Zoo Animal Nutrition Workshop

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Apenheul 2022

University of Zurich[UZH]

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Matching biological information with husbandry practice

Feeding frequency

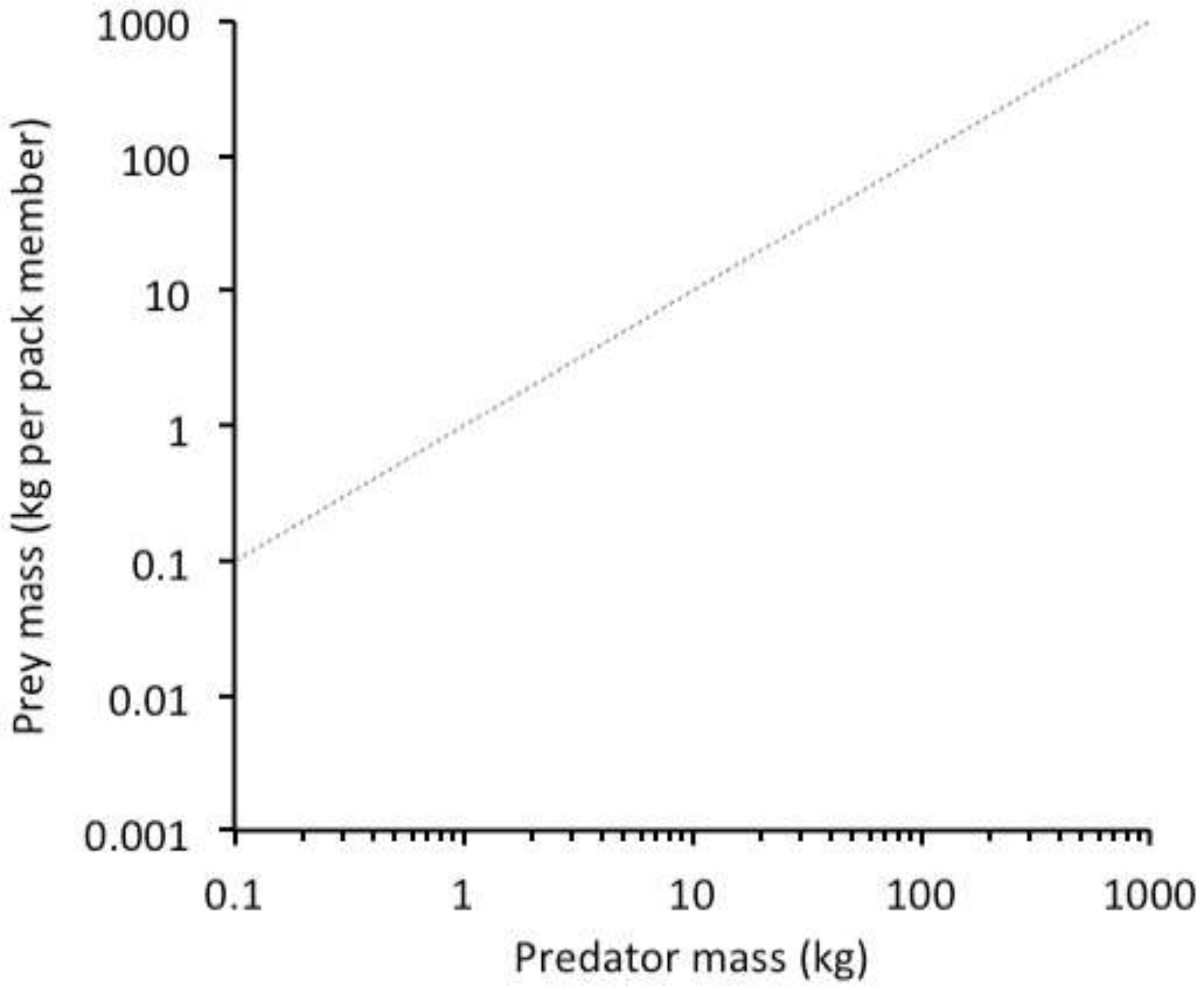
Predator size and prey size–gut capacity ratios determine kill frequency and carcass production in terrestrial carnivorous mammals

Editor's OIKOS Choice

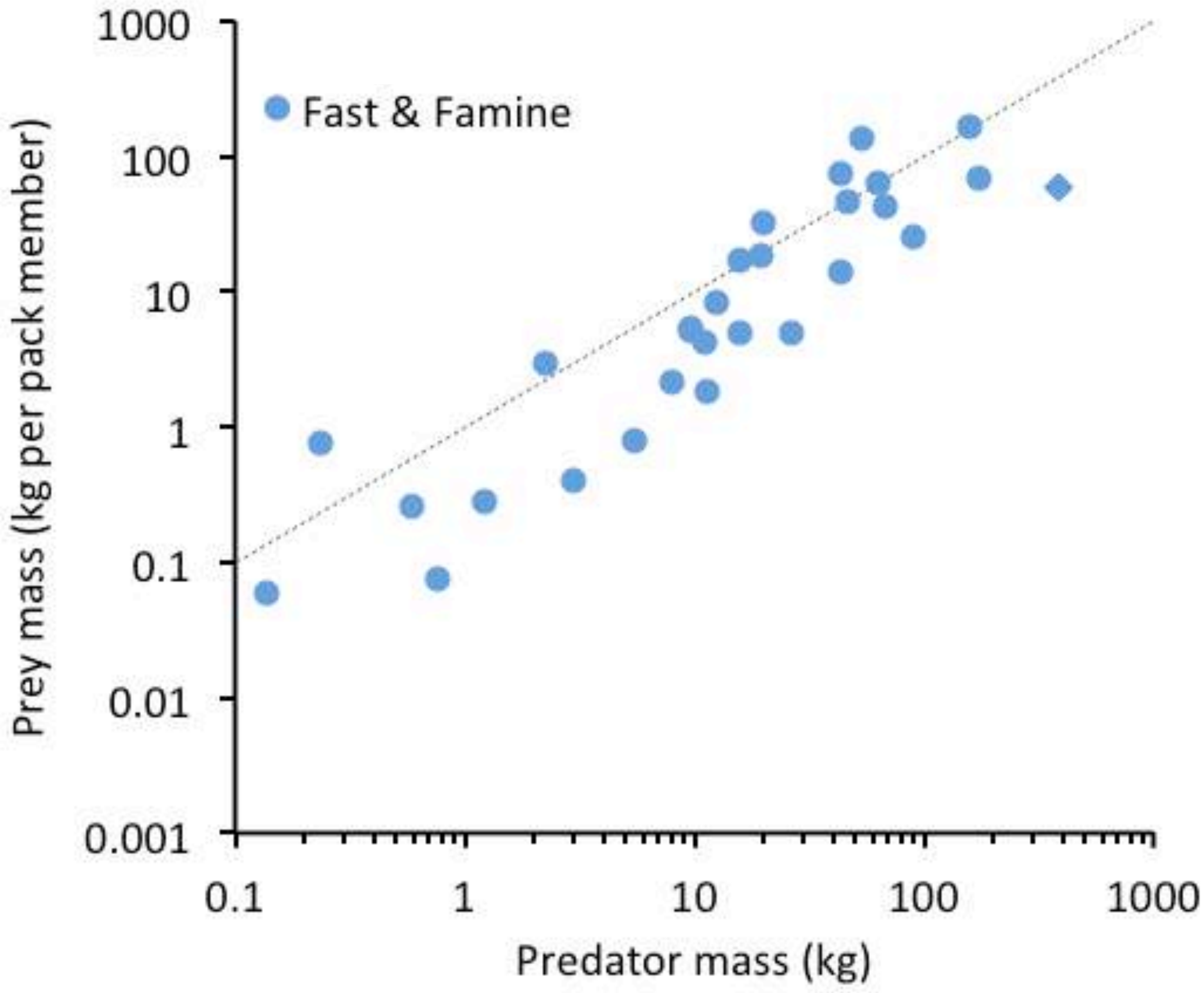
Annelies De Cuyper, Marcus Clauss, Chris Carbone, Daryl Codron, An Cools, Myriam Hesta and Geert P. J. Janssens

Oikos
128: 13–22, 2019

Prey size vs. body size



Prey size vs. body size



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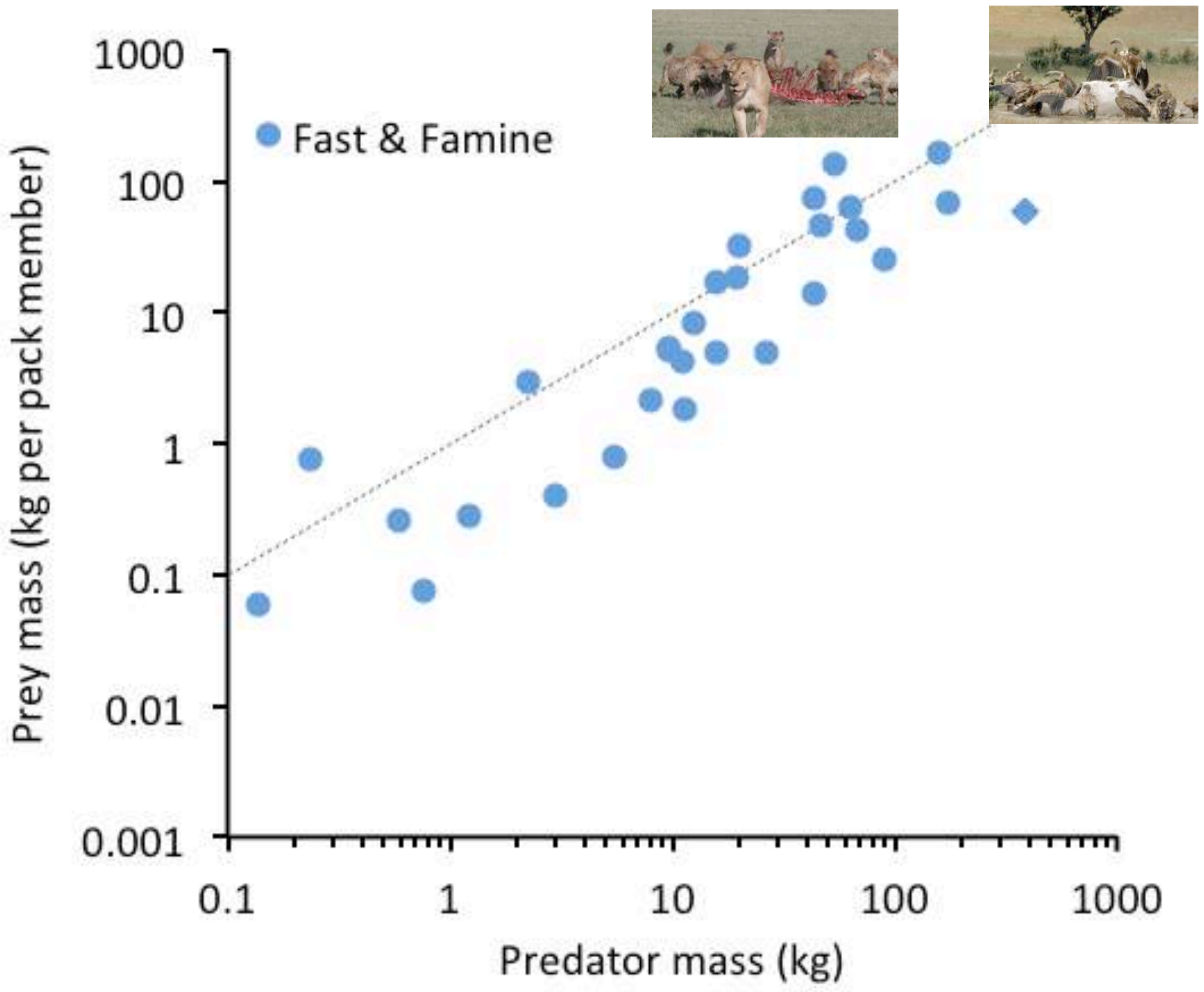

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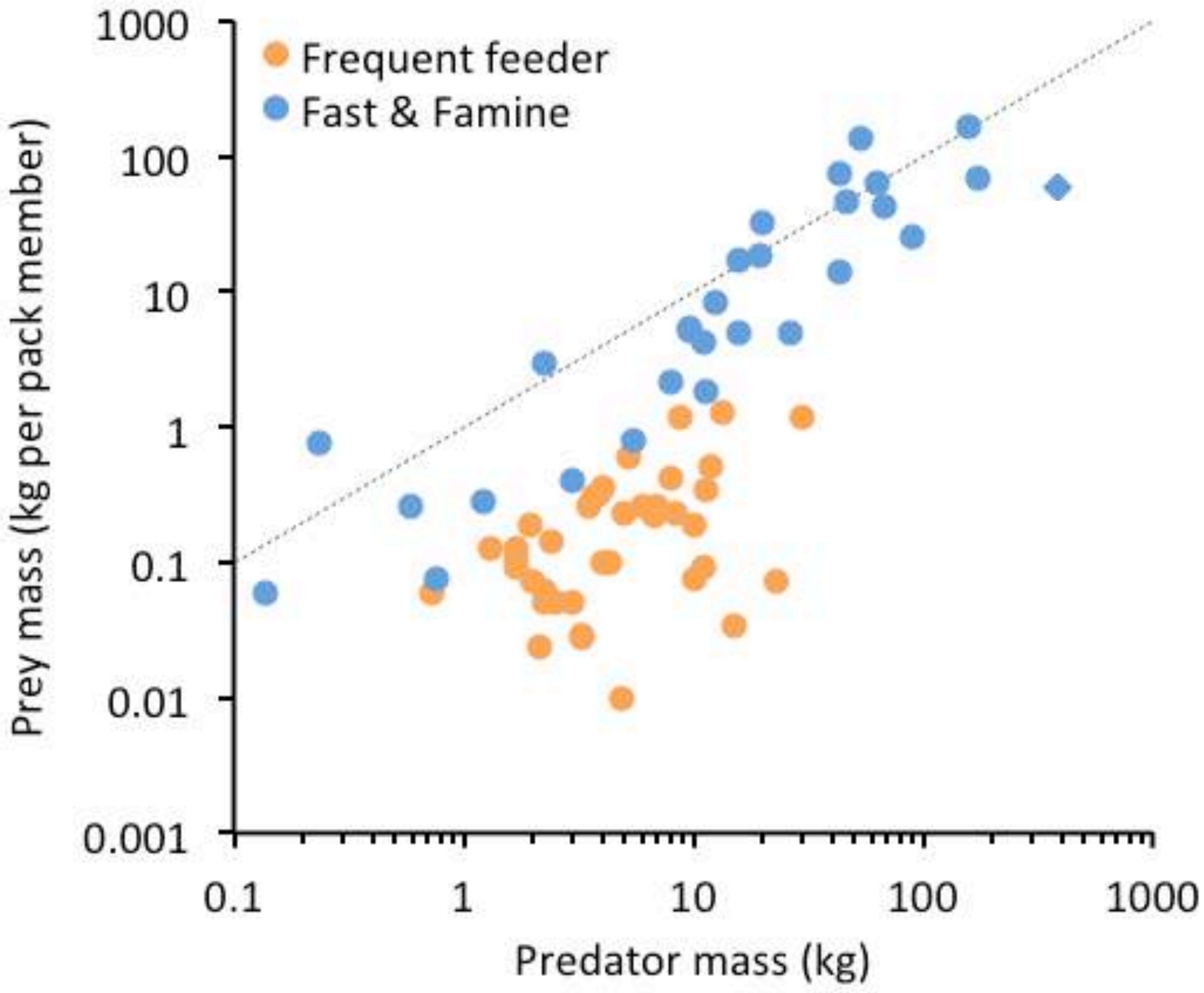

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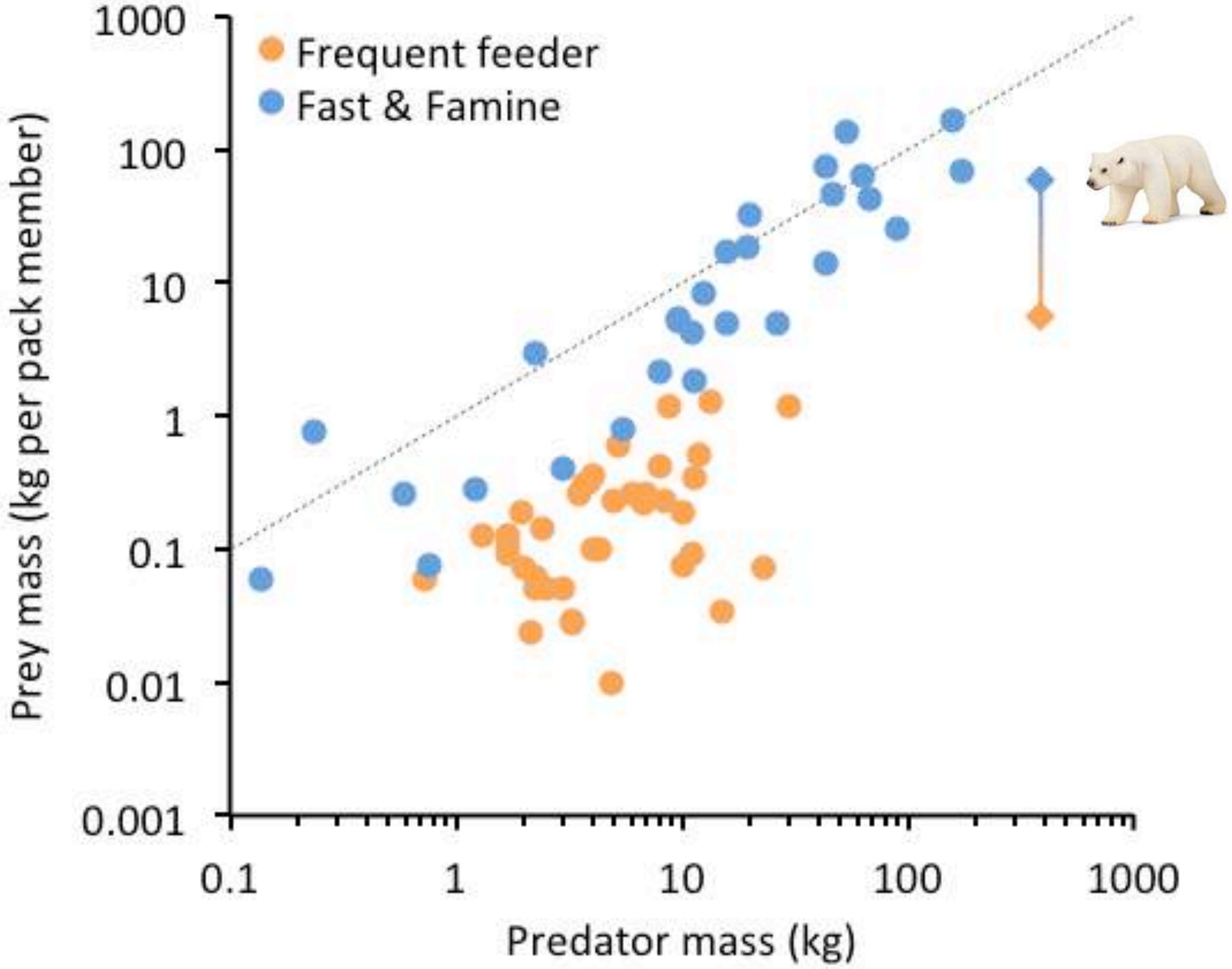
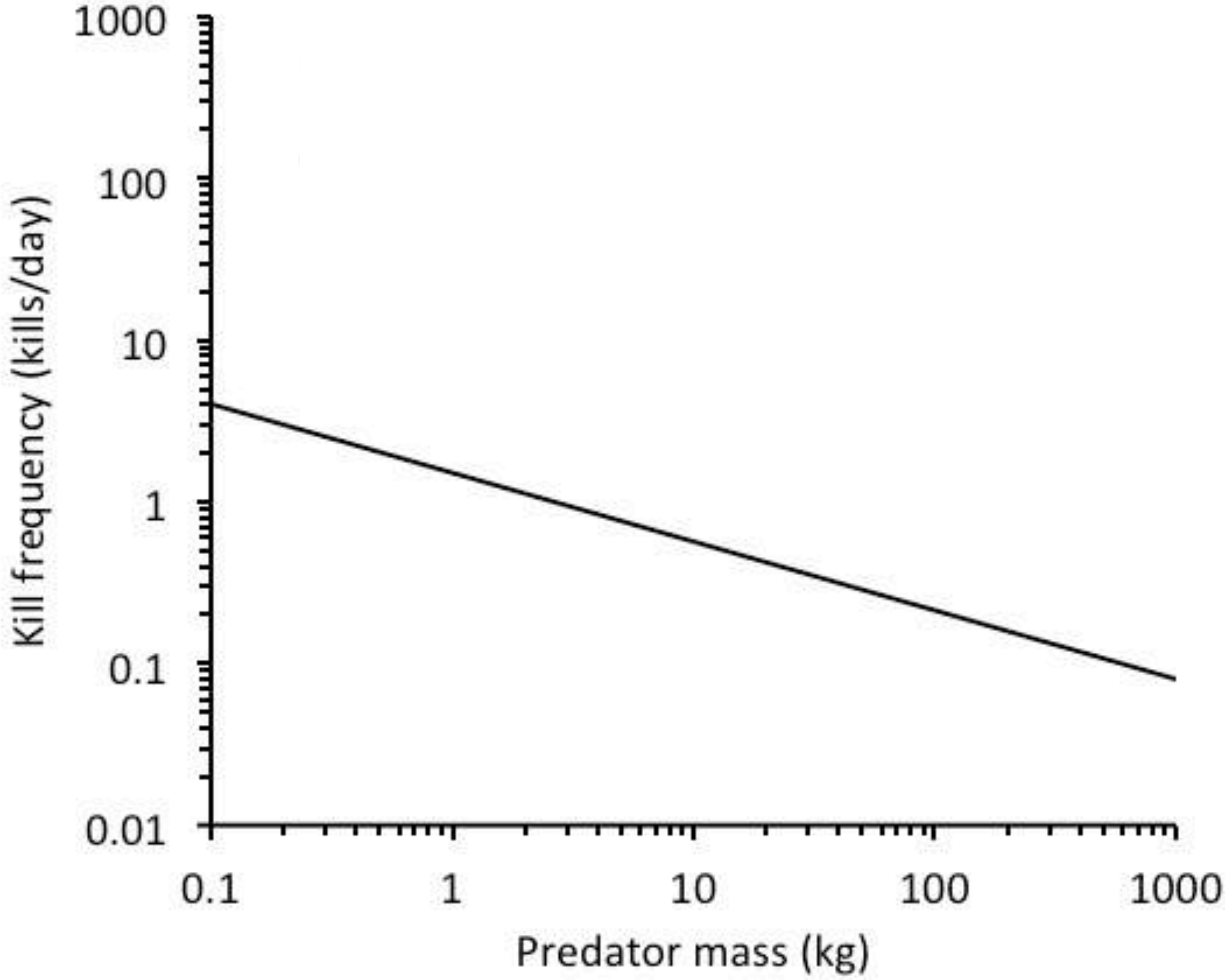


