Zoo animal nutrition: a historical approach and some general rules

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European Zoo Nutrition Conference 2015 Arnhem

University of Zurich[UZH]

Clinic of Zoo Animals, Exotic Pets and Wildlife


Child of the wilderness ...
... or potato couch?
Feeding herbivores in zoos
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Feeding ruminants
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Zoo animal nutrition
- nutritional diseases

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

Zoo Biology 30 : 149–164 (2011)

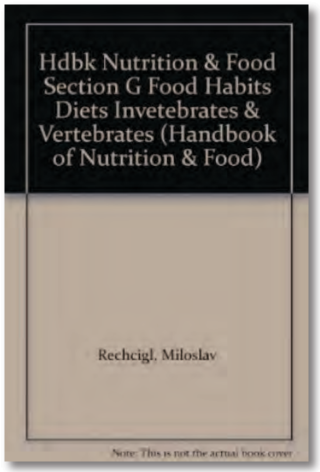
JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
www.jzar.org

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"

\-

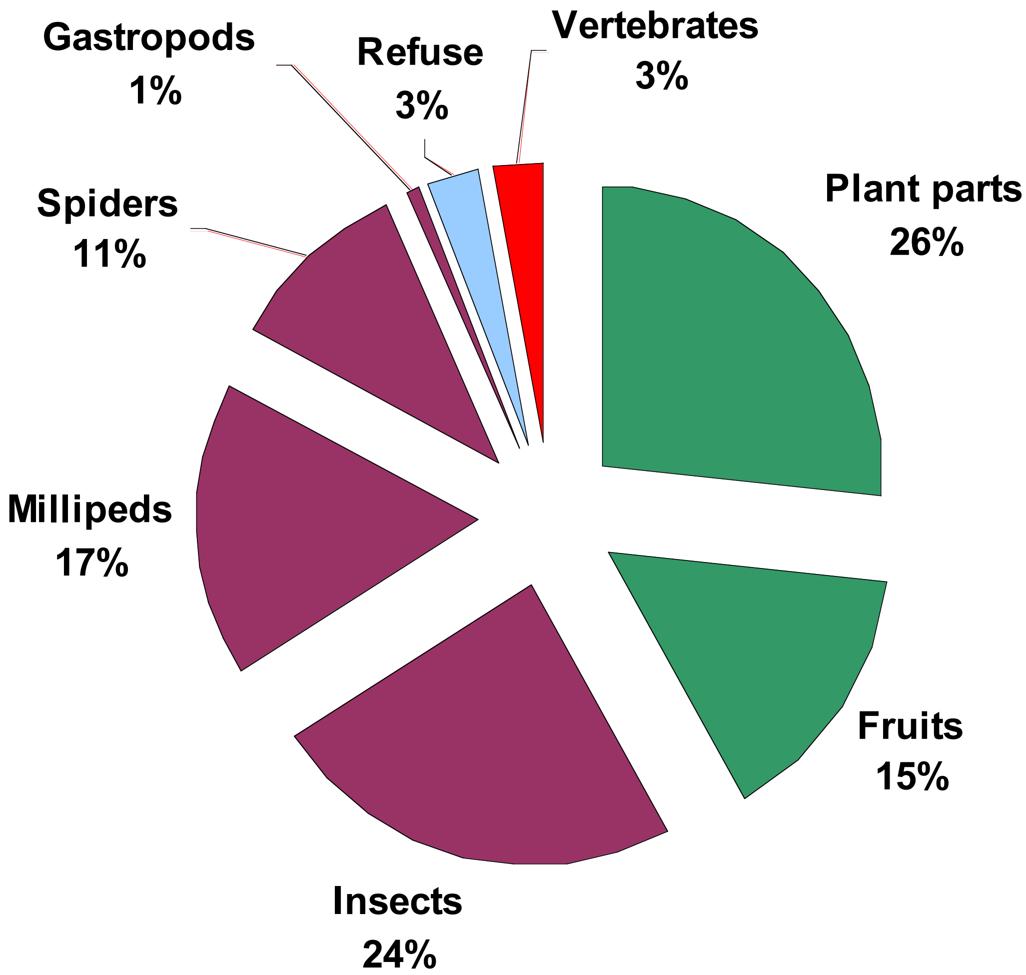
based on experiences what has been working

sometimes 'experiences' are mistakes one has been making for long time

"imitate the natural diet"

