Approaches to zoo animal nutrition

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University of Zurich[UZH]

Clinic of Zoo Animals, Exotic Pets and Wildlife

Zoo animal nutrition

Historical approach

Variations in Eastern Bongo (*Tragelaphus eurycerus isaaci*) Feeding Practices in UK Zoological Collections

D. J. Wright,[1]* H. M. Omed,[1] C. M. Bishop,[1] and A. L. Fidgett[2]

Zoo Biology 30 : 149–164 (2011)

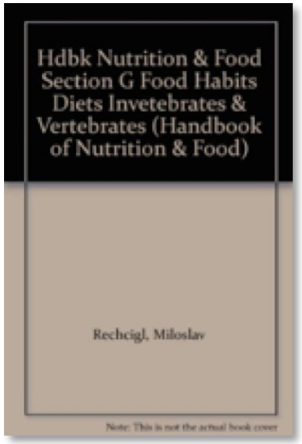
JZAR www.jzar.org JOURNAL OF ZOO AND AQUARIUM RESEARCH

EAZA

Research Article

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

Lucy A. Taylor[1,*], Christoph Schwitzer[1], Norman Owen-Smith[2], Michael Kreuzer[3] and Marcus Clauss[4]



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

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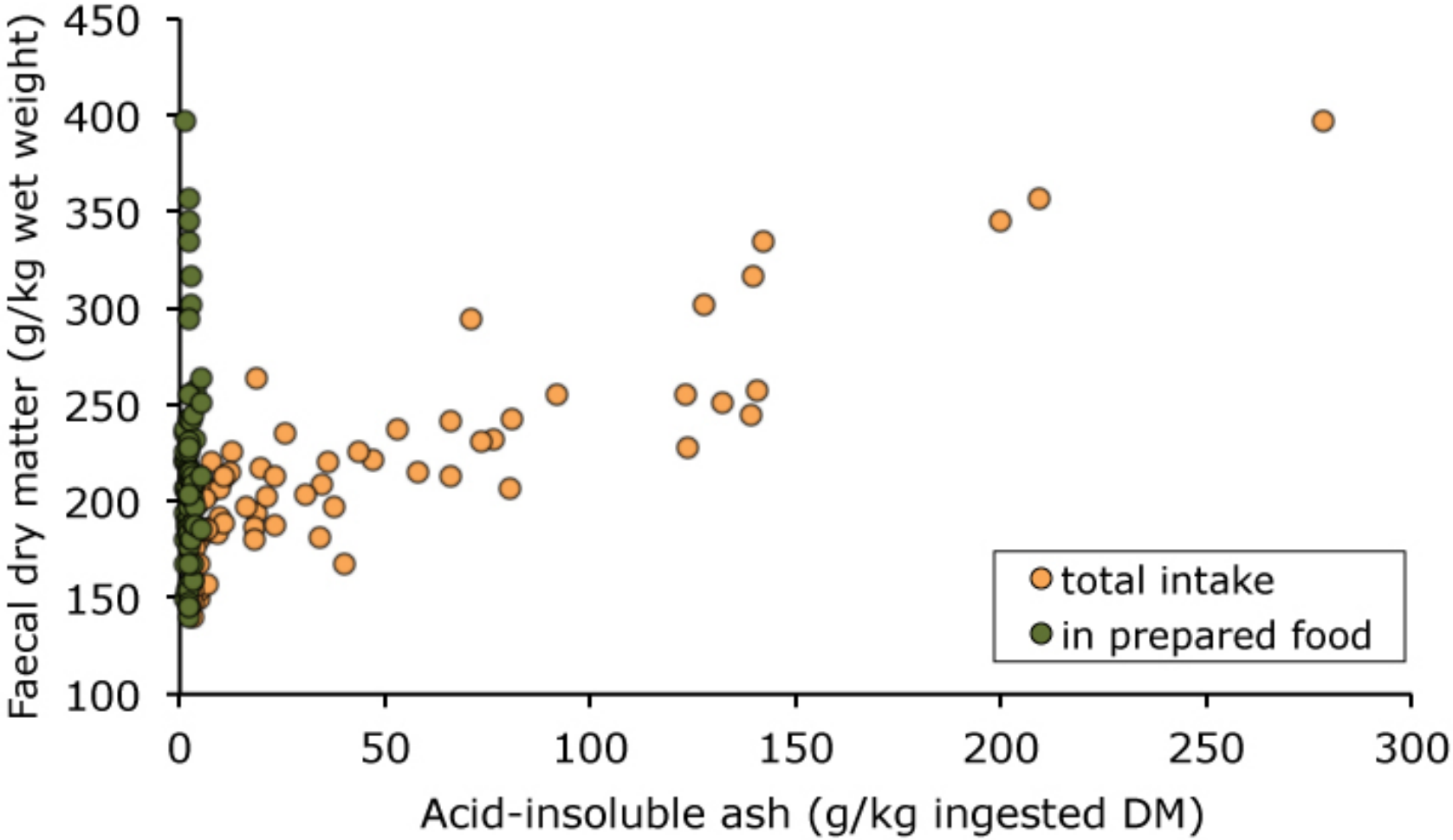
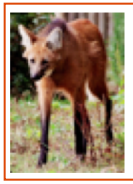
depends on what you know about the natural diet, and what feeds are available

