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Abstracts

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Un ringraziamento particolare va a tutto il personale del Museo di Storia Naturale per l'attiva collaborazione alla realizzazione dell'evento.

Abstracts - oral presentations

according to programme

Chairperson: Elisabetta Visalberghi

Plenary lecture

10.05 IT WAS A DARK AND STORMY NIGHT

Francesco Bonadonna

Centre d'Ecologie Fonctionnelle et Evolutive of Montpellier, France

It was a dark and stormy night when a petrel seabird appeared in the light beam of my head-lamp, and immediately found the entrance of its nest burrow. How was it possible in the complete darkness of a moonless night? Birds in general rarely display obvious olfactory-driven behaviours, and at that time only olfactory orientation of homing pigeons was deeply investigated. However, the idea that chemical cues could have been behind that petrels' ability arose. Most of my work started from there. My talk will be a storytelling about my last 18 years of research whose results contributed, little by little, at spreading research on birds' olfaction in all its forms. Evidence, which relates to many aspects of petrels' ecology, provides a comprehensive case study of avian behaviour relying on chemical cues. Odours over the sea guide petrels during navigation. Odours at the colony allow recognition and nest finding. Personal odours, reflecting species, identity, and kin, may be used for communication and mate choice. These results, almost 50 years after the first seminal work on homing pigeons' olfaction by Prof Floriano Papi, indicate that chemical signals can contribute, as well as colours, calls and songs, to avian social behaviours.

Oral communications

11.35 EFFECTS OF EXPOSURE TO ARTIFICIAL ODOURS BOTH DURING DISPLACEMENT AND BEFORE RELEASE ON ORIENTATION OF HOMING PIGEONS: A GPS TRACKING STUDY

Anna Gagliardo¹, Enrica Pollonara¹, Martin Wikelski²

¹Department of Biology, University of Pisa

²Max Planck Institute for Ornithology, Radolfzell, Germany

The olfactory navigation hypothesis predicts that pigeons rely on natural local odour to determine the home direction after displacement, thanks to an olfactory map acquired by memorising at the home loft the wind directions in association with wind-borne odours. An alternative explanation of the role of olfactory stimuli proposes that odours, rather than providing spatial information, activate a navigational mechanism based on non olfactory cues (magnetic or infrasound for instance). The

prediction of the olfactory activation hypothesis is that exposure to artificial non sense odours produce homeward orientation, as well as exposure to natural local odours. To test these hypotheses, we tracked three groups of pigeons from an unfamiliar release site: unmanipulated pigeons (C); pigeons transported and kept at the release site in an air tight container ventilated by natural air and made anosmic before release with zinc-sulphate nasal washing (ZnC); pigeons transported in an air tight container ventilated by purified air and exposed to artificial odours stimuli during transportation and at the release site, and made anosmic before release (ZnAO). The analysis on the mean vector distributions, obtained averaging the directions taken by the birds to move from one fix to the next, showed that both C and ZnC were significantly oriented towards the home direction, while the ZnAO pigeons were oriented in a direction significantly different from the home direction. In addition, the ZnAO were more likely to display non oriented movements compared to both C and ZnC. However the homing success of both anosmic group were significantly poorer than those of C. We concluded that exposure to artificial non sense odours is not sufficient for allowing homeward orientation, differently from local natural odours. Consistently to previous study we observed that the perception of local odours along the way is needed to accomplish a successful homing.

Keywords: olfaction, navigation, homing pigeon

12.00 TO STAY OR TO GO: DECISION-MAKING AT STOPOVER SITES

Leonida Fusani

Konrad Lorenz Institute of Ethology, University of Veterinary Medicine, Vienna, & Department of Cognitive Biology, University of Vienna, Austria

Most migratory birds of small size need to stop along their route to refill their energy stores. The time spent at stopover sites usually takes a large proportion of the total migration period. The duration of the stopover is a trade-off between the refuelling needs, which depends on the previous flights, and the push to reach the breeding or wintering sites. Therefore, an array of factors including weather conditions, position of the stopover along the migratory route, and internal physiological condition contribute to stopover decisions. In the last years, we conducted a series of studies focusing on the physiological mechanisms underlying decision-making at stopover sites in small migratory passerines. The studies were conducted on the islands of Ponza and Ventotene, important stopover sites off the western Italian coast which birds reach after crossing the Mediterranean Sea. We caught birds, hosted them temporarily in special recording cages, and studied how fat stores, body mass, food intake, and circulating levels of hormones influenced migratory restlessness, an indicator of migratory disposition. In addition, we manipulated levels of hormones and food availability to test the role of these factors in controlling migratory behaviour. In sum, our studies show consistently that body condition and in particular the size of subcutaneous fat stores are the best predictors of the tendency to leave a stopover site. Our most recent data furthermore show that the hormone ghrelin secreted by the gastrointestinal tract may act as a link between food intake, body condition, and the brain centres responsible for migratory decisions.

Keywords: bird migration, hormone, migratory restlessness

12.20 MIGRATORY BEHAVIOUR OF *CERITHIDEA DECOLLATA*: NEW RESEARCH PERSPECTIVES

Anna Marta Lazzeri¹, Alessia Lotti², Veronica Pazzi², Marco Vannini³

¹Dipartimento di Agraria, Università di Sassari

²Dipartimento Scienze della Terra, Università di Firenze

³Dipartimento di Biologia, Università di Firenze

The Indo-West Pacific mangrove gastropod *Cerithidea decollata* feeds on the ground at low tide and climbs trees (*Avicennia marina*) two hours before the arrival of water, regularly settling well above the level of the incoming tide (0-80 cm, depending on tidal phase), despite the irregular East African tidal pattern. Furthermore, it has been seen that snails, when translocated to lower shore areas (dominated by *Rhizophora mucronata*), show a sort of escape reaction, thus climbing twice as high than controls. In such an area, *C. decollata* is missing and water level can exceed 160 cm. There are two problems for the snails to face: 1) How to foresee the exact tidal level? 2) How to evaluate the actual shore depth after displacement? Incoming tide foreseeing cannot rely on biological clock alone (too regular in front of tidal irregularity), whereas direct visual cues and local chemical information had already been experimentally rejected. Moreover, the nature of substratum (chemicals, texture) was proven to carry no information about shore depth. Recent results suggest that possibly unexplored signals on which snails could potentially rely exist, in order to solve the aforementioned problems: 1) the oceanic wave reaching the coast and the barrier reef, 7 km away from the study site, produces a detectable low-frequency noise (seismic noise), whose periodicity and intensity vary, according to tidal periodicity and excursion; 2) chemicals released by trees may carry suitable information in order to evaluate shore depth, and a relationship has been found between *R. mucronata* density and displaced snails' escape reaction. We still ignore whether snails are actually able to perceive seismic vibrations or *R. mucronata* chemicals but for the first time we have identified two potential signals worth being thoroughly investigated, and which may also play a role in behavioural adaptation of a long list of intertidal organisms.

Keywords: plant-animal chemical interaction, ambient noise vibration, intertidal migration

12.40 THE CELESTIAL ORIENTING FACTORS IN *TALITRUS SALTATOR* (CRUSTACEA, AMPHIPODA)

Alice Ciofini¹, Luca Mercatelli², Alberto Ugolini¹

¹Department of Biology, University of Florence

²National Institute of Applied Optic, CNR, Florence

The diffusion of the solar radiation through the atmosphere defines specific patterns of intensity and spectral distribution across the sky, concordant with the position of the sun, that constitute compass orienting factors for some species. There are evidence that also the supralittoral sandhopper *Talitrus saltator* (Montagu, 1808) rely on the skylight intensity pattern to orientate along the sea-land axis of sandy shores, while no investigation has been conducted in this species to assess the utilization of the spectral celestial gradient. In this work we mean to deepen our knowledge on the role of these celestial factors in the zonal recovery of *T. saltator*. We conducted experiments using artificial skies corresponding to intensity or spectral profiles designed through the software Matlab (projected over the bowl containing the animals) or realized with coloured gelatine filters (arranged on the top of a

fibre-optic illuminator used to light the internal surface of a dome surrounding the bowl). Individuals tested using the artificial profile corresponding to the natural intensity gradient were well-oriented toward the expected direction enabling us to confirm the use of this factor as a compass reference. Instead, attenuate intensity profiles induced positive phototactic responses. When tested with the spectral profiles realized with the software Matlab, animals were in any cases orientated toward the hemidome rich in blue wavelengths. However, we obtained preliminary evidence on the use of this factor as a compass cue in tests carried out using coloured filters arranged on the fibre-optic illuminator, even though further investigations are required to confirm this statement.

Keywords: orientation, sandhopper, celestial gradient

13.00 ASSESSING RELIANCE ON VECTOR NAVIGATION IN THE OCEANIC MIGRATIONS OF GREEN TURTLES

Giulia Cerritelli¹, Giacomo Santini², Giuseppe Bianco³, Paolo Luschi¹, Susanne Akesson³

¹Department of Biology, University of Pisa

²Department of Biology, University of Florence

³Department of Biology, University of Lund, Sweden

We aimed at investigating if green turtles (*Chelonia mydas*) use a vector navigation strategy during their oceanic migrations to and from Ascension Island, South Atlantic Ocean. For this, we developed a novel approach through individual-based models that use remote sensing oceanographic data to simulate the migratory routes of virtual turtles, that were also compared to routes of real turtles tracked in the past. A three step procedure was followed: 1) To test if an hypothetical turtle could arrive in Brazil using vector navigation, a model employing generic parameters obtained from previous tracking data was used. Simulations was run twice a month between March and July, for 12 years. A simulation was successful only if it fell in a large target area which included landfall and foraging sites of all tracked turtles. The results showed that turtles leaving Ascension can reach the target area only when keeping a heading between 270° and 280°. 2) To assess if vector navigation was actually used by previously tracked turtles, models were run with parameters specific for each individual, including the target area. We measured how simulations with different navigational strategies (true navigation towards different targets, vector navigation with different headings) differed from the actual routes. In most cases, actual routes were best described by simulations using a vector navigation or a true navigation aimed at the turtle's first landfall. Conversely, a true navigation strategy towards the foraging grounds poorly represent the actual routes. 3) We also explored whether vector navigation can permit successful migrations from Brazil to Ascension. The simulations were run twice a month from October to February, started from different sites in Brazil and were successful if reaching an asymmetrical target around Ascension. Since most simulations failed to reach the target, vector navigation does not seem a viable strategy for this migration.

Keywords: navigation, sea turtle, individual-based model

Chairperson: Leonida Fusani

14.40 ROLLING STONES GATHER NO MOSS: STONE HANDLING BEHAVIOR IN MACAQUES AND THE VALUE OF BEING FOREVER YOUNG!

Michael A. Huffman¹ & Charmalie A. D. Nahallage²

¹Kyoto University, Japan

²University of Sri Jayawardenepura, Sri Lanka

Stone handling (SH), a solitary-object play behavior was first observed in 1979 in a troop of free-ranging Japanese macaques in Arashiyama, Kyoto, Japan. From as early as 1980 it was being transmitted horizontally among immature peers in the troop, and after 1985 to the present, to all infants born in the troop within the first 3-6 months. Systematic studies of SH have helped to clarify the mechanism of social transmission, clarifying its status as a cultural behavior. Unlike previously described primate cultural behaviors, related mostly to the processing or procurement of food, SH is the first example of the long-term transmission of a behavior with no obvious direct benefits. While it is not difficult to interpret the potential long-term benefits of SH from the perspective of motor and perceptual skill development in immatures, it is not as easily explained why SH continues to be practiced by these individuals well into advanced old age. For adults, SH may be relaxing, and with advanced age, the ultimate function of this greatly prolonged period of object play may be to maintain and regenerate deteriorating neural pathways, thus potentially slowing down the deterioration of cognitive function. Human clinical studies have shown a similar advantage for prevention of dementia and Alzheimer disease in elderly who engage in regular leisure activities involving concentrated mental leisure activity. Comparisons with play in humans may hold the key to explaining the role of culture in maintaining biologically important functions in humans and non-human primates.

Keywords: solitary object play, social learning, adaptive function

15.10 POSSIBILITIES AND IMPLICATIONS OF CYBERTRACKER SOFTWARE USES IN ETHOLOGICAL PROJECTS

Toni Romani¹, Carmelinda Giannone¹, Louis Liebenberg²

¹Kokulandela – CyberTracker Italia, Osoppo (Udine)

²CyberTracker Conservation NPC, Cape Town, South Africa

Technology has been, and continues to be, implemented to help men and supporting them in research activities. There are a lot of free and greenware softwares available for science; CyberTracker software is one of them, designed to be moulded into a myriad of different studies. Very useful program, designed and released entirely in Africa to protect animal and plant biodiversity and now used all over the world. It was created in the 90's in South Africa: it is a fundamental tool that allows to collect georeferenced data (images, sounds, field notes,...) creating your own program on PC and then using your smartphone or tablet, in addition to PDA devices to collect data. It can be useful for planning the monitoring activity, being able to analyse daily successes and smash. There is the possibility to create reports and simple analyses in a very simple and standardized way in accordance with the project; also data could be exported in a variety of typologies depending on needs. The definition and the creation of the ethogram for the study, the research hypothesis and the subjects to be studied, as well as the objectives and the experimental

design with methods and sampling protocols, are of fundamental importance. The data collection phase is a critical step that any study must take into account in order to minimize the errors that may ensue. Technology, if used properly, could help to minimize bias and to provide us with the best tools to analyse and understand the World, giving it the space it deserves.

Keywords: cybertracker, software, conservation

15.30 TELOMERE DYNAMICS, MATE CHOICE AND REPRODUCTIVE SUCCESS IN A PASSERINE BIRD

Andrea Romano¹, Marco Parolini¹, Elena Giulotto², Nicola Saino¹

¹Dipartimento di Bioscienze, Università degli Studi di Milano

²Dipartimento di Biologia e Biotecnologie, Università degli Studi di Pavia

Telomeres are conserved DNA sequences at the termini of eukaryotic chromosomes which contribute to maintenance of genome integrity, and their shortening leads to cell senescence, with negative consequences for organismal functions. Because telomere erosion is influenced by extrinsic and endogenous factors, and can affect survival prospects, telomere dynamics may provide a mechanistic basis for evolutionary and physiological trade-offs, and might be the target of natural and sexual selection. However, few studies examined the causes of telomeres shortening, their consequences on individual fitness, and the existence of phenotypic traits possibly signalling telomere length (TL), especially in free-living organisms. We investigated telomere dynamics, as well as phenotypic and fitness correlates of TL at different life stages, in a socially monogamous passerine bird: the barn swallow (*Hirundo rustica*). We showed that individual TL decreases during the period of nestlings growth and it is affected by rearing conditions, as gauged by brood size and sex ratio. In addition, TL of both adult males and females positively predicts seasonal reproductive success, thus suggesting that individuals harbouring longer telomeres are prime performers (e.g. larger fecundity and/or better parental care). We also found evidence of assortative mating for TL, which seems to be adaptive because of the direct fitness benefits acquired by pairing with a high-quality mate that possess long telomeres, and, since TL is partly heritable, the indirect ones of producing offspring which inherited long telomeres. The evidence of assortative mating for TL also suggests that epigamic signals exist that reliably reflect TL and mediate mutual mating preferences. This is the case because an association between TL, body size and sexually dimorphic plumage coloration was documented for the first time in any species. Therefore, TL appears to be a source of variation in major fitness traits and may be an ultimate target of mate choice.

Keywords: telomere, sexual selection, assortative mating

15.50 NEST ATTENDANCE, EXTENDED PHENOTYPE AND SOCIAL SELECTION IN MULTISPECIES COLONIES

Daniela Campobello¹, James F. Hare², Maurizio Sarà¹

¹Department STEBICEF, University of Palermo

²Department of Biological Sciences, University of Manitoba, Canada

Colonial species interact not only with conspecifics but often with other species nesting in the same site. The effect of conspecific traits have been measured recently with a multilevel selection analysis, but the effect of social traits of heterospecifics on individual fitness remain not quantified. We recorded nest attendance effort of two species, lesser kestrels (*Falco naumanni*) and jackdaws

(*Corvus monedula*), nesting on the Gela Plain (Sicily, Italy). Both species are secondary-cavity nesters breeding in abandoned rural buildings where they form single-species or mixed-species colonies. By correlating reproductive success as a measure of fitness to conspecific and heterospecific nest attendance we revealed an asymmetric relationship where only lesser kestrels accrued fitness benefits by nesting with jackdaws in the same colony-housing site. Jackdaws, on the other hand, benefited from conspecific vigilance effort at their own nest, regardless of the attendance level of co-nesting lesser kestrels. In single-species colonies, stabilizing social selection coefficients revealed that the most favoured lesser kestrels were those living in groups with intermediate attendance, whereas, in mixed-species colonies, disruptive social selection coefficients altered the fitness surface so that the most successful kestrels were those associated with the highest attending jackdaw groups. Thus, in both cases, attendance efforts of focal individuals did not affect their own fitness, but their breeding performance depended on the social phenotypes of the individuals they associated with. Together with results from a larger scale investigation of the same study system, our findings illustrate the utility of applying a multilevel selection approach to social and behavioural traits in advancing hypotheses regarding ecological factors that may act as causal agents of selection.