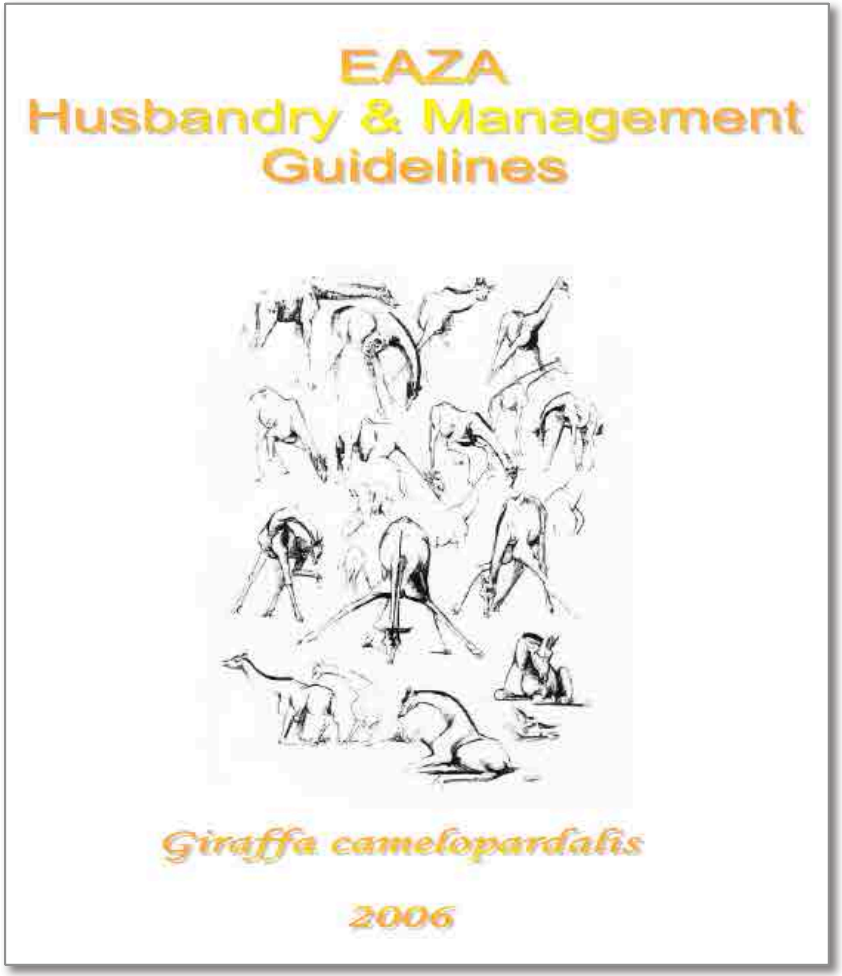
best approach

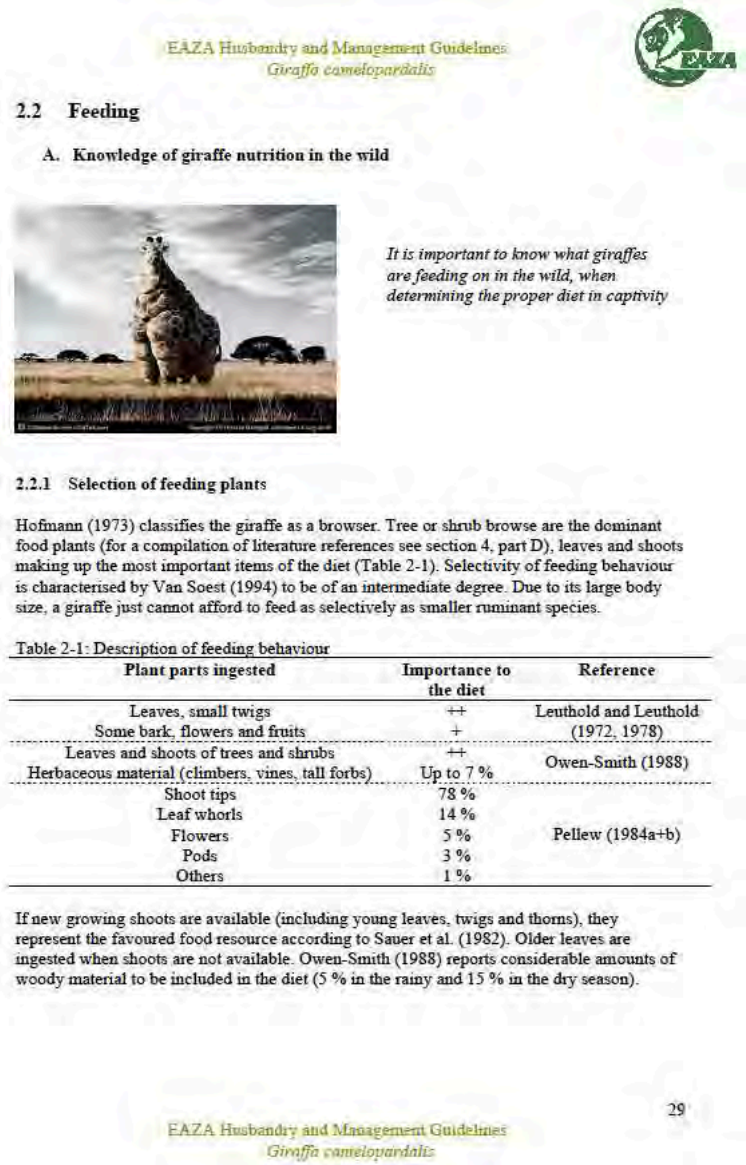
Example: Coati *(Nasua spp.)*



Alves-Costa et al. (2004)

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

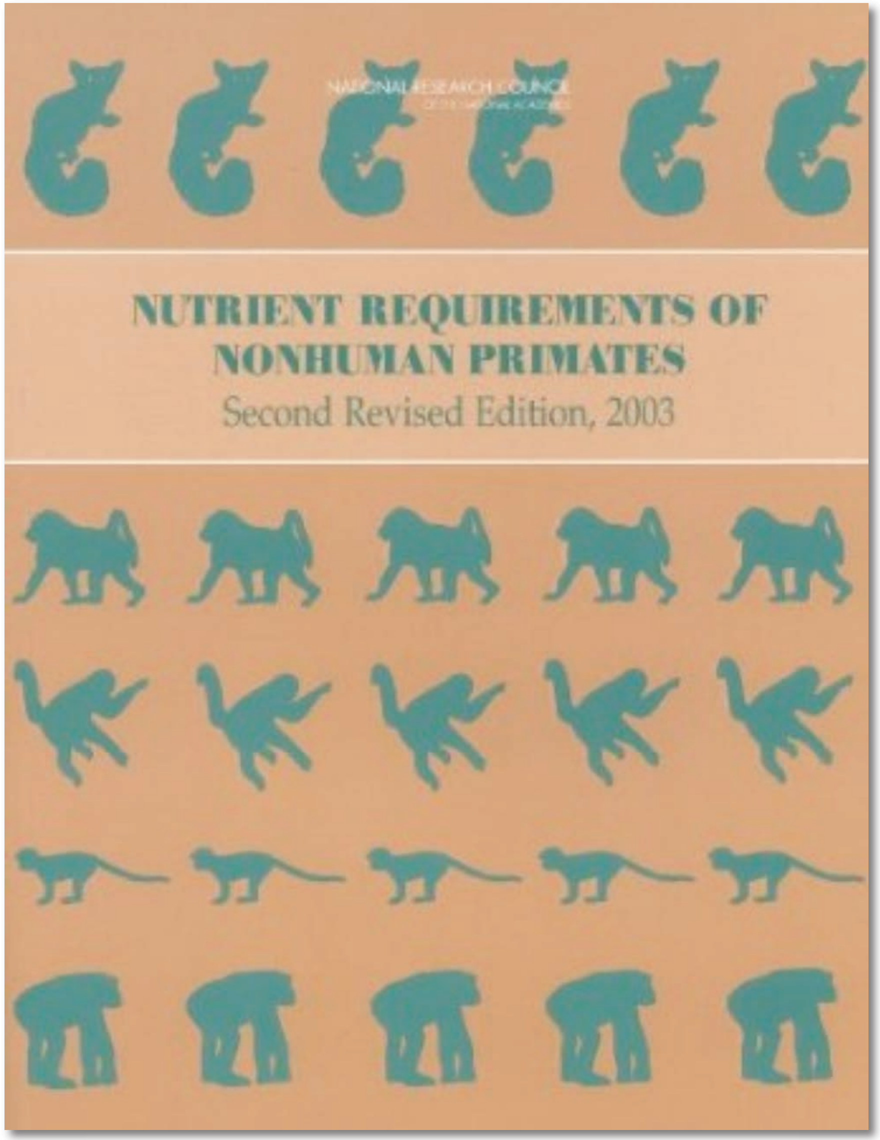
Hofmann (1973) classifies the giraffe as a browser. Tree or shrub browse are the dominant food plants (for a compilation of literature references see section 4, part D), leaves and shoots making up the most important items of the diet (Table 2-1). Selectivity of feeding behaviour is characterised by 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



Natural diets

July 2014 DATA PAPERS 2027

Ecology, 95(7), 2014, p. 2027

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

Ecological Archives E095-178

Hamish Wilman,[1] Jonathan Belmaker,[1,2] Jennifer Simpson,[1,3] Carolina de la Rosa,[1] Marcelo M. Rivadeneira,[4] and Walter Jetz[1,5,6]

Einfügen Löschen Zusammenführen Bedingte Formatierung Formatvorlagen Einfügen Löschen Format Des

B761 *fx* Nasalis larvatus

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	MSW3_ID	Scientific	MSWFamilyLatin	BodyMass-Value	Diet-Inv	Diet-Vend	Diet-Vect	Diet-Vfish	Diet-Vunk	Diet-Scav	Diet-Fruit	Diet-Nect	Diet-Seed	Diet-PlantO	Diet-Source	Diet-Certainty
2	1	Tachyglossus aculeatus	Tachyglossidae	3025	100	0	0	0	0	0	0	0	0	0	Ref_1	ABC
3	2	Zaglossus attenboroughi	Tachyglossidae	8532.39	100	0	0	0	0	0	0	0	0	0	Ref_65	ABC
4	3	Zaglossus bartoni	Tachyglossidae	7180	100	0	0	0	0	0	0	0	0	0	Ref_2	D1
5	4	Zaglossus bruijni	Tachyglossidae	10139.5	100	0	0	0	0	0	0	0	0	0	Ref_1	ABC
6	5	Ornithorhynchus anatinus	Ornithorhynchidae	1484.25	80	0	0	20	0	0	0	0	0	0	Ref_1	ABC
7	6	Caluromys philander	Didelphidae	229.25	20	0	0	0	10	0	20	0	10	40	Ref_1	ABC
8	7	Caluromys derbianus	Didelphidae	297	20	0	0	0	10	0	20	0	10	40	Ref_1	ABC

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"