Kill frequency vs. body size



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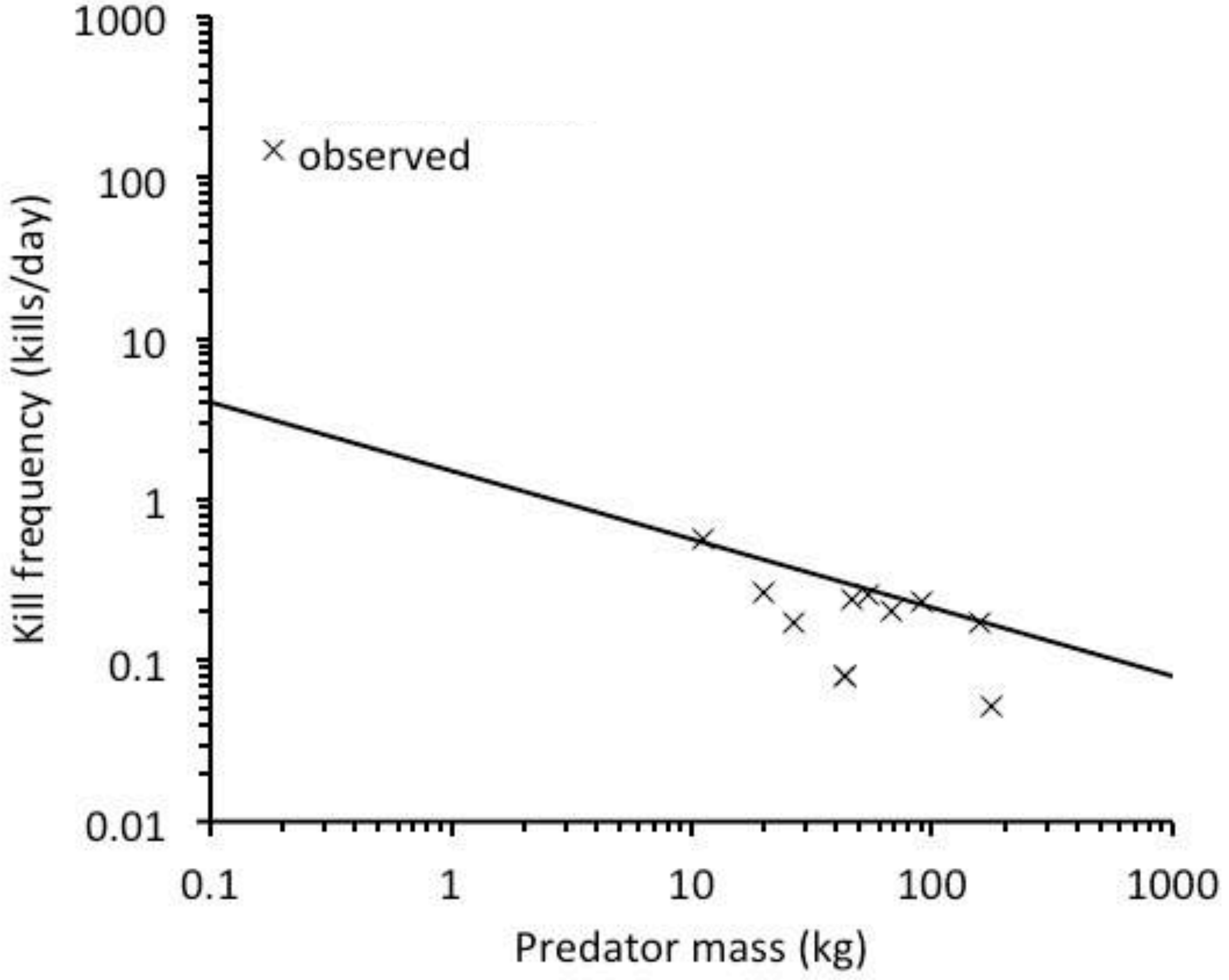

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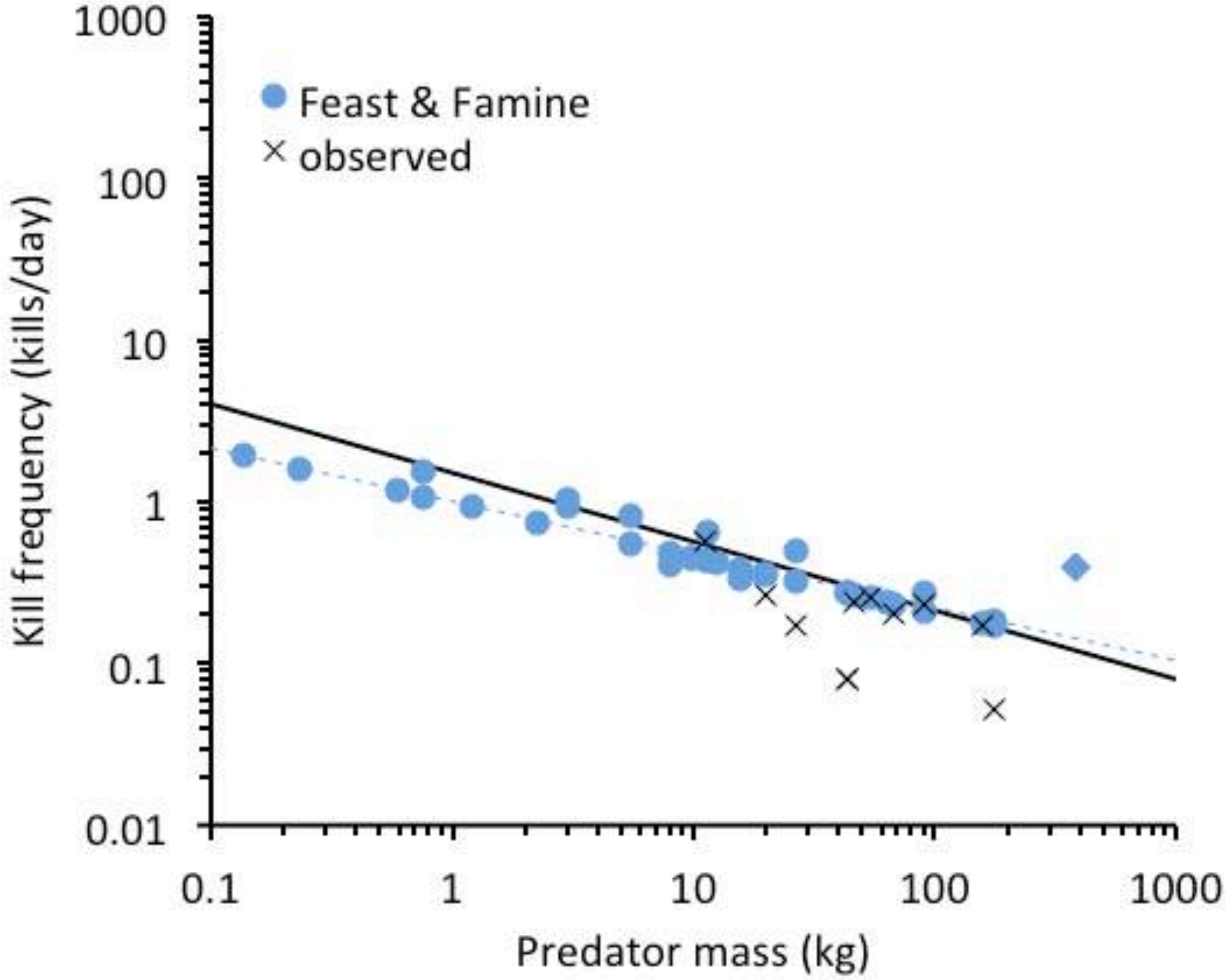

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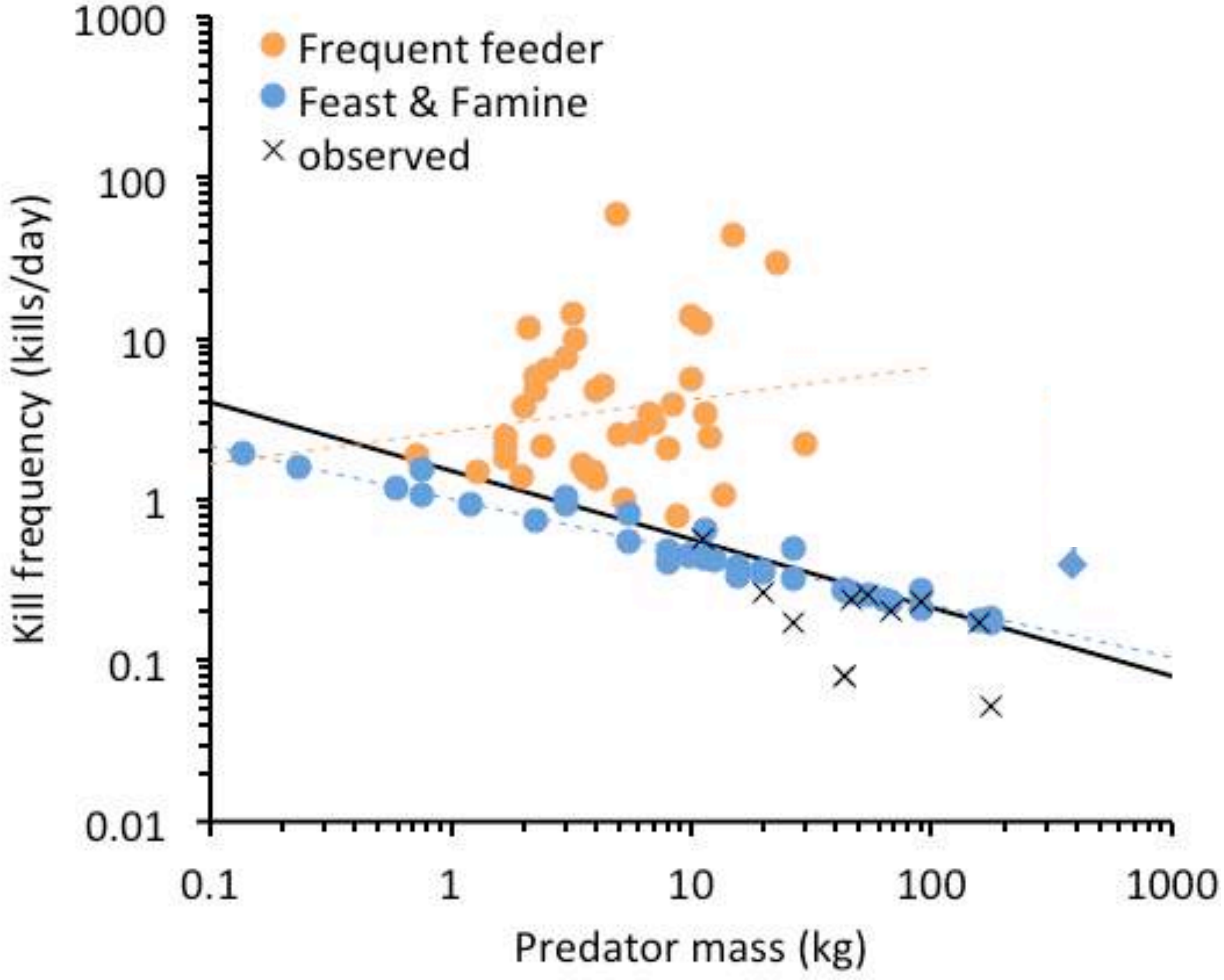

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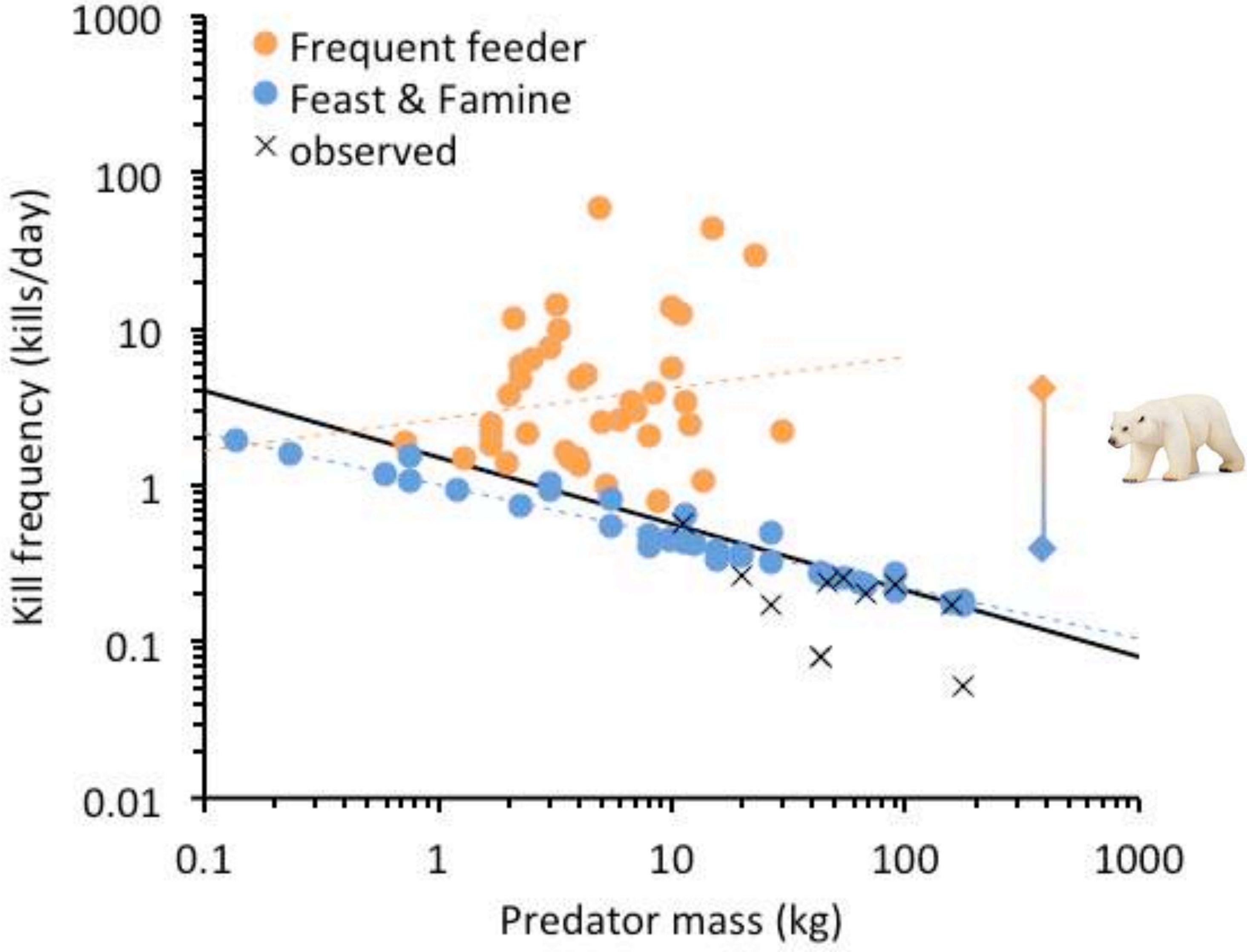

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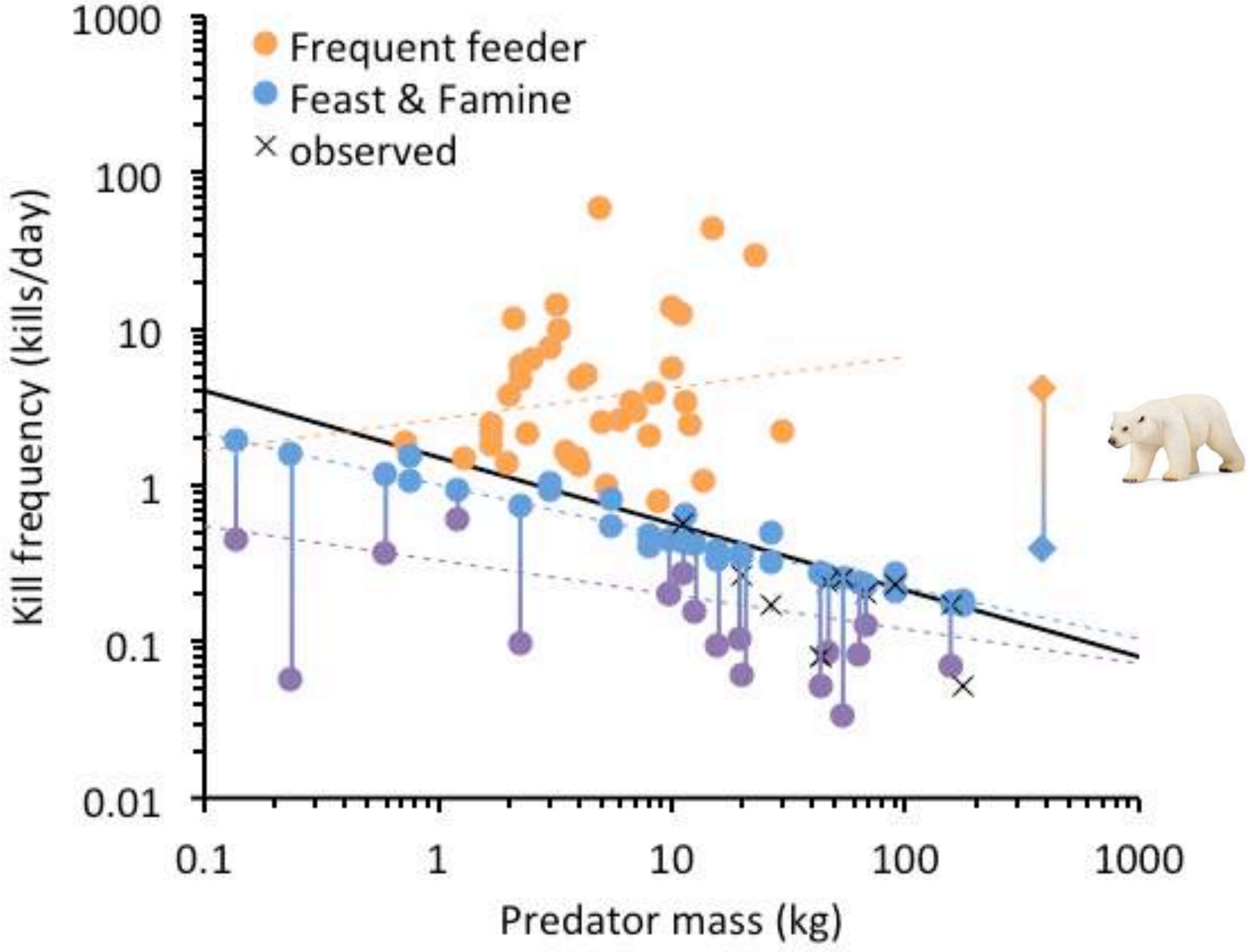

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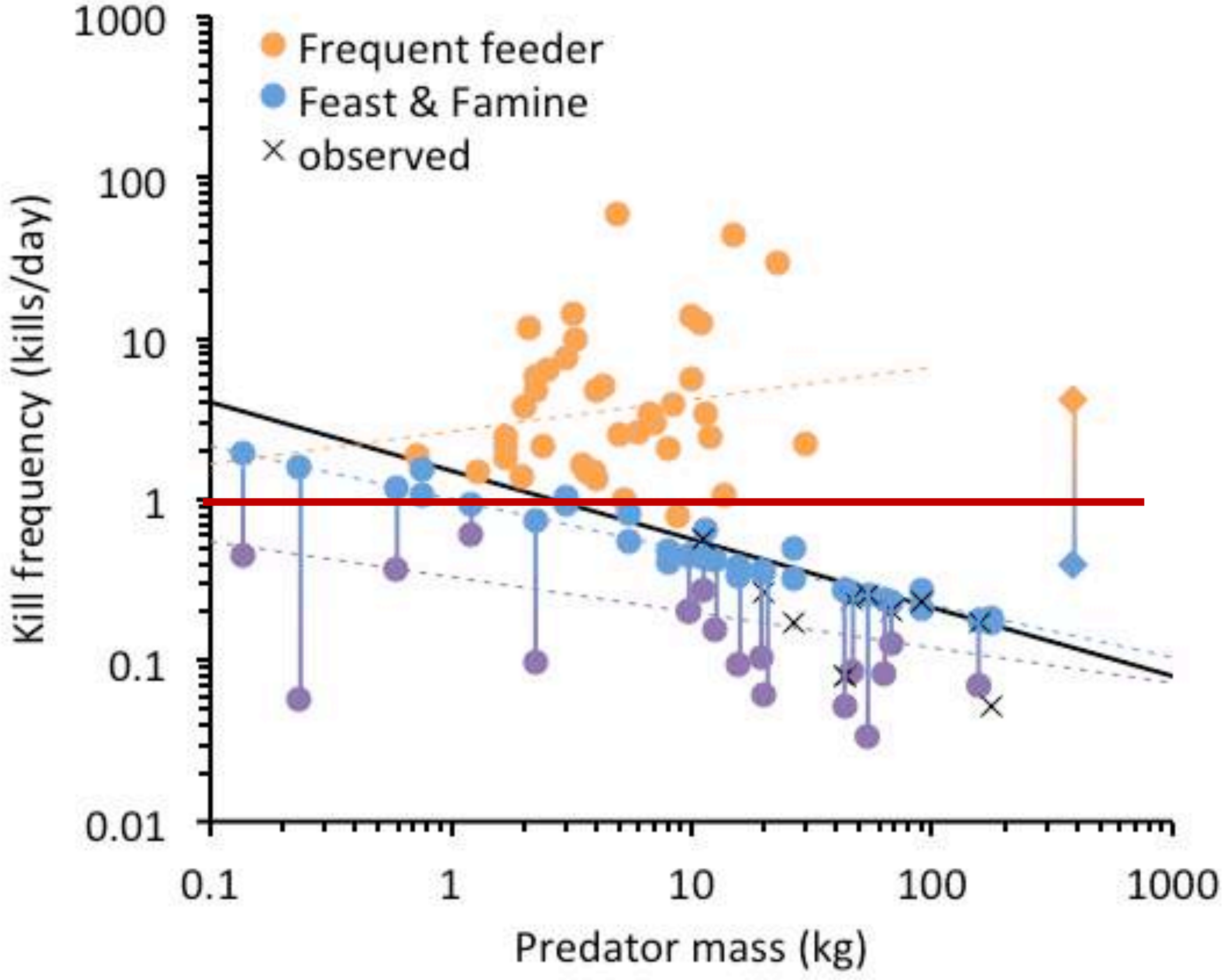

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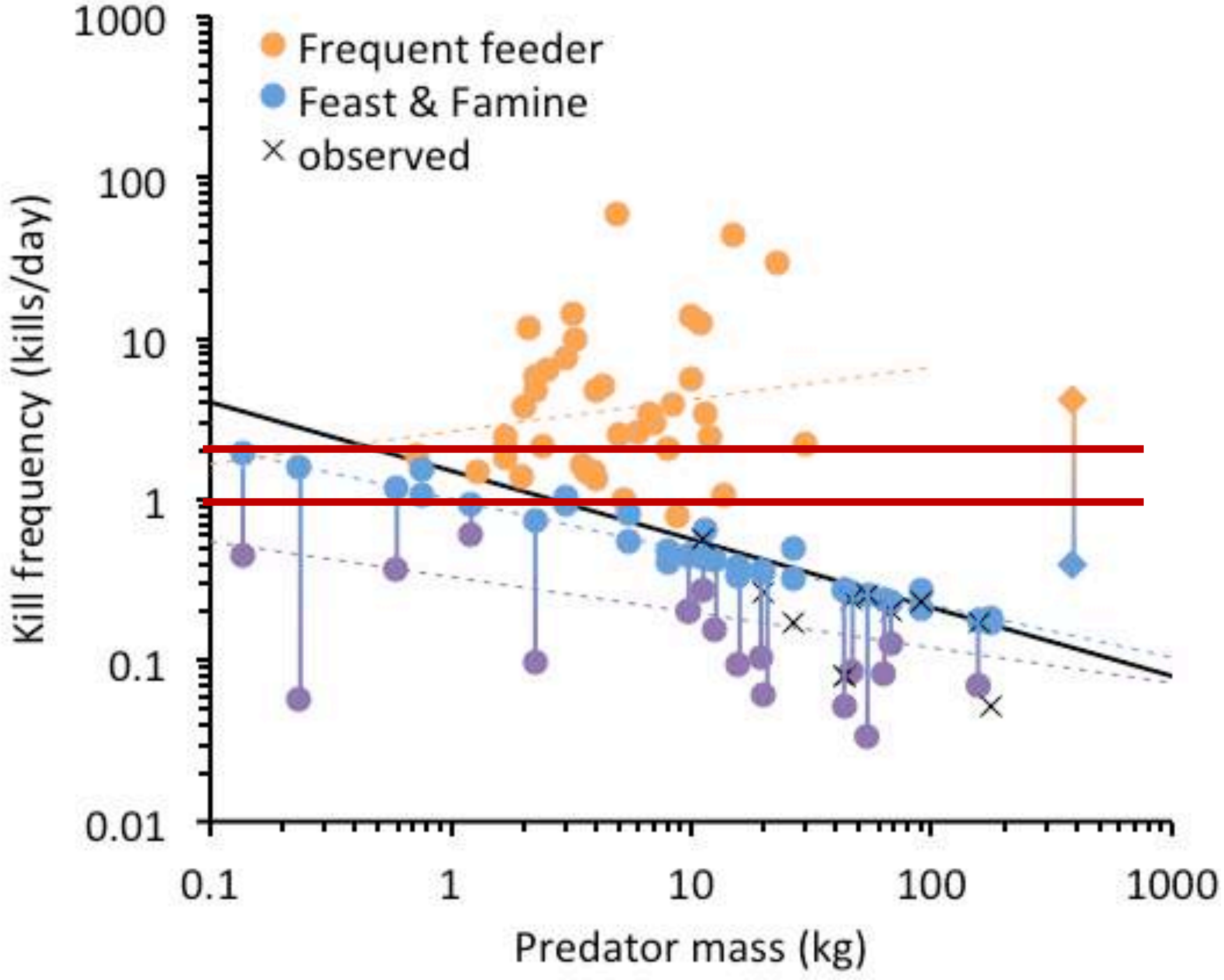

Zoo feeding frequency

Predator size and prey size–gut capacity ratios determine kill frequency and carcass production in terrestrial carnivorous mammals

Annelies De Cuyper, Marcus Clauss, Chris Carbone, Daryl Codron, An Cools, Myriam Hesta and Geert P. J. Janssens

Oikos
128: 13–22, 2019

domestic cats or wild cats kept in zoos are often offered single meals per day, which may contribute to the increasing problem of obesity at least in domestic cats (Laflamme 2006, Bissot et al. 2010, Deng et al. 2013).