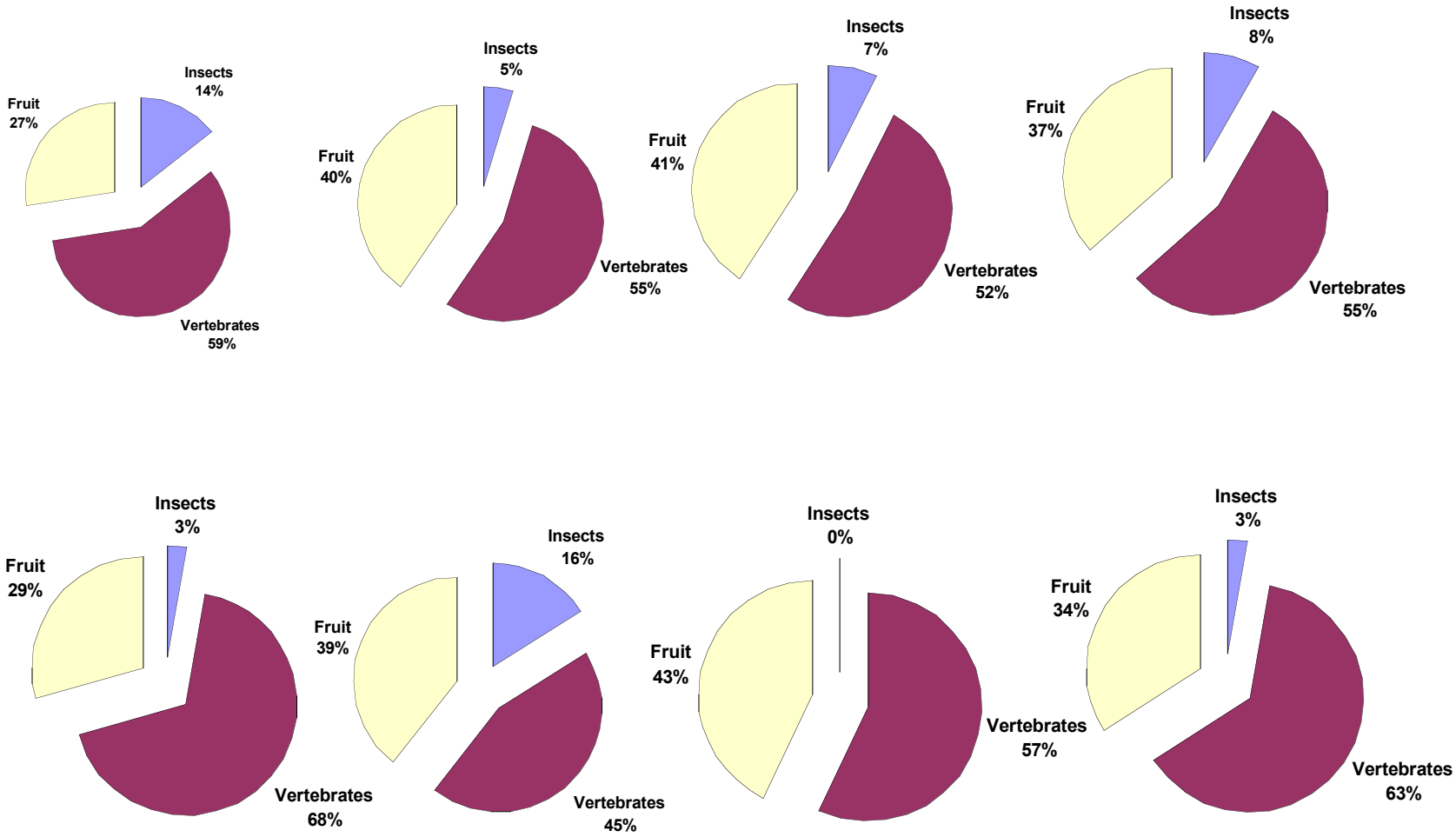
Example: Giant anteater *(Myrmecophaga tridactyla)*



Gull et al. (subm.)