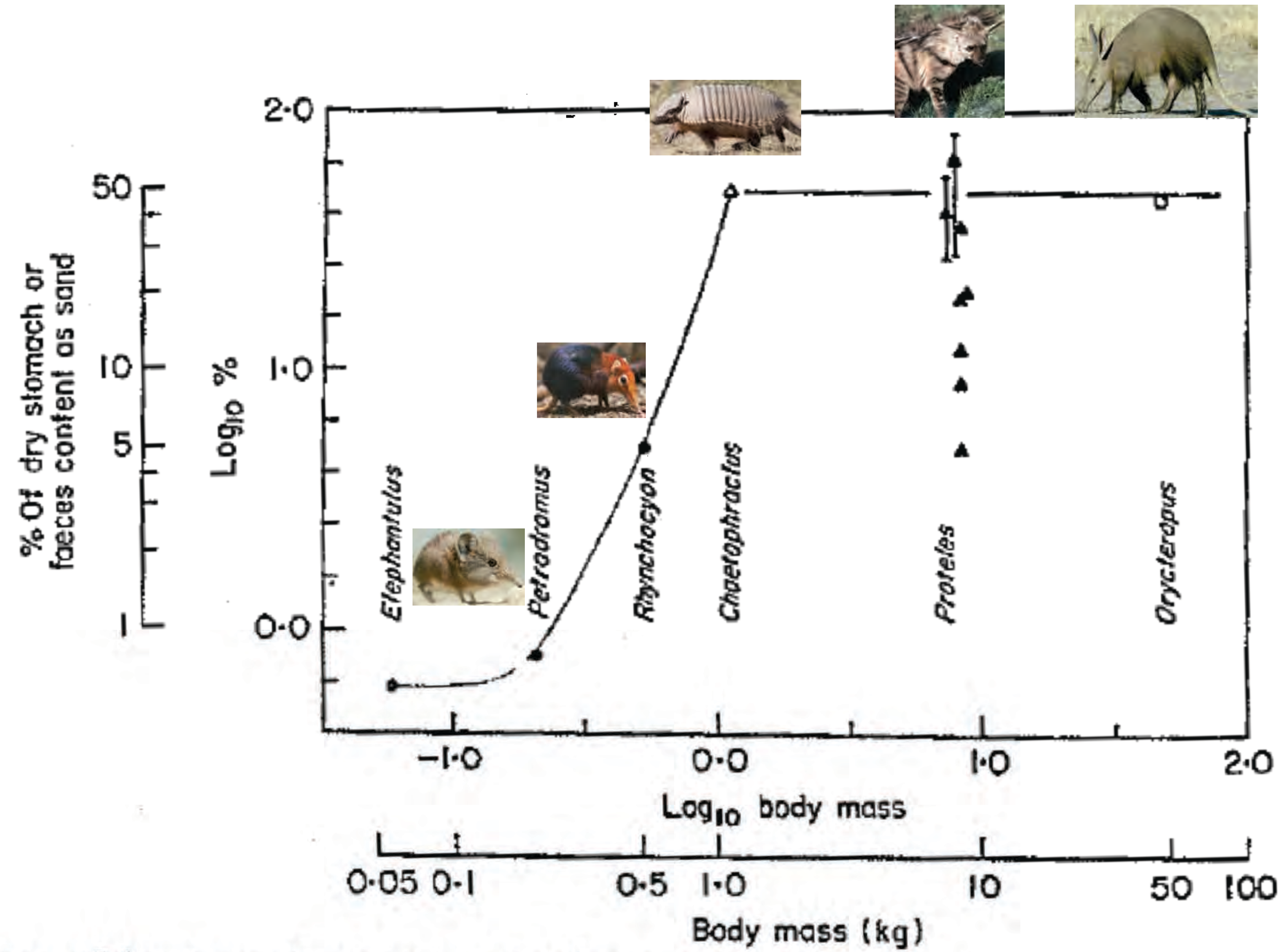
best approach

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

	MSW3_ID	Scientific	MSWFamilyLatin	BodyMass-Value	Diet-Inv	Diet-Vend	Diet-Vect	Diet-Vfi
441	443	Cyclopes didactylus	Cyclopedidae	329.5	100	0	0	
442	444	Myrmecophaga tridactyla	Myrmecophagidae	22333.15	100	0	0	
443	445	Tamandua mexicana	Myrmecophagidae	4209.98	100	0	0	
444	446	Tamandua tetradactyla	Myrmecophagidae	5515.06	100	0	0	

No easy-to-harvest packages of tiny invertebrates

Unavoidable detritus ingestion in myrmacophages



from McNab (1984)

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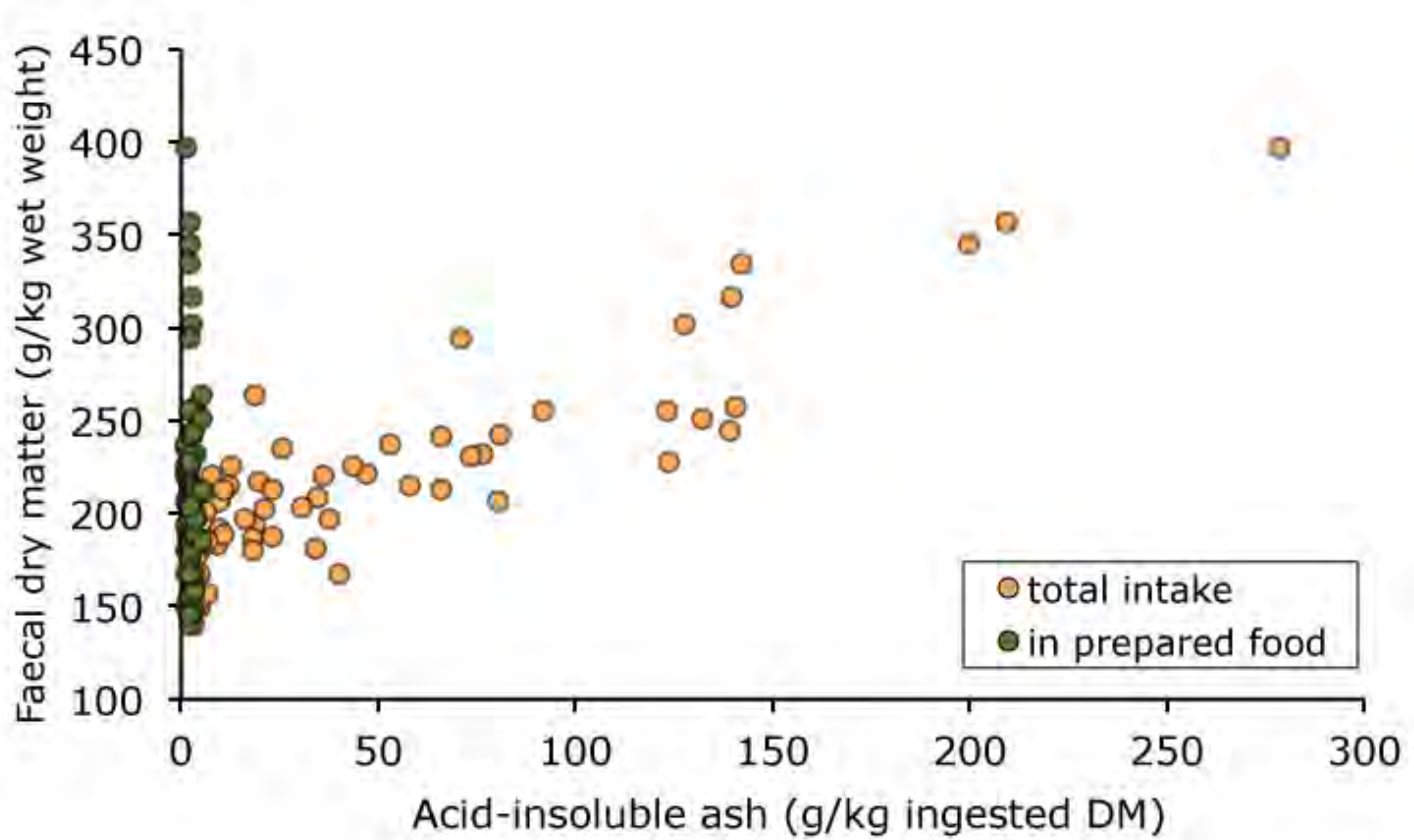
Example: Giant anteater *(Myrmecophaga tridactyla)*