Keywords: extended phenotype, social selection, nest attendance

16.10 INTEGRATION OF ACTIVITY SENSOR , GPS MONITORING AND PHOTOTRAPPING TO DESCRIBE BROWN BEAR (*URSUS ARCTOS*) BEHAVIOUR IN THE EASTERN ALPS

Samanta Seganfredo¹, Francesco Bertolini¹, Sara Vezzaro², Andrea Vendramin², Toni Romani³, Andrea Madinelli¹, Stefano Pesaro¹, Stefano Filacorda¹

¹Dipartimento di Scienze Agroalimentari, Ambientali e Animali, Università degli Studi di Udine

²Associazione Il Villaggio degli Orsi, Pulfero (Udine)

³Associazione Kokulandela, Osoppo (Udine)

The Eastern part of the Alps is a sink area for Brown bear (*Ursus arctos*), between the Dinaric and Trentino populations: the study of the behaviour and of habitat use of bears that living in this area represents an important conservation issue. We have studied the behaviour of bears, on the basis of 300 videos obtained with phototrapping (on 10 different bears), GPS fixes, every 2-4 hours, and activity data (true acceleration) on two axis, X and Y, every 5 minutes (on 5 bears radiocollared). The videos obtained at feeding points, hair traps and along paths, were analysed to detect the frequency of presence, in different months and hours, at the monitoring sites. The behaviour, observed in the videos, was combined with the activity data (true acceleration obtained from the collars), for defining the numeric interval of true acceleration, corresponding to: resting, feeding and locomotion. For each hours of the day and in the different month, we have estimated the percentage dedicated to the main behaviour and related to meters travelled per hours, estimated on the basis of GPS fixes. The bears show different seasonal pattern: from May to September bears spend more than 30% of daily time for locomotion; during October and November the bears use more time for feeding (more than 25%), as in March and April. The daily and hourly pattern changes with the season. The integration of GPS fixes, activity data (true acceleration) and phototrapping is a promising approach to study the behaviour and energy requirement of the brown bear in the Alps.

Keywords: Ursus arctos, behaviour, activity sensor

Chairperson: Augusto Foà

17.00 CHEMICAL ALARM CUES MEDIATE ANTIPREDATOR BEHAVIOUR AND LEARNING IN ZEBRAFISH LARVAE

Tyrone Lucon-Xiccato¹, Giuseppe Di Mauro², Angelo Bisazza¹, Cristiano Bertolucci²

¹Dipartimento di Psicologia Generale, Università di Padova

²Dipartimento di Scienze della Vita e Biotecnologia, Università di Ferrara

To recognise and avoid predators, many prey species have evolved the ability to exploit multiple sources of information. For example, in aquatic environments, chemicals released by injured conspecifics (hereafter ‘alarm cues’) are important indicators of predation risk. Adult zebrafish, *Danio rerio*, are capable to perceive presence of conspecific alarm cues dissolved in the water and respond with typical antipredator responses such as decreased swimming activity. However, whether zebrafish larvae exploit alarm cues to defend from predators remains to be understood. To address this point, we developed a fast procedure to study alarm cue-mediated responses in zebrafish larvae based on automated tracking of swimming activity. We showed that 12- and 24-day-old zebrafish larvae decreased activity when exposed to alarm cues from injured conspecifics compared to water control, indicating that zebrafish larvae recognise alarm cues as risk indicators and respond with an antipredator behaviour. In a second experiment, we used alarm cues to train zebrafish larvae to recognise the odour of a novel predator. We conditioned larvae by presenting the odour of another fish species paired with either alarm cues or water control and, after a 6-hour interval, we tested them with the fish odour alone. During the test with fish odour, both experimental groups reduced activity, but the reduction was faster for larvae conditioned with alarm cues than larvae conditioned with water as control, indicating novel predator odour recognition. Our results suggest that young zebrafish larvae can use alarm cues to recognise a predation event and to identify predators in their habitat.

Keywords: alarm cues, antipredator behaviour, zebrafish larvae

17.20 HOW DOES SEX MATTER? IMPLICATIONS OF SEX DIFFERENCES IN BEHAVIORAL AND METABOLIC EFFECTS OF GENE INACTIVATION IN CONDITIONAL NPY1r KO MICE

Silvia Paterlini¹, Riccardo Panelli¹, Laura Gioiosa¹, Stefano Parmigiani¹, Alessandra Oberto², Carola Eva², Paola Palanza¹

¹Dipartimento di Medicina e Chirurgia, Unità di Neuroscienze, Università di Parma

²Neuroscience Institute of Cavalieri Ottolenghi Foundation, NICO, Università di Torino

Interaction between genes, sex, early developmental events and stress plays a crucial role in the development of psychological and metabolic disorders. NPY and its receptors have been shown to be involved in individual vulnerability to stress, anxiety, depression and metabolic disorders. We have demonstrated that conditional knockout *Npy1r^{rfb}* mice, in which the inactivation of the NPY-Y1 receptor (*Npy1r*) gene was restricted to the limbic system in juvenile and adult mice, showed lower body weight growth and increased anxiety in relation to sex and maternal cares received during the first postnatal week. In this study, we examined body weight growth in response to hypercholoric diet (HFD) and response to chronic stress in KO (*Npy1r^{rfb}*) and control (*Npy1r^{2lox}*) mice. At birth mice were fostered to CD1 dams displaying high maternal care. When limbic *Npy1r*

gene is inactivated, Npy1r^{rfb} male, but not female, mice showed a slower body weight growth compared to Npy1r^{2lox} but, when challenged with a HFD, only Npy1r^{rfb} males showed a rapid body weight increase, higher blood glucose levels and higher abdominal adipose tissue as compared to controls and STD mice. These effects were enhanced when male Npy1r^{rfb} and their control littermates were fed with HFD after been exposed to a chronic stress procedure. Interestingly, none of these effects was observed in female mice nor in standard or under stress conditions. However, when challenged with reproduction, Npy1r^{rfb} female mice showed decreased reproductive success (lower offspring birth weight and reduced pups' survival) but unaltered maternal behavior as compared to controls. These results indicate that limbic Npy1r effects are differently regulated between sex. Present findings demonstrate that sex-related hormonal background may play a crucial role in determining the functional consequences of gene manipulation, an aspect that is often not evaluated as the majority of studies on KO mice focus only on males.

Keywords: NPY, sex differences, behavior

17.40 ENVIRONMENTAL STIMULATION AND BRAIN PLASTICITY

Alessandro Sale

Neuroscience Institute, National Research Council (CNR), Pisa

Brain plasticity refers to the remarkable property of cerebral neurons to modify their structure and function in response to experience, eventually leading to adaptive behavioral changes. This fundamental theoretical theme has been inspiring a wealth of experimental work, with the remarkable paradigm of Environmental Enrichment (EE), which consists on a highly ethological setting aimed at providing the animals with the opportunity for enhanced stimulation at multiple cognitive, sensory, and motor levels. Recent research performed at the Neuroscience Institute of CNR in Pisa has underscored a dramatic impact of EE on behavior and brain plasticity. In both mice and rats exposure to stimulating environments was shown to elicit, during development, a marked acceleration of brain maturation and, in the adult, resulted in the reopening of plasticity windows comparable to those characterizing juvenile sensitive periods. A common feature of this plethora of effects is the experience-dependent modulation of major regulators of neuronal plasticity, including the cerebral inhibition/excitation balance, the brain-derived neurotrophic factor (BDNF) and serotonin. The talk will present recent data concerning the influence of EE on brain plasticity, with also a focus on the therapeutic potential for clinical application in the field of human behavior and sensory disabilities.

Keywords: environmental enrichment, visual system, cortical plasticity

18.00 EFFECTS OF EARLY MATERNAL ENVIRONMENT ON OFFSPRING DEVELOPMENT, BEHAVIOR AND METABOLISM IN A MOUSE MODEL

Giada Caviola¹, Silvia Paterlini¹, Laura Gioiosa¹, Stefano Parmigiani², Paola Palanza¹

¹Dipartimento di Medicina e Chirurgia, Unità di Neuroscienze, Università di Parma

²Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università di Parma

Experiences occurring early in life can set the stage for later development, leading to long-term changes in physiology, brain, and behaviour. In mammals, the quality of the early life environment is affected by the interactions between parents and offspring. In rats, levels of specific maternal

behaviours are associated with the development of physiological and behavioural responses to stressors in the adult offspring due to epigenetic mechanisms (Francis et al. 1999). Thus, mother–offspring interactions provide a direct, flexible link between the dam and the pups that shape adult behaviors and can affect the development of psychiatric and metabolic disorders. We examined social and emotional behaviour, body weight growth and metabolic functions in C57BL/6 derived mice fostered at birth to lactating females of different strains. Foster mothers were observed for spontaneous maternal behaviour from PND 1 to 7 and characterized for the level of maternal care displayed. Specifically, CD1 and FVB foster mothers showed high arched back nursing (HABN), as opposed to C57 and Balbc mice showing low arched back nursing (LABN). Their male and female offspring were examined for body weight growth from birth to adulthood, and in several behavioural tests to evaluate response to novelty, anxiety, social and agonistic behaviour, and diet-induced obesity (DIO). Results indicate that the early maternal environment affect body growth rates and susceptibility to DIO as well as emotional and agonistic behaviours in a sex-dependent manner, with the male offspring showing larger effects than females. Remarkably, the quality of the maternal care, i.e. high or low ABN, cannot by itself entirely predict the observed effects on the offspring but other factors, such as foster mothers' body weight, emotionality or possibly milk quality seem to impact offspring development.

Keywords: early maternal environment, sex differences, behavior

Chairperson: Enrico Alleva

Plenary lecture

09.30 THE ORIGIN AND FUNCTION OF MATHEMATICAL ABILITIES IN ANIMALS

Angelo Bisazza

Department of General Psychology, University of Padua

Did our remarkable mathematical abilities evolve de novo in the hominid lineage, in parallel with the emergence of symbolic language? In the last two decades ethologists and comparative psychologists have systematically investigated numerical abilities in a large number of species, both in the laboratory and in the field. Numerical abilities appear widespread among vertebrates but might be also common in other phyla (e.g., arthropods and molluscs). The capacity to process numerical information was found to affect a surprisingly large number of functions, including mating, parental care, foraging, predation, opponent assessment, spatial navigation and antipredator strategies. The proximate mechanisms underlying numerical abilities have been investigated under controlled conditions in laboratory. Primates are by far the best studied organisms but some teleost species have recently emerged as a model for investigating number sense. Similarities even among distantly related species are often remarkable but it is still unclear if they are due to inheritance from a common ancestor or the result of convergent evolution.

Oral communications

11.00 PHIDIPPUS REGIUS LEARNS TO DISCRIMINATE BETWEEN ARTIFICIAL STIMULI

Massimo De Agrò¹, Lucia Regolin¹, Enzo Moretto²

¹Department of General Psychology, University of Padua

²Butterfly Arc, Esapolis' Living Insects Museum, Padua

The spider's Family Salticidae shows in nature a variety of complex behaviours, like detouring and learning, with a high degree of flexibility. They are active predators and rely mostly on their visual system to search for and to stalk their preys. Even if the learning abilities of these spiders have already been tested, they were never shown capable of distinguishing between different artificial stimuli, which are unlikely encountered in nature. Here we provided a first demonstration of learning abstract stimuli in jumping spiders, using a novel training procedure. We trained *Phidippus regius* spiders to associate a shape ("X" or "O") with a reward (sugary water), and then tested their performance on unrewarded trials. The spiders were also tested on discrimination between an occluded version of the previously rewarded shape and a "cut" version of it, to assess the presence of mechanisms of visual completion. The spiders showed the ability to learn the discrimination task, although the learned discrimination was not generalised to the illusory stimuli. Such failure could depend on the lack of a mechanism for amodal completion (the visual system of Salticidae, given its composition, could simply not need amodal completion). However, alternative explanations will be considered and discussed, like the possible focus of the spider on the unrewarded shape rather than the other, which is completely absent in the illusory condition.

Keywords: Salticidae, learning, visual system

11.20 QUANTITY DISCRIMINATION IN REPTILES (*PODARCIS SICULA*)

Maria Elena Miletto Petrazzini¹, Isabel Fraccaroli², Francesco Gariboldi², Christian Agrillo¹, Angelo Bisazza¹, Cristiano Bertolucci², Augusto Foà²

¹Dipartimento di Psicologia Generale, Università di Padova

²Dipartimento di Scienze della Vita e Biotecnologie, Università di Ferrara

The ability to estimate and compare quantities is fundamental for several aspects of the relationship between animals and their natural environment. For instance, being able to select the largest amount of food available is of prime importance for optimising foraging behaviour in several species. To date, quantity discrimination has been extensively studied in all vertebrate groups except reptiles. In the present study we used two methodological approaches, both a spontaneous choice test and a training procedure, to assess quantitative skills of ruin lizards. In Experiment 1, lizards tested with a choice between two food items (1 vs. 1) differing in size (0.25, 0.50, 0.67, and 0.75 ratio) proved able to select the larger one in any contrast. Conversely, in Experiment 2 lizards presented with two groups of food items differing in number (1 vs. 4, 2 vs. 4, 2 vs. 3, and 3 vs. 4 items) were unable to select the larger group in any comparison. The lack of discrimination in the presence of multiple items represents an exception in numerical cognition studies. To assess whether results of Experiment 2 may reflect a true limit in lizards' ability to process quantitative information, in Experiment 3 lizards were trained to discriminate between two sets containing different numbers of three-dimensional objects. Only a few individuals successfully discriminated 1 vs. 4 items (0.25

ratio), a numerical contrast easily discriminated by other species. Overall these results show poor numerical abilities in lizards raising the question as to whether reptiles' quantitative skills are different compared to other vertebrate groups.

Keywords: lizard, reptile cognition, quantity discrimination

11.40 THE HORSE (*EQUUS CABALLUS*) IN THE IMPOSSIBLE TASK PARADIGM

Alessandra Alterisio¹, Anna Scandurra¹, Paolo Baragli^{2,3}, Biagio D'Aniello¹

¹Department of Biology, University of Naples "Federico II"

²Department of Veterinary Science, University of Pisa

³Natural History Museum, University of Pisa, Calci (Pisa)

The impossible task paradigm provides insight into the decision-making processes, particularly in the realm of expectancy violation and consists of several solvable trials in which the experimental subject solves an easy task to obtain a reward, followed by an unsolvable trial in which the reward becomes unreachable. This paradigm is a useful tool for assessing the persistence of the subject in trying to solve the task independently, or ask for support to human partners. Horses have never been challenged with this paradigm. We tested 18 stabled horses (9 males, mean age \pm SD: 13.9 \pm 1.4; 9 females, mean age \pm SD: 10.6 \pm 2.3) comparing the responses between the baseline in absence of food and the impossible condition, in which the horses were no longer able to reach the food on a table positioned outside the box. The ethogram included: olfactory exploration and interaction toward the table and the people (the caretaker and a stranger) present in the experimental setting, frustration behaviours and the attentional state (selective focusing: both ear cups pointing towards the same target; differential focusing: the two ears were directed in different directions). In the impossible trial the horses explored the caretaker for shorter time ($p < 0.05$), while interacting with the table more frequently ($p < 0.01$), longer ($p < 0.05$) and sooner ($p < 0.01$); they also performed frustration behaviours more often ($p < 0.001$), for more time ($p < 0.01$) and faster ($p < 0.01$) than in the baseline. The selective focusing toward the table had a higher frequency ($p = 0.001$), duration ($p < 0.01$) and a lower latency ($p < 0.001$) in the impossible phase. The differential caretaker-table focusing was longer ($p < 0.05$) and faster ($p < 0.05$), as well as the stranger-table focusing in frequency ($p < 0.01$) and duration ($p < 0.05$), maybe supporting the view of some helping request toward humans.