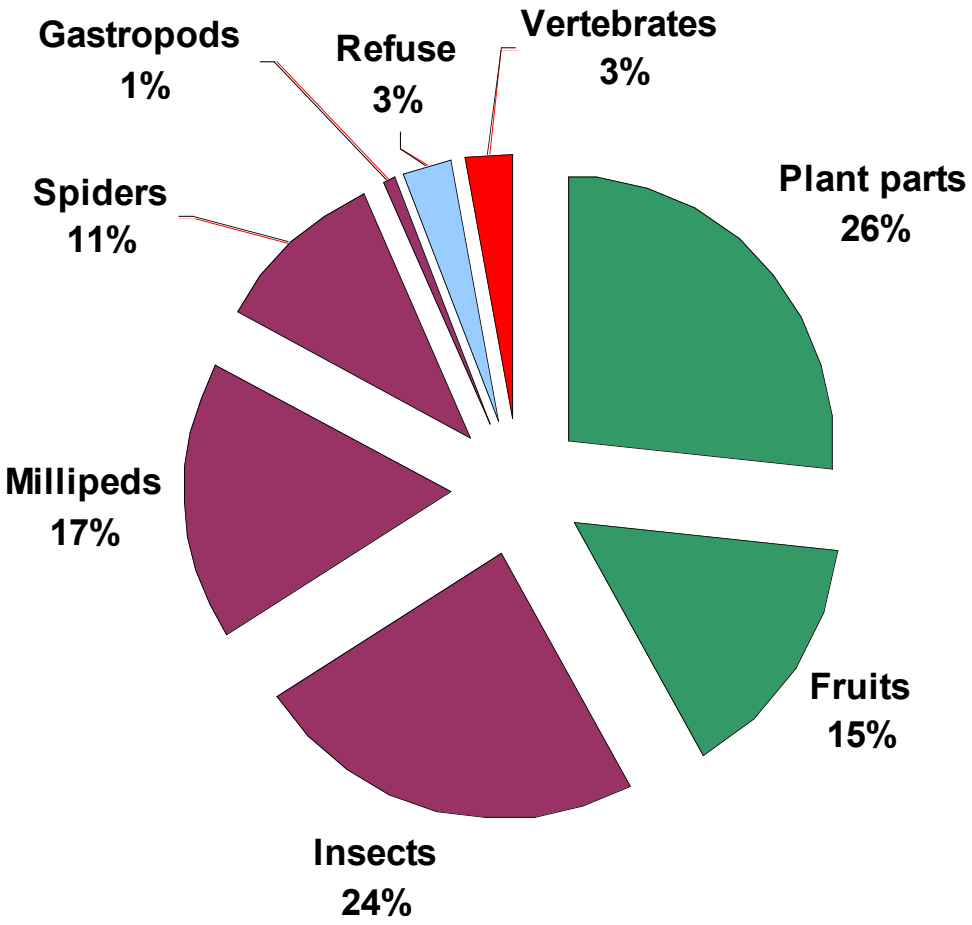


Example: Maned wolf *(Chrysocyon brachyurus)*



various studies, e.g. Bueno et al. (2004)

Example: Coati *(Nasua spp.)*



Alves-Costa et al. (2004)

Natural diets

JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
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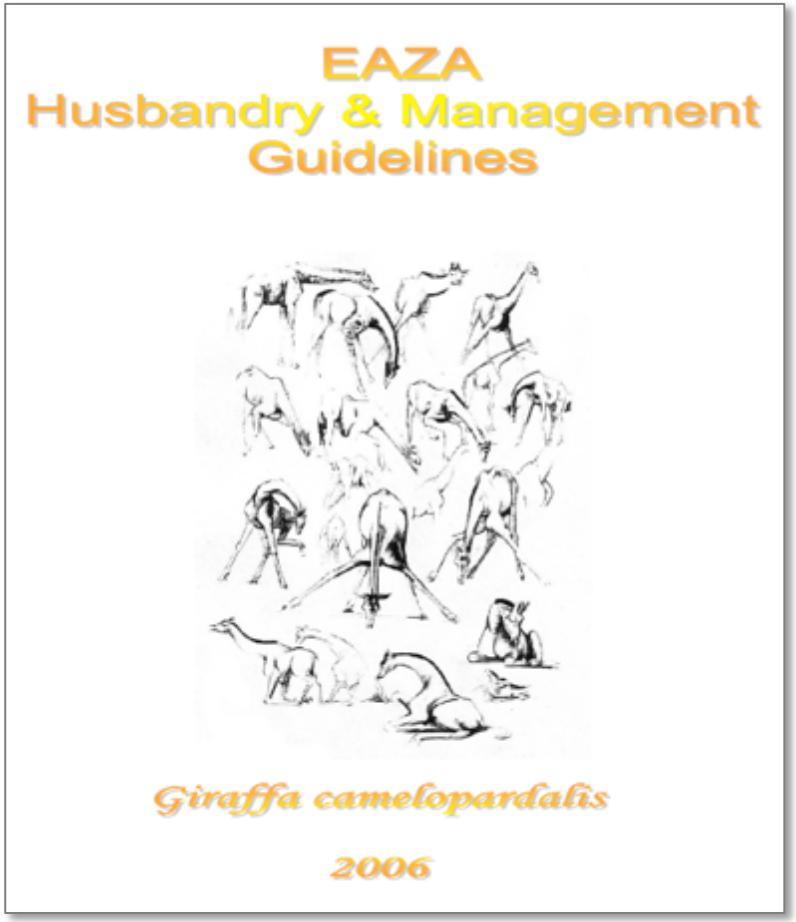
Research Article

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

Lucy A. Taylor[1,*], Christoph Schwitzer[1], Norman Owen-Smith[2], Michael Kreuzer[3] and Marcus Clauss[4]

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

Hofmann (1973) classifies the giraffe as a browser. Tree or shrub browse are 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 characterised by Van Soest (1994) to be of an intermediate degree. Due to its large body size, a giraffe just cannot afford to feed as selectively as smaller ruminant species.

