Challenges in zoo animal nutrition

Marcus Clauss

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

Kraków 2018
# Lectures: Marcus Clauss

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Notes</th>
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<tbody>
<tr>
<td>2004</td>
<td>Boskos Seminar Pretoria</td>
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<td>2008</td>
<td>ESVON (Talk)</td>
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<td>2012</td>
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<td>2013</td>
<td>Wildlife digestive physiology course, UZH</td>
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- Tannins and herbs (PDF, 3758 KB)
- Digestive physiology of sauvs (PDF, 1055 KB)
- Evolutionary adaptations of ruminants (PDF, 6054 KB)
- Adaptations of desert animals (PDF, 4236 KB)
- Hard management (PDF, 4669 KB)
- Stress in captive solitary species (PDF, 1011 KB)
- Digestive physiology of primates (PDF, 4057 KB)
- Comparative fibre digestion (PDF, 10430 KB)
- Diet abrasiveness and teeth (PDF, 7035 KB)
- Fütterung von Reptilien (PDF, 7745 KB)
- The incomparable mouse (PDF, 12051 KB)
- Dinosaur reconstructions (PDF, 13144 KB)
- Why birds fly and dinosaurs died out (PDF, 3062 KB)
- Introduction general physiology (PDF, 2912 KB)
- Introduction digestive physiology (PDF, 16024 KB)
- 1 Introduction (PDF, 242 KB)
- 1b Intro Physiology (PDF, 3603 KB)
Approach to zoo animal nutrition
Approach to zoo animal nutrition

+ “do as we always did”  -
Historical approach

Variations in Eastern Bongo (Tragelaphus eurycerus isaaci) Feeding Practices in UK Zoological Collections
D. J. Wright, M. Omed, C. M. Bishop, and A. L. Fidgett
Zoo Biology 30:149–164 (2011)

Research Article
Feeding practices for captive greater kudus (Tragelaphus strepsiceros) in UK collections
Lucy A. Taylor, Christoph Schwitzer, Norman Owen-Smith, Michael Kreuzer, and Marcus Clauss
Approach to zoo animal nutrition

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Approach to zoo animal nutrition

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- based on experiences what has been working
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- sometimes ‘experiences’ are mistakes one has been making for long time
Example: tortoises

Recommendations from successive editions of the same (German) textbook
Example: tortoises

Recommendations from successive editions of the same (German) textbook

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<th>Year</th>
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**Example: tortoises**

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| 1999         | Leafy green vegetables, vegetables, fruits (apple, banana, pear, grapes, kiwi), sometimes canned dog/cat food, grain products |
| 2004-2009    | Greens (herbs, low proportion of salad/vegetables), low amounts of fruits (lead to malfermentation and diarrhoea),  
canned dog/cat food should not be main component (cause gout),  
milk and grain products only in small amounts,  
hay always ad libitum,  
cuttlefish bone/egg shells |
## Example: tortoises

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Approach to zoo animal nutrition

+ “do as we always did”
   based on experiences what has been working

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“imitate the natural diet”
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Example: Maned wolf (Chrysocyon brachyurus)
Example: Maned wolf  
*(Chrysocyon brachyurus)*

Various studies, e.g., Bueno et al. (2004)
Example: Coati (Nasua spp.)
Example: Coati \textit{(Nasua spp.)}

- Plant parts: 26%
- Fruits: 15%
- Insects: 24%
- Millipeds: 17%
- Spiders: 11%
- Refuse: 3%
- Vertebrates: 3%
- Gastropods: 1%

\textit{Alves-Costa et al. (2004)}
Natural diets

Research Article

Feeding practices for captive greater kudus (Tragelaphus strepsiceros) in UK collections.

Lucy A. Taylor¹,², Christoph Schwitzer¹, Norman Owen-Smith³, Michael Kreuzer³ and Marcus Claus³
Natural diets

Research Article

Feeding practices for captive greater kudus (Tragelaphus strepsiceros) in UK collections as compared to diets of free-ranging specimens

Lucy A. Taylor¹*, Christoph Schwitzer¹, Norman Owen-Smith¹, Michael Kreuzer³ and Marcus Claus²
Natural diets
Natural diets

2.2 Feeding

A. Knowledge of giraffe nutrition in the wild

It is important to know what giraffes are feeding on in the wild, when determining the proper diet in captivity.

