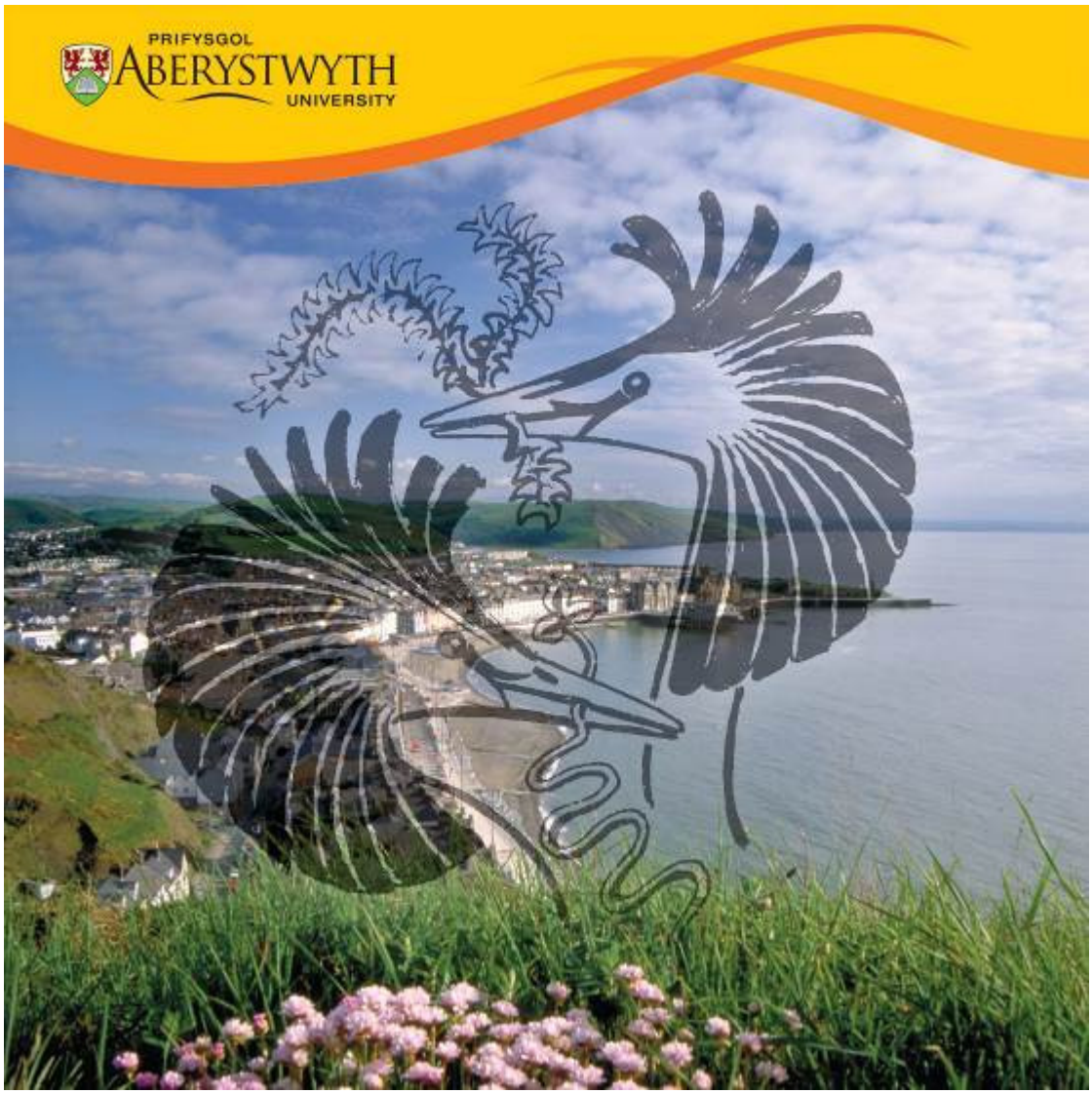
ASAB Easter Conference 2016

30th March – 1st April

Aberystwyth University

ABSTRACTS



Association for the Study of Animal Behaviour

Abstracts for Talks – in order of presentation

Thursday 31st March

9.20 **Dr Lauren Brent**, Exeter University
Social network based insights into the evolution of animal behaviour

10:30 TEA & COFFEE in Medrus Hall

11.00 **Jessica Mitchell** & HJ Nichols, Liverpool John Moores University
Mum's the word: Female reproductive state is detectable via scent in banded mongooses

In social species odour cues often encode multimodal information. This makes it difficult to interpret how they function solely in reproductive decision making. Using a wild, but habituated population of the banded mongoose, Mungus mungo, we tested whether members of each sex could discriminate between female odours based on the reproductive state (pregnant or non-pregnant) of the odour-donor. Due to the long term data available for our population we could control for the effects of familiarity and relatedness in our analysis, providing a novel assessment of how female reproductive state influences response to odours. Female banded mongooses showed elevated responses when odours were of the same reproductive state as recipients. These results support the intra-sexual competition function of scent marking; females appear to increase scent marking toward odours which represent direct competitive threats. However scent marks may also influence mate choice in this system as male recipients showed increased marking behaviour toward odours from receptive donors than those from pregnant donors. Together results suggest reproductive state is detectable via scent, and that this information could be used in reproductive decision-making by both male and female banded mongooses.

11.15 **Lia Gilmour**, G. Jones, M. Holderied, S. Pickering, Bristol University
Deterring to conserve: evaluating bat deterrence methods for use at wind turbines.

Noise pollution is a serious threat to many animals, as it can change their behaviour and therefore their ability to carry out vital life history traits, such as foraging, finding shelter and finding mates. Being reliant on echolocation to orientate and capture prey, bats are especially sensitive to ambient sounds in their environment. Bats will avoid traffic noise in foraging experiments, either because a masking effect of the sound precludes the use of echolocation, or simply as it is an aversive stimulus. The aversion of bats to this type of acoustic stimuli has led to the development of bat deterrent speakers. Acoustic deterrents have been suggested

along with radar and light as potential mitigation measures for when bats come into contact with human built structures. One application is to deter bats from approaching wind turbines (which pose a significant threat to volant animals such as birds and bats). My PhD therefore aims to evaluate methods to reduce bat fatalities at wind farms in the UK, focussing specifically on developing bat deterrence methods. I will present research findings from my first field season, where I tested the effectiveness of radar and acoustic deterrents at bat foraging sites.