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lions or tigers, daily – and hence comparatively small – rations, may prevent these animals from ever experiencing the extreme distension of their stomach that occurs after a gorge-feeding event, and that is putatively linked to satiety (Veasey 2017). Hence, these animals might be in a constant condition where their energetic requirements are met but they do not receive an important satiety signal, which could be the reason why these carnivores are particularly susceptible to showing stereotypies (Clubb and Mason 2007).

Rabbit example

Rabbit study

4 x 8 rabbits kept in pairs
(neutered, vaccinated)
17 months duration




		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study

BSAVA

JSAP JOURNAL OF SMALL ANIMAL PRACTICE

PAPER

Bodyweight and body condition score in rabbits on four different feeding regimes

J. L. Prebble, D. J. Shaw and A. L. Meredith

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J.L. Prebble was employed on a KTP partnership between the Royal (Dick) School of Veterinary Studies and Burgess Pet Care, Victory Mill, Priestman's Lane, Thornton-Le-Dale, Pickering, North Yorkshire YO18 7RU. Her current address is Askham Bryan College, Askham Bryan, York YO23 3FR

Objectives: The aim of this study was to assess the effects of four diet regimes (extruded diet with *ad lib* hay, muesli with *ad lib* hay, *ad lib* hay only, *ad lib* muesli only) on bodyweight and body condition score in rabbits.

Methods: Thirty-two Dutch rabbits were studied over 9 months. Bodyweight and body condition score were recorded weekly.

Results: All groups gained weight with age, but relative to the *ad lib* hay only group (mean, 1·77 ±0·13 kg), after 9 months rabbits in the *ad lib* muesli only group were 146% heavier (2·59 ±0·32 kg); extruded diet with *ad lib* hay group 125% heavier (2·21 ±0·10 kg); and muesli with *ad lib* hay group 123% heavier (2·18 ±0·13 kg). Median body condition score of the *ad lib* muesli only group was obese (4·5) and was higher than that in both the extruded diet with *ad lib* hay and muesli with *ad lib* hay (median = 3·5) groups (P<0·001). Both the extruded diet with *ad lib* hay and muesli with *ad lib* hay groups had above-ideal body condition score despite having bodyweights within the breed standard range. The *ad lib* hay only group had a median body condition score of 3 (ideal). There was an overall positive correlation between body condition score and weight (ρ_s = 0·814, P<0·001).

Clinical Significance: The feeding of muesli without hay should be avoided, to prevent obesity.

Journal of Small Animal Practice (2015) **56**, 207–212
DOI: 10.1111/jsap.12301

Accepted: 8 October 2014; Published online: 21 December 2014

INTRODUCTION

Rabbits are popular pets, with an estimated number of 1 to 1·7 million in the UK (PDSA 2011, PFMA 2013a). Despite their popularity, studies to determine basic dietary requirements of pet rabbits have not been carried out, resulting in variable dietary recommendations. Nutritional guidelines available for rabbits (NRC 1977) are based on research conducted on commercially farmed or laboratory rabbits. Commercially formulated diets for pet rabbit consist of traditional muesli-type mixes, or monocomponent pellets/extruded nuggets, fed alone or in addition to grass, hay and/or green vegetables. Muesli-type diets are suggested to play a role in many disease processes, including obesity, particularly when fed in the absence of hay or grass (Mullan & Main 2006, Meredith 2012, RSPCA 2013). However, there have been no controlled studies investigating the effect on health of these commonly fed pet rabbit diets.

As in dogs and cats, (Lund *et al.* 2005, McGreevy *et al.* 2005, Lund *et al.* 2006), obesity is a concern in pet rabbits with a reported prevalence of being overweight or obese ranging from 7 to 24% (Mullan & Main 2006, Courcier *et al.* 2012). Obesity is defined as abnormal or excessive fat accumulation that may impair health (WHO 2012). Pets are generally considered overweight at 10 to 20% above-ideal bodyweight and obese if their weight exceeds 20% above ideal (Burkholder & Toll 2000). Breed standard bodyweights do exist for show rabbits (BRC 2012), but determining bodyweight alone may be difficult in obese rabbits owing to the lack of standard data for cross-breeds, and differences in husbandry between show and pet rabbits. Obesity can also be determined in terms of body condition score (BCS); in rabbits, a score of 5 on a 1- to 5-point scale corresponds with obesity (PFMA 2013b; Table 1). The overfeeding of commercially available concentrate diets may play a role in the development of obesity in pet rabbits (Meredith 2006), particularly

4 x 8 rabbits kept in pairs
(neutered, vaccinated)
17 months duration

		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study

PAPER

Body… rabbit…

J. L. Prebble, …

Royal (Dick) Scho…

JSAP JOURNAL OF SMALL ANIMAL PRACTICE

Journal of Animal Physiology and Animal Nutrition

DOI: 10.1111/jpn.12163

ORIGINAL ARTICLE

Food and water intake and selective feeding in rabbits on four feeding regimes

J. L. Prebble* and A. L. Meredith

Royal (Dick) School of Veterinary Studies and the Roslin Institute, University of Edinburgh, Midlothian, UK

Summary

Diet plays an important role in maintaining rabbit health. Feeding an incorrect diet, particularly a low fibre diet, has been linked with digestive, dental and urinary tract disease. However, food intake and dietary requirements have been poorly studied in pet rabbits. This study assessed the effects of two commonly fed pet rabbit diets [extruded nuggets with hay (EH) and muesli with hay (MH)] alongside hay only (HO) and muesli only (MO) on food and water intake in 32 Dutch rabbits. Dry matter (DM) intake was greater in the HO group and lower in the MO group than in the EH and MH groups (p < 0.001). The portion of the diet made of hay was greater in the EH group than in the MH group (p < 0.001). Water intake was positively correlated with DM intake and was greatest in the HO group (p < 0.001). Selective feeding occurred in all rabbit groups fed muesli, whether or not hay was also available. Pellets were rejected, and grains and extrudates selected. The presence of selective feeding in all rabbits fed muesli leads to the consumption of an unbalanced diet. In addition, hay intake and water intake were lower when muesli was fed. Conclusions drawn from this study are based on general recommendations for pet rabbits, and clinical disease may have developed by feeding the study diets over a longer time period, as many diet-related conditions typically present in older rabbits. However, the study demonstrates that the feeding of muesli diets cannot be recommended.

Keywords hay diet, fibre, muesli

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Received: 25 February 2013; accepted: 8 December 2013

Introduction

The wild rabbit diet is made up predominantly of grasses (Williams and Wells, 1974), with dicotyledonous plants (e.g. legumes) consumed in higher amounts when grass availability is low (Bhadresa, 1977). In contrast, concentrate rations (both muesli mixes and extruded/pelleted nuggets) produced for domesticated rabbits can be higher in energy (carbohydrates and fats) and lower in fibre (Meredith, 2006). Forage-based diets are commonly recommended for pets (Harcourt-Brown, 2002a; Meredith, 2006; Clauss, 2012) to mimic the diet of wild rabbits; however, the specific dietary requirements of pet rabbits are not fully understood. The feeding of lower fibre feeds has been implicated in the development of dental (Crossley, 2003) and digestive disease in pet rabbits (Bennegadi et al., 2001; Gidenne et al., 2001) and a higher frequency of abnormal behaviours (Lidfors, 1997; Berthelsen and Hansen, 1999; Hansen and Berthelsen, 2000).

Food intake in rabbits has been assessed in farm and laboratory conditions and is influenced by multiple factors including fibre levels, digestible energy (DE) levels, fat levels, amino acid composition and level of gut fill (Pascual et al., 1999; Gidenne et al., 2000, 2002, 2010; Tome, 2004). Physical composition of the diet and environmental conditions also affect intake. Pellets are preferred to meals (ground raw materials; Harris et al., 1983) and, if fed in a limited quantity, are consumed rapidly (Lidfors, 1997). Ambient temperature (Eberhart, 1980; Chiericato et al., 1994; Cervera et al., 1997), the absence of light (Lebas, 1977) and restricted access to fresh water (Prud'hon et al., 1975; Cooke, 1982a; Bovera et al., 2013) all affect food intake.

Journal of Animal Physiology and Animal Nutrition 98 (2014) 991–1000 © 2014 Blackwell Verlag GmbH 991

4 x 8 rabbits kept in pairs
(neutered, vaccinated)
17 months duration

		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study

Applied Animal Behaviour Science 169 (2015) 86–92

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

The effect of four different feeding regimes on rabbit behaviour

Jennifer L. Prebble[a,1,2], Fritha M. Langford[b], Darren J. Shaw[a], Anna L. Meredith[a,*]

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ARTICLE INFO

Article history:
Received 10 June 2014
Received in revised form 4 May 2015
Accepted 10 May 2015
Available online 22 May 2015

Keywords:
Rabbit
Feeding
Behaviour
Abnormal behaviour
Hay

ABSTRACT

Dietary composition and presentation impacts on the behaviour of animals, and failure to provide a suitable diet can lead to reduced welfare through the development of poor health, the inability to express normal behaviours and the development of abnormal behaviours. This study assessed the effects of two commonly fed pet rabbit diets (extruded nuggets with hay (EH) and muesli with hay (MH)) alongside hay only (HO) and muesli only (MO) on the behaviour of 32 Dutch rabbits observed over 17 months. Increased time spent feeding was observed in the groups fed ad libitum hay (HO, EH, MH) compared to the MO group ($P<0.05$). A corresponding high level of inactivity was observed in the MO group compared to rabbits receiving hay ($P<0.05$). In the groups provided with hay a preference to consume hay in a natural grazing posture was observed. The higher activity levels and absence of abnormal behaviours when hay was fed support recommendations that forage should form a significant portion of the diet for domestic rabbits.

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1. Introduction

As herbivores, wild rabbits consume relatively large amounts of a high fibre diet of low nutritional quality (Williams and Wells, 1974). This requires them to apportion a large amount of their time budget to grazing. Rabbits spend 30–70% of time outside the burrow grazing, pausing occasionally to groom (Mykytowycz, 1958; Myers and Poole, 1961; Myers and Mykytowycz, 1958; Lockley, 1961). Time spent eating varies with age, sex and social status within the group and has also been shown to increase when food availability falls during drought (Myers and Mykytowycz, 1958; Mykytowycz, 1958). Grazing occurs mainly during late afternoon and throughout the night and daylight hours are spent underground in warrens (Myers and Mykytowycz, 1958; Mykytowycz, 1958; Lockley, 1961, 1962). Caecotrophy is performed while underground (Southern, 1942). Domestic rabbits kept in free range conditions exhibit a similar feeding pattern to their wild counterparts (Vastrade, 1987; Lehmann, 1991). In contrast, many pet rabbits are housed in small hutches with limited exercise opportunities (Mullan and Main, 2006; PDSA, 2011) and a diet consisting largely of concentrates (mono-component nugget or muesli mixes) (PDSA, 2011) which can be consumed rapidly (Lidfors, 1997), with limited or no access to hay or grass (Mullan and Main, 2006; PDSA, 2011).

Stereotypic behaviours are described as behaviours that are relatively invariant, regularly repeated and without an obvious function (Mason, 1991). Stereotypic behaviours reported to occur in laboratory rabbits include excessive grooming, sham chewing (chewing with nothing in mouth), bar biting, licking parts of cage, digging against cage, biting water nipple, sliding nose against bars, head pressing and running repeatedly in a defined pattern (Gunn and Morton, 1995; Lidfors, 1997). An apathetic state of inactivity and boredom has also been reported by Gunn and Morton (1995). Stereotypic behaviours occur most frequently during the night (Gunn and Morton, 1995) when rabbits are naturally at their most active (Mykytowycz, 1958).

Whilst not studied in pet rabbits, the beneficial impact of providing hay to laboratory rabbits has been demonstrated (Lidfors, 1997; Berthelsen and Hansen, 1999). The provision of hay to individually housed laboratory rabbits has proved effective at reducing the expression of abnormal behaviours (Lidfors, 1997; Berthelsen and Hansen, 1999).

Rabbits can consume pelleted feeds rapidly (Lidfors, 1997) and, whilst they may provide adequate nutrition for the maintenance of the rabbit, foraging behaviour is limited. If fed in limited amounts the rapid consumption of the daily ration may leave the rabbit in a state of hunger for a considerable portion of the day (Lidfors, 1997). It has been suggested that stereotypies in pigs and broiler

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http://dx.doi.org/10.1016/j.applanim.2015.05.003
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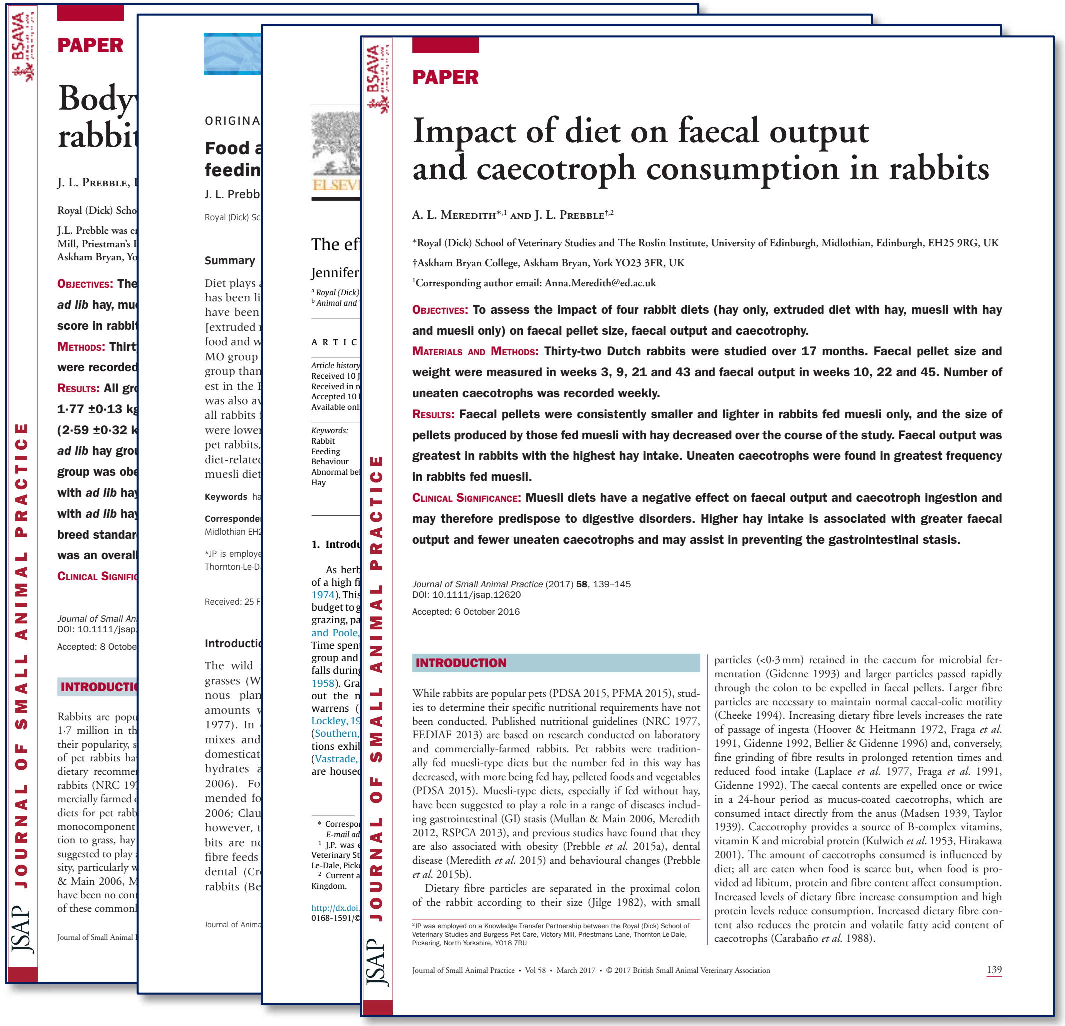
4 x 8 rabbits kept in pairs
(neutered, vaccinated)
17 months duration




		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study



PAPER

Impact of diet on faecal output and caecotroph consumption in rabbits

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Objectives: To assess the impact of four rabbit diets (hay only, extruded diet with hay, muesli with hay and muesli only) on faecal pellet size, faecal output and caecotrophy.

Materials and Methods: Thirty-two Dutch rabbits were studied over 17 months. Faecal pellet size and weight were measured in weeks 3, 9, 21 and 43 and faecal output in weeks 10, 22 and 45. Number of uneaten caecotrophs was recorded weekly.

Results: Faecal pellets were consistently smaller and lighter in rabbits fed muesli only, and the size of pellets produced by those fed muesli with hay decreased over the course of the study. Faecal output was greatest in rabbits with the highest hay intake. Uneaten caecotrophs were found in greatest frequency in rabbits fed muesli.

Clinical Significance: Muesli diets have a negative effect on faecal output and caecotroph ingestion and may therefore predispose to digestive disorders. Higher hay intake is associated with greater faecal output and fewer uneaten caecotrophs and may assist in preventing the gastrointestinal stasis.

Journal of Small Animal Practice (2017) **58**, 139–145
DOI: 10.1111/jsap.12620

Accepted: 6 October 2016

INTRODUCTION

While rabbits are popular pets (PDSA 2015, PFMA 2015), studies to determine their specific nutritional requirements have not been conducted. Published nutritional guidelines (NRC 1977, FEDIAF 2013) are based on research conducted on laboratory and commercially-farmed rabbits. Pet rabbits were traditionally fed muesli-type diets but the number fed in this way has decreased, with more being fed hay, pelleted foods and vegetables (PDSA 2015). Muesli-type diets, especially if fed without hay, have been suggested to play a role in a range of diseases including gastrointestinal (GI) stasis (Mullan & Main 2006, Meredith 2012, RSPCA 2013), and previous studies have found that they are also associated with obesity (Prebble *et al.* 2015a), dental disease (Meredith *et al.* 2015) and behavioural changes (Prebble *et al.* 2015b).

Dietary fibre particles are separated in the proximal colon of the rabbit according to their size (Jilge 1982), with small particles (<0·3 mm) retained in the caecum for microbial fermentation (Gidenne 1993) and larger particles passed rapidly through the colon to be expelled in faecal pellets. Larger fibre particles are necessary to maintain normal caecal-colic motility (Cheeke 1994). Increasing dietary fibre levels increases the rate of passage of ingesta (Hoover & Heitmann 1972, Fraga *et al.* 1991, Gidenne 1992, Bellier & Gidenne 1996) and, conversely, fine grinding of fibre results in prolonged retention times and reduced food intake (Laplace *et al.* 1977, Fraga *et al.* 1991, Gidenne 1992). The caecal contents are expelled once or twice in a 24-hour period as mucus-coated caecotrophs, which are consumed intact directly from the anus (Madsen 1939, Taylor 1939). Caecotrophy provides a source of B-complex vitamins, vitamin K and microbial protein (Kulwich *et al.* 1953, Hirakawa 2001). The amount of caecotrophs consumed is influenced by diet; all are eaten when food is scarce but, when food is provided ad libitum, protein and fibre content affect consumption. Increased levels of dietary fibre increase consumption and high protein levels reduce consumption. Increased dietary fibre content also reduces the protein and volatile fatty acid content of caecotrophs (Carabaño *et al.* 1988).

[2]JP was employed on a Knowledge Transfer Partnership between the Royal (Dick) School of Veterinary Studies and Burgess Pet Care, Victory Mill, Priestmans Lane, Thornton-Le-Dale, Pickering, North Yorkshire, YO18 7RU

4 x 8 rabbits kept in pairs
(neutered, vaccinated)
17 months duration

		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study


PAPER

Impact of diet on incisor growth and attrition and the development of dental disease in pet rabbits

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Objectives: To assess the impact of four rabbit diets (hay only; extruded diet with hay; muesli with hay; muesli only) on length and curvature of cheek teeth and eruption and attrition rates of incisors.

Materials and Methods: Thirty-two Dutch rabbits, randomly divided into four diet groups, had length and saggital plane curvature of the first cheek teeth measured radiographically at 1, 9 and 17 months. Eruption/attrition of the left upper incisor was directly measured at weeks 30, 32 and 35.

Results: Eruption rates matched attrition rates in all groups, but were higher in the hay only group than in both groups fed muesli. By month 9, a greater degree of tooth curvature was present in rabbits fed muesli only than in those fed hay only and extruded diet with hay. After 17 months, rabbits fed muesli only and muesli with hay had longer lower first cheek teeth and larger interdental spaces between the first two molars than rabbits fed extruded diet and hay and hay only. Three rabbits fed muesli only developed evidence of dental disease.

Clinical Significance: Presence of increased tooth length, curvature and interdental spaces indicated early dental pathology in rabbits fed muesli. Muesli diets cannot be recommended for pet rabbits.

Journal of Small Animal Practice (2015) 56, 377–382
DOI: 10.1111/jsap.12346

Accepted: 2 February 2015; Published online: 19 March 2015

INTRODUCTION

Despite rabbits being the third most popular mammalian pet in the UK (PDSA 2011), their dietary requirements are not fully understood. Diet is frequently implicated in the development of acquired dental disease in pet rabbits (Harcourt-Brown 1996, Crossley 2003, Meredith 2007, Okuda et al. 2007); however, its exact role in the aetiology of dental disease remains unclear. The prevalence of dental disease in pet rabbits has been reported to be 29–38·1% (Mullan & Main 2006, Jekl et al. 2008), but these reports may underestimate the true prevalence as radiography was not performed and early cases may have been undetected (Jekl et al. 2008).

Rabbits have continuously growing elodont teeth (Shadle 1936). The upper incisors erupt at a rate of approximately 2 mm/week and the lower at 2·4 mm/week (Shadle 1936), and incisor eruption rate and length vary widely between individuals (Shadle 1936, Ness 1956). The growth rates of the cheek teeth (premolars and molars) have been reported to be approximately 3 mm a month (Crossley 2005, Meredith 2007, Lord 2012), but more recent studies have reported growth rates of 1·4–3·2 mm/week (Müller et al. 2014). Tooth length is maintained by the abrasive nature of the diet, tooth on tooth action during chewing and grinding of the teeth during periods of rest (Shadle 1936, Crossley 2005). The functional differences between incisors and cheek teeth indicate that different diets affect each type of tooth differently (Müller et al. 2014). Eruption rates change to match rates of attrition (Wolf et al. 1993); taking the incisors out of occlusion by shortening them increases eruption rates (up to 0·7 mm/day) until the tooth returns to occlusion (Ness 1956). Tooth length, wear and growth are also linked to dietary abrasiveness, which is caused by the dietary content of both internal (plant phytolith) and external abrasives such as sand (Müller et al. 2014). In addition to diet, age and pregnancy may also influence the rate of eruption of teeth (Shadle 1936, Ness 1956, Wolf et al. 1993).

