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## Letter from the editors

Welcome to the 2014 Winter Edition of Canopy, the in-house journal of the MSc in Primate Conservation at Oxford Brookes University.

Greater scientific research is revealing that much of our world is not as quantifiable as we would like to believe. Species emerge that are unable to be uniformly classified and behaviours and phenotypes appear that seem new and strange. Few areas on earth provide as good of an example of this increasingly spectral view as Madagascar. Left to evolve in isolation since its separation from India over 88 million years ago, the island has produced over 200,000 species of flora and fauna, of which 150,000 are thought to be endemic. Madagascar has intrigued and enchanted scientists for many years with its extraordinary level of unique biodiversity. In this issue we present to you a selection of works by previous MSc students, which focus on the endemic primates of Madagascar, in all of their complexity.

The articles selected for this issue provides a well-rounded view of Madagascan primates. In order to support the conservation of these endangered species, it is essential to understand the diverse shareholders in their story. From field studies regarding communication in the wild to captive management and even environmental education in schools, conservation must be seen as the conglomeration that it is.

We hope that you find this issue of Canopy informative as it explores the fascinating and increasingly rare endemic lemurs of Madagascar.

Best Wishes,  
The Editors



Left to right: Magdalena Svensson, Sharon McCabe, Siobhan Webster and Grecia Lacayo





## Letter from the Course Tutor

I'm delighted to introduce this volume of Canopy that is the result of the hard work of a group of students passionate about primate conservation who have volunteered to put this issue together on top of their many other commitments. I am also proud to write this letter as the following work was completed entirely by MSc students here at Oxford Brookes University and comes on the tail of the recent publication of the new IUCN Lemur Conservation Action Plan. This plan points out that almost 94% of the current lemur species are threatened with extinction, making this group of mammals the most threatened on earth.

The lemurs' situation is the result of the additive effect of naturally limited distributions coupled with anthropogenic pressures such as slash-and-burn cultivation, hunting (a growing threat due to increasing immigration and poverty), logging and exportation of precious wood. All these threats have been exacerbated by the political turmoil between 2009 and 2013 that led to increased poverty and the exploitation of Madagascar's resources by national and foreign actors. Thus, it is time to emphasize the urgent need for research and conservation actions to outline a way to save Madagascar's 104 lemur species. Despite the obstacles, there is hope emerging from Madagascar. The recently elected President Hery Rajaonarimampianina has shown a commitment to a return to legality. A growing number of studies are showing lemurs to be more resilient in the face of environmental change than previously thought (Kata and Morris in this issue). Most importantly, however, are the multi-faced projects that are demonstrating that collaboration between local communities, non-government organizations and researchers can effectively reverse the vortex of environmental depletion in Madagascar (Flanagan in this issue).

I wish to conclude this introductory note by stressing the importance of any little advancement in our ability to manage wild and captive lemur populations. The lemurs' presence plays a central role for seed dispersal within the Malagasy forests; we have no idea what losing them might mean for the countless plant families that share the island with them. It is also disturbing to realize that should we lose the lemurs, we will be losing 25% of our family tree in one fell swoop and possibly the key to answering the question of how and why we originally appeared as primates on this earth. There must be a way out.

**Dr. Giuseppe Donati**  
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# A preliminary investigation of the factors that impact upon the diet of the Cheirogaleidae (Lemuriformes, Primates)

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Studying the feeding ecology, diet and nutrition of primates enables us to gain a better understanding of many aspects of their behaviour, including how they cope with and adapt to the numerous challenges imposed upon them (Fietz & Ganzhorn, 1999). It also enables us to better understand their distribution (Biebouw, 2009) and to explore the factors that impact upon their fitness and abundance in order to create effective conservation plans (Chapman *et al.*, 2003). Food is the sole source of energy for animals and therefore plays a critical role in all aspects of their lives. Most humans are fortunate in that they do not need to spend a lot of time and energy foraging for food. Wild animals do not have this luxury and spend a considerable amount of their time engaged in feeding activities in order to obtain the foods that contain the energy and nutrients that they need to survive (Rodman & Cant, 1984). An integral part of studying primate diets is to look at the interrelationships between consumers, producers and the environment as a whole, by studying the abundance and availability of food resources within their habitat (Atsalis, 1999),

how those resources are utilised and how they fluctuate in response to environmental and anthropogenic factors (Dammhahn & Kappeler, 2008; Génin, 2008). Whilst there are a wide number of foods available in any environment, only certain foods will be chosen based upon the costs and benefits associated with foraging and feeding upon them, the metabolic needs of the individual and the tolerance levels for particular nutritional components (Simmen *et al.*, 1999). There are a number of environmental, anthropogenic, mechanical and chemical challenges that must be overcome in order to locate and process food items. Primates utilise a number of different behavioural and physiological strategies to overcome these challenges. These strategies vary considerably among primates and are affected by numerous factors, such as body size (Preuschoft *et al.*, 1998), digestive constraints, and nutritional requirements (Oftedal, 1991). Very little is known about the nutritional requirements of primates; a lot of what is known comes from studies on the diets of humans and captive animals whose dietary needs and feeding behaviours often differ from

their wild counterparts (National Research Council, 2002).

The Malagasy primates have been a focus of research attention since the early 1950's, but the nocturnal lemurs were not studied until the 1970's (Charles-Dominique & Petter, 1980) and were still largely overlooked into the 1990's. Whilst primates are the most understood mammals in terms of feeding ecology and diet (Rodman & Cant, 1984), research on the diets of nocturnal species is still quite limited. Research is increasing but there are still few studies relating to the Cheirogaleidae, in comparison to other lemur families (Dammhahn & Kappeler, 2008), particularly with respect to diet and nutrition. The Cheirogaleidae are a family of small nocturnal lemurs, consisting of five genera and at least 32 known species, 13 of which have only been described in the past. It is generally assumed that small-bodied primates consume a diet rich in insects and animal matter, which contain a large quantity of proteins and lipids required for energy and are a great source of carbohydrates and essential minerals. It is also assumed that they will seek low levels of dietary fibre, such as cellulose and hemicellulose, to make foods easier to digest (Oftedal, 1991) and low levels of plant secondary compounds, such as tannins, which are produced by a plant as a chemical defence and can be toxic. Those species that consume plant exudates, such as

gums, also require gastrointestinal adaptations to enable digestion.

In attempting to gain an understanding of the biotic and abiotic factors that impact upon the diets of the Cheirogaleidae, data for this project were drawn from 20 published studies, which were carried out at 10 sites across Madagascar. The data represent 11 species from all five genera of Cheirogaleidae. Data regarding the types of foods being consumed, the plant parts utilised and the specific plants and arthropods consumed were collected from the source literature and compared. Data from biochemical analyses of food and non-food items (not seen to be consumed) were collected from the literature and statistically analysed in an attempt to understand the role nutrition plays in food selection and overall diet. The impact of some topographic and climatological factors was also investigated.