Keywords: horse-human communication, impossible task paradigm, horse attentional states

12.00 MIRROR SELF-RECOGNITION IN HORSES: MORE THAN A SIMPLE HYPOTHESIS

Paolo Baragli^{1,2}, Elisa Demuru², Chiara Scopa^{1,2}, Elisabetta Palagi²

¹Department of Veterinary Science, University of Pisa

²Natural History Museum, University of Pisa, Calci (Pisa)

Mirror Self-Recognition (MSR) unveils complex cognitive, social and emotional skills and it has been found only in humans and few other species, such as great apes, dolphins, elephants and magpies. Here we tested if horses show the capacity of recognize themselves in the mirror. Previous studies demonstrated that horses are capable to integrate different sensory cues to recognize both conspecifics and humans; moreover, they can also communicate their emotions. These findings are

indicative that horses, like other highly cognitive social animals, show some degree of awareness, which implies the ability to assess and deduce the significance of a situation according to both the social environment and the self. Four horses living socially under naturalistic conditions were selected for the experiment. We adopted the classical mark test, which consists in placing a coloured mark on an out-of-view body part, visible only through mirror inspection. If the animal considers the image as its own, it will use its reflection to detect the mark and will try to explore it. Only in the presence of the reflecting surface, animals performed tactile and olfactory exploration of the mirror and looked behind it. These behaviors suggest that subjects were trying to associate multiple sensory cues (visual, tactile and olfactory) to the image in the mirror. The lack of correspondence between the collected stimuli in front of the mirror and the response to the colored mark lead us to affirm that horses are able to perceive that the reflected image is incongruent when compared with the memorized information of a real horse. However, without replication of data, the self-directed behavior towards the colored marks showed by our horses cannot be sufficient *per se* to affirm that horses are capable of self-recognition. For this reason we are aiming at filling the gap.
Keywords: Equus caballus, cognition, self-awareness

12.20 FROM TOUCH TO VISION: THE ROLE OF TACTILE MEMORY IN VISUAL DISCRIMINATION BY CAPUCHIN MONKEYS (*SAPAJUS* SPP.)

Paola Carducci^{1,2}, Valerio Squillace¹, Barbara Simeoni^{1,3}, Giorgio Manzi², Valentina Truppa¹

¹Unit of Cognitive Primatology and Primate Center, Institute of Cognitive Sciences and Technologies, National Research Council (CNR), Rome

²Department of Environmental Biology, Sapienza University of Rome

³Department of Science, Roma Tre University

Diurnal primates mostly rely on sight to gather information from the environment. However, the tactile input seems to be as essential as visual input and the development of tactile memory can significantly contribute to fast object recognition. Particularly, visuo-tactile integration is supposed to be more important in the discrimination of surface features of objects compared to larger-scale features such as size and shape. The present study, conducted on capuchin monkeys (*Sapajus* spp.), aimed to assess (i) whether the learning ability to visually discriminate objects was enhanced by the possibility to manipulate them and retain tactile memory; (ii) whether the tactile input differently affected the visual discrimination of object size, shape and surface. Capuchins (N=12) were trained in a two-alternative forced choice task in which they had to visually select the positive stimulus between two wooden objects differing in size, shape or surface. We presented pairs of objects in two experimental conditions: in one condition, capuchins were allowed the manipulation of the chosen object after the visual discrimination (Sight & Touch Condition) whereas, in another condition, they were prevented from haptically exploring the selected object (Sight Condition). We found that capuchins' learning speed was higher in the Sight & Touch Condition compared to the Sight Condition. Moreover, regardless of the experimental conditions, capuchins' learning speed was higher in both size and shape discrimination compared to surface discrimination. Overall, our findings demonstrated that capuchins benefit from the possibility to haptically explore the objects. Tactile information acquired in the course of the experiment allowed high visual accuracy levels to be achieved in a shorter time. This suggests that learning speed strongly depends on the mode of object exploration and it encourages further research on the role of tactile memory in visual discrimination.

Keywords: object discrimination, visuo-tactile integration, New World monkeys

12.40 SOCIAL TOLERANCE AND YAWN CONTAGION: THE CASE OF MACAQUES

Alessandra Zannella¹, Roscoe Stanyon¹, Elisabetta Palagi²

¹Anthropology Laboratories, Department of Biology, University of Florence

²Natural History Museum, University of Pisa, Calci (Pisa)

Empathy is the capacity to perceive/understand the internal emotional states of others. The perception-action mechanism based on the mirror neuron system allows individuals to automatically experience others affective states. Sharing emotions passes through the face with facial mimicry and yawn contagion being the two most common mechanisms of this sophisticated form of communication. Both genetic and epigenetic factors influence the development of empathy. Empathic abilities are particularly important in those species characterized by complex social networks and high levels of tolerance. Being able to freely interact with other group members in the early phases of life (low levels of social canalization) reflects into a higher capacity to empathize with others later in life. We thus hypothesize that yawn contagion, an empathy-related behaviour, is expressed in tolerant more than despotic species. We tested this hypothesis by comparing spontaneous and infected yawns in two macaque species placed at opposite ends of the tolerance continuum: despotic Japanese macaques (*Macaca fuscata*) and tolerant Tonkean macaques (*Macaca tonkeana*). The basal levels of spontaneous yawning did not differ between the two species. This homogeneity permitted us to evaluate potential differences in the meaning of spontaneous yawning as a function of i) social tension, ii) aggressive contexts and iii) dominance hierarchy. Our results highlighted a greater redundancy and a possible communicative function of yawning only in the tolerant species. Moreover, only Tonkean macaques showed the phenomenon of yawn contagion. Similarly to humans, Tonkean macaques were susceptible to others' spontaneous yawns because they returned at least one yawn within the 3 min time slot. Moreover contagious yawning followed an empathic gradient since it was more frequent in those dyads characterised by an high level of social closeness. These data support our hypothesis about the linkage between social tolerance and the propensity of yawn contagion.

Keywords: emotional contagion, yawning, social styles

13.00 GORILLAS ARE NOT INFECTED BY OTHERS' YAWNS: A NATURALISTIC AND EXPERIMENTAL APPROACH

Elisabetta Palagi, Elisa Demuru, Ivan Norscia, Giada Cordoni

Natural History Museum, University of Pisa, Calci (Pisa)

Yawn contagion echoes emotional contagion, the basal level of empathy. This phenomenon and its linkage with social closeness between subjects have been demonstrated in humans and in the two *Pan* species. Here, we investigated for the first time the occurrence of yawn contagion in a colony of lowland gorillas (*Gorilla gorilla gorilla*) hosted at the ZooParc de Beauval (France). We gathered data both via a naturalistic and experimental approach. During the experimental phase, we alternatively showed to the animals four mute videos showing yawning (yawn condition) and other mouth movements (control condition) of an unfamiliar gorilla and a virtual ape-like face (avatar). Both under naturalistic (the trigger yawns were those emitted spontaneously by group members) and experimental observation, gorillas failed to respond to the yawn stimuli. Moreover, the analysis revealed a significant positive correlation between yawn response and self-directed behaviours (i.e. scratching and self-grooming) independently from the presence or absence of the yawning stimulus thus suggesting that the yawn response is the expression of an anxiety state. The fact that gorillas were not infected by yawns of others can be linked more to their social dynamics rather than to their cognitive abilities. In gorillas, the low levels of affiliative interactions, cooperation and

synchronization between group-members may negatively affect the expressions of yawn contagion. Nevertheless, the absence of evidence is not necessarily the evidence of absence, but it is interesting to note that the same approaches applied to the other great apes gave opposite results, for this reason the topic is worth of further investigation.

Keywords: emotional contagion, social cohesion, anxiety

Chairperson: Marco Vannini

14.40 THE HEAT OF EMOTIONS: A REVIEW ON INFRARED THERMOGRAPHY AS METHOD TO INVESTIGATE EMOTIONAL STATES IN ANIMALS

Tiziano Travain & Paola Valsecchi

Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università degli Studi di Parma

Infrared thermography (IRT) is a passive, remote and non-invasive method that measures surface temperature, detecting infrared radiation emitted by a subject and providing a pictorial representation of body temperature. Several studies showed that IRT provides information on animals' health and represents a useful method to assess acute and chronic stress in laboratory and farm animals. More recently, IRT has been utilized to assess negative and positive emotions in animals: the available literature on changes in body temperature under emotional conditions is relative to a variety of body surface areas, tools and species tested (comb in hens; nose in cows and macaques; eye and ear in dogs; eye in horses). Data obtained using IRT in the study of animal emotions showed that surface body temperature can increase/decrease depending on the investigated species, the anatomical areas and the type of stimulus used, making cross-species comparisons difficult. In dogs, eye temperature increased regardless the presumed valence of the stimulus, i.e. food delivery or veterinary visit; and recently it has been showed that ear pinna temperature in dogs decreased as effect of being separated from the owner. Similarly, nasal temperature decreases in macaques during negative emotional states induced by threatening stimuli and in cows when exposed to a positive stimulus. In hens, comb surface temperature significantly drops in response to anticipation and consumption of a palatable food reward, but also during exposure to unpleasant events. Overall, this evidence suggests that body surface temperature is an optimal index to identify a general state of arousal, but it does not discriminate the positive or negative emotional valence of the stimulus itself. It will be discussed whether body temperature and IRT, combined with behavioural analysis, can be useful tools in assessing emotional states in animals with the aim of improving animal welfare.

Keywords: infrared thermography, emotional states, welfare

15.00 BOWL HALF FULL OR HALF EMPTY? ASSESSING AFFECTIVE STATE IN SHELTER DOGS

Carlotta Burani¹, Shanis Barnard², Deborah L. Wells², Paola Valsecchi¹

¹Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università degli Studi di Parma

²Animal Behaviour Centre, School of Psychology, Queen's University Belfast, UK

The kennel environment may cause poor psychological welfare due to scarce possibility to perform ethologically relevant activities. Furthermore, the emotional state of dogs may affect their ability to cope with a confined condition and the subjects' vulnerability relies upon several factors (e.g.

personality). Previous studies in human and non-human animals have shown that the affective state can be assessed by observing the judgement bias (i.e. optimistic or pessimistic) of an ambiguous stimulus, but this well-being measure has been overlooked in dogs. In this study, we investigated if the dog's judgement of an ambiguous stimulus (using the latency to reach a bowl as a cue of pessimistic or optimistic expectation) could be predicted by specific behavioural traits (scored using a Qualitative Behaviour Assessment, QBA, tool) and/or the dog's coping style when presented with a problem-solving task. The analyses (N=25) showed that subjects that readily asked for human help in front of an impossible task were slower than more "persistent" dogs in reaching the bowls during the judgement bias test, suggesting that personality may influence the outcome of the task rather than the emotional state alone. Moreover, dogs scoring high on "depression" (assessed via QBA) took longer (than others) to reach the bowl in the near negative position (linear mixed-effects model, $p < 0.005$) than in any other location. This is in line with previous findings showing that individuals affected by a greater level of depression have also a greater expectation of lack of reward. Overall, this project has a great importance on both a scientific and practical standpoint. It is the first time that the judgement bias test has been associated with the dog's coping style during a problem-solving task. Furthermore, some evidence emerged to suggest that the QBA could be an easy-to-implement tool to assess the affective state of kenneled dogs.

Keywords: judgment bias, affective state, coping style

15.20 NATURAL BIOCIDES DISRUPTS NESTMATE RECOGNITION AND ACCEPTANCE BEHAVIOUR IN HONEYBEES

Federico Cappa, Iacopo Petrocelli, Francesca Romana Dani, Leonardo Dapporto, Michele Giovannini, Jeferson Silva Castellari, Stefano Turillazzi, Rita Cervo

Dipartimento di Biologia, Università degli studi di Firenze

Social bees and managed honeybees experienced a severe decline in last decades with a huge economic impact for agricultural economies, since many important crops depend on these insects for pollination. Moreover, as many wild plants are pollinated by bees the disappearance of these insects may challenge the integrity of plant communities and associated diversity in natural ecosystems. Intensive farming and use of agrochemicals are the main causes of this decline. In recent years, biological treatments against insect pests have partially replaced synthetic plant-protection products. *Beauveria bassiana*, a cosmopolitan entomopathogenic fungus, has been extensively used since the '80s as a natural biocide in organic agriculture and its side-effect for non-target species appeared negligible. Here, for the first time, we provide evidence that *B. bassiana* affects nestmate recognition and acceptance behaviour in honeybees. Foragers treated with the fungus have an altered profile of cuticular lipids and, consistently, guard bees patrolling the hive entrance cannot successfully recognize the infected alien foragers. An efficient nestmate recognition is crucial to maintain the integrity of bees' colony since it reduces plundering during nectar shortage and limits horizontal transmission of phoretic parasite mites (e.g. *Varroa*) and of many severe diseases (e.g. American foulbrood, chalkbrood, *Nosema* sp.). Our results highlight that potential side-effects of bio-insecticides on the behaviour of non-target pollinators such as social bees should be assessed more thoroughly by considering, beside direct toxicity, the effects on behavioural traits linked to complex social organization.

Keywords: honeybees, nestmate recognition, natural biocide

15.40 PERSONALITY AND GROUP PERFORMANCE IN A SOCIAL INSECT

Claudio Carere^{1,2}, Celine Audebrand¹, Heiko G. Rödel¹, Patrizia d’Ettorre¹

¹Laboratoire d’Ethologie Expérimentale et Comparée EA4443, Sorbonne Paris Cité, France

²Department of Ecological and Biological Sciences, CISMAR, University of Tuscia, Tarquinia (Viterbo)

The link between individual personality and group-level behaviour is a fundamental issue in biology, but how individual differences translate into group performance is yet unclear. In eusocial insects, consistent behavioural differences have been found both at individual and group level. One possibility could be that groups simply differ in the average personality of their members. We tested this hypothesis in the ant *Formica fusca* by constructing homogeneous same-age groups of individuals of known personality. At the individual level, we established that exploratory activity measured by time of mobility when entered singly into an open field arena, was significantly repeatable across two consecutive trials. Based on this trait, nine groups with different average personality were composed, each consisting of six individuals with similar exploration tendency housed in a box with three cocoons and a refuge. We then repeatedly disturbed each group by removing the ants and cocoons from the refuge. The relative within-group differences among individuals in the latency to transport cocoons into the refuge were significantly repeatable across the two trials, and the relative individual differences in the latency to enter the refuge showed a similar tendency. There were clear associations between individual exploration activity and the performance in transport of cocoons at the group level. Groups composed of more exploratory individuals started significantly earlier to transport cocoons and transported significantly more cocoons into the nest. Furthermore, in such groups a significantly higher percentage of individuals entered the nest within 15 minutes of testing. When in a group, more exploratory animals showed significantly more returns to the nest than less exploratory ones and tended to transport more cocoons. This is the first evidence showing a direct link between individual and collective personality in eusocial insects and suggests that colony personality reflects the average personality of its workers.

Keywords: personality, collective behaviour, exploration

16.00 BEING NEXT TO YOU IS ENOUGH. THE PRESENCE OF A GROUP MATE DECREASES RISK PREFERENCES IN TUFTED CAPUCHIN MONKEYS (*SAPAJUS* SPP.)

**Flaminia Casadei^{1,3}, Roberta Vitiello^{1,4}, Gabriele Oddi^{1,2}, Francesca Zoratto¹,
Francesca De Petrillo^{1,3}, Fabio Paglieri⁵, Elsa Addressi¹**

¹Unità Primatologia Cognitiva, Istituto di Scienze e Tecnologie della Cognizione, CNR, Roma

²Dipartimento di Scienze della Terra, Sapienza Università di Roma

³Dipartimento di Biologia Ambientale, Sapienza Università di Roma

⁴Dipartimento di Biologia e Biotecnologie Charles Darwin, Sapienza Università di Roma

⁵Goal-Oriented Agents Lab, Istituto di Scienze e Tecnologie della Cognizione, CNR, Roma

In non-human primates, the social context influences many aspects of behavior; however, only a few studies have investigated how social influences affect risk preferences. In chimpanzees and bonobos, competition with a human opponent increased risk preferences, whereas in tufted

capuchin monkeys the presence of a group mate had an opposite effect. Here, we investigated risk preferences in capuchins tested in a competitive situation involving a group mate. Focal subjects faced choices between a constant option (2 food items) and a variable option (0 or 6 food items with 30% probability) when alone or in view of a group mate. When the focal subject chose the risky option with the “zero” outcome, the alternative reward (6 food items) was either given to the group mate or placed in the adjacent, empty cage, according to condition. For the focal subjects, we scored latency to choose and switching. For both subjects we scored scratching, urine washing and alarm calls, which likely indicate distress. Focal subjects showed a longer latency to choose, a higher number of choices for the risky option, and alarmed more in the Alone than in the Social condition. In the Alone condition focal subjects scratched more before than after choice, while in the Social condition they did the opposite. Focal subjects showed more urine washing and switching attempts when they received 0 rather than 2 or 6 food items. Finally, in the Social condition, focal subject’s risk preferences were not related to the group mate’s distress behaviors. Thus, although there was no direct influence of the group mate’s behaviors on the focal subject’s choice, the group mate’s presence seems to effectively reduce focal subject’s risk preferences compared to the Alone condition, as shown in humans.