Table 2-1: Description of feeding behaviour

Plant parts ingested	Importance to the diet	Reference
Leaves, small twigs	++	Leuthold and Leuthold (1972, 1978)
Some bark, flowers and fruits	+	
Leaves and shoots of trees and shrubs	++	Owen-Smith (1988)
Herbaceous material (climbers, vines, tall forbs)	Up to 7 %	
Shoot tips	78 %	Pellew (1984a+b)
Leaf whorls	14 %	
Flowers	5 %	
Pods	3 %	
Others	1 %	

If new growing shoots are available (including young leaves, twigs and thorns), they represent the favoured food resource according to Sauer et al. (1982). Older leaves are ingested when shoots are not available. Owen-Smith (1988) reports considerable amounts of woody material to be included in the diet (5 % in the rainy and 15 % in the dry season).

Natural diets

There are no secret, species-specific ingredients!

Formic acid in anteater formulas?

Natural diets

There is no single source of quantitative natural diet information on mammals.

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

Two traditions in imitating natural diets

Ratcliffe and Wackernagel

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

atypcial 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

DWW
AnimalWelfareWeb.nl

Sugars and other nutrients in produce (of fruits and vegetables)

All values expressed as g/kg wet weight, unless otherwise stated.

Fruits

Banana
Musa acuminata

104 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
3.4	234	28.8	6.6	13.3	12.4	0.04	0.27	0.28	0.002	44.2	5.5	0.14

Apple
Malus domestica

86 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
2.2	143	14.6	8.6	4.3	8.3	0.04	0.17	0.04	0.001	20.8	5.5	0.1

Orange
Citrus x sinensis

56 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
2.2	130	14.3	9.2	7.8	4.9	0.35	0.22	0.1	0.001	40	5.5	0.5

Kiwi
Actinidia deliciosa

52 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
2.5	156	25.3	19.7	12.9	8.3	0.32	0.33	0.13	0.003	31.4	5.5	0.65

Papaya
Carica papaya

27 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
2.1	135	18.5	16.5	18.4	4.7	0.25	0.1	0.22	0.007	197	-	0.55

Vegetables

Carrot
Daucus courota

45 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
1.6	115	11.2	10.2	8.8	4	0.36	0.29	0.12	0.004	9170	5.5	0.02

Sweet potato
Ipomoea batatas

32 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
3.0	197	39.4	9.7	8.3	11	0.45	0.47	0.15	0.009	3730	-	0.26

Celery
Apium graveolens

14 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
0.9	71	11.1	8.9	12.2	2.1	0.57	0.3	0.08	0.004	14.2	2	0.2

Spinach
Spinacia oleracea

1 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
1.1	83	16.7	9.7	32.1	6.6	1.29	0.41	0.26	0.05	3490	29	0.52

Endive
Cichorium endivia

0 gram sugar

Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
0.6	62	11	8.9	13	2	0.52	0.28	0.15	0.008	1030	-	0.07

Photos and design, Emile Prins, 2012.
Information used from Danish Food Composition Table and Schmidt *et al.*, (2005).

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Phone: +31-(0)58-2846311

courtesy Tjalling Huisman

Traditions in imitating natural diets

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

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

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.****

J. Zoo An. Med. 13: 104-107, 1982

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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Approach to zoo animal nutrition