4 x 8 rabbits kept in pairs (neutered, vaccinated)
17 months duration

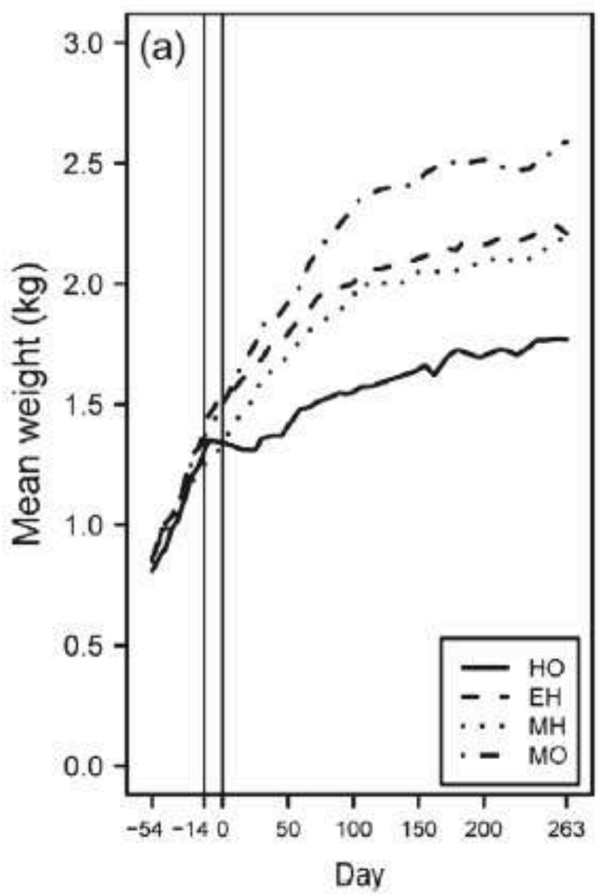
		Crude fibre (%DM)
Hay only *ad lib*	HO	29
Extruded (+hay)	EH	19
Muesli (+hay)	MH	
Muesli only *ad lib*	MO	14

Rabbit study - obesity

Bodyweight and body condition score in rabbits on four different feeding regimes

Journal of Small Animal Practice (2015) **56**, 207–212

J. L. Prebble, D. J. Shaw and A. L. Meredi



Rabbit study - obesity

Bodyweight and body condition score in rabbits on four different feeding regimes

Journal of Small Animal Practice (2015) **56**, 207–212

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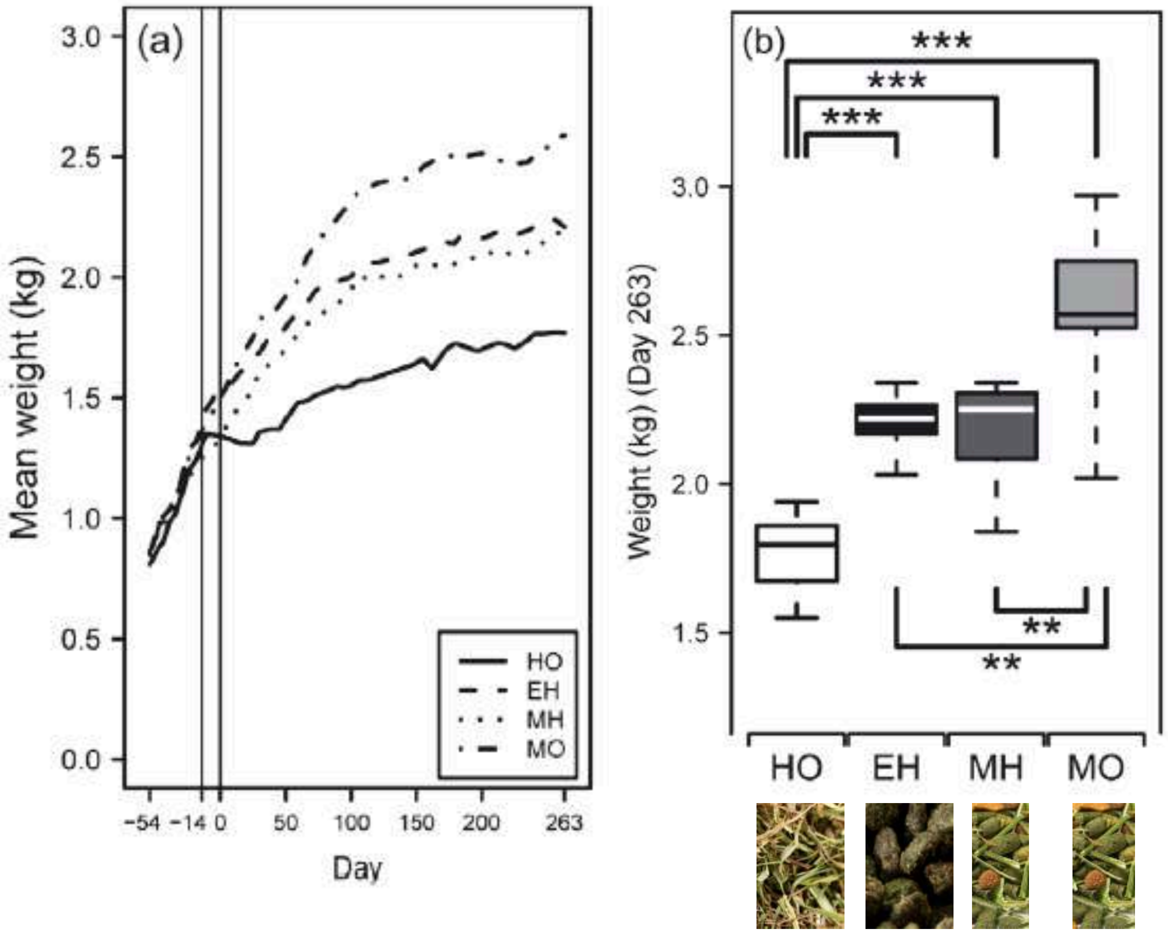

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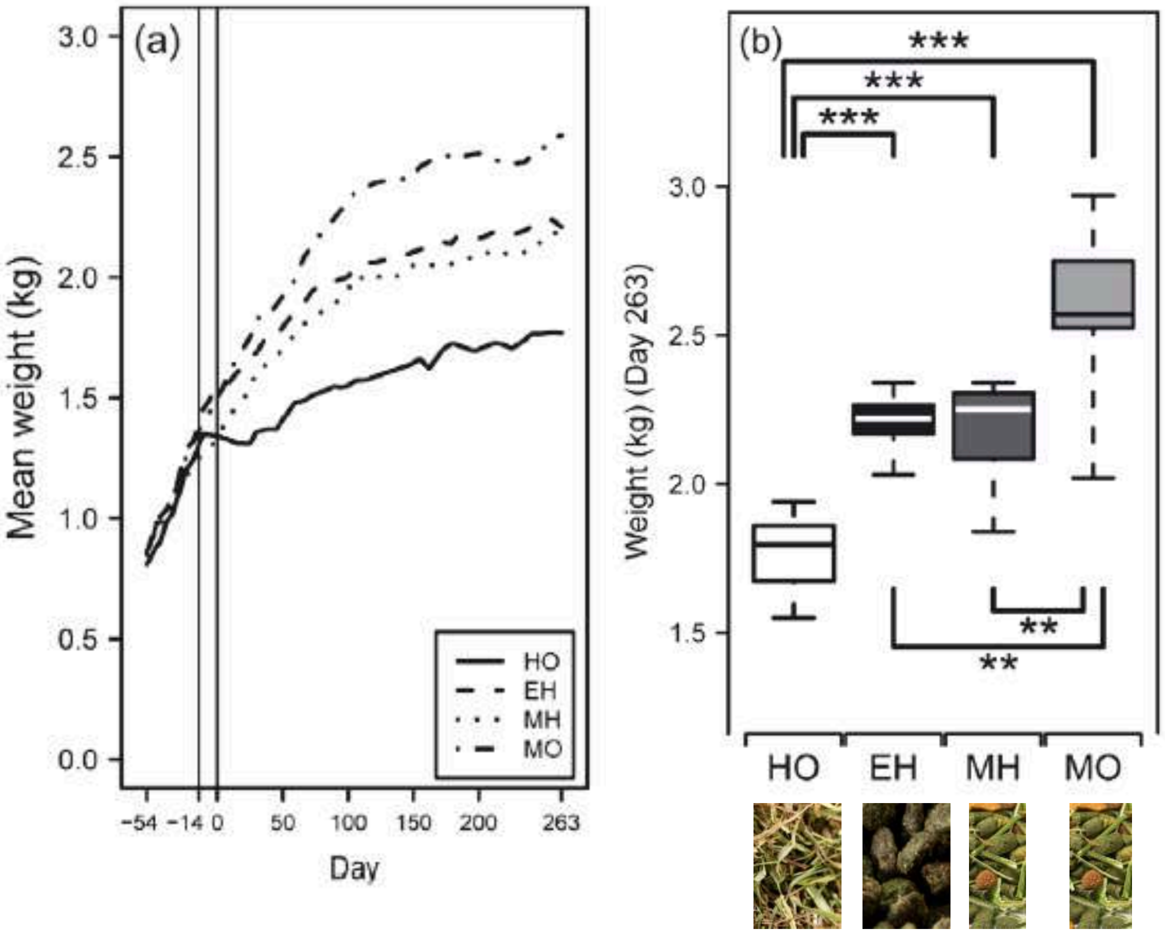

Rabbit study - behaviour

Applied Animal Behaviour Science 169 (2015) 86–92

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journal homepage: www.elsevier.com/locate/applanim

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ARTICLE INFO

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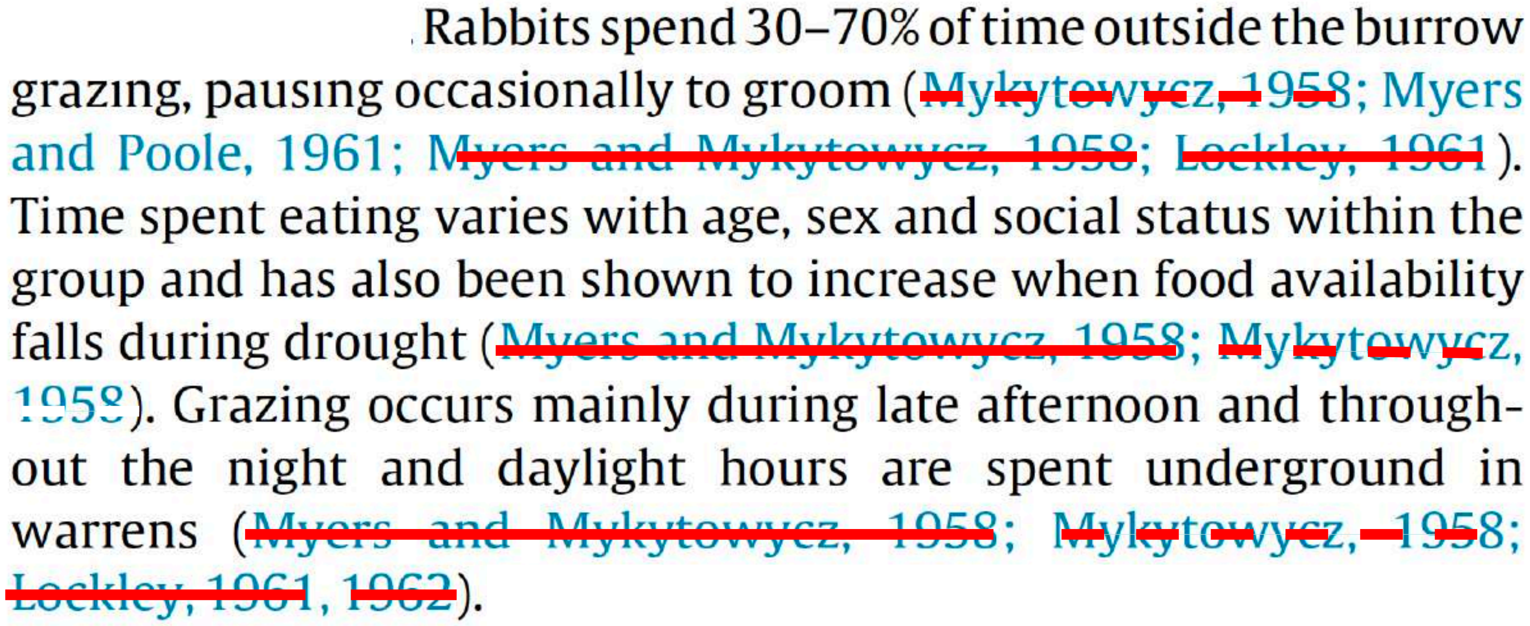

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Rabbit study - behaviour

CONTINUOUS OBSERVATIONS OF THE ACTIVITY OF THE WILD RABBIT, *ORYCTOLAGUS CUNICULUS* (L.), DURING 24-HOUR PERIODS

By R. Mykytowycz* and Ian Rowley*

[*Manuscript received March 11, 1958*]

Summary

Continuous observations during three separate 24-hour periods were carried out in late spring on a population of individually marked wild rabbits, *Oryctolagus cuniculus* (L.), established in an artificially illuminated enclosure. Rabbits were observed to feed throughout the night, with a peak at 2100 hr. Sexual behaviour during post-partum oestrus, and copulation between a buck and a virgin doe, are described. An account of the daily activities of individual rabbits is given; and the bearing of the observed pattern of activity on the reliability of sight counts for the estimation of rabbit populations is discussed.

I. Introduction

Although it is generally accepted that a knowledge of an animal's activity throughout the 24 hours is essential to the interpretation of its behaviour very few animals have been thus observed. There are some reports dealing with domestic species (Tribe 1949), but the problems involved in the study of wild ones are very much greater. This is especially so in the case of the rabbit, which is mainly nocturnal. During studies of a rabbit colony in an enclosure which could be artificially illuminated at night (Mykytowycz 1958), a unique opportunity arose for continuous observation, and some of the results are reported in this paper.

These observations cover only a limited period and relate to specific conditions of both population density and breeding cycle; and some of them might not apply under different circumstances and at a different season. Thus Rowley (1957) has recorded seasonal changes in emergence time; and shortly after the termination of the observations recorded in this paper, a deterioration in the quantity and quality of the pasture led to changes in grazing behaviour.

II. Methods

The specially built enclosure which was used and the facilities available for watching the rabbits are described elsewhere (Mykytowycz 1958). Not counting nestlings, at the time of observations reported here the enclosure was occupied by 53 animals all of which, except for 10 very young kittens, were conspicuously fur-dyed with individual patterns and carried "Scotchlite" ear tags. This assured an easy recording of surface activity both by day and night. Some of these rabbits were warren-dwellers whilst others remained permanently above ground. When the latter occupied their habitual resting "squats" (which were, in effect, equivalent to warrens) they were not considered as being "active on the surface".

*Wildlife Survey Section, C.S.I.R.O., Canberra.

TIME SPENT BY REPRESENTATIVE INDIVIDUAL RABBITS IN VARIOUS ACTIVITIES OVER A 24-HOUR PERIOD

Status of Rabbit	Percentage of Total Time						Total Time Visible (hr)
	Grazing	Resting	Running	Washing	Aggression	Copulation	
Dominant buck	37	19	14	7	16	7	13¾
Dominant doe (pregnant)	64	20	2	7	7	0	11
Subordinate doe (pregnant)	53	36	2	7	2	0	11¼
Juvenile buck	53	15	4	19	9*	0	11¼
Virgin doe	29	17	5	3	10*	36	13¼

Rabbit study - behaviour

CONTINUOUS OBSERVATIONS OF THE ACTIVITY OF THE WILD RABBIT, *ORYCTOLAGUS CUNICULUS* (L.), DURING 24-HOUR PERIODS

By R. MYKYTOWYCZ* and IAN ROWLEY*

[*Manuscript received March* 11, 1958]

Summary

Continuous observations during three separate 24-hour periods were carried out in late spring on a population of individually marked wild rabbits, *Oryctolagus cuniculus* (L.), established in an artificially illuminated enclosure. Rabbits were observed to feed throughout the night, with a peak at 2100 hr. Sexual behaviour during post-partum oestrus, and copulation between a buck and a virgin doe, are described. An account of the daily activities of individual rabbits is given; and the bearing of the observed pattern of activity on the reliability of sight counts for the estimation of rabbit populations is discussed.

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4-7 h feeding

Rabbit study - behaviour

SHORT COMMUNICATION: ASSESSMENT OF ACTIVITY PATTERNS OF GROWING RABBITS IN A FLUX-CONTROLLED CHAMBER

OLIVAS I.[*], RODRÍGUEZ-LATORRE A.[†], ESTELLÉS F.[†], CALVET S.[†], VILLAGRÁ A.[*]

World Rabbit Sci. 2013, 21: 107-110

	Average percentage of time (%)		
	Day	Night	Total
Lying	22.56±8.45	20.57±10.82	21.67±8.42
Sleeping	46.95^{a}±8.39	33.46^{b}±9.98	40.87±8.13
Sitting	5.74±1.57	5.23±1.68	5.55±1.54
Eating	6.60^{a}±2.98	13.27^{b}±4.93	9.56±3.45

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2 h feeding

Rabbit study - behaviour

Applied Animal Behaviour Science 169 (2015) 86–92

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

The effect of four different feeding regimes on rabbit behaviour

Jennifer L. Prebble[a,1,2], Fritha M. Langford[b], Darren J. Shaw[a], Anna L. Meredith[a,*]

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ARTICLE INFO

Article history:
Received 10 June 2014
Received in revised form 4 May 2015
Accepted 10 May 2015
Available online 22 May 2015

Keywords:
Rabbit
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Behaviour
Abnormal behaviour
Hay

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http://dx.doi.org/10.1016/j.applanim.2015.05.003

hay only | extrud. & hay | muesli & hay | muesli only

Rabbit study - behaviour

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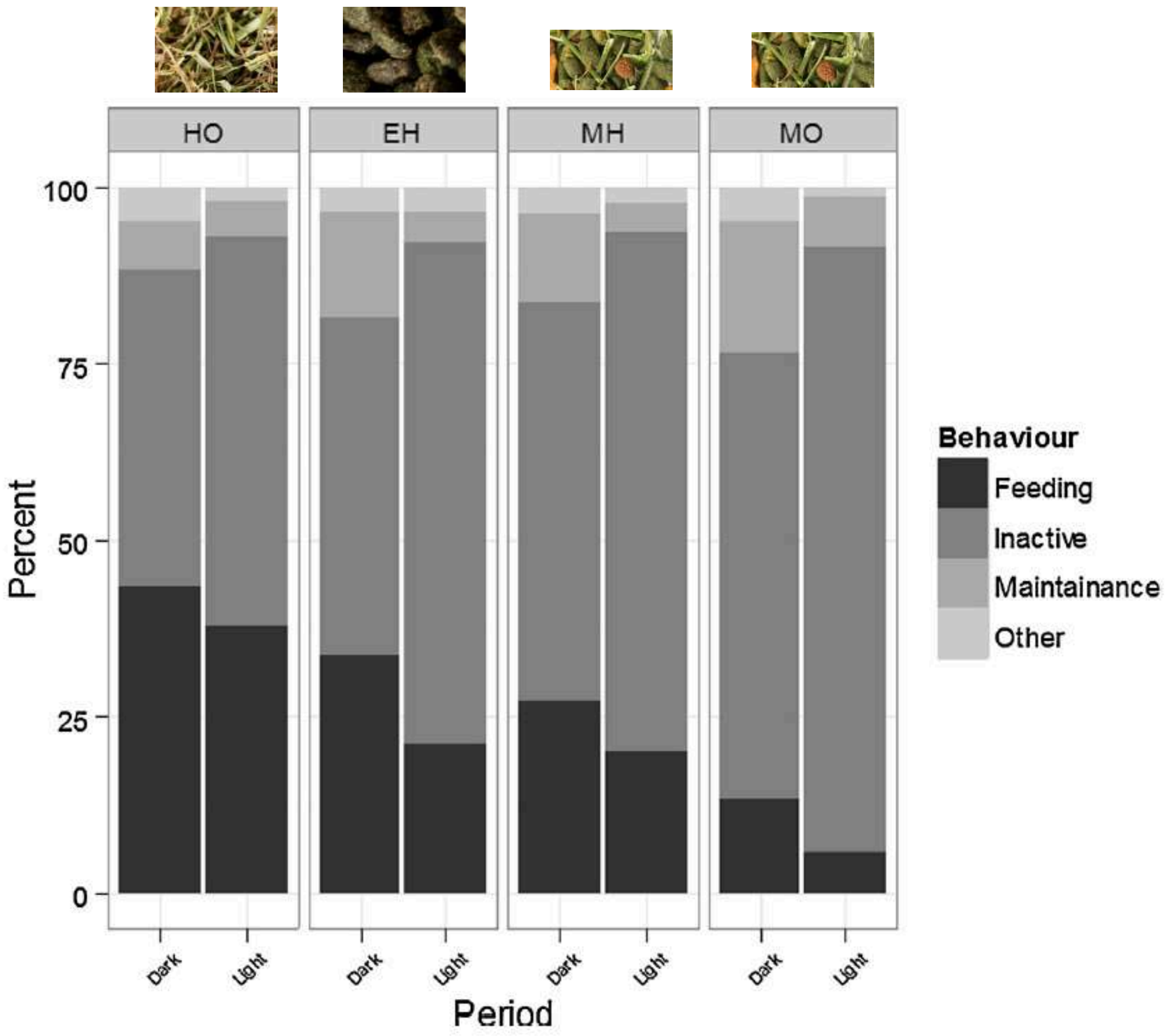

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http://dx.doi.org/10.1016/j.applanim.2015.05.003
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8-10 h eating
10 h 'inactive'

2 h eating
15-18 h 'inactive'

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Contents lists available at ScienceDirect

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http://dx.doi.org/10.1016/j.applanim.2015.05.003
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8-10 h eating
10 h 'inactive'

as described for wild rabbits

2 h eating
15-18 h 'inactive'

as described for lab rabbits

Rabbit example

Rabbit example

The choice of the diet impacts the daily behaviour !

Rabbit example

The choice of the diet impacts the daily behaviour !

How long do your rabbits feed per day ?