Keywords: decision-making, risk, social influences

16.20 CHANGES IN TURN ALTERNATION PATTERN IN TERRESTRIAL ISOPODS AS A RESPONSE TO SUBSTRATE-BORNE VIBRATIONS

Sofia Cividini¹ & Giuseppe Montesanto²

¹Independent researcher in Biostatistics, Como

²Dipartimento di Biologia, Università di Pisa

Armadillo officinalis, is a xeric woodlouse (Isopoda, Oniscidea) that can produce vibrations, audible even by the human ear, by means of a ledge of scales situated on the propodus of the fourth and fifth pereopod. This work investigates the behavior of this species in terms of turn alternation in response to substrate-borne vibrations, in a multiple T-maze. We collected data about the turn alternation, meant as number of times that the animal turns on the opposite side in a predefined path, in four groups of animals: i) adults of *A. officinalis* exposed and ii) not exposed to micro-vibrations, iii) juveniles of *A. officinalis* exposed to micro-vibrations, and iv) adults of *Armadillidium vulgare* exposed to micro-vibrations. Hence, we were able to assess the pattern of the turn alternation at a level of i) exposure to micro-vibrations (not exposed vs. exposed), ii) animal’s state (adults vs. juveniles), and iii) species (*A. vulgare* vs. *A. officinalis*). A Poisson regression with robust standard errors was used. The models highlighted a statistically significant association between turn alternation and the micro-vibration, animal’s state, and species, with a higher number of turn alternations in the adults of *A. officinalis* exposed to micro-vibrations compared to i) the adults of *A. officinalis* not exposed, ii) the juveniles exposed, and iii) *A. vulgare* exposed. The adults of *A. officinalis* seem to be very sensible to vibrations, unlike *A. vulgare*. The sensitiveness also seems increasing passing from the juvenile state to the adult condition. This might be related to the peculiarity of this species to emit vibrations. The reactivity of *A. officinalis* to an external substrate-borne vibration as well as its capability to produce vibrations might be linked to an interspecific signaling and/or an intraspecific communication.

Keywords: multiple t-maze, vibrational communication, stridulatory organ

16.40 TO BE BIGGER, TO BE RESIDENT OR TO BE COLOURED? EXPERIMENTAL ANALYSIS ON TERRITORIALISM OF *PODARCIS SICULUS CAMPESTRIS* (DE BETTA, 1857) OF NORTHERN TUSCANY

Valentina Titone¹, Francesca Marsiglia¹, Marco Mangiacotti², Roberto Sacchi², Stefano Scali³, Marco A.L. Zuffi¹

¹Museum Natural History, University of Pisa, Calci (Pisa)

²Department of Earth and Environmental Sciences, University of Pavia

³Museum Natural History, Milano

Territoriality evolves when the benefits gained from exclusive access to limited resources exceed the costs of defence. Sometimes animals evolve distinct morphs, that may reflect different capability, and in some territorial species of lizards the polymorphism is associated to alternative strategies, both for reproductive efficiency and territorial dominance. It is known that normally larger males are more aggressive and able to defend a larger area and for more time than small males. In fact, this dynamic is widespread in many animal species and even in the genus *Podarcis*. The aim of our study is to test which factors determine the outcome of fighting in the strongly territorial wall lizard, *Podarcis siculus*, using two types of contests, i) resident versus intruder and ii) in a neutral arena. Furthermore, because these lizards are characterized by strong ventral colour variability, usually restricted to jaws and throat, we wish to investigate if coloured lizards have higher changes to win than white lizards. The results confirm that the fight's outcome is significantly influenced by the state of residence, while the colour has no effect, instead the body mass has significant influence on the outcome in the neutral arena. Furthermore, we demonstrate that resident lizards spend less time than intruders in the activity of avoidance, while there is not any size effect for both roles. On the other hand, in the contest of neutral arena the avoidance activity is strongly correlated with the size of the contenders. These results underline that, in this subspecies, both the size and the state of residency, no matter the colour, play an important role to determinate the outcome of a clash depending on the contest. *Podarcis siculus* should be object of future studies, that focus on behavioural and ecological aspects, even considering the presence of different colour's occurrence within and among populations.

Keywords: residence asymmetry, body size, throat and jaw colour

17.00 USING THE SAND TO HIDE OR AS A COVER: THE ROLE OF THIS DEFENSIVE BEHAVIOUR IN FISH SPECIES THAT DO NOT LIVE IN SANDY SETTLEMENTS

Roberto Bedini, Marco Bedini, Elisa Salvadori

Istituto di Biologia ed Ecologia, Marina di Piombino (Livorno)

During scuba diving and in our laboratory aquaria we have proved the outstanding cryptic mimicry in the fish *Lithognathus mormyrus* Linnaeus, 1758 of the Sparidae family and *Scorpaena porcus* Linnaeus, 1758 of the Scorpeanidae family. We know that some osteichthyes living on sandy settlements usually hide into the sand when they are at risk or when they are hunting as the Trachinidae and Uronoscopidae species. On the contrary, hiding into the sand, or covering its own body with the sand is a behaviour used by fish that have not developed appropriate anatomical structures for the goal. Surprisingly, this behaviour is used by fish usually living on rocky settlements. During a night scuba diving we have filmed an individual of *Lithognathus mormyrus* that, frightened by the diver, quickly hidden itself into the sand. We have also noted that two specimen of *Scorpaena porcus*, in an aquarium with sandy bottom, promptly covered their body with sand when in a risky situation. These behaviours are very interesting because these species do

not have appropriate anatomical structures to hide into or with sand. Fish that hide into the sandy bottoms have developed tails and anal fins to the goal while in the studied species there are no body parts fit to hide into the sand and Scorpaenidae live even on rocky settlements!

Keywords: fish, to hide, sand

Plenary lecture

18.00 PROSOCIAL PRIMATES: COOPERATION AND EMPATHY

Frans B. M. de Waal

Living Links, Yerkes Regional Primate Research Center, and Psychology Department,
Emory University, Atlanta, USA

The possibility that animals may have empathy has until recently received little attention. Part of the reason may have been excessive fear of anthropomorphism and a taboo on animal emotions. Change has come from studies of consolation behavior and yawn contagion in primates (and other mammals), the discovery of mirror neurons in macaques, as well as the first neuroscience on this phenomenon in rodents. The empathy hypothesis is strongly supported in that caring behavior is biased towards socially close partners, involves state matching (e.g. the other's distress causes distress in the observer), and is blocked when oxytocin receptors are blocked. This would lead one to agree with Darwin that "Many animals certainly sympathize with each other's distress or danger." Expressions of empathy range from a core mechanism of emotional contagion to cognitive perspective-taking and targeted helping. As for cooperation, the strange myth has taken hold that humans are unique in this regard, such as the claim that human cooperation represents a "huge anomaly" in the animal kingdom. This is an odd endpoint to our journey of cooperation research which began in the 1960s and 70s with theories of kin selection and reciprocal altruism, both of which inspired by animal behavior. There is in fact compelling evidence that other primates are capable of suppressing competition, dealing with freeloaders, engaging in reciprocity, or developing a sense of fairness. The latter is expressed in reactions to inequity and outcomes of the Ultimatum Game. All of these tendencies contribute to the highly developed cooperation one would expect from our close relatives.

Chairperson: Paolo Baragli

Plenary lecture

09.30 INTEGRATIVE SOCIAL BEHAVIOUR OF GROUP LIVING FISHES

Adam R. Reddon

Department of Biology, McGill University, Montreal, Canada

Social interactions are critically important for many animals, particularly those that live within groups. Group living animals must recognize and differentially respond to distinct individuals and coordinate their actions with other group members while avoiding costly conflict that could outweigh the benefits of group living. To progress in our understanding of sociality, it is crucial that

we understand the interplay between the mechanisms that underpin group living and the adaptive function that a social lifestyle serves. To do so, it is necessary to take an integrative approach. The proximate underpinnings of social behaviour are broadly conserved across the vertebrate taxon, but the within and between species variation in those mechanisms raises questions about the evolution of social regulation. I will discuss my ongoing work on social behaviour and the resolution of conflict within social groups. I will present data collected on the cooperatively breeding Tanganyikan cichlid, *Neolamprologus pulcher*, and the Trinidadian guppy, *Poecilia reticulata*, both model systems in behavioural and evolutionary ecology. I will discuss the importance of the nonapeptide neurohormone, isotocin (the teleost fish homologue of oxytocin), in modulating social responses, and its potential role as a proximate substrate for group living. The behavioural and neurobiological data that I present will help to shed light on the evolution and maintenance of group living in the most diverse vertebrate group, the teleost fishes.

Oral communications

11.00 WHO CALLS WHOM: INDIVIDUAL VOCAL RECOGNITION IN THE ZEBRA FINCHES

Pietro D'Amelio, Milena Klumb, Nicolas Adreani, Lisa Trost, Manfred Gahr, Andries ter Maat

Department of Behavioral Neurobiology, Max Planck Institute for Ornithology, Seewiesen, Germany

The study of bird vocal communication has historically focused on the most elaborated and loud of the vocalizations, the song, whereas the study of unlearned calls has not been given much attention. Calls are generally much shorter, simpler and softer; but while songs only serve few functions calls are employed in numerous situations. Calls are used from alarming to recruit feeding companions and, most interestingly, they can mediate social relationships. The lack of knowledge about calls mainly derives from the absence of appropriate tools for recording vocalizations individually. Recently, cutting-edge methods for recording individual vocalizations in social settings have been developed and constitute exciting tools for studying vocal communication networks. Zebra finches (*Taeniopygia guttata*) have been the focus of several such studies; however, whether and how they can identify and address an individual within the group is still unknown. After providing a background about zebra finches calls and songs, we describe a playback experiment in which we employed miniaturized backpack microphones (0.6 grams) to study the vocal response of zebra finches to different stimuli. We asked the birds “who is calling?”. The analysis of the answers demonstrated, for the first time, that unlearned soft vocalizations contain markers of individual identity and that timing is much more important than quantity and quality when answering. We hence provide a mechanism by which individuals can address specific subjects in a group and mark a change of paradigm showing that what was thought to be an undirected and unspecific vocalization can convey messages for specific individuals. Vocal recognition is a fascinating aspect of communication, since the ability to recognize individuals in a group of vocalizing conspecifics is a prerequisite for complex communication networks and collective performance.

Keywords: vocal communication, unlearned calls, songbirds

11.20 RHYTHMS, FREQUENCIES AND GENES: THE MANY ASPECTS OF THE INDRIS' SONG

Cristina Giacomini¹, Valeria Torti¹, Giovanna Bonadonna¹, Chiara De Gregorio¹, Daria Valente¹, Rose Marie Randrianarison², Olivier Friard¹, Luca Pozzi³, Marco Gamba¹

¹Department of Life Sciences and Systems Biology, University of Torino

²GERP (Group d'Etude et de Recherche sur les Primates de Madagascar), Madagascar

³Department of Anthropology, University of Texas at San Antonio, USA

The occurrence of non-random structures over time is a key feature of both music and speech. The 'singing primates', which produce elaborated and complex sequences of vocalizations, are of particular interest for this topic. Indris (*Indri indri*) are the only singing lemurs and emit songs whose most distinctive portions are "descending phrases" consisting of 2-5 units. The indris of Madagascar produce loud howling choruses in which all members of a group sing. We analysed the temporal structure of the individuals' contribution to the song to understand whether overlapping and turn-taking followed a precise pattern. The results showed that the dominant male and the dominant female in a group overlapped each other more frequently than they did with the non-dominant individuals. Focusing on the temporal and frequency structure of the phrases occurring during the song, we found that males and females have dimorphic inter-onset intervals and median frequencies, with males showing longer intervals and higher frequencies when compared to females. We have not found an effect of age on the temporal and spectral structure of the phrases. We will discuss the potential for patrilineal signatures in indri.

Keywords: Indri indri, inter-onset intervals, vocal learning

11.40 PLAY ASYMMETRY AND FACIAL COMMUNICATION IN SOUTH AMERICAN SEA LIONS (*OTARIA FLAVESCENS*)

Clara Llamazares-Martín¹, Chiara Scopa², Federico Guillén-Salazar¹, Elisabetta Palagi²

¹Ethology and Animal Welfare Section, University CEU Cardenal Herrera, Valencia, Spain.

²Natural History Museum, University of Pisa, Calci (Pisa)

Although play fighting has been studied for over a century in both human and non-human animals, quantitative data on marine mammals are still scarce. Here, we investigated play fighting and facial displays in South American sea lions (*Otaria flavescens*), one of the most sexually dimorphic species characterized by high levels of both intra- and inter-sexual competition. Although playful interactions were punctuated by competitive behaviours, animals were able to adjust their competitive playful interactions in a flexible manner (symmetric play). This result is predictive of the motivation of these animals to engage in play behaviour, which can have a possible role not only in the acquisition of dominance status, but also in the establishment and maintenance of social relationships, an unexpected role in so a highly competitive species. Facial expressions are one of the most frequent patterns in play communication. The reciprocity of facial signals expressed by the players provides information on their reciprocal attentional state and on the correct perception/decoding of the signal itself. For the first time, we explored the Relaxed Open Mouth (ROM), a widespread playful facial expression among mammals, in the South American sea lion (*Otaria flavescens*). Even though ROM did not vary in the frequency of emission as a function of the number of players involved, it was reciprocated more often during dyadic encounters, in which the players had the highest probability to engage in a face-to-face interaction. Moreover, the

reciprocation of ROMs, more than their frequency, was effective in prolonging playful bouts. In conclusion, ROM is widespread in many social mammals and *Otaria flavescens* is not an exception. At least in those species for which quantitative data are available, ROM seems to be characterized by similar design features clearly indicating that the signal underwent similar selective pressures.

Keywords: cooperative/competitive playful interactions, relaxed open mouth, reciprocity of facial expression

12.00 PLAY BEHAVIOUR IN WILD JUVENILE CHIMPANZEE (*PAN TROGLODYTES*)

Calogero Montedoro¹, Hans Van Dyck¹, Marie-Claude Huynen², Zarin Machanda³, Richard Wrangham³

¹Department of Behavioural Ecology, Earth & Life Institute, University of Louvain, Belgium

²Department of Behavioural Biology, University of Liège, Belgium

³Department of Human Evolutionary Biology, Faculty of Arts & Sciences, Harvard University, USA

Many primates live in social groups in which members coordinate their activities, communicate and interact in affiliative and agonistic ways. In order to integrate social life, play behaviours are considered as an effective and universal learning ‘engine’ of social rules and facilitate knowledge on other individuals. Play also contributes to social cohesion and development of cognitive skills for social life. The aim of this research project was to test a number of sociobiological assumptions about play behaviour in juvenile chimpanzees. Chimpanzees coordinate their activities by a variety of social interactions and communication, forming strong social bonds. These complex interactions are often expressed in adulthood as dominance, cooperation, coalition and grooming, and could be related to juvenile social play development in term of evolutionary adaptations. In this study, we focused on a community of 50 wild chimpanzees in the Kibale Forest National Park, Uganda. Observations were video recorded using “behavioral sampling” with a focus on play behaviour. Only juveniles (<15 years old) were included as initiators of play behaviour. Time budget of social play was calculated as the proportion of social play duration relative to the total play time. Moreover, the intensity of play was estimated by assigning an intensity value relative to the type of play. Play session intensity was scored by combining intensity values of observed behaviours. We observed that the intensity of play sessions differed relative to gender and age of the player and of the playing partner. Male games were on average more intense. Play also increased in intensity with age, especially when directed to females. Moreover, time allowed to social play activities was found to be longer in males than in females, who spent more time in solitary and mothering games. Finally, we observed the emergence of preferences in the choice of specific playing partners.

Keywords: behavioural ecology, sociobiology, primatology

12.20 JEALOUSY IN DOG DYADS

Emanuela Prato-Previde¹, Sofia Fusar Poli¹, Velia Nicotra², Annalisa Pelosi², Paola Valsecchi³

¹Dipartimento di Fisiopatologia Medico-Chirurgica e dei Trapianti, Università degli Studi di Milano

²Dipartimento di Medicina e Chirurgia, Università degli Studi di Parma

³Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università degli Studi di Parma

While there is evidence that primary or basic emotions have a long evolutionary history and can be found across a wide range of vertebrate species, research on secondary or complex emotions in nonhuman animals is very limited. Jealousy is a secondary emotion arising in triadic social contexts

when an individual perceives that a valued relationship is threatened by an interloper: it is expressed by negative affective responses and behaviors directed at regaining attention and care from a significant social partner. Adapting a paradigm from human infant studies, we assessed the presence of jealousy-related behaviors in a realistic triadic social context testing 13 dog dyads living together. Owners were instructed to, at first, ignore both dogs and then direct their attention exclusively towards one dog, while ignoring the other. Eleven mutually exclusive behaviors and 3 non mutually exclusive behaviors were recorded. When the owners cuddled the companion dog, the ignored ones engaged in jealousy-related behaviors including monitoring the interaction (100% of dogs), attempting to disrupt the interaction acting on the owner (i.e. pushing, gently biting and nudging the owner or placing themselves between the owner and the other dog; 73.1%) and attempting to disrupt the interaction acting on the other dog (38.5%). There was a significant difference in the duration of these behaviors ($p < 0.001$), with dogs spending more time monitoring the third-party interaction than trying to disrupt the interaction acting on the owner or on the other dog. There were individual differences in the exhibition of jealous behaviors suggesting that dogs, like children, may have different coping strategies when exposed to a jealousy evoking situation. Current findings show that dogs exhibit jealousy behaviors in a realistic social context, supporting the emerging view that secondary emotions are not necessarily restricted to humans and other primates.