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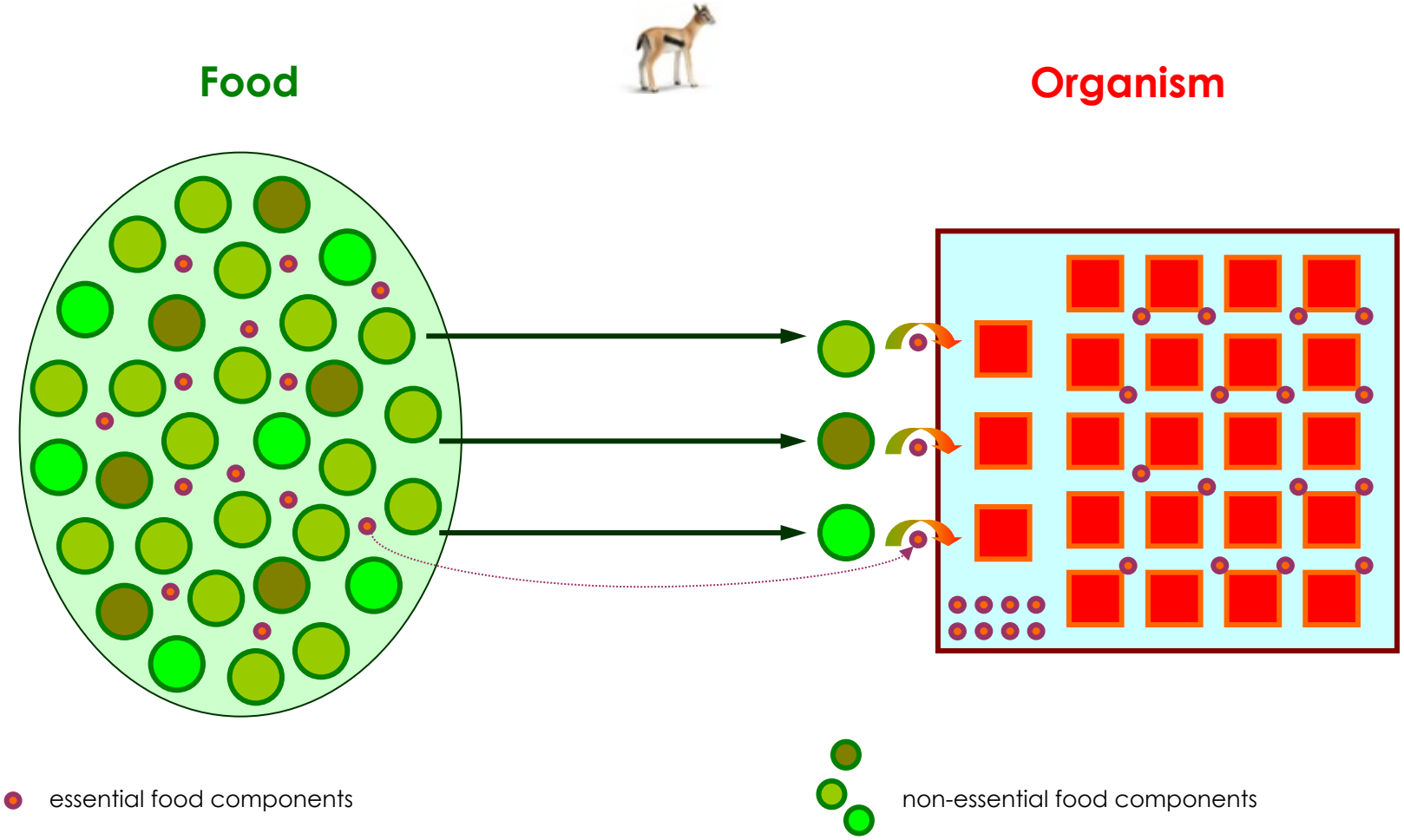
based on experiences what has been working		sometimes ‘experiences’ are mistakes one has been making for long time
	“imitate the natural diet”	
best approach		depends on what you know about the natural diet, and what feeds are available
	“use a suitable domestic species as model”	
‘scientific compromise’ huge amount of knowledge		species-specific peculiarities are easily overlooked

Nutrition Research Reviews (2002), **15**, 153–168
DOI: 10.1079/NRR200238

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

James G. Morris



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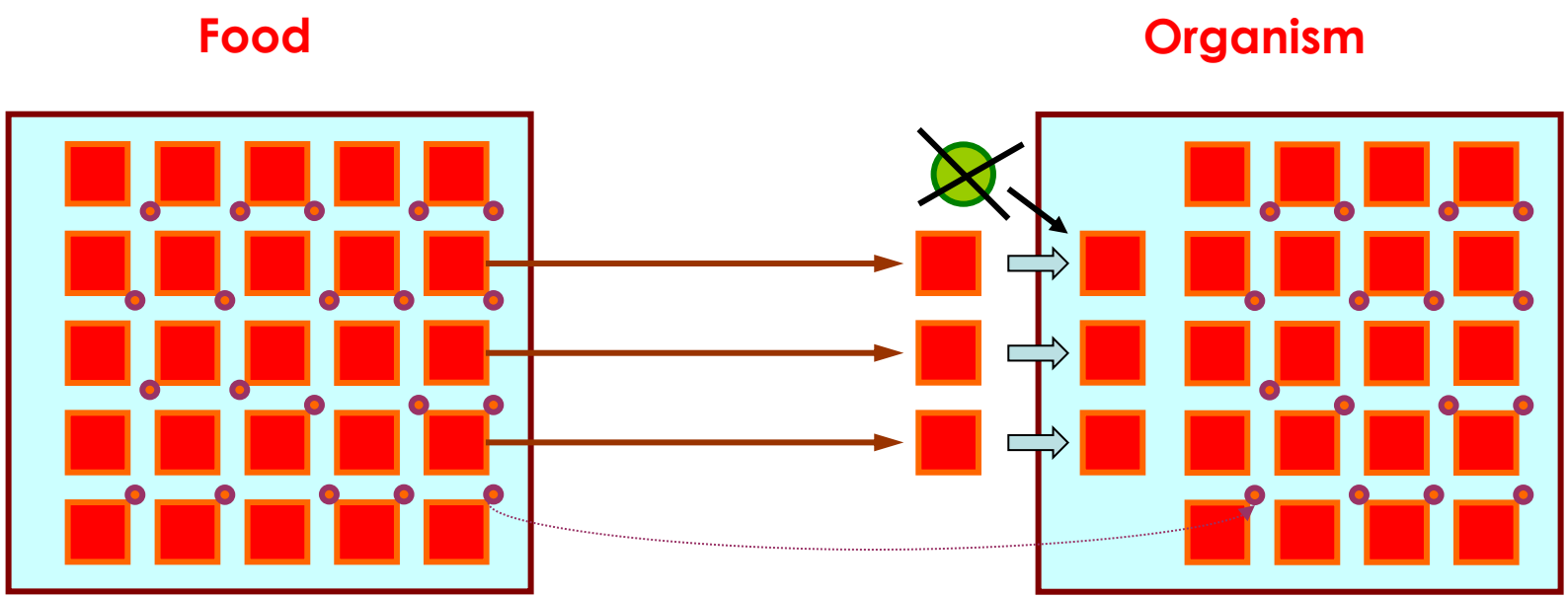