2.2.1 Selection of feeding plants:

Hoffmann (1973) classifies the giraffe as a browser. Trees or shrubs become the dominant food plants (for a compilation of literature references see section 4, part D), leaves and shoots making up the most important items of the diet (Table 2-1). Selectivity of feeding behaviour is characterized by Van Scoot (1954) to be of an intermediate degree. Due to its large body size, a giraffe past cannot afford to feed as selectively as smaller ruminant species.

Table 2-1: Description of feeding behaviour

<table>
<thead>
<tr>
<th>Plant parts ingested</th>
<th>Importance to the diet</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves, small twigs</td>
<td>++</td>
<td>Leuthold and Leuthold</td>
</tr>
<tr>
<td>Some bark, flowers and fruit</td>
<td>++</td>
<td>(1972, 1978)</td>
</tr>
<tr>
<td>Leaves and shoots of trees and shrubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbaceous material (climbers, rume, tall herbs)</td>
<td>Up to 7%</td>
<td>Owen-Smith (1968)</td>
</tr>
<tr>
<td>Shoot tips</td>
<td>78%</td>
<td></td>
</tr>
<tr>
<td>Leaf sheaths</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Flowers</td>
<td>3%</td>
<td>Fellows (1984+6)</td>
</tr>
<tr>
<td>Pods</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

If new growing shoots are available (including young leaves, twigs and shoots), they represent the favoured food resource according to Sander et al. (1982). Older leaves are ingested when shoots are not available. Owen-Smith (1968) reports considerable amounts of woody material to be included in the diet (5% in the rainy and 15% in the dry season).
Natural diets
EltonTraits 1.0: Species-level foraging attributes of the world’s birds and mammals

Ecological Archives E095-178

Hamish Wilman, Jonathan Belmaker, Jennifer Simpson, Carolina de la Rosa, Marcelo M. Rivadeneira, and Walter Jetz
Natural diets

**EltonTraits 1.0: Species-level foraging attributes of the world’s birds and mammals**

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Approach to zoo animal nutrition

“do as we always did”

+ based on experiences what has been working

- sometimes ‘experiences’ are mistakes one has been making for long time

“imitate the natural diet”

best approach

depends on what you know about the natural diet, and what feeds are available
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No easy-to-harvest packages of tiny invertebrates
Unavoidable detritus ingestion in myrmacophages

from McNab (1984)
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Example: Giant anteater (Myrmecophaga tridactyla)

Gull et al. (2015)
Example: Giant anteater \((Myrmecophaga tridactyla)\)

Gull et al. (2015)
Example: Giant anteater *(Myrmecophaga tridactyla)*

Gull et al. (2015)
Natural diets

There are no secret, species-specific ingredients!

Formic acid in anteater formulas?
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Two traditions in imitating natural diets
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Ratcliffe and Wackernagel

Hediger
Two traditions in imitating natural diets

Ratcliffe and Wackernagel

a complete feed for each animal (group) (pelleted/extruded)

Hediger

‘natural’ feeds (forages, fruits/vegetables), that resemble the natural diet
Two traditions in imitating natural diets

Ratcliffe and Wackernagel

- A complete feed for each animal (group) (pelleted/extruded)
- Atypical physical structure
- Some nutrients difficult to limit
- Behavioural deficits

Hediger

- ‘Natural’ feeds (forages, fruits/vegetables), that resemble the natural diet
- Selective feeding possible
- Available feeds differ from in nutrient content from the natural diet
Frugivores don’t eat supermarket fruit
Frugivores don't eat supermarket fruit
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Frugivores don’t eat supermarket fruit
Traditions in imitating natural diets
Traditions in imitating natural diets

**Diet and Oral Health in Captive Amur Tigers (Panthera tigris altaica)**

J. Zoo An. Med. 15: 142-146, 1984

L. I. Haberstroh, D.V.M.*
D. E. Ullrey, Ph.D.**
J. G. Sikarski, D.V.M., M.S.*
N. A. Richter, D.V.M.***
B. H. Colmery, D.V.M.*
T. D. Myers, D.D.S.****

**A SOFT VERSUS HARD DIET AND ORAL HEALTH IN CAPTIVE TIMBER WOLVES (Canis lupus)**


K.M. Vosburgh, B.S.*
R.B. Barbiers, B.S.*
J.G. Sikarskie, D.V.M., M.S.*
D.E. Ullrey, Ph.D.**
Traditions in imitating natural diets
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“use a suitable domestic species as model”
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“use a suitable domestic species as model”
  ‘scientific compromise’ huge amount of knowledge
<table>
<thead>
<tr>
<th>Use</th>
<th>Fibre content*</th>
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<tbody>
<tr>
<td>Beef cattle</td>
<td>12 %DM</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>18 %DM</td>
</tr>
<tr>
<td>Feral cattle</td>
<td>30 %DM</td>
</tr>
</tbody>
</table>