Keywords: dog-human interaction, emotions, jealousy

12.40 MIMICKING THE FEMALE TO CHEAT ANOTHER MALE: THE RIVARLY STRATEGY OF A LEAFHOPPER

Rachele Nieri^{1,2}, Shira D. Gordon³, Rodrigo Krugner³, Valerio Mazzoni¹

¹Sustainable Agro-Ecosystems and Bioresources Department, Edmund Mach Foundation, San Michele all'Adige (Trento)

²Department of Biology, University of Florence

³USDA-Agricultural Research Service, San Joaquin Valley Agricultural Sciences Center, USA

When sexually receptive females are scarce, males compete to increase the possibilities to mate. Male-male interactions exploit species-specific communication and involve aggressive or ritualized behavior. In leafhoppers, a well-studied model for vibrational communication, all stages of pair formation (i.e. identification, location and courtship) and male rivalry interactions are mediated mainly by vibrational signals. We described the intraspecific communication of the glassy-winged sharpshooter (GWSS), *Homalodisca vitripennis*, which is an important leafhopper pest of grapevines in Southern USA. The description of the pair formation and associated signals of the GWSS revealed a complex system involving the emission of three male and two female vibrational signals that convey specific information to identify, locate and court the partner. Behavioral analysis of trials with two males and one female revealed a peculiar male rivalry behavior that involved the emission of three different rivalry signals. We found that two rivalry signals specifically mimic female signals and are used by the rival male to replace the female in the duet with the first male. The effect of this is that the first male starts a duet and establishes communication with the rival male. Only when the two males are in close proximity the third rivalry signal is emitted and a vibratory duel takes place until one of the males stops signaling. Data suggested that rival males used mimicry to interrupt the ongoing male-female mating duet and hostile signals are employed in a ritualized behavior to exclude a rival and gain access to a female. This is the first report, in both vibrational and acoustic communication, of such a use of a female mimic strategy.

Keywords: vibrational communication, mating behavior, rivalry

Chairperson: Natale Emilio Baldaccini

14.10 FROM MUTUALISM TO MANIPULATION IN ANT-PLANT RELATIONSHIPS MEDIATED BY EXTRAFLORAL NECTAR

Donato A. Grasso¹, Daniele Giannetti¹, Cristina Castracani¹, Alessandra Mori¹, Massimo Nepi², Stefano Mancuso³

¹Dipartimento di Scienze Chimiche della Vita e della Sostenibilità Ambientale, Università di Parma

²Dipartimento di Scienze della Vita, Università di Siena

³Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente, Università di Firenze

Interactions involving ants and plants constitutes textbook examples in animal-plant biology. A special case is represented by associations with plants bearing extrafloral nectaries (EFNs). This trait is generally considered as a plant defensive system to reduce herbivory. In most cases, EFNs seem to be specially designed to attract ants whose feeding ecology and behaviour make them very efficient plant defenders. Although this case of trophobiosis (food in exchange of protection) is a classic mutualistic relationship, it is well known that the outcomes of interspecific interactions may be often conditional or context-dependent and develop along a continuum (e.g. from antagonism to mutualism) both from an ecological and evolutionary point of view. Most data available on EFNs-based ant-plant interactions refer to mutualisms in tropical regions and no detailed study has been conducted so far in Italy. In order to reduce this gap we carried out a series of field and laboratory investigation involving different ant-plant study systems. Here, we focus on *Crematogaster scutellaris* a common arboreal ant engaging in close relationships with several plant species. Our data clearly confirm the importance of the ants for the associated-plant fitness showing their crucial role against herbivores. Some aspects of the plant biology, such as nectar production and amount, seem designed to improve ant attraction and performances. In fact, the ants patrol restless the host plants and are strongly attracted towards EF nectar they eat greedily. Moreover, the ants that fed on nectar showed a higher level of aggression against other insects and changes in response to social and environmental stimuli. Present results strongly support the hypothesis that plants may control/manipulate the behaviour of ants in order to maximize partner-derived rewards and obtain a better service as bodyguards without disrupting the association.

Keywords: ant-plant mutualism, EFNs, behavioural manipulation

14.30 POST-CONFLICT AFFILIATION IN A TOLERANT SPECIES (*Macaca tonkeana*)

Virginia Pallante^{1,2}, Roscoe Stanyon², Elisabetta Palagi¹

¹Natural History Museum, University of Pisa, Calci (Pisa)

²Anthropology Laboratories, Department of Biology, University of Florence

Post-conflict peaceful interventions are valuable mechanisms aimed at reducing tensions at individual and group level. However, depending on the target, third party affiliation may be driven by different motivations of the performer, which can reveal both strategic and emotional components of the behaviour. The choice to contact either the victim or the aggressor after a conflict can have different implications. Spontaneous affiliation towards the aggressor has been interpreted as a self-serving, egoistic behaviour. On the other hand, contacting the victim has been ascribed to an empathic response of the consoler. *Macaca tonkeana* is a good model to investigate the different meanings underpinning post-conflict affiliation, because the species shows a high rate

of conflict resolution with various strategies, including consolation. Our data show that post-conflict affiliation towards the aggressor has an appeasement function by decreasing anxiety and arousal in the receiver and reducing the likelihood of an escalation of the aggression. Tonkean macaques mainly affiliated with the aggressors when they occupied low ranking positions. This fact demonstrates that post-conflict affiliation can include an accurate risk evaluation by the bystander. On the other hand, consolation is a phenomenon probably driven by an emotional involvement of the bystander. It works in improving not only the emotional state of the victim (lower self-directed behaviours) but also that of the consoler. Apparently this phenomenon relies on a mirroring emotional variation between the two interacting subjects. The observers not engaging in any post-conflict affiliation experienced the same emotional state as the victim. However, witnessing the consolatory event was not sufficient to reduce self-directed behaviours. This matching-state effect indicates that the bystanders are able to perceive the victim distress and, therefore, to respond with an "empathic" consolatory act.

Keywords: appeasement, consolation, tonkean macaques

14.50 VIBRATIONAL SIGNALS IN *POLISTES* PAPER WASP: DOES SOCIAL PARASITE AMPLIFY HOSTS SIGNALS

Irene Pepiciello¹, Rachele Nieri^{1,2}, Alessandro Cini^{3,1}, Valerio Mazzoni², Rita Cervo¹

¹Dipartimento di Biologia, Università di Firenze

²Dipartimento agroecosistemi sostenibili e biorisorse centro ricerca e innovazione, Fondazione Edmund Mach, San Michele all'Adige (Trento)

³Centre for Biodiversity and Environment Research, University College London, UK

Chemical communication has been traditionally considered the most important communication channel in social insects. Recently, however, substrate borne vibrations (SBV) have been shown to play crucial roles in many insect societies, from termites to paper wasps. Independent founding paper wasps, such as *Polistes* wasps, show conspicuous and frequent behaviours, mainly consisting of body oscillations, that produce SBV through the paper comb. Several functions have been proposed for these vibratory signals, such as adult-brood communication, regulation of dominance hierarchies and, more recently, modulatory effects on caste determination. The social parasite-host system *P. sulcifer*-*P. dominula* is a promising model to start disentangling these many, partially overlapping, adaptive functional hypotheses. The social parasite usurps and maintains control over host colonies especially by an exaggerated physical dominance and, instead of producing workers, it only produces reproductive individuals. Moreover, it shows a particular behaviour, which consists in beating the abdomen against the nest surface (Abdominal drumming, AbD) and which resembles an exaggerated version of the host SBV-producing behaviour (abdominal wagging, AbW). The first main aim of our study is to compare the fundamental spectral and temporal features of the host and the parasite's SBV, recorded with laser vibrometer, in order to evaluate if the parasite's signal is an amplification of the host's one. We then use behavioural observations and playback experiments to investigate the context and the timing of occurrence of both behaviours, in order to understand the potential receiver of these signals. Our results show that both species produce a broad-band spectrum vibrations characterized by a series of pulses and suggest that AbD might be an amplification of the host AbW. Moreover, we demonstrate that AbD is mainly directed toward larvae, which opens the possibility that it might be a way to bias caste fate determination.

Keywords: vibrational signals, social parasite, caste determination

15.10 SIGHT IN A CLIQUE, SCENT IN SOCIETY: PLASTICITY IN THE USE OF NESTMATE RECOGNITION CUES ALONG COLONY DEVELOPMENT IN THE SOCIAL WASP *POLISTES DOMINULA*

Alessandro Cini^{1,2}, Federico Cappa¹, Irene Pepiciello¹, Leonardo Platania¹, Rita Cervo¹

¹Dipartimento di Biologia, Università di Firenze

²Centre for Biodiversity and Environment Research, University College London, UK

Nestmate recognition, i.e. the ability to discriminate nestmates from foreign individuals, is a crucial feature of insect societies and it has been traditionally considered to be predominantly based on chemical cues. Recent empirical evidence however suggests a certain level of plasticity in the use of different communication channels according to cues availability and reliability in different contexts. In particular, visual cues have been shown to influence various types of social recognition in several social insects, but their role in nestmate recognition is still under-investigated. We tested the hypothesis of plasticity in the use of visual and chemical recognition cues in the primitive eusocial wasp *Polistes dominula*, in which the availability and reliability of recognition cues varies across the season. Indeed, before the emergence of workers, *P. dominula* colonies are rather small (one to few individuals), and the variability in the facial pattern might allow resident wasps to use visual cues for nestmate recognition. After workers emergence, the increase in colony members number reduces the reliability of visual cues, thus leaving chemical cues as the most reliable nestmate recognition cues. We thus predict a differential use of chemical and visual cues along colony life. We experimentally separated visual and chemical cues of nestmates and non-nestmates and presented them alone or in combination (with coherent or mismatched cues) to resident wasps to test which communication channel was used in the two stages and, in case, how visual and chemical cues interacted (redundancy, dominance, and enhancing effect). Our results show a differential use of visual and chemical cues according to colony phase, which supports the hypothesis of a plastic, reliability related use of recognition cues in this species. We believe that this study would help in redefining the mechanisms of nestmate recognition while opening interesting prospects for the study of multimodal communication in social insects.

Keywords: nestmate recognition, multimodal communication, paper wasps

15.30 SOCIAL MODULATION OF RISKY DECISION-MAKING IN RATS (*RATTUS NORVEGICUS*) AND TUFTED CAPUCHIN MONKEYS (*SAPAJUS SPP.*)

Francesca Zoratto¹, Gabriele Oddi^{1,2}, Emanuele Gori¹, Antonia Micucci¹, Francesca De Petrillo^{1,3}, Fabio Paglieri⁴, Walter Adriani⁵, Giovanni Laviola⁵, Elsa Adressi¹

¹Unit of Cognitive Primatology and Primate Centre, Institute of Cognitive Sciences and Technologies, CNR, Rome

²Department of Earth Sciences, Sapienza University of Rome

³Department of Environmental Biology, Sapienza University of Rome

⁴Goal-Oriented Agents Lab, Institute of Cognitive Sciences and Technologies, CNR, Rome

⁵Reference Centre for Behavioural Sciences and Mental Health, ISS, Rome

Pathological gambling is a public concern representing both a social and a health issue. In humans, it has been repeatedly demonstrated that the social context affects decision-making under risk. Despite a powerful role of social influences on the behaviour of non-human animals, little is known

about how the social context modulates their risk preferences. We aimed to investigate whether the presence of a conspecific influences risk preferences in rats and in tufted capuchin monkeys, to evaluate whether similar mechanisms were at work. Subjects were presented with a series of choices between constant, safe options and variable, risky options, both alone and when paired with a conspecific. The average payoff of the risky option was always lower than that of the safe option. Overall, the two species differed in their attitude towards uncertainty: whereas rats did not prefer either the safe or the risky option, capuchins always preferred the risky option. In both species, risk preferences and emotional responses changed in the Paired condition compared to the Alone condition, although in an opposed way. Whereas rats increased their risk preferences over time in the Paired condition, capuchins chose the risky option less in the Paired condition than in the Alone condition. Nonetheless, the different modulation of risk preferences by social influences observed in the two species likely relies on a common mechanism. In fact, independent behavioural measures indicated that, whereas rats showed a decrease in anxiety in the Paired condition compared to the Alone condition, in capuchins the opposite held true. Thus, our findings strengthen the evidence, available for human beings, of an inverse relationship between anxiety and risk preferences. The results of the present study will hopefully contribute to a better understanding of the contextual and social factors determining the occurrence of gambling disorder in humans.

Key-words: social influences, gambling task, emotional responses

Chairperson: Paola Palanza

16.10 OBSERVATIONS OF THE GOLDEN JACKAL (*CANIS AUREUS MOREOTICUS* I. GEOFFROY SAINT HILAIRE, 1835) BEHAVIOUR IN LIVESTOCK CARCASS CONSUMPTION

Yannick Fanin & Stefano Filacorda

Dipartimento di Scienze Agroalimentari, Ambientali e Animali. Università degli Studi di Udine

The Karst near Gorizia, in the southeastern part of Friuli Venezia Giulia, is home of a consolidated population of Golden jackal since 1996. This species, native from the Balkans, is present in Italy since 1984 and is still subject to expansion. In 2015 a monitoring study by the University of Udine using the Jackal Howling technique has allowed to estimate the density (0.7 jackals / 100 ha) and the number of jackals (about 12 animals on the site of 1760 ha) through the application of Distance sampling. In this area there are many domestic grazing animals (sheep, cows and donkeys). One of the farms has been subject to predation on sheep by jackals, which resulted in the loss of 29 animals between 2015 and 2016. The carcasses of preyed animals (and in some cases the carcasses of animals died for natural causes) were monitored through the use of camera traps. The frequentation of carcasses by jackals and other kleptoparasites was documented. For this study were used 300 videos containing one or more individuals of jackals collected from four camera traps placed near carcasses for a total of 110 minutes of footage. The videos were analyzed by the BORIS software to identify the behavioural pattern of the jackals and the BSA web tool for the creation of flowcharts. For the definition of ethogram we used as a reference the study conducted by Wandrey in 1975. Jackals alternate phases of feeding and vigilance-related behaviours. It is observed that such behaviours are influenced by: the number and rank of the animals present in the feeding point, the state of consumption of the carcass and its relative position to the surrounding environment.

Keywords: Canis aureus, feeding behaviour, BORIS

16.30 TEMPORAL PATTERNS OF BONE GNAWING BEHAVIOUR BY CRESTED PORCUPINE IN CENTRAL ITALY

Emiliano Mori¹, Sandro Lovari¹, Giuseppe Mazza²

¹Department of Life Sciences, University of Siena

²Department of Biology, University of Florence

The diet of the crested porcupine *Hystrix cristata* is strictly vegetarian and predominantly composed by roots and hypogeal storage organs. Osteophagy has been reported and gnawed bone residuals have often been observed in the surroundings of dens. This behaviour may have evolved to reduce the indefinite growth of incisor teeth, to increase calcium and phosphorous supply, or to fulfill both these functions. To clarify this issue, we analyzed a total of five den setts was monitored for three years and bones in front of den entries counted once a month. One of them was occupied by a homosexual pair of male porcupines. A total of 67 bones (mainly femurs and shins: 38.8%) was detected, most of them belonging to wild (46.03%) and domestic (28.57%) ungulates. In two cases, gnawed stones (limestone rocks) were also observed. The presence of gnawed bones in front of den entries was recorded the year, but the Rayleigh test suggested a peak at the start of February (mean direction = 43.41th day of the year, CI_{95%} = 8.08, R = 0.99, P = 1.7⁻⁶). Camera-trapping data from the same study site confirmed that areas surroundings farms, where most bones may be collected, were only selected on winter (Ivlev's Index, E = 0.42; N = 703 videos). The peak of gnawed bone detection overlapped with the birth peak, suggesting that bones may be consumed to increase the amount of calcium in lactating females. This suggestion is confirmed by the detection of no gnawed bones in front of the den of the male-male pair.

