Marine Sanctuary, on the west coast of the United States. We deployed acoustic recorders at five sites in the Sanctuary, at depths of 21-156 m. The hydrophones recorded for a period of a year. We extracted bocaccio calls using a detection algorithm and related calling patterns to time of day, lunar illumination and time of year. Bocaccio calls were mostly produced at night, with clear peaks at crepuscular time periods. The timing of calling at dusk or dawn showed correlations with site depth, possibly due to vertical migration of fish through the course of the night. They occurred more during days with weak lunar illumination. Calls were noted throughout the year but with higher rates during April through July. Describing and understanding patterns of fish calling behavior can provide insight into communication, habitat preference, mating behaviour, or animal density of these species as well as help characterize the acoustic environment that sustains them.

David López-Idiáquez Room 3. Poster 5
(Centre d'Ecologie Fonctionnelle et Evolutive (CEFE-CNRS) & University of the Basque Country)
Arnaud Grégoire, Céline Teplitsky, Amélie Fargevielle, María del Rey, Christophe de Franceschi, Anne Charmantier, Claire Doutrelant

Long-term decrease in colouration as a consequence of climate change

Animals signals are key for animal fitness, they often evolve through sexual and social selection and work in both intra- and inter-sexual communication contexts. The expression and reliability of these signalling traits can be condition dependent and thus driven by the variation in environmental conditions that can modulate the relative costs associated with their expression. This link with the environment suggests the current rapid climate change experienced in all ecosystems on Earth could impact these signalling systems. To date, the information available about the consequences of climate change on animal signalling is scarce. To tackle this issue, we take advantage of a long-term data set including 15-years of data on blue tit colouration in two populations located in southern France (Montpellier and Corsica). Specifically, we focus on the yellow chest and blue crown colourations that have been suggested to play a role as signals in the blue tit. Our results evidence an overall decrease in both blue and yellow coloured traits in the 2 populations along our study period. They also show a negative association between both colourations and temperature in Corsica, with in particular a sensitivity to warming during the moulting period. Finally, our results also document that there is a

within-individual response to warming, as we found a within-individual decrease in colouration with increasing temperatures. Overall, we report a decrease in the blue tit colouration over the last 15-years that, at least to some degree, can represent a plastic response to warming in the study area. We suggest that this pattern could arise through the negative effects of increased temperatures on the body condition of the blue tits. However, we are unaware of the processes behind those changes and more research is needed to shed light on the mechanisms behind the described trends.

Gabriella Gall (Tel Aviv University) Room 3. Poster 6
Pauline Toni, Tim Clutton Brock, Marta Manser

Signalling adjustments to direct and indirect environmental effects on signal perception in meerkats

The efficiency of communication between animals is determined by the perception range of signals. With changes in the environment, signal transmission between a sender and a receiver can be influenced both directly, where the signal's propagation quality itself is affected, and indirectly where the senders or receivers' behaviour is impaired, impacting for example the distance between them. Here we investigated how meerkats (*Suricata suricatta*) in the Kalahari Desert adjust to these challenges in the context of maintaining group cohesion through contact calls. We found that meerkats changed their calling rate when signal transmission was affected indirectly due to increased dispersion of group members as during a drought, but not under typical wet conditions, when signal transmission was directly affected due to higher vegetation density. Instead under these wetter conditions, meerkats remained within proximity to each other. Overall, both direct and indirect environmental effects on signal perception resulted in an increased probability of groups splitting. In conclusion, we provide evidence that social animals can flexibly adjust their vocal coordination behaviour to cope with direct and indirect effects of the environment on signal perception, but these adjustments have limitations.

Ebi Antony George (Tata Institute of Fundamental Research) Room 4. Poster 1
Smruti Pimplikar, Neethu Thulasi, Patrick Kohl, Benjamin Rutschmann, Axel Brockmann

Similarities in follower behaviour across honey bee species suggest a conserved mechanism of dance communication

Social communication systems are predominantly multimodal and can combine modulatory and information-bearing signals. The honey bee waggle dance, one of the most elaborate forms of social communication in animals, activates nestmates to search for food and communicates symbolic information about the location of the food source. Previous studies on the dance behaviour in diverse honey bee species demonstrated distinct differences in the concurrence of visual, auditory, olfactory and tactile signals produced by the dancer. We studied the behaviour of dance signal receivers, the dance followers, to explore the potential significance of different signals in the communication process. In particular, we asked whether the behaviour of dance followers differs between the three major Asian honey bee species, *Apis florea*, *Apis dorsata* and *Apis cerana*, and whether this might correlate with the differences in the signals produced by the dancing foragers. Our comparison demonstrated that the behaviour of the dance followers is highly conserved across all three species despite differences in the dance signals. The mean body orientation of the dance followers with respect to the waggle dancer was close to 90° throughout the run, with the majority positioning themselves lateral to the dancer. These findings suggest that the communication of spatial information might be more conserved than implied by the differences in the signals produced by the dancer. Along with studies in *Apis mellifera*, our results suggest that all honey bee species rely on tactile contacts between the dancer and follower to communicate spatial information. The cues and

signals that differ between the species may be involved in attracting the followers towards the dancer or increase their motivation to start foraging in the different nest environments.

Alexander Hutfluss (Ludwig-Maximilians-Universität München) Room 4. Poster 2
Niels Dingemanse, Hans Slabbekoorn, Mark Briffa, Eira Bermudez-Cuamatzin

The individuality in stability: Residual within-individual variance in bird song

Animal behaviour varies on multiple levels, including between individuals, within contexts (personality, expressed by the intercept in the figure) and within individuals, but between contexts (plasticity). Only recently, attention has been drawn to a third type of variation: Residual within-individual variance (RWV). This short-term, reversible variability within contexts is assumed to represent an individual's predictability or stability. While in some contexts, e.g. anti-predator behaviour, being unpredictable might be beneficial, other contexts, such as mate attraction and intraspecific conflicts, might require reliable information about an individual. Furthermore, RWV is expected to show between-individual differences, resulting in more or less predictable animals. One prime example is birdsong, for which certain traits are perceived as “attractive”, and thus stable production of such traits could signal male quality. However, few studies have investigated individual differences in RWV. To assess these differences for birdsong and how that relates to life-history and reproductive traits, we collected song recordings in 12 great tit nest box populations over the course of three years. Every breeding male was presented with an intruder four times per season, resulting in hundreds of recordings. From these recordings we collected data on temporal and spectral aspects of the song. Then data were analysed using hierarchical mixed effect models, enabling us to estimate “individuality in stability”. Data analysis is still ongoing, but we expected that we would find evidence for “stable” and “unstable” singers, and that these differences are also linked to reproductive success. Preliminary results, indeed indicate the existence of individual differences in the stability of specific song features, as well as “plasticity in stability”.

Pedro Lopes Aguiar (Universidade Federal de Juiz de Fora) Room 4. Poster 3
Raphael Felipe Souza, Eduardo Borges de Oliveira, Renato Christensen Nali

Male aggressiveness in the tree frog *Dendropsophus branneri*: Physical combat, fighting call and escalated behavior

The evolution of aggressive behavior in animals is usually related with competition for resources. In frogs, male-male interactions occur in a myriad of forms and degrees, and are normally related with competition for females and/or territories. In species that reproduce in dense aggregations, aggressive interactions are common and may include chases, encounter calls, and physical combats. During fights, males may emit vocalizations - the fighting calls - although their exact function remains unknown. Detailed descriptions of male aggressive interactions in frog species are relatively scarce, especially in Brazil, which harbors the greatest diversity of frogs in the world. Herein, we describe for the first time a male-male fight of the Neotropical tree frog *Dendropsophus branneri*, as well as vocalizations emitted during this behavior (fighting calls) in southeastern Brazil. The fight occurred in a grass emerging from a pond, during which the males engaged in kicking and pushing one another while circling around the grass. One of the behaviors included the male grasping onto the grass with its feet, while throwing the other male to the bottom using its hands. We also observed a larger male chasing a smaller male while emitting vocalizations with a higher emission note rate and intensity compared to the advertisement call, likely encounter calls. Combined, our observations suggest an escalated aggressive behavior for the species, which is still poorly reported in frogs and is likely a strategy to avoid injuries. Our results will aid in future studies regarding the evolution of territoriality

and aggressiveness in this group, especially in light of a recent phylogeny of the genus, which comprises over 100 known species.