11.30 **Javier Abalos**, G. Pérez i de Lanuza, P. Carazo, E. Font, Valencia University
The role of male coloration in the outcome of staged contests in the European common wall lizard (*Podarcis muralis*)

Colour signals play a key role in regulating the intensity and outcome of animal contests. Males of the common wall lizard (Podarcis muralis) show conspicuous ventrolateral UV-blue and black patches, and ventrally some populations display a striking colour polymorphism (i.e. discrete orange, white and yellow morphs). In this study, we set out to evaluate the potential agonistic signalling function of these patches by staging combats between 60 size-matched adult lizards (20 per morph). Combats were held in a neutral arena, with each lizard facing rivals from the three morphs in a tournament with a balanced design. We then calculated a fighting ability ranking using the Bradley Terry model, and used it to explore whether morph, the size of UV-blue and black patches, and/or the spectral characteristics (brightness, hue, chroma) of UV-blue patches are good predictors of fighting ability. Our results show that the size of black patches is a good predictor of fighting ability. In addition, we also found that orange males were more likely to lose than win fights against yellow and white males. In light of these results, we discuss the potential signalling function of both ventrolateral and ventral colour patches in mediating agonistic encounters in this species.

11.45 **Emily Churchill**, York University
Consequences of Plasticity: How do Individual Conditions Affect Physiology, Longevity and Copulatory Behaviours in Drosophila?

Drosophila melanogaster are a polygamous species: males and females repeat copulation with multiple mates. When more than one male's sperm have to compete to fertilise the same female's eggs, sperm competition occurs. This has driven individuals to develop physiological and behavioural plastic responses to enable them to out-compete others and increase their chances of siring successful offspring. However, plasticity comes with a cost and reproductive-survival trade-offs often occur.

When an individual is stressed, it is possible that it will not be able to afford the energetic cost required to reproduce and survive. It may opt to exert all of its remaining energy into producing successful offspring, rather than conserving energy for survival, despite being close to death – known as reproductive terminal investment.

To test this, Drosophila melanogaster were placed under age, sperm competition and starvation stresses; and changes to physiology, longevity and copulatory behaviours were observed. Weaker flies were less active and had a shorter lifespan. They also tended to exert less energy into courtship or rejection behaviours; however they were often observed to be investing in longer copulation durations. However, increasing sperm competition lead to decreased courtship and copulation efforts. This suggests a trade-off is occurring somewhere – but where?

12.00 **Natasha Price**, Exeter University
Crabs, Patterns & Camouflage: Do shore crabs (Carcinus maenas) develop different pattern formations depending on background and does camouflage technique vary between habitats?

Camouflage is the most widespread anti - predator defence system in the animal kingdom and an invaluable survival strategy for animals facing high predation risk. Shore animals regularly become exposed when tide levels are low, making them highly vulnerable to predatory birds. Here, I discuss the adaptive benefit of two different camouflage techniques; background matching and disruptive colouration, in the common marine species the European green shore crab (*Carcinus maenas*). Using edge detection software, I aim to assess how the method adopted may vary depending on the habitat occupied by this highly adaptable and widespread marine species. Previous work has shown that shore crabs change the brightness of their carapace over consecutive moults, becoming lighter or darker in colour as a result of being kept on a black or white artificial background. I explore this capability further, using patterned and uniform backgrounds to assess whether shore crabs are capable of developing or losing patterns over a period of 12 weeks. Using the visual system of a predatory bird as a model, I use image analysis techniques to quantify carapace pattern change whilst providing an accurate representation of prey concealment across different backgrounds.

12.15 **Michael Harrap**, Dr Sean Rands, Dr Heather Whitney, Bristol University
Bumblebees recognise flowers by temperature patterns: novel floral cues

Pollinating insects utilise a variety of floral cues in order to identify and learn the more rewarding flower species they encounter in their environment. The ability to do so is key for foraging efficiency and providing pollination services to the plants they visit. In addition to colour, scent, texture, and electrostatic cues, bees are able to use floral temperature as a cue to distinguish flowers.

When floral temperatures are observed with infra-red thermography, it is seen that the temperature often differs between different parts of the flower, creating a temperature structure or pattern. We observe the floral temperature patterns presented by different floral species. These are then classified into five common patterns to create a framework that aims to summarise the variety of floral temperature patterns seen in nature.

Using differential conditioning techniques, we show that bumblebees can distinguish artificial flowers that differ in temperature patterns comparable to those seen in nature. This suggests that the variety of floral temperature patterns observed represents a newly discovered floral cue that can be utilised by pollinators to recognise rewarding flowers.

12.30 LUNCH – Hot & Cold meals available for purchase in Ta Med (below Medrus Hall)

13.30 **Arnaud Badiane**, G. Pérez i de Lanuza, J. Abalos, S. Reguera, E. Font, M. Whiting, P. Carazo, Macquarie University
Strategic and tactical design of color signals in the common wall lizard *Podarcis Muralis*

Podarcis lizards show cryptic dorsal colorations designed to avoid predators and enhance thermoregulation, and conspicuous ventral or lateral colorations that function as chromatic signals. Ventral colorations are pigment-based and appear to play a role in mate choice, while laterally most Podarcis display ultraviolet (UV)-reflecting colour patches seem to act as quality signals and are under strong sexual selection. In this study, we sampled 916 lizards (455 females and 459 males) from 11 populations across a 400-2000m altitude gradient. We then examined: 1) the relationship between UV coloration (i.e. brightness, hue and chroma) and morphometric (e.g. head size, digit ratios, fluctuating asymmetry) and performance (i.e. bite force) variables to examine the potential functional content of these signals and 2) inter-population co-variation between the spectral characteristics of UV and ventral colorations and local visual ecology (i.e. irradiance, background colour) to study the existence of adaptive local variations in the tactical design of UV signals and ventral colorations. Our results highlight the importance of UV and ventral colorations as intra-specific signals in this species, and offer some insight into the socio-ecological factors underlying its design.

13.45 **Anna Frohnwieser**, T.W. Pike, J.C. Murray, K. Covalin, A. Wilkinson, Lincoln University
Which cues do bearded dragons *Pogona vitticeps* use to learn about their environment?

Learning about the environment is vital for survival, and different species attend to different perceptual cues, which is likely to depend on their sensory systems and experience. Very little is known about stimulus salience in reptiles. Using a classical conditioning procedure we trained bearded dragons (*Pogona vitticeps*) to associate a particular colour (C+) and scent combination (S+) with a positive environment, and a different colour (C0) and scent (S0) combination with a neutral environment. Animals were then given a binary choice between the stimulus combinations, in four testing conditions: C+S+ vs. C0S0; C+S0 vs. C0S+; C+ vs. C0; and S+ vs. S0. The animals chose the positive colour and scent combination significantly more often than the neutral colour and scent combination, and, when the cues were put in conflict, preferred the positive colour over the positive scent. This is one of the first studies

comparing visual and scent learning in reptiles and therefore provides valuable insights into their perceptual capabilities and the information that they attend to in the environment when making decisions.

14.00 **Rebecca Pike**, J.M. McNamara, A.I.Houston, Bristol University
Describing mortality risk as more than one effect gives better predictions of parental behaviour.