Keywords: Hystrix cristata, osteophagia, lactation period

16.50 DIFFERENT SILAGE AFFECTS BEHAVIOR IN LACTATING DAIRY COWS

Andrea Martini¹, Claudia Lotti¹, Charleni Crisostomo¹, Maria Novella Benvenuti², Lorella Giuliotti²

¹Dipartimento di Scienze Produzioni Agroalimentari e dell'Ambiente, Università di Firenze

²Dipartimento di Scienze Veterinarie, Università di Pisa

Attention to animal welfare is becoming increasingly relevant for farmers, consumers and researchers. Therefore, the study of methods for the assessment of the level of welfare in livestock represents an interesting topic. Novelty, such as unusual feeding, represents a stressor for dairy cows able to induce modifications in behaviour. The present investigation focused on monitoring the behaviour of lactating dairy cows fed different diets. The study was carried out at the experimental dairy farm of the Interdepartmental Centre of Agri-Environmental Research "Enrico Avanzi" of the University of Pisa over a 6-week period. Forty cows were divided into two groups, homogeneous for parity, days in milk, and milk production. The animals were fed isoproteic and isoenergetic diets differing in silage sources. The Control group received the usual diet based on corn silage (CS), while the experimental group received triticale silage (TS). Behavioural patterns were evaluated along with the focal sampling technique. The following behavioural parameters were recorded: "Inactive Standing or Laying"; "Movement"; "Rumination Standing or Laying"; "Eats or Drinks"; "Individual Activities"; "Social Activities"; "Urines or Defecates". Behavioural

data were analysed with a Kruskal Wallis non-parametric test. At the beginning of the trial, greater TS values were evident for the following behaviours: “Inactive Standing or Laying” (259.5”±230.36 vs 129.2”±198.00), “Individual Activities” (17.6”±22.25 vs 6.2”±13.02) and “Social Activities” (15.9”±77.51 vs 1.9”±3.70). This occurred to the detriment of “Eats or Drinks” that was significantly higher ($p \leq 0.01$) in the CS group (333.3”±273.41 vs 177.7”±224.67). At the end of the study there was a significant difference ($p \leq 0.01$) only for “Rumination” that was greater in the TS group (271.2”±274.43 vs 114.0”±225.96). In conclusion, the change of the source of silage resulted in the alteration of some behavioural patterns, which disappeared during the experimental period.

Keywords: behaviour, diet, dairy cow

17.10 PASTURE DEPLETION: CASCADING EFFECTS ON INTRASPECIFIC AGGRESSION AND SOCIAL STRESS IN A MOUNTAIN-DWELLING HERBIVORE

Niccolò Fattorini¹, Claudia Brunetti¹, Carolina Baruzzi¹, Elisabetta Macchi², Maria Chiara Pagliarella³, Noemi Pallari¹, Antonella Cotza¹, Sandro Lovari¹, Francesco Ferretti¹

¹Dipartimento di Scienze della Vita, Università di Siena

²Dipartimento di Scienze Veterinarie, Università di Torino

³Dipartimento di Bioscienze e Territorio, Università del Molise

Among other areas, vegetation changes have been recently documented on the upper meadows of the Central Apennines (Italy), with a local reduction of pasture quality for herbivores. The depletion of food availability has led to lower diet quality, foraging efficiency, maternal cares and offspring survival for the *Vulnerable* Apennine chamois *Rupicapra pyrenaica ornata*, in the core of its distribution (Abruzzo, Lazio and Molise National Park). The effects of temperature rising on the cold-adapted vegetation grazed by chamois, spread of unpalatable tall grass in secondary meadows, as well as resource exploitation by reintroduced red deer *Cervus elaphus*, have been suggested as factors underlying pasture depletion, with negative effects on population dynamics of chamois. We investigated the effects of pasture depletion on social stress of female chamois, by comparing behavioural/endocrine indicators across areas with different quality of pasture. Also, we tested whether feeding interference to access resources was influenced by weather during the growing season of vegetation. Social behaviour of female chamois was recorded throughout July-October (2014-2015), a crucial period for early growth/weaning of kids. During the same period, we collected fresh faeces (2015) to assess levels of faecal endocrine metabolites. In “poor” areas, which were subject to greater temperature, we observed: (i) the greatest aggression rate/intensity between individuals; (ii) the greatest time spent in vigilance and feeding interruptions; (iii) the greatest endocrine levels. Higher temperature and lower rainfall in previous weeks led to greater feeding interference between chamois. Our results have shown that pasture depletion triggered cascading effect on social behaviour of chamois by increasing their aggressiveness, alertness and endocrine levels. We suggest that hot-dry weather affect availability and nutritional content of the cold-adapted food resources grazed by chamois. If so, current climatic/vegetation changes may further emphasise contest competition for resources, i.e. stress-related behaviours, in wild mountain ungulates.

Keywords: aggression, stress, ungulates

Abstracts - posters

Sorted alphabetically by the first Author

PATCHES, BANDS, BLOTCHES AND CHANGING COLOURS IS A VERY OUTSTANDING SKILL TO CONFUSE PREDATORS IN SOME CRABS LIVING IN *POSIDONIA OCEANICA* (LINNAEUS) DELILE, 1813 MEADOWS

Roberto Bedini, Marco Bedini, Elisa Salvadori

Istituto di Biologia ed Ecologia Marina di Piombino (Livorno)

For two years we studied the carapace colour change to match the colours of *Posidonia oceanica* in six species of crabs during their juvenile stage around the isle of Pianosa (Tuscany, Italy). In each season of the year we collected specimen, whose carapace was taken from 0,5 to 0,9 cm, of the species *Acanthonyx lunulatus* (Risso, 1816); *Liocarcinus navigator* (Herbst, 1794); *Liocarcinus zariquieyi* (Gordon, 1968); *Lophozozymus incisus* (H. Milne Edwards, 1834); *Ilia nucleus* (Linnaeus, 1758), *Pinnotheres pisum* (Linnaeus, 1767) using a plankton net by scuba diving. The specimens of this study have been collected both at the upper and at the lower limit and in the central zone of the meadows. We observed that their colours do not change in relation to season or depth but only to the transition from the juvenile to the adult stage. All the specimens of the above mentioned crabs when fully grown do not live in *Posidonia oceanica* meadows but they usually live in settlements very different from the leaves where they all have been collected. Once reached the adult stage, with a homogeneous coloration of their exoskeleton, they leave the meadows because the new coloration is no more a cryptic mimicry among the leaves mottled above all by encrusting multicoloured algae, epiphytic bryozoa and hydrozoa. So they leave the *Posidonia oceanica* meadows and reach the ultimate living settlements.

Keywords: crabs, Posidonia oceanica, juveniles

SIMULATING TO BE DEAD IS A VERY INTERESTING BEHAVIOUR USED BY THE MEDITERRANEAN CRAB *ERIPHIA VERRUCOSA* (FORSKAL, 1775) WHEN THREATENED

Roberto Bedini, Marco Bedini, Elisa Salvadori

Istituto di Biologia ed Ecologia Marina di Piombino (Livorno)

Going next to an aquarium in our laboratories, where we had placed two crabs of *Eriphia verrucosa* species, I noted that one, in front of the other, was dead because it was upturned with its pereopods contracted which is the posture of a dead crab. When I tried to remove it from the aquarium using a landing net the false dead crab rose on its pereopods and escaped to the opposite side of the aquarium. Then I noted that they were two males and the false dead crab had, in addition to its claws, only two pereopods on the right side of the carapace and only one on the left side but with claws of the same size of the other. So I thought that the mutilated crab posture, simulating to be dead, was a submission posture considering the other the dominant crab according to its anatomical inferiority. We must consider that in an aquarium we have a narrow space and shelter for which each individual needs to defend its domination area. So we have tested to put in the aquarium crabs always with the same size of the claws because we know that claw size is an outstanding power

symbol among crabs. The results of the experiments have confirmed that, when disabled, the crabs of the *Eriphia verrucosa* species do not try to fight with an anatomically complete rival but simulate to be dead to placate the competitor. For the experiments we used males against males, males against females, females against females.

Keywords: simulation to be dead, Eriphia verrucosa

LONG-TERM ASSESSMENT REVEALS THE HIDDEN AND HIDING EFFECTS OF EXPERIMENTAL STRESS ON ANT COLONIES

Adele Bordoni, Mattia Aaron Miroddi, Leonardo Dapporto, Stefano Turillazzi

Dipartimento di Biologia, Università degli Studi di Firenze

Social insects react to stress at both the individual and colonial level by modifying their physiology, behaviour, offspring morphology and colonial productivity. Methodological protocols involve treatments that potentially increase the stress load and may lead to misleading conclusions if not appropriately evaluated. We compared the long-term consequences on *Crematogaster scutellaris* queens of a widely-used experimental treatment with those produced by an entomopathogenic fungus. The fungus we selected was *Metarhizium anisopliae* and the experimental stress was the widely used non-destructive procedure of Solid Phase Micro Extraction (SPME) sampling. This involves holding the ants for two minutes and rubbing them with a glass capillary on the abdomen. The two forms of stress produced a similar effect on foundress survival by increasing the mortality of queens. SPME sampling also accelerated the emergence of the first worker thus shortening the critical claustral period. On the other hand, the stress did not significantly affect the number of successful colonies, the final number of workers and their quality. However, a thorough understanding of these effects has been only possible in the long-term, at the end of the first colonial season. We showed that each manipulation may be followed by hidden effects which only become evident months after the application of the stress, and that immediate effects may disappear in the long-term. Thus, in pluriannual species, it is important to extend the observation to cover an entire colonial season. Finally, since different stresses can produce similar effects, the inclusion of different types of stress (e.g. microbiological and physical) allows to understand the specificity of the observed responses and decipher their biological significance.

Keywords: ants, stress, colony development

FEEDING BEHAVIOUR OF ADULT AND JUVENILE WILDCATS IN SOUTHERN TUSCANY (CENTRAL ITALY): A PRELIMINARY ASSESSMENT

Marcello Franchini¹, Paola Fazzi², Marco Lucchesi³, Emiliano Mori⁴

¹Wildlife Biologist, Serramazzoni (Modena)

²Wildlife Biologist Independent Researcher, Montignoso (Massa)

³Wildlife Biologist Independent Researcher, Giustagnana (Lucca)

⁴Department of Life Sciences, University of Siena

The wildcat is a rare and elusive small carnivore, with a broad feeding spectrum. According to review studies, voles and/or wild rabbits represent the staple of its diet on the basis of their local availability. Despite the diet of wildcat has been widely treated, an extensive and detailed study comparing the diet of adult and juvenile wildcats is still lacking. We collected 34 scats of wildcat in

the surroundings of a reproductive site to assess the diet of juveniles wildcats and relevant parents in a rural area of Central Italy. As a result, wood mice were the most preyed species (70.5%), followed by the bank vole (9.1%). In our study area, no remains of wild rabbit were recorded in scats of both adult and kittens. Birds were rarely consumed and mostly present in the diet of adult individuals, with the exception of the red-legged partridge, observed only in cubs scats. As kittens need nutritious, adults may have captured and brought them carcasses of bigger prey such as red-legged partridges. To conclude, the wildcat in Poggi di Prata seems to behave as a facultative specialist, selecting rodents when available, probably due to their abundance and greater capture ease, but also preying on birds when rodents are scarce.

Keywords: Felis silvestris, central Italy, age classes

ANT COLONIZATION OF GALLS PRODUCED BY ANDRICUS QUERCUSTOZAE: A FIELD SURVEY

Daniele Giannetti, Cristina Castracani, Alessandra Mori, Donato A. Grasso

Dipartimento di Scienze Chimiche della Vita e della Sostenibilità Ambientale, Università di Parma

Galls are growths on plant tissue resulting from a parasitic insect attack. These structures, caused by more than 13000 insect species, represent highly sophisticated systems, characterized by a huge variety of shapes, dimensions and positions on plants. Galls support different communities of specialized parasitic insects and their predators. In addition, they can provide a refuge to other insects, such as moths and beetles, which can be considered secondary occupants. These structures may also represent an ideal environment for the establishment of colonies by different ant species. However, extensive information about gall colonization by ants and their adaptations to exploit these peculiar nesting sites are lacking. The present work is the first detailed field survey aiming to describe and quantify the presence of ants in galls of *Andricus quercustozae* on oak trees. Field experiments were carried out to clarify the level of galls' colonization compared to other nearby suitable nesting sites and to describe eventual differences in the active modification of gall architecture by ants. Results showed that galls are a key factor for ant presence in specific areas. Moreover, preliminary data suggest that there are differences among the species in the mode of gall occupation and modification according to their use in the economy of colony organization.

Keywords: gall colonization, nesting sites, nest architecture

FIRST CASE KNOWN OF ADOPTION IN NATURE OF BEARDED VULTURE GIPAETUS BARBATUS

**Elena Grasso¹, Emiliano Mori², Enrica Molinaro³, Giovanni Celi⁴, Antonio Maccarone⁴,
Laura Martinelli⁵, Luca Giraud⁵**

¹Independent Researcher, Messina,

²Department of Life Sciences, University of Siena

³Independent Researcher, Torino,

⁴Independent Researcher, Milazzo

⁵Parco Naturale Alpi Marittime, Cuneo

We have observed the first case of adoption by bearded vultures in nature, in Alpi Marittime Natural Park, Vallone Gesso Barra from 2010 onward. As a part of the international project for the re-introduction of this species in the Alps and in some European areas, the bearded vulture labeled

BG388 was reintroduced in the Park in 2002. The bird, nicknamed Paolo Peila, returned to the release area in 2004 after two years of erratic behaviour, typical of juvenile individuals, along with another male individual. The latter died a year later, but Paolo Peila remained in this area of the Alps. This behavior is unusual as isolated individuals seem not to have their own territory. After each reintroduction event, consisting in laying two young birds inside a nest, from 2010 onward Paolo Peila overflows the valley and controls the nest almost daily after the occupation and until the fledging of the introduced birds. In doing so, it adopts the reintroduced individuals, either they are males or females, by carrying food to the nest, feeding vultures and continuing to follow the young individuals after the fledging, accompanying them in the exploratory flights. On the other hand, chicks call and often look for the adult one. Approaches similar to courtship display have also been observed. The constant presence of Paolo Peila has certainly resulted in a faster learning of a series of behaviour with respect to unadopted chicks. Surveillance and protection activities of Paolo Peila, combined with adoptive parenting behaviour, has reduced fledging times of adopted chicks. Similar adoptive behaviors were observed on captive aegyptian and bearded vultures (A. Llopis, G. Ceccolini, personal communications).

Keywords: bearded vulture, Alpi Marittime Natural Park, adoption

SOCIAL CONTEXT MODULATES DIGESTIBILITY IN GREYLAG GEESE (*ANSER ANSER*)

Lara Iaiza¹, Carla Fabro¹, Federico Mason¹, Chiara Sarnataro¹, Stefano Filacorda¹, Didone Frigerio²

¹Dipartimento di Scienze Agroalimentari, Ambientali e Animali, Università degli Studi di Udine

²Core facility KLF for Behaviour and Cognition, University of Vienna

In group living animals, social context is known to modulate physiology, behaviour, fertility and immune system of individuals. Furthermore, individuals' nutritional strategies may profoundly affect their performance, also impacting their social interactions. In the present study we discuss the results of a pilot study conducted on N = 38 individuals of the semi-tame, long-term monitored and individually marked flock of Greylag geese (*Anser anser*) at the Konrad Lorenz Research Station in Upper Austria. Focal animals belonged to different social categories within the flock, i.e. paired with and without offspring, single and juveniles (5 males and 3 to 5 females per category). The animals are well habituated to the close presence of humans and are used to get fed twice a day on the meadow in front of the Research Station. During 9 consecutive days in winter 2017, when the snow pack was closed, we standardized the food given to the birds and collected a total number of 184 individual droppings from the focal individuals (mean=4,8; SD=0,4) after the morning and afternoon feedings. Samples were analysed at the lab facilities of the Department for Agro-Food, Environmental and Animal Science, University of Udine (Italy) by determining the apparent digestibility of total organic matter. Preliminary results show similarities between males and females but hint at differences depending on the social category with parental individuals showing higher digestive capability than unpaired individuals or paired without offspring. We discuss our findings with respect to the complex relationships between social status, physiology and the capacity of digesting food, extracting nutrients and improving fitness.

