Everyone can do some science: don't overlook things you can do

Marcus Clauss

Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

EAZA 2023 Helsinki Research Committee session

University of Zurich[UZH]

Clinic
of Zoo Animals, Exotic Pets and Wildlife

What is research ?

EAZA Research Standards

Approved by EAZA Annual General Meeting
7 April 2022

Introduction

The European Association of Zoos and Aquaria (EAZA) is the largest professional zoo and aquarium association in the world. With over 400 Members in 47 countries, EAZA is the Membership organisation that sets the standard for progressive zoos and aquariums and other partners across Europe, Western Asia and beyond. EAZA and its Members continuously strive to define and demonstrate excellence in integrated species conservation through a transparent and collaborative approach to population management, wild animal care and welfare, representation with international organisations, conservation education, and scientific research. EAZA believes relevant and successful scientific research and training underpins EAZA Member activities in animal husbandry, population management programmes, animal welfare, education, wildlife conservation, and many other areas. The EAZA Research Committee aims to encourage every EAZA Member to engage in and contribute to high quality research in zoos and aquariums, and to promote their facilities as a venue for applied and academic research.

The EAZA membership is made up of lots of different physical sites of living collections. These include zoos, aquariums, safari parks, bird parks and wildlife centres. Within this standards document, the term "zoo" is used henceforth to indicate any EAZA Member institution.

Purpose

The EAZA Research Committee has developed the EAZA Research Standards to outline what is expected from EAZA Members in relation to research and to help guide, inform and provide a coordinated approach to research in zoos. This document is an update from the EAZA Research Standards 2003 and it will be reviewed by the EAZA Research Committee on a regular basis.

The importance of research in zoos and aquariums

Zoos are uniquely positioned to carry out research on a wide range of topics, including biological sciences, conservation, animal welfare, social sciences, education and environmental sustainability. Through research we can, for example, identify problems

EUROPEAN ASSOCIATION OF ZOOS AND AQUARIA

EAZA

The EAZA Research Strategy

EAZA Research Standards

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The European Council Directive 1999/22/EC relating to the keeping of wild animals in zoos (the EU Zoos Directive)

The Member States guarantee that all zoos will implement the following conservation measures:

> participating in research from which conservation benefits accrue to the species, and/or training in relevant conservation skills, and/or the exchange of information relating to species conservation and/or, where appropriate, captive breeding, repopulation or reintroduction of species into the wild;

Committee on a regular basis.

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What is research ?

Something you have to do to tick off an item from your task list.

Research Project Application Form

Please read the Terms and Conditions of the Project Pass ***before*** completing this form.

1. Personal Details	
Name:	**Contact address:**
Telephone number:	**Email:**

2. Details of Academic Institution	
Academic institution:	**Course subject:**
What qualification does the project contribute towards? (e.g. BSc, BA, MSc)	**Supervisor's name:**
Supervisor's contact address:	**Supervisor's email:**

3. Project Details	
Project title:	**Project keywords:**
Species (common name and scientific name):	**Taxonomic order:**
Proposed start date at XXX Zoo:	**Proposed end date at XXX Zoo:**
Are you proposing to carry out this project at more than one site? ☐ **Yes** ☐ **No** *If yes please specify here:*	

4. Brief Project Summary
Please include justification for project, aim of study, brief methods and expected outcome of project (max. 250 words):

5. Payment for a Student Payment Pass	
There are two options for payment for a Research Project. We regret that payment is non-refundable once the project has been approved. Please tick relevant option and complete where appropriate:	
1) XXX for the duration of your research (maximum one academic year)	☐
2) Annual Zoo Membership	☐ Membership number:
If selected option 1 please indicate your method of payment	
Payment by cheque – made payable to 'XXX Zoo'	☐
Payment by BACS Transfer XXX Zoo Bank Details: Account: The XXX Zoological Society Account Number: XXXX Sort Code: XX XX XX BIC: ABCDEFGHIJKL IBAN: XXX XXXX XXXX XXXX XXXX ***(If paying by Bank Transfer please put reference as 'SSP' and add your name then send remittance advice to address below)***	☐
By Credit/Debit Card: Please provide a telephone number we can contact you on to process payment once approval of your pass has been given and this is about to be issued.	

6. Acceptance of Terms and Conditions of XXX Zoo's Research Project		
Student signature	**Printed name of student**	**Date**
Academic supervisor signature	**Printed name of academic supervisor**	**Date**
By signing this form, students and supervisors accept the Terms and Conditions of XXX Zoo's Research Project Rules ***Please note these must be physical signatures on the hard copy submitted; omission of these will delay the approval process.***		

7. Submission of application form
Please submit an electronic copy and a signed (PLEASE NOTE – ELECTRONIC SIGNATURES WILL NOT BE ACCEPTED) hardcopy of this form to: **Email:** email@zoo.org **Post:** XXXXX, XXXX, XXXX, XXXX **PLEASE ALLOW A MINIMUM OF TWO WEEKS FOR PROCESSING**

All details provided will be held in our database in accordance with the Data Protection Act. Your personal details will remain confidential but project information may be given to other zoological databases for scientific purposes only.

What is research ?

A bureaucratic nightmare ?

SCIENTIFIC REPORTS

OPEN

Rumen microbial community composition varies with diet and host, but a core microbiome is found across a wide geographical range

Received: 14 April 2015
Accepted: 01 September 2015
Published: 09 October 2015

Gemma Henderson[1], Faith Cox[1], Siva Ganesh[1], Arjan Jonker[1], Wayne Young[1], Global Rumen Census Collaborators[†] & Peter H. Janssen[1]

Ruminant livestock are important sources of human food and global greenhouse gas emissions. Feed degradation and methane formation by ruminants rely on metabolic interactions between rumen microbes and affect ruminant productivity. Rumen and camelid foregut microbial community composition was determined in 742 samples from 32 animal species and 35 countries, to estimate if this was influenced by diet, host species, or geography. Similar bacteria and archaea dominated in nearly all samples, while protozoal communities were more variable. The dominant bacteria are poorly characterised, but the methanogenic archaea are better known and highly conserved across the world. This universality and limited diversity could make it possible to mitigate methane emissions by developing strategies that target the few dominant methanogens. Differences in microbial community compositions were predominantly attributable to diet, with the host being less influential. There were few strong co-occurrence patterns between microbes, suggesting that major metabolic interactions are non-selective rather than specific.

Ruminants are one of the most successful groups of herbivorous mammals on the planet, with around 200 species represented by approximately 75 million wild and 3.5 billion domesticated individuals worldwide[1]. Ruminants are defined by their mode of plant digestion, and have evolved a forestomach, the rumen, that allows partial microbial digestion of feed before it enters the true stomach. Ruminants themselves do not produce the enzymes needed to degrade most complex plant polysaccharides, and the rumen provides an environment for a rich and dense consortium of anaerobic microbes that fulfil this metabolic role. These rumen microbes ferment feed to form volatile fatty acids that are major nutrient sources for the host animal and contribute significantly to ruminant productivity. The host also uses microbial biomass and some unfermented feed components once these exit the rumen to the remainder of the digestive tract. Ruminants have evolved various rumen anatomies and behaviours to thrive on a range of plant species, and this flexibility has enabled them to occupy many different habitats spanning a wide range of climates[2]. These were also important factors in their domestication, allowing conversion of human-indigestible plant material into readily-accessible animal goods, especially dairy products, meat, and useful fibres. Ruminants have thus played a vital role in sustaining and developing many human cultures, as well as being used as draft animals and having religious and status values.

[1]AgResearch Limited, Grasslands Research Centre, Palmerston North 4442, New Zealand. [†]A comprehensive list of authors and affiliations appear at the end of the paper. Correspondence and requests for materials should be addressed to G.H. (email: gemma.henderson@agresearch.co.nz) or P.H.J. (email: peter.janssen@agresearch.co.nz)

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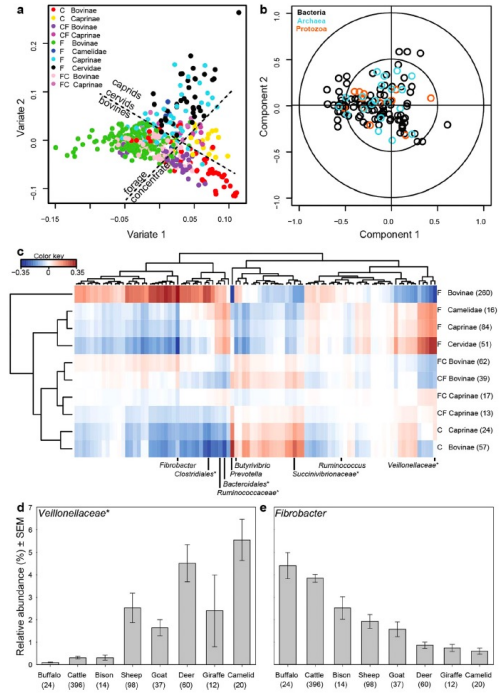

Figure 3. Effect of host species and dietary forage to concentrate ratios on microbial communities. Diets were grouped (Supplementary Table 7) as forage-dominated (F), mixed forage-concentrate (50–70% forage, FC), mixed concentrate-forage (50–70% concentrate, CF), or concentrate-dominated (C). (a) Discriminant analysis of microbial communities in samples (represented by points coloured by animal and diet) revealed that both host and diet determined community composition. (b) Bi-plot that shows microbial groups (identified by colours) underlying the separation of samples in panel (a). Several bacterial groups strongly discriminate the samples by host and diet, indicated by their presence towards the outside of the bi-plot. Archaeal and protozoal groups are less discriminatory, and so are clustered nearer the centre. (c) The heatmap shows that bacterial abundances are differentially associated with diet and host (colour key shows the association score; see Supplementary Figs 3–5 for additional data). (d) Unclassified *Veillonellaceae*, and (e) *Fibrobacter* are examples of bacteria that caused bovines and caprids to cluster separately from other species in the heat map. The number of samples in each category is given in parentheses in panels (c–e). *indicates unclassified bacteria within an order or family.

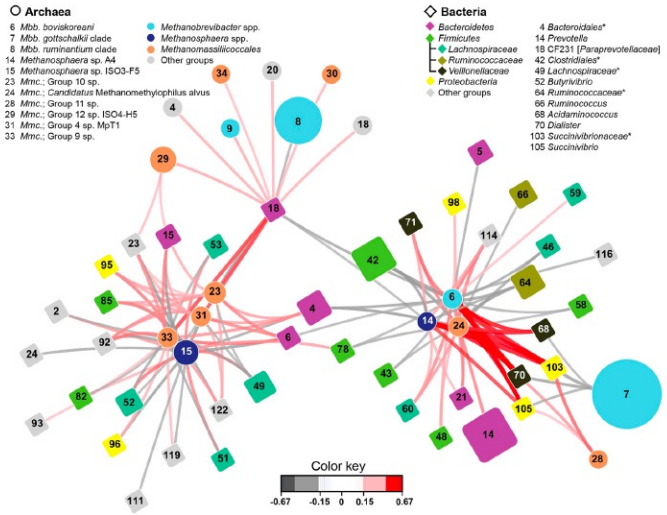

Figure 4. Associations between bacteria and archaea. The network is based on association scores computed via regularised canonical correlation analysis with an absolute association score greater than 0.15. The colour of the lines indicates the strength of the association. The sizes of the diamonds and circles indicate the mean average abundance and microbial groups are identified by numbers (Supplementary Tables 1 and 3). *Mbb. Methanobrevibacter*, *Mmc. Methanomassiliicoccales*, *indicates unclassified bacteria within a family.

nature aging

Resource

https://doi.org/10.1038/s43587-023-00462-6

Universal DNA methylation age across mammalian tissues

Received: 29 September 2022

Accepted: 21 June 2023

Published online: 10 August 2023

Check for updates

A list of authors and their affiliations appears at the end of the paper

Aging, often considered a result of random cellular damage, can be accurately estimated using DNA methylation profiles, the foundation of pan-tissue epigenetic clocks. Here, we demonstrate the development of universal pan-mammalian clocks, using 11,754 methylation arrays from our Mammalian Methylation Consortium, which encompass 59 tissue types across 185 mammalian species. These predictive models estimate mammalian tissue age with high accuracy ($r > 0.96$). Age deviations correlate with human mortality risk, mouse somatotropic axis mutations and caloric restriction. We identified specific cytosines with methylation levels that change with age across numerous species. These sites, highly enriched in polycomb repressive complex 2-binding locations, are near genes implicated in mammalian development, cancer, obesity and longevity. Our findings offer new evidence suggesting that aging is evolutionarily conserved and intertwined with developmental processes across all mammals.