essential food components

Nutrition Research Reviews (2002), **15**, 153–168
DOI: 10.1079/NRR200238

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
- niacine

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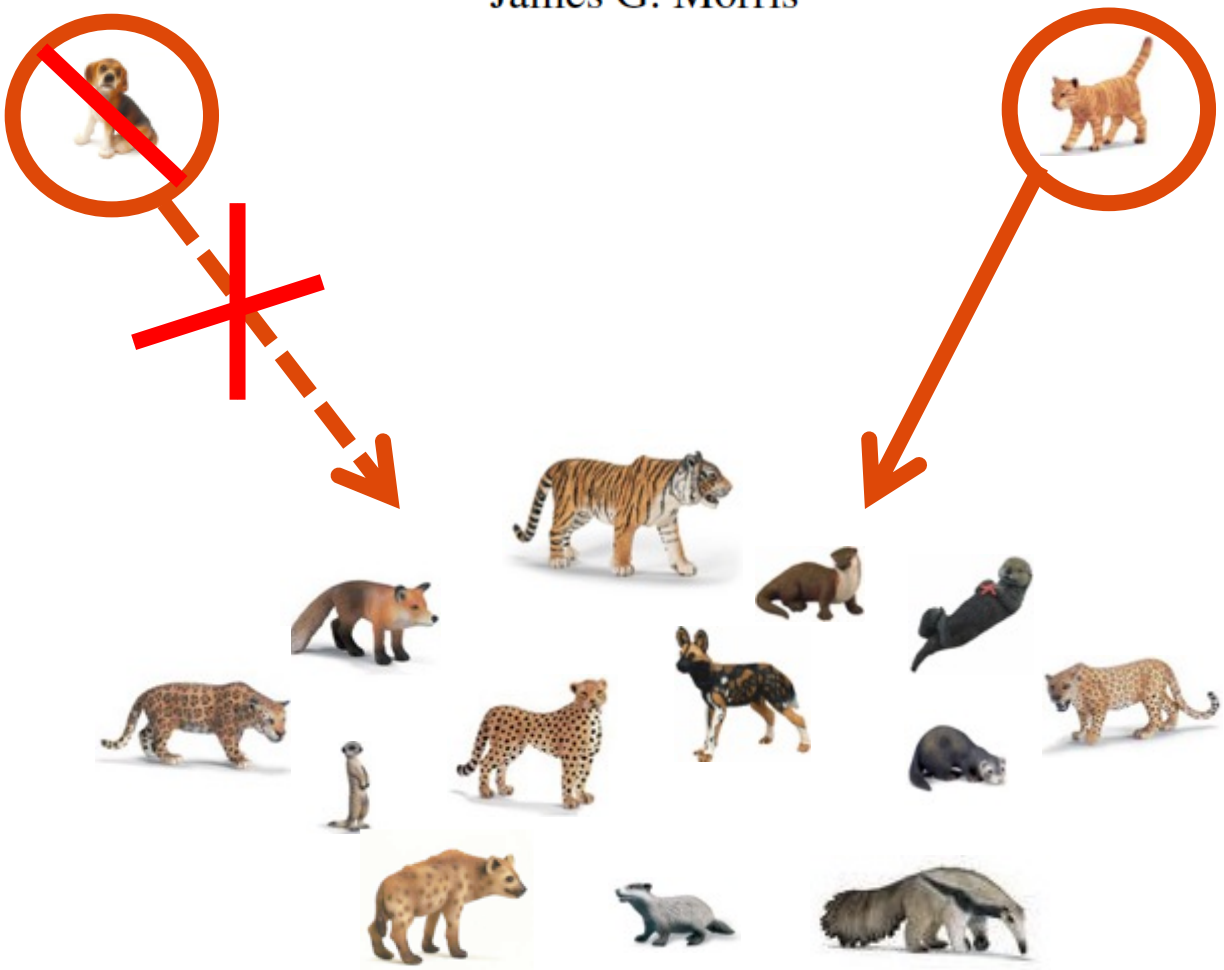