The types of food items used by different species were seen to vary considerably, with only two species, *Allocebus trichotis* (hairy-eared dwarf lemur) and *Microcebus rufus* (Rufous mouse lemur), seen to consume arthropods above all other food types. Whilst both of these species are very small, they are not the smallest Cheirogaleids, therefore body mass cannot be said to be a determinant of their highly insectivorous diets as would be expected. It is interesting to note that the data

for these two species were reported in eastern rainforests at the highest altitudes of all study sites included in this dataset. When tested further, altitude was found to have a significant positive correlation with arthropod consumption (Pearson's product-moment correlation  $r=0.902$ ,  $p<0.05$ , two-tailed), suggesting that as altitude increases, arthropod consumption also increases. *Cheirogaleus medius* (western fat-tailed dwarf lemur), *Microcebus berthae* (Madame Berthe's mouse lemur), *M. murinus* (grey mouse lemur) and *M. ravelobensis* (golden-brown mouse lemur) consumed insect secretions as their main food type, with *M. berthae* consuming the highest amounts. Whilst altitude correlated with arthropods, it did not correlate with insect secretions. All nine species included in the feeding observation were seen consuming tree exudates, however *Phaner furcifer* showed the highest preference for tree exudates, feeding almost exclusively on this food type. Fruits only seemed to be a large component (>63%) of the diets of *Cheirogaleus medius*, *C. major*, and *Microcebus murinus*, the latter of whom switches diets in times of low food availability (Atsalis, 1999). There was a significant negative correlation between rainfall seasonality and the amount of fruits and flowers consumed by Cheirogaleids (Pearson's product-moment correlation  $r = -0.656$ ,  $p < 0.01$ ).

Significant differences were found in the amount of protein and tannins in foods that were consumed compared to foods that were not consumed ( $p<0.05$ ) suggesting that Cheirogaleids select food items based upon overall nutritional composition. No significant differences were found for lipids, sugar, nitrogen, NDF (neutral detergent fibre), ADF (acid detergent fibre) and other polyphenolics. There was too little data to compare consumption of carbohydrates or overall energy content.

This study suggests that a number of factors may impact upon the diets of the Cheirogaleidae. The data used in this project has been drawn from a number of studies, carried out on different species at different study sites. These studies were carried out during different years, with different study lengths and used different data collection methods. All of these factors may confound the results and so it is recommended that they be interpreted with a degree of caution. It is clear that our knowledge of Cheirogaleid diets is not sufficient enough to be able to make accurate comparisons across the whole family, or even among genera, but some species comparisons can, and have been made, from data collected (Dammhahn & Kappeler, 2008a; 2008b). To be able to fully understand the diets of the Cheirogaleidae and make adequate comparisons across genera, species and



habitats, further research is required. It is also important that data is collected and reported as consistently as possible to enable comparisons between studies. Due to the limited data within this study, further research is needed. Further studies into the affect of arthropod consumption at different altitudes could help us to better understand arthropod assemblages, and in turn may enable us to better predict fluctuations in primate food sources as a result of environmental and anthropogenic change. These studies may also help us to better understand insects' responses to environmental change, particularly when we also take into account historical changes in habitat arrangement (Olivieri *et al.*, 2007). This understanding is particularly important in light of global climate change and could help to conserve species, such as insects, which are particularly sensitive to changes in temperature (Chen, 2008).

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# Comparing glucocorticoid levels in captive black lemurs (*Eulemur macaco macaco*) housed in single-species and mixed-species enclosures

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Although black lemurs are regarded in both religious and economic aspects within Malagasy communities, population densities are threatened by rapidly decreasing forest area and quality due to increasing human activity, and hunting (Bayart and Simmen, 2005). These pressures have caused a dramatic decrease in wild black lemur populations indicating a growing threat of extinction for *E. macaco* amidst their growing dependence and despite their evolutionary adaptations.

Lemurs displaced from their native habitats are often relocated to zoos and wildlife parks for conservation, breeding, and reintroduction purposes. The developments of abnormal behaviours, obesity, modification of time and energy budgets, and even biological changes in the brain suggest a possible linkage to chronic physiological stress experienced in captivity. Prior captive studies have demonstrated the impact of diet, nutrition, and decreased activity budget on obesity in lemurs (Goodchild & Schwitzer, 2008). Prolonged physiological stress has been correlated with hippocampal damage and gastric ulcers (Uno *et al.*, 1989), increased zoonotic disease transmission (Daszak *et al.*,

2000), and negative infant rearing behaviour (Maestriperi, 2010). Other findings have shown that captivity induces the repetition of certain behaviours by causing frustration, anxiety, or impeding natural behavioural processes (Mason, 2006). Some stereotypic behaviours identified are pacing, self-abuse, aggression, and inactivity as a result of stress with additional consequences of decreased immune function and infertility (Padgett & Glaser, 2003; Wielebnowski, 1998).

Studies assessing physiological stress in non-human primates have used urinary or faecal glucococortoid (GC) levels as a noninvasive indicator (Möstl & Palme, 2002). This method has been used to study, amongst other primate species, pileated gibbons (*Hylobates pileatus*) (Pirovino *et al.*, 2011), ring-tailed lemurs (*Lemur catta*) (Pride 2005), red-fronted lemurs (*Eulemur fulvus rufus*) (Ostener *et al.*, 2007), douc langurs (*Pygathrix nemaeus*) (Heistermann *et al.*, 2006), and vervet monkeys (*Chlorocebus pygerythrus*) (Uno *et al.*, 1989). However, physiological stress in *E. m. macaco* has yet to be explored.

The aims of this project are to measure physiological stress by comparing faecal glucocorticoid (GC) levels in captive black lemurs (*Eulemur macaco macaco*) housed in single-species and mixed-species enclosures. Data was collected for one week at each of the four participating UK zoos in April and May 2013. Faecal samples were collected at least twice daily with positive identification and behavioural data was obtained using instantaneous scan sampling every 5 minutes, yielding over 160 total faecal samples and 180 hours of behavioural observation. Faecal samples were freeze-dried and cortisol metabolites isolated. Immunoassays were conducted on the hormone extracts at the German Primate Centre. In light of evidence suggesting that the least stressful environment most closely resembles an animal's natural habitat (Poole 1991, Wielebnowski 1998), we hypothesize that black lemurs housed in mixed-species enclosures would be more stressed than those inhabiting single-species enclosures. The expected benefits of this research include the improvement of physical and psychological welfare of captive black lemurs through the identification of preferred (i.e. least stressful) captive housing conditions.

Including the two known *E. m. maccao* births in early summer 2013, there are only 27 total captive black lemur individuals housed in all UK zoos. The 13 (7F, 6M) individuals studied for

this research represent nearly 50% of this total population.