Aging is associated with multiple cellular changes that are often tissue specific[1]. Cytosine methylation, however, stands out, as it allows for the development of pan-tissue aging clocks (multivariate age estimators) that are applicable to all human tissues[2–4]. The subsequent development of similar pan-tissue clocks for mice and other species suggests a conserved aspect to the aging process[5–7], thereby challenging the belief that aging is solely driven by random cellular damage accumulated over time. To investigate this, we sought to (1) develop universal age estimators applicable to all mammalian species and tissues (pan-mammalian clocks) and (2) identify and characterize cytosines with methylation levels that change with age across all mammals. For this purpose, we employed the mammalian methylation array, which we recently developed to profile methylation levels of up to 36,000 CpG sites with flanking DNA sequences highly conserved across the mammalian class[8]. We employed such profiles from 11,754 samples from 59 tissue types, originating from 185 mammalian species across 19 taxonomic orders (Supplementary Data 1.1–1.4 and Supplementary Notes 1 and 2) with ages ranging from prenatal to 139 years old (bowhead whale, *Balaena mysticetus*)[9]. These data are a subset from our Mammalian Methylation Consortium, which characterized maximum lifespan[9]. As we were interested in developing pan-mammalian clocks, we restricted the analysis to animals with known ages.

Results

Universal pan-mammalian epigenetic clocks

In separate articles, we described the application of the mammalian methylation array to individual mammalian species[10–19]. These studies already demonstrate that one can build dual-species epigenetic age estimators (for example, human–naked mole rat clocks)[10–17], in contrast to first- and second-generation clocks that measure human age[4,20,21] and mortality risk[22,23], respectively. However, it is not yet known whether one can develop a mathematical formula to estimate age in all mammalian species. Here we present three such pan-mammalian age estimators.

The first, basic clock (clock 1), regresses log-transformed chronological age on DNA methylation levels of all available mammals. Although such a clock can directly estimate the age of any mammal, its usefulness could be further increased if its output were adjusted for differences in the maximum lifespan of each species as well, as this would allow biologically meaningful comparisons to be made between species with very different lifespans. To this end, we developed a second universal clock that defines individual age relative to the maximum lifespan of its species; generating relative age estimates between 0 and 1. Because the accuracy of this universal relative age clock (clock 2) could be compromised in species for which knowledge of maximum lifespan is inaccurate, we developed a third universal clock, using age at sexual maturity (ASM) and gestation time instead of maximum lifespan,

e-mail: shorvath@mednet.ucla.edu

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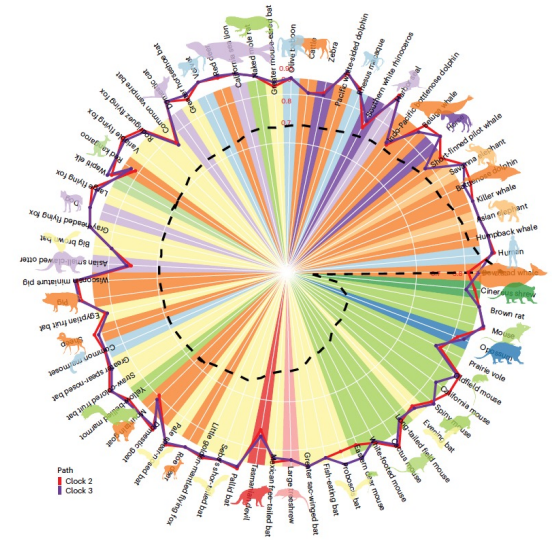


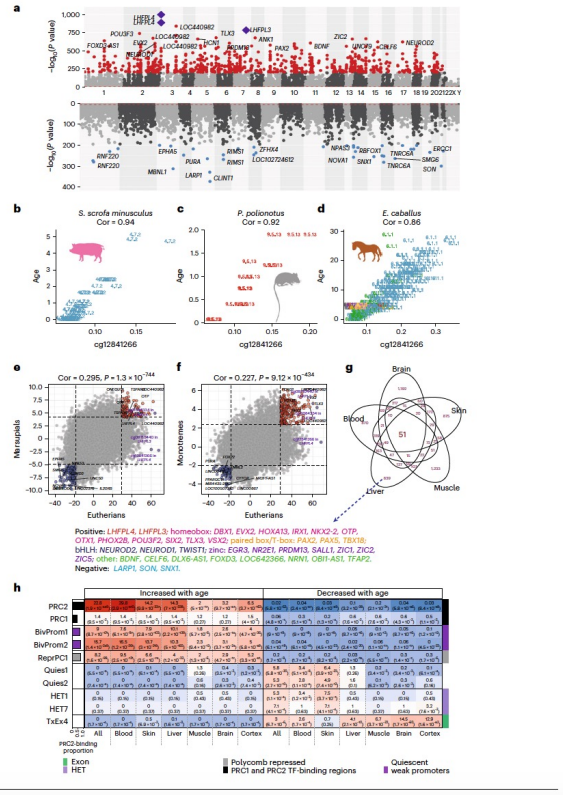
narrow-sense heritability estimates for clock 2 ($h^2 = 0.44$, $P = 3.4 \times 10^{-8}$) and clock 3 ($h^2 = 0.41$, $P = 4.0 \times 10^{-7}$). These heritability estimates for pan-mammalian clocks are on par with that of Horvath's human pan-tissue clock ($h^2 = 0.39$, $P = 4.0 \times 10^{-7}$)[4].

Epigenetic reprogramming reverses epigenetic age

Epigenetic clocks, such as the human pan-tissue clock, suggest that cellular reprogramming based on the Yamanaka factors (collectively termed as OSKM: OCT4, SOX2, KLF4, and c-MYC) induces age reversal[4,30].

(OR = 3.2, $P = 9.7 \times 10^{-47}$). Indeed, the majority of the top 1,000 positively age-related CpG sites were significantly enriched in PRC2-binding sites: 80.8% (808 CpG sites) in blood, 67.5% in liver and 67.2% in skin (Supplementary Data 8.1).

PRC2, a transcriptional repressor complex, is a key contributor to H3K27 methylation, a chromatin modification linked to transcriptional repression[37]. Importantly, PRC2-mediated histone 3 lysine 27 (H3K27) methylation is crucial for establishing bivalent promoters, which house



What is research ?

Stuff that is compicated, expensive, difficult to understand … but you can contribute samples to ?

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Stuff that is compicated, expensive, difficult to understand … but you can contribute samples to ?

Something that requires a lot of expertise, thinking, and generally exceeds your capacities?

What is research ?

anything that interests you

What is research ?

anything that interests you

If you have a hypothesis on something, go for it.

If you have a hypothesis on something, go for it.

If not, ask yourself – what interests you?
A certain species? A certain behaviour?
A certain studbook?

=> have a look !

The greatest story ever planned?

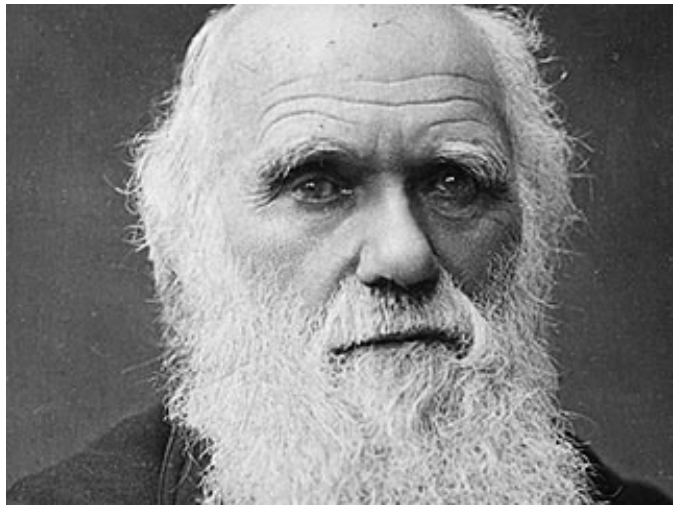
Darwin's diary:

1. Hypothesis

Species originate by selection acting on the variability of phenotypes so that only certain ones can reproduce/so that certain ones can reproduce more efficiently.

2. Research plan

Travel around the world and find model systems to test hypothesis.



Example 1

lucky leftovers

Eur J Wildl Res (2005) 51: 291–294
DOI 10.1007/s10344-005-0113-0

SHORT COMMUNICATION

Marcus Clauss · Nadia Robert · Chris Walzer
Christelle Vitaud · Jürgen Hummel

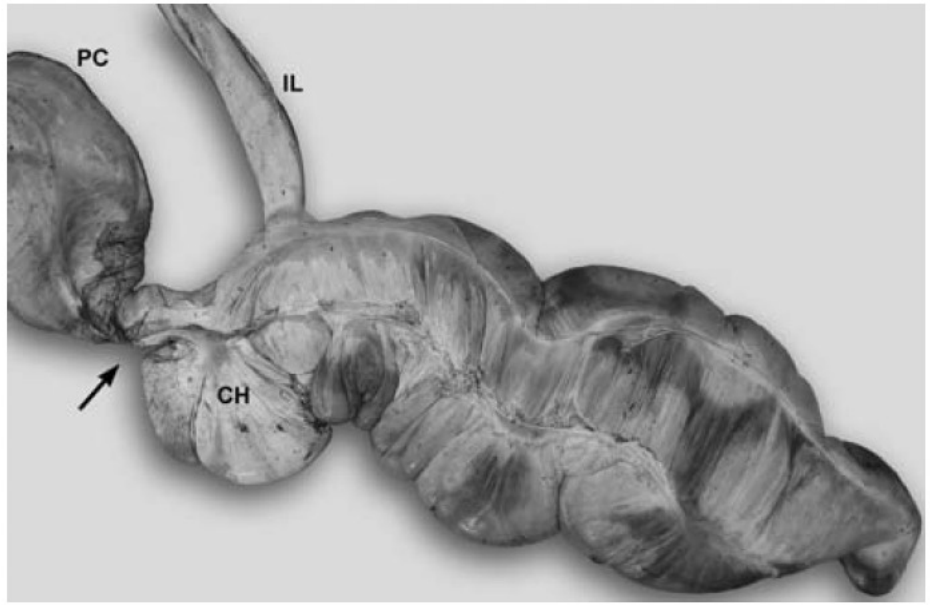
Testing predictions on body mass and gut contents: dissection of an African elephant *Loxodonta africana* Blumenbach 1797