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Studies in zoo animals

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

Examples: case studies

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

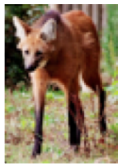
J. Andrew Teare, DVM, MS,[1] Alan D. Weldon, DVM, Dipl AVCIM,[2] and Nikolay Kapustin, DVM[1]*

2009 PROCEEDINGS AAZV AAWV JOINT CONFERENCE

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

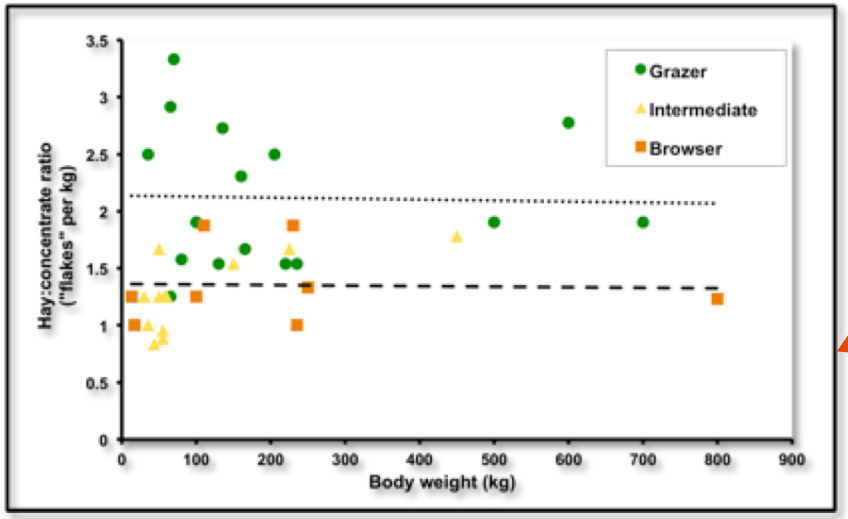
Sara E. Childs-Sanford, DVM[1] and C. Roselina Angel, PhD[2]*

2004 PROCEEDINGS AAZV, AAWV, WDA JOINT CONFERENCE



no control group

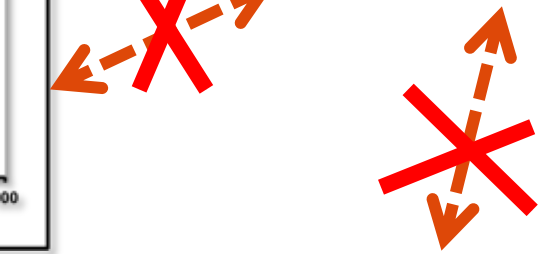
Examples: inventories



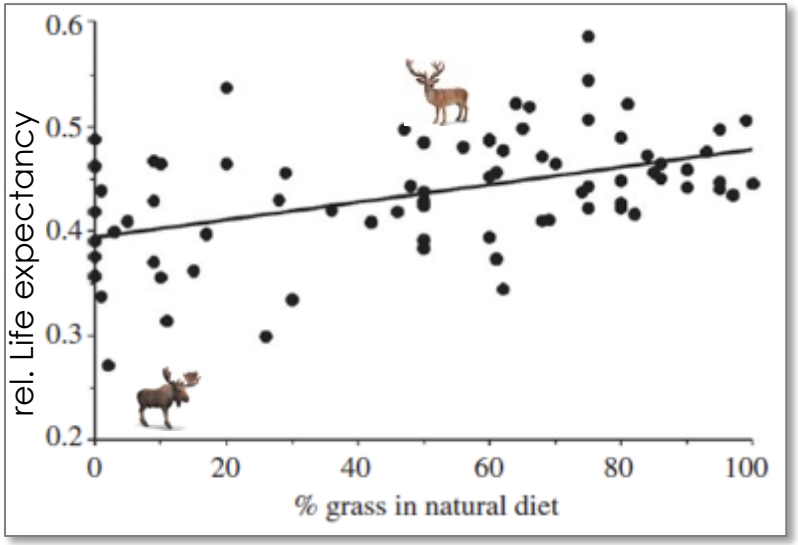
Grisham and Savage (1990)

Feeding type	n	Acidotic changes of the rumen mucosa (%)
Grazer	13	23
Intermediate	30	27
Browser	24	83

Marholdt (1991)



no direct association



Müller et al. (2011)

Examples: differences wild - zoo

obesity

Examples: **epidemiological**/controlled studies

Social Factors Influence Ovarian Acyclicity in Captive African Elephants (*Loxodonta africana*)

Elizabeth W. Freeman,[1,2]* Greg Guagnano,[2] Deborah Olson,[3] Mike Keele,[4] and Janine L. Brown[1]