Using an optimality model we establish a new expression to determine the optimal behaviour for parents raising offspring when care can take on more than one form (e.g. giving the young food versus being vigilant for predators) and when mortality to both the parent and its young are considered. We illustrate our approach by considering the special case that the parent's reproductive value is dependent on just the size of its young. Our model predicts that as the young grow in size and value, a parent should reduce its provisioning rate and spend a greater proportion of time being vigilant for predators.
We consider mortality functions for both the parent and young such that mortality is described in terms of background mortality risk and mortality risk dependent on parental behaviour. Mortality functions of this nature generate novel predictions of parent behaviour.
A parent should invest a greater proportion of time to being vigilant as opposed to feeding the young with an increase in the mortality risk of the young dependent on the provisioning rate of the parent. An increase in other forms of mortality risk prompts an opposite effect.
Our new expression shows that mortality risk should be described as multiple effects to fully predict how a parent should behave.

14.15 **Khia Dobbinson**, L. Morrell, Hull University
Visual predation: confusion effects in a turbid environment

Groups can be visually confusing to predators, leaving them unable to 'lock on' to and successfully target a particular individual, reducing the number of successful attacks. This 'confusion effect' results from an overburdened visual system and can be overcome by targeting distinct or odd individuals (the 'oddity effect'). Behavioural experiments using stickleback (*Pungitius pungitius*) predators and Daphnia prey demonstrate that certain group characteristics, like size and density, can enhance confusion effects requiring predators to change their behaviour in order to maintain feeding rate.

14.30 **Mary Friel**, H. P. Kunc, K. Griffin, L. Asher & L. M. Collins, Queen's University Belfast
Acoustic signalling reflects personality in a social mammal

Social interactions among individuals are often mediated through acoustic signals. If acoustic signals are consistent and related to an individual's personality, these consistent individual differences in signalling may be an important driver in social interactions in animal societies. However, few studies in non-human mammals have

investigated the relationship between acoustic signalling and personality. Here we show that acoustic signalling rate is repeatable and is strongly related to personality in a highly social mammal, the domestic pig (*Sus scrofa domestica*). Furthermore, acoustic signalling showed some flexibility, with males from a poor quality environment having a reduced vocalisation rate compared to females and males from an enriched environment. Such differences may be influenced by personality, with pigs from a poor quality environment having more reactive and more extreme personality scores compared to pigs from an enriched environment. Our results add to the evidence that acoustic signalling rate reflects personality in a non-human mammal. Signals reflecting personalities may have far reaching consequences in shaping the evolution of social behaviours as acoustic communication forms an integral part of animal societies.

14.45 **David Wells**, Bielfeld University & Liverpool John Moores University
Disassortative mating for MHC class II heterozygosity in the grey seal

The major histocompatibility complex (MHC) is the most important part of the vertebrate immune system and is also often involved in mate choice. In the grey seal 70% of pup survival is determined by MHC class II heterozygosity. Despite the benefits of multiple alleles, grey seal populations only have five different MHC class II alleles. This begs the question of how MHC diversity is maintained in this species. Using MHC linked microsatellites I detect disassortative mating with respect to MHC class II but not class I heterozygosity. This heterozygosity is heritable and therefore mate choice produces offspring with an intermediate MHC class II heterozygosity. This suggests a cost to high MHC class II diversity which could limit the number of alleles in a population.

15.00 TEA / COFFEE

15.30 **Catherine Carrick**, Hull University
Forager responses to patch size, density and purity: exploring resource concentration and resource dilution effects

Two opposing hypotheses predict how resource density should affect a forager's functional response: the resource concentration hypothesis (RCH) predicts increasing vulnerability to attack in densely aggregated patches, whereas the resource dilution effect (RDE) predicts decreasing vulnerability to attack with increased aggregation. Empirical tests show attack rates that align with either RCH or RDE, or show density-independence of attack rates. My project explores the effect of wheat crop density and purity and their interaction, on 1) attack rates by aphids and 2) parasitoid attack rates on aphids.
Results show there was no significant interaction between purity and density on aphid numbers. Aphids were attracted to pure plots ($P=0.00148$), aligning with RCH, but an effect of low density occurred ($P=0.0164$), aligning with RDE. There was a significant interaction between purity and density in low density pure plots that

affected parasitisation (P=0.0314), aligning with a RC in terms or purity, but RD in terms of density, and is concurrent with previous findings.
The next steps are to explore the concurrent effects of patch density/purity and aphid number on parasitoid numbers, to explore the resource factors that drive attack rate by parasitoids, and to confirm my interpretation of the results in line with the two hypotheses.

15.45 **Tamsin Shepherd-Waring**, S. Dalesman, R. Santer, Aberystwyth University
Effects of early life predation events on the behaviour and consistency of hatchling and juvenile pond snails

Many aquatic species rely on chemical information to determine predation risk, and are able to adjust behavioural responses based on current threats in their environment. In the pond snail, (*Lymnaea stagnalis*), information collection starts during embryonic development. Previous studies have shown that exposure during the embryo stage, to chemical cues released from a predatory fish increase the response to predator cues shortly after hatching. However, it is not known if this response is due to elevated stress during development or specific to the predator threat. In this set of experiments, snail embryos were exposed to specific (predator) and generalised (injured conspecific) threat cues during embryo development. Individuals were then tested for behavioural responses to predation threat post hatching and as 3 month old juveniles to determine: 1) whether the impact of embryonic experience lasts beyond hatchling stage; 2) if embryos learn specific information about predation threat or respond to it as a general stress; and 3) whether individuals demonstrate consistency in threat avoidance between hatching and late juvenile stages. The data are discussed in terms of how the potential reliability of information received in embryonic stages can impact on the plasticity and consistency in behaviour throughout early life.

16.00 **Nicola Davidson** & J. Hurst, Liverpool University
Differential avoidance of predator and competitor odours by small rodents.

The response of animals to the odours of their predators and heterospecific competitors may vary with species specific constraints and context. To examine the role that species specific constraints have on predator and competitor odour avoidance, I tested three small rodent species with a predator odour and a competitor odour in semi-natural enclosures. All species avoided the predator odour, but only two avoided the competitor odour. The differential avoidance of the competitor odour may relate to species specific constraints, such as the potential for a speedy escape. Further to this experiment I tested the same three small rodent species with the same predator odour in a laboratory test arena. Only two species avoided the predator odour in laboratory arenas, implying that the context of predator odour presentation is important in establishing natural responses. This result has implications for the design of behavioural experiments using odours and other stimuli. Under naturalistic conditions, the costs of encountering predators is

likely to be similar between these rodent species, but the costs of direct interaction with a competitor may be quite different.