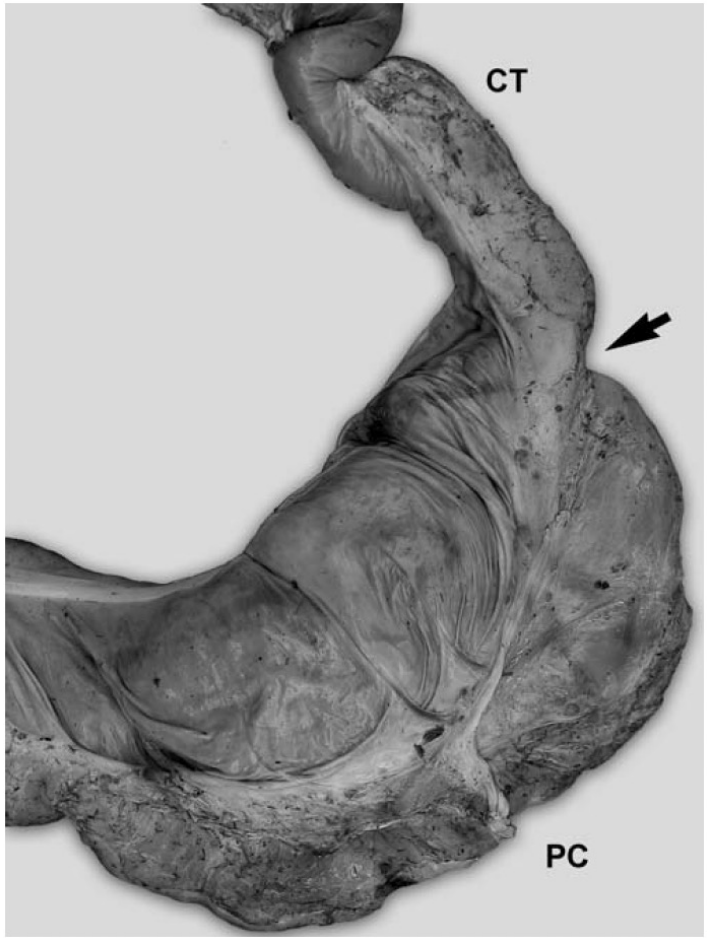
Eur J Wildl Res (2008) 54:347–351
DOI 10.1007/s10344-007-0126-y

SHORT COMMUNICATION

An isthmus at the caecocolical junction is an anatomical feature of domestic and wild equids

Marcus Clauss · Jürgen Hummel · Angela Schwarm · Patrick Steuer · Julia Fritz · Olga Martin Jurado · Anja Tschudin · Jean-Michel Hatt



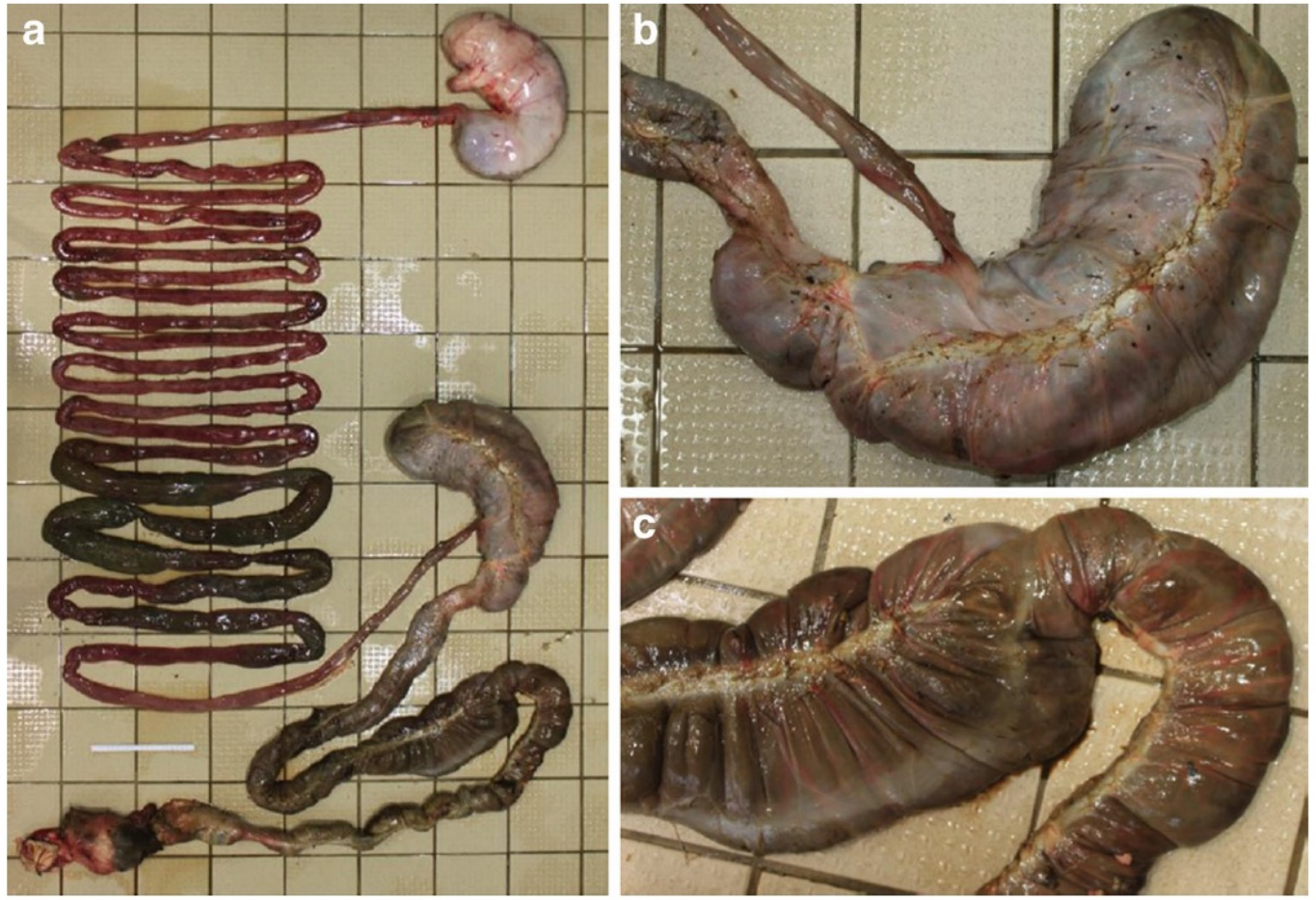


Eur J Wildl Res (2015) 61:171–176
DOI 10.1007/s10344-014-0870-8

SHORT COMMUNICATION

The macroscopic intestinal anatomy of a lowland tapir (*Tapirus terrestris*)

Katharina Hagen · Dennis W. H. Müller · Gudrun Wibbelt · Andreas Ochs · Jean-Michel Hatt · Marcus Clauss



Example 2

When elephants fall asleep

Received: 30 December 2017 | Revised: 13 February 2018 | Accepted: 20 February 2018
DOI: 10.1002/zoo.21406

RESEARCH REVIEW WITH CASE STUDIES

WILEY ZOOBIOLOGY

When elephants fall asleep: A literature review on elephant rest with case studies on elephant falling bouts, and practical solutions for zoo elephants

Christian Schiffmann[1,2] | Stefan Hoby[3] | Christian Wenker[3] | Therese Hård[4] | Robert Scholz[5] | Marcus Clauss[1] | Jean-Michel Hatt[1]

[1] Vetsuisse Faculty, Clinic for Zoo Animals, Exotic Pets and Wildlife, University of Zurich, Zurich, Switzerland

[2] Elefantenhof Platschow, Ziegendorf, Germany

[3] Zoologischer Garten Basel, Basel, Switzerland

[4] Borås Djurpark, Boras, Sweden

[5] Zoologischer Stadtgarten Karlsruhe, Karlsruhe, Germany

Correspondence
Christian Schiffmann, Vetsuisse Faculty, Clinic for Zoo Animals, Exotic Pets and Wildlife, University of Zurich, Winterthurerstr. 260, CH-8057 Zurich, Switzerland.
Email: c.schiffmann.elephantproject@gmail.com

Little attention has been paid to the resting and sleeping behavior of zoo elephants so far. An important concern is when elephants avoid lying down, due to degenerative joint and foot disease, social structure, or stressful environmental changes. Inability or unwillingness to lie down for resting is an important welfare issue, as it may impair sleep. We emphasize the importance of satisfying rest in elephants by reviewing the literature on resting behavior in elephants (*Loxodonta africana* and *Elephas maximus*) as well as the documentation of four cases from European zoos and our own direct observations in a zoo group of four female African elephants during 12 entire days. The common denominator in the case reports is the occurrence of a falling bout out of a standing position subsequently to a cessation of lying rest for different periods of time. Although well-known in horses as "episodic collapse" or "excessive drowsiness," this syndrome has not been described in elephants before. To enable its detection, we recommend nocturnal video monitoring for elephant-keeping institutions. The literature evaluation as well as own observational data suggest an inverse relationship between lying rest and standing rest. Preventative measures consist of enclosure modifications that facilitate lying rest (e.g., sand hills) or standing rest in a leaning position as a substitute. Anecdotal observations suggest that the provision of appropriate horizontal environmental structures may encourage safe, sleep-conducive standing rest. We provide drawings on how to install such structures. Effects of providing such structures should be evaluated in the future.

KEYWORDS
elephant, leaning, lying rest, sleep, zoo

1 | INTRODUCTION

Modern zoos have achieved many improvements in elephant husbandry and management during the past years (Greco, Meehan, Hogan et al., 2016; Greco, Meehan, Miller et al., 2016). In doing so, studies on natural behavior of elephants supplied basic information concerning their needs. Most probably due to challenging observation conditions, only little research on nocturnal behavior of free-ranging elephants has been conducted yet, leaving few "natural benchmark" data in particular with respect to sleeping behavior.