Gull et al. (2015)

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

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+	-
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	Hediger
a complete feed for each animal (group) (pelleted/extruded)	*'natural' feeds (forages, fruits/vegetables), that resemble the natural diet*
atypcial physical structure	*selective feeding possible*
some nutrients difficult to limit	***available feeds differ from in nutrient content from the natural diet***
behavioural deficits	

Frugivores don‘t eat supermarket fruit

AnimalWelfareWeb.nl

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

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

Item	Sugar	Energy MJ	Dry Matter	NDF	ADF	Crude Protein	Fat	Ca	P	Mg	Fe	Vit. A RE	Vit. E α-TE	Vit. C
Fruits														
Banana *Musa acuminata*	104 gram sugar	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	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	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	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	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 caurota*	45 gram sugar	1.6	115	11.2	10.2	6.8	4	0.36	0.29	0.12	0.004	9170	5.5	0.02
Sweet potato *Ipomoea batatas*	32 gram sugar	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	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	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	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).

Contact: Tjalling Huisman
Email: tjalling.huisman@wur.nl
Phone: +31-(0)58-2846311

courtesy Tjalling Huisman

Traditions in imitating natural diets

Traditions in imitating natural diets

Traditions in imitating natural diets

Traditions in imitating natural diets

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Approach to zoo animal nutrition

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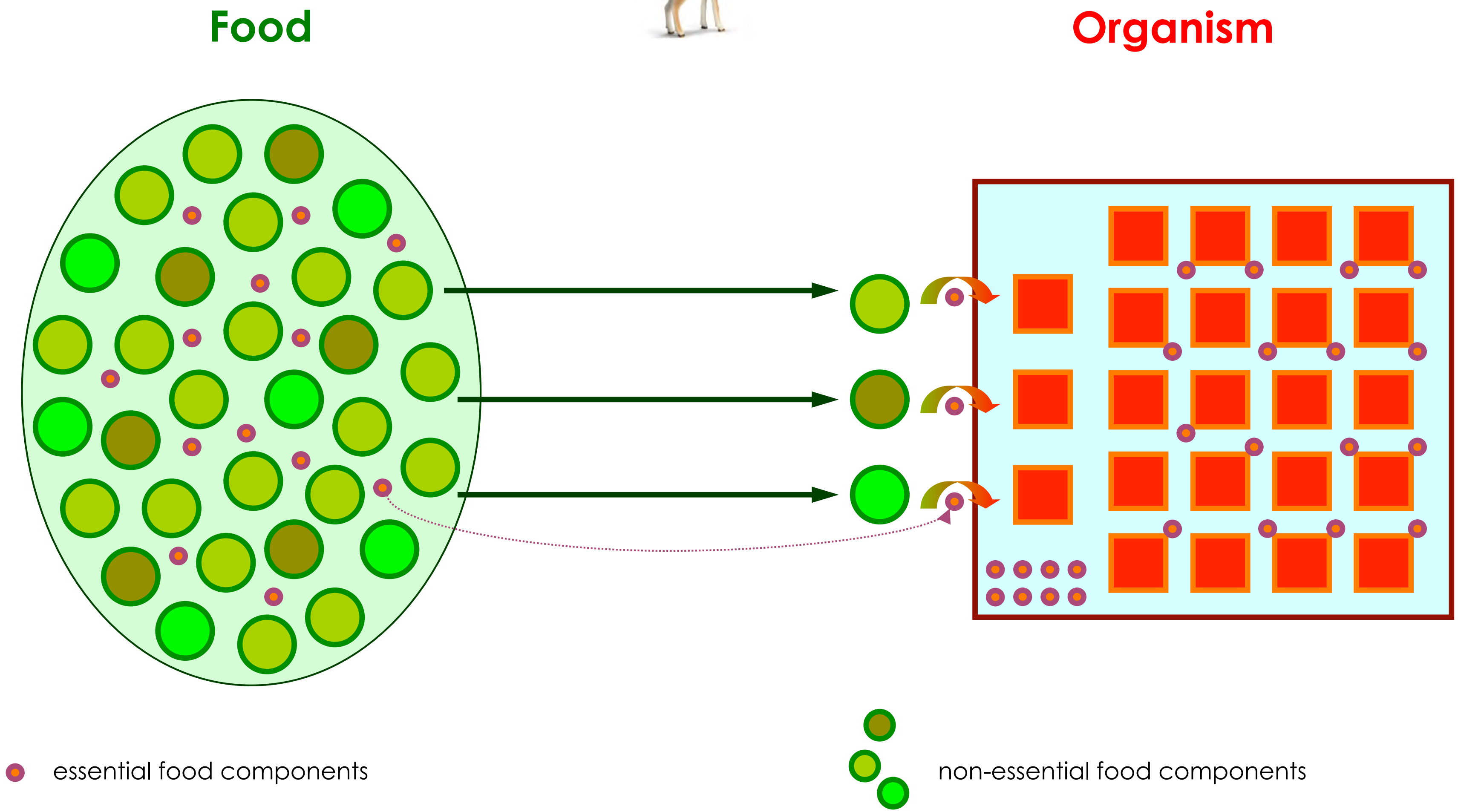
	"do as we always did"	
based on experiences what has been working		sometimes 'experiences' are mistakes one has been making for long time
	"imitate the natural diet"	
best approach		depends on what you know about the natural diet, and what feeds are available
	"use a suitable domestic species as model"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