16.15 **Syuan-Jyun Sun** & R.M. Kilner, Cambridge University
Variation in the Extent of Local Adaptation between Burying Beetles and their Phoretic Mites

Symbiotic organisms adapt to one another, but the extent of adaptation can vary among pairs of the same symbiotic species drawn from different populations. Here I investigate whether this can be attributed to the nature of the interspecific interaction – ie whether it is commensal or mutualistic – using burying beetles and their phoretic mites as a model symbiosis. Burying beetles carry mites to carrion, which both species require for reproduction. Mites and beetles breed alongside each other on the carcass and during this time exert their greatest influence on each other's fitness. I analysed the interactions of mites and beetle drawn from two adjacent Cambridgeshire populations, Gamlingay Woods (G) and Waresley Woods (W). I found that G mites had a net positive effect on components of G burying beetle fitness, whereas W mites were neutral in their effect on W burying beetles. With a reciprocal transplant experiment, I found that beetles and mites were locally adapted to each other in the G population. However, in the W population, mites were locally adapted to beetles but beetles were not locally adapted to their mites. The results thus show that a mutualistic interaction promotes reciprocal local adaptation while a commensal relationship does not.

16.30 **Georgina Glaser**, D.M. Shuker, S.D.Healy, St Andrews University
Are the foraging preferences of male rufous hummingbirds context-dependent?

When making decisions, animals must evaluate the available options. Animals can either use absolute evaluation, where a resource or option has a fixed value, or they can use comparative evaluation, where the value of an option depends on the other options available (i.e. values are context-dependent). To determine whether male rufous hummingbirds (*Selasphorus rufus*) use comparative evaluation when making foraging decisions, we first quantified sucrose concentration preference functions, with arrays of six options spanning 5% to 55% sucrose. Males preferred higher concentrations, peaking in preference at 45%. Second, we determined the effects of a low quality, "decoy" option on foraging preferences. We therefore presented males with a binary choice of: (1) 35% and 45%, or 45% and 55% sucrose, followed by a trinary choice of (2) 5%, 35%, and 45%, or 5%, 45%, and 55% sucrose, where 5% acted as the "decoy" option. In the binary treatments, males showed no preference for either option, contrasting with the preference function in the first experiment. In the trinary treatments, males only showed a preference for 45% when it was paired with 55%. These data show that option availability can determine preferences and that the role of "decoy" options can themselves be context-dependent.

Friday 1st April

9:30 **Dr Iain Barber**, Leicester University
Nest building in a warmer, wetter and 'wormier' world: insights from Spineless Simon, Frisky Phil and friends

The construction of a nest, to provide optimal conditions for the development of offspring, is a taxonomically widespread behaviour that plays a critically important role in the reproduction of many species. In the face of environmental change, nest-building animals may therefore need to adjust their nesting behaviour to ensure conditions for their offspring remain optimal, but are nesting species capable of such plastic responses? If so, which behaviours are altered, and what are the likely fitness costs associated with behaviour change? In this talk, I will examine the problems faced by nest-building animals in aquatic environments subject to anthropogenic perturbation, and outline recent experimental studies examining responses to environmental change in a nest-building fish, the three-spined stickleback.
**Spineless Simon and Frisky Phil were nest-building sticklebacks that shot to fame on BBC's 'Springwatch' series in 2015. IB acted as scientific advisor to the developing story. For a summary of their antics, check out https://www.facebook.com/BBCSpringwatch/videos/873165546110288/*

10:30 COFFEE & TEA in Medrus

11.00 **Joanne Dorning**, Bristol University
Social dynamics in urban foxes

I used remote sensing to study the social lives of urban foxes (*Vulpes vulpes*) and investigate how groups of solitary foragers operate when living at high density. I conducted 28 seasonal camera trapping surveys in the territories of seven fox social groups in northwest Bristol and collected over 152,000 photos of foxes. Individual foxes could be identified in 98% photos using a combination of visual features. Initially I defined territory residents as foxes sighted on ≥50% survey days. Mean group size varied seasonally and was highest in autumn and winter coinciding with the dispersal and mating seasons, both times of high inter-territorial movement. Yet foxes moved between territories year round and at least 30% of all visitors were known neighbours, suggesting that social groups defined by space use appear more fluid than expected. Group membership in two territories appeared unstable, in one case this was considered due to the departure of a dominant male.
I then used social network analysis techniques to characterise social relationships within individual territories. Foxes had preferred and avoided companions and associations were stable over a maximum of 3 consecutive seasons. Ongoing analysis

will reveal further details on social group organisation, cohesion and spatiotemporal activity.

11.15 **Ginny Greenway**, V Balfour, DM Shuker, St Andrews University
Do female seed bugs choose to avoid mating failure?

It is becoming increasingly clear that copulation does not lead to offspring production in many organisms, despite fertilisation success presumably being under both strong natural and sexual selection. In the seed bug Lygaeus simulans, between 40-60% of copulations fail to produce offspring, with this 'mating failure' representing a significantly repeatable, male-associated trait. Mating has been demonstrated to be costly in this species and, as such, we might expect females to minimise the chance of mating failure by displaying a preference for males with higher insemination success where possible. After assaying males for mating success or failure, we asked whether females preferred previously successful males over unsuccessful males in pairwise mate choice trials. Despite the fact that larger males were significantly more likely to successfully inseminate female in the initial assay phase, females showed no preference for these larger males in choice trials and, overall, no preference for more successful over less successful males. This apparent lack of female pre-copulatory choice suggests that post-copulatory choice mechanisms may be key to interpreting mating failures in this species, with broader implications in turn for the role of mating failure in determining the costs of choosiness, sexual conflict and multiple mating.

11.30 **Drew Picken**, J. Gaycken, T. Pike, A. Wilkinson, Lincoln University
Mechanisms Underlying String Pulling Behaviour in Green-Winged Macaws

Competence in the pull-up string pulling test has been suggested to result from an understanding of the link between the string and the reward (means-end comprehension), trial and error learning (operant conditioning) or innate behaviour. The pull down test, being non-intuitive, removes the possibility of completion due to innate behaviour and tests if means-end comprehension or operant conditioning is the underlying mechanism. Twenty green-winged macaws were divided into two groups; the experimental group were presented with the string pull up test using a single string and, upon completion, with a non-intuitive pull down test using a single string, the control group were only presented with the pull down test. Six parrots from the experimental group successfully completed the pull up task and five were successful from the first trial. However when presented with the non-intuitive pull down test no bird from either group was successful in retrieving the reward although birds in the experimental group tried pulling the string but failed to complete the

actions needed to reach the reward. This suggests that string pulling behaviour in green winged macaws is based on operant conditioning as the macaws failed to show understanding of the link between the string and reward.

11.45 **Ellis Langley** & Jayden van Horik, Exeter University
The relationship between social rank and spatial learning in the common pheasant

The relationship between an individual's position in a social hierarchy and their performance on cognitively demanding tasks are unclear. In male pheasants (*Phasianus colchicus*) dominant individuals obtain a territory and acquire a harem of females, whereas subordinate males behave as satellites and move between territories. Social rank therefore leads to differences in home range size and use of the environment. We established social rank among captive male pheasants using the Elo-rating method based on the outcomes of aggressive interactions during the breeding period in a mixed sex pen. We explored the relationship between an individuals' social rank and their performance on a maze task as chicks, before the social hierarchy is established. We also investigated whether this relationship is evident in adults using a spatial discrimination task. As chicks, future subordinate males solve the maze task faster whereas future dominants investigated more cells and take longer to exit. As adults, these dominant males outperform subordinates on a spatial discrimination task. We found that the relationship between spatial learning and social rank is dependent on age and the type of spatial learning task. We discuss the reasons and implications why social rank may influence learning speed.