Evans (1910) already postulated that "it is of outmost importance that the elephant should have his sleep. . ." and common sense

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RESEARCH REVIEW WITH CASE STUDIES

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[3] Zoologischer Garten Basel, Basel, Switzerland

[4] Borås Djurpark, Boras, Sweden

[5] Zoologischer Stadtgarten Karlsruhe, Karlsruhe, Germany

Correspondence
Christian Schiffmann, Vetsuisse Faculty, Clinic for Zoo Animals, Exotic Pets and Wildlife, University of Zurich, Winterthurerstr. 260, CH-8057 Zurich, Switzerland.
Email: c.schiffmann.elephantproject@gmail.com

Little attention has been paid to the resting and far. An important concern is when elephants a joint and foot disease, social structure, or stress unwillingness to lie down for resting is an imp sleep. We emphasize the importance of satisfy literature on resting behavior in elephants (*Loxo* well as the documentation of four cases fron observations in a zoo group of four female Africa common denominator in the case reports is th standing position subsequently to a cessation of Although well-known in horses as "episodic co syndrome has not been described in elephant recommend nocturnal video monitoring for literature evaluation as well as own observation between lying rest and standing rest. Preven modifications that facilitate lying rest (e.g., sa position as a substitute. Anecdotal observa appropriate horizontal environmental structures standing rest. We provide drawings on how providing such structures should be evaluated

KEYWORDS
elephant, leaning, lying rest, sleep, zoo

1 | INTRODUCTION

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Evans (1910) already postulated that "it is of outmost importance that the elephant should have his sleep. . ." and common sense

Received: 30 December 2017 | Revised: 13 February 2018 | Accepted: 20 February 2018
DOI: 10.1002/zoo.21406

RESEARCH REVIEW WITH CASE STUDIES

WILEY ZOOBIOLOGY

When elephants fall asleep: A literature review on elephant rest with case studies on elephant falli solutions for zoo elephants

Christian Schiffmann[1,2] | Stefan Hoby[3] | Christian
Robert Scholz[5] | Marcus Clauss[1] | Jean-Michel Ha

[1] Vetsuisse Faculty, Clinic for Zoo Animals, Exotic Pets and Wildlife, University of Zurich, Zurich, Switzerland

[2] Elefantenhof Platschow, Ziegendorf, Germany

[3] Zoologischer Garten Basel, Basel, Switzerland

[4] Borås Djurpark, Boras, Sweden

[5] Zoologischer Stadtgarten Karlsruhe, Karlsruhe, Germany

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FIGURE 4 Making use of its tusks to get a more relaxed sleeping position (resting and locking the head into the grid door) may lead to abrasions on the tusks of an elephant

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WILEY ZOOBIOLOGY

When elephants fall asleep: A literature review rest with case studies on elephant falling bout solutions for zoo elephants

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Robert Scholz[5] | Marcus Clauss[1] | Jean-Michel Hatt[1]

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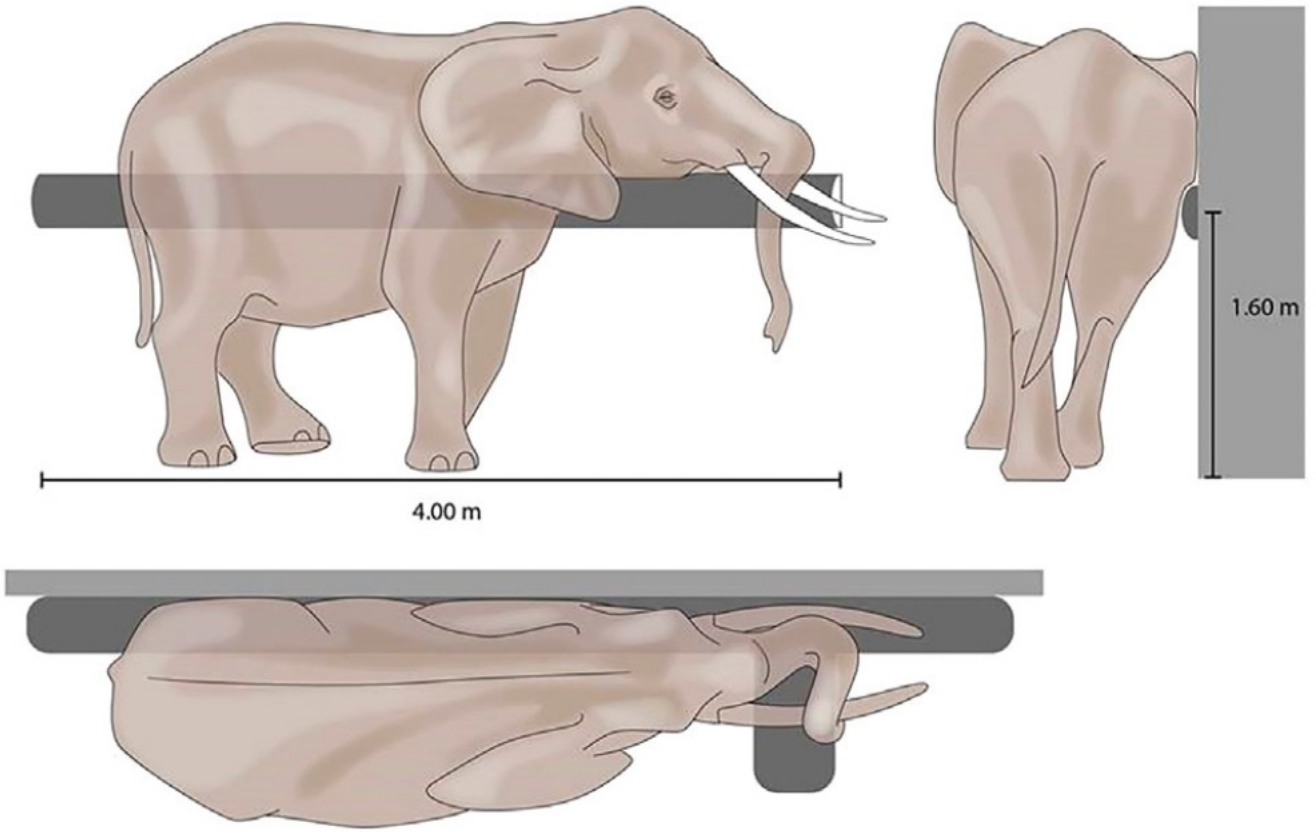

FIGURE 5 Drawing of a horizontal protuberance suggested to facilitate relaxed leaning behavior for an elephant (drawing by Jeanne Peter)

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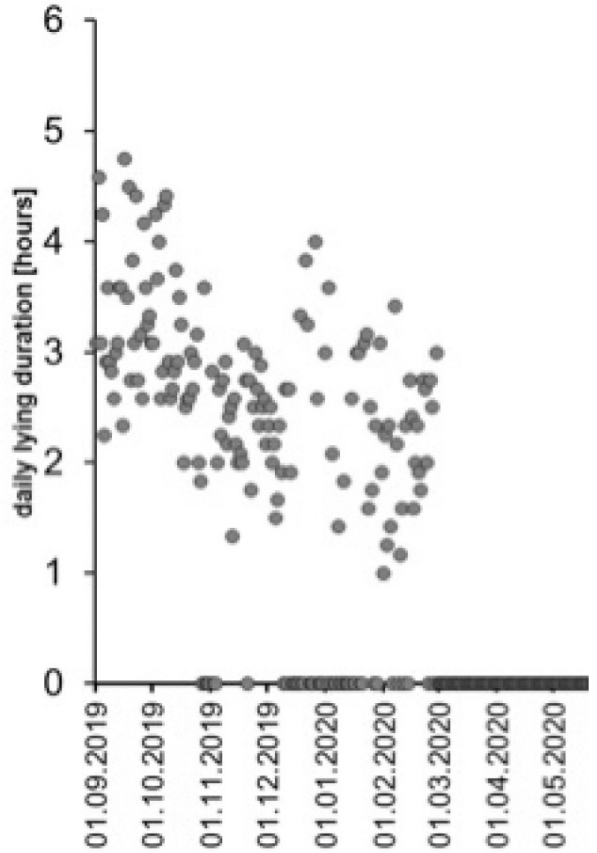

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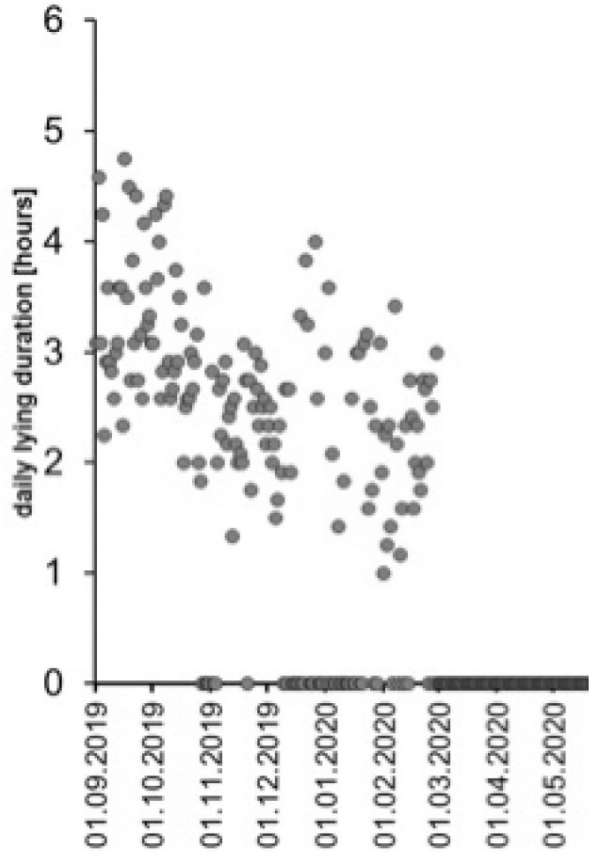

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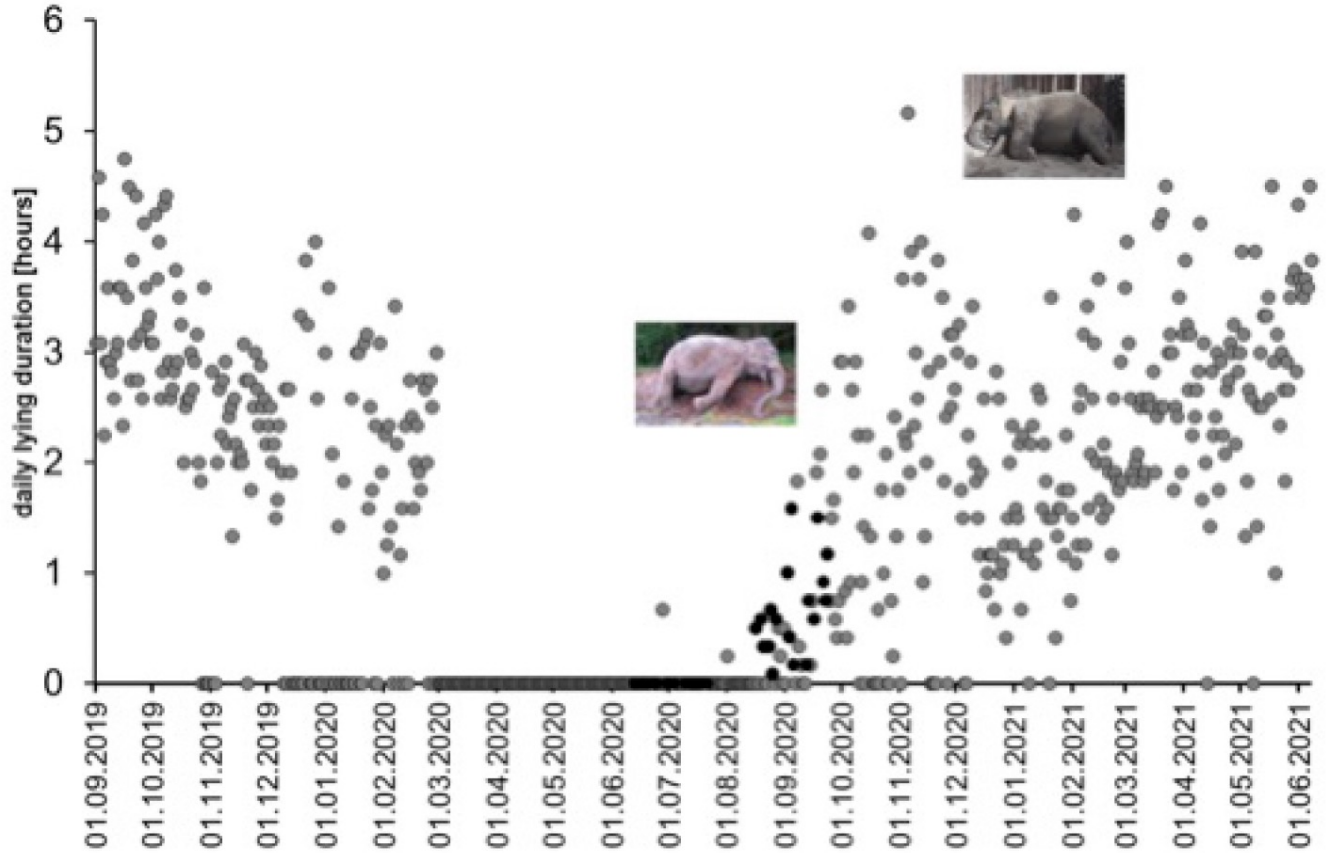
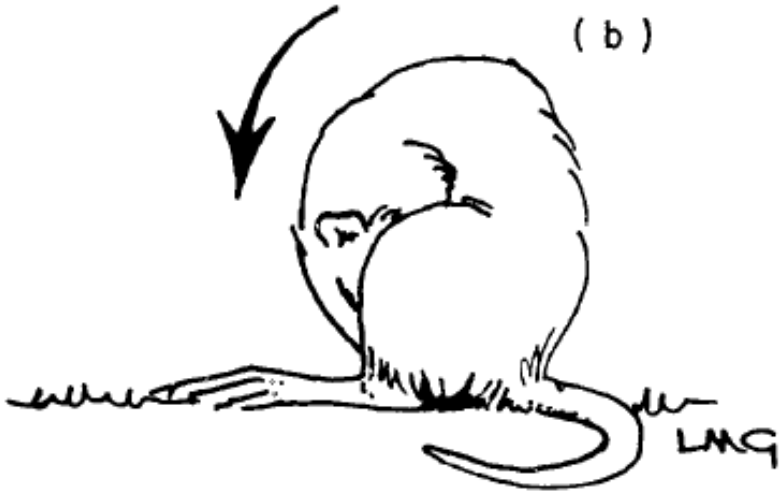