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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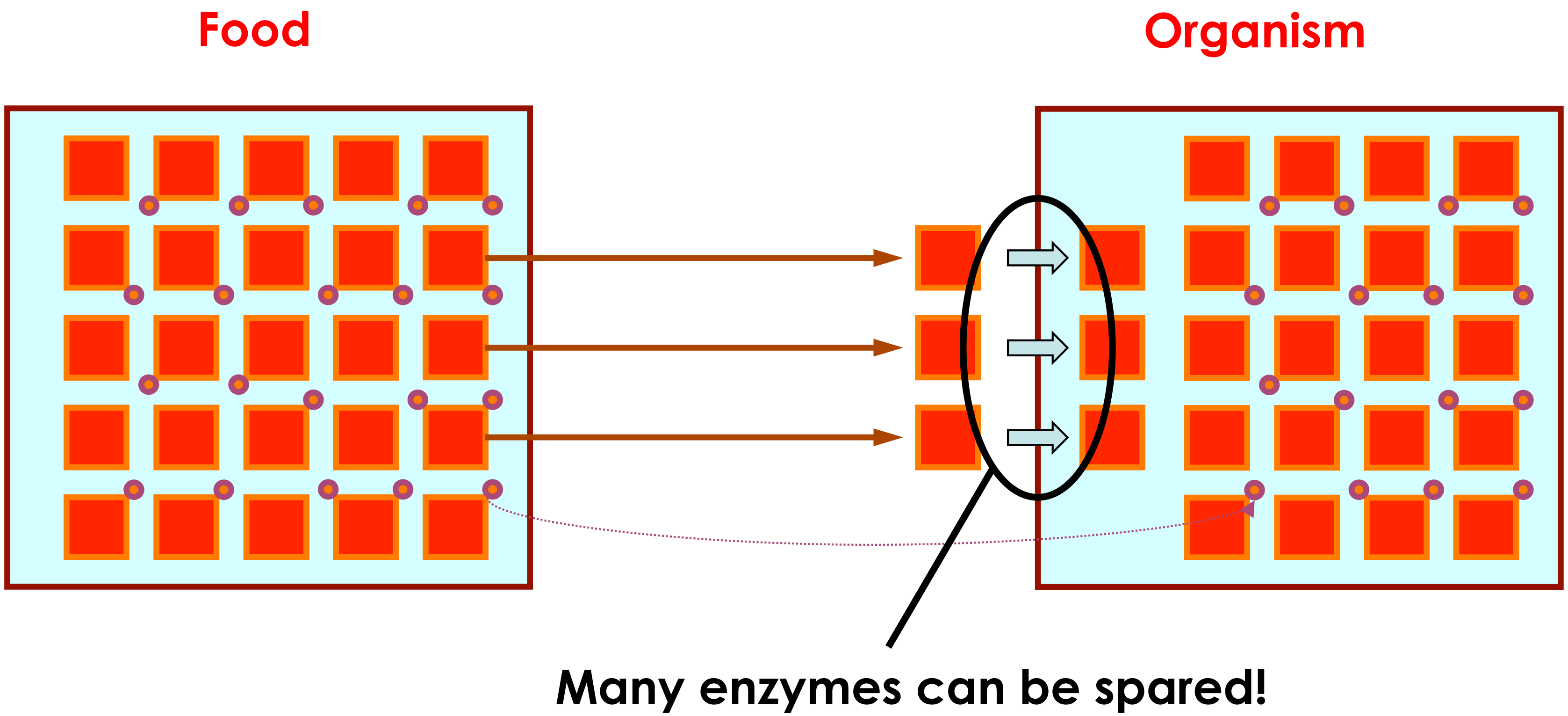

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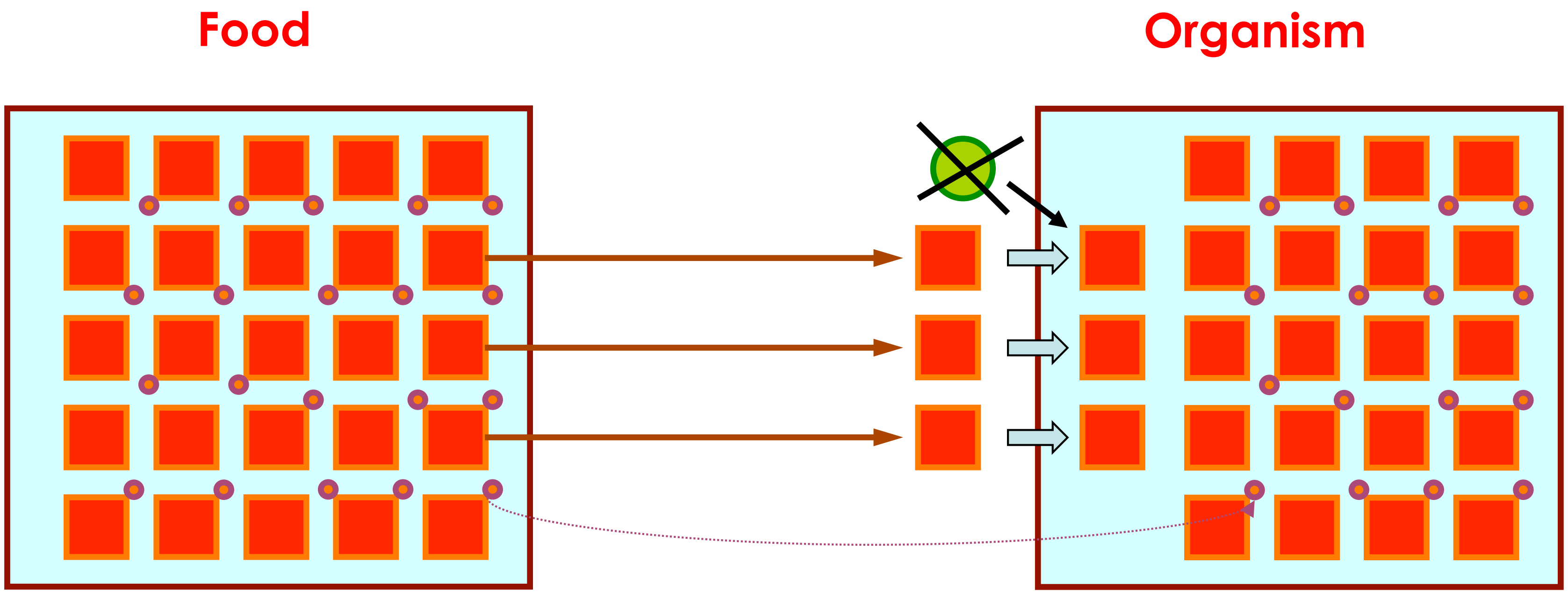

essential food components

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

essential nutrients:

- high protein requirement
- amino acids taurine and arginine
- arachidonic acid
- vitamin A (β-carotine useless)
- vitamin D
- niacine

not essential for dogs ↔

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

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

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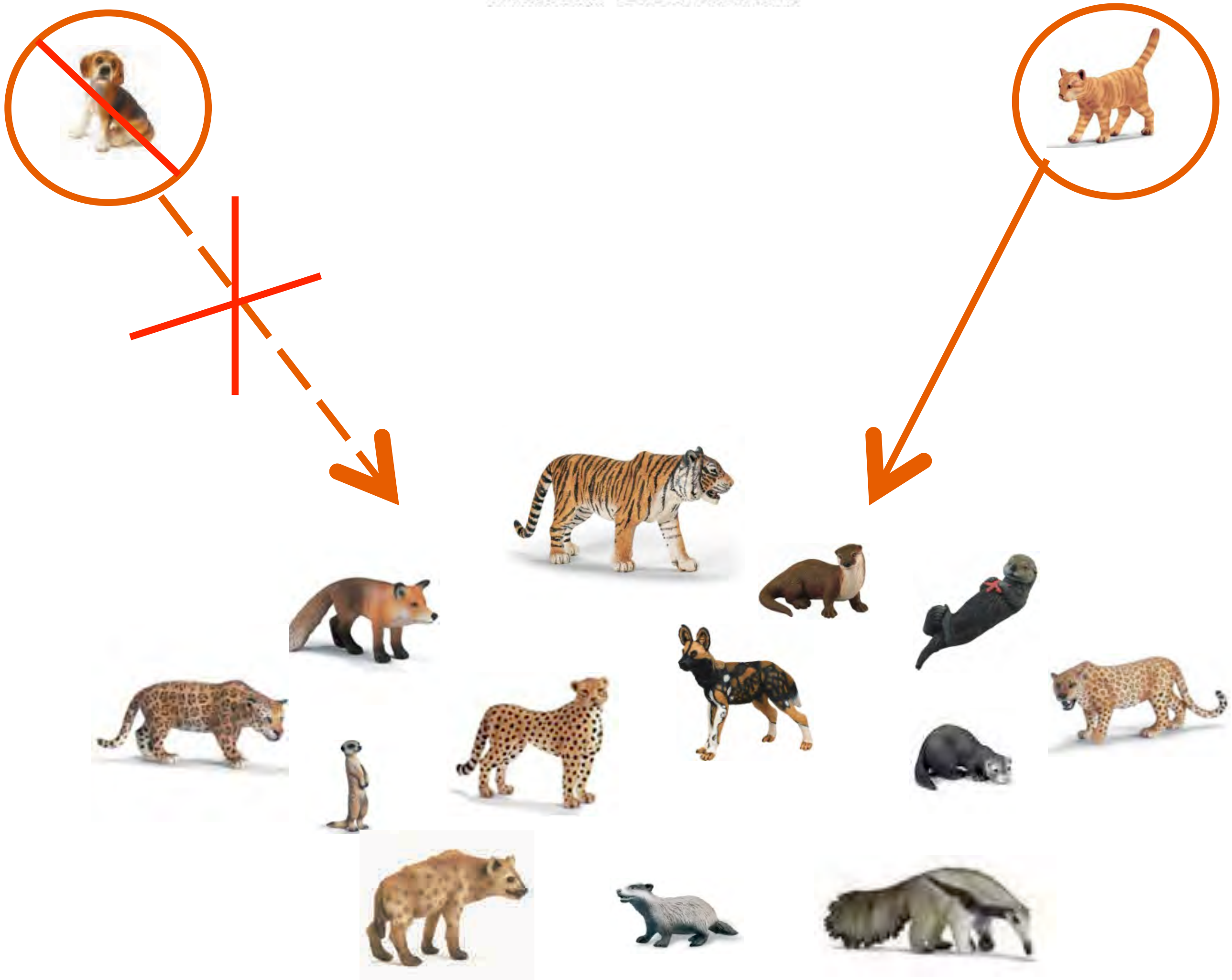