12.00 **Benjamin Jarrett**, M. Schrader, R.M. Kilner, Cambridge University
Experimental evidence that interacting phenotypes modulate the capacity for evolutionary change.

Predicting the rate at which populations evolve and adapt in a rapidly changing world is a major challenge for evolutionary biology. Classical models of evolution rarely accurately predict evolutionary change in wild populations exposed to natural selection. Theory suggests this may in part be attributable to social behaviour with conspecifics. These social interactions create a social environment that may itself evolve, generating interacting phenotypes between individuals that potentially affect the direction of evolutionary change. Here, we describe experiments on the burying beetles, *Nicrophorus vespilloides*, an insect that displays elaborate parental care, in which we manipulated the social environment experienced by developing larvae by removing parents before hatching. We used an artificial selection experimental design and imposed directional selection for body size in both directions, in two social environments. We found that the social environment

imposed by parents influenced the capacity for evolutionary change and the direction in which change occurred. Our results demonstrate that social traits can profoundly influence the subsequent course of evolution.

12.15 **Marylka Griffiths**, D.Feary, C.Wade, Nottingham University
How do populations persist within an extreme environment: genetic connectivity of coral reef fish across the Arabian Pensinsula

Resolving patterns of population connectivity in the ocean is necessary for fishery management, conservation and in answering key questions in evolutionary ecology. A main theme in terms of understanding population structure can be how environmental and oceanographic factors shape communities. Such questions weave an understanding of genetic and demographic patterns against the importance of environmental gradients and oceanographic processes. The dispersal and movement of individuals may be enhanced or limited by environmental and physical factors, which may then impact gene flow within and between populations.

My work is focused on the Arabian Gulf, which has the largest thermal SST range globally, while also showing extremes in salinity. This system is connected to the Indian Ocean which has much more benign oceanic conditions of a typical tropical marine system. Does the environmental gradient across these regions act as a potential barrier to survival and larval dispersal of fish communities across this peninsula? I will show how populations of the coral reef associated fish, *Lutjanus ehrenbergii*, are shaped across the Arabian Peninsula, using genetic analysis to describe patterns of genetic connectivity and how such connectivity may be impacted by regional environmental barriers to the movement and survival of this species' larvae.

12:30 LUNCH – Hot & Cold meals available for purchase in Ta Med (below Medrus Hall)

13.30 **Hannah West**, & I. Capellini, Hull University
Exploring the Evolutionary Relationships Between Male Care and Social Monogamy in Mammals

The direction of the evolutionary association between male parental care and social monogamy has been long debated. Recent findings in mammals indicate that the evolution of male care follows the evolution of social monogamy rather than precedes it. These studies give little consideration to the different forms of care behaviours exhibited by male mammals, considering a species to have male care only if males provision or carry the offspring. Here we re-examine the evolutionary association between social monogamy and the different male care behaviours individually. Employing Pagel's method for examining the correlated evolution of

binary traits, we test the hypothesis that male care is associated with social monogamy in a sample of over 500 mammalian species. We find that the relationship between male care and social monogamy is not as simple as previously reported; provisioning and carrying behaviours by males evolve only in socially monogamous species, but grooming behaviours by males often precede the evolution of social monogamy. Thus, the presence of simple, low-cost male care behaviours may promote the evolution of social monogamy, while high-cost male care behaviours only evolve in systems where males exhibit a socially monogamous mating system.

13.45 **James Kempton**, O Padget, T Guilford, G Taylor, Oxford University
A novel video based methodology for analysing flight dynamics - development and future directions

Small, animal-borne data loggers provide information for researchers working in a range of fields. For those studying flight dynamics, inertial measurement units (IMUs) provide dynamical information in the three axes of a bird coordinate system. They work best however under steady flight. Under highly dynamic flight, the difficulty in disassociating gravitational acceleration from inertial acceleration, makes IMUs less effective. Seabirds that exploit non-uniform wind fields to obtain atmospheric energy, such as Procellariiformes, often undertake such dynamic flight. Presented here is the development of a novel processing method applied to video data from the Manx Shearwater (*Puffinus puffinus*) that attempted, as a proof-of-principle exercise, to determine whether it is possible to obtain flight dynamics information from animal-borne video footage. As the outcome was successful, with the control parameters of bank angle and yaw angle output, a consideration is also made of potential future directions. Firstly, method refinement, reducing error and assumption number. Secondly, an experimental comparison to IMUs. Thirdly, obtaining data alongside other logging devices. And finally, data analysis, enabling precise energetic measurements of soaring flight, resolving the mechanism of dynamic soaring, assessing wind trajectory effectiveness and determining how birds modulate their flight behaviour with wind conditions.

14.00 **Amy Smith,** L. Proops, K. Grounds, J. Wathan, K. McComb, Sussex University
Horse responses to human facial expressions of emotion

Nonhuman animals' recognition of human social signals, including emotions, has both scientific and applied importance, and is particularly relevant for domesticated species. The presented study represents the first evidence of horses' abilities to spontaneously discriminate between positive (happy) and negative (angry) human facial expressions. When horses were shown photographs of human facial expressions, angry faces induced responses indicative of a functional understanding of the stimuli: they displayed a left-gaze bias (a lateralization generally associated with stimuli perceived as negative) and a quicker increase in heart rate (HR) towards these photographs. Such lateralized responses towards human emotion have previously only been documented in dogs, and the effect of facial expressions on HR

represents a novel research approach in this field. These findings provide insights into interspecific communication, and raise questions about the generality and adaptiveness of emotional expression and perception across the species barrier.

14.15 **John Hutchinson**, E. Dreijers, H. Reise, Senckenberg Museum
Lust conquers all: considerable differences in genital anatomy and mating behaviour are incomplete barriers to reciprocal spermatophore exchange in two species of terrestrial slugs

In diverse taxa, differences in mating behaviour have been useful in proving that sibling species really are distinct; close behavioural observations can also point to previously unrecognised morphological differences that allow species distinction. Our study of two species of large Arion slugs provides a converse example: A. rufus and A. vulgaris (= A. lusitanicus auct. non Mabille) differ considerably and consistently in their genital anatomy and mating behaviours but nevertheless managed to exchange spermatophores successfully both in the laboratory and field. However, spermatophore exchange in mixed pairs occurred significantly less often than in pairs of the same species (7% vs 52% and 36%). The failure rate in mixed pairs exceeded that predicted from rates in same-species pairs at each of three successive stages of mating. Where there was conflict in behaviour, for instance over whether the pair rotated or over the length of the copulation, it was A. vulgaris that compromised. This may be associated with its rapid, and economically damaging, invasion across Europe into areas formerly occupied by A. rufus. The incompleteness of species isolation and indications of consequent introgression complicate the taxonomy of large Arion slugs.