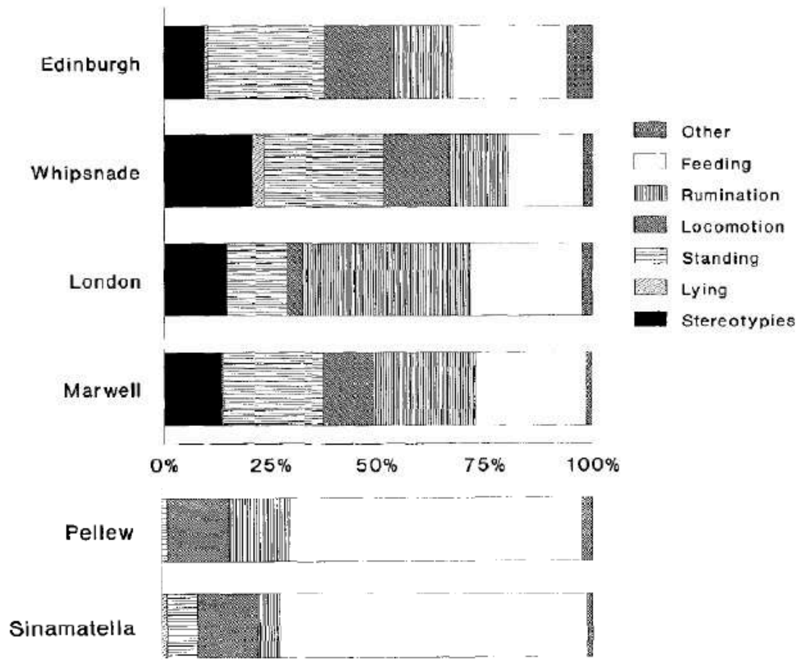
Giraffe example

Giraffe activity budgets

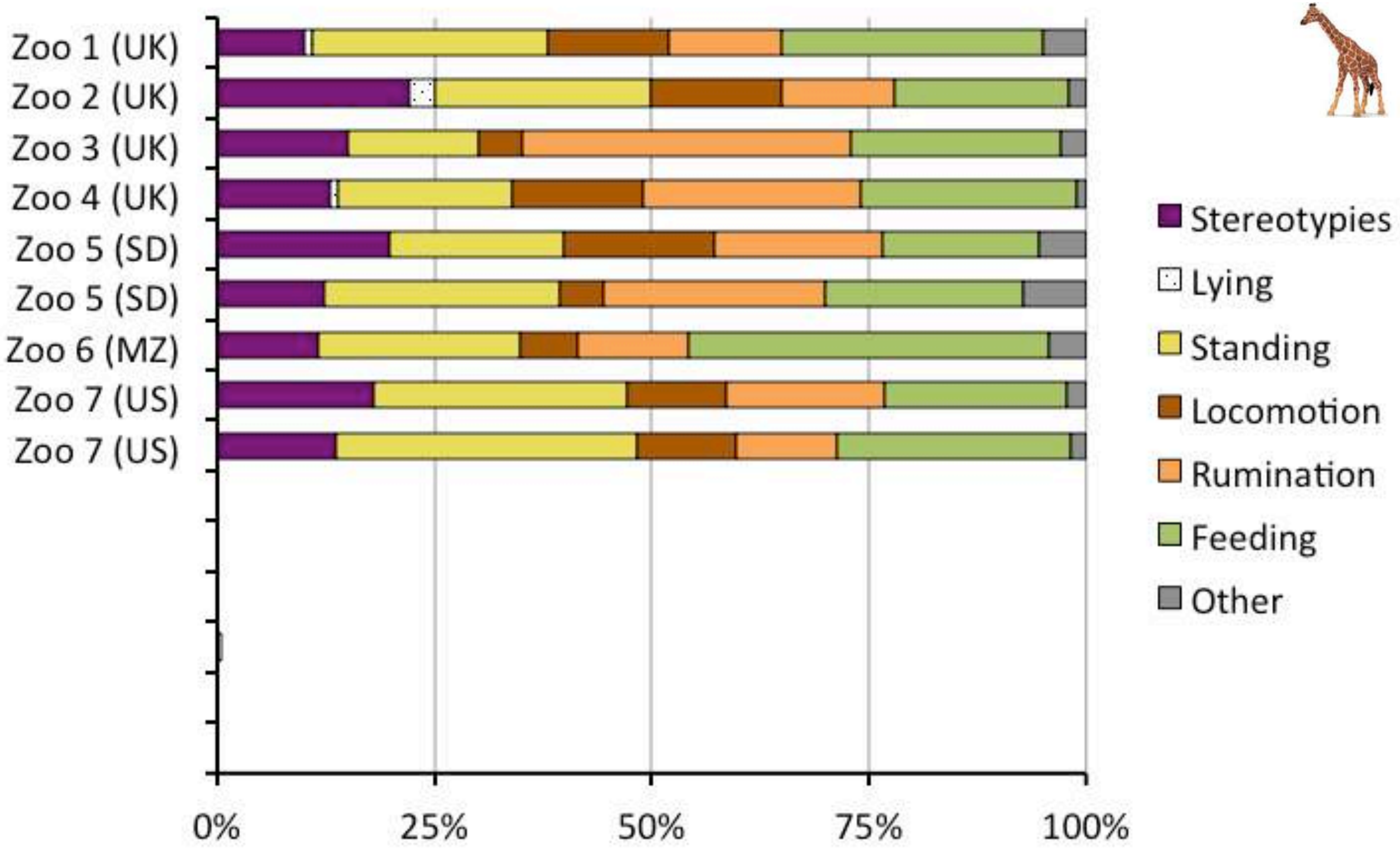
ON COMPARING THE BEHAVIOUR OF ZOO HOUSED ANIMALS WITH WILD CONSPECIFICS AS A WELFARE INDICATOR, USING THE GIRAFFE (*GIRAFFA CAMELOPARDALIS*) AS A MODEL

J S Veasey[1], N K Waran[1] and R J Young[2†]

Animal Welfare 1996, 5: 139-153

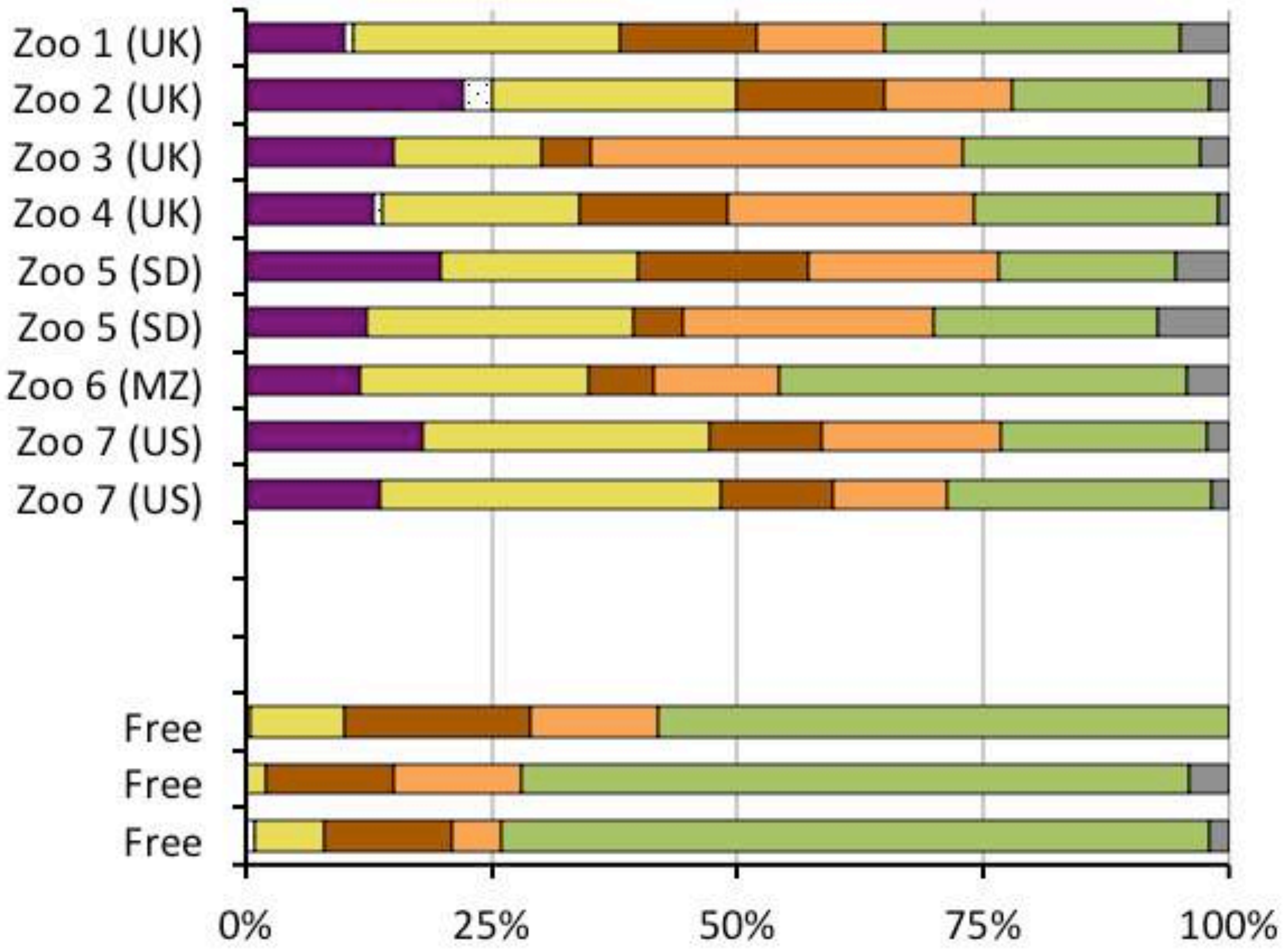


Giraffe activity budgets



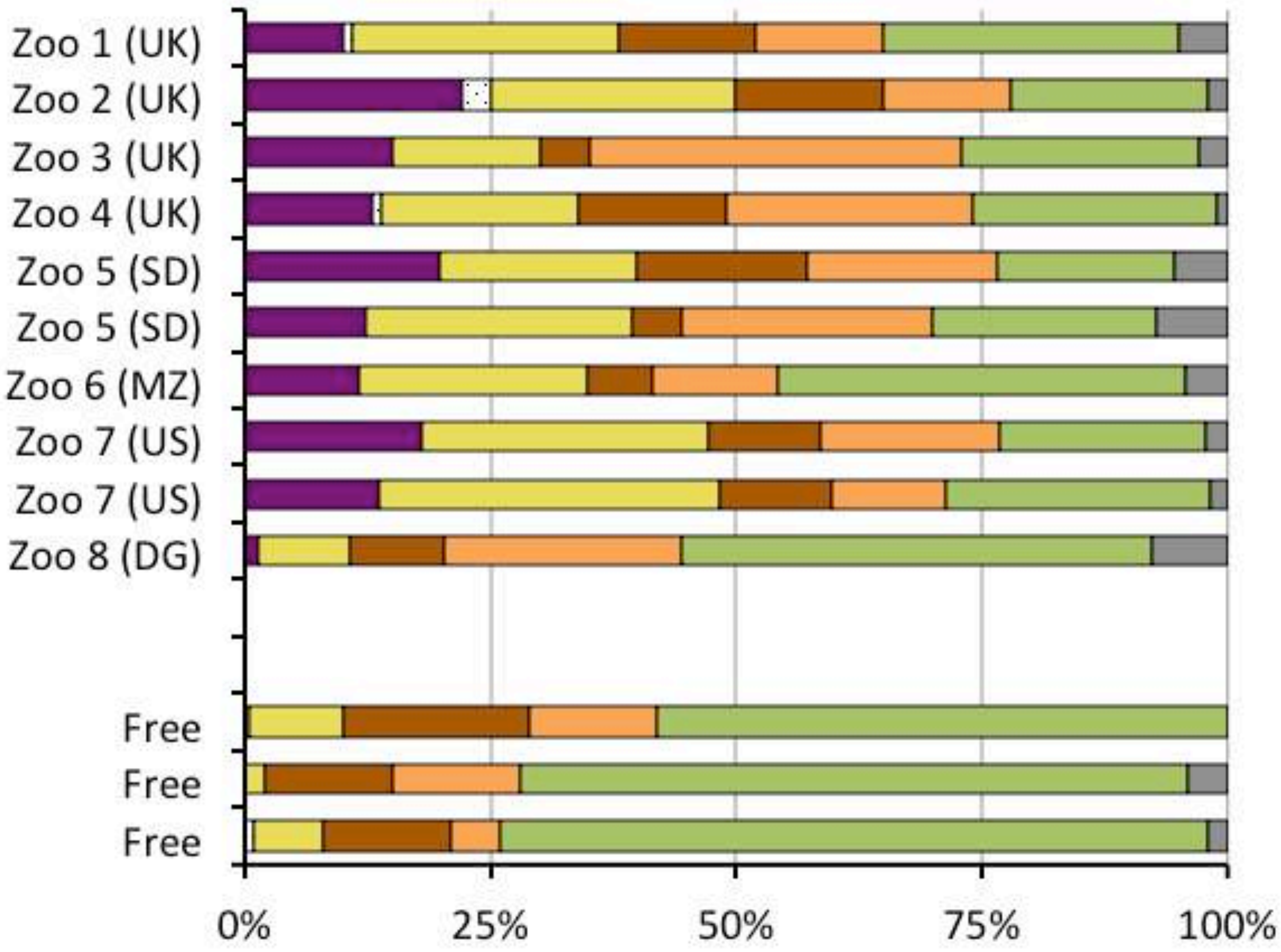
Veasey et al. (1996), del Castillo et al. (2005), Bashaw (2011), Orban et al. (2016)

Giraffe activity budgets



Veasey et al. (1996), del Castillo et al. (2005), Bashaw (2011), Orban et al. (2016); du Toit & Yetman (2005), Pellew (1984)

Giraffe activity budgets



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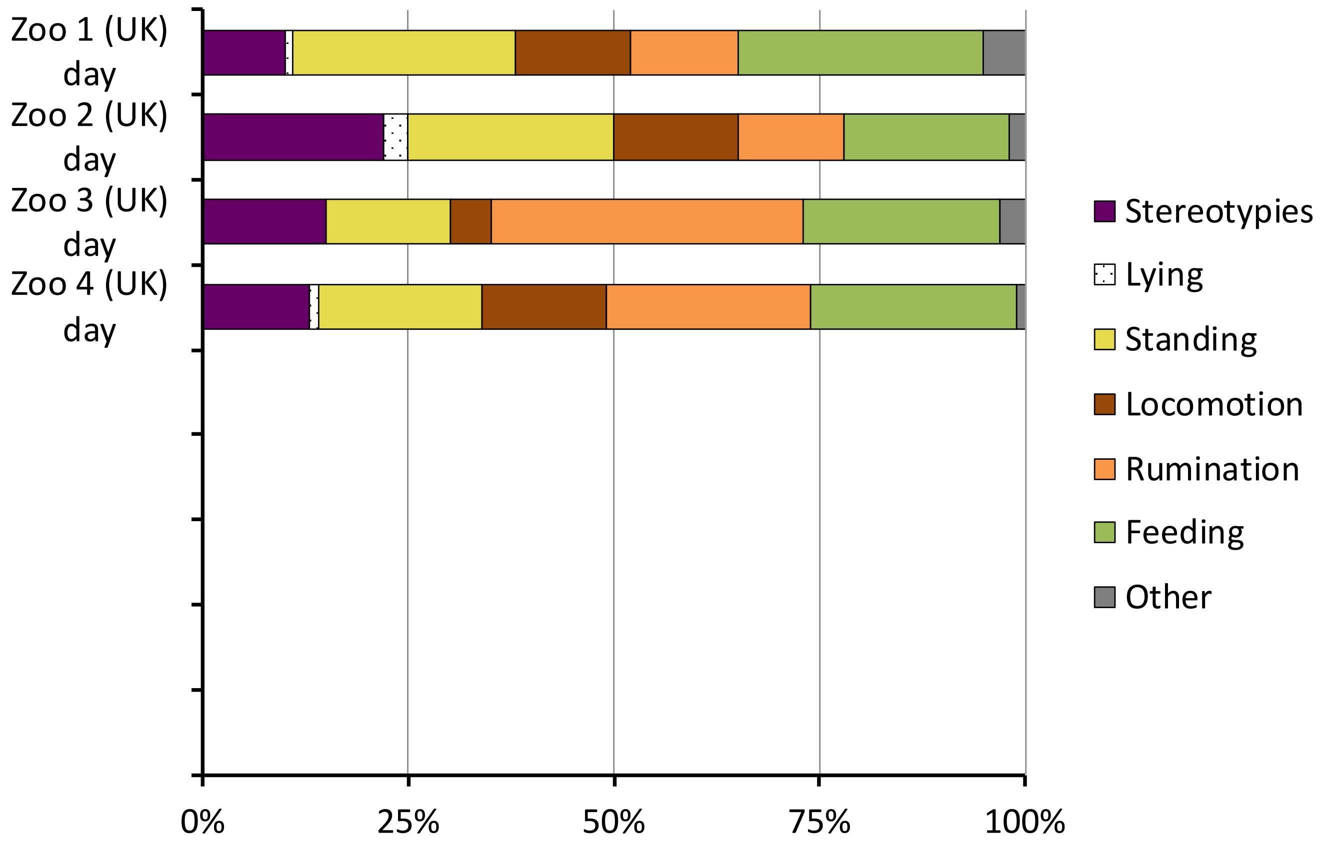
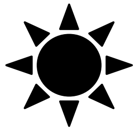
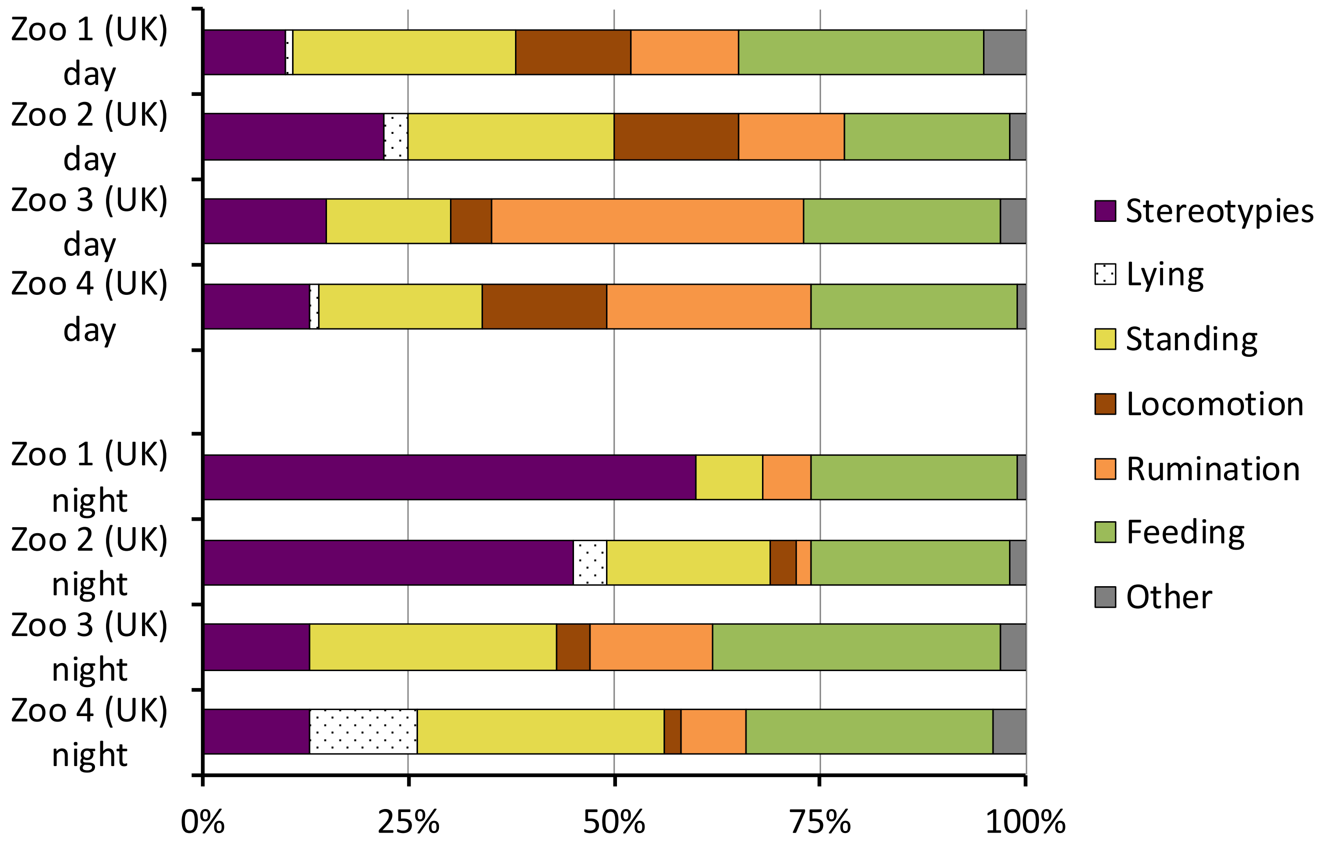
Giraffe activity budgets

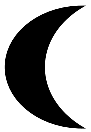


Veasey et al. (1996)

Giraffe activity budgets







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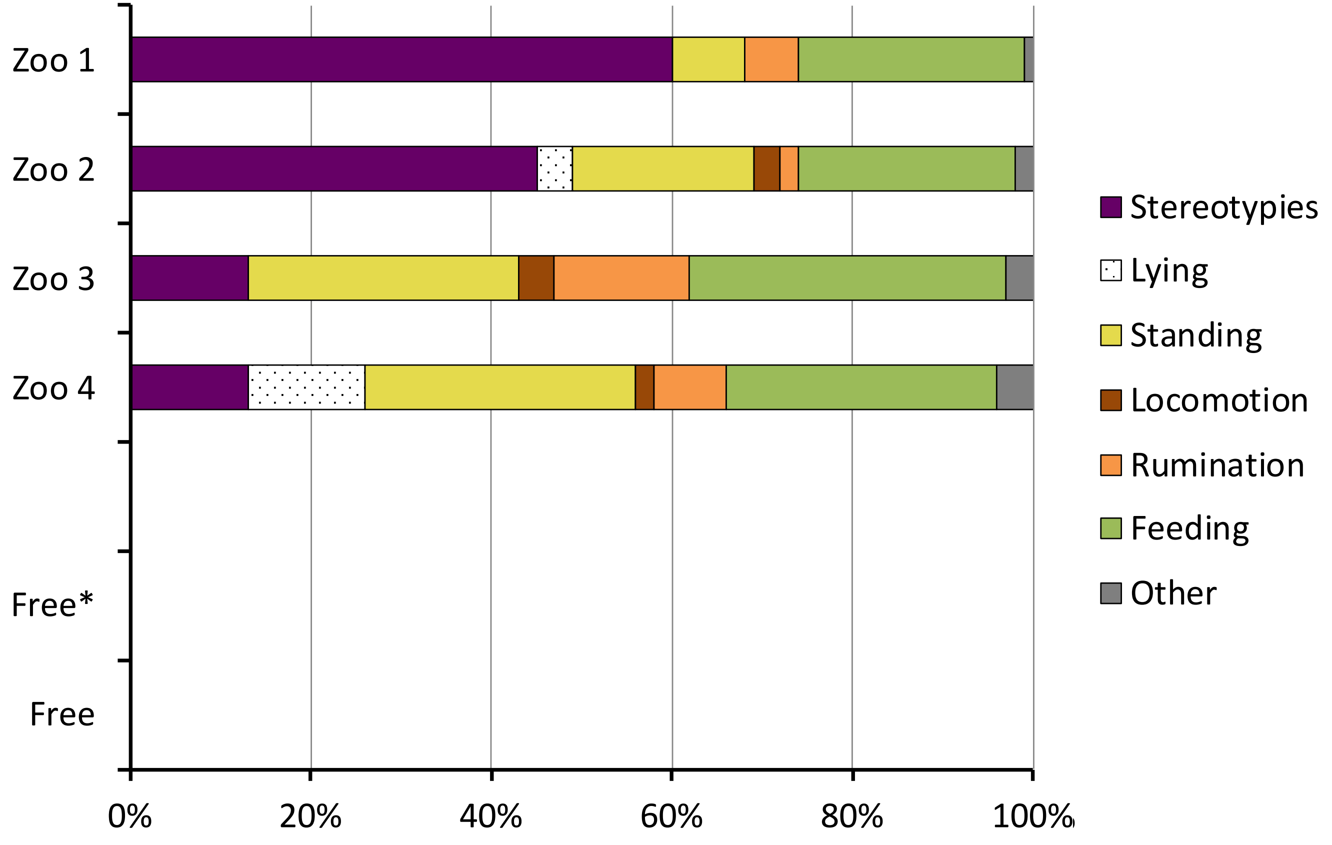

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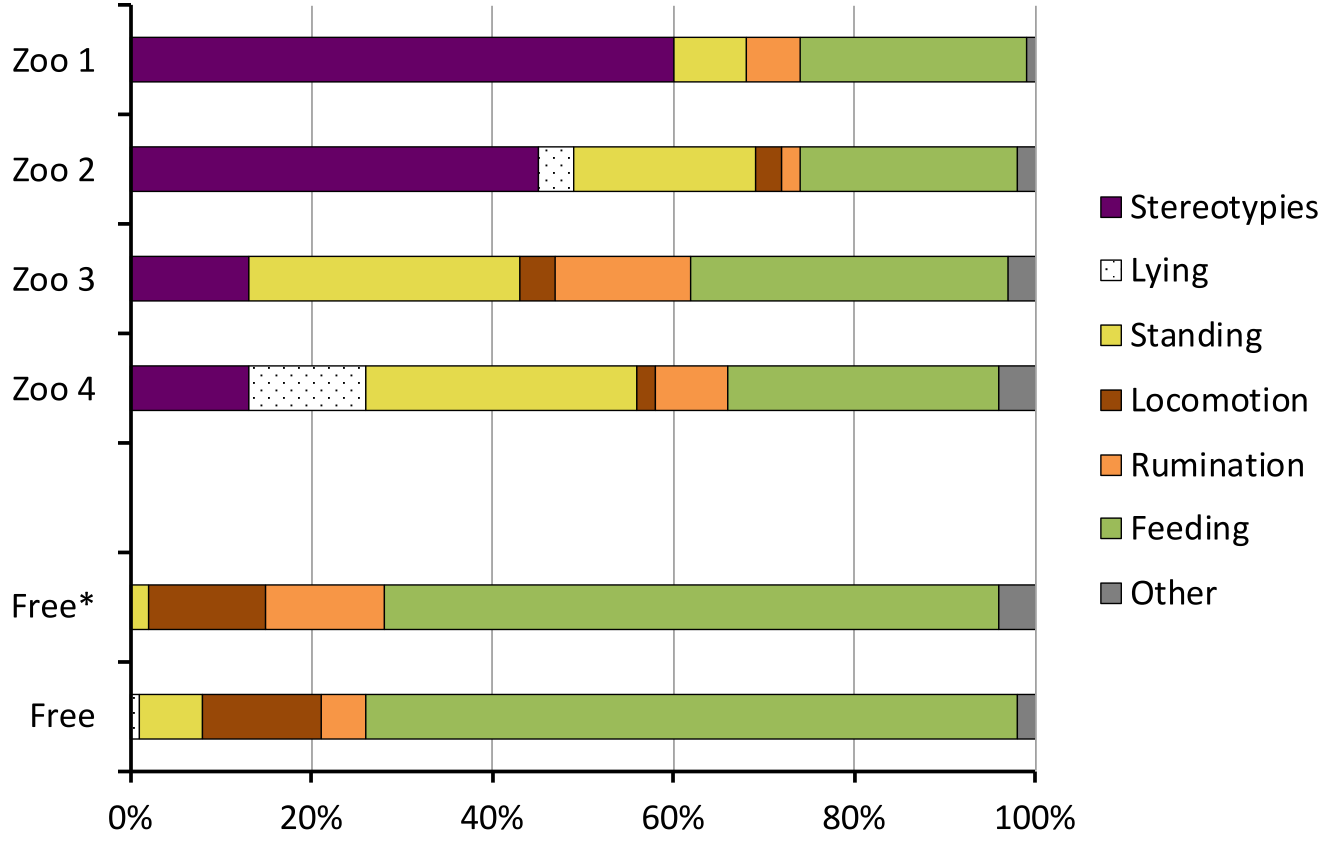
Giraffe activity budgets



Veasey et al. (1996), Pellew (1984)

Giraffe example

Giraffe example

The choice of the diet impacts the daily behaviour !