Example 3

Porcupines

Hystricomorph rodents and coprophagy



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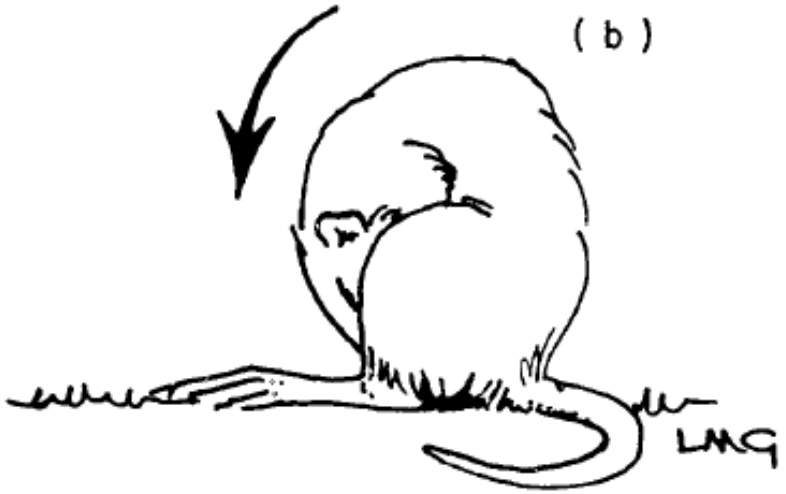

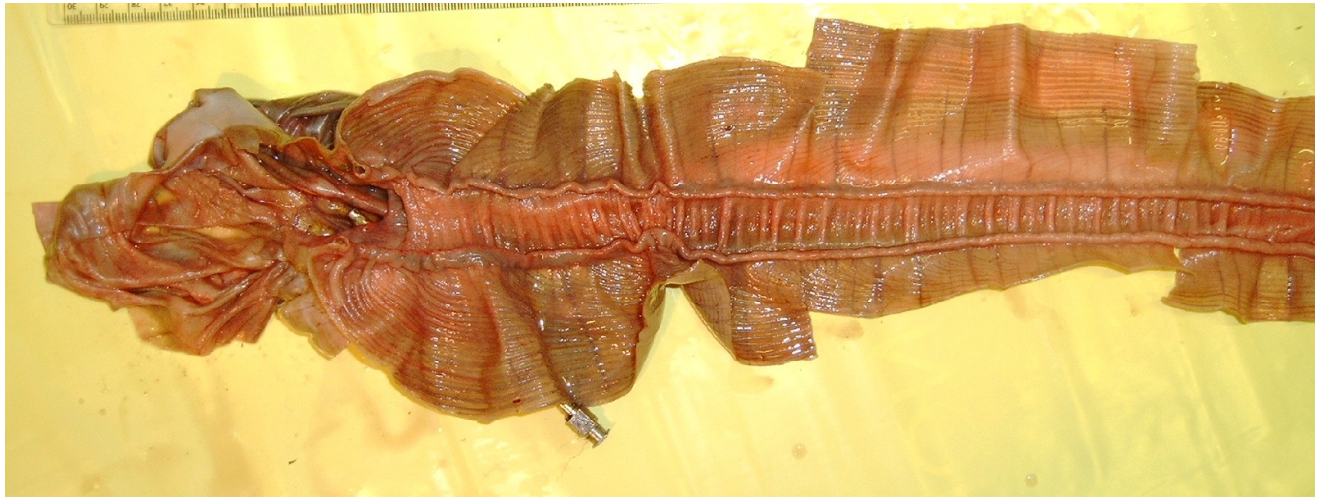

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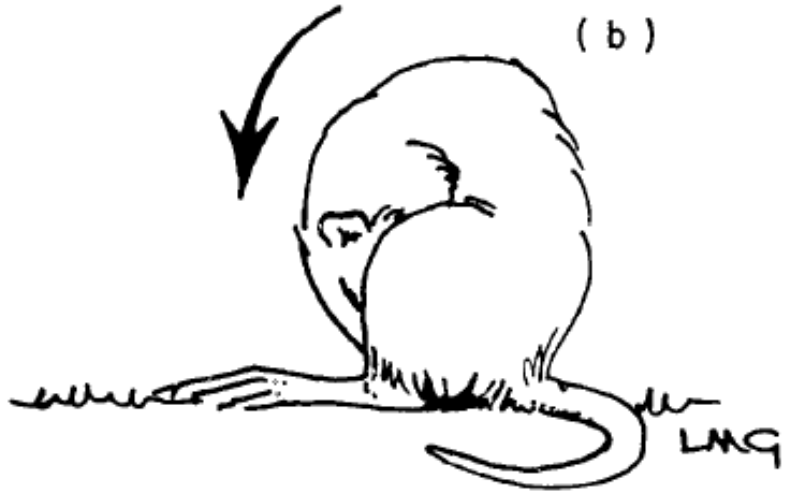

The Porcupine Cecal Fermentation [1]

JOHN L. JOHNSON [2] AND RICHARD H. McBEE
Department of Botany and Microbiology, Montana State University, Bozeman, Montana

ABSTRACT The fermentation in the cecum of the wild porcupine was studied to determine the principle products, their rates of formation, percentage absorption and contribution toward satisfying the energy requirement of the animal. Fermentation rates were determined by the zero-time method using cecal content from slaughtered animals. Volatile fatty acids (VFA) were determined by gas chromatography. VFA levels in the cecal blood were also measured. The fermentation resembled that of a ruminant eating a high roughage diet. The products were chiefly the VFA acetic, propionic and butyric, found in average proportions of 74, 12 and 14% respectively. Most of these were absorbed with 88% of the absorption from the cecum and 12% from the large intestine. Absorption rates are proportional to concentrations. The average contribution of the cecal fermentation to the maintenance energy requirements of the animal was 16% but was as high as 33% in one animal.

J. NUTRITION, *91:* '67

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Mammalian Biology
https://doi.org/10.1007/s42991-023-00376-1

SHORT COMMUNICATION

Behaviour indicative of coprophagy in zoo-managed porcupine (*Hystrix indica*)

Martin Polotzek[1,2] · Jasmin Schirmer[1] · Judith Schindler[1] · Marcus Clauss[2]

Received: 10 July 2023 / Accepted: 25 August 2023

Abstract
Although all hystricomorph rodents have the colonic furrow or groove that is the anatomical prerequisite for a 'mucous trap' colonic separation mechanism linked to coprophagy or cecotrophy, the taxon that gives this group its name, the porcupines, have been claimed to not practice coprophagy. Absence of coprophagy has repeatedly been claimed for hystricomorph species in which it was later confirmed. Here, we report the observation of a characteristic posture—sitting on one hindleg, with the other hindleg lifted and the snout covering the anogenital region—that is the typical posture during coprophagy in other large hystricomorph rodents, in two zoo-managed Indian crested porcupines (*Hystrix indica*). Together with other circumstantial evidence, these observations are suggestive of coprophagy in porcupines, and support claims that it may be wise to assume all hystricomorph rodents can use this strategy.

Keywords Rodent · Herbivory · Cecotrophy · Digestive physiology · Nutrition · Protein

The hystricomorph rodents are characterized by a groove in their proximal colon (Gorgas 1967; Langer 2017) that is an integral part of a so-called 'colonic separation mechanism' (Björnhag and Snipes 1999). Its major function is to trap microbes from the colonic digesta and transport them backwards into the caecum (Takahashi and Sakaguchi 2000). Hence, the regular, so-called 'hard' faeces are somewhat depleted of microbial material (Takahashi and Sakaguchi 1998). In the caecum, the microbes are collected and form a major part of the so-called 'soft' faeces that are re-ingested in the act of 'coprophagy' or 'caecotrophy'.

Ingestion takes place directly as the soft faeces exit the anus, so that the behaviour might be interpreted as autogrooming or cleaning. In some species, the typical posture is a sagittal bending of the body, while squatting on both hindlegs, so that the snout reaches the anus—as depicted for nutrias (*Myocastor coypus*) (Gosling 1979) or viscachas (*Lagostomus maximus*) (Hagen et al. 2015). In larger species, the typical posture is sitting on one hindleg, while the other is slightly lifted and the body bends back sideways, with the snout reaching towards the anus underneath the lifter leg—as depicted for capybaras (*Hydrochoerus hydrochaeris*) (Mendes and Nogueira-Filho 2013) or pacas (*Cuniculus paca*) (Guerra Aldrigui et al. 2018a).

It has been suggested that all hystricomorph rodents should be considered coprophagic based on the ubiquitous presence of the colonic groove (Clauss et al. 2007). Apart from the species mentioned above, coprophagy has been demonstrated in many other hystricomorph rodent species: in the guinea pig (*Cavia porcellus*) and the chinchilla (*Chinchilla laniger*) (Holtenius and Björnhag 1985), the greater cane rat (*Thryonomys swinderianus*) (Holzer et al. 1986), the punare (*Thrichomys apereoides*) (Roberts et al. 1988), the naked mole rat (*Heterocephalus glaber*) (Sherman et al. 1992), the degu (*Octodon degus*) (Kenagy et al. 1999), the

Handling editor: Heiko Georg Rödel.