Drusillas Zoo Park holds 5 *E. m. macaco* individuals in their collection (2F, 2M, 1I). Excluding the newly born infant, there were 4 (2F, 2M) *E. m. macaco* study subjects. These individuals were housed in a mixed-species walk-through enclosure, with a bachelor group of 9 ring-tailed lemurs.

Isle of Wight Zoo holds 4 *E. m. macaco* individuals (3F, 1M). Excluding the newly born infant, there were 3 (2F, 1M) *E. m. macacao* study subjects. These individuals were housed in two separate enclosures. One enclosure housed the breeding pair (1F, 1M) and the other housed a female in isolation with her infant.

Dudley Zoological Gardens holds 3 *E.m.macaco* individuals (1F, 2M). Study subjects were housed in 2 separate enclosures. Their breeding pair (1F 1M) was housed in a mixed-species free-ranging enclosure, with collared lemurs, ring-tailed lemurs, and black-and-white ruffed lemurs. The other male was housed with a black-and-white ruffed lemur.

Exmoor Zoo holds 3 *E.m.macaco* individuals (2F, 1M). Study subjects were housed in a single-species enclosure.

Individuals were continuously watched for defecation during behavioural data collection to

ensure positive identification and time accuracy of the samples produced. Samples from each *E. m. macaco* individual were collected in a labelled plastic container *at least* twice daily (anytime between 09:00h-11:00h and 15:00h-17:00h) for one week. However, additional samples were collected opportunistically throughout the day. Only fresh (>2 hours post production) and uncontaminated (untouched by urine or other faeces) samples were collected and then stored at freezing temperatures (at least -18°C).

To eliminate differences in water content, faecal samples were freeze-dried at St. John's College. Clear tape was applied to the labels on each collection pod to reinforce sticking. A needle was used to punch 3-4 holes in the caps. Samples were placed in liquid nitrogen for several minutes and then dried in a VirTis benchtop K series freeze-drier at -99°C for 3 days. Each collection container was then covered in parafilm and stored in the freezer at -18°C.

Cortisol metabolites were isolated at the Oxford Brookes Biology Laboratory. Each freeze-dried sample was pulverized into a powder using a spatula. An aliquot of 0.05-0.08g (exact weight recorded) was weighed and transferred into a 15mL plastic centrifuge tube where 3ml 80% methanol in water was added. Each mixture was centrifuged for 20 min at 460 g. At least

1ml of the supernatant containing the hormones was placed into a labelled 1.5ml plastic Eppendorf tube. The extracts were sent to the German Primate Centre for further GC analysis in the laboratory of Dr Michael Heistermann.

A validation test is required (Touma & Palme, 2005) to quantify the glucocorticoid metabolites isolated from the faecal samples. However, since a validation test assessing adrenocortical function using faecal hormone analysis for *Eulemur macaco* currently does not exist, an immunoassay commonly used for *Eulemur collaris* known as 3a,11oxo-CM was applied to these samples. This 3a,11oxo-CM immunoassay has proven most successful monitoring stress hormones in a variety of primate taxa (see Heistermann *et al.* 2006) and is likely to reflect the real GC metabolite values obtained from *E. macaco*.

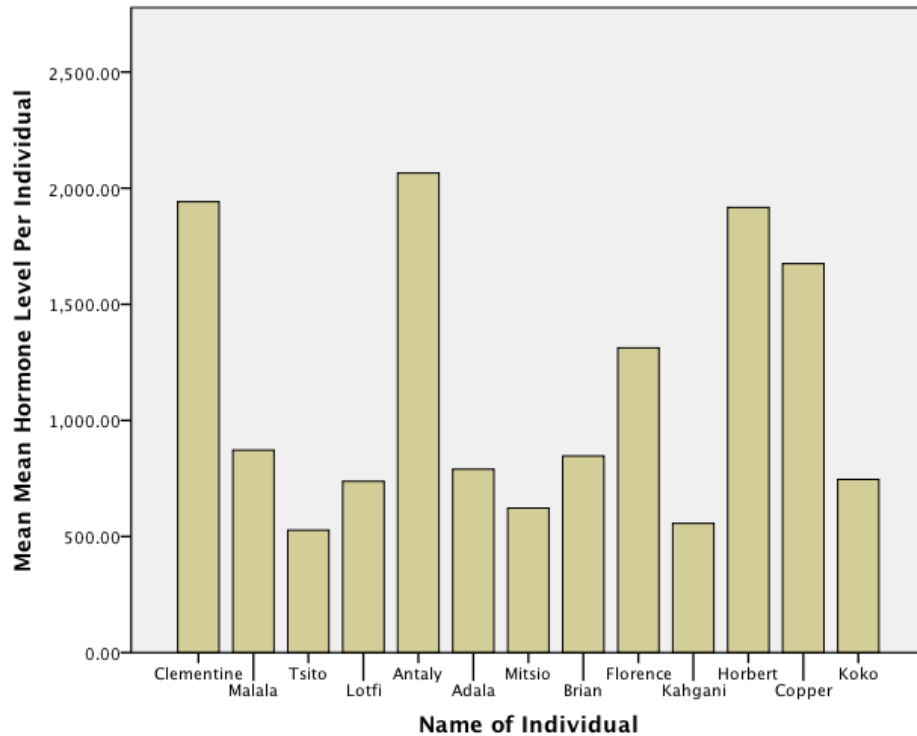
To determine 3a,11oxo-CM levels, all faecal extracts were diluted 1:150 with assay buffer (0.04 M PBS, pH 7.2). A microtiter EIA plate was used to measure 50µl aliquots of the diluted samples and 50µl aliquots of reference standard in doubling dilution within a 1.02-125 pg range (Heistermann *et al.* 2006). Following overnight incubation at 4°C, the plates were washed three times, incubated in the dark at room temperature for 30 minutes with 150µl streptavidin–peroxidase (HRP), and washed a

second time. An aliquot of 150µl HRP-substrate solution was added to each well and the plate was incubated for an additional 45 minutes. The enzyme reaction was stopped with the addition of 50µl 2M H<sub>2</sub>SO<sub>4</sub> to each well and absorbance was measured at 450 nm (reference 630 nm) on a plate reader. Sensitivity of the assay was 3 pg. All hormone levels reported are expressed as ng/g dry faecal mass.

Behavioural data was collected 8 hours per day from 10am-6pm for one week at each participating zoo. Using instantaneous scan sampling every 5 minutes, normal behaviours such as huddling, resting, feeding, drinking, grooming, playing, vocalising, and locomoting were recorded. Continuous scan sampling was used to record stereotypies including self-injurious behaviour (i.e. biting, hair-plucking), cacography, repetition of behaviours (i.e. pacing, continuous licking, rocking) (Mason, 2006; Mariner & Drickamer, 1994), and any

aggressive events toward conspecifics and/or visitors. If study subjects were housed separately, 1-2 hour block periods were spent at each enclosure, alternating between the two locations throughout the day.