Giraffe example

The choice of the diet impacts the daily behaviour !

How long do your giraffes feed per day (and night) ?

Equid example

Zebra activity budgets

The link between sexual dimorphism, activity budgets, and group cohesion: the case of the plains zebra (*Equus burchelli*)

Can. J. Zool. **80**: 1437–1441 (2002)

P. Neuhaus and K.E. Ruckstuhl

Table 1. Percentages of time spent in different activities by plains zebras (*Equus burchelli*) that differed in sex and reproductive status.

	Females					
	Lactating (N = 14)	Highly pregnant (N = 8)	Nonlactating[a] (N = 10)	Males (N = 12)	p (GLM)	Bachelor group[b] (N = 7)
Lying	0.8 (0.59)	3.0 (1.06)	6.3 (2.04)	0.3 (0.19)	0.001	10.6
Grazing	63.3 (4.91)	60.2 (8.62)	54.3 (6.86)	63.5 (4.40)	ns	46.8
Standing	26.1 (5.73)	19.6 (3.12)	26.6 (3.78)	25.3 (2.97)	ns	31.9
Walking	9.9 (1.31)	17.2 (6.18)	12.7 (1.97)	11.0 (1.69)	ns	10.6

Przewalski horse food effect

Time Budgets of Adult Przewalski Horses: Effects of Sex, Reproductive Status and Enclosure

LEE E. BOYD

Applied Animal Behaviour Science, 21 (1988) 19–39

Effects of enclosure on male time budgets

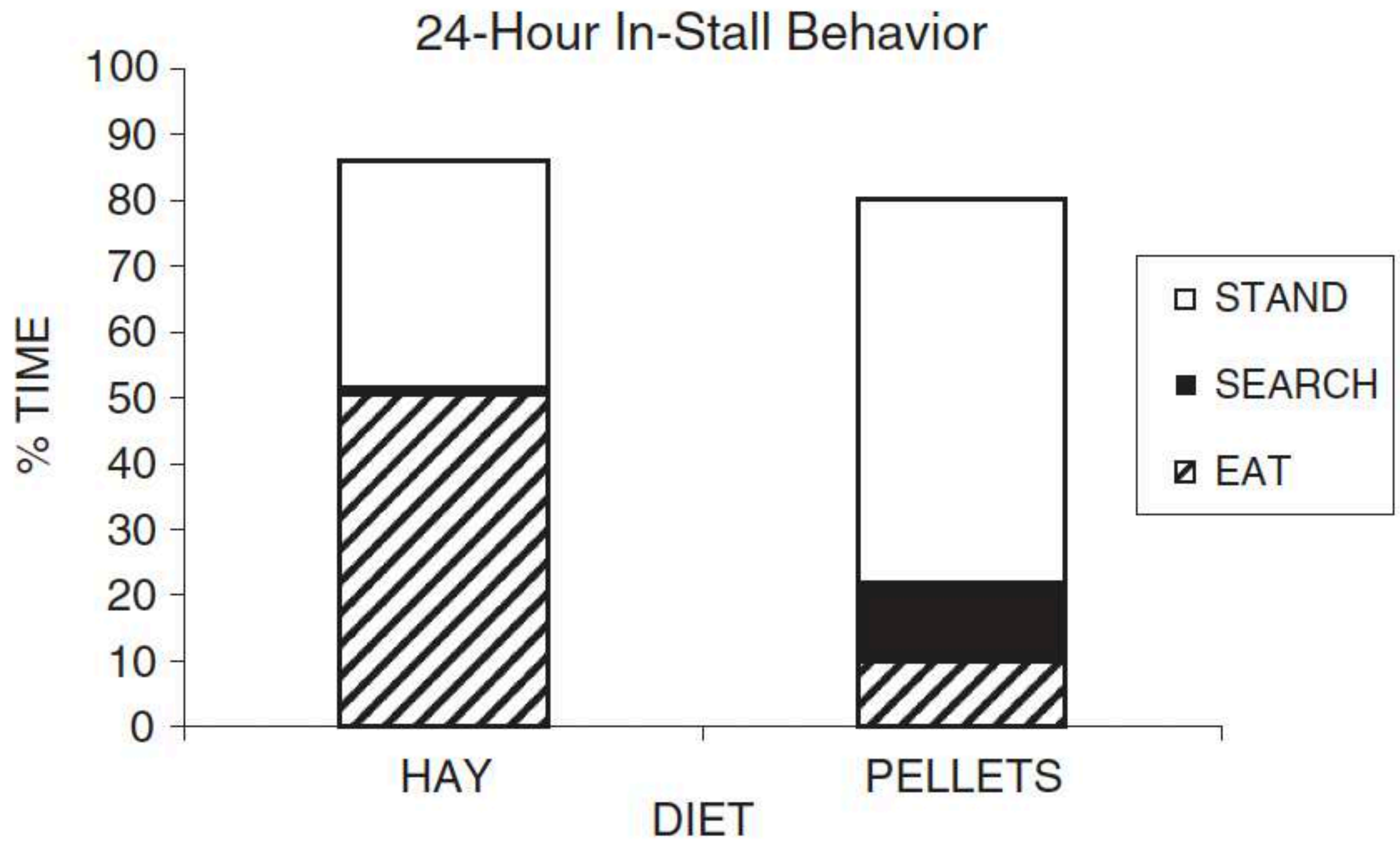
	All observations			Forage present		
	Sm. yard ($n=9$)	Lg. yard ($n=6$)	Pasture ($n=3$)	Sm. yard ($n=9$)	Lg. yard ($n=6$)	Pasture ($n=3$)
States (% time)						
Feed	54.5 ± 4.5	39.0 ± 4.9	46.1 ± 8.9	68.6 ± 6.2	55.6 ± 3.9	46.1 ± 8.9

Domestic horse food effect

Motivation for hay: Effects of a pelleted diet on behavior and physiology of horses

Jamie B. Elia [a], Hollis N. Erb [b], Katherine Albro Houpt [b,*]

Physiology & Behavior 101 (2010) 623–627



Domestic horse presentation effect

The effect of presenting forage in multi-layered haynets and at multiple sites on night time budgets of stabled horses

Andrea Dorothea Ellis[a,*], Sarah Redgate[b], Svitlana Zinchenko[b], Heather Owen[b], Clare Barfoot[c], Patricia Harris[d]

Applied Animal Behaviour Science 171 (2015) 108–116

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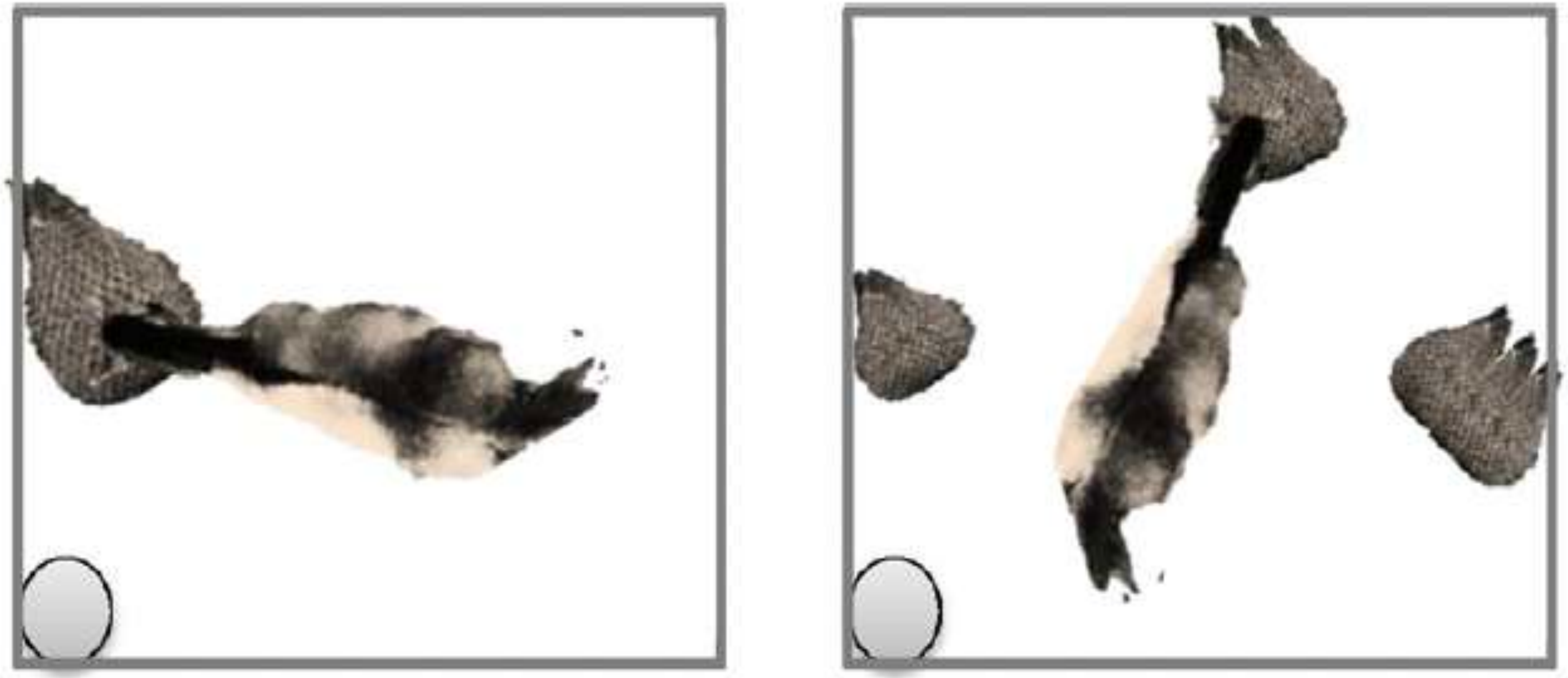

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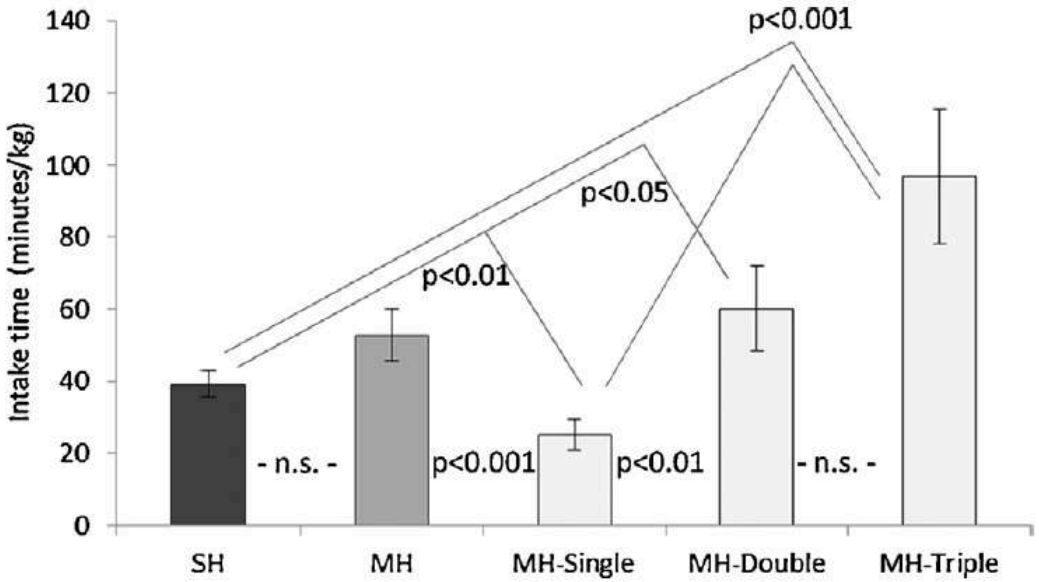

Fig. 1. Intake times (h/kg) from haynets for 6 horses fed either on SH (single haynet) or MH (multiple haynets: one haynet, double layered haynet and triple haynet presented simultanously) (ANOVA).

Domestic horse presentation effect

The effect of presenting forage in multi-layered haynets and at multiple sites on night time budgets of stabled horses

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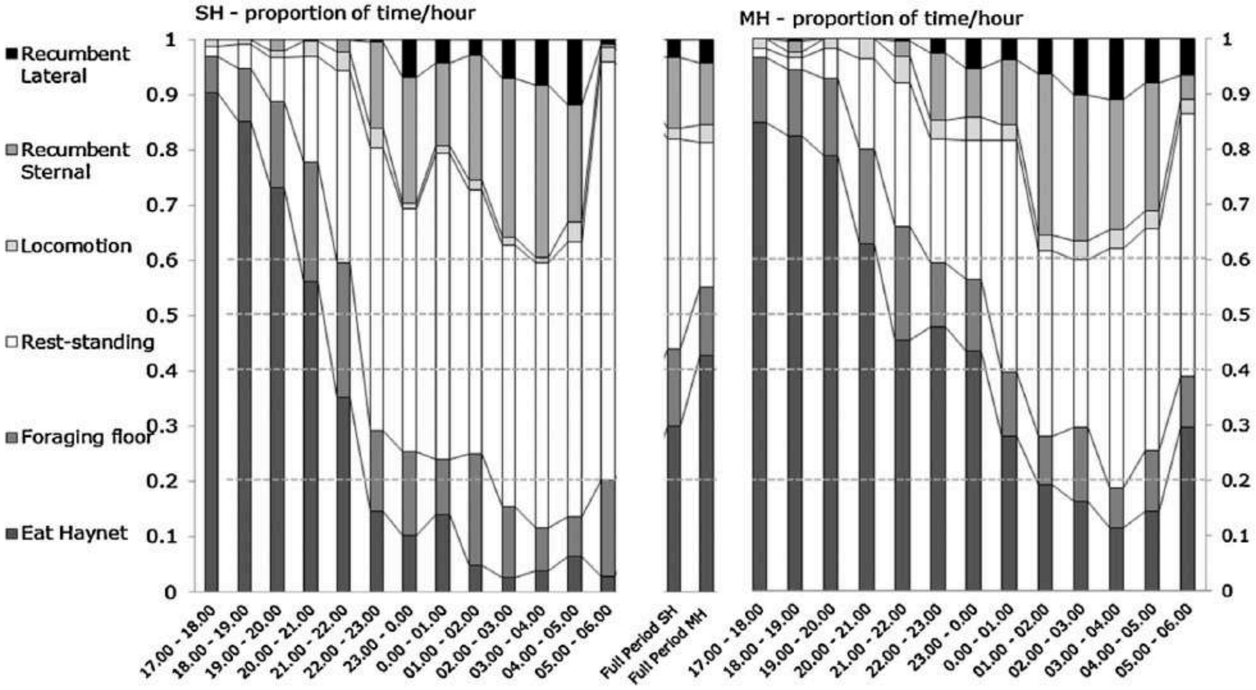

Fig. 2. Night time budget of 6 horses showing mean proportion of time spent on each behaviour per hour when either on SH (single haynet) or MH (multiple haynets: one haynet, double haynet and triple haynet presented simultaneously at three points; Foraging floor includes eating complimentary feed between 17.00 and 18.00 as feed was presented on floor level).

Equid example

Equid example

The choice of the diet and the diet presentation impacts the daily behaviour !

Equid example

The choice of the diet and the diet presentation impacts the daily behaviour !

How long do your equids feed per day (and night) ?

Sloth example

Sloth (in)activity

MAMMALIAN SPECIES 43(873):37–55

Choloepus hoffmanni (Pilosa: Megalonychidae)

VIRGINIA HAYSSEN

Sloth (in)activity

MAMMALIAN SPECIES 43(873):37–55

Choloepus hoffmanni (Pilosa: Megalonychidae)

VIRGINIA HAYSSEN

Captive animals rest or sleep about 20 h/day (Goffart 1968), but in the wild are active about 11 h/day through most of the night (Sunquist and Montgomery 1973).

Sloth (in)activity

MAMMALIAN SPECIES 43(873):37–55

Choloepus hoffmanni (Pilosa: Megalonychidae)

VIRGINIA HAYSSEN

Diet.—*Choloepus hoffmanni* is primarily an arboreal herbivore and eats buds, leaves, flowers, fruit, twig tips, and young stems (Meritt 1985). In Costa Rica, *C. hoffmanni* visited 101 tree species and used 34 species as food (Vaughan et al. 2007). Tree species used as food were fresh leaves and inflorescences of *Cecropia obtusifolia*, *Cestrum racemosa*, *Cordia alliodora*, *Coussapoa villosa*, *Erythrina poeppigiana*, *Eucalyptus globulus*, *Ficus werckleana*, *Hieronyma alchorneoides*, *Hura crepitans*, *Inga oerstediana*, *Leucaena leucocephala*, *Luehea seemannii*, *Ocotea sinuate*, *Piper auratum*, *Spondias mombin*, *Theobroma cacao*, and *Trophis racemosa* (Vaughan et al. 2007).

Sloth (in)activity

MAMMALIAN SPECIES 43(873):37–55

Choloepus hoffmanni (Pilosa: Megalonychidae)

VIRGINIA HAYSSEN

Captive *Choloepus hoffmanni* eat diverse fruits and vegetables and will also eat meat products (Enders 1935; Meritt 1970, 1973, 1985). *C. hoffmanni* will feed on apples (diced), bananas, bread, carrots, cecropia leaves, citrus, grapes, green beans, ground meat, ground smelt, lettuce, mango, oranges, peas, salmon (canned), spinach, sweet potatoes, and yucca (Enders 1935; Esplin and Woodbury 1961; Gilmore et al. 2001; Herrer and Christensen 1980; Hill and Tenney 1974; Seymour et al. 1983a).

Sloth example

Sloth example

The choice of the diet impacts the daily behaviour !

Sloth example

The choice of the diet impacts the daily behaviour !

How long do your sloths sleep per 24 hours ?

Hedgehog example

Hedgehog feeding activity

ACTA THERIOLOGICA
Vol. 21, 30: 401—424, 1976

The Food of the Hedgehog in England

D. W. YALDEN

Yalden D. W., 1976: The food of the hedgehog in England. Acta theriol., 21, 30: 401—424 [With 4 Tables & 1 Gig.].

The contents of 177 hedgehog (*Erinaceus europaeus* Linnaeus, 1758) stomachs were analysed to ascertain the diet. The results are expressed in terms of percentage occurrence, percentage prey animals eaten, and percentage weight of prey eaten. On the weight basis, caterpillars, scarabeoid beetles and earthworms are the most important prey providing 55% of the food. Vertebrate prey is relatively unimportant, contributing perhaps 15% of the diet. So far as possible, the prey animals are identified to generic or specific level.

[Dept. Zool., Manchester Univ., Manchester, England]

1. INTRODUCTION

Although there is a considerable amount of general information available on the food of the hedgehog, *Erinaceus europaeus*, there has been very little systematic work. Kalabukhov (1928) analysed the droppings or stomachs of 24 *Erinaceus roumanicus* (= *E. europaeus roumanicus* Barret-Hamilton, 1900) and 11 *Hemiechinus auritus* (Gmelin, 1770) from the Ukraine and North Caucasus, collected throughout the summer. Shilova-Krassova (1952) analysed 262 droppings of *E. europaeus* from oak and pine forests in the Ukraine and southern Russia, nearly all collected in spring. In China, Liu (1937) analysed the stomach contents of 47 *E. europaeus dealbatus* (Swinhoe, 1870) from suburban areas, all collected in August. The fullest analyses, in terms of numbers and time-spread are those by Brockie (1959) and Campbell (1973 a, b) on the introduced *E. europaeus* in New Zealand; they examined material collected in a number of localities and at all times of the year. Brockie examined 10 stomachs and 90 droppings, while Campbell examined 60 stomachs and 230 droppings. Apparently the only systematic analysis of the food of hedgehogs in Western Europe is the limited study by Kruuk (1964) of 33 droppings collected between March and June in the vicinity of the black headed-gull *(Larus ridibundus)* colony at Ravenglass, Cumberland. Dimelow (1963) used captive hedgehogs in feeding trials with a wide range of invertebrates. Hedgehogs have also been used, in experimental situations less directly

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An interesting sidelight from this is that only 18 of the stomachs examined contained over 10 g of food, and most contained less than 5 g. Shilova-Krassova (1952) found the food consumption of some experimental hedgehogs to be about 100 *Melolontha hippocastani* per day; that would be about 100 g per day. Kruuk (1964) carried out similar tests using chicks of *Larus ridibundus*, and suggested an average food consumption of 71 g per day, while Morris (1967) recommends a figure of 57 g por day for laboratory stock. The maximum amount found in any stomach was 32 g and that stomach was tightly filled. It would seem from this that the hedgehog must effectively fill its stomach twice each night, and that it must have a rather high rate of digestion.