✉ Marcus Clauss
mclauss@vetclinics.uzh.ch

Martin Polotzek
polotzek@tiergarten-kleve.de

Jasmin Schirmer
schirmer@tiergarten-kleve.de

Judith Schindler
schindler@tiergarten-kleve.de

[1] Tiergarten Kleve (Zoo Cleves), Tiergartenstr. 74, 47533 Cleves, Germany

[2] Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurerstr. 260, 8057 Zurich, Switzerland

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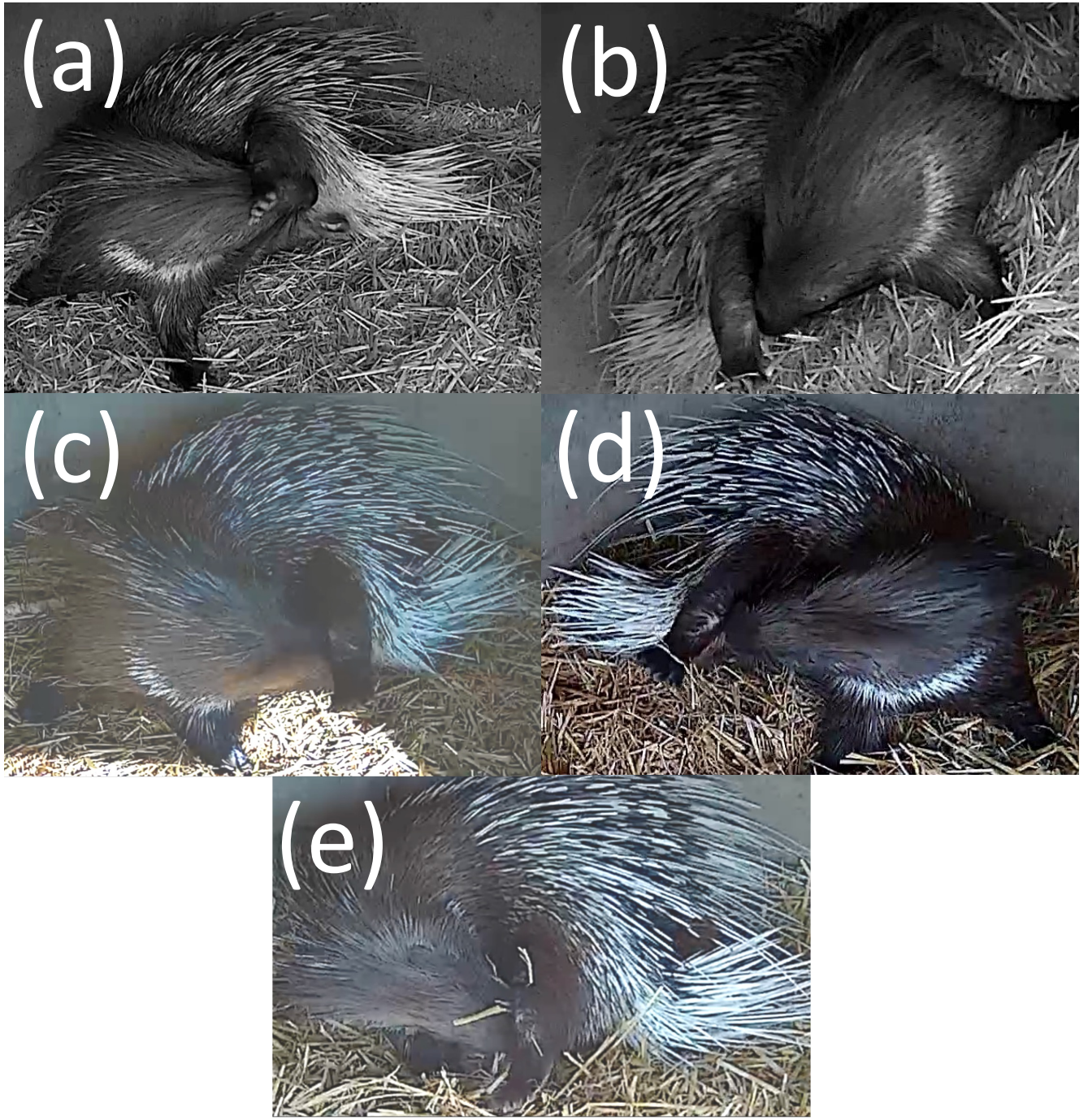

Example 4

What parents do at night

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Research article

Activity budget and behaviour of giant otters *Pteronura brasiliensis* at Parken Zoo, Eskilstuna, Sweden

Mélodie Friedmann[1], Anita Burkevica[2], Linn Lagerström[2], Jenny Gustafsson[2], Julia Johnsson[2], Peter Lundgren[2] and Marcus Clauss[1]

[1]Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurerstr. 260, 8057 Zurich, Switzerland
[2]Parken Zoo, Flackstavägen 13, 63222 Eskilstuna, Sweden

Correspondence: Marcus Clauss, email; mclauss@vetclinics.uzh.ch

Keywords: activity budget behaviour, feeding enrichment, *Pteronura brasiliensis*, welfare, zoos

Article history:
Received:
Accepted:
Published online:

Abstract

Modern zoos must ensure the welfare and conservation of their captive animals. For this, it is recommended to provide cognitive stimuli ('enrichment'), good habitat management and adequate nutrition amongst other things. Assessment of animal welfare should include behavioural observation. One frequently used approach compares the activity budget of zoo animals with their wild conspecifics, carefully interpreting resulting differences. Here, this method is used for giant otters *Pteronura brasiliensis* on a feeding regime with three fixed feeding times during the keeper's working day, and ice blocks containing fish suspended above the pool, thawing over time and thus releasing fish well into the night. This time-delayed food dispensing was expected to make the subjects spend a large proportion of time foraging. Nevertheless, results show a lower feeding proportion than reported in the literature for this species in the wild (27% versus 64%), likely related to the fact that zoo animals did not have to hunt live prey. The captive otters also spent less time scent-marking (1% versus 9%), possibly due to the absence of other conspecific groups in their vicinity. By contrast, there was a higher proportion of resting (34% versus 21%) and affiliative behaviours (14% versus 1%), suggesting that shifts in the activity budget between natural habitats and zoos need not always be interpreted as indicators of reduced welfare. 'Calling family members to food', reported in the wild, was observed repeatedly when one family member was awake and the rest were asleep at a time that fish fell from the thawing block into the pool. Extending food distribution over time, particularly into the night, might develop behaviours other than increased feeding activity as indicators of welfare in captive giant otters. Further investigations with delayed feeding methods for this and other species are needed.

Introduction

The assessment of animal welfare is complex. One approach is to compare the activity budget of zoo animals with that of their free-ranging conspecifics, with a special focus on behaviours considered appropriate for keeping the animals occupied, such as feeding (Melfi and Feistner 2002; Veasey et al. 1996). Some studies on activity budgets focus only on zoo (Azevedo et al. 2015; Bashaw 2011; Bashaw et al. 2003; Brereton et al. 2023; Jenny and Schmid 2002; Ross 2002; Wallgren 2014) or wild individuals (Cortez et al. 2016; Duplaix 1980; Leuchtenberger et al. 2014; Walker et al. 2008), while others directly compare results from zoo subjects either with pre-existing literature (Melfi and Feistner 2002) or with data recorded during parallel observations in the wild (Inoue and Shimada 2020; Yamanashi and Hayashi 2011). Most of these studies indicate that feeding behaviours like foraging or hunting occur less frequently in zoo individuals than in the wild but might increase when the individuals are exposed to new stimuli ('enrichment'). Nevertheless, Veasey et al. (1996) point out that not all behaviours expressed in the wild need to be replicated in zoos, especially if one assumes that the consequences of the behaviour are more important than the expression of the behaviour itself. More recently, Browning (2020) emphasised

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Published online:

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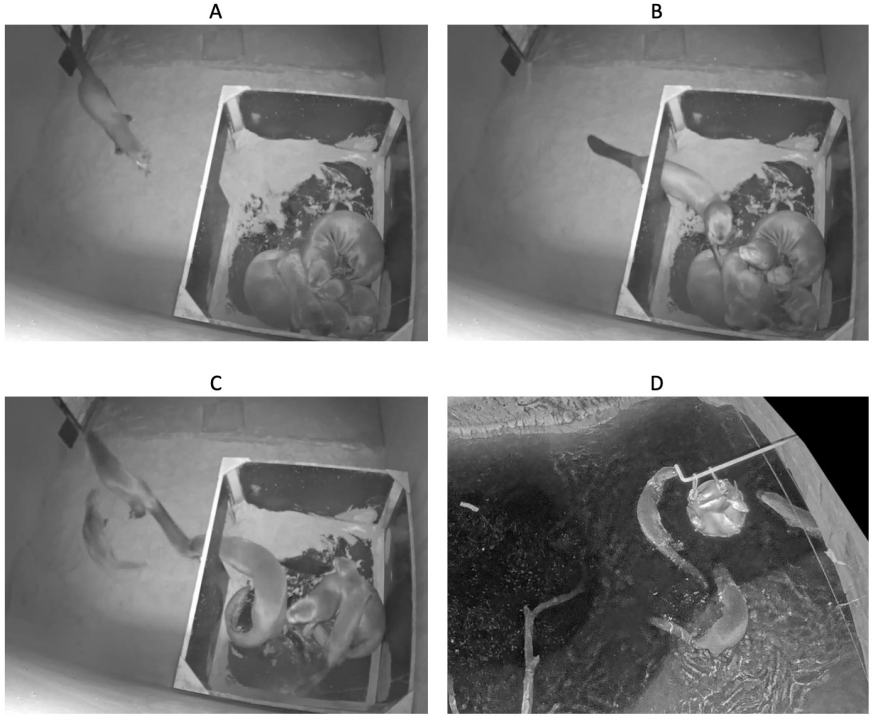
Modern zoos must ensure the welfare and conservation of their captive animals. For this, it is recommended to provide cognitive stimuli ('enrichment'), good habitat management and adequate nutrition amongst other things. Assessment of animal welfare should include behavioural observation. One frequently used approach compares the activity budget of zoo animals with their wild conspecifics, carefully interpreting resulting differences. Here, this method is used for giant otters *Pteronura brasiliensis* on a feeding regime with three fixed feeding times during the keeper's working day, and ice blocks containing fish suspended above the pool, thawing over time and thus releasing fish well into the night. This time-delayed food dispensing was expected to make the subjects spend a large proportion of time foraging. Nevertheless, results show a lower feeding proportion than reported in the literature for this species in the wild (27% versus 64%), likely related to the fact that zoo animals did not have to hunt live prey. The captive otters also spent less time scent-marking (1% versus 9%), possibly due to the absence of other conspecific groups in their vicinity. By contrast, there was a higher proportion of resting (34% versus 21%) and affiliative behaviours (14% versus 1%), suggesting that shifts in the activity budget between natural habitats and zoos need not always be interpreted as indicators of reduced welfare. 'Calling family members to food', reported in the wild, was observed repeatedly when one family member was awake and the rest were asleep at a time that fish fell from the thawing block into the pool. Extending food distribution over time, particularly into the night, might develop behaviours other than increased feeding activity as indicators of welfare in captive giant otters. Further investigations with delayed feeding methods for this and other species are needed.