Nonparametric tests including descriptive statistics and the Kruskal-Wallis test (Triola, 2012) were used to analyse the data using the SPSS computer program. Behaviour was qualitatively assessed. The descriptive statistics output using SPSS showed the mean faecal GC level was 1215.671 ng/gfaeces.. However, the mean faecal GC level was lowest (75.39 ng/gfaeces) for animals housed in a mixed-species enclosure and highest (102.27 ng/gfaeces) for the animal housed in an isolation. However, the Kruskal-Wallis test showed no significant difference ( $p=0.106$ ) between faecal GC levels in black lemurs housed in mixed-species, single-species, and isolated enclosures.



**Figure 1.** A histogram graph illustrating mean hormone level for each individual studied.

The black lemurs with the highest mean hormone levels (Figure 1) are Clementine (1,941.31 ng/gfaeces), Antaly (2,065.08 ng/gfaeces), Horbert (1,916.69 ng/gfaeces), and Copper (1,674.78 ng/gfaeces). The individuals with the lowest mean hormone levels are Tsito (527.49 ng/gfaeces), Mitsio (622.05 ng/gfaeces), and Kahgani (556.36 ng/gfaeces). All males had low (<900ng/g faeces) mean GC levels, with the exception of Horbert.

Males generally had lower faecal GC levels than females, which was expected considering black lemurs demonstrate

female dominance in social groups (Sussman, 1999; Kappeler & Ganzhorn, 1993). The individuals exhibiting the highest stress levels were Clementine, Antaly, Horbert, and Copper. An association between number of individuals per group and cortisol concentration suggest that unstable social dynamics contribute to stress experienced by captive individuals.

Clementine, a female individual housed in a mixed-species walk-through enclosure, showed high mean cortisol levels (1,941.31 ng/gfaeces). It is likely that some of her stress was attributed to new motherhood



since she had given birth to new infant one week prior to the start of the study. Occupying the dominant role coupled with living in a mixed-species enclosure where visitors are able to come into very close contact with the animals are likely contributors to the high level of stress Clementine experienced. Defending occupied territory, competing for food, and group protection, are suspected to account for high levels of GC secretion.

Antaly, a female individual housed in isolation, also showed high cortisol levels (2,065.08 ng/gfaeces) and demonstrated continuous locomotory and vocal activity. She emitted numerous “quacking”, “barking”, and “scream” calls with noticeable intermittent “grunt” and “whimpering” noises. The high-pitched, prolonged “screams” are attributed to distress calls in wild black lemurs and “grunting” noises to local communication with other group members (Petter & Charles-Dominique, 1979). The “whimpering” is unknown and not discussed in the literature. However, since this female had just reached the age of sexual maturity, perhaps this is a juvenile vocalisation used to communicate with the mother. Collated with the faecal GC data, this research shows that “quacks”, “barks”, and “screams” may be behavioural

indications of increasing levels of stress experienced by an individual. Although additional studies are required to confirm these hypotheses, it is possible that specific vocalisations can be used as auditory cues by zookeepers to identify if an animal is stressed.

Horbert, an individual housed in a single-species enclosure, was the only male that demonstrated high cortisol levels (1,916.69 ng/gfaeces). Interestingly, Mitsio, an individual also housed in a single-species enclosure, showed contrastingly low GC levels, thereby eliminating enclosure type as an influential variable. Further, the enclosure size for these individuals were comparable. The primary difference in living environment was group size and consequent social dynamic experienced by these individuals. Mitsio is part of a male-female pair, which has been found as the minimum stable group structure in the wild (Sussman, 1999). However, Horbert is the only male in a multi-female group. Since females elicit social dominance, Horbert was always the last to food, often left the undesired vegetables and occasional pieces of leftover fruit the females dropped on the ground. On the occasional attempt to eat when the food had arrived, Horbert experienced aggressive screams and attacks from the females. To avoid physical

harassment, Horbert was often observed sitting outside until the females had eaten their share before exploring the leftovers. Therefore, food competition is a likely factor contributing to the high physiological stress experienced by Horbert.

Interestingly Copper, a female housed in a single-species enclosure, also showed high cortisol levels (1,674.78 ng/gfaeces) despite eliciting the least amount of daily movement of all individuals studied. Although pregnancy was suspected at the time of the study, this was not confirmed and therefore will not be discussed as a possible contributor to her physiological stress. However, continuous licking of her hands and fingerpads (particularly after feeding) was observed. The acidity in the citrus fruits present in the diet was suspected to cause skin irritation especially after physical handling of the food. This individual was also observed walking gingerly on wooden substrates throughout the enclosure, often stopping to hold her hands upward either in a protective fashion or to possibly relieve pressure. In addition to expected pain and discomfort, another contributor to stress could be the location of the enclosure, which was adjacent to bird and carnivore enclosures.

Stereotypic behaviour was elicited by Malala at Drusillas Zoo Park. This individual was observed ingesting hand sanitizer from the dispenser at least once daily. Although verbally discouraged by staff and volunteers, Malala continued this behaviour after hours when the walk-through enclosure was not manned.

## **RECOMMENDATIONS**

Scattering food as much as possible (i.e. both around indoor and outdoor enclosures) spreads the food source allowing all individuals equal opportunity to the variety of food available and reducing intra- and intergroup competition. This food distribution method also ensures that each group member is obtaining a comprehensive nutritional diet.

Eliminating acidic foods such as citrus fruits could reduce chances of skin irritation that may occur from excessive fruit handling, which, in turn, may cause physical discomfort and physiological stress. Dermatological issues can be painful and are susceptible to infection with excessive self-grooming.

In general, individuals with the lowest faecal GC levels were those housed in mixed-species enclosures with at least 2 individuals and therefore is the preferred

captive environment for *E. m. macaco*. However, even in this enclosure type, it is undesirable to house 3 individuals together, especially a single male with 2 females. At least 5 total individuals are recommended if an odd number of black lemurs are housed together.

The least preferred enclosure type is isolation. High faecal GC level, hyperactivity of normal behaviours, and distressed vocalisations in the individual studied suggest that solitary living is a very stressful type of environment.