Hedgehog feeding activity

Acta Theriologica 51 (4): 363–371, 2006.
PL ISSN 0001–7051

Habitat use and behaviour of European hedgehog *Erinaceus europaeus* in a Danish rural area

Anja B. RIBER

Riber A. B. 2006. Habitat use and behaviour of European hedgehog *Erinaceus europaeus* in a Danish rural area. Acta Theriologica 51: 363–371.

Hedgehogs *Erinaceus europaeus* Linnaeus, 1758 were radio-tagged and monitored during the summer of 2001 in a Danish rural area with the objective of quantifying home ranges, nightly distances travelled, habitat use, activity patterns, day-nesting habits, and body-weight changes of the five males and five females being recorded. Males had larger home-range sizes and travelled longer nightly distances than females. The two most common habitat types within the home ranges of the hedgehogs were deciduous forest and arable land, whereas the two most frequently used habitat types were deciduous forest and grassland. No differences between the sexes were found in the proportions of different habitat types within the home ranges or in habitat use. Non-random habitat use was found; forested areas and edge habitats seemed preferred to open areas. The most frequently used day-nesting habitat was deciduous forest. Foraging was by far the most time-consuming nightly activity for both sexes. Males lost weight during the study period (May–July), whereas females gained weight. A peak in the frequency of sexual behaviour was found from late-June to mid-July. The high level of male ranging activity and the weight loss of males are interpreted as a consequence of the promiscuous mating system of hedgehogs.

Section of Ethology, Department of Large Animal Sciences, The Royal Veterinary and Agricultural University, DK-1870, Frederiksberg C, Denmark, e-mail: abrj@kvl.dk

Key words: body weight, day-nesting habits, home range, movements, sexual behaviour

Introduction

European hedgehogs *Europaeus erinaceus* Linnaeus, 1758 are small secretive nocturnal animals that spend the day in well hidden day-nests. Such characteristics complicate monitoring of the behaviour of free-ranging individuals, contributing to poor understanding of certain aspects of their behavioural ecology. For instance, knowledge of the activity patterns of hedgehog is still limited in spite of the wide distribution of hedgehog in Western Europe and New Zealand. The continuously improving radio-telemetry technology has, however, made comprehensive studies of such animals possible, although the cost of the equipment and the time-consuming form of the method usually still limit the number of study animals involved (eg Morris 1988, Huijser 2000).

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moving 1-2 km per night

spending app. 4 h feeding (foraging)

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FEEDING RHYTHMS OF CAGED HEDGEHOGS (*ERINACEUS EUROPAEUS* L.)

P. A. CAMPBELL

Lincoln College, Canterbury

SUMMARY: The feeding behaviour of four adult caged hedgehogs was studied for a period of 22 weeks. The maximum feeding activity of all four animals occurred between 1900 and 2200 hours, and two of them showed a second, but minor, peak of activity about 0300 hours. Individual feeds were of short duration with the first feed each evening tending to exceed the mean. Variations in behaviour between individuals were considered to be a function of their differing body weights, or to be related to the size of the sample. The feeding behaviour of the caged animals was similar to that reported from comparable field studies.

INTRODUCTION

Herter (1938), Burton (1969) and Campbell (1973) have shown that hedgehogs in their natural habitats have a definable feeding rhythm. Observations of caged hedgehogs (Kristoffersson 1964 and Otway 1965) have shown comparable feeding rhythms, but these studies were of only 6 and 14 days duration respectively. The present study was an attempt to determine if hedgehogs retained their natural feeding rhythm when fed under laboratory conditions for an extended period.

METHODS

Four adult hedgehogs taken from pasturelands near Lincoln were fed under laboratory conditions for 22 weeks. The animals were housed in a temperature controlled room (18 ± 2°C) to prevent hibernation and lessen the risk of pneumonia, a major mortality factor of caged hedgehogs (Campbell 1973). To avoid possible effects from the abrupt change in habitat the first 9 weeks were used to condition the animals to captivity, and the remainder for a feeding trial. Each animal was housed in a separate 120 x 30 x 30 cm cage that had a nest box partly filled with shredded paper at one end. The entrance to the nest box was covered by a light-proof curtain. A food tray, which was too narrow for a feeding hedgehog to stand in, was located against the opposite end of the cage, and a pressure pad connected to a four-pen event recorder was placed in front of it (Fig. 1). The pressure pad did not operate unless weight was applied near the contact end. The event recorder operated continually, but movement of the

FIGURE 1. *Diagramatic lateral view of a test cage.*

paper tape was restricted to between 1800 and 0700 hours daily.

The only lighting in the room throughout the 13 week feeding trial was daylight from an east-facing window shaded by a baffle. A selenium photocell, which could be read from outside the room was used to record light intensities. During the conditioning period only, the animals were observed with the aid of a shaded red photographic safety lamp.

A daily diet of 300 g of a 1:1:3 volume mixture of cooked mince, bread and milk was provided. Small quantities of mineral salts, cod-liver oil and liver were added regularly.

As the variances were different the modified t-test (Snedecor and Cochran 1967) was used to test data for significance.

RESULTS AND DISCUSSION

The animals did not react to the red light used to assist observations made during the conditioning period. On first emerging from their nests each night the animals normally groomed themselves, then evacuated. Behaviour beyond this point was variable but they would usually complete at least one

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Anja B. RIBER

Riber A. B. 2006. Habitat use and behaviour of European hedgehog *Erinaceus europaeus* in a Danish rural area. Acta Theriologica 51: 363–371.

Hedgehogs *Erinaceus europaeus* Linnaeus, 1758 were radio-tagged and monitored during the summer of 2001 in a Danish rural area with the objective of quantifying home ranges, nightly distances travelled, habitat use, [illegible] patterns, [illegible] females being recorded. Males had larger home ranges and travelled longer nightly distances than females. The two most common habitat types within the home ranges of the hedgehogs were deciduous forest and arable land, whereas the two most frequently used habitat types were deciduous forest and grassland. No differences between the sexes were found in the proportions of different habitat types within the home ranges or in habitat use. Non-random habitat use was found; forested areas [illegible] preferred to open areas. The most [illegible] habitat was deciduous forest. Foraging was by far the most time-consuming nightly activity for both sexes. Males lost weight during the study period (May–July), whereas females gained weight. A peak in the frequency of sexual behaviour was found from late-June [illegible] ranging activity and the weight loss of males are interpreted as a consequence of the promiscuous mating system of hedgehogs.

Section of Ethology, Department of Large Animal Sciences, The Royal Veterinary and Agricultural University, DK-1870, Frederiksberg C, Denmark, e-mail: abrj@kvl.dk

Key words: body weight, day-nesting habits, home range, movements, sexual behaviour

moving 1-2 km per night

spending app. 4 h feeding (foraging)

Introduction

European hedgehogs *Europaeus erinaceus* Linnaeus, 1758 are small secretive nocturnal animals that spend the day in well hidden day-nests. Such characteristics complicate monitoring of the behaviour of free-ranging individuals, contributing to poor understanding of certain aspects of their behavioural ecology. For instance, knowledge of the activity patterns of hedgehog is still limited in spite of the wide distribution of hedgehog in Western Europe and New Zealand. The continuously improving radio-telemetry technology has, however, made comprehensive studies of such animals possible, although the cost of the equipment and the time-consuming form of the method usually still limit the number of study animals involved (eg Morris 1988, Huijser 2000).

FEEDING RHYTHMS OF CAGED HEDGEHOGS (*ERINACEUS EUROPAEUS* L.)

P. A. CAMPBELL

Lincoln College, Canterbury

SUMMARY: The feeding behaviour of four adult caged hedgehogs was studied for a period of 22 weeks. The maximum feeding activity of all four animals occurred between 1900 and 2200 hours, and two of them showed a second, but minor, peak of activity about 0300 hours. Individual feeds were of short duration with the first feed each evening tending to exceed the mean. Variations in behaviour between individuals were considered to be a function of their differing body weights, or to be related to the size of the sample. The feeding behaviour of the caged animals was similar to that reported from comparable field studies.

7-15 "meals" per night

at 100-200 sec / meal

= 22-27 min per night

INTRODUCTION

Herter (1938), Burton (1969) and Campbell (1973) have shown that hedgehogs in their natural habitats have a definable feeding rhythm. Observations of caged hedgehogs (Kristoffersson 1964 and Otway 1965) have shown comparable feeding rhythms, but these studies were of only 6 and 14 days duration respectively. The present study was an attempt to determine if hedgehogs retained their natural feeding rhythm when fed under laboratory conditions for an extended period.

METHODS

Four adult hedgehogs taken from pasturelands near Lincoln were fed under laboratory conditions for 22 weeks. The animals were housed in a temperature controlled room (18 ± 2°C) to [illegible] hibernation and lessen the risk of [illegible] mortality factor of caged hedgehogs ([illegible] 19[illegible]). To avoid possible effects from the abrupt change in habitat the first 9 weeks were used to condition the animals to captivity, and the remainder for a feeding trial. Each animal was housed in a separate 120 x 30 x 30 cm cage that had a nest box partly filled with shredded paper at one end. The entrance to the nest box was covered by a light-proof curtain. A food tray, which was too narrow for a feeding hedgehog to stand in, was located against the opposite end of the cage, and a pressure pad connected to a four-pen event recorder was placed in front of it (Fig. 1). The pressure pad did not operate unless weight was applied near the contact end. The event recorder operated continually, but movement of the

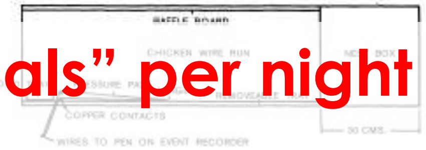


FIGURE 1. *Diagramatic lateral view of a test cage.*

[illegible] between 1900 and [illegible] daily.

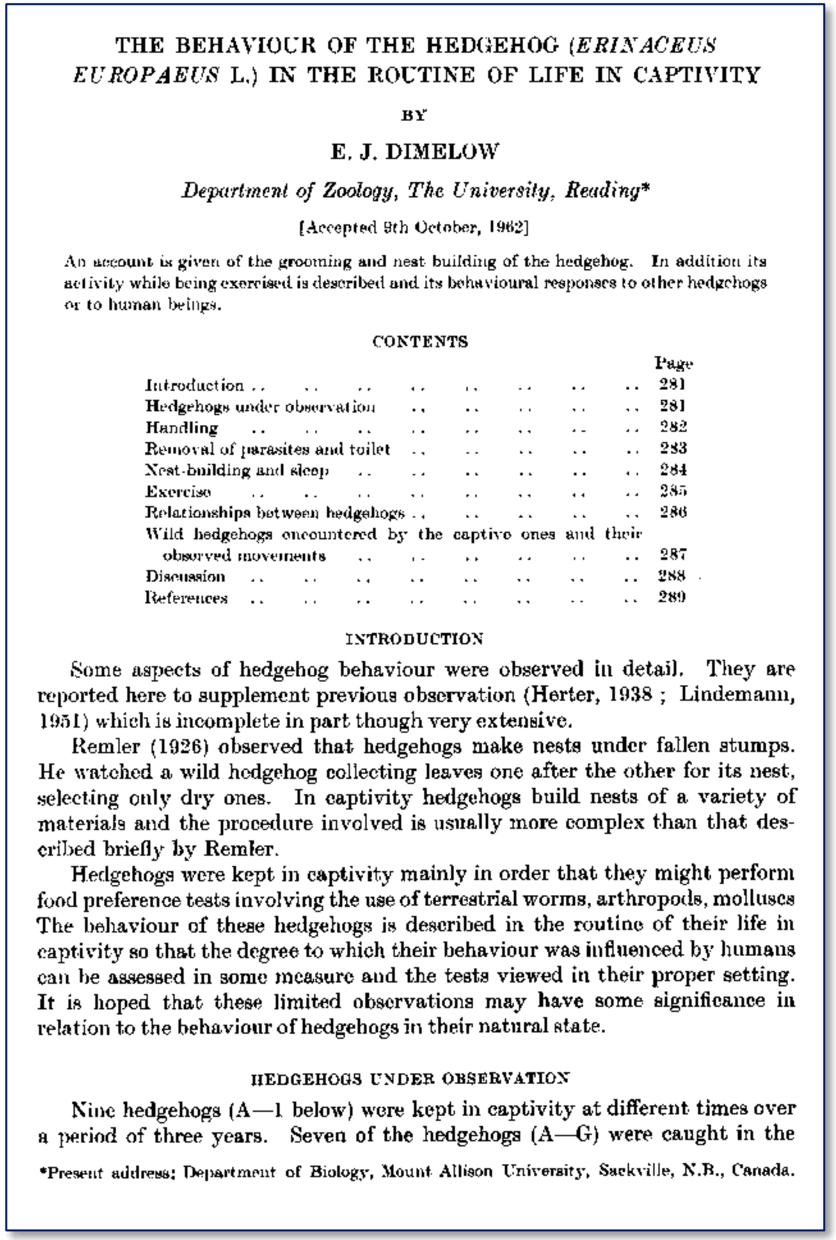
The only lighting in the room throughout the 13 week feeding trial was daylight from an east-facing window shaded by a baffle. A selenium photocell, which could be read from outside the room was used to record light intensities. During the conditioning period only, the animals were observed with the aid of [illegible] of cooked mince, bread and milk was provided. Small quantities of mineral salts, cod-liver oil and liver were added regularly.

As the variances were different the modified t-test (Snedecor and Cochran 1967) was used to test data for significance.

RESULTS AND DISCUSSION

The animals did not react to the red light used to assist observations made during the conditioning period. On first emerging from their nests each night the animals normally groomed themselves, then evacuated. Behaviour beyond this point was variable but they would usually complete at least one

Hedgehog other behaviour



THE BEHAVIOUR OF THE HEDGEHOG (*ERINACEUS EUROPAEUS* L.) IN THE ROUTINE OF LIFE IN CAPTIVITY

BY

E. J. DIMELOW

*Department of Zoology, The University, Reading**

[Accepted 9th October, 1962]

An account is given of the grooming and nest building of the hedgehog. In addition its activity while being exercised is described and its behavioural responses to other hedgehogs or to human beings.

CONTENTS

INTRODUCTION

Some aspects of hedgehog behaviour were observed in detail. They are reported here to supplement previous observation (Herter, 1938 ; Lindemann, 1951) which is incomplete in part though very extensive.

Remler (1926) observed that hedgehogs make nests under fallen stumps. He watched a wild hedgehog collecting leaves one after the other for its nest, selecting only dry ones. In captivity hedgehogs build nests of a variety of materials and the procedure involved is usually more complex than that described briefly by Remler.

Hedgehogs were kept in captivity mainly in order that they might perform food preference tests involving the use of terrestrial worms, arthropods, molluscs The behaviour of these hedgehogs is described in the routine of their life in captivity so that the degree to which their behaviour was influenced by humans can be assessed in some measure and the tests viewed in their proper setting. It is hoped that these limited observations may have some significance in relation to the behaviour of hedgehogs in their natural state.

HEDGEHOGS UNDER OBSERVATION

Nine hedgehogs (A—I below) were kept in captivity at different times over a period of three years. Seven of the hedgehogs (A—G) were caught in the

*Present address: Department of Biology, Mount Allison University, Sackville, N.B., Canada.

Hedgehog other behaviour

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As an alternative to running for a time in fixed circles of different diameter or in concentric circles of diminishing or increasing diameter, D and F might " waltz ". In this case either would spin round once on his axis at one definite point in the process of running round in a circle of about one and a half metres in diameter. D and F also ran backwards and forwards in a straight line along one wall or the side of a box.

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Hedgehog example

Hedgehog example

Food presentation determines activity budget !

Hedgehog example

Food presentation determines activity budget !

What is (or would be) your concept to facilitate imitation of the natural behaviour for hedgehogs, armadillos etc. ?

Anteater example

Anteater feeding mode

Behavioral repertoire of giant anteater (*Myrmecophaga tridactyla*, Linnaeus 1758) in nature at Serra da Canastra National Park, MG and in captivity at Curitiba Zoo, PR, Brazil

ALESSANDRA BERTASSONI[1] E LENY C. MILLÉO COSTA[2]

Revista de Etologia 2010, Vol.9, N°2, 21-30.

Table 1- Number of occurrence of giant anteater's behavior categories in SCNP and Curitiba Zoo. The zero is the lack of behavior and *only refers to ad libitum sampling.

Category	Behavior	Motor Pattern	SCNP	Zoo
Maintenance (n=9301)	Foraging	Sniffing	514	460
		Rummaging branches	*	*
		Snout near the soil	3552	785
		Digging	573	49
		Changing dir. forag.	226	*
	Feeding	Feeding zoo mixture	0	194
		Feeding termite/ant	552	08
		Drinking water	*	15
		Stop Specific point	1551	17
	Resting	Sleeping	06	424
		Stretching	*	15
		Lying down	05	68
		Static position	15	111

Anteater feeding mode

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Behaviour	wild	zoo
	% observations	
Foraging - search	54	28
Foraging - dig	3	1
Feeding	7	5
Resting	0	14

Anteater feeding mode

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The average duration of feeding zoo's food was 15.1 ± 7 minutes. The female and male could eat in the same moment (figure 2).

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15 minute meals !

Anteater feeding mode

Feeding and food preference in captive and wild Giant anteaters (*Myrmecophaga tridactyla*)

KENT H. REDFORD

J. Zool., Lond. (*A*) (1985) **205**, 559–572

TABLE I

Results from paired preference tests of captive Giant anteaters (all tests combined)

	Total number seconds feeding	Mean seconds feeding per bout (S.D.)
Cornitermes	8862	422·0(248·0)
Procornitermes	6533	311·1(216·4)
Cortaritermes	4387	208·9(212·0)
Armitermes	3036	144·6(189·2)
Grigiotermes	2348	111·8(128·6)
Nasutitermes	1618	77·0(119·9)
Orthognathotermes	1552	73·9(98·8)
Velocitermes	1182	56·3(85·5)

Anteater feeding mode

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1-7 minute meals !

Anteater feeding mode

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Field studies

The mean number of feeds per bout on identified prey was 1·7 (S.D. = 1·2, range = 1–8). For all feeds combined, the mean duration was 21·1 sec (S.D. = 11·9, range = 1–319), with a mode of 3 sec. Of these 1,487 feeds, 46·5% were less than 10 sec, 66·2% were less than 20 sec and 93·5% were a minute or less in duration.

Anteater feeding mode

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20 second meals !

(0-5 min)

Anteater example

Anteater example

Surprising observations of natural behaviour !

Anteater example

Surprising observations of natural behaviour !

What is (or would be) your concept to facilitate imitation of the natural behaviour ?

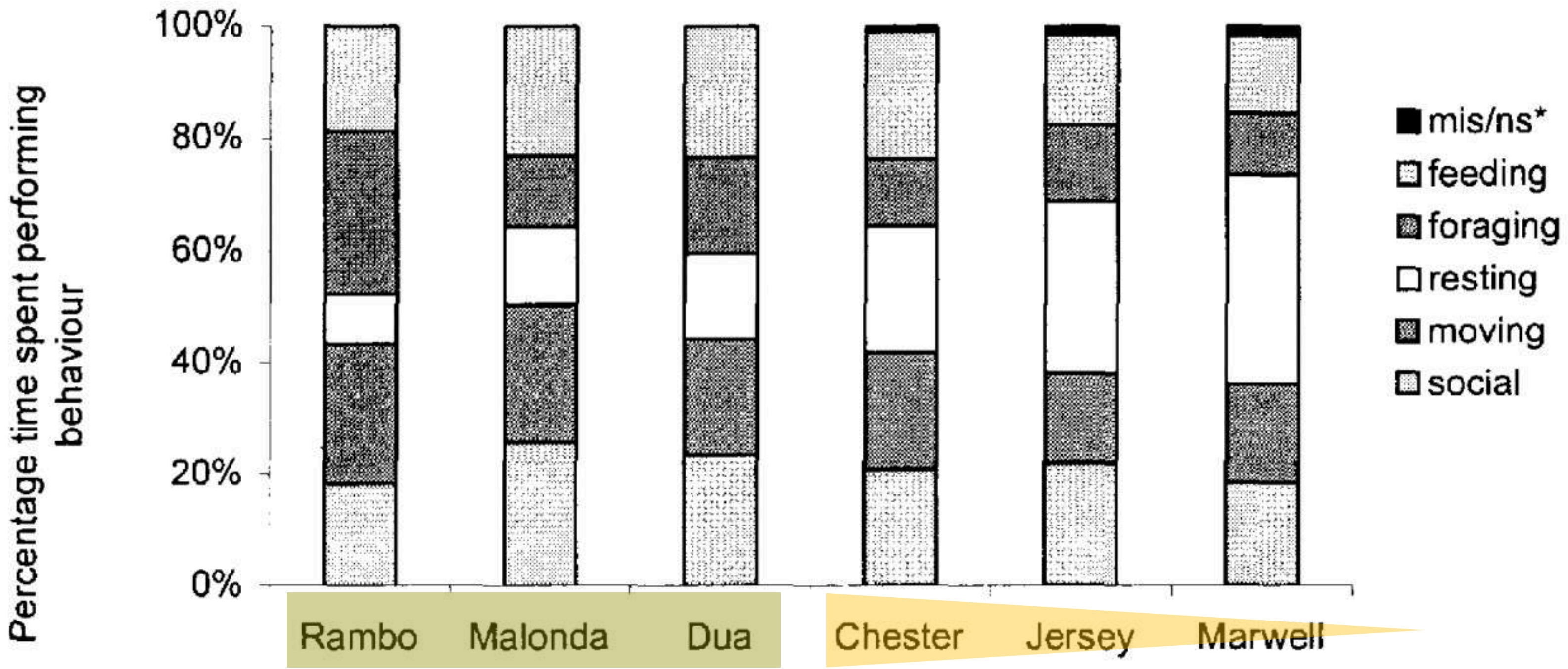
Primate examples

Primate activity

A COMPARISON OF THE ACTIVITY BUDGETS OF WILD AND CAPTIVE SULAWESI CRESTED BLACK MACAQUES (*MACACA NIGRA*)

V A Melfi[*] and A T C Feistner[†]

Animal Welfare 2002, 11: 213-222



Primate activity

Activity Budget and Postural Behaviors in Orangutans on Bukit Merah Orang Utan Island for Assessing Captive Great Ape Welfare

Siti Norsyuhada Kamaluddin[a], Ikki Matsuda[b,c,d,e], and Badrul Munir Md-Zain[a,f]

JOURNAL OF APPLIED ANIMAL WELFARE SCIENCE
https://doi.org/10.1080/10888705.2021.1910032

Primate activity

Table 3. Percentages of activity budget in comparison to previous studies.