Introduction

The assessment of animal welfare is complex. One approach is to compare the activity budget of zoo animals with that of their free-ranging conspecifics, with a special focus on behaviours considered appropriate for keeping the animals occupied, such as feeding (Melfi and Feistner 2002; Veasey et al. 1996). Some studies on activity budgets focus only on zoo (Azevedo et al. 2015; Bashaw 2011; Bashaw et al. 2003; Brereton et al. 2023; Jenny and Schmid 2002; Ross 2002; Wallgren 2014) or wild individuals (Cortez et al. 2016; Duplaix 1980; Leuchtenberger et al. 2014; Walker et al. 2008), while others directly compare results from zoo subjects either with pre-existing literature (Melfi and Feistner 2002) or with data recorded during parallel observations in the wild (Inoue and Shimada 2020; Yamanashi and Hayashi 2011). Most of these studies indicate that feeding behaviours like foraging or hunting occur less frequently in zoo individuals than in the wild but might increase when the individuals are exposed to new stimuli ('enrichment'). Nevertheless, Veasey et al. (1996) point out that not all behaviours expressed in the wild need to be replicated in zoos, especially if one assumes that the consequences of the behaviour are more important than the expression of the behaviour itself. More recently, Browning (2020) emphasised



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Research article

Activity budget and behaviour of giant otters *Pteronura brasiliensis* at Parken Zoo, Eskilstuna, Sweden

Mélodie Friedmann[1], Anita Burkevica[2], Linn Lagerström[2], Jenny Gustafsson[2], Julia Johnsson[2], Peter Lundgren[2] and Marcus Clauss[1]

[1]Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurerstr. 260, 8057 Zurich, Switzerland
[2]Parken Zoo, Flackstavägen 13, 63222 Eskilstuna, Sweden

Correspondence: Marcus Clauss, email; mclauss@vetclinics.uzh.ch

Keywords: activity budget behaviour, feeding enrichment, *Pteronura brasiliensis*, welfare, zoos

Article history:
Received:
Accepted:
Published online:

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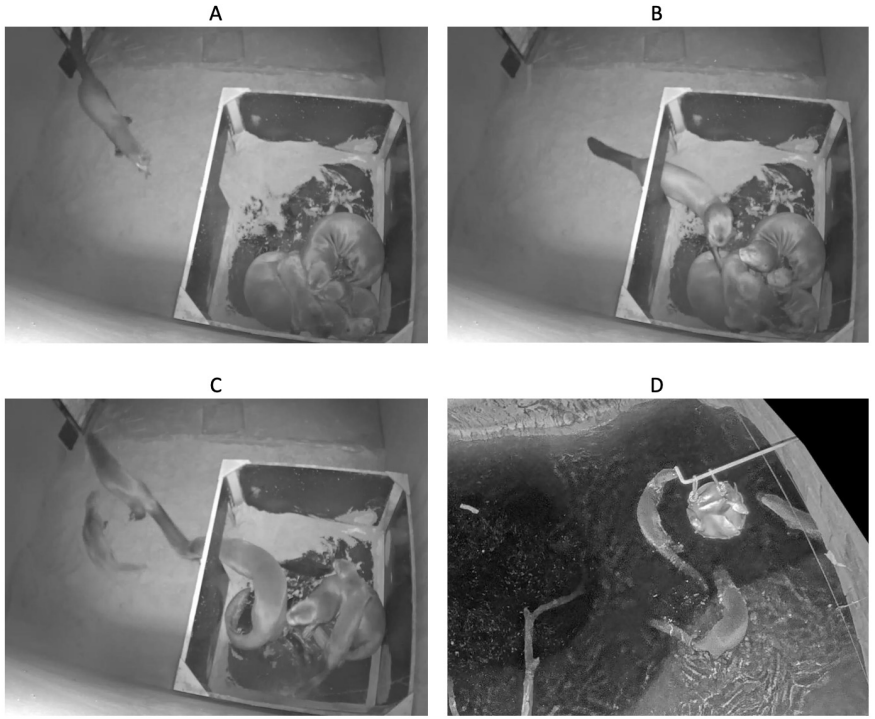

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Other examples

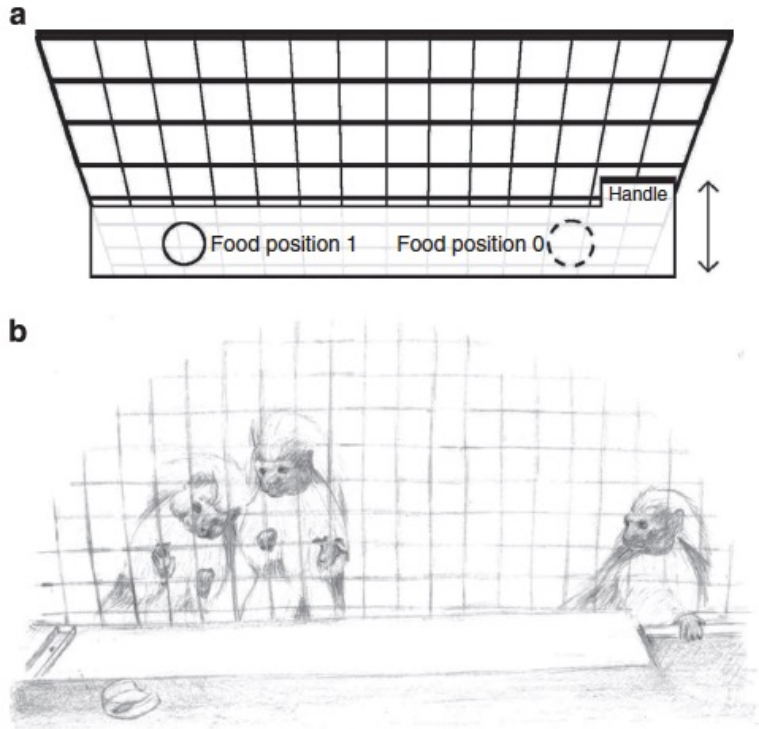
There is so much more!

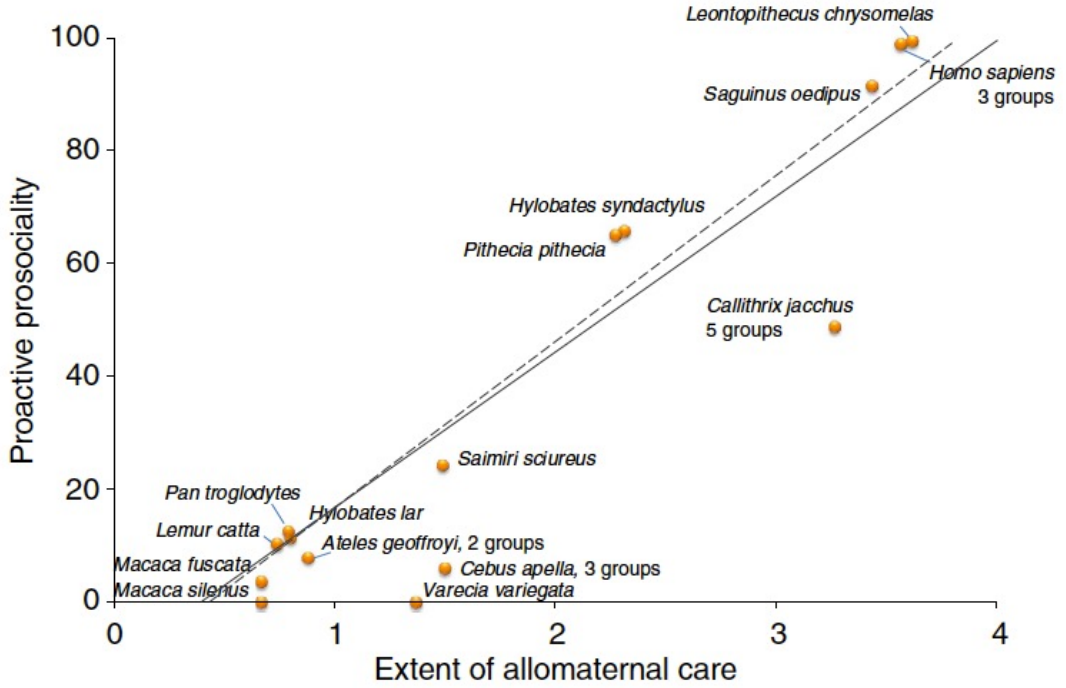
Cellina Kleinlugtenbelt (2022)

The evolutionary origin of human hyper-cooperation

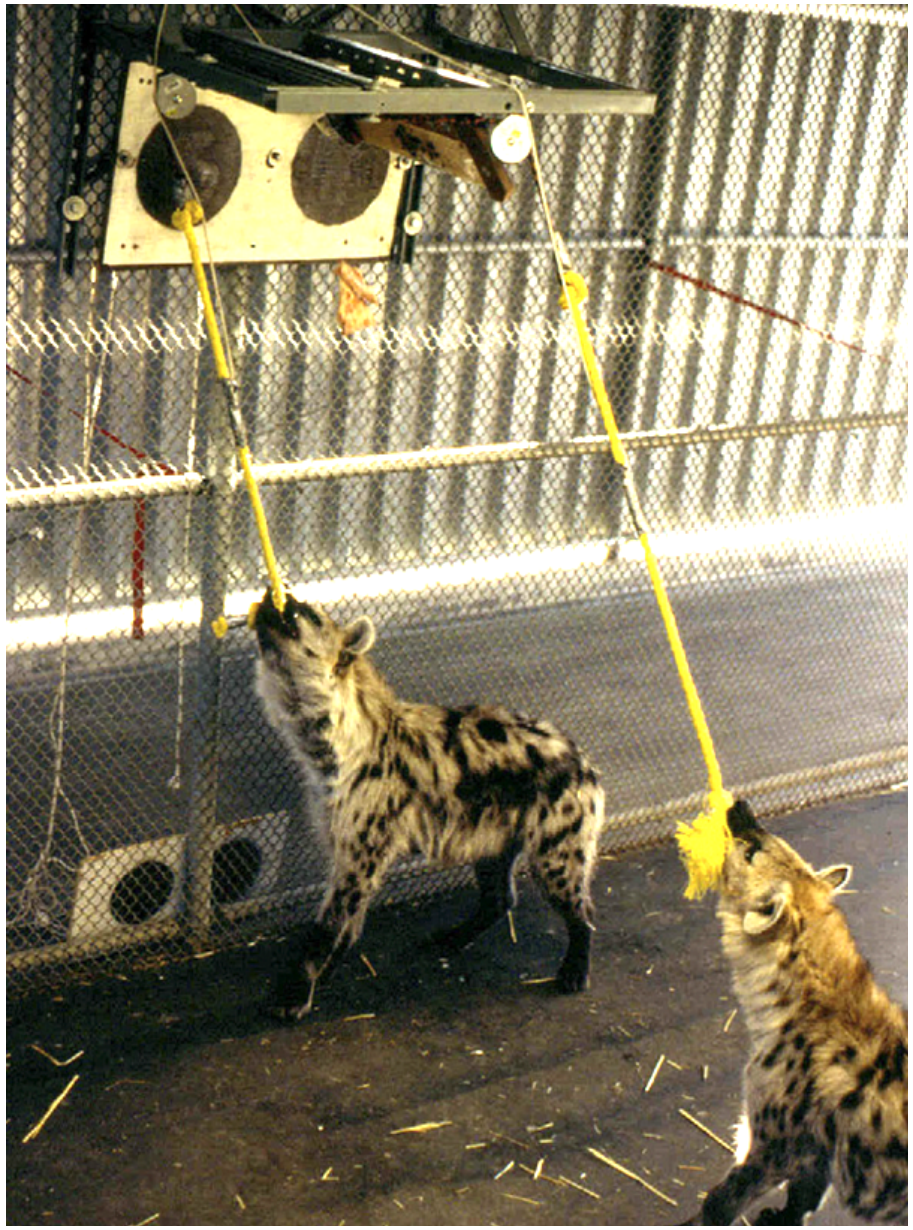
NATURE COMMUNICATIONS | 5:4747

J.M. Burkart[1], O. Allon[2], F. Amici[3], C. Fichtel[4], C. Finkenwirth[1], A. Heschl[5], J. Huber[6], K. Isler[1], Z.K. Kosonen[1], E. Martins[1], E.J. Meulman[1], R. Richiger[1], K. Rueth[1], B. Spillmann[1], S. Wiesendanger[1] & C.P. van Schaik[1]





Cooperation displays



If you work in a zoo, most likely you like something about animals.