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## Factors influencing the body weight of captive *Lemur catta* in UK institutions

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Ring-tailed Lemurs, *Lemur catta*, are commonly seen in UK Zoos and are particularly susceptible to obesity (Kuhar *et al.*, 2013). Obesity is predominantly due to either high energy intake or low energy expenditure, and can cause type II diabetes, cardiovascular disease, Metabolic Syndrome and reproductive problems (Speakman *et al.*, 2007). *Lemur catta* are commonly overfed in captivity, due to both

their low basal metabolic rate and to ensure subordinate individuals are able to meet their energy requirements (Fidgett & Plowman, 2009). The ability and need to be active in captivity are greatly reduced from the wild, due to steady food sources, warm environments and restricted space (Schwitzer & Kaumanns, 2003). Other factors that could influence body weight include age – older individuals are less active

and likely to gain weight (Ramsey *et al.*, 2000), dominance – dominant individuals control valued food items and have ‘first pick’ (Plowman, 2013), gender – females are dominant over males (Jolly, 1966), enclosure type – larger, more complex enclosures would encourage more activity but may also have more naturally growing food sources (Mallapur, 2005), and night access – *Lemur catta* are known to be cathemeral in the wild, so those with outdoor access at night may be more active than those with no outdoor access at night (Donati *et al.*, 2013).

To determine whether an individual is overweight, body weights are generally compared to weights for wild individuals, which is inaccurate as captive animals are managed, restricted, do not face seasonal food scarcity, do not have access to their natural diet, and do not have to travel or forage for their food (Plowman, 2013).

This study aimed to discover whether differences in body weights of *Lemur catta* were predominantly due to energy consumed or energy expended, as well as other factors which may influence body weights of UK *Lemur catta* and to produce weight ranges of normal, overweight and obese weights based on captive body weights.

Food intake and activity observations were conducted on six individuals at ZSL Whipsnade

Zoo. Each individual was observed for four consecutive days, using continuous sampling for food intake and instantaneous scan sampling at five minute intervals for activity patterns (Altmann, 1974). The number of grams of each food item consumed was calculated and entered onto Zootrition software for analysis. Behaviours were converted to percentages and grouped into time spent active and inactive. Significance was tested for using Pearson’s Correlation for food intake results and Spearman’s Rank Correlation for activity patterns.

Questionnaires were sent to all ZIMS registered UK Institutions holding *Lemur catta*, requesting information concerning body weight, age, gender, health, enclosure details and dominance status. Any individuals with long term health issues or under 2.5 years were excluded from analysis. Significance was tested for using a General Linear Mixed Model.

Individuals consumed 200-299g of provisioned food but there was no link with body weight. There was a strong trend between body weight and Metabolisable Energy consumed. All individuals exceeded their caloric requirements, and it was the lightest individual who consumed the most fruit. The dominant individual ate the most food but the most subordinate did not consume the least. All individuals also ate non-provisioned items, such as soil and grass.

On average, individuals spent 61% of time inactive. They all spent more time inactive than active with little variation between them. The heaviest individual was also the most active. There was no significant relationship between body weight and time spent active.

In total, weights from 144 individuals from 27 institutions were used for analysis. Males were significantly heavier than females, and individuals with full access throughout their enclosure at night were significantly heavier than those with just indoor or weather dependent access. There was also a strong trend with body weight and enclosure type, with individuals in standard public view enclosures heaviest and walk-through enclosures lightest. There was no link between body weight and age, dominance status, group size, the presence of other species, browse or talks. The average weight of captive *Lemur catta* was 2603g compared to 2219g for wild individuals (Talyor & Schwitzer, 2012).

Metabolisable Energy is the key factor influencing body weight. All individuals met their energy requirements but through a different selection of items, with the dominant individual consuming more fruit than any other food group and the most subordinate consuming more vegetables. No individual was even close to consuming an average amount of food, highlighting the problems in assuming all

individuals consume the same food items and quantities.

Individuals spent 11% of their time feeding, compared to 25-31% of time in the wild (Schwitzer & Kaumanns, 2003). Individuals have been found to eat faster in the wild when food resources are finite, which could explain the shorter feeding time in captivity, as once items have been consumed, the group has to wait until the next feed (Rasamimanana, 1999).

No study found males to be heavier than females, and it is unexpected with female dominance. Rasamimanana (1999) found that in the wild, males feeding strategy is to maximise their food intake whilst females choose the high value items. Perhaps in captivity, with an excess of food provided and naturally growing browse in their enclosures, males are more likely to overfeed than females.

Individuals in standard public view enclosures could be heavier than those in walk-through enclosures due to less need to move and less stress from decreased visitor proximity, or due to having a smaller space or less spatial complexity (Hosey, 2005). Individuals with weather dependent access at night could be lighter than those with full access because the ability to be active outdoors is more novel, or there may be other factors involved. As expected, weight ranges based on captive weights are heavier than those for wild weights.



Differences in classifications could influence husbandry regimes if individuals which were considered overweight are now considered to be a normal captive weight. Although energy consumed and energy spent are the main influencers of body weight, genetics, as in humans, must play a role to a degree (NRC, 2003). The 2% difference in time spent inactive and 20kcal difference in food intake between the heaviest and lightest individuals are unlikely to lead to such a big difference in body weight.

Body weight differences are influenced more by energy intake than energy expenditure. However, other factors such as genetics are likely to be involved to some degree. The links between body weight and gender, enclosure design and night access are worth exploring in more detail in case any underlying factors can be identified and so managed to prevent obesity. It is recommended that institutions conduct food intake and activity observations on their groups before any husbandry or weight related decisions are made.

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## Launching the Ako Project U.S. curriculum for lemur conservation education

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The endemic primates of Madagascar, superfamily Lemninae, are in increasing danger of extinction due to human encroachment including poor agricultural practices, hunting, illegal logging and climate change (Schwitzer *et al.*, 2012). Boasting the highest level of species endemism, over 90%, Madagascar is one of the highest priority areas worldwide for biodiversity conservation (Myers *et al.*, 2000). The IUCN Red List of Threatened Species confirms that 94% of lemur species are currently threatened with extinction, including most of the species featured in the Ako Series books, making lemurs “one of the most threatened groups of vertebrates on Earth” (IUCN, 2014).

The Ako Project, conceived in 2006 by renowned primatologist Dr. Alison Jolly, is a lemur conservation education initiative that aims to inspire worldwide caring concern and conservation action through a set of six children’s picture books called the Ako Series. The books are accompanied by educational posters and curriculums developed for Madagascar, the United Kingdom, and most recently, the United States. The Ako Series, a set of 6 lemur-themed children’s picture books, written by Dr. Jolly and Dr. Hantanirina Rasamimanana, illustrated by Deborah Ross, and

designed by Melanie Kirchner McElduff, is the focal resource for this new curriculum. The books all address a different conservation-themed conflict, which relay concepts as direct as Malagasy local versus tourist perspectives and knowledge on lemurs, and as broad as being young and still having the ability to make an impact.