Living-condition	Study site	Activities (%) Resting	Feeding	Moving	Playing	Grooming	Interaction	Others	*[3]Observation effort	Reference
Rehabilitant	Bukit Merah, Perak	60	13	9	14	0	2	3	252 h	This study
Rehabilitant	Bukit Merah, Perak	46	20	12	9	8		5	20 h	Hayashi et al. (2018)
Rehabilitant	*[1]Bukit Merah, Perak	52	23	19	3	1		1	54 h	Hayashi et al. (2018)
Rehabilitant	Bukit Merah, Perak	62	6	17	12	4			30 h	Zaki et al. (2017)
Rehabilitant	Bukit Merah, Perak	33	24	27	9	6		1	180 h	Lee (2003)
Rehabilitant	*[2]Meratus Forest, Indonesia	19	58	9	13				740 h	Kuncoro (2004)
Rehabilitant	Matang Wildlife Center, Sarawak	41	23	7	25	2		2	96 h	Lee (2006)
Zoo	Zoo Negara	58	19	11	9	1		2	57 h	May (2004)
Zoo	Zoo Taiping	43	21	14	10	12		1	103 h	Wong (2003)
Zoo	Singapore Zoo	50	27	13	8		2		192 h	Ting (2011)
Zoo	Singapore Zoo	80	9	12					24 h	Matsuda et al. (2017)
Zoo	Cleveland Metroparks Zoo, USA	32	15	10	7	3		3	3.5 mo	Cassella et al. (2012)
Free-ranging	Batang Serangan, Indonesia	54	24	15				7	2300 h	Campbell-Smith et al. (2011)
Free-ranging	Danum Valley Sabah	34	47	17				2	1786 h	Kanamori, Kuze, Bernard, Malim, and Kohshima (2010)
Free-ranging	Tanjung Puting, Indonesia	18	62	18	1			1	3805 h	Galdikas (1988)
Free-ranging	Mentoko, Indonesia	45	44	10				1	3900 h	Mitani (1989)
Free-ranging	Ulu Segama, Sabah	51	32	16					1200 h	Mackinnon (1974)
Free-ranging	Suaq Balimbing, Indonesia	24	57	18					11,700 h	Fox, Van Schaik, Sitompul, and Wright (2004)
Free-ranging	Sungai Wain Forest, Indonesia	20	59	14				6	5 mo	Fredriksson (1995)
Free-ranging	Tanjung Puting Indonesia	16	51	14	2			18	349 h	Snaith (1999)
Free-ranging	Sabangau, Indonesia	22	61	15	1			2	5502 h	Morrogh-Bernard (2009)
Free-ranging	Meratus Forest, Indonesia	36	42	17				5	14 mo	Grundmann (2006)

*[1]Behavioral data from semi-captive orangutans using an almost entire island besides BMOUI

*[2]Behavioral data from rehabilitant orangutans influenced by the rehabilitation program before reintroduced to Meratus Forest, Indonesia

*[3]Noted that the observation effort in hours would be an important factor influencing the results (activities %), though the number of subjects not in this table may also be an influential factor, especially for the playing category if the subjects include subadults or not.

Primate activity

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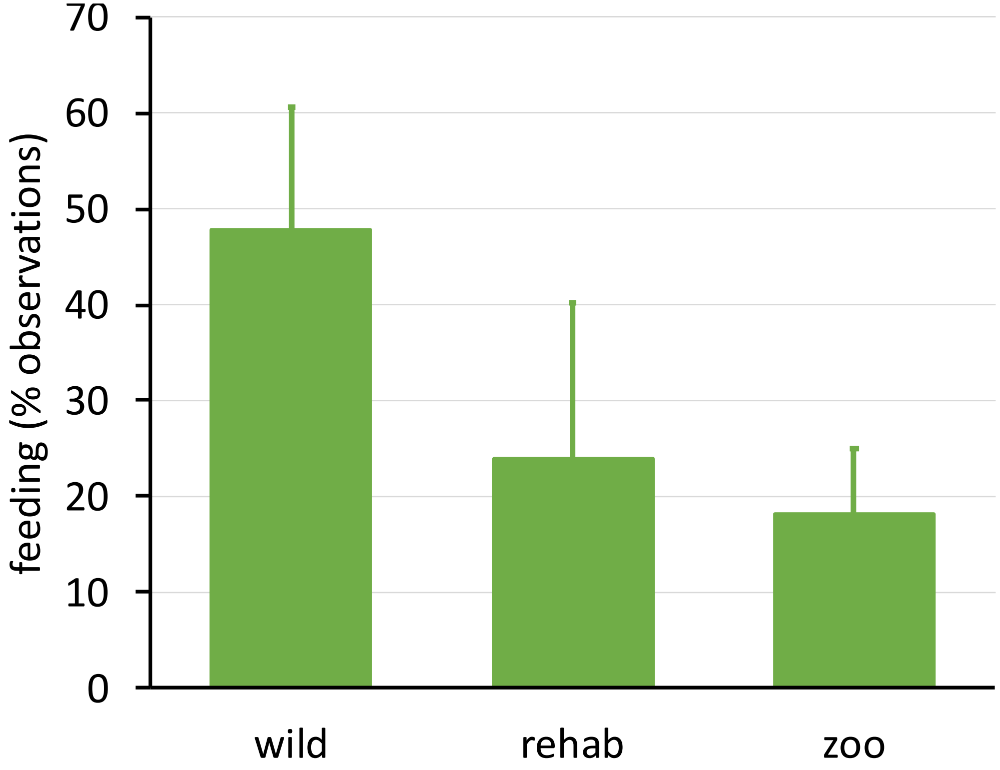

Primate cognition

The reluctant innovator: orangutans and the phylogeny of creativity

C. P. van Schaik, J. Burkart, L. Damerius, S. I. F. Forss, K. Koops, M. A. van Noordwijk and C. Schuppli

Phil. Trans. R. Soc. B **371**: 20150183

Primate cognition

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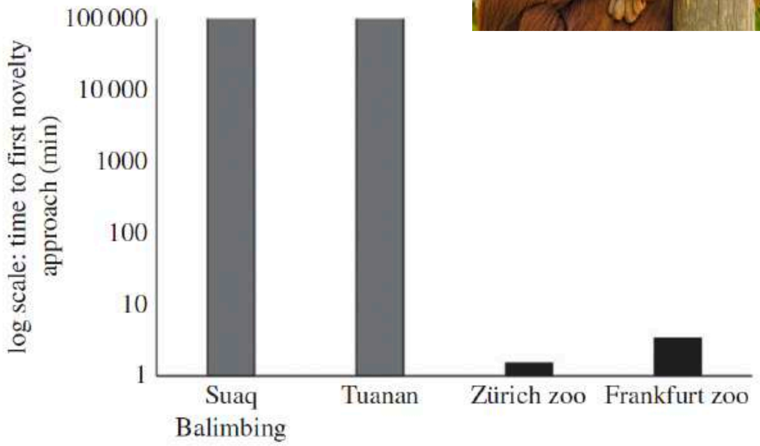

Figure 1. Mean latency to first contact by individuals in novel object tests on (*a*) wild Sumatran (Suaq) and Bornean (Tuanan) orangutans, and (*b*) Sumatran orangutans living in zoos in Zurich and Frankfurt.

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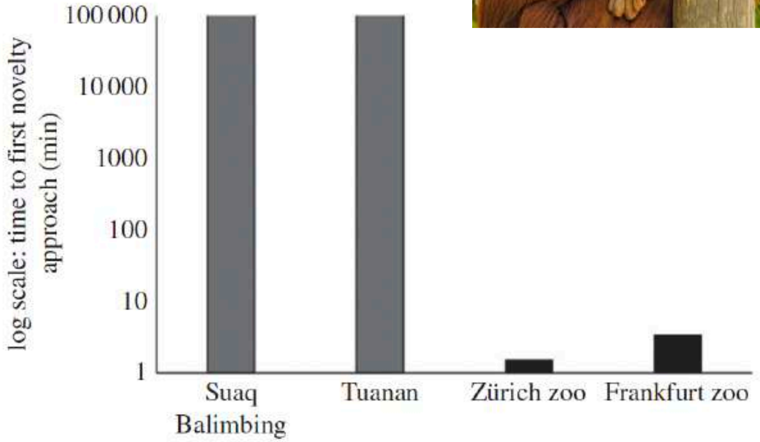

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Wild orangutans are therefore not innovative. In striking contrast, zoo-living orangutans actively seek novelty and are highly exploratory and innovative, probably because of positive reinforcement, active encouragement by human role models, increased sociality and an expectation of safety.

Primate cognition

Assessing the Effects of Cognitive Experiments on the Welfare of Captive Chimpanzees (*Pan troglodytes*) by Direct Comparison of Activity Budget Between Wild and Captive Chimpanzees

YUMI YAMANASHI[1,2*] AND MISATO HAYASHI[1]

American Journal of Primatology 73:1231–1238 (2011)

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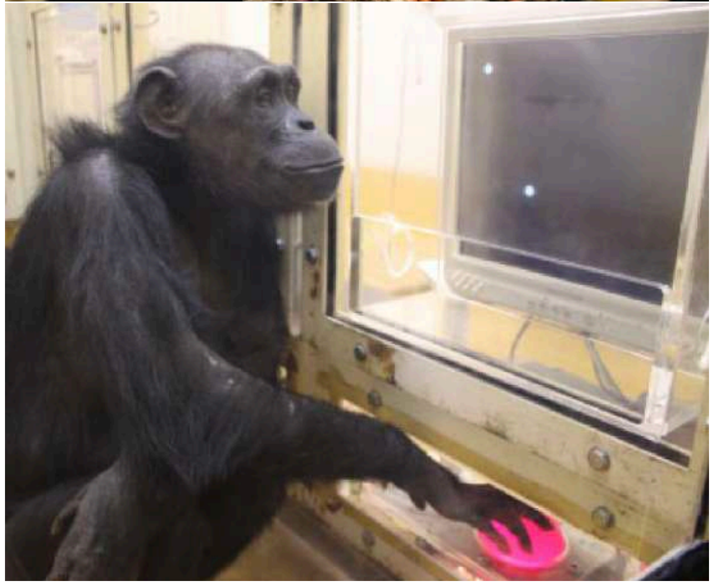

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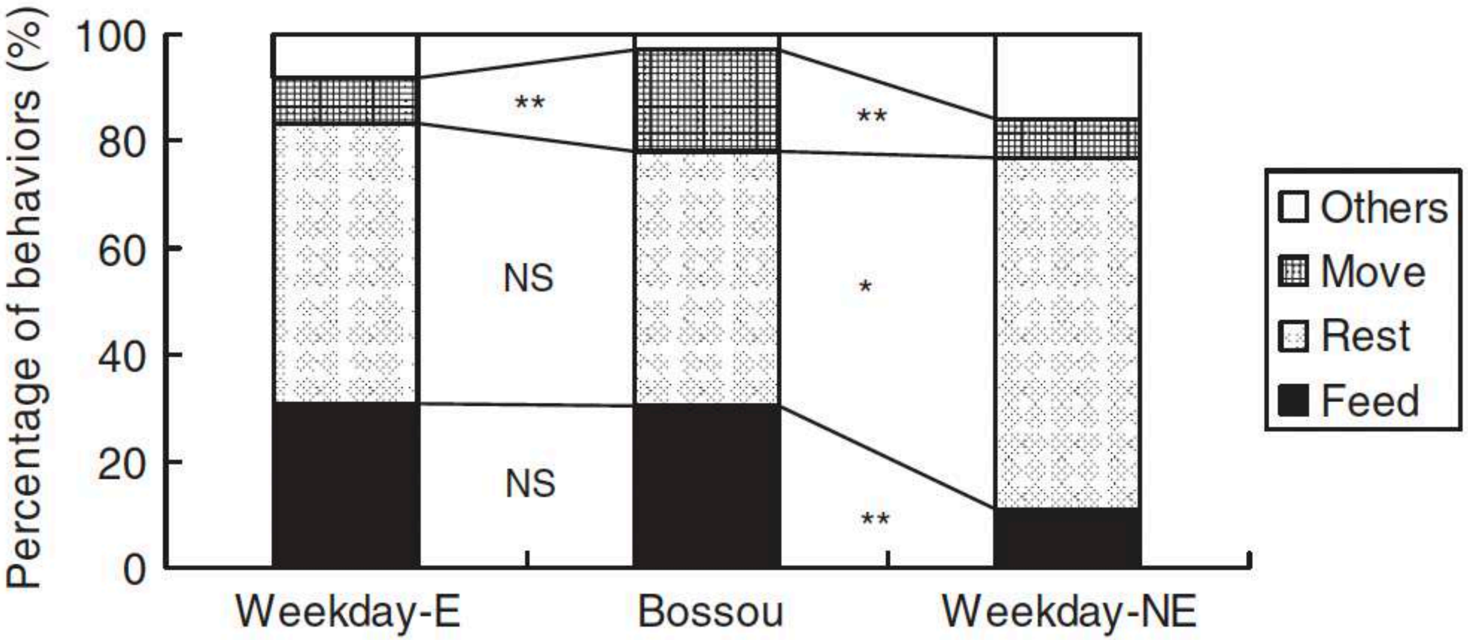

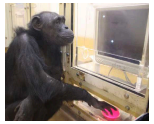

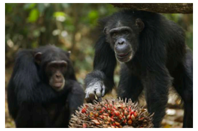

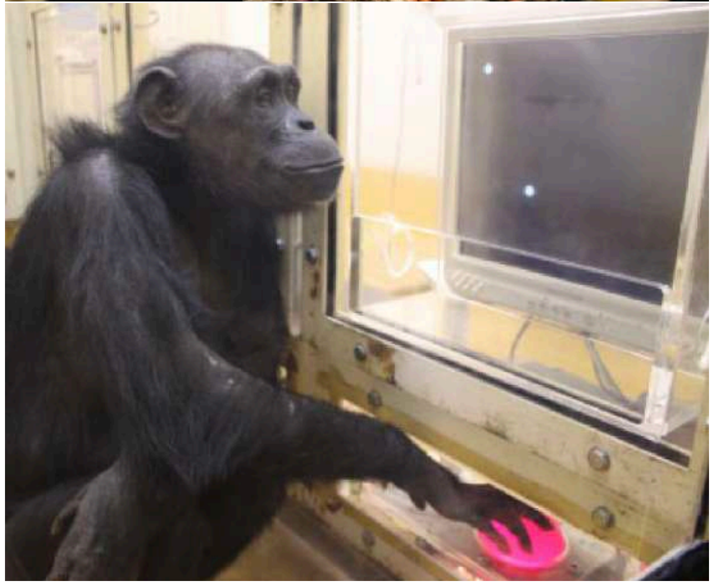

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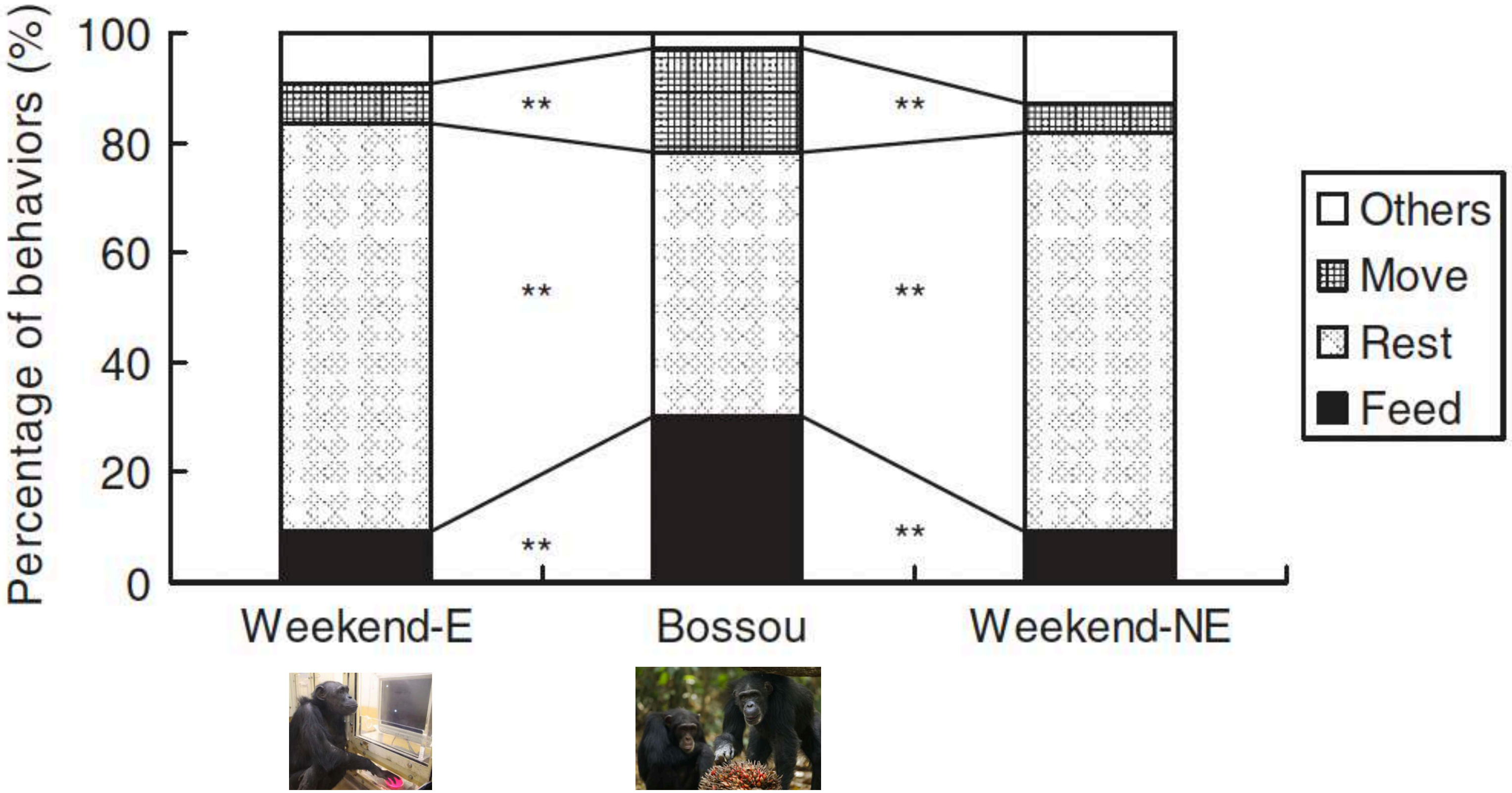

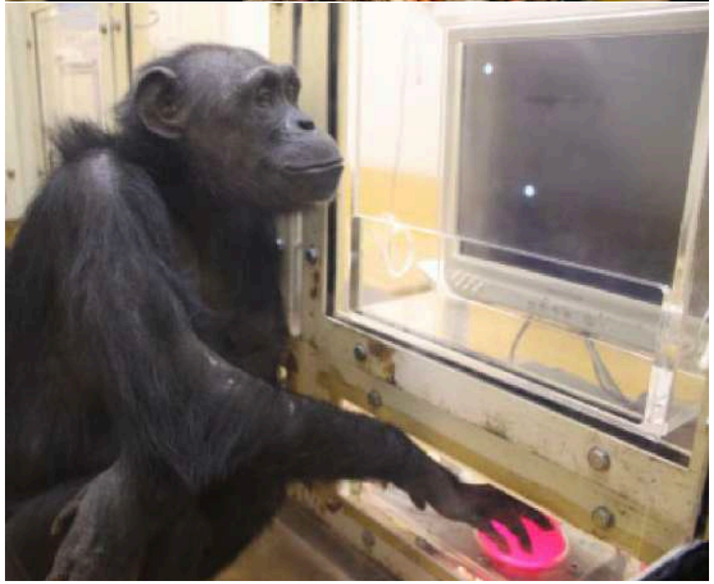

Primate examples

Primate examples

Cognitive challenges are part of natural life

Primate examples

Cognitive challenges are part of natural life

What is (or would be) your concept to facilitate imitation of the natural behaviour ?

Large carnivore examples

Carnivore hunting success

Feeding habitat selection by hunting leopards *Panthera pardus* in a woodland savanna: prey catchability versus abundance

GUY BALME*, LUKE HUNTER† & ROB SLOTOW*

ANIMAL BEHAVIOUR, 2007, **74**, 589–598

Table 5. The number of successful, unsuccessful and opportunistic hunts observed while following radiocollared leopards by habitat type

	Hunt outcome			
Habitat type*	Unsuccessful	Successful	% Successful	Number of opportunistic hunts
CRB	27	7	25.93	10†
ORB	25	7	28.00	2†
PV	19	5	26.32	4
G	11	2	18.18	1†
SF	1	0	0	0
CMB	7	1	14.29	4†
OMB	13	4	30.77	2
RW	0	0	0	0
Total	103	26	20.16	23

Carnivore hunting success

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Carnivore hunting success

HUNTING SUCCESS OF AFRICAN WILD DOGS IN SOUTHWESTERN KENYA

Todd K. Fuller and Pieter W. Kat

J. Mamm., 74(2):464–467, 1993

Table 1.—*Hunting success (% of successful pack chases) of a pack of African wild dogs monitored during July–August 1989 near Aitong, southwestern Kenya, and hunting success of wild dogs in Serengeti National Park, Tanzania.*

	This study		Schaller (1972)[a]		Malcolm and van Lawick (1975, in litt.)[a]	
Prey species	%	*n*	%	*n*	%	*n*
Thomson's gazelle	68	40[b]	64	69[c]	24	83
Grant's gazelle			100	7[d]	23	22
Wildebeest	31	16	74	42[e]	59	49[f]
Impala	80	10				
Wart hog	14	7	57	7		
Zebra	0	4	(16)	(32)[g]	92 (50)	24 (38)[g]
Topi	0	4				
Springhare	100	2				
Brown hare	50	2			29	21

Carnivore hunting success

HUNTING SUCCESS OF AFRICAN WILD DOGS IN SOUTHWESTERN KENYA

TODD K. FULLER AND PIETER W. KAT

J. Mamm., 74(2):464–467, 1993

TABLE 1.—*Hunting success (% of successful pack chases) of a pack of African wild dogs monitored during July–August 1989 near Aitong, southwestern Kenya, and hunting success of wild dogs in Serengeti National Park, Tanzania.*

	This study		Schaller (1972)[a]		Malcolm and van Lawick (1975, in litt.)[a]	
Prey species	%	*n*	%	*n*	%	*n*
Thomson's gazelle	68	40[b]	64	69[c]	24	83
Grant's gazelle			100	7[d]	23	22
Wildebeest	31	16	74	42[e]	59	49[f]
Impala	80	10				
Wart hog	14	7	57	7		
Zebra	0	4	(16)	(32)[g]	92 (50)	24 (38)[g]
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Carnivore hunting success

Foraging behaviour and hunting success of lions in Queen Elizabeth National Park, Uganda

KARL G. VAN ORSDOL

Afr. J. Ecol. 1984, Volume 22, pages 79–99

Table 1. Comparison of hunting attempts and successes for each of six hunting methods used by lions in Queen Elizabeth National Park

	Mweya		Southern Circuit		Northern Circuit		Combined		
Type of hunt	No. of hunts observed	No. of hunts successful	No. of hunts observed	No. of hunts successful	No. of hunts observed	No. of hunts successful	No. of hunts observed	No. of hunts successful	% successful
Stalk	69	16	35	7	23	8	127	31	24·4
Charge	3	2	6	3	5	1	14	6	42·9
Ambush	4	2	1	0	2	2	7	4	57·1
Grass-search	0	0	14	7	3	1	17	8	47·1
Unexpected	3	2	1	0	1	1	5	3	50·0
Dig	5	0	0	0	0	0	5	0	0
Unknown	1	1	7	1	7	1	15	3	20·0
Total	85	23 (27·1%)	64	18 (28·1%)	41	14 (34·1%)	190	55	28·9

Carnivore hunting success

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Large carnivore examples

Large carnivore examples

Predators do not have guaranteed access to food !

Large carnivore examples

Predators do not have guaranteed access to food !

What is (or would be) your concept to facilitate imitation of the natural behaviour ?

Contingency plan ?

If you feed your tiger like this …

… you deprive it of 0.5-3 hours of hunt/ chase/ strain/ effort every day.

What is your plan to compensate for that ?

Contingency plan ?

If you feed your meerkat like this …

… you deprive it of 3-4 hours of searching effort every day.

What is your plan to compensate for that ?

Contingency plan ?

If you feed your herbivore like this …

… you deprive it of a lot of locomotion and searching effort every day.

What is your plan to compensate for that ?

No food should ever just be 'put there'

(in a bowl, on a dish, on the floor)

into an animal's enclosure.

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For every food item, you need a plan how and when to feed it.

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This plan should be visible to everyone (keepers, curators, auditors) – and not be at anyone's discretion to put into practice.

Checklist

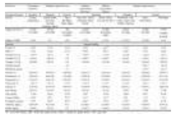
What is the natural food?

What are the (assumed) requirements?

What is the natural foraging mode?

What is the natural feeding frequency?





What is the appropriate surrogate food?

What safety feeds do I need?

What feeding behaviour should be evoked?

How often should food be provided?



How can this be combined with management, education and entertainment aims?




WAZA Guidelines for Animal - Visitor Interactions

April 2020

4. Establish procedures that assure that all animals are treated with respect, allowing and supporting species-specific behaviour in their depiction and presentation.

Thank you for your attention