Sophie Harrower (University of St Andrews) Room 4. Poster 4
Malinda Carpenter

Testing problem-solving in lizards using a novel citizen science approach

Problem-solving has been widely documented in mammals and birds, but few studies have investigated this ability in reptiles. There are reports of positive findings in a handful of lizard species, but the abilities of the vast majority of lizard species have yet to be investigated. Using a citizen science approach, the problem-solving capabilities of pet lizards were tested remotely over Skype in collaboration with their owners. So far (testing is still in progress), a total of 18 lizards of various species have been tested using a novel problem-solving test wherein the animals needed to remove a lid from a dish to obtain a food reward. Of these, one bearded dragon and one starred agama have been successful in solving the test. All other participants were unsuccessful: they either did not pass the initial training phases or, if they made it to the test, did not make any attempt to interact with the apparatus. This study provides the first evidence of problem-solving ability in a starred agama and bearded dragon. It did not appear that these animals learned to solve the problem using trial-and-error learning: instead, they displayed behaviours suggestive of insightful problem-solving. This study is the first to successfully utilise a citizen science approach in the study of reptiles, highlighting the benefits of this approach in the study of nonhuman behaviour and cognition.

Jennifer Colbourne (University of Veterinary Medicine Vienna) Room 4. Poster 5
Alice Auersperg, Megan Lambert, Ludwig Huber, Christoph Völter

Adopting a New Tool for Comparative Tool Use Research

To date, nonhuman animal tool use research has largely maintained a categorical perspective; that is, describing what kinds of tools are being used and for what purpose. Despite this approach, there has been surprisingly little agreement about what actually constitutes tool use, which has allowed extraordinary claims to attain unmerited prominence through vague definitions. Fragaszy & Mangalam (2018) have proposed a complete reconceptualization of tool use, which is focused on the object, to “tooling”, which is instead focused on the action, more specifically the creation of a mechanical interface between the “tooler's” body, a grasped object and a target object/surface. The adoption of the tooling perspective not only offers a new interpretation of the existing tool use literature, but simultaneously establishes more conservative criteria with which to judge specific cases. The nonhuman animal literature is consistently filled with ill-supported, borderline and/or anecdotal reports of tool use in new species with little or no empirical support, which has blurred the line between instrumental problem solving and actual tooling, and has resulted in grandiose claims for these species' capabilities. In this paper, we highlight those problems and review Shumaker et al's (2011) comprehensive book on tool use to identify species that show tooling behaviors according to Fragaszy & Magalam's definition. We also extend tooling theory, which is primarily based in an ethological/psychological perspective, into the neurocognitive domain. Ultimately, the focus on tooling will help us identify behaviors that are better suited for a comparative cognitive investigation of tool use across species.

Denise Dalbosco Dell'Aglio (Smithsonian Tropical Research Institute) Room 4. Poster 6
Sebastián Mena; Rémi Mauxion; Owen W McMillan; Stephen Montgomery

Heritable changes in Heliconius flight behaviour is associated with different forest structures

Micro-habitat or niche partitioning plays a major role in shaping local patterns of biodiversity. In butterflies, stratification in flight height has an important role in maintaining community diversity. For example, closely related species can persist in sympatry by specialising on host-plants that are vertically stratified in the forest. However, little is known about the mechanisms by which these divergent flight behaviours evolve, or even the extent to which they are heritable. In *Heliconius* butterflies, speciation is often associated by strong assortative mating on colour patterns, but ecological isolation and local adaptation is generally considered essential for complete speciation. Despite its presumed importance in the early stages of speciation, the role of heritable behavioural shifts in response to differences in habitat structure is yet to be established. Here, we investigated variation in flight height behaviour in two closely related species, *H. erato cyrbia* and *H. himera*, which produce viable hybrids but are isolated across an environmental gradient, spanning lowland wet forest to high altitude scrub forest. We show that the two species fly at different heights in the wild, and demonstrate that this can be explained by differences in the vertical distribution of plant resources. We subsequently explored whether this divergence in flight height has a heritable component using common garden experiments. In both the wild and captivity, *H. himera*, choose to fly lower and feed at lower positions, mirroring differences in resource availability in the wild. We suggest that this shift in foraging behaviour may reflect local adaptation to divergent forest structures.

Ilori Babatunde Moses (Federal University of Agriculture) Room 5. Poster 1

Is the level of fear in domestic chickens related to breed and age?

Fear is an unwholesome emotion resulting from awareness of danger and the management of which is essential to the maximization of production efficiency in poultry enterprise. This study was designed to compare fear behaviour in commercial fast-growing broiler breed (Cobb 500), an improved indigenous slow-growing broiler breed, FUNAAB Alpha (based on selection from the Nigerian indigenous chicken (NIC) population for improved growth) and NIC using tonic immobility (TI) and inversion (INV) tests at the 4th and 6th week of age. Fifty birds of each breed were obtained and kept in different pens and managed under the same conditions. At week 4 of age, fifteen birds of each breed were randomly selected for TI and INV and was repeated when the birds were 6 weeks of age. The maximum duration allowed for TI was 300 seconds and 30 seconds for INV. To determine the effect of breed at week 4 and 6, data collected was subjected to Kruskal-Wallis test. The effect of age on the level of fear of each breed was analysed using Wilcoxon Two-Sample tests. Breed had a significant effect on the level of fear at week 4 and 6. At week 4, the duration of TI was higher in the Cobb 500 and FUNAAB Alpha than NIC. Result from the inversion test, the duration of flapping before the birds became still was greater in FUNAAB Alpha than Cobb 500 and NIC. At week 6, breed had a significant effect on TI and not INV. The duration of TI at week 6 followed the same trend as that of week 4. There was a significant effect of age on the level of fear in Cobb 500 (TI and INV) and NIC (TI). In Cobb 500, using the TI and INV, the level of fear increased with age. In Nigerian indigenous chickens, only TI of the birds increased with age. Interestingly, there was no age effect on the level of fear in FUNAAB Alpha. We conclude that the level of fear was higher in Cobb 500 and lower in NIC while level of fear also increased with age in Cobb 500 and NIC

Theo Robert (Newcastle University)
Dune Ganot, Tan Yi Ting, Yi-Jie Loh, Vivek Nityananda Room 5. Poster 2

Cue position in 3D space biases selective attention in praying mantises

In a world abundant with sensory stimuli, attentional processes provide important evolutionary advantages by helping animals focus on the most relevant stimuli. Since mantises are the only insects

known to have stereoscopic vision, they present a unique opportunity to investigate how the spatial and temporal characteristics of a 3D cue influence their selective attention. To do so, we fitted mantises (*Sphodromantis lineola*) with 3D glasses and fixed them 10 cm in front of a screen. We simultaneously presented the mantises with a high contrast target and a target of variable contrast, both simulated to be 2.5 cm in front of the mantis. In separate experiments, the targets were preceded by 3 types of cues simulated to be at 2.5 cm (3D cue) or 10 cm (2D cue) in front of the mantis, or at an impossible depth as a control. Each cue stayed on screen for either 4 s or 100 ms before the targets appeared, and were placed either on the side of the high contrast target or on the side of the variable contrast target. Finally, we also recorded a control condition without cues. Head saccades toward each target were recorded as our main measurement of target detection. We found that the effect of the cue was stronger when the cue was simulated to be at the same distance as the targets (2.5 cm) than in any other condition. Interestingly, however, the saccades of the mantis were biased away from the cue. This effect was stronger when the cue stayed on screen for 4 s but a similar trend was still seen when the cue was presented for 100 ms. Selective attention in mantises is thus influenced by the position of a cue in 3D space and its duration. The bias away from the side of the cue may be explained by the mantises' disinterest for a location where a potential prey (the cue) recently disappeared or by a masking effect of the cue, leading to a lower ability of the insects to detect a target at the same location.