The Lemur Conservation Foundation (LCF) is a non-profit organization whose mission is C.L.E.A.R: conservation, lemurs, education, art, and research. Partnered with funder EnviroKidz, LCF has taken the responsibility to launch the Ako Project as part of its education outreach program as the U.S. distributor of the Ako Series. I have taken a primary role in introducing the new curriculum material to the American public. I took a different role in each of three workshops to introduce the U.S. Ako curriculum: as a participant in a pilot for zoo educators at Jacksonville Zoo & Gardens, coordinator for a 3-day event for schoolteachers at the LCF reserve site in central Florida, and coordinator/teacher for a children’s launch event in Portland, Oregon. I developed the basic framework for evaluating the curriculum in its wider public release, composed the structure for future workshops, and suggested an incentive system

to give teachers and students rewards that would give valuable feedback as well as show environmental agency, not just attitudinal changes, after completing Ako curriculum lessons. The latter is a reporting system called “Lemur Perks” in which teachers would send LCF “Ako Activity Reports” detailing the lessons, how they went, their context, continued work related to the lesson, some evaluative questions, and some form of proof of their work. The classrooms would then receive any of a number of rewards, anywhere from lemur gift shop items, additional teaching resources, lemur photos/videos/paintings, and live, interactive videoconference opportunities with LCF staff and lemurs. In having these reports, LCF would be provided with feedback for making improvements and an idea of the number of people affected by and using the curriculum. LCF has committed to making the Ako Project its education focus and with these first steps will help ensure that future outreach is effective in practice through proper evaluation.

In a study to discover the developmental roots of environmental activism, Chawla (1999) stated the following after finding that first-hand experiences of natural areas, family attitudes, and organizations were the most common sources: “Environmental educators need not only to understand how to prepare people for a general level of environmental citizenship but

also to produce leaders who can mobilize others to take action” (pg. 25). The Ako Project allows for this important trickle-down effect. Educators receive training themselves but also share with their colleagues, especially new teachers who may not have experience with environmental education to prepare them for teaching novel material not compulsory in most national standards (Schwarz *et al.*, 2008). With more of the public eye on lemurs this year than ever before due to the popular IMAX film, *Island of Lemurs: Madagascar*, the implementation of World Lemur Festival in October, and the updated IUCN Red List of Endangered Species assessment, the launching of this project could be vital in fostering conservation education and action for lemurs in schools, zoos, camps and homes across America.

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## Preliminary report on the use of contact calls ‘grunt’ and ‘long grunt’ of *Eulemur collaris*, in Sainte Luce, South-eastern Madagascar

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*Eulemur collaris* have intermediary visual adaptations, between that of diurnal and nocturnal primates, making them more poorly adapted to activity at night if compared to specialized nocturnal primates. *Eulemur* spp. all display cathemeral activity, meaning that they are active sporadically both in the day and night. They are missing nocturnal specialized visual adaptations such as the tapetum lucidum (Donati *et al.*, 2001; Donati *et al.*, 2007). They do have visual adaptations such as their corneal size and peak rod and cone densities that are intermediate between those of diurnal and nocturnal species making them more adapted for nocturnal activity than strictly diurnal species (Veilleux & Kirk, 2009).

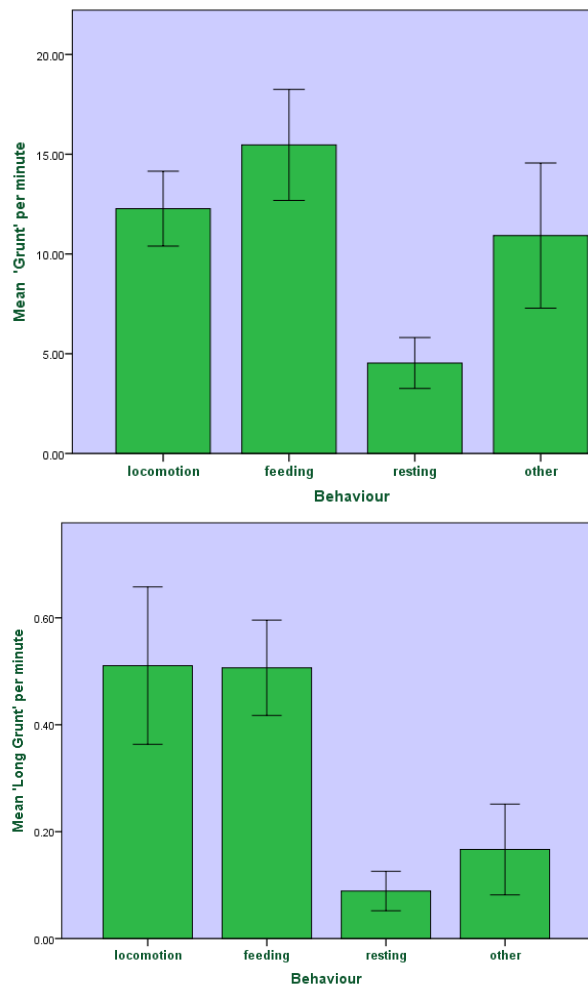
A common type of vocalization found across not only primates, but mammals and other animals are the contact, or cohesion, calls. These calls vary between species, but all serve the same essential function: to keep a group together and cohesive and to help find one another. Specifically the call may maintain cohesiveness over shorter and/or longer distances (pygmy marmosets: Snowden and Cleveland, 1980), help sub groups or individuals find each other during fission fusion (chimpanzee: Crockford & Boesch, 2003; parrotlets: Berg *et al.*, 2011) and coordinate the behaviours of offspring and

parents (seals: Charrier *et al.* 2003). The contact call of *Eulemur* spp. including *E. collaris* is the ‘grunt’ and ‘long grunt’ and it is the most frequent call given by these lemurs. They are used in different contexts, and there is also evidence that they can convey identity (Gamba *et al.*, 2012) and that they may facilitate affiliative interactions, if done while approaching others (Pfluger & Fichtel, 2012).

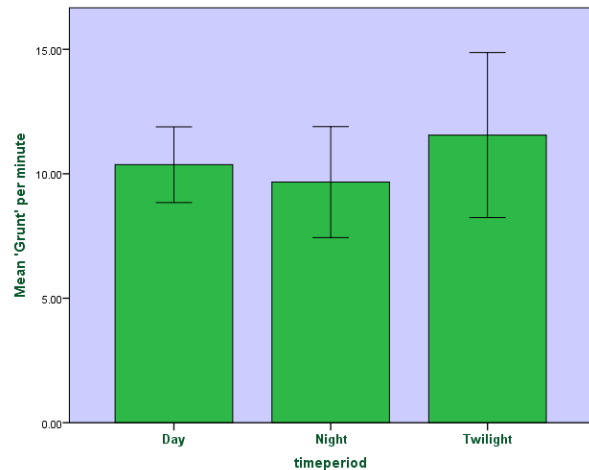
It was hypothesised that *E. collaris* compensate for the lack of visual sensitivity at night with other forms of communication, specifically vocal communication. The rate of contact calls should go up as the risk of separation get increases and visibility get decreases. This study is the first to attempt to compare the use of contact calls in a cathemeral lemur species over different time periods of the 24-hour cycle.