*historical recommendations for ration design
### Fibre content depends on intended use

<table>
<thead>
<tr>
<th>Use</th>
<th>Fibre content*</th>
<th>Longevity</th>
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<tbody>
<tr>
<td>Beef cattle</td>
<td>12 %DM</td>
<td>app. 2 years</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>18 %DM</td>
<td>app. 4 years</td>
</tr>
<tr>
<td>Feral cattle</td>
<td>30 %DM</td>
<td>app. 25 years</td>
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</tbody>
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*historical recommendations for ration design
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations*  

James G. Morris
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations

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James G. Morris

*essential food components
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations*

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James G. Morris
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations* 

James G. Morris

Many enzymes can be spared!
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations

James G. Morris
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations

James G. Morris

Food

Organism

essential food components
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations

James G. Morris

Food

Organism

● essential food components
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations

James G. Morris

not essential for dogs

essential nutrients:
- high protein requirement
- amino acids taurine and arginine
- arachidonic acid
- vitamin A (β-carotine useless)
- vitamin D
- niacin
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations*

James G. Morris
Idiosyncratic nutrient requirements of cats appear to be diet-induced evolutionary adaptations*

James G. Morris
Approach to zoo animal nutrition

**+ “do as we always did”**
- sometimes ‘experiences’ are mistakes one has been making for long time

based on experiences what has been working

**“imitate the natural diet”**

best approach depends on what you know about the natural diet, and what feeds are available

**“use a suitable domestic species as model”**

‘scientific compromise’ species-specific peculiarities are easily overlooked

huge amount of knowledge
COPPER DEFICIENCY IN CAPTIVE BLESBOK ANTELOPE
(\textit{Damiliscus dorcus phillipsi})

Ellen S. Dierenfeld, Ph.D., Emil P. Dolensek, D.V.M., Tracey S. McNamara, D.V.M., and James G. Doherty, B.S.
### Approach to zoo animal nutrition

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“based on studies in zoo animals”
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“use a suitable domestic species as model”
  ‘scientific compromise’ species-specific peculiarities are easily overlooked
  huge amount of knowledge

“based on studies in zoo animals”
  ‘scientific approach’ financially and logistically challenging, difficulty in summarizing knowledge
  huge amount of knowledge
Studies in zoo animals

- Case reports / case series
- Inventories of diets, pathological states, husbandry success
- Differences between free-range and zoo
- Epidemiological / controlled studies
Examples: case studies
Examples: case studies

**Dietary Taurine Supplementation and Cardiac Function in the Giant Anteater (Myrmecophaga tridactyla): Preliminary Findings**

J. Andrew Teare, DVM, MS, Alan D. Weldon, DVM, Dipl AvCIM, and Nikolay Kapustin, DVM

2009 Proceedings AAZV AAWV Joint Conference

**Taurine Deficiency in Maned Wolves (Chrysocyon brachyurus) Maintained on Two Diets Manufactured for Prevention of Cystine Urolithiasis**

Sara E. Childs-Sanford, DVM and C. Roselina Angel, PhD

2004 Proceedings AAZV, AAWV, WDA Joint Conference
Examples: case studies

DIETARY TAURINE SUPPLEMENTATION AND CARDIAC FUNCTION IN THE GIANT ANTEATER (Myrmecophaga tridactyla): PRELIMINARY FINDINGS

J. Andrew Teare, DVM, MS,¹* Alan D. Weldon, DVM, Dipl AVCIM,¹ and Nikolay Kapustin,
DVM²
2009 PROCEEDINGS AAZV AAWV JOINT CONFERENCE

TAURINE DEFICIENCY IN MANED WOLVES (Chrysocyon brachyurus) MAINTAINED ON TWO DIETS MANUFACTURED FOR PREVENTION OF CYSTINE UROLITHIASIS