Joanna R. Attwell (University of Bristol) Room 5. Poster 3
Dr Christos C. Ioannou, Dr Chris R. Reid, Dr James E. Herbert-Read

Fish avoid visually noisy environments that reduce their perceptual abilities

Animals' perceptual capabilities can be compromised by environmental noise, reducing their likelihood of detecting important cues or signals in their environment. How might animals respond to those constraints? One way would be for animals to avoid environments that challenge their perceptual ability, or alternatively increase their reliance on social information when perception became compromised. By immersing sticklebacks (*Gasterosteus aculeatus*) into virtual environments that differed in an ecologically relevant form of visual noise (flickering bands of light called caustics, ubiquitous in shallow-water environments), we tested how fish changed their habitat preferences, movements and social behaviour in response to changes in environmental visual noise. Faster moving caustic flicker reduced fish's abilities to visually detect prey in their environment, demonstrating that this common form of visual noise placed constraints on their perceptual abilities. In response, fish increased their activity in noise as a mechanism to move away from areas of higher visual noise, and when avoidance of these areas was not possible, adapted their social interactions with others . Our results highlight that animals can use behavioural strategies to mitigate the effects of environmental noise on their perceptual abilities, ultimately increasing their likelihood of detecting information in noisy environments.

Maria Loconsole (Università degli Studi di Padova) Room 5. Poster 4
Samuela Maria Pasculli, Lucia Regolin

Left and right, black, or white? Young domestic chicks spontaneously associate luminance with spatial position

Humans often associate non-redundant information across different sensory modalities, i.e. crossmodal correspondences. E.g., we match high luminosity with high pitches and low luminosity with lower sounds. Three-month-old infants and some non-human species (i.e. chimps, monkeys, and dogs) showed crossmodal correspondences akin to adult humans, suggesting a shared origin (at least among mammals). Limited, or no experience was seemingly required, although its role was not

specifically investigated. Here we aimed at investigating visual-spatial crossmodal correspondences in a precocial avian species, i.e. the domestic chicken, providing evidence from a non-mammalian species and, at the same time, deepening the role of experience. Three-day-old chicks were presented with two identical panels, either black (low luminance) or white (high luminance), placed on the left and right side in an arena. Subjects could approach and circumnavigate either panel to obtain a food reward. Consistently to what reported for humans, chicks circumvented more often the left panel in the low luminance trials (black panels) and toward the right one in the high luminance trials (white panels). The control group, tested with two grey cardboards, showed no spatial preference. Based on our data, we hypothesized that crossmodal correspondences might rely on an inborn spontaneous associative mechanism for multisensory perception. This is consistent with evidence of multimodal integration of information reported in many animal species, included the domestic chicken. Moreover, as such mechanism is shared between different species, it might date back to an old ancestor, common to mammals and birds.

Kelly J Robinson (University of St Andrews) Room 5. Poster 5
Neil Hazon, Sean Twiss and Patrick Pomeroy

'Love made flesh'; Positive oxytocin feedback loops, pro-social behaviour and energetics.

Oviposition decisions can have important fitness consequences for offspring. We investigated the responses of European bitterling, *Rhodeus amarus*, a freshwater fish that spawns in the gills of living unionid mussels, to oviposition site cues. Using an artificial mussel, we manipulated the flow velocity, dissolved oxygen concentration and odour cues of mussels presented to *R. amarus*. Females responded positively to mussel odour and to dissolved oxygen cues. Male response was dependent on mussel odour and the flow velocity of water emerging from the artificial mussel. These responses are potentially adaptive, with females responding to cues that indicate the quality of oviposition sites for incubation of eggs. Males responded to cues with implications for optimal sperm allocation.

Emma Tivey (The Roslin Institute, The University of Edinburgh) Room 5. Poster 6
Sarah Brown, Vincent Bombail, Birte Nielsen, Alistair Lawrence, Simone Meddle

Elucidating potential neural correlates for positive affect induced by tickling in female and male juvenile Wistar rats.

Positive welfare is considered to be not simply the absence of suffering but also the presence of positive experiences. 'Tickling' has been shown to induce positive affective states in laboratory rats as evidenced by the production of 50 kHz ultrasonic vocalisations (USVs). Tickling studies have shown inconsistent results of the response to tickling between male and female rats and few studies have investigated positive affect in female rats alone. Therefore, whether female and male rats respond differently to being tickled and the positive affect induced by tickling is not well understood. It was hypothesised that female rats exhibit different behavioural responses and neural correlates to tickling than male rats due to sex-specific neural regulation of positive affective states. Rats (n=32/sex) received either tickling (Tickled, n=16/sex) or no hand contact (Controls, n=16/sex). Play behaviours and USVs were quantified. Rats were culled and their brains taken: double-labelled immunohistochemistry was used to quantify c-fos expression (a marker of neuronal activity) in oxytocinergic neurons of the paraventricular nucleus of the hypothalamus (PVN); these neurons project to the reward circuitry and are thought to play a vital role in coding the rewarding nature of prosocial behaviours. We found that tickled female rats produced significantly more 50 kHz USVs than any tickled male or control rats ($p<0.001$) but the number of trill 50 kHz USVs (associated with reward and positive affect) did not differ significantly between tickled females and tickled males ($p= 0.133$). Tickled rats had significantly more active magnocellular ($p=0.006$) and parvocellular ($p=0.014$)

oxytocin neurons in the PVN and this was independent of sex. This suggests a role of the oxytocin system in aspects of positive affect, which may not differ between male and female rats. Elucidating the neurobiological basis of positive affect will develop our understanding of the importance of positive welfare.

Poster Session Two

Toby Champneys (University of Bristol) Room 1. Poster 1
Dr Christos Ioannou, Prof Martin Genner

Invasive Nile tilapia dominates a threatened indigenous tilapia in competition over shelter

Invasive species are one of the greatest threats to freshwater ecosystems globally. However, the causal mechanisms that drive negative impacts of many invasive species are poorly understood. In Tanzania, non-native Nile tilapia (*Oreochromis niloticus*) exists in sympatry with a diverse range of native species, many of which are congenerics with strong niche overlap. It has been suggested that *O. niloticus* can displace native species from preferred habitat through dominance during interference competition, yet interference competition between *O. niloticus* and a native tilapia species has never been directly tested under experimental conditions. In this study juvenile *O. niloticus* and Manyara tilapia (*Oreochromis amphimelas*), a functionally similar but endangered Tanzanian cichlid, were size matched in conspecific and heterospecific pairs. We presented pairs with limited shelter and recorded competitive interactions. We found that *O. niloticus* were more aggressive and faster to initiate agonistic interactions than *O. amphimelas*. Furthermore, *O. niloticus* showed a strong competitive dominance in their interactions with *O. amphimelas*. One-sided dominance hierarchies can drive fundamental changes in resource use by subordinate individuals, potentially resulting in habitat displacement over the long term. Based on this experimental evidence, we conclude that *O. niloticus* may threaten native tilapia species through dominance in interference competition.

Nicky Staes (University of Antwerp) Room 1. Poster 2
Verena Behringer, Daan W. Laméris, Jonas Verspeek, Edwin J.C. van Leeuwen, Marcel Eens, Jeroen M.G. Stevens

When the Peter Pan ape grows old: Changes in sex, play and aggression with age in bonobos

Typically, the behavioural dichotomy between bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*) is highlighted, presenting bonobos as peaceful, playful and highly sexual. However, a majority of studies investigating bonobo behavioural patterns rely on small sample sizes of rather young and often related individuals living in the same institution. Behaviour in small groups can easily be influenced by outliers, differences in management protocols and demographic factors like age and sex. Research has also shown that as a result, between-group cultural differences exist within bonobos. To obtain a more comprehensive picture about bonobo behaviour, here we analyse the play, aggressive and sociosexual behaviour of a large cross-sectional sample of 64 bonobos housed in six European zoos, ranging in age from 0 to 61 years. Each bonobo was followed using a combination of focal and all occurrence sampling. We analysed behaviour in relation to age and sex of the subjects. We found that age significantly influences all three behaviours in bonobos, and that the behaviour of

adolescent individuals in their early teens differs significantly from older adults, and for aggression and sociosexual behaviour it changes in a sex-specific manner. While play and sociosexual behaviour are more frequent in adolescents, levels of aggression do not peak until later in life, around age 18 for females and 35 in males. These results show that the extent to which bonobos fit the stereotypical profile of being the Peter Pan ape is actually age and sex dependent and can highly vary between social groups depending on demography. This study has implications for the interpretation of bonobo behaviour and thus cautions against generalizations about a long-lived species based on small samples of relatively young individuals.