Approach to zoo animal nutrition

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"use a suitable domestic species as model"

'scientific compromise' huge amount of knowledge	species-specific peculiarities are easily overlooked

Journal of Zoo Animal Medicine 19(3): 126–131, 1988

COPPER DEFICIENCY IN CAPTIVE BLESBOK ANTELOPE (*DAMILISCUS DORCAS 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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"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"

'scientific approach'

financially and logistically challenging, difficulty in summarizing 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

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]*

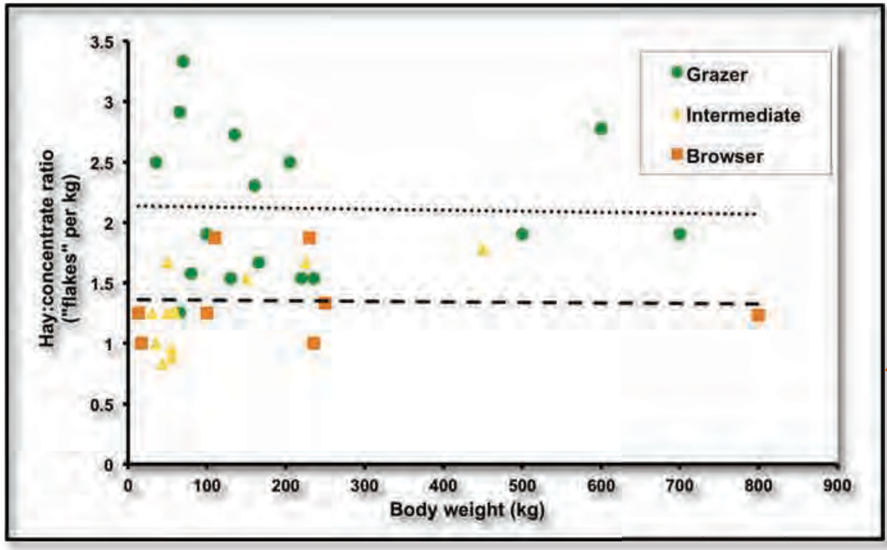
2004 PROCEEDINGS AAZV, AAWV, WDA JOINT CONFERENCE

no control group

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*

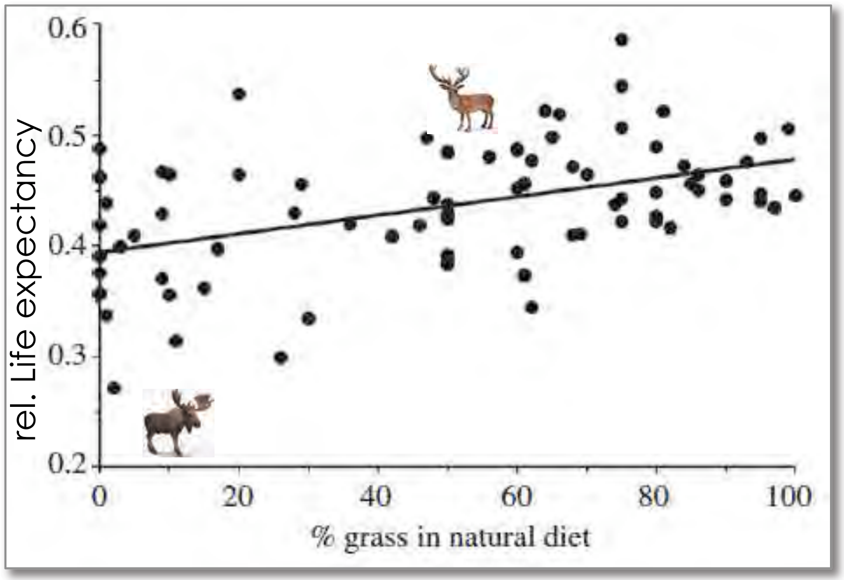
Examples: inventories



Grisham and Savage (1990)

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

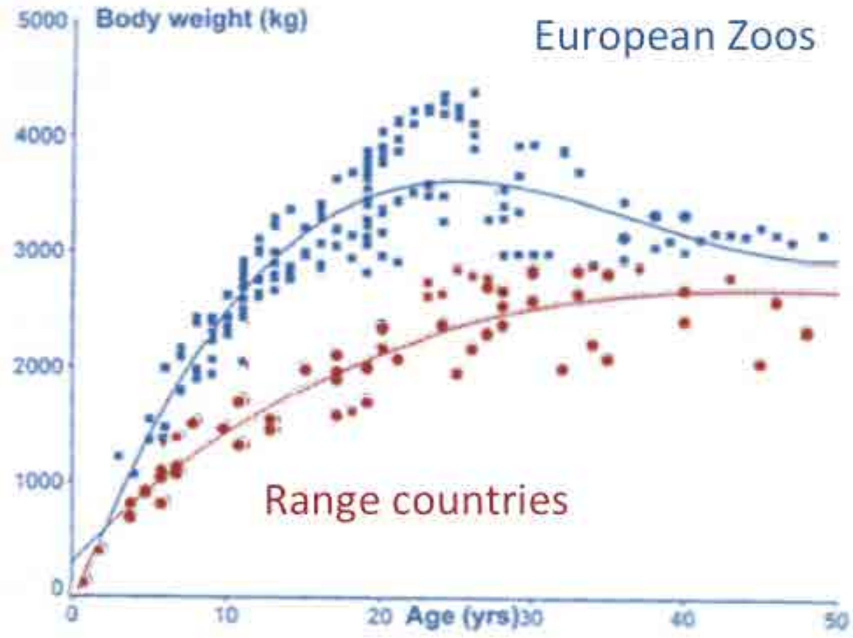
Marholdt (1991)