14.30 **Colin Hendrie** & Rebecca Lakin, Leeds University
Effects of alarm call playback on wild Herring Gull behaviour

Playback of audio recordings is a well established method to elicit behaviour in the wild (e.g. Seyfarth et al, 1980). The effects of playback on Herring Gulls (*Larus argentatus*) has not however been well studied. To this end Herring Gull alarm calls, reversed alarm calls, Herring Gull food begging calls, a woodland dawn chorus or silence were played, one call per day, at a site baited with a highly palatable food mixture. Sounds were initiated 30 secs after birds had landed at the bait site and continued for 2 minutes. The number of birds on the ground within the observation area was recorded at various time points before and after the calls being played. Results were clear and showed that Herring Gulls took flight and left the observation within seconds of hearing their own species' alarm calls. Other calls were largely ignored, with the exception of the woodland dawn chorus which produced a similar effect. Interestingly, the woodland chorus but not the alarm call also initiated flight in other bird species in the vicinity. These data are discussed in terms of the specificity of these responses and the possible applications of the findings.

Poster Abstracts (in alphabetical order by 1st author surname)

1 **Adam Bakewell** & I. Capellini University of Hull
The Evolution of Delayed Implantation in Mammals

"Delayed implantation" is an unusual adaption present in some mammals where fertilized eggs enter a period of inactivity before implantation into the uterus. At least 100 species across 8 orders exhibit such periods of inactivity. Delays can either be obligate and last for several months at a time, or facultative being induced by lactation which delays growth of subsequent litters in utero until the first litter is weaned. It is currently unknown which selective pressures have led to the evolution of obligate and lactational delays, but several hypotheses have been put forward. We compiled the largest database on the nature and duration of delays across species along with their life history traits, and using phylogenetic comparative methods we will test the following hypotheses:

(1) Reproductive delays are the ancestral state in mammals and that they have been secondarily lost.

(2) Obligatory delays allow females to invest more heavily in litters, producing higher quality offspring in each reproductive attempt.

(3) Facultative delays have evolved to increase reproductive output by reducing interbirth interval.

(4) Reproductive delays have evolved in an attempt by females to oppose sperm competition, so those with the most sperm competition will be most likely to have reproductive delays.

2 **Christine Beardsworth**, Langley, E. J. G., Whiteside, M., Van-Horik, J., Madden, J. R. University of Exeter
Using tri-axial accelerometers and machine learning to produce activity budgets in the pheasant (*Phasianus colchicus*)

For a long time, manual observations have been the primary data collection method for monitoring animal behaviour. However this can be time consuming is often unable to acquire high resolutions of behavioural activity. As a consequence, monitoring and measuring behaviour through remote sensing technology has become more popular in recent years. Accelerometers in particular are proving a valuable technological advancement and have been used to detect behaviours in a wide range of species. In this study, we use tri-axial accelerometers to obtain high frequency acceleration data from captive individuals of the common pheasant (Phasianus colchicus). We used video footage to classify and ground truth the raw acceleration data before investigating the efficacy of a primitive machine learning algorithm, K-nearest neighbour, in correctly predicting behaviours and thus, activity budgets.

3 **Lauren Branfield** & C. Ijichi University of the West of England
Does dog personality affect learning ability?

Understanding dog personality and learning ability can drastically improve training and welfare. Training can become more effective and aligned to an individual's needs after understanding the subject's personality and performance. The aim of this study was to understand how personality affects a dog's cognitive performance. Personality was assessed using the validated Monash Canine Personality Questionnaire. An objective approach was used to measure cognitive performance through two learning ability tasks, V-shaped Fence and Spin the Bottle, using three measurements. These three measurements included; performance, engagement and subjects ability to learn through sets and attempts at each task. These performance factors were then compared to the individual's results from the personality questionnaire. It was hypothesised that personality does affect learning ability and more specifically an individual with a neurotic state would perform less than a subject which was not. After analysis the hypothesis' can be accepted as significant findings were found in the personality trait Motivation and learning ability task Spin the Bottle Average level of Engagement (P= 0.046, R=.362, N=31). PCA analysis also found correlations between neuroticism and learning ability. However, this was not reflected in the Post Hoc analysis which indicates the need for further research and larger sample to validate results.

4 **Doreen Cabrera** & T. Stankowich California State University, Long Beach
Tusk Evolution Among Terrestrial Cetartiodactyls

Combat weaponry, including elaborate horns, noxious sprays, and complex dentition, has evolved independently several times among mammals. Tusk and tusk-like dentition, in particular, have evolved in response to different ecological selective pressures, but primarily among males for intrasexual combat and are thus utilized for fighting and food retrieval. We investigated patterns of tusk evolution in Artiodactyls while exploring specific ecological factors that might favor their use over other cranial weapons (e.g., antlers, horns). We found that smaller solitary males in closed environments tend to have bigger canines, and smaller females in closed environments tend to have bigger canines. These results suggest that tusks are a better weapon option for smaller slinking Artiodactyls in forested environments with low visibility, whereas larger taxa can bear the cost of larger headgear which can also serve as an honest signal of fighting ability in more open environments. Small species in dense habitats may also be more likely to be ambushed by predators and have a need to defend themselves; small slicing daggers may be a better defensive weapon and allow more maneuverability and faster escape than awkward headgear in densely vegetated habitats.

5 **Alex Cones**, A. Russell, A. Liebl University of Exeter
The Secret Life of The Avian Embryo: Environmental and Intrinsic Effects on Embryonic Heart Rate in the Chestnut-crowned babbler (*Pomatostomus ruficeps*)

During the incubation period, avian embryos face a variable, often unpredictable environment, which can result in fitness consequences both pre and post-hatching. Past research suggests that avian embryos themselves vary in their 'developmental trajectory' due to key factors such as ambient temperature, embryonic age and egg size. We aim to uncover the patterns of variation in embryonic heart rate in a cooperatively breeding bird, the Chestnut-crowned babbler (*Pomatostomus ruficeps*) by investigating the effects of temperature, age, size, time of day, hatch order and clutch size on embryonic heart rate. Heart rate measurements and cooling curves were amassed from wild Chestnut-crowned babbler eggs, collected in the field and artificially incubated, during the 2015 breeding season. By uncovering how different environmental and intrinsic factors affect embryonic heart rate and cooling, we can also begin to understand and investigate the effects of variation in the breeding female's incubation behaviour on her eggs.