Durosaro, S.O. (Federal University of Agriculture) Room 1. Poster 3
Iyasere, O.S., Ilori, B.M., Odubola, T.A., Adewunmi, A., Oyeniran, V.J., Ozoje, M.O.

Plumage colour differences in fear behaviour of Nigerian indigenous turkeys at early life

Fear is a painful emotion excited by danger. It is one of the primary emotions that govern the way an animal respond to its social and physical environment. The deleterious consequences of fear include injury, pain, reduced productivity and death. The three major plumage colours of Nigerian indigenous turkeys are black, white and lavender and the effect of plumage colour on fear behaviour in this turkey breed is yet to be reported. This study examined the effect of plumage colour on fear behaviour in Nigerian indigenous turkeys. Tonic immobility, attention bias, inversion and emergence tests were used to measure fear behaviour in Nigerian indigenous turkeys with different plumage colours (n=45, with 15 each of white, lavender and black). Tonic immobility and emergence tests were conducted when the birds were 7 and 9 days old, respectively. Inversion and attention bias tests were done when the birds were 14 and 15 days old, respectively. The maximum duration allowed for tonic immobility, emergence and attention bias tests was 300 seconds and 30 seconds for inversion. Kruskal-Wallis test was used to determine the effect of plumage colour on the fear responses while Spearman rank correlation was used to determine the relationship among the fear responses in the birds. All the fear responses were not significantly ($Pr>0.05$) affected by plumage colour except emergence. The highest latency to emerge was observed in lavender turkeys (mean rank: 28.57) while the least was observed in black turkeys (mean rank: 14.93). All the correlation coefficients among the fear responses in all the plumage colour types were either low or negative except a moderate positive correlation of 0.53 observed between attention bias and inversion in black turkeys. This study concluded that fear behaviours were similar in Nigerian indigenous turkeys with different plumage colours except emergence and one fear test cannot be used in place of another one in Nigerian indigenous turkeys at early life.

Hella Péter (University of Kent) Room 1. Poster 4
Dr Catherine Hobaiter

Emergence and spread of well-digging behaviour in a community of wild East African chimpanzees (*Pan troglodytes schweinfurthii*)

Wild chimpanzees have group-specific behaviour patterns that are potentially cultural, relying on socially transmitted information. Research on the spread of novel behaviours in wild chimpanzee populations, and whether it is via social transmission, is scarce. Innovation is rarely observed, and spread within or between communities is limited by conformity and observer-bias towards older and more dominant individuals. Here we describe the appearance and spread of a well-digging behaviour in a naïve community (Waibira, Budongo) of wild East African chimpanzees (*Pan troglodytes schweinfurthii*), apparently introduced by an immigrant female in 2014. We used camera-trap and handheld camcorder videos collected between 2012 and 2019 to trace how well-digging spread, and to which individuals. We coded the videos for year, individual identity, sex, age, and the type of

digging-related behaviour performed or observed (well-digging, digging, observing another individual well-digging, water play). We found that both the number of well-digging events and all digging-related behaviour increased across subsequent dry seasons after 2014. Females were more likely to dig wells or observe well-digging as compared to males, and only adult females served as models for others observing well-digging. The four individuals observed to repeated dig wells were three adult females, and one juvenile female. No adult males were recorded engaging in any digging-related behaviour, despite frequently visiting the waterhole. We discuss the possible cultural nature of well-digging, as well as its potential adaptive benefits, and how both of these might influence its further spread.

Jakub Szymkowiak (Adam Mickiewicz University) Room 1. Poster 5

Interspecific social learning of novel mobbing calls recognition in wild birds

Mutual recognition of mobbing calls among bird species being vulnerable to the same predators is ubiquitous and involves even distantly related heterospecifics. However, how individuals of different species gain an ability to recognise each other's calls remains unclear. Here, I provide experimental evidence that under natural conditions, birds (wood warblers, *Phylloscopus sibilatrix*) can acquire this ability through interspecific social learning. I used robust experimental design and, in the absence of an actual predator, trained naïve wood warblers to recognise the initially unfamiliar sounds as mobbing calls by matching these sounds with familiar heterospecific mobbing calls during repeated training playbacks. Moreover, I assessed the persistence of socially-learned recognition. Initially, wood warblers ignored the unfamiliar sounds, but learned to recognise them as mobbing calls after the training. Once learned, the recognition of novel mobbing calls was retained over at least two weeks. These results demonstrate that under natural conditions, birds can acquire an ability to recognise novel heterospecific mobbing calls through interspecific social learning, by associating unfamiliar and known heterospecific alarm signals. Such a mechanism of learning is likely to be common in the wild and result in a rapid cultural transmission of novel anti-predator signal recognition within avian communities.

Thibault Tamin (Université de Lyon)
Blandine Doligez Room 1. Poster 6

Assortative mating for between-patch dispersal status in a wild bird population: exploring the role of direct and indirect underlying mechanisms

Functional integration between dispersal and other phenotypic traits allowing individuals to alleviate dispersal costs have been reported, and such associations can affect dispersal evolution in return. In sexually reproducing species, assortative mating according to dispersal can shape the maintenance of these trait associations. Despite the potentially crucial consequences of dispersal in natural populations, assortative mating with respect to dispersal and its underlying mechanisms remain largely unexplored. Here, we assessed assortative mating for between-patch dispersal status in a fragmented population of a small passerine bird, the collared flycatcher, and explored whether such assortative mating could result from (i) direct mate choice based on dispersal or behavioural (aggressiveness, neophobia and boldness) and morphological traits (tarsus, wing and tail length, body mass and condition) potentially linked to dispersal, (ii) biased mate choice due to spatio-temporal heterogeneity in the distribution of dispersal phenotypes and/or (iii) post-mating adjustment of dispersal phenotype or associated traits. We found intrinsic assortative mating (i.e. intra-pair correlation) with respect to the current (i.e. in the year of mating) dispersal status but not to natal dispersal status or to the behavioural and morphological traits investigated. The probability for pair members to be assorted by current dispersal status depended on within-pair similarity in age. We thus

identified assortative mating by age as the most likely underlying mechanism for assortative mating by dispersal status, through a bias in the distribution of dispersal phenotypes among age categories. More work is needed to understand the evolutionary implications for such an age-based assortative mating for dispersal.

Carolyn Dunford (Queen's University Belfast) Room 2. Poster 1
Nikki J. Marks, Christopher C. Wilmers, Caleb M. Bryce, Barry Nickel, Lisa L. Wolfe, D. Michael Scantlebury, and Terrie M. Williams

Surviving in steep terrain: A lab-to-field assessment of locomotor costs for wild mountain lions (*Puma concolor*)

Current scenarios of climatic change and habitat loss restrict wild animals to novel, energetically challenging environments, where steep terrains may heighten individuals' travel costs and accelerate the decline of populations in new localities. We applied a laboratory-to-field approach to examine how terrain steepness impacts locomotor costs of pumas (*Puma concolor*). The oxygen consumption of trained pumas was measured during treadmill locomotion, and incline walking was 42% more costly than level travel. GPS and accelerometer loggers measured the daily energy expenditure (DEE) of free-ranging pumas in the Californian Mountains. Pumas minimised the energetic impact of incline travel by choosing to walk on shallower paths and by walking more slowly when climbing steeper slopes. Calculations show that a 20° increase in mean terrain steepness would increase daily energy expenditure by <1% as pumas spent a small (10%) proportion of their day travelling and avoided elevated costs by utilizing slower speeds and shallower paths. While many factors influence survival in novel habitats, we demonstrate the importance of behaviours which reduce locomotor costs when traversing new, energetically challenging environments.