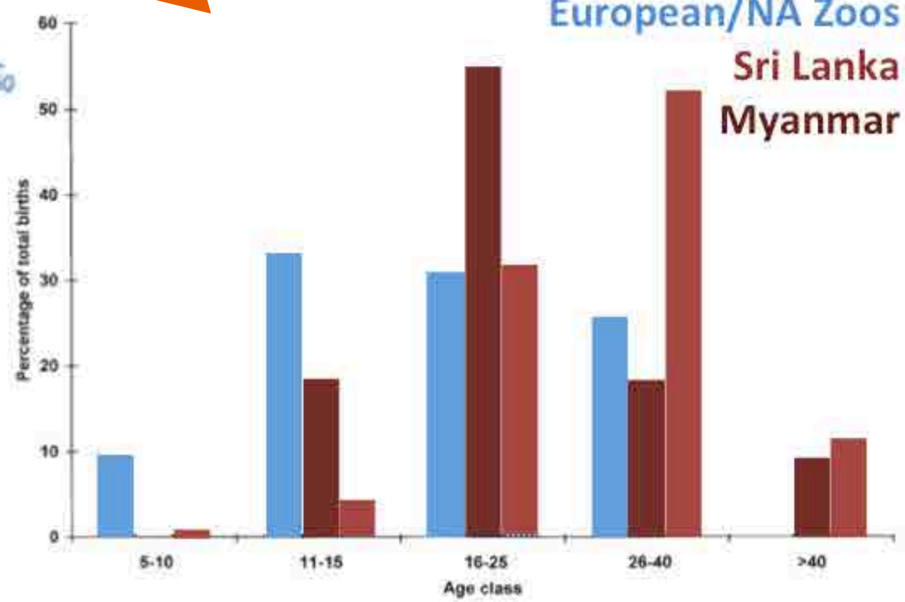


Müller et al. (2011)

no direct association

Examples: inventories





Kibby Treiber - Plenary (2015)

Studies in zoo animals

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

Journal of Zoo and Wildlife Medicine 43(3): S6–S18, 2012

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.

Species	Individual case[a,b]	Case series[a,b]	Epidemiologic survey[a,b]	Age dep[a,b]	Comparison free-range[a,b]
Tapirs					
Malayan tapir (*Tapirus indicus*)		(+) histo[2]	(+) blood[73]	(+) blood[73]	
Mountain tapir (*Tapirus pinchaque*)			(+) blood[73]	(+) blood[73]	
Baird's tapir (*Tapirus bairdii*)		(+) histo[2]	(+) blood[73]	(+) blood[73]	(+) blood[45,73]
Brazilian tapir (*Tapirus terrestris*)	(+) histo[2,59]	(+) histo, blood[76]			
Rhinos					
Sumatran rhinoceros (*Dicerorhinus sumatrensis*)		(+) histo[58]	(+) blood, tissue[22,71]		
Asian one-horned rhinoceros (*Rhinoceros unicornis*)			(–) blood, tissue[22,71]		
White rhinoceros (*Ceratotherium simum*)			(–) blood, tissue[22,71,88]	(–) tissue[88]	(–) blood[22]
Black rhinoceros (*Diceros bicornis*)	(+) blood[43]	(+) histo[80]	(+) histo, tissue, blood[22,71,72,88]	(+) blood, tissue[22,88]	(+) histo, blood, tissue[22,56,64,71,72]

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)

Dental calculus

Relationship between diet, dental calculus and periodontal disease in domestic and feral cats in Australia

DE CLARKE[a] and A CAMERON[b]

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	-
-	tooth wear (browsers, bears)	+
+	dental calculus	++
-	undesired GIT bacteria	+
-	feeding-related dysbehaviour	+

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), Fujita & Kageyama (2007)

Great ape R/R

Removing Milk from Captive Gorilla Diets: The Impact on Regurgitation and Reingestion (R/R) and Other Behaviors

Kristen E. Lukas,[1,2,3*] Gloria Hamor,[3] Mollie A. Bloomsmith,[2,3] Charles L. Horton,[3] and Terry L. Maple[2,3]

Zoo Biology 18:515 - 528 (1999)

0196-206X/86/0705-0314$02.00/0
DEVELOPMENTAL AND BEHAVIORAL PEDIATRICS

Vol. 7, No. 5, October 1986
Printed in U.S.A.

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	-
-	iron deposits in organs	+
+	unsaturated (n-3) fatty acids in diets and body tissues	-
-	tooth wear (browsers, bears)	+
+	dental calculus	++
-	undesired GIT bacteria	+
-	feeding-related dysbehaviour	+
-	***obesity***	++

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), Fujita & Kageyama (2007), Schwitzer & Kaumanns (2001)

Examples: differences wild - zoo

obesity

Examples: **epidemiological**/controlled studies

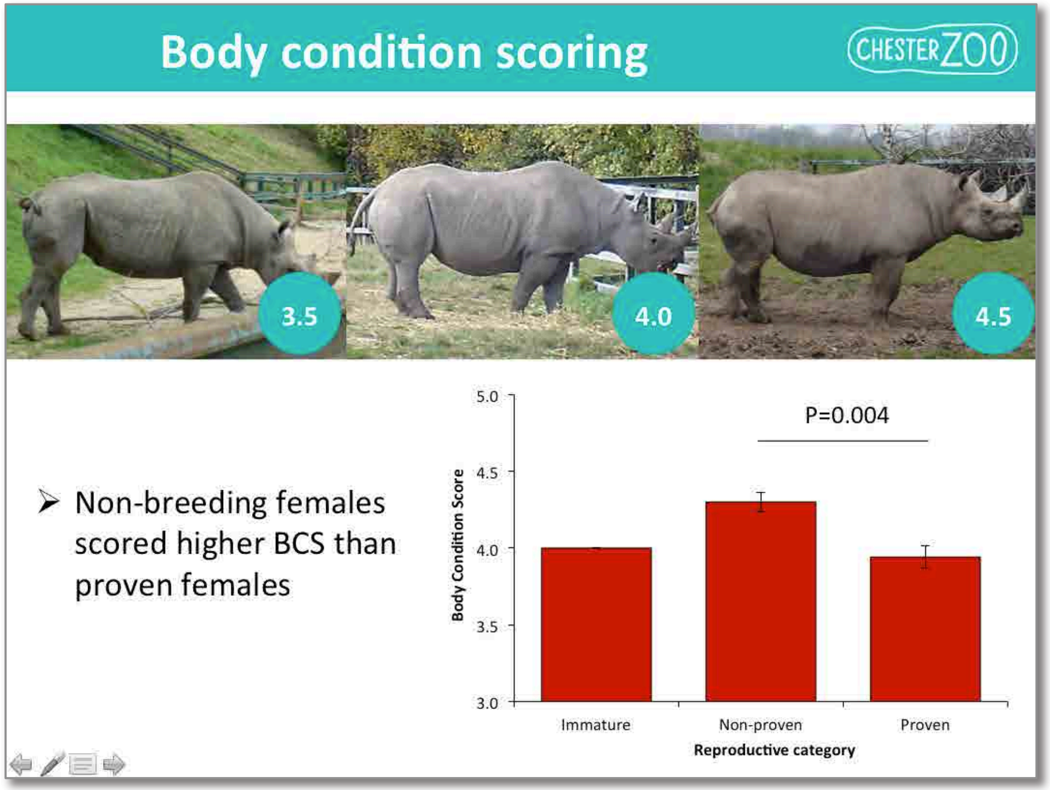
Social Factors Influence Ovarian Acyclicity in Captive African Elephants (*Loxodonta africana*)

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



courtesy Christoph Schwitzer

Examples: epidemiological/**controlled** studies

Nutritional Metabolic Bone Disease in Juvenile Veiled Chameleons (*Chamaeleo calyptratus*) and Its Prevention[1–3]

J. Nutr. 140: 1923–1931, 2010.

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]

Journal of Animal Physiology and Animal Nutrition **95** (2011) 489–498

Examples: epidemiological/**controlled** studies

Nutritional Metabolic Bone Disease in Juvenile Veiled Chameleons (*Chamaeleo calyptratus*) and Its Prevention[1–3]