Zoo Biology 28:1–15 (2009)

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

Laboratory Animal Science

Hepatic Hemosi
Common Marmosets, Co
Effect of Diet on Incide

Georgina F. Miller,[1] Dennis E. Barnard,[1] Ruth A. Woodwar

Marmoset

Crude Oil	%	7.50
Crude Protein	%	25.40
Crude Fibre	%	3.70
Ash	%	10.50
N.F.E.	%	42.90
Starches	%	27.80
Sugars	%	7.80
Gross Energy	MJ/Kg	15.80
Dig. Energy	MJ/Kg	13.30
Met. Energy	MJ/Kg	12.00
Linoleic Acid	%	2.12
Linolenic Acid	%	0.27
Calcium	%	2.16
Phosphorus	%	1.46
Phytate Phosphorus	%	0.18
Sodium	%	0.33
Chlorine	%	0.45
Potassium	%	0.81
Magnesium	%	0.29
Iron	mg/Kg	358.00
Copper	mg/Kg	18.00
Manganese	mg/Kg	85.00
Zinc	mg/Kg	71.00
Cobalt	µg/Kg	2018.00
Iodine	µg/Kg	3379.00
Selenium	µg/Kg	232.00
Fluorine	mg/Kg	54.00
Vitamin A	IU/Kg	30142.00
Vitamin D_3	IU/Kg	11640.00
Vitamin E	mg/Kg	105.60
Vitamin B_1	mg/Kg	27.70
Vitamin B_2	mg/Kg	18.20
Vitamin B_6	mg/Kg	14.10
Vitamin B_{12}	µg/Kg	39.40
Vitamin C	mg/Kg	2966.00
Vitamin K_3	mg/Kg	5.30
Folic Acid	mg/Kg	10.20
Nicotinic Acid	mg/Kg	92.70
Pantothenic Acid	mg/Kg	37.30
Choline	mg/Kg	1951.00
Inositol	mg/Kg	1649.00
Biotin	µg/Kg	398.00

=> Fe ≥ 350 ppm DM leads to massive liver damage

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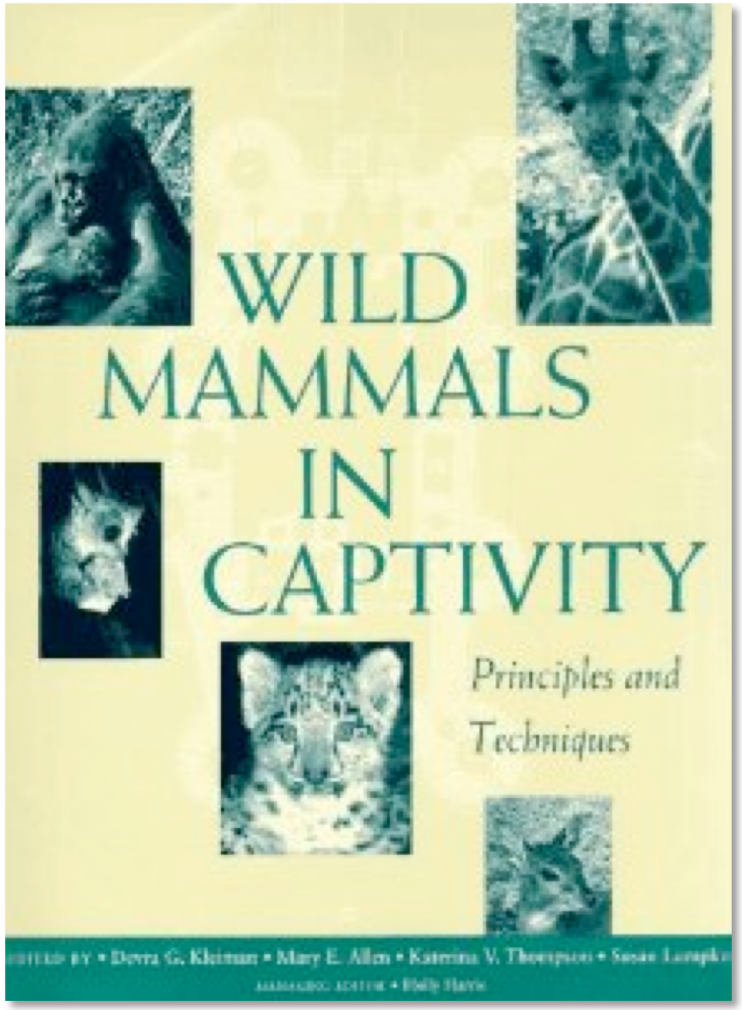
Where is the information?



The Feeding and Nutrition of Herbivores

Olav T. Oftedal, David J. Baer, and Mary E. Allen

The Feeding and Nutrition of Carnivores

Mary E. Allen, Olav T. Oftedal, and David J. Baer

The Feeding and Nutrition of Omnivores with Emphasis on Primates

Olav T. Oftedal and Mary E. Allen

Thank you for your attention