6 **Jennifer Coomes** & A. Thornton University of Exeter
The effect of dominance and group size on the decision to join a collective behaviour in the jackdaw (*Corvus monedula*)

Collective animal behaviours are seen across many taxa in the animal kingdom. The seemingly complex movements demonstrated by starlings in flight or in fish shoals numbering thousands of individuals, baffled biologists for a long time. It was not known how these huge aggregations were coordinated and it was thought that there must be a central coordinator of or some sort of unconscious signal received by all members of the group. Self-organisation models were developed to explain how coordinated movements arise without the need for a visible leader. They suggest that individuals follow the same simple rules and in this way a collective global behaviour is achieved. These models however assume that all individuals are the same. Individuals differ in personality, position of dominance and motivations so are unlikely to act in exactly the same way in a collective group. The work presented here will look at the information that different individuals take into account when deciding to join a collective behaviour. Jackdaws exhibit mobbing in response to an aerial predator and playback experiments are used to determine the effect of dominance rank and group size on recruitment of individuals to a mobbing event.

7 **Massimo De Agro**, L. Regolin, E. Moretto Padova University
Shape discrimination in the jumping spider *Phidippus regius*

In recent years a growing number of studies in animal cognition has focused on minute brains' abilities, especially those of species phylogenetically more distant from primates or even vertebrates. Arthropods species were shown able to navigate

complex environments, of a variety of forms of learning, they can communicate, and even do some rudimental counting. We are studying perception and cognition in an arachnid species, the jumping spider Phidippus regius. This family distinguishes itself among spiders, and from the other Arthropoda as well, due to its sophisticated visual system, composed of 4 pairs of simple (single lens) eyes. Receptor size and density in the anterior median eyes in particular allow for an extraordinary visual acuity, though the small visual view of these eyes makes it very probably necessary to scan and then stitch together (in some form of inner representation) multiple images. In spite of extensive investigation of the anatomy and physiology of jumping spiders' visual system, shape perception and discrimination has to our knowledge never been assessed experimentally. We have been trying to work in this direction and will discuss the experimental paradigm and the preliminary data so far obtained.

8 **Katie Dunkley**, J. Cable, S. Perkins Cardiff University
Sharing is caring: multi-species cleaning stations influence cleaner-client interactions in the Caribbean.

Cleaner fish can have an important influence on the ecology of coral reefs, but the role of multiple cleaner species sharing the same resource is not well understood. In the Caribbean, the predominant cleaner species the sharknose goby (*Elacatinus evelynae*), may share cleaning stations with juvenile French angelfish (*Pomacanthus paru*), a facultative cleaner. Mutualistic cleaner-client interactions are ubiquitous on coral reefs, where the cleaners remove parasites, dead skin and mucus from the bodies of visiting reef fish species (clients), influencing their health and behaviour. However, the cleaning behaviour of the juvenile French angelfish and the impact of this multi-species mutualism, in terms of creating variation in cleaner-client interactions, is largely unknown. Between 2010 and 2015 we monitored client-cleaner interactions on Booby Reef in Tobago. The presence of a French angelfish at a cleaning station influenced both the diversity of visiting clients and the duration of cleaning events by sharknose gobies. However, juvenile French angelfish were not present at cleaning stations every year, and the abundance of sharknose gobies was also highly variable. This represents a major strength of this long-term dataset in that it allows us to assess both temporal and spatial variation in cleaner-client interactions.

9 **Kym Griffin**, S. Redgate, K. Yarnell, C. Hall Nottingham Trent University
Sleep deprivation and its association with performance, safety and welfare in horses

Within marine systems, phylogenetically-based comparative analysis has been used to address key questions on everything from speciation rates and body-size evolution in fishes, to the evolutionary origins and ancestral state reconstruction of cephalopods. Here we adopt this approach to investigate the evolution of a long-standing paradox in jellyfish ecology; namely, how gelatinous species that are often portrayed as negative stressors of fish communities can serve as habitat providers during their early life history. Specifically, we explore the evolutionary history of fish-jellyfish

associations and test hypotheses on the potential selective forces that have promoted the evolution of such associations across 24 families and 86 different species of fish from across the world's oceans. Given the wide-spread occurrence and diversity of fishes involved in these associations, they provide a valuable model to explore the evolutionary origins of a jellyfish-fish interaction occurring on a global scale. Moreover, the potential role of jellyfish as ecosystem providers is not insignificant considering 72% of the fish identified in this study as displaying this association were economically important either as commercial species or as gamefish. As pressure on fish stocks continues to rise, it is important to consider all potential impacts jellyfish can have on fish communities.

10 **Donal Griffin**, Isabella Capellini, Chris Harrod,& Jonathan D.R. Houghton, Queen's University Belfast
Solving the jellyfish paradox: life history traits in the evolution of fish-jellyfish interactions.

Although the specific physiological functions of sleep in mammals are still debated among scientists, there is an agreement that sleep is essential for good health and performance. Horses display polyphasic sleeping patterns, meaning they sleep multiple times within a 24 hours window and early studies using Electroencephalography (EEG) to investigate equine sleep identified 4 stages of vigilance: wakefulness, drowsiness, slow wave sleep (SWS) and paradoxical sleep (PS also called REM sleep).
Notwithstanding this early work, the consequence of sleep deprivation in horses has not received much attention. Recent studies on sleep in horses are based on behavioural observations alone, providing a coarse measure of total time sleeping. However, without detailed EEG measures of sleep phase, crucial information may be missed. EEG technology has improved significantly in recent years and when used in conjunction with behavioural observations, may shed new light on the quantity and quality of sleep horses are receiving whilst in work.
Here we aim to perform an in-depth look at the impact of ridden work on horse sleeping patterns using both behavioural and EEG observations. This work could have far reaching implications on performance, safety and welfare of competition and leisure horses alike.

11 **Christopher Hermiston** and S, Jones University of West England (UWE), Hartpury College
The effect of dog appeasing phermones in regard to intensity of vocalisations and frequency of stress related behaviours in a rescue shelter

Dog appeasing pheromones (DAPs) were used on rescue shelter dogs to measure the effect they had on the intensity of barking amplitude. The frequency of stress related behaviours were also measured, including; barking, paws on fence, low posture and lying down. These variables were measured in the presence of a 'stressor', a neutral dog, who was led past the kennels. A convenience sample (n=25) of mixed breed and

aged dogs was used; males (n=16) and females (n=9). The data was collected when the neutral dog was walked past the kennels. The intensity of barking was recorded using a decibel meter, located 15 meters away from the kennels. Behaviours were captured using a camera. The process was carried out in the morning of day 1 and repeated in the afternoon (the control day). This was repeated on day 2 using pheromones. The process was carried out 10 times and then analysed using SPSS. The barking amplitude was significantly reduced when using DAPs (p=0.002), together with the frequency of barking (p= 0.025). However, the frequency of other behaviours resulted in no significant differences when exposed to DAP; low posture (p= 0.257), paws on the fence (p= 0.96) and lying down (p= 0.194).