Keywords: social status, Anser anser, apparent digestibility

FIRST OBSERVATIONS ABOUT A REWILD POPULATION OF *EQUUS CABALLUS* IN STURLA VALLEY (GENOVA)

Evelina Isola, Giulia Mutinelli, Giorgia Peruzzo, Chiara Galli

DISTAV, University of Genova

The rewilding of wide areas, due to the depopulation of pastures and countryside, is affecting the Apennine and Alpine regions with the return of big predators, but also with animals actually living only in captivity and thought to be extinct in nature. Therefore, many “domestic” animals are now repopulating our mountains and countries. The aim of this work is to study the population of re-wild horses living in the Northern Apennine (hinterland of Tigullio Gulf, Liguria IT). We report the preliminary results about systematic observations taken in field between 2015 and 2016, in about 600 hours and sporadic observations done during the previous two years. The study area is in the Aveto Natural Regional Park and it is included in a Site of Community Importance (SCI IT1331104). The most interesting habitats related to the presence of herds are: beech forests and grazing areas with *Nardus stricta*. This population is the heritage of horses (about ten heads) working in the valleys more than twenty years ago. The release in the wild of these horses created a feral population of *Equus caballus* living without any direct influence from humans on their behavior, their reproduction and feeding habits. The population is divided into five herds consisting of 10-16 heads. Each one of them is identified by photograph and monitored. It is possible to recognize hierarchies based on dominance relationships among herd members. Currently the adult-juvenile ratio is 3.2 and sex ratio approximately 4 female for each male. Studies on equine behavior are in progress and effect of the grazing on the habitats of the SIC will be evaluated. Interactions between horses and their natural predators as wolf will be developed. Impacts with rural activities in the area will be evaluate in order to reach a sustainable coexistence.

Keywords: rewild horses, grazing, ethogram

INNOVATION IN A TOOL-MANUFACTURING TASK IN CAPUCHIN MONKEYS (*SAPAJUS* SPP.)

Laura Manduca¹, Giusy Meglio^{1,2}, Marialba Ventricelli^{1,2}, Sabrina Bechtel-Kuehne², Babett Voigt³, Sabina Pauen², Elisabetta Visalberghi¹, Gloria Sabbatini¹

¹Institute of Cognitive Sciences and Technologies, CNR, Roma

²Institute of Psychology, Heidelberg University, Germany

³Clinical Child and Adolescent Psychology, Ruhr-Universität Bochum, Germany

Innovation has been defined as the ability to find a solution to a novel problem by using motor and cognitive strategies already acquired, or to find a novel solution to an old problem by using new motor and cognitive strategies. This ability can have important fitness consequences allowing animals to adapt flexibly to social and ecological changes, but it could also be detrimental exposing animals to potential risks and costs. Little is known about how this capacity emerges and whether/how innovators differ from non-innovators. The major aim of the study was to investigate the innovation capabilities of capuchin monkeys and 4-year-old children towards a task requiring tool-manufacturing. Here we report, the results concerning the sixteen capuchins presented with an innovative tool-manufacturing task in which they had to modify a tool to obtain a reward from a transparent apparatus. Each individual received three trials: in each trial three different material sets were presented to the subject. Each set consisted of four potential tools; if appropriately modified and used into a different opening in the apparatus, each tool provided the opportunity to reach the

reward. Thirteen out of sixteen capuchin monkeys were able to modify objects to use them as tools to obtain the reward. Successful innovators differed from unsuccessful innovators in the amount of interaction with the apparatus and the tools but not in the latencies to approach the task stimuli. Moreover, previous experience in tool-use tasks affected success and time needed to solve the task. These results offer interesting insights into which factors influence innovative tool behavior in primates.

Keywords: innovation, tool use, capuchin monkeys

ACTIVITY RHYTHMS OF THE EURASIAN BADGER IN RELATION TO MOON PHASES

Giuseppe Mazza^{1,2} & Emiliano Mori³

¹Department of Biology, University of Florence

²Research Centre for Plant Protection and Certification (CREA – DC), Firenze

³Department of Life Sciences, University of Siena

Variation in light conditions induced by the different brightness of the moon during the lunar cycle generally make prey species to be poorly active or very vigilant at the time of full moon. As a consequence, carnivores seem to benefit from high light levels while hunting.

The nocturnal activity of Eurasian badgers *Meles meles* was studied in a hilly area of Southern Tuscany (“Poggi di Prata”, Central Italy). Camera traps were located near the access of six den setts inhabited by badgers, as well as on the paths commonly used by wildlife within the woodlands. During the study period, the presence of badgers was not detected in any other den sett within the study site. Badgers showed mainly crepuscular and nocturnal activity, generally starting after sunset and ending before sunrise with a peak of diurnal activity in spring, when nights get shorter. A total of 522 movies was collected (N = 132 in winter, N = 129 in autumn, N = 153 in spring, N = 108 in summer). The median duration of nocturnal activity was 9 h and 45 minutes, with no significant seasonal variation, although in winter badgers seem to be active for a lower number of nights with respect to the other seasons. Full moon enhanced the activity of badgers only in winter (Rayleigh test, $Z = 3.91$; $P = 0.028$); throughout the rest of the year, activity rhythms of this species were irrespective of moon phases. The winter shortage of earthworms and insects, which built up the staple of the diet of Eurasian badgers, may determine an increase of their activity in bright nights. Indeed, during the cold months, the trophic niche breadth of badger becomes narrow and individuals are forced to search for other food categories (e.g. rodents), possibly requiring a higher visibility.

Keywords: Meles meles, moon cycle, circular statistics

HAIR CORTISOL LEVEL IN THE GOLDEN JACKAL (*CANIS AUREUS MOREOTICUS* I. GEOFFROY SAINT HILAIRE, 1835) IN RELATION TO THE SAMPLE CONSERVATION, SEX AND ECOLOGICAL CHARACTERISTICS

Marta Montillo, Stefano Pesaro, Tanja Peric, Veronica Maran, Stefano Filacorda

Dipartimento di Scienze Agroalimentari, Ambientali e Animali, Università degli Studi di Udine

Hair cortisol analysis is a complementary method for monitoring HPA axis activity, capturing systemic cortisol exposure over longer periods of time. We have tested the hair cortisol concentration on 16 specimens of Golden jackal (*Canis aureus moreoticus*): 5 from frozen animals,

10 from stuffed animals and 1 taken from injured animal during recovery in an Animal Care Center; the samples came from Italy (Friuli Venezia Giulia and Veneto Region) and Croatia (Istria and Dalmatian region). We have studied the hair cortisol concentration by RIA method in respect to conservation method, sex and areas of origin, with non parametric tests and mixed model. The hair cortisol concentration (values expressed in pg/mg) from the frozen animals (mean=3.38 SD=3.13, n=5) was not different in respect to the stuffed samples (mean=2.81 SD=2.72, n=9), also the sex has not showed any statistical effect (males mean=1.96 SD=0.63 n=9; females mean=4.56 SD=3.99 n=6). The hair cortisol concentration in respect to the sites of origin of samples, dispersal and core areas was not different (dispersal areas: mean=1.56 SD=0.77 n=5, core areas: mean=3.72 SD=3.14 n=10). The use of mixed model to detect the effect of areas (core and dispersal areas) and interaction between sex and areas has showed the presence of significative higher hair concentrations of cortisol in core areas for the females (mean=6.27 SD=3.84 n=4) in respect to the males (mean=2.02 SD=0.52 n=6). The concentration of hair cortisol of sick and injured animal recovered in the Animal Care Center was higher (> of 12 pg/mg) in respect to the other samples. Hair sample can be used to develop a clearer understanding of the interrelationship of health and physiology, mobility and social behaviour.

Keywords: hair, Canis aureus, cortisol

RECONCILIATION IN GELADAS (*THEROPITHECUS GELADA*): A LONG-TERM STUDY

Alessia Musanti, Virginia Pallante, Elisabetta Palagi

Natural History Museum, University of Pisa, Calci (Pisa)

Social living is beneficial and costly at the same time. To cope with competitive and dispersal forces and to guarantee group cohesion several social species engage in a variety of peace-keeping strategies. The affiliative post-conflict reunion between former opponents is defined reconciliation. Here, we test some hypotheses on reconciliation in a tolerant monkey species organized in a multilevel social structure, the gelada (*Theropithecus gelada*). The data collection covering five different years from 2007 to 2014 represents one of the most extensive databases for this species. The analyses confirmed the presence of reconciliation in each of the period analysed and the occurrence of the phenomenon in the first minute after the end of the conflict. The Corrected Conciliatory Tendency (CCT) did not vary significantly across the years of observation, suggesting that reconciliation is a stable strategy in this species. Despite the presence of a linear hierarchy, dominance relationships (measured by NDS values) did not affect reconciliation dynamics. The high levels of tolerance characterizing the species and the agonistic support frequently provided to the victims independently from their dominance position can explain this finding. Contrary to other species living in multilevel societies with the one-male unit as the basic social component (e.g. *Papio hamadryas*), gelada females reconciled with all members of the group, although a slight trend towards males can be detected. Reconciliation was more frequent between unrelated subjects and it produced a real improvement of the emotional state of the victims who restored their self-directed behaviours (e.g., scratching) at the levels recorded in absence of any kind of conflict. In conclusion, even though the study of post-conflict behaviour in geladas needs further investigations, the peculiar nature of their social network is a good opportunity to test some theoretical assumptions on conflict resolution in primates.

Keywords: peacemaking, tolerant species, anxiety reduction

WHEN DOGS LOSE THEIR OWNER EXCLUSIVE ATTENTION: IS IT JEALOUSY?

Velia Nicotra¹, Emanuela Prato-Previde², Chiara Losacco³, Irene Zantedeschi³, Annalisa Pelosi¹, Paola Valsecchi³

¹Dipartimento di Medicina e Chirurgia, Università degli Studi di Parma

²Dipartimento di Fisiopatologia Medico-Chirurgica e dei Trapianti, Università degli Studi di Milano

³Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università degli Studi di Parma

Jealousy is a secondary and complex emotion triggered by the perception that an affective relationship between two individuals is threatened by the presence of a rival. It is crucial in terms of fitness in humans and occurs early in infancy in the absence of sexual interest. This suggests that it could be expressed in dogs, since they establish an infant-like attachment bond with their owners. To test this hypothesis, we conducted two experiments readapting the procedure used by Hart and colleagues (1998) with children. In each experiment thirty-six dogs were exposed to a situation in which the owner and a stranger ignored them directing attention towards different objects: a book, a novel object (a puppet) and a fake dog (furry: experiment 1; plastic: experiment 2). Results of both experiments showed that dogs directed their attention significantly more towards the fake dog, rather towards the other objects; they also interacted longer with the fake dog when it was manipulated by the owner compared to the stranger. Both in the fake dog and puppet conditions the attention to the owner was driven by the presence of the object in his/her hands, but this did not occur in the book condition. In detail, dogs remained oriented to their owner significantly more when he/she was handling the dog than the book, whereas no difference emerged when the owner was handling the dog or the puppet. Orientation towards the stranger showed a similar but inverted trend. In conclusion in both our experiments dogs reacted similarly in puppet and fake dog conditions and did not show different behaviours towards the owner and the stranger. Differently from previous findings our results do not support the presence of jealousy-like behaviours in dogs, indeed a naturalistic paradigm could be more appropriate to investigate this topic.

Keywords: jealousy, dogs, attention

RED OR YELLOW? COLOUR PREFERENCE IN ALDABRA GIANT TORTOISES (*GEOCHELONE GIGANTEA*)

Giorgio Ottolini¹, Barbara Regaiolli¹, Carola Leonardi², Caterina Spiezio¹

¹Parco Natura Viva, Garda Zoological Park, Bussolengo (Verona)

²University of Modena and Reggio Emilia

Although it is known that chelonians are capable to discriminate colours and rely on vision to find food, little research has been investigating colour preference in these species. This study aims at assessing whether zoo Aldabra giant tortoises (*Geochelone gigantea*) housed in Parco Natura Viva (Italy) show a colour preference between red and yellow stimuli. The study was made of two periods in which red and yellow balls of the same size were provided to the tortoises in their social context. In the first period, carrots were hidden behind each ball whereas in the second period carrots were replaced with apples. In both periods we collected the frequencies of interaction of the tortoises with red and yellow balls. Non-parametric tests were used to analyse the data and significance level was set at $p < 0.05$. At the group-level, no colour preference was found. However, individual colour preference was reported. Moreover, tortoises interacted significantly more with the yellow balls in the second period (apple) than in the first period (carrot) suggesting an influence

of food on chelonian colour preference. This kind of research on zoo animal behaviour might be relevant on the one side to improve our knowledge on the species biology, on the other side to enhance their husbandry and safeguard their welfare in zoological gardens (e.g.: designing positive reinforcement training or environmental enrichment programs).

Keywords: colour preference, chelonians, zoological garden

LOOKING FOR HUMAN HELP: A PILOT STUDY ON CZECHOSLOVAKIAN WOLFD OG USING THE IMPOSSIBLE TASK PARADIGM

Elisabetta Palagi¹, Veronica Maglieri¹, Erica Tommasi¹, Emanuela Prato-Previde²

¹Natural History Museum, University of Pisa, Calci (Pisa)

²Department of Pathophysiology and Transplantation, University of Milano

It has been suggested that human-directed gazing represents a foundation on which dog–human communication evolved, and that dogs’ propensity to look at humans, or to quickly learn to do so, is a behavioural feature that distinguishes dogs from wolves, emerged during the course of domestication. When unable to obtain a desired goal dogs spontaneously gaze towards humans and this behaviour is influenced by both the domestication process and the breed selection for specific working purposes. However, it is not yet clear to what extent genetic similarity to wolves influence dog’s eye contact with humans. In this pilot study we used the ‘unsolvable task’ paradigm adopted in previous studies to test 5 adult Czechoslovakian Wolfdog (3 males, 2 female), a recent breed retained the closest to wolves. The test consisted of six consecutive ‘solvable’ trials (1 min each) in which dogs could obtain a food reward by manipulating a container followed by a single ‘unsolvable’ trial (1 min) in which obtaining the food became impossible. The behaviours of the dog towards the apparatus (gazing, manipulating) and towards the owner or researcher (gazing, interaction) were recorded and analysed. All dogs quickly obtained food (less than 40 seconds) in all the six ‘solvable’ trials without gazing at humans and no difference in gaze/manipulation of the apparatus emerged in the solvable and unsolvable conditions; in the ‘unsolvable’ trial three dogs spent all the 60 seconds manipulating the apparatus while one dog gazed at the owner for less than 1 sec before returning to interact with the apparatus. These preliminary findings suggest that Czechoslovakian Wolfdogs are less human-oriented compared to other breeds, supporting the hypothesis that gaze behavior towards humans is associated with genetic similarity to wolves.

Keywords: dog, human-directed communication, gaze

AGONISTIC INTERACTIONS BETWEEN THE ITALIAN HONEYBEE (*APIS MELLIFERA LIGUSTICA*) AND THE EUROPEAN WASP (*VESPULA GERMANICA*) REVEAL CONTEXT-DEPENDENT DEFENSE STRATEGIES

Michelina Pusceddu, Ignazio Floris, Franco Buffa, Emanuele Salaris, Alberto Satta

Università degli Studi di Sassari

Predator–prey relationships between sympatric species underpin the evolution of defense behaviors such as honeybee colonies defending their nests against predatory wasps. We investigated the predator–prey relationship between the Italian honeybee (*Apis mellifera ligustica*) and the European wasp (*Vespula germanica*) by evaluating the effectiveness of attack and defense behaviors, which

have coevolved in these sympatric species, as well as the actual damage and disturbance caused to the colonies under attack. Attack and defense behaviors were recorded in front of the hive to observe attacks at the hive entrance (68 attacks in 279 h) and at ground level on isolated and weakened honeybees close to the hive (465 attacks in 32 h). We found that *V. germanica* attacks the hive entrance infrequently due to the low success rate of this strategy and instead prefers a specialized attack method targeting adult honeybees at ground level, demonstrating opportunistic scavenger behavior. Individual honeybees usually respond effectively to an attack by recruiting an average of two nestmates, causing the wasp to flee, whereas collective balling behavior was only observed on four occasions. *V. germanica* does not appear to disrupt the foraging activity of the colonies under attack. We found that agonistic events supported by other nestmates were typically the most intense ones, involving physical combat and prolonged attacks at the entrance to the hive. These observations support the hypothesis that *A. mellifera ligustica* can adapt its behavior to match the severity of the threat and the context of the attack.

Keywords: agonistic support, balling, behavioral defenses

EX-SITU CONSERVATION OF AFRICAN PENGUINS: A CASE STUDY AT THE PISTOIA ZOO

Enea Silvio Rabazzi¹, Francesco Dessì-Fulgheri¹, Francesca Bandoli²

¹Dipartimento di Biologia, Università degli Studi di Firenze

²Giardino Zoologico di Pistoia

The African penguin (*Spheniscus demersus*) is an endangered seabird species endemic to southern Africa. Zoos contribute to its protection supporting *in-situ* conservation projects and participating in captive breeding programmes. Studies carried out in zoos can provide key information evaluating which factors can influence penguin welfare and reproductive success. The aim of this study was to analyse the activity budget and the behavioural repertoire of a colony of twenty penguins hosted at Pistoia Zoo and evaluate the effect of visitor presence and microclimatic factors on their behaviour. Observations were carried out from July to September 2015 and data were collected using a randomized experimental design. Six 30-min observation sessions per day were conducted over a 9-h period, encompassing morning and afternoon. Behaviours were videorecorded and 918±140 (mean±SE) minutes of recording per individual were obtained. Data were analysed using non-parametric statistical tests. No difference in activity budgets was found among age-sex classes and no abnormal behaviour was detected. Otherwise penguins showed higher frequencies of active behaviours and lower frequencies of pond use compared to previous studies. Affiliative behaviours were mainly performed among mates and their chicks, but they were also recorded between former couple members. These findings highlighted the importance of accurately monitor affiliative interactions to identify breeding couples. Visitor number did not influence the birds' behaviour, whereas background noise level negatively affected nesting and couple behaviours performed by males. This study provided useful information to improve the penguins' husbandry and management. Our results were also used to plan the new penguin exhibit with the aim of enhancing positive welfare states and reducing the influence of environmental factors on the birds' reproductive success. Further studies will be performed after the transfer of the colony in the new area.