Elham Nourani (Max Planck Institute of Animal Behavior) Room 2. Poster 2

Sea-crossing behavior in terrestrial birds is limited more strongly by wind than by lack of uplift

The open sea is considered an ecological barrier to terrestrial bird movement. However, over-water journeys of many terrestrial birds, sometimes hundreds of kilometers long, are being uncovered by bio-logging technology. To understand how these birds afford their flights over the open sea, we investigated the role of atmospheric conditions in subsidizing sea-crossing behavior at the global scale. By analyzing forty years of temperature data, we show that the spatio-temporal patterns of sea-crossing in terrestrial migratory birds correspond to favorable uplift conditions. We then analyzed route selection over the open sea for four bird species with varying levels of dependence on soaring flight, representing all major migratory flyways worldwide. Our results showed that favorable uplift conditions, albeit not as common and as powerful as over land, are not rare over the open seas and oceans. Moreover, wind, which is more variable than uplift in its spatio-temporal distribution, is the determining factor in the birds' route selection over the open sea. Our findings suggest a need for revisiting how ecological barriers are defined, to reflect what we know of animal movement in the era of bio-logging.

Elisa Perinot (University of Veterinary Medicine Vienna) Room 2. Poster 3
Johannes Fritz, Leonida Fusani, Bernhard Voelkl

High-precision GNSS loggers for studying flocks of free-flying birds

Many birds engage in seasonal long migrations, flying sometimes for thousands of kilometers no-stop. Several species fly in V-formation or echelon formation and it has been put forward that these would

allow birds to save energy. However, collecting data on this phenomenon is quite challenging first because almost all birds taking part in the formation need to be equipped with loggers and then because high-precision positioning data is required to study in-wake flying. During a human-guided autumn migration of Northern bald ibis (*Geronticus eremita*) we could for the first time equip all birds of a flock with high-precision GNSS loggers and collect data about free-flying birds. Usually, tracked animals are equipped with GPS loggers, which return positional data at best accuracy of ± 2.5 m. Instead, our units collect signals from several satellite constellations, GPS, GLONASS, and Galileo, and save only the raw satellite data, without delivering directly the positions. To obtain the positional information, the data undergoes post-processing that allows to check data quality, to filter it for signal strength, and to correct for typical inaccuracies of this method, like ephemeris error or atmosphere disturbance. This returns cm-level precision positioning and opens the opportunity to explore in-wake flying, formation flight, and other aspects of flock dynamics during free-flying. I will present these data obtained from six flights of the migration and the new method we developed to collect the raw data and extract the positioning information. Moreover, I will also illustrate the first promising results showing that birds prefer to fly in a specific position behind another individuals, which might suggest in-wake flying.

Victoria Franks (Royal Holloway) Room 2. Poster 4
John Ewen, Mhairi McCready, Rose Thorogood

Foraging behaviour alters with social environment in a juvenile songbird

Early independence from parents is a critical period where social information acquired vertically may become outdated, or conflict with new information. However, across natural populations it is unclear if newly-independent young persist in using information from parents, or if group-level effects of conformity override previous behaviours. We tested if wild juvenile hihi (*Notiomystis cincta*, a New Zealand passerine) retain a foraging behaviour from parents, or if they change in response to the behaviour of peers. We provided feeding stations to parents during chick-rearing to seed alternative access routes, and then tracked their offspring's behaviour. Once independent, juveniles formed mixed-treatment social groups, where they did not retain preferences that we detected when with parents. Instead, juvenile groups converged over time to use one access route per group, and juveniles that moved between groups switched to copy the locally-favoured option. Juvenile hihi did not copy specific individuals, even if they were more familiar with the preceding bird. Our study shows that early social experiences with parents affect initial foraging decisions, but social environments encountered later on can update transmission of arbitrary behaviours. This suggests that conformity may be widespread in animal groups, with potential cultural, ecological, and evolutionary consequences.

Kelsey Bezaire (University of Edinburgh) Room 2. Poster 5
A. Lawrence; M. Farish; A. Futro; M. Brims; S. Brown

Validating a Worn Tracking Device to Measure Pig Behavioural Activity under Barren and Enriched Environmental Conditions

This study evaluated a wearable activity tracker (Noldus TrackLab), as a tool to collect behavioural activity of individual commercial pigs (*Sus scrofa domesticus*) kept in group housing. The aim explored whether TrackLab can be used to measure variations in pig behavioural activity based on environmental conditions. To achieve this, behavioural differences were stimulated by housing pigs in either barren (B) or environmentally enriched (EE) treatment groups. In the first experiment, 32 juvenile pigs were allocated to EE or B conditions and 16 male pigs, balanced across treatments, were selected to wear the tracking device via clip to the ear tag. Data from estimated peak activity periods

was compared between TrackLab outputs (Distance) and ethogram data collected from video recordings. General Linear Modelling suggests significant differences in Distance by Date ($F_{5,76}=9.2$, $p<0.001$), Treatment ($F_{5,76}=17.35$, $p<0.001$) and the interactions of Treatment & Date ($F_{5,76}=3.92$, $p=0.003$) and Treatment & Weight ($F_{1,76}=16.84$, $p<0.001$). Overall, observed activity behaviours held significant correlations (Spearman's Rho, $p<.05$) to Distance, though these correlations were all nonsignificant ($p<0.05$) on the final day of the study. Distance significantly ($p<0.001$) correlated over more days to static activity (Stationary) than Locomotion. Principal Component Analysis (PCA) results indicate Distance grouped with some activity-related behaviours (Dimension 1, 53.7% of variance). In the second experiment, the study design was altered to collect continuous data over a longer period of time with the aim of further testing the validity of TrackLab distance travelled against ethogram derived data. This suggests relative TrackLab distance measures may reflect pig movements and some behaviours. Pending further validation, TrackLab may be used as a means to collect data on individuals housed in group settings and may aid research exploring the interaction of environment and behaviour.

Yoonjung Yi (Nanjing Forestry University) Room 2. Poster 6
Ani Mardiastuti, Jae. C. Choe

Family dynamics: intra-group social interactions in a pair-living primate, the Javan gibbon (*Hylobates moloch*)

A growing body of studies suggest that pair-living species have more flexible social interactions than previously thought. Gibbons are a good example of pair-living species which exhibits complex intra-group social relationships. We investigated the dynamics of intra-group social interactions with a special focus on the adult female-male pair and parent-offspring dyads in three groups of wild Javan gibbons (*Hylobates moloch*) in Gunung Halimun-Salak National Park, Indonesia. Among all group members, adult males spent the highest proportion of time grooming other individuals. Males groomed females more than vice versa as infants became independent and females neared cycling. Among the parent-offspring dyads, fathers extensively groomed juveniles, suggesting an important role of paternal care in the species with prolonged juvenile periods while mothers mostly took care of infants through body contact (*e.g.*breast-feeding) and carrying. Parent-offspring conflicts in Javan gibbons might not be severe as they have long developmental periods with gradual weaning. Our results suggest that Javan gibbons have dynamics in a way they socially interact with their family members and especially adult males have important roles in both pair bond maintenance and parental care.

Clémentine Mitoyen (University of Vienna) Room 3. Poster 1
Cliodhna Quigley, Simon Wölfl, Virginie Canoine, Silvia Columbo, & Leonida Fusani.

Temporal synchronization of multimodal courtship signals affects female sexual behaviour in the ring dove (*Streptopelia risoria*)

Multimodal courtship displays (i.e. displays involving more than one sensory modality) are widespread in the animal kingdom. To understand the function of these signals, individual components have been investigated, however, their configuration and how modalities are temporally and spatially synchronized have received little attention so far. We used high-speed audio-visual playback of male ring dove courtship to investigate how females responded to stimuli differing in the extent to which the visual and acoustic parts of the courtship were temporally synchronized. Additionally to unmanipulated courtship, we presented to females a temporally shifted stimulus and an asynchronous stimulus. The shifted stimulus was composed of the same acoustic and visual part as the natural courtship, but the acoustic channel was shifted relative to the visual by a fixed value. In

the asynchronous stimulus, calls were placed randomly along the visual channel, without conserving the natural timing between calls like in the shifted and in the natural stimulus. We presented three groups of females with the same type of stimulus every day for a week, and their behaviour was recorded. We found that females responded more to playback than to control. Additionally, circling behaviour (a likely sign of sexual stimulation) increased over the week only in the synchronous condition. This study shows that audio-visual playback can be efficiently used in doves to study sexual communication. In addition, we showed that synchronization of multimodal elements has effects on female response. This stresses the importance of the signals' configuration in multimodal communication, as information is likely to be contained in the temporal association between different modalities.