Sara E. Childs-Sanford, DVM¹* and C. Roselina Angel, PhD²
2004 PROCEEDINGS AAZV, AAWV, WDA JOINT CONFERENCE

no control group
The classic problem repertoire

- **Carnivore**
  - Red meat
  - Calcium deficiency

- **Primate**
  - Fruits & vegetables
  - Calcium deficiency

- **Fish-Eater**
  - Thawed fish
  - Sodium- and vitamin B deficiency

- **Herbivore**
  - Hay & grains
  - Acidosis, vitamin E- and calcium deficiency
Examples: inventories
Examples: inventories

Grisham and Savage (1990)
Examples: inventories

Grisham and Savage (1990)

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<td>Grazer</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Intermediate</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Browser</td>
<td>24</td>
<td>83</td>
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Marholdt (1991)
Examples: inventories

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Müller et al. (2011)
Examples: inventories

Grisham and Savage (1990)

Marholdt (1991)

Müller et al. (2011)

"concentrate selectors"
Examples: inventories

Grisham and Savage (1990)

Marholdt (1991)

Müller et al. (2011)

no direct association
Examples: inventories

European Zoos

Range countries

European/NA Zoos
Sri Lanka
Myanmar

Kibby Treiber - Plenary (2015)
Studies in zoo animals

- Case reports / case series
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IRON STORAGE DISORDERS IN CAPTIVE WILD MAMMALS: THE COMPARATIVE EVIDENCE

Marcus Clauss, M.Sc., Dr. med. vet., Dipl. E.C.V.C.N., and Donald E. Paglia, M.D.
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IRON STORAGE DISORDERS IN CAPTIVE WILD MAMMALS:
THE COMPARATIVE EVIDENCE

Marcus Clauss, M.Sc., Dr. med. vet., Dipl. E.C.V.C.N., and Donald E. Paglia, M.D.

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<td>(+) blood&lt;sup&gt;ss&lt;/sup&gt;</td>
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<td>(+) blood, tissue^13,14</td>
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### Iron Storage Disorders in Captive Wild Mammals: The Comparative Evidence

Marcus Clauss, M.Sc., Dr. med. vet., Dipl. E.C.V.C.N., and Donald E. Paglia, M.D.

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<tr>
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<tr>
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<td>(+) histof</td>
<td>(+) blood, tissuef</td>
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<td>(+) histof</td>
<td>(-) blood, tissuef</td>
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<td>(+) histof</td>
<td>(+) blood, tissuef</td>
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<td>(+) bloodf</td>
<td>(+) histof</td>
<td>(+) histof, blood</td>
<td>(+) blood, tissuef</td>
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</table>

* Data from available literature. ** Data from authors' observations.
IRON STORAGE DISORDERS IN CAPTIVE WILD MAMMALS: THE COMPARATIVE EVIDENCE

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<td>(+) histio²</td>
<td>(+) blood³⁰</td>
<td>(+) blood³⁰</td>
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<td>Baird's tapir (Tapirus bairdii)</td>
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<td>(+) histio²</td>
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<td>(+) blood³⁰</td>
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<td>(+) histio³⁴</td>
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<tr>
<td>Black rhinoceros (Diceros bicornis)</td>
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<td>(+) histio⁹</td>
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<td>(+) blood,tissue⁵²,⁵⁷,⁵⁸,⁶⁷,⁶⁸,⁷⁸</td>
<td>(+) histio, blood,tissue⁵²,⁵⁷,⁵⁸,⁶⁷,⁶⁸,⁷⁸</td>
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Examples: differences wild - zoo
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+ fibre in herbivore diets

- 

e.g. Taylor et al. (2013)
Examples: differences wild - zoo

+ fibre in herbivore diets
- iron deposits in organs

e.g. Taylor et al. (2013), Clauss & Paglia (2012)
Examples: differences wild - zoo

+ fibre in herbivore diets
- iron deposits in organs
+ unsaturated (n-3) fatty acids in diets and body tissues

e.g. Taylor et al. (2013), Clauss & Paglia (2012), Clauss et al. (2007)
Examples: differences wild - zoo

- fibre in herbivore diets
- iron deposits in organs
+ unsaturated (n-3) fatty acids in diets and body tissues
- tooth wear (browsers, bears)

e.g. Taylor et al. (2013), Clauss & Paglia (2012), Clauss et al. (2007), Wenker et al. (1999), Kaiser et al. (2009), Taylor et al. (2014)
Examples: differences wild - zoo

- fibre in herbivore diets
- iron deposits in organs
+ unsaturated (n-3) fatty acids in diets and body tissues
- tooth wear (browsers, bears)
+ dental calculus

e.g. Taylor et al. (2013), Clauss & Paglia (2012), Clauss et al. (2007), Wenker et al. (1999), Kaiser et al. (2009), Taylor et al. (2014), Clarke & Cameron (1998)
Relationship between diet, dental calculus and periodontal disease in domestic and feral cats in Australia

DE CLARKE\textsuperscript{a} and A CAMERON\textsuperscript{b}

\textit{Aust Vet J} 1998;76:690-693.