There is always something you can record about the animals in your care.

If you work in a zoo, most likely you like something about animals.
There is always something you can record about the animals in your care.

Even if ‘only’ their activity budget.

Activity budgets: tortoises

Activity and home range of *Testudo hermanni* in Northern Italy

Stefano Mazzotti[1], Anna Pisapia[2], Mauro Fasola[2]

[1] Museo di Storia Naturale, Via De Pisis 24, I-44100 Ferrara, Italy
e-mail: conszool@comune.fe.it
[2] Dipartimento Biologia Animale, Università, Piazza Botta 9, I-27100 Pavia, Italy

Abstract. We describe the behavioral adaptations of a population of Hermann's tortoise to the climate of a northern sector of its range, and to a wooded biotope that is uncommon for the species. The activity, the home range, and the thermal relations along the daily and the yearly cycle are described. In contrast to other populations that have bimodal activity peaking in spring and in autumn, the tortoises in our study area had unimodal seasonal activity that can be related to lower summer temperatures. Home range size, 7.4 ha for females and 4.6 ha for males in our study area, was from three to seven times larger than that of all other populations. The large home range, and the low population density of the tortoises in our study area, may be due to food scarcity in the wooded habitat.

Introduction

Reptiles are conditioned by environmental factors, especially temperature that influences their metabolism and activity (Swingland and Fraizer, 1980; Meek and Jayes, 1982; Meek and Avery, 1988; Parmenter and Avery, 1990; Diaz-Paniagua et al., 1995), although most species may also control their body temperature through behavioral and physiological mechanisms (Huey, 1982; Sturbaum, 1982; Gavaud, 1987). Several studies have shown that thermal relations strongly influence the behavior and ecology of Hermann's tortoise *Testudo hermanni* (Hailey et al., 1984; Meek, 1984, 1988; Pulford et al., 1984; Chelazzi and Calzolai, 1986; Panagiota and Valakos, 1992; Carretero et al., 1995; Huot-Daubremont et al., 1996; Huot-Daubremont and Grenot, 1997; Mazzotti and Vallini, 1999). Long-term research on the movement patterns and homing behaviour of Hermann's tortoise (Chelazzi and Francisci, 1979) have shown that these tortoises stay within a stable home range, whose size varies seasonally (Calzolai and Chelazzi, 1991).

Amphibia-Reptilia 23: 305-312

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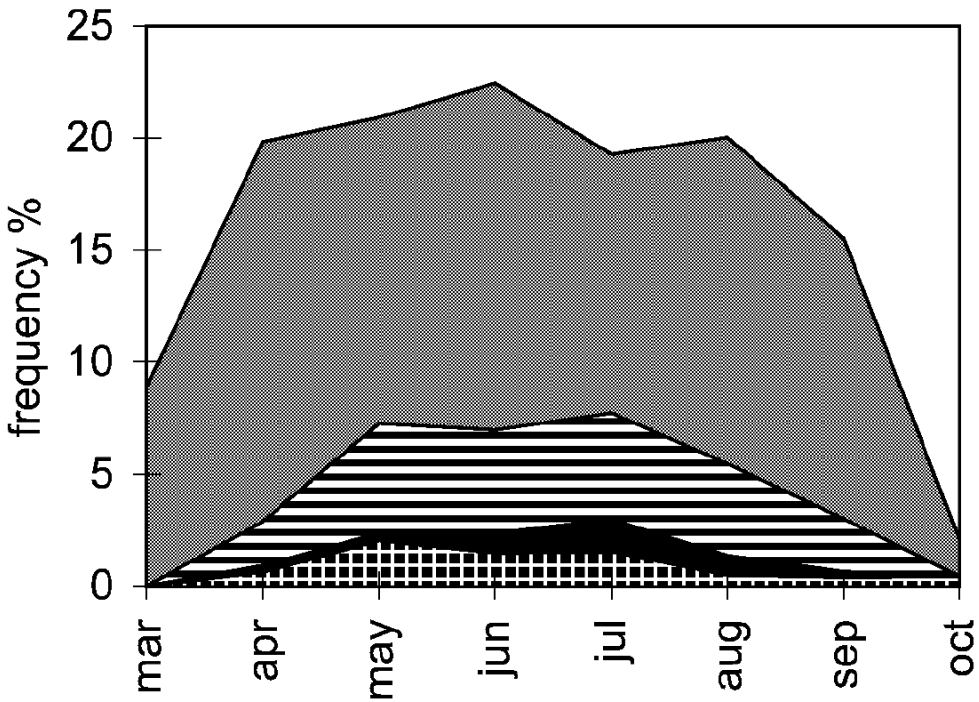

Activity budgets: tortoises

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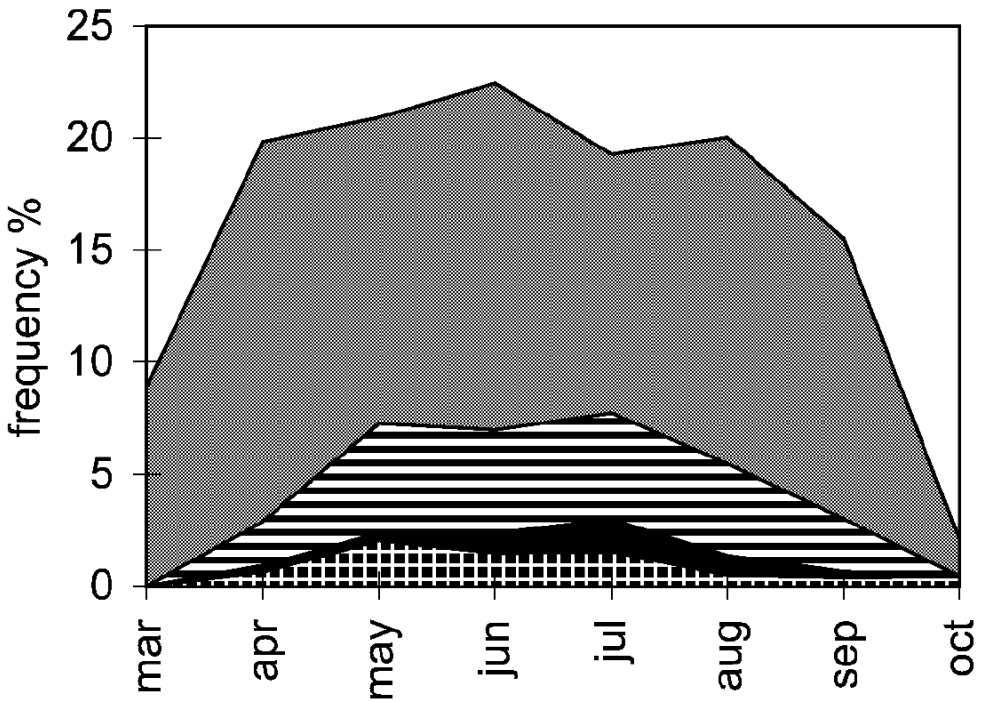

Assume 12 h-period: 14 min feeding / day*

*2 % of 12 = 0.24 h = 14 min

Activity budgets: tortoises

ECOGRAPHY 26: 236–242, 2003

Foraging behaviour and diet of an ectothermic herbivore: *Testudo horsfieldi*

Frédéric Lagarde, Xavier Bonnet, Johanna Corbin, Brian Henen, Ken Nagy, Baktjior Mardonov and Guy Naulleau

Lagarde, F., Bonnet, X., Corbin, J., Henen, B., Nagy, K., Mardonov, B. and Naulleau, G. 2003. Foraging behaviour and diet of an ectothermic herbivore: *Testudo horsfieldi*. – Ecography 26: 236–242.

Herbivorous vertebrates of arid regions are frequently faced with inadequate food quality, quantity or both. The time and energy devoted to foraging is vital to balancing their energy budgets. For desert ectotherms, a low metabolism should be advantageous, reducing their total energy requirement, but extreme ambient temperatures can strongly constrain these animals' activity periods. We provide the first data

They remain inactive most of their "active season" (90%), and spend very little time foraging (< 15 min per day).

F. Lagarde (lagarde@cebc.cnrs.fr), X. Bonnet, J. Corbin and G. Naulleau, Centre d'Etudes Biologiques de Chizé-CNRS, F-79360 Villiers en Bois, France. – B. Henen, Dept of Zoology, Biodiversity and Conservation Biology, Univ. of Western Cape, Belville 7535, South Africa. – K. Nagy, Dept of Organismic Biology, Ecology and Evolution, 621 Young South Drive, Univ. of California, Los Angeles, CA 90095-1606, USA. – B. Mardonov, Samarkand Div. of the Academy of Sciences, 40 Djisakskaya St., Samarkand, 703032, Uzbekistan.

An appreciation of the feeding ecology of a wide diversity of species is central to understanding the general processes of resource acquisition and allocation. Biologists debate the degree of influence of ectothermic and endothermic physiology upon the marked divergence seen in their feeding ecologies. Compared to endotherms, ectotherms are characterised by low metabolic rates, low energy requirements, and low food intakes (Pough 1980, Nagy 1983, Karasov et al. 1986, Zimmerman and Tracy 1989). These traits may represent pre-adaptations (or exaptations, Bradshaw 1997) in ecosystems (e.g., deserts) where food shortages occur frequently and may confer ecological advantages to ectotherms. These features enable ectotherms to have high densities (i.e., individuals per area), high biomasses and production values (Nagy 1983, Bradshaw 1986), relative to comparable-sized endotherms. Conversely, ectotherm sensitivity to environmental conditions, particularly ambient temperature, strongly constrains the periods when ectotherms can be active (Hutchison 1979, Peterson et al. 1993). Typically, the periods favourable for activity are greatly reduced in desert-dwelling animals that are subject to extremely harsh climatic conditions. Strict time-activity budgets can help organisms to satisfy the demands of growth, reproduction and maintenance

Accepted 8 July 2002

ISSN 0906-7590

Miriam Göbel
ALLWETTERZOO.DE

Department of Behavioural Biology
University of Muenster

ALLWETTERZOO MÜNSTER

Miriam Göbel
ALLWETTERZOO.DE

Department of Behavioural Biology
University of Muenster

ALLWETTERZOO MÜNSTER

Miriam Göbel
ALLWETTERZOO.DE

Department of Behavioural Biology
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What can you do ?

- you have the animals 
- you might have to invest (a tiny bit) in cameras and recording equipment
- you can always recruit students

(no need for fancy labwork, expensive methods)

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… but you may have one problem:

What can you do ?

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- you can always recruit students

(no need for fancy labwork, expensive methods)

… but you may have one problem:

- Someone needs to write it up (and do the graphs, some basic statistics, Tables etc.)
- … which also means: someone has to read a bit
- as a start: team up with someone who will do it

There must be something you find fascinating about animals.

There must be something you find fascinating about animals.

Have a close look at whatever that is.

There must be something you find fascinating about animals.

Have a close look at whatever that is.

Find a way of communicating that to the community as a scientific publication.