Emily Burdfield-Steel (University of Amsterdam) Room 3. Poster 2
Elise Fruitet, Thomas Blankers, Astrid Groot

The price of beauty - costs and consequences of pheromone variation in a moth

In many insect species females attract mates via long-range pheromones. Although this form of chemical communication depends on fixed proportions of different compounds in order to attract the correct species, intraspecific variation can still be found. Such variation can be driven by reproductive character displacement. However the role of other processes, such as costs associated with pheromone production, remains controversial, particularly in Lepidoptera where pheromone production is expected to be cheap. *Heliothus subflexa* co-exists with a closely-related species, *H. virescens* across parts of its range. The species have very similar pheromone blends and can hybridize, although cross-species matings are costly. Cross-species attraction is inhibited by a single component of their pheromone blend, (Z)11-hexadecenyl acetate which is attractive to *H. subflexa* males, but acts as an anti-aphrodisiac to *H. virescens.* Female *H. subflexa* show geographic variation in the production of these acetates as they produce greater amounts when in sympatry with *H. virescens*, and can even increase acetate production in response to exposure to *H. virescens* pheromones. Given the benefits of acetates for conspecific mate attraction in this species it remains unclear why the production of acetates is reduced in the absence of *H. virescens*. We used selection lines for high and low acetate production in *H. subflexa* females to investigate the costs and consequences of this variation for mate attraction and survival. Male *H. subflexa* were more attracted to pheromones containing acetates, and this was unaffected by selection on female pheromone - confirming the expected lack of linkage between male preference and female signal. However, when the two lines were reared under resource limitation, differences in survival were revealed. Our results suggest that, while they may increase female attractiveness, the production of high levels of acetates does indeed come at a cost during development.

Ginny Greenway (University of Florida) Room 3. Poster 3
Emily Angelis & Christine W Miller

How does the timing of weapon loss influence reproductive traits in the insect *Narnia femorata*?

Males across many species invest in elaborate and costly weapons in order to secure access to mates. Whilst permanent loss of one of these sexually selected weapons is assumed to reduce competitive ability and, therefore, reproductive success, this is not always the case. In the leaf footed bug *Narnia femorata*, autotomy (loss of a weaponized hind limb) reduces competitive success but leads to the growth of larger testes. However, the extent to which this resource reallocation can occur likely depends on the developmental stage at which weapon loss occurs. To investigate whether the capacity to respond to autotomy changes over the course of development, we assigned fourth instar juveniles, fifth instar juveniles, newly eclosed adults and two-week-old adults to either control

(unmanipulated) or autotomized (induced left hind limb loss) treatments. The ability to reallocate resources to testes mass in response to autotomy appears to disappear upon eclosion to adulthood, by which point males have already invested in their enlarged hind leg weapons. We also uncover potential behavioral compensation for weapon loss in the form of increased mating duration, which may provide autotomized males with a post-copulatory advantage. These findings highlight the dynamic nature of individual investment in pre- and post-copulatory sexually selected traits.

Fedra Bollatti (Universidad Nacional de Córdoba) Room 3. Poster 4
Alfredo V. Peretti, Anita Aisenberg

Neither so monogamous nor so sacrificed: the possibility of alternative reproductive tactics in *Allocosa senex*.

Alternative reproductive tactics refer to different ways to obtaining fertilization in both males and females, resulting in the selection of certain traits, and eliminating intermediate expressions as a way to maximize fitness. Therefore, some individuals will invest in privileged access to partners, while others will exploit their congeners' inversion. *Allocosa senex* is a wolf spider that shows a reversal in sex roles and in sexual size dimorphism, meaning that females search for partners and start courtship, being also the smallest sex. Males construct burrows, wait for females to locate them and be chosen as sexual mates. After successful mating, females will inhabit the males' burrow and leave it for spiderling dispersal. However, since the male burrow donation is energetically costly and has negative implications for individuals' weight, the evolutionary conditions for the emergence of alternative reproductive tactics are ideal. In this context, males may visit and mate with females inside the burrows of prior partners avoiding burrow construction costs. We aimed to evaluate male ability to find mated females inside other males' burrows and test female receptiveness to re-mating. For the sexual trials, we exposed 20 mated females inside the previous males' burrows to new males. We found that males of A. senex can detect and court mated females in this situation (45%), while 25% of females accepted re-mating. Although the tendency to re-mate was low, females responded similarly to the courtship of a male who offered her a refuge compared to a male who did not offer the construction, being able to mate in both cases. The males of A. senex can perform an expensive tactic, such as the construction of energetically demanding structures to attract mates and care for the offspring, or omit these costs and exploit the investment of their competitors to gain access to mates. These findings reveal that sexual dynamics in this species are much richer than expected.

Nikolaos Smit (Institute of Evolution Sciences of Montpellier) Room 3. Poster 5
Marie Charpentier, Elise Huchard

Sexual coercion in mandrills (*Mandrillus sphinx*), costs and benefits

Female mating strategies in mammalian societies might be constrained by sexual conflicts, resulting from diverging evolutionary interests between the sexes. Such sexual conflicts may be intense in some primates: males might, for example, incite females to mate with them and/or prevent them from mating with rivals by means of physical coercion, mate-guarding or intimidation, leaving only little space for female choice. Therefore, soliciting various males or picking particular ones, may have nothing to do with the expression of female choice, but instead reflect the outcome of sexual coercion. Here, we focus on the only long-term studied wild-living mandrills, a primate with an extreme sexual dimorphism, but where females can form coalitions against males. We aim to ascertain the mechanisms through which mating is accomplished and test the hypothesis that sex is coerced in this species. Under sexual coercion hypothesis, we predict that (1) male aggression is directed towards cycling females (more than females in other reproductive states), (2) sexual coercion is costly to females (through analyses of injuries and stress patterns), and (3) coercion increases male mating

success. Preliminary results support the two first predictions, indicating that cycling females receive significantly more aggression and are more injured than females in other reproductive states. Regarding the last prediction, we are currently investigating the temporal coupling between males' aggression towards cycling females and their mating success with the victims. Our results will be discussed in the light of current knowledge of sexual coercion in primates.

Jordan Milner (University of Sheffield) Room 3. Poster 6
Paul Blackwell, Mu Niu

Two's Company, Three's a Crowd: Modelling the Movement of Interacting Animals

Improvements in tracking technology mean that it is now often possible to monitor the movements of several individual animals in a wild population simultaneously, using GPS tags, collars or similar devices. This creates exciting opportunities to learn about the way in which animals interact, and so improve our understanding of social structure, impacts of anthropogenic activity etc. Currently, however, these opportunities are largely unexploited, as typically the analysis of movement data is carried out separately for each animal or for a population as a whole. We aim to develop a statistical model that realistically captures the ways in which social animals influence each other's movements and behaviours. Our approach is based on the concept of social hierarchies, which is embedded in a multivariate diffusion process that models the movement of a group. The inclusion of behaviour state switching facilities the ability to capture dynamic interactive behaviour - enabling us to gain insight into how social changes evolved over time. Furthermore, we model the animal's behaviour naturally in continuous time. Results from fitting the model to GPS locations of wild baboons will be presented, where we can gain rich insight such as which animals have high levels of influence and which subsets frequently connect.

Sanne Van Donink (University of Antwerp) Room 4. Poster 1
Jeroen M.G. Stevens, Marcel Eens, Edwin J. C. van Leeuwen

Group-level variation in social tolerance across two neighbouring communities of chimpanzees (Pan troglodytes)

Social tolerance in group living animals can be viewed as a counterweight against competitive interests necessary to obtain coexistence equilibrium and maintain group cohesion. As such, it forms an interesting phenomenon to study at the group-level, but how can this be done most informatively? Here, we use three group-level co-feeding assays and analysis of independent proximity networks to study tolerance in two neighbouring groups of chimpanzees (N1 = 11, N2 = 13) living within the Chimfunshi Wildlife Orphanage Trust, Zambia. The assays comprised the peanut swing, the peanut plot -characterized by depleting resources- and a novel juice pipe experiment which has replenishing resources. All three assays were scaled on group size, such that the larger group obtained proportionately more resources. Proximity networks were constructed based on focal follow data (total of 120 hours across 130 sampling days) and analysed for association strength and social differentiation. Our aims were to *i*) assess whether co-feeding tolerance may be a group-specific parameter in chimpanzees and, in conjunction with previous findings, derive inferences about its long-term stability, and *ii*) compare the characteristics and resultant patterns between the two established and the new assay. In conjunction, the three assays exposed the same group-level differences as in the original study eight years ago, thereby providing evidence for stability in group-specific levels of co-feeding tolerance in chimpanzees, despite changing group compositions. The more tolerant group also had higher mean associations which were more evenly distributed over all group members. Further, we identified the new assay as more valid based on the consideration that resource depletion may differently affect the need for tolerance across groups. We end by delineating implications for

the study of social tolerance and highlight the importance of taking into account intraspecific variation in social animals.