**Results** Dental calculus scores were significantly higher in domestic cats than in feral cats. There was no statistical difference in the prevalence of periodontal disease between the two groups.

**Conclusion** It can be inferred that diet may play a role in the accumulation of calculus, but a diet based on live prey does not protect cats against periodontal disease.

Figure 1. Calculus on the buccal surface of the upper fourth premolar tooth in a feral cat.
Examples: differences wild - zoo

+ fibre in herbivore diets
- iron deposits in organs
+ unsaturated (n-3) fatty acids in diets and body tissues
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Great ape R/R
Removing Milk from Captive Gorilla Diets: The Impact on Regurgitation and Reingestion (R/R) and Other Behaviors

Kristen E. Lukas, Gloria Hamor, Mollie A. Bloomsmith, Charles L. Horton, and Terry L. Maple

Zoo Biology 18:515 - 528 (1999)

Special Articles

Regurgitation in Gorillas: Possible Model for Human Eating Disorders (Rumination/Bulimia)

EDWIN GOULD, PH.D.
Department of Mammalogy, National Zoological Park, Smithsonian Institution, Washington, D.C.

MIMI BRES, M.S.
Department of Biological Sciences, The George Washington University, Washington, D.C.
Examples: differences wild - zoo

+ fibre in herbivore diets
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- tooth wear (browsers, bears)
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- feeding-related dysbehaviour

+ + +

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Examples: differences wild - zoo

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- tooth wear (browsers, bears)
+ dental calculus
- undesired GIT bacteria/non-diverse microbiome
- feeding-related dysbehaviour
- obesity

Examples: differences wild - zoo

obesity
Examples: differences wild - zoo

obesity
Examples: epidemiological/controlled studies
Social Factors Influence Ovarian Acyclicity in Captive African Elephants (*Loxodonta africana*)

Elizabeth W. Freeman, Greg Guagnano, Deborah Olson, Mike Keele, and Janine L. Brown


Females more likely to be acyclic had a larger body mass index and had resided longer at a facility with the same herdmates. Results suggest that controlling the weight of an elephant might be a first step to helping mitigate estrous cycle problems.
Examples: epidemiological/controlled studies

When feeding stops breeding –
How inappropriate diets can reduce (or enhance) reproductive output

Christoph Schwitzer¹ & Katie Edwards²
¹Bristol Conservation and Science Foundation, Bristol Zoo Gardens, Clifton, Bristol, UK.
²Chester Zoo, Upton, Chester, UK.

Body condition scoring

- Non-breeding females scored higher BCS than proven females

courtesy Christoph Schwitzer
Examples: epidemiological/controlled studies
Nutritional Metabolic Bone Disease in Juvenile Veiled Chameleons (*Chamaeleo calypttratus*) and Its Prevention$^{1-3}$


Stefan Hoby,$^{4,5}$ Christian Wenker,$^5$ Nadia Robert,$^4$ Thomas Jermann,$^5$ Sonja Hartnack,$^6$ Helmut Segner,$^4$ Claude-P. Aebischer,$^8$ and Annette Liesegang$^7$.

Effects of starch and fibre in pelleted diets on nutritional status of mule deer (*Odocoileus hemionus*) fawns

S. McCusker$^1$, L. A. Shipley$^1$, T. N. Tollefson$^{1,2}$, M. Griffin$^{3,4}$ and E. A. Koutsos$^4$

Nutritional Metabolic Bone Disease in Juvenile Veiled Chameleons (Chamaeleo calyptratus) and Its Prevention\textsuperscript{1–3}