The data were collected from April to June 2014 in the littoral forest of Sainte Luce, south eastern Madagascar. Vocal recordings and contextual data was taken over 30 minute sessions focusing on a single animal (focal). The lemurs were followed and observed over various time periods spread across day, twilight and night. Avisoft SAS-Lab was used to retrieve data from these recordings, and SPSS 10.2 was used for the statistical analyses.

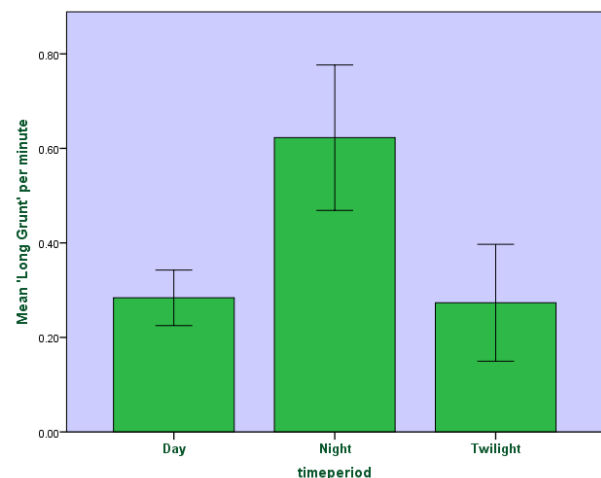
Both contact calls grunts and long grunts occurred significantly more during feeding and locomotion than resting (figure 1). There was no significant difference between the use of grunts over the time periods (day, night, twilight) but there was one for the use of long grunts (figure 2 & figure 3). There were no differences between the two sexes, which in the case of long grunts is inconsistent with other studies.



**Figure 1.** Mean (+/- SE) rates per minute of different call types; Grunt (top) and long grunt (bottom).



**Figure 2.** Distribution of mean rates per minute of the contact call 'grunt'. There was no significant difference between the time periods. Day\*Night (Mann Whitney U= 260, n=64, p= 0.574); Day\*Twilight (Mann Whitney U= 364.5, n=69, p=0.397); Night\*Twilight (Mann Whitney U= 82, n=27, p= 0.767).



**Figure 3.** Average rate of 'long grunts' per minute during various time periods. The difference is significant (Kruskal-Wallis H= 6.142, df=2, p=0.046). The significance is between the night samples with the day (Mann-Whitney U= 162.5, n=64, p=0.046) and twilight (Mann-Whitney U= 48, n=27, p= 0.044) but not between day and twilight (Mann-Whitney U= 422, n=69, p= 0.976).

The findings of this exploratory study suggest that some type of contact calls, the long grunts, are produced more frequently at night than during the other phases of the 24-hour cycle. This may potentially compensate for the lack of visual adaptations in the cathemeral lemur species *Eulemur collaris*. Only preliminary conclusions can be made because the data are too limited, both in quality of recordings and sample size. Both the grunt and long grunt seemed to be significantly affected by behavior, although there does not appear to be a difference between the rates during locomotion and feeding. The hypothesis that contact calls compensate in low visibility is only partly supported. The rate of the grunt does not vary greatly or significantly between time periods, while the long grunt does. This could be caused by the small sample size or be related to real functional difference between the grunt and the long grunt at night. The latter idea is worth to be explored further with a larger data-set. The call rates do not vary between sexes, suggesting that both calls have a more neutral use, which is constant with contact calls, although in the case of the long grunt it contradicts prior research on *E. rufifrons*.

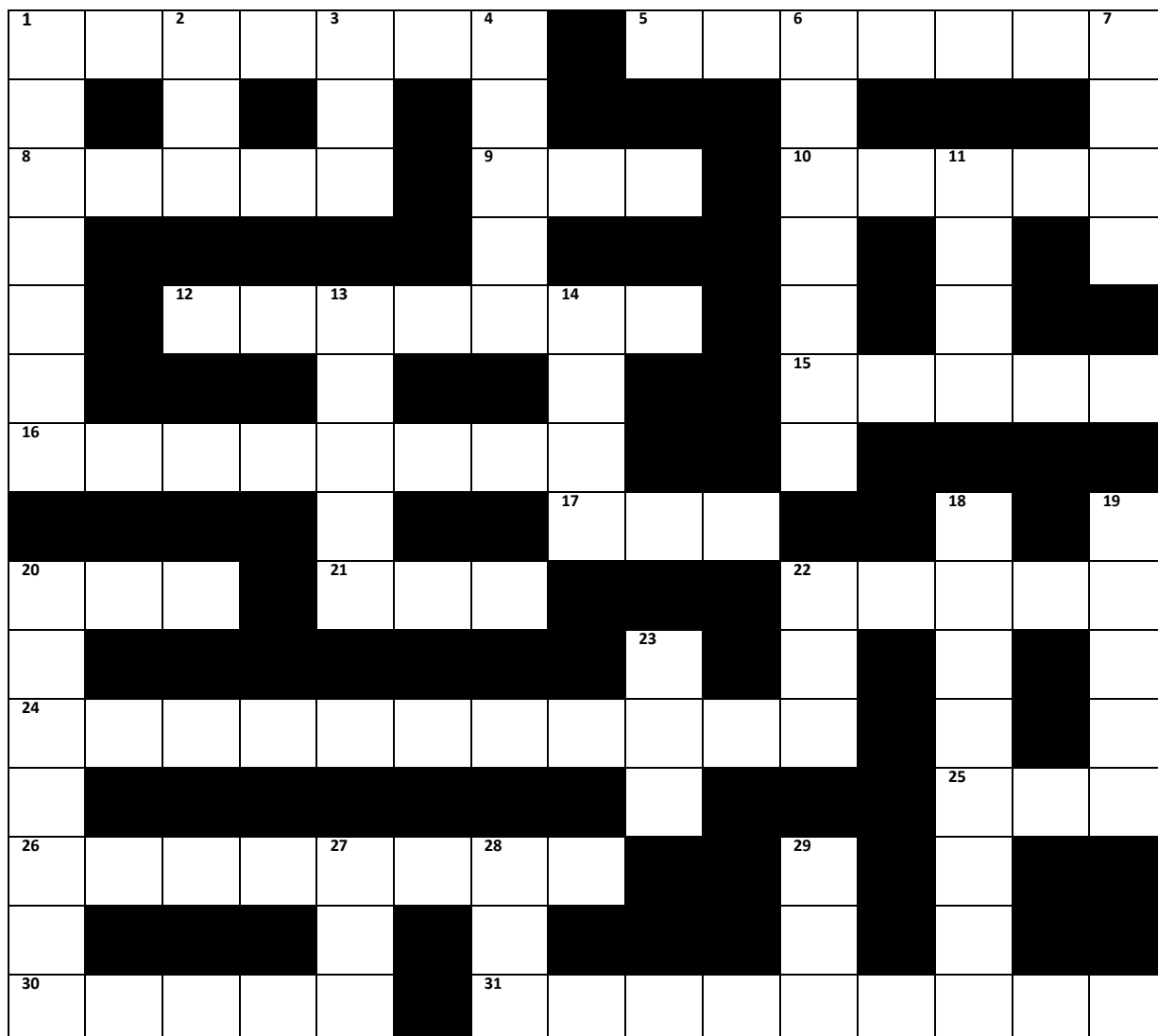
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# Primate Crossword