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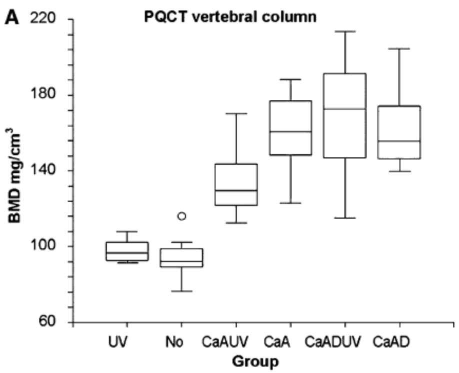
Group	*n*	Body dimensions: Weight	Body dimensions: SVL
		g	*mm*
UV	10	26.7 (19.2–34.2)	100.1 (90.4–109.8)
No	10	13.5 (11.3–15.7)	74.4 (69.1–79.7)
CaAUV	9	58.2 (47.3–69.2)	144.2 (133.8–154.6)
CaA	9	60.5 (52.1–68.9)	144.2 (133.4–155.1)
CaADUV	9	54.3 (38.1–70.5)	138.2 (117.6–158.8)
CaAD	9	57.9 (38.2–77.6)	136.8 (117.8–155.7)



Examples: epidemiological/**controlled** studies

Laboratory Animal Science

**Hepatic Hemosi
Common Marmosets, C
Effect of Diet on Incide**

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

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

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

Examples: epidemiological/**controlled** studies

Laboratory Animal Science
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Research in a zoo setting

- 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

- typical 'risk-free' nutrition studies in zoos with potential relevance: inventories, epidemiological studies
- 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"

+	-
'scientific approach'	financially and logistically challenging, **difficulty in summarizing knowledge**

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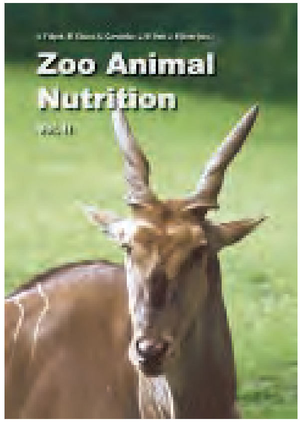

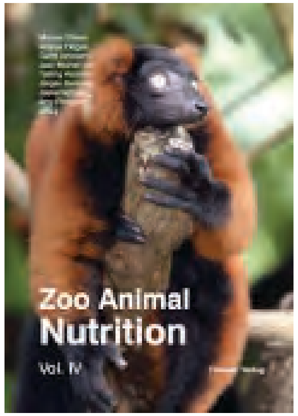

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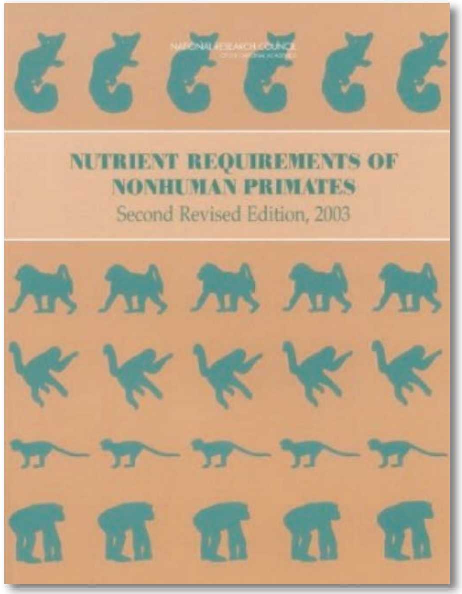

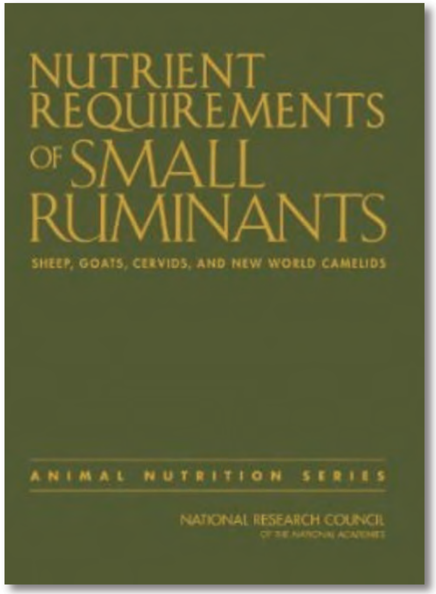

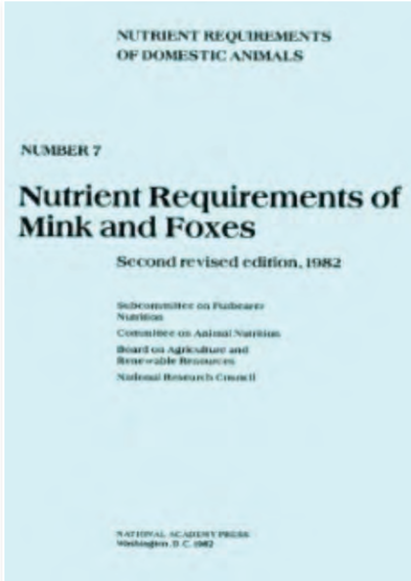

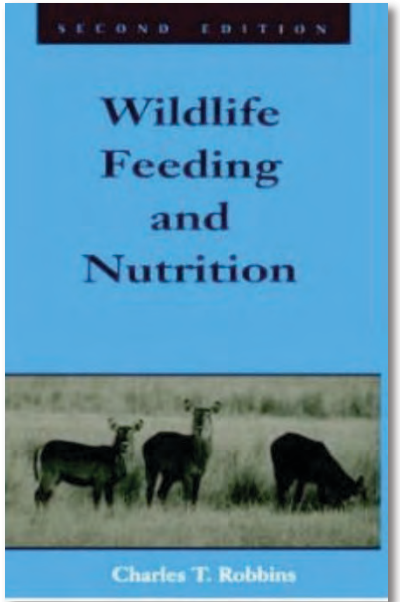

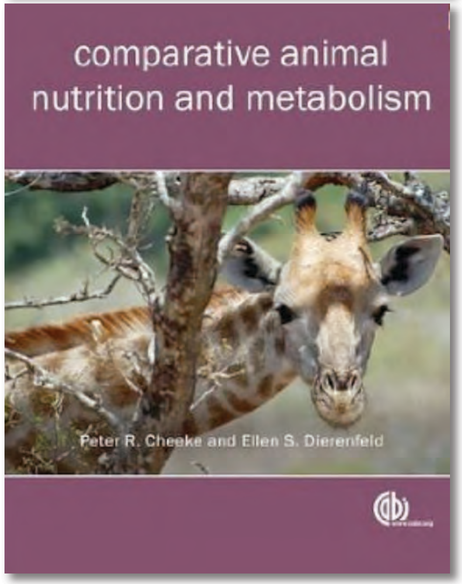

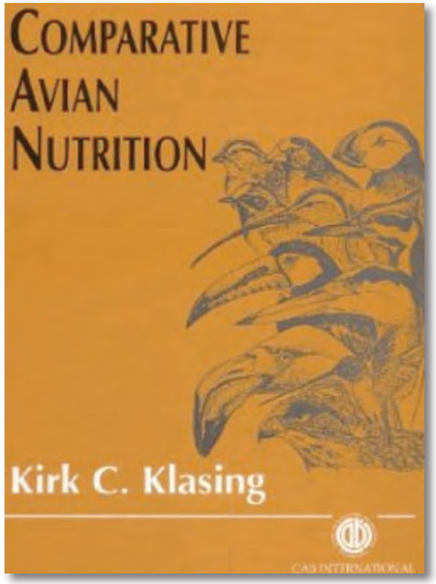