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\begin{table}[h]
\centering
\begin{tabular}{cccc}
\hline
\textbf{Group} & \textbf{\(n\)} & \textbf{Weight (g)} & \textbf{SVL (mm)} \\
\hline
UV & 10 & 28.7 (15.2–34.2) & 100.1 (90.4–108.8) \\
No & 10 & 13.5 (11.3–15.7) & 74.4 (68.1–78.7) \\
Ca\textsubscript{UV} & 9 & 56.2 (47.3–69.2) & 144.2 (133.8–154.5) \\
Ca & 8 & 60.5 (52.1–68.9) & 144.2 (133.4–155.1) \\
Ca\textsubscript{AD} & 9 & 54.3 (38.1–70.5) & 138.2 (117.5–156.9) \\
Ca\textsubscript{AD} & 9 & 57.6 (38.2–77.6) & 136.9 (113.8–156.7) \\
\hline
\end{tabular}
\end{table}
Hepatic Hemosiderosis in Common Marmosets, *Callithrix jacchus*: Effect of Diet on Incidence and Severity

Georgina F. Miller, Dennis E. Barnard, Ruth A. Woodward, B. Michael Flynn, and Jeff W. M. Bulte
Examples: epidemiological/controlled studies

=> Fe ≥ 350 ppm DM leads to massive liver damage
Examples: epidemiological/controlled studies

=> Fe ≥ 350 ppm DM leads to massive liver damage
Examples: epidemiological/controlled studies

Hepatic Hemosiderosis in Common Marmosets, Caused by Diet: Effect of Diet on Incidence

Georgina F. Miller,1 Dennis E. Barnard,1 Ruth A. Woodward1

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=> Fe ≥ 350 ppm DM leads to massive liver damage
Controlled studies often put animals at risk

Nutritional Metabolic Bone Disease in Juvenile Veiled Chameleons (Chamaeleo calyptratus) and Its Prevention


Stefan Hoby, Christian Wenker, Nadia Robert, Thomas Jermann, Sonja Hartnack, Helmut Segner, Claude-P. Aebischer, and Annette Liesegang

Effects of starch and fibre in pelleted diets on nutritional status of mule deer (Odocoileus hemionus) fawns

S. McCusker, L. A. Shipley, T. N. Tollefson, M. Griffin, and E. A. Koutsos


Hepatic Hemosiderosis in Common Marmosets, Callithrix jacchus: Effect of Diet on Incidence and Severity

Georgina F. Miller, Dennis E. Barnard, Ruth A. Woodward, B. Michael Flynn, and Jeff W. M. Bulte
• lack of risk for zoo animals is usually a prerogative for a zoo study to be allowed
• studies that shall have relevance for HEALTH mostly by definition require setups of more and less healthy options/treatments
Research in a zoo setting

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• typical ‘risk-free’ nutrition studies in zoos with potential relevance: inventories, epidemiological studies
Research in a zoo setting

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• typical ‘risk-free’ nutrition studies in zoos with less potential relevance: measuring digestibility and digesta passage on used diets
Approach to zoo animal nutrition

+ “do as we always did”
  based on experiences what has been working

- sometimes ‘experiences’ are mistakes one has been making for long time

“imitate the natural diet”
  best approach
  depends on what you know about the natural diet, and what feeds are available

“use a suitable domestic species as model”
  ‘scientific compromise’
  huge amount of knowledge
  species-specific peculiarities are easily overlooked

“based on studies in zoo animals”
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  financially and logistically challenging, difficulty in summarizing knowledge
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Where is the information?
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Captive Management Husbandry Manuals

This Husbandry Manual Register is in two parts;

1. The first section is an index of Mammal Taxonomic Orders. Click on the Taxonomic link to be taken to the relevant section within the second section of the Registry. Please note that Husbandry Manuals are not currently available for all groups or species.

2. The second section provides the contact details for the Husbandry Manuals known to us from the taxonomic group you have selected, listed by Taxonomic Family.

If the contact details for a specific Manual has changed or you know of, or are searching for, a specific Manual which is not listed here, please contact me and I will endeavour to assist.

Many of the following Husbandry Manuals are available from one or more of the regional Zoo Management Associations; unfortunately in most cases you need to be a financial member of the relevant Association in order to be eligible to obtain a copy of a Manual. However, wherever possible, contact details for obtaining a copy directly from the authors (or elsewhere) is provided.
Where is the information?
Where is the information?
Where is the information?

The Feeding and Nutrition of Herbivores
Olav T. Ofstedal, David J. Baer, and Mary E. Allen

The Feeding and Nutrition of Carnivores
Mary E. Allen, Olav T. Ofstedal, and David J. Baer

The Feeding and Nutrition of Omnivores with Emphasis on Primates
Olav T. Ofstedal and Mary E. Allen
Where is the information?

not in any one place
thank you for your attention