12 **Álvaro Ly Prieto**, P. Gutiérrez, L.A. Ebensperger Pontificia Universidad Católica de Chile
Communal breeding and kinship in the social rodent, *Octodon degus*

Kin selection is the main mechanism argued to explain cooperation in animals. *Octodon degus* is a communal breeding rodent in which many females cooperate with the offspring care. Nonetheless, this species forms groups with an unstable composition and without-kin-structure populations. Despite this fact, it is possible to find groups with females with different kinship degrees. Therefore, it can be determined if kin selection plays an important role in this behavior identifying if the kinship degree is positively related to the level of cooperation. In order to do this, it was quantified the number of nights the lactating females of each group shared the den using telemetry, as an estimation of the number of times they communally care the offspring. Moreover, it was estimated the time the lactating females spent doing communal breeding during the day and the time offspring were alone by using light loggers. Females were genotyped for 12 microsatellite loci. For the 3 measures, the results show that there is no relation between the levels of cooperation and the kinship degree of the females. Thus, kin selection may not be important and other mechanisms may explain the presence of the cooperation in O. degus.

13 **Lucy Nevard**, K. Hall, L. Nevard, A. Ramesh, S. Vijayan, H. Somanathan, N. Hempel de Ibarra, University of Exeter
Foraging behaviour of Asian social bees, *Apis cerana* and *Trigona iridipennis*, in a fragmented landscape of the Western Ghats, India

Nearly all tropical plants are animal-pollinated. In the Asian tropics the most abundant and important group of pollinators are social bees, however, relatively little is known about their foraging behaviour. We investigate the foraging behaviour of the medium-sized Eastern honeybee, *Apis cerana*, and small-sized stingless bee, *Trigona iridipennis*, in the Western Ghats of South India, to understand how agriculture can benefit from conservation of pollinators and of native forests. We studied how individual bees forage and how foragers of a colony are distributed in agricultural and urban landscapes. Experiments included training experiments with artificial feeders, recording of A. cerana waggle dances and observing foraging patterns of individual bees, and the collection of pollen loads from individual foragers. Current data will be

presented to discuss the foraging efficiency of these two species of social bees, similarities and differences in plant resource utilisation and spatial distribution of foragers in different landscapes.

14 **Megan Orr** & L. Bamford Myerscough College
Secondary emotions in domestic animals – Does jealousy exist in canines?

There is minimal peer reviewed research investigating canine ability to experience secondary emotions which have previously been thought to be exclusive to humans and non-human primates. Previous qualitative research suggests domestic canines are capable of experiencing the secondary emotion jealousy similar to that of six month old infants when denied attention from their mother. The current study aims to establish the extent to which domestic canines experience jealously and the implications of secondary emotion display on human-animal relationships. Simulated scenarios were implemented to illicit behavioural responses to quantify the emotional capabilities of canines and potentially confirm the existence of secondary emotions. Canines (n=24) and their owners were observed individually in their homes whilst owners performed four simulated scenarios; (1) reading aloud from a book, (2) interacting with a soft toy, (3) interacting with an AniMagic© electrical toy dog capable of vocalisation and locomotion, and (4) interacting with a person already known to the dog each for a duration of 60 seconds. No difference was observed between single and group housed canines, typical jealous behaviours were exhibited and directed towards scenario (2) and (3) indicating that domestic canines are capable of experiencing secondary emotions in relation to recognised jealous behaviours.

15 **Aaron Sibma**, T.A. Burke, M.J.P. Simons Sheffield University
Bet-hedging on chick size in wild House sparrows

The number of chicks in a brood is traded-off with chick size. Under good environmental circumstances, mothers could achieve higher fitness by producing a larger number of chicks. However, when circumstances are bad, producing larger chicks is likely beneficial. A flexible trade-off is thus expected. In addition, bet-hedging can be optimal under unpredictable circumstances. Bet-hedging should select for a more diverse chick size if mothers cannot estimate what brood and offspring size provides the highest fitness.
I examined this bet-hedging strategy in House Sparrows (*Passer domesticus*) from Lundy. This House sparrow population is well suited for this question because we have reliable fitness estimates and a near-complete genetic pedigree to assess heritability. I will present data on the standard deviation in mass and analyse these using mixed models (meta-analysis of variance, Nakagawa et al. 2014). This allows me to test whether mothers show repeatable variation in chick sizes, whether this variation is heritable and how it is related to fitness. If a bet-hedging strategy operates, we expect to detect repeatability and heritability for this trait. Furthermore, we expect balancing selection because an optimum variance in mass in the face of unpredictable environmental conditions is expected to yield the highest fitness.

16 **Svenja Tidau**, M. Briffa Plymouth University
Driven to Distraction: Behavioural Impact of Ocean Noise on the European Hermit Crab

Most research on the behavioural impacts of ocean noise pollution on marine animals has focussed on mammals and, increasingly, on fish, while crustaceans are considerably understudied.
This study aims to determine if, how and to what extent ocean noise distracts the marine hermit crab *Pagurus bernhardus* in its behaviour by exploring various stimuli (tactile, visual and chemical). Hermit crabs serve as a model system to investigate different decision-making processes in the presence and absence of ocean noise. In the first experiment we investigate individual shell selection, answering if individuals acclimatise to noise and if individuals vary in their behaviour. This experiment is followed by studying the effects of noise on intra-specific interactions by focussing on tactile information gathering during shell fights and chemically stimulated predator events under noise exposure. I will give a brief overview about the current stage of research in the field of ocean noise and decapod crustaceans followed by our guiding hypotheses for the study. Given the infrastructure, I will show a two minute video about the shell assessment of a hermit crab under noise treatment. Finally, I will illustrate the first experimental set up and close with an outlook.

17 **Erin Walsh**, H. P. Kunc, G. Arnott, Queens University Belfast
The influence of anthropogenic noise on information gathering and decision-making in the Hermit crab (*Pagurus bernhardus*)

Human pollutants such as anthropogenic noise interfere with animals' ability to operate optimally, which directly compromises fitness. Loud, persistent, and unexpected noise has the potential to cause stress, mask important sounds, and demand attention. To investigate the potential impact of the effect of anthropogenic noise on cognitive tasks, the ability of hermit crabs to assess and select a shell with, and without the presence of anthropogenic noise will be examined. Hermit crabs were selected as a model species as they conduct in-depth visual and tactile appraisals of potential shells, before deciding whether it is suitable to inhabit. This process requires the crabs to engage in information gathering, relatively complex calculations, and decision-making processes. Distraction has been shown to cause increased latency to investigate resources, increased incidences of inaction, and an overall increase in time taken to complete resource assessment. Therefore, each consecutive stage of shell assessment will be measured in a series of controlled, tank-based experiments. It is hypothesised that during anthropogenic noise playback crabs will take longer to assess shells both during each discrete assessment stage, and overall, as noise pollution will create an extra demand to be drawn from a limited pool of mental resources.

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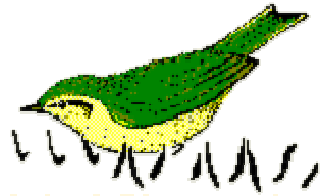

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