Martin Seltmann (University of Turku) Room 4. Poster 2
Emily Lynch, John Jackson, Laura Zanette, Win Htut, Mirkka Lahdenperä, Carly Lynsdale, Virpi Lummaa

Links between the social landscape, faecal glucocorticoid metabolites and parasite load in semi-captive Asian elephants

Though living closely with others may heighten the spread of disease, as well as lead to competition and conflict, social behaviors can also have positive effects, including enhanced access to resources and protection during times of need. Beyond such immediate benefits, it is possible that social interactions culminate in improved health and fitness. However, our understanding of the link between sociality and fitness is often restricted to model systems and difficult to tease apart in wild populations. Here, we use a unique and comprehensive dataset from semi-captive working elephants from Myanmar to examine the relationship between sociality and health in a highly social, long-lived mammal. This dataset provides an exceptional opportunity to study the effects of sociality and health: mortality rates, reproductive profiles, and social behaviours resemble those of wild elephants, and the Myanma Timber Enterprise maintains detailed log-books on each individual. We use the term "social landscape" to identify four measures of sociality (solitariness, work group size, group sex ratio, and presence of calves in the group) and explore variation in individual stress (faecal glucocorticoid metabolite level; FGM) and parasite load (faecal nematode egg count; FEC). We found that male elephants had significant reductions in FGMs both when actively maintaining social ties with conspecifics and when working in a group with a more female biased sex-ratio. Females, on the other hand, exhibited a significant decrease in FGMs when immature elephants were present in the same work group. In addition, when calves were present in a group, adults showed lower FECs. Interestingly, work group size was not related to FGMs in males nor in females, but to FECs, with adults in larger groups having lower FECs. Here we provide a link for understanding costs and benefits of group living in natural populations and highlight the importance of the social landscape for animal welfare and management.

Ishani Mukherjee (Indian Institute of Science Education and Research) Room 4. Poster 3
Anuradha Bhat

Shoals under threat: Immediate response of wild zebrafish shoals to predator cues

1Shoaling in fishes is regulated by a variety of factors like predation, vegetation cover, water flow and food availability. In our current study, we focus on one major factor- i.e., predation to understand the role of cues from a natural predator, the snakehead *Channa sp.,* on shoaling in wild zebrafish (*Danio rerio*). Zebrafish shoals (n= 60) comprising ten fishes were recorded for twenty minutes after exposure to a predator cue (visual or olfactory) or both cues together. In control experiments, shoals received no predator cue. Generalized linear mixed models followed by post hoc tests suggested the largest subgroup was significantly larger among shoals exposed to predator cue (compared to controls) and it did not change significantly across twenty minutes for all treatments. We also performed a detailed characterization of shoal properties across the different predator exposure conditions. We found that: (i) Shoal cohesion, depicted in heatmaps, increased significantly in the presence of any of the cues. (ii) Polarization was significantly greater in shoals receiving a predator cue, suggesting a shift from more shoaling to more schooling in presence of a predator cue. (iii) Shoals receiving both cues exhibited lower shoal centroid speeds than shoals receiving either cues. (iv) We observed differences in interaction (leader-follower interactions and contacts) frequencies between shoals receiving both

cues and shoals receiving a single cue. Zebrafish relied on both visual and olfactory cues (of a given concentration) to escape predation. While visual cues informed the zebrafish on the position of the predator, olfactory cues gave information about the presence of predators. Our results suggest, presence of both cues can have a synergistic effect and enable fish to detect a predator more accurately. We speculate that such plastic responses over generations in high predation pressure populations have led to the evolution of tighter shoal formations.

Morgan Welch (University of Chester) Room 4. Poster 4
Dr. Christina Stanley, Dr. Charlotte Hosie, Prof. Tessa Smith, Dr. Eluned Price, Dominic Wormell

Social Experience of Captive Livingstone's Fruit Bats (*Pteropus livingstonii*)

There are now approximately 1200 Livingstone's fruit bats (*Pteropus livingstonii*) globally due to acute threats from an increased frequency of extreme weather events and chronic land encroachment onto roost sites on their native Comoros archipelago. To safeguard this species, a captive breeding population was established in 1992 from 17 wild individuals by the Durrell Wildlife Conservation Trust in conjunction with the Comorian government. This population has since grown to 80 individuals, 67 of which are housed at Jersey Zoo, Channel Islands. Little is known of the social experience of this species in captivity or how that information may be used to maximize their welfare in the present and shape effective reintroduction strategies in the future. To describe the social structure and investigate social roles in this population, novel social network techniques were employed on behavioural data collected over two seasons. Networks based on associative, affiliative, and aggressive social interactions were significantly complex with 3-4 types of interaction occurring at different frequencies. There was positive network assortment based on age and dominance level, and individual social roles (defined by node metrics) remained consistent over a ten-month period. The results highlighted in this talk and the corresponding paper can be practically applied to the zoo-based management of the Livingstone's fruit bat and other fruit bat species. We recommend that to improve captive welfare and breeding success, relationships between individuals of similar ages and dominance levels should be allowed to persist where possible and separating individuals that interact frequently in an affiliative context should be avoided. This information is particularly relevant to the relocation of individuals to other institutions or to separate zones within the enclosure. In this way, the welfare of this population of Livingstone's fruit bats can be maximized through evidence-based management.

Jonas Torfs (University of Antwerp) Room 4. Poster 5
Nicky Staes; Edwin J.C. van Leeuwen; Jonas Verspeek; Kim Vermeulen; Marcel Eens; Jeroen M.G. Stevens

Constructing individual social tolerance measures using a non-monopolizable food source test in bonobos and chimpanzees, and the role of age, sex, and social network position

Social tolerance has been compared between bonobos and chimpanzees, but with contradictory results, possibly due to large within-species variation. While variation in group and dyadic tolerance has been studied before, individual variation in tolerance and the underlying factors have never been quantified in these species. Previous studies were also often based on a single study group per species, or differed in methodology, making inter-species comparisons difficult. We conducted a standardised test for social tolerance in 2 groups of chimpanzees (N=22) and 3 groups of bonobos (N=21), using a non-monopolizable food source, the pasta plot. Behaviour of the apes during this test was video recorded for 10 minutes and scored afterwards with a standardised ethogram, focussing on 6 different behaviours of individuals in the plot. Principal component analysis revealed two factors that explained 71.0% of the total variance in behaviour. We labelled the first factor Participation, a factor reflecting

how much time was spent near the food source and eating the food; and the second Tolerance, a factor reflecting a higher number of neighbours in proximity to the food source and more relaxed and passive food sharing. We further investigated the role of sex, age, and the position in a grooming-based social network on individual scores for these two factors. Neither Participation nor Tolerance scores differed significantly between sexes in either species. Tolerance scores increased with age in chimpanzees, but not in bonobos. Individuals scoring high on Participation had a more central position in the social network, but scores for Tolerance were independent of social network position. These results show that, when considering multiple aspects of food-related tolerance in a large multi-group sample, bonobos and chimpanzees do not show consistent between-species differences. Large within-species variation is found, and can partially be explained by social network position and age.