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## Across

- 1 Monty Python's woolly lemur (7)  
5 World authority on 8 across (7)  
8/7 down Small, nocturnal Asian primate (4, 5)  
9 When diurnal primates are active (3)  
10 African strepsirrhine of the family *Lorisidae* (5)  
12 Pseudopotto's favourite drink! (7)  
15 Leading lemur lady (5)  
16 Cotton headed tamarin \_\_\_\_\_ *Oedipus* (8)  
17 What a langur would do with a leaf! (3)  
20 Food accessed by tree-gauging primates (3)  
21 Night monkey (3)  
22 Baboon (5)  
24 Locomotion of 20 down (11)  
25 Number of tongues of 8 across (3)  
26 Greater galago (8)  
30 Habitat of *Allenopithecus nigroviridis* (5)  
31 Large Old World monkeys with striking blue and red muzzles (9)

## Down

- 1 This primate comes in red, bay, black and black and white (7)  
2 Hairy on a dwarf lemur, tufted on a marmoset (3)  
3 Orang-utan conservation organisation (1, 1, 1)  
4 Large vocal lemur; so good they named it twice (5)  
6 Newly discovered primate known as the highland mangabey (7)  
7 see 8 across  
11 Sported by 1 down but not 20 down or 8 across (4)  
13 \_\_\_\_\_pithecus; named for its nose (5)  
14 Strepsirrhines have a wet one (4)  
18 Tarsier with ghost-like associations (8)  
19 Orang-utan, also lead character in 101 dalmations (5)  
20 Lar, Hoolock or funky! (7)  
22 Chimpanzee (3)  
23 Pink animal with tail like a langur (3)  
27 EAZA population management programme (1, 1, 1)  
28 Global positioning system which uses zones (1, 1, 1)  
29 Country with gorillas (1, 1, 1)

## **Advice and suggestions for commenting on illegal loris material on the internet**

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Millions of people around the world have fallen in love with the slow loris through a series of viral YouTube videos. These videos on first appearance seem adorable. A wide-eyed loris grasping for an umbrella... A plump pygmy loris stretching her arms up for a tickle... A loris in a nappy reaching out for an umbrella...but why are these videos truly cruel and what can you do about them?

In a recent study by Oxford Brookes University researchers, we showed that that of 100 slow loris videos on the internet, every single one violated the principles of the five freedoms every animal deserves to have for good welfare and to avoid cruelty. In fact, most videos violated four or five of these tried and tested tenets for good husbandry. Yet social networking sites ignore when users flag them as cruel, do not provide an option for flagging, or promote them with ads, rewarding the perpetrators not only of the cruel care of the animals, but also the fact that slow loris pets are almost always illegal.

Slow lorises are listed under CITES Appendix 1, meaning they cannot be traded for commercial

purposes. Few if any slow lorises have ever been shipped for the pet trade to any country in the world. Even if they have, even the best zoos rarely breed slow lorises. They are a 'Red Light' species in zoos, meaning urgent action is required to breed them. The offspring of illegally smuggled animals are also illegal – so please do not believe an uploader just because he claims to have bought the loris in a pet shop!

The path to the pet trade is so horrific it cannot be imagined. Animals are ripped from the forest; shoved into plastic crates and bags; their teeth are clipped out with crude mechanisms with no anaesthesia, no aftercare, no medicine and most die; multiple animals are transported in crates where they wound each other with their venomous bites; market conditions are inhumane, boiling hot, and cruel, with no proper food fed to the animals; most owners have no idea how to care for these social primates with their specialised diets and their deaths are very long and painful as they starve to death in loneliness, obese with diabetes or rotting teeth from being fed fruit.

### HOW YOU CAN HELP:

- Please don't 'like' or 'thumbs up' this video and encourage this cruel trade.
- Thumbs down such videos
- Report them to the Web 2.0 service as cruel and illegal
- Kindly ask the uploader to remove their video and provide links to our web site as evidence
- Do not be angry and cruel to uploaders as they may not understand why loris videos are cruel
- Provide people who own loris pets with information for a nearby rescue centre or zoo
- Never buy an illegal animal from a market as this encourages trade.
- Report the animal to the police, your ambassador and to a local newspaper.

### LEAVE LORIS IN THE FOREST

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## Crossword answers

#### Across

- 1 cleesei
- 5 Nekar
- 8 loris
- 9 day
- 10 potto
- 12 martini
- 15 Jolly
- 16 saguinus
- 17 eat
- 20 gum
- 21 owl
- 22 papio
- 24 brachiation
- 25 two
- 26 ootemur
- 30 swamp
- 31 mandrills

#### Down

- 1 colobus
- 2 ear
- 3 sos
- 4 indri
- 6 kipunji
- 7 slow
- 11 tail
- 13 rhino
- 14 nose
- 18 spectral
- 19 pongo
- 20 gibbons
- 22 pan
- 23 pig
- 27 eep
- 28 utm
- 29 car

## University Events

### Seminar Series

The seminar series is a weekly event which events guest speakers to present their research. We are currently in the process of recruiting speakers for our spring semester. If you are interested in attending or presenting please do not hesitate to get in contact with us. Contact details are provided within the contents pages

29 Sept	<b>Nic Dunn &amp; Julie Matthews</b> (Shaldon Wildlife Trust)
6 Oct	<b>Dr Susan Cheyne</b> (OuTrop)
13 Oct	<b>Nida Al Fulaij</b> (People's Trust for Endangered Species)
27 Oct	<b>Pedro Mendez</b> (Fundación Pro-Conservación de los Primates Panameños)
3 Nov	<b>Dr Stefano Vaglio</b> (Durham University)
10 Nov	<b>Dr Nobuyuki Yamaguchi</b> (Qatar University)
17 Nov	<b>Dr Bonaventura Majolo</b> (University of Lincoln)
24 Nov	<b>Prof Ulrike Meinhof</b> (University of Southampton)
1 Dec	<b>Jan Gogarten</b> (McGill University)
8 Dec	<b>Dr John Fa</b> (Durrell Wildlife Conservation Trust)





2014-2015 Cohort of the MSc Primate Conservation

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<http://www.social-sciences.brookes.ac.uk/more/primates/>