Keywords: welfare, captive breeding, ex-situ conservation

WHY HAVING (OR HAVING NOT) TWO MOTHERS: HOMOSEXUAL BEHAVIOUR IN GREATER FLAMINGOS (*PHOENICOPTERUS ROSEUS*)

Barbara Regaioli¹, Carolina Sammarini¹, Vittoria Vallarin², Camillo Sandri¹, Caterina Spiezio¹

¹Parco Natura Viva, Garda Zoological Park, Bussolengo (Verona)

²Department of Neurosciences, University of Parma, Parma

Homosexual behaviour, involving both female-female and male-male pairs, is widespread in the animal kingdom, particularly in birds. To better understand its adaptive value, more studies should focus on differences and similarities between heterosexual and homosexual pair behaviour. This study aimed at investigating the parental behaviour of two female-female breeding pairs of greater flamingos, hosted in Parco Natura Viva, an Italian zoological garden. For each breeding pair, we recorded the behaviour of both female partners during twenty 10-minute sessions within the incubation period. A continuous focal animal sampling method was used to collect whether the partner was near the nest, on the nest or far from the nest and the behaviour (agonistic behaviours toward disturbing conspecifics, attentive behaviour, egg-care, nest-building, self-comfort behaviour, sleeping) being performed. Single-case analysis was performed and significance level was set at $P < 0.05$. Our results showed that within each pair the females that laid the egg stayed away from the nest more than the other female. In addition, the females that did not laid the egg were more involved in agonistic behaviour than the other females, particularly when in specific postures. As in heterosexual pairs male flamingos are more involved in the incubation and in nest protection, our findings suggest that female-female pair-bonds seem to be equivalent to male-female bonds in greater flamingos, showing similar parental behaviour.

Keywords: same-sex pair, zoo flamingos, parental behaviour

TEACHING ANIMAL BEHAVIOUR IN SCHOOL

Gabriella Salerno

Istituto Tecnico Statale Carlo Cattaneo, San Miniato (Pisa)

It is now clear that the traditional teaching methods of scientific subjects in the secondary school, which is based on the traditional method of conveying concepts through regular lectures, is not suitable anymore for the current generation of students, and must therefore be replaced with active learning techniques, in which the student itself can mold his/her own scholastic career. The regular lectures do not have to be completely dismissed; instead, they need to be enhanced with workshop activities to conduct during classes. The learning process of such teaching activities allows the student to learn how to observe and carry out a research, it leads them to ask questions on the phenomena and the processes they are studying, to conduct experiments based on hypothesis and to build interpretative models. I have been focusing on these ideas in latest years, and while I plan activities to teach animal behaviour I always try to put them at work. I stimulate active situations in which the students can develop observational skills, discover connections and cause/effect relationships, and therefore understand the complexity and the evolution of the animal world. In this work, I present some of these teaching methods, which I used with my secondary school's students. Such activities can turn into chances of collaboration between schools and universities and contribute to encourage students to undertake scientific careers for their studies.

Keywords: learning resources, scientific career, teaching methods

WHAT DOES BEING A GOOD DAD MEAN? LESSONS FROM GREATER FLAMINGOS (*PHOENICOPTERUS ROSEUS*)

Carolina Sammarini¹, Barbara Regaiolli¹, Vittoria Vallarin², Alessandra Piccirillo³, Caterina Spiezio¹, Camillo Sandri¹

¹Parco Natura Viva, Garda Zoological Park, Bussolengo (Verona)

²Department of Neurosciences, University of Parma, Parma

³Department of Comparative Biomedicine and Food Science, University of Padua

It is well-known that in greater flamingos both partners share the incubation duties and take care of the egg and the chick. However, little research has investigated in detail parental care time budgets in this species. This study aimed at evaluating and comparing parental care behaviour of females and males in 35 breeding pairs of greater flamingos hosted in Parco Natura Viva, an Italian zoological garden. For each pair, data on the parental care behaviour of both females and males were collected. In particular, for each partner we recorded whether they were near the nest or on the nest and the duration of the behavioural category performed (agonistic behaviours toward disturbing conspecifics, attentive behaviour, egg-care, nest-building, self-comfort behaviour, sleeping). Moreover, we collected the time spent by each partner far from the nest. Non parametric tests were used to analyse the data with significance level set at $P < 0.05$. First, both greater flamingo parents were involved in parental care and performed all the typical activities reported in the wild. Male flamingos remained on the nest and near the nest significantly more than females. Moreover, they performed more aggressive behaviour than females. These findings suggest that greater flamingo fathers seem to spend more time than females incubating the egg and protecting the nest. This kind of research is important to expand our knowledge on greater flamingo ethology as well as to stimulate new research in both wild and zoo populations.

Keywords: Phoenicopteridae, incubation, egg care

DO RING-TAILED LEMURS (*LEMUR CATT*) AND GUPPIES (*POECILIA RETICULATA*) PERCEIVE THE DELBOEUF ILLUSION?

Maria Santacà¹, Barbara Regaiolli², Tyrone Lucon-Xiccato¹, Marco Dadda¹, Maria Elena Miletto Petrazzini¹, Caterina Spiezio², Christian Agrillo¹

¹Department of General Psychology, University of Padua

²Parco Natura Viva, Garda Zoological Park, Bussolengo (Verona)

Visual illusions are commonly used in animal cognition studies to compare visual perception among vertebrates. Few studies have investigated sensitivity to visual illusions in fish and none in prosimians. Here, we investigated whether guppies, *Poecilia reticulata*, and ring-tailed lemurs, *Lemur catta*, perceive the Delboeuf illusion, consisting in the misperception of the size of an object due to the surrounding context. We adopted the same spontaneous preference paradigm in both species. Guppies and lemurs were observed in their natural tendency to select the larger amount of food. In control trials, we presented two different amounts of food (the ratio between food portions was 0.66) in two identical plates. In test trials, we presented equal food portion sizes in two plates differing in size: if they were sensitive to the illusion, they were expected to select the food portion presented in the smaller plates. Lemurs' choices did not differ significantly from chance in both control and test trials. This may indicate that lemurs are not sensitive to the Delboeuf illusion although the poor performance exhibited in the control trials prevents us from drawing a firm conclusion about. On the contrary, preliminary data on guppies suggest that subjects can select the

larger food portion in control trials; interestingly, in test trials guppies seem to select the food portion included in the larger array, the one typically perceived as smaller by human observers. These results suggest the intriguing possibility that the perceptual bias affecting size discrimination in humans, lemurs and guppies might be different.

Keywords: visual illusions, size illusion, comparative perception

STUDY OF INTERSPECIFIC ADOPTION IN THE ANT *CREMATOGASTER SCUTELLARIS*

Daria Scala Del², Adele Bordoni¹, Stefano Turillazzi¹, Leonardo Dapporto¹

¹Dipartimento di Biologia, Università degli Studi di Firenze

²Dipartimento di Biologia, Università degli studi di Pisa

Crematogaster scutellaris is an arboreal myrmicine ant with a complex social structure. The monogynic queens are characterized by a long claustral phase. In the wild, the colonial structure is commonly composed of a central core hosting the queen, the workers and the immature offspring and of satellites groups of workers with immature offspring. During spring and summer season these groups are connected to the main colony but during the cold season the connections are usually interrupted leading to the formation of isolated wintering groups. Pre-founding queens, small colonies one year old, and isolated groups of workers often hibernate in poplar and oak galls. These characteristics make *C. scutellaris* a good model to experimentally test evolutionary hypotheses, using combinations of different components of the colonies in a natural condition. Among these it is possible that founding queens can adopt offspring and/or workers of other colonies belonging to isolated groups. This could reduce the duration of the critical claustral phase of the queens that might have the strong adaptive significance of potentially increase her survival chances survival and the foundation success. Additionally, the possibility to create unrelated mixed groups could have important methodological developments, like the possibility to verify the existence of vertical and horizontal transmission mechanisms of immune components. We carried out an experiment in cross-fostering designed to test for the first time the feasibility of such adoptions. We created different experimental combinations: founding queens and workers, founding queens and immature offspring, workers and immature offspring and we have verified their success over time. Some experimental combination have led to the immediate failure of the adoption, while others have led to the emergence of workers. This allowed us to conclude that the adoption is an unlikely event in this species but, at least in experimental conditions, it was possible.

Keywords: adoption, Crematogaster scutellaris

EMOTIONAL CONTAGION IN DOGS: WHAT DO THEY UNDERSTAND ABOUT THEIR OWNERS?

Tiziano Travain^{1,2}, Valsecchi Paola¹, Deborah Custance²

¹Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università di Parma

²Department of Psychology, Goldsmiths University, London, UK

In dogs, the domestication process may have resulted in advanced socio-cognitive abilities and strong predisposition to form affective bonds. However, a questionable habit is to attribute intentionality and mental states to non-human animals, a phenomenon known as anthropomorphism. If, on one hand,

anthropomorphism could greatly contribute on the discussion about animal welfare, on the other hand it could make harder the study of animal behavior and emotions giving a non-objective interpretation of an experimental situation and of its results. This topic is particularly relevant when considering pet animals living in a family environment with a strong affective/emotional relationship with humans. A previous study investigating emotional contagion showed that domestic dogs oriented toward their owner or a stranger more often when the person was pretending to cry than when they were talking or humming. Our study expands this previous work, analyzing behavioral and cardiac reactions of three different groups of dogs when their owners are crying, laughing, or emitting an unusual but emotively neutral sound “Om”. Behaviors and cardiac data were collected during the baseline, the stimulation and immediately after it. A similar number of dogs approached the owner in response to different stimuli ($\chi=0.503$, $P=0.777$). Besides, dogs were simply waked up if they were resting (decrement in Rest: $F=6.11$, $P=0.003$) and they looked at the owner during stimulation (increase in Looking at the owner: $F=5.34$, $P=0.006$). Cardiac parameters did not vary among phases. Therefore, dogs seem to be behavioral activated by stimuli; however, they do not seem to discriminate among them. In conclusion, these data does not confirm the existence of emotional contagion and they suggest that this experimental setting could not be the most suitable to investigate this topic.

Keywords: emotional recognition, heart rate variability, dog-owner relationship

MIGRATORY RESTLESSNESS IN SHOREBIRDS (AVES, CHARADRIIFORMES). A CASE STUDY BY MEANS OF ACCELEROMETERS

Lorenzo Vanni¹, Natale Emilio Baldaccini², Matteo Piacentini¹, Alessandro Turchi¹, Dimitri Giunchi¹

¹Dipartimento di Biologia, Università di Pisa

²CIRSeMAF, Università di Firenze

The knowledge of individual and environmental parameters affecting stopover length in shorebirds is important for the conservation and management of species and habitats often seriously threatened, such as Mediterranean wetlands. The role of external factors affecting the decision to leave a stopover site is not always easy to study in the field, due to the high number of variables (i.e., atmospheric conditions) potentially involved. Combining both field and laboratory research has proved to be extremely useful in order to identify the main factors affecting stopover length, at least in passerines. Recent studies demonstrated that the amount of migratory restlessness in these species can be considered a good proxy for quantifying the willingness to depart from a refuelling site. Even if shorebirds have proved to be good models for laboratory research, the only papers regarding migratory restlessness in this group concern studies on orientation mechanisms, which are mainly aimed at showing their use of magnetic compass. The present work aims at studying the migratory restlessness in shorebirds and its relation with body conditions and stopover length by using spring migrating Wood sandpiper (*Tringa glareola*) as a model species. Despite this method proved to be effective in recording Wood sandpipers activity, we failed to find any relationship among their stopover length, body conditions and nocturnal activity. The degree of nocturnal activity was overall low, whereas a peak in activity was registered at sunset. This twilight activity was oriented, and its amount varied significantly according to the amount of available food in captivity. Our results suggested that migratory restlessness in shorebirds might show some peculiar characteristics that would deserve further investigations.

Keywords: migratory restlessness, shorebirds, accelerometer

SKULL CONFORMATION AND SELECTION TO COOPERATE WITH MAN IN THE DOMESTIC DOG: ANALYSIS OF ATTENTION TOWARDS THE OWNER IN TWO INSOLUBLE PROBLEM-SOLVING TASKS

Marcella Zilocchi, Maristella Giordano, Asahi Ogi, Chiara Mariti, Claudio Sighieri, Angelo Gazzano

Dipartimento Scienze Veterinarie, Università di Pisa

Paedomorphosis has enabled the creation of many canine breeds differing for both morphology and certain behavioural traits. Based on the cephalic index, breeds are classified as dolichocephalic, mesocephalic or brachycephalic. The aim of this study was to evaluate whether brachycephalic breeds selected for companionship or for utility behave differently for the attention paid to the owner in two insoluble problem solving tasks. Eleven adult dogs, 5 belonging to companion breeds (2 Pugs, 2 French Bulldogs, and 1 Cavalier King Charles Spaniels; 3 males and 2 females) and 6 belonging to breeds selected for utility (2 American Pitbull Terriers, 2 American Staffordshire Terriers, 1 Rottweiler, and 1 Boxer; 4 females and 2 males), were involved. The dogs, after a period of training, were subjected to two kinds of insoluble problem solving tasks. The first consisted in trying to reach food located in a container having a closed lid. In the second test the dog had to retrieve the food tied to a rope and placed inside a wire mesh cage. In both tests, the latency of the first look at the owner (in seconds) and the number of glances towards him/her were measured. The statistical analysis, carried out using Mann-Whitney test ($p < 0.05$), did not show any differences in the first test (latency: $U = 13.5$, $p = 0.93$; number of gazes: $U = 14.5$; $p = 0.79$) nor in the second one (latency: $U = 13.5$, $p = 0.93$; number of glances: $U = 11.0$; $p = 0.54$). These preliminary results suggest that the group of brachycephalic dogs did not show differences in the behaviour of attention to the owner in situations that require a collaboration with him/her, despite the different selection carried out within this group of dogs according to the functions to be performed by different breeds.

Keywords: attention to owner, brachycephalic, dog

VARIABILITY IN THE “STEREOTYPED” PREY CAPTURE SEQUENCE OF CUTTLEFISH RELATES TO PERSONALITY DIFFERENCES

Francesca Zoratto¹, Giulia Cordeschi¹, Giacomo Grignani², Roberto Bonanni³, Enrico Alleva¹, Giuseppe Nascetti², Jennifer A. Mather⁴, Claudio Carere^{2,5}

¹Reference Centre for Behavioural Sciences and Mental Health, ISS, Rome

²Department of Ecological and Biological Sciences, CISMAR, University of Tuscia, Tarquinia (Viterbo)

³Department of Neuroscience, University of Parma

⁴Department of Psychology, University of Lethbridge, Canada

⁵Laboratory of Experimental and Comparative Ethology, University of Paris 13, Sorbonne Paris Cite, France

The study of animal personality has shown consistent between-individual variation in many social and non-social contexts, but hunting behaviour has been overlooked. Prey capture sequences, especially in invertebrates, are supposed to be quite invariant. In cuttlefish, the attack includes three components: attention, positioning, seizure. Previous studies found variability in these components and we hypothesise that it could be due to personality differences. We analysed predation sequences of adult cuttlefish to measure this variability and to test its association with personality traits in different contexts. Nineteen subjects were first exposed to an “alert” and a “threat” test and then given a live prey, for 10 days. Predation sequences were scored for components of the attack,

locomotor and postural elements, body patterns, and number of successful tentacles ejections (i.e. seizure). PCA analysis identified three dimensions accounting for 53.1%, 15.9% and 9.6% of the variance and discriminating individuals based on “speed in catching prey”, “duration of attack behaviour” and “attention to prey”. Predation rate, success rate and hunting time were significantly correlated with first, second and third PCA factors, respectively. Significant correlations between capture patterns and responsiveness in two different contexts were found, highlighting a consistency between measures of personality and prey capture patterns. Personality may permeate even those behaviour patterns that appear relatively invariant.

Keywords: cephalopods, hunting behaviour, behavioural consistency

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