Tommaso Ruberto (Liverpool John Moores University) Room 4. Poster 6
Adam R. Reddon, Jamie L. Talbot

Head up displays are a submission signal in the group-living daffodil cichlid

Dominance hierarchies can reduce conflict within social groups and agonistic signals can help to establish and maintain these hierarchies. Behaviours produced by subordinates in response to aggression are often assumed to function as signals of submission, however, these behaviours may serve other purposes, for example, defence or escape. For a behaviour to act as a submission signal, the receiver must respond by reducing their likelihood of further aggression towards the signaller. In the current study, we examine the receiver response to a putative signal of submission, the head up display, within established social groups of the cooperatively breeding fish, the daffodil cichlid (*Neolamprologus pulcher*). We found that when subordinate signallers produce the head up display in response to aggression from the breeder male, he exhibited a longer latency to behave aggressively towards that individual again. We also report that head up displays are rarely produced without being elicited by aggression, and the number of head up displays correlates with the amount of aggression received. Our results demonstrate that the head up display is used as a signal of submission in the daffodil cichlid and provide insight into intragroup communication in an emerging model system for the study of social behaviour.

Gilbert Roberts (Independent Researcher) Room 5. Poster 1

Honest signalling of cooperative intentions

Trust can transform conflicting interests into cooperation. But how can individuals know when to trust others when choosing social or sexual partners? Here, I develop the theory that reputation building may signal cooperative intent, or ‘trustworthiness'. I model a simple representation of this theory in which individuals (1) optionally invest in a reputation by performing costly helpful behaviour (‘signalling' e.g. by allogrooming); (2) optionally use others' reputations when choosing a partner; and (3) optionally cooperate with that partner. I show that costly helping behaviour evolved into an honest signal of trustworthiness when it was adaptive for cooperators, relative to defectors, to invest in the long-term benefits of a reputation for helping. This occurs when cooperators gain larger marginal benefits from investing in signalling than do defectors. This happens without the usual costly signalling assumption that individuals are of two ‘types' which differ in quality. Signalling of trustworthiness may help explain phenomena such as philanthropy, pro-sociality, collective action, punishment, and advertising in humans. It may be particularly applicable to courtship where animals may honestly signal that they will make cooperative mates.

Alice Clark (University of Liverpool) Room 5. Poster 2
Ross MacLeod

Foraging behaviour, habitat use and overwintering survival of house sparrows in an urban environment

House sparrows (*Passer domesticus*) have experienced severe declines in the UK since the 1970s, particularly in urban and suburban areas. Although house sparrow survival and population growth has been studied in the past, little has been done on the relationship between habitat use and overwintering survival, particularly in an urban environment. This study investigates the overwintering population changes and habitat of house sparrows in an urban environment and seeks to determine the main factor influencing these population changes. Based on earlier research in the breeding season, it was predicted that cover and food availability would be the main factors influencing overwintering survival, and that a trade-off would be observed between predator avoidance and active feeding and foraging behaviours. These results show that house sparrows preferentially select habitats with higher availability of hedges and medium trees, and lower mean distance from cover which are all factors likely to reduce predation risk. Despite the strong habitat preferences found, population growth did not appear to be limited by these factors. Behaviour of house sparrows was largely influenced by the accessibility of cover and a trade-off was found between predator avoidance behaviour and boldness. Questions to address in future research include if the amount of cover from predators can predict survival rate of a colony of house sparrows, and if population growth is limited by the number of bird feeders and quality of food in a garden in comparison to simply the presence or absence of feeders. Improving our understanding of habitat selection is useful for conservation of not only house sparrows but many other declining species by determining habitat types to target for habitat management and restoration.

Marcell Boviz (University of Veterinary Medicine, Budapest) Room 5. Poster 3
Andras Kosztolanyi, Agnes Satori

Behaviour disorders in pet parrots: an exploratory study of potential risk factors

Companion animals, such as parrots, often demonstrate behaviour disorders in captivity for example feather damaging behavior, aggression, and stereotypies. These signs can suggest compromised welfare. However, researchers have not yet found clear evidence about the etiology of these disorders. 2. In this study, we sampled 493 individuals of 54 different parrot species through an online survey system, filled out by parrot owners. We tested for demographic, life-history, environmental and nutritional factors that might be associated with behavioral disorders. We included the factor hand-rearing, a technique commonly used by breeders, that the literature often links with behaviour disorders. 3. The survey consisted of 52 questions. It was advertised in non-species-specific social media groups and forums. To eliminate the chance of sampling bias owners were not aware of the survey's main objectives before completion. The results were analyzed with mixed-effects multinomial logistic regression, with the owner as a random factor; Chi-square test; and Fisher's exact test. We only included parrot species with sample sizes larger than 15 in the statistical analyses. A subsample of 16 birds from the surveyed population was evaluated on-site to validate the reliability of the questionnaire. 4. We found significant associations with the following predictor variables: species ($p<0.001$), solitary caging ($p= 0.022$), and age cluster ($p=0.028$). From the analyzed pet parrot species two showed behavior disorder rates higher than 50% (*Agapornis roseicollis*: 72%, and *Psittacus erithacus*: 59%). These two species might be more sensitive to captivity than others. Additionally, keeping individuals alone had a clear association, 85% of solitary birds had behavior disorders. Age was also an expected predictor since individuals are more likely to develop any disorder with increasing lifetime. However, we found no evidence that hand-rearing is associated with behavior disorders.

Wafa Abudayah(University of Sheffield) Room 5. Poster 4
Helen Hipperson, Penelope Watt

Gene expression varies with level of anxiety in zebrafish

Individual differences in behaviour across time and contexts are often referred to as personality traits. These traits are known to be under genetic control but the underlying mechanisms are not well known. In this study, I investigated whether zebrafish with different levels of anxiety, a consistent behavioural trait, showed differences in gene expression and whether there were candidate genes associated with this trait. Total RNA was extracted from the brains of male and female zebrafish that varied in their level of anxiety. Sequenced reads were mapped to the zebrafish reference genome and expressed genes identified. Several genes were differentially expressed depending on zebrafish anxiety level and sex. This study suggests that individual behavioural differences in anxiety might be controlled by differences in gene expression.

Stefano Bigiani (Zoomarine) Room 5. Poster 5
Cristina Pilenga

The Bell Sound Theory

For humans, the breaks represent a real welfare tool; capable of improving health, performance, and promoting social bonds' consolidation. The use of the break does not concern only humans but, on the contrary, other animals have the habit of separating activities with some breaks, which have similar effects to those manifested in humans. In this study, we tried to transfer these positive effects to animals living in a controlled environment. Thus, we theorized that the absence of clear signals correlated to the breaks could lead to ambiguous situations in which animals, not knowing they are on pause, do not benefit from its effects. Starting from this hypothesis, we have enunciated a theory that we have called The Bell Sound theory. This argues that using a signal capable of informing the animals when they are on a break allows them to take full advantage of its beneficial effects. Our results support this hypothesis. In fact, during the sessions preceded by a signal associated with a pause, the dolphins reduced both attention behaviors and the time spent with the head above the water while they increased social behaviors. Therefore, our study emphasizes the correctness of the theory developed and suggests that it can be applied to promote animal welfare.

Costanza Zanghi (University of Bristol) Room 5. Poster 6
Christos Ioannou, Martin Genner, Andy Higginson, Amy Deacon, Jeremy Biggs

Effects of turbidity on predator-prey interactions in fish

Human activities are exacerbating environmental change globally. Levels of turbidity in freshwater systems are increasing due to extreme weather events and intensification of upstream human activities like deforestation and quarrying. Even low levels of turbidity can reduce visibility with impacts on fish behaviour that have ecological-level consequences. A number of studies have tested for the effects of turbidity on predator-prey interactions in fish but show mixed results. In our review of the literature, we found 74 papers assessing the effects of turbidity on predator-prey interactions in freshwater fish. A weak majority of studies (62%) assessing turbidity effect on anti-predator behaviour reported an overall decrease of risk awareness in prey in turbid compared to clear conditions. However, 49% of studies on prey survival reported negative effects of turbidity, i.e. greater mortality in turbid water. Similarly, many studies (54%) on predators also reported negative effects of

turbidity in terms of lower attack rates and smaller prey size selection. This demonstrates the wide variety of results found in how turbidity impacts predator-prey interactions. However, predicting if a change in turbidity will favour prey or predator species greatly depends on predator traits (non/visual or piscivorous/planktivorous), their life stage and the prey species. Importantly, most papers reviewed looked at turbidity in isolation as a single stressor. The review highlights the need to test effects of turbidity with other environmental parameters, particularly potential stressors, and predator and prey traits under environmentally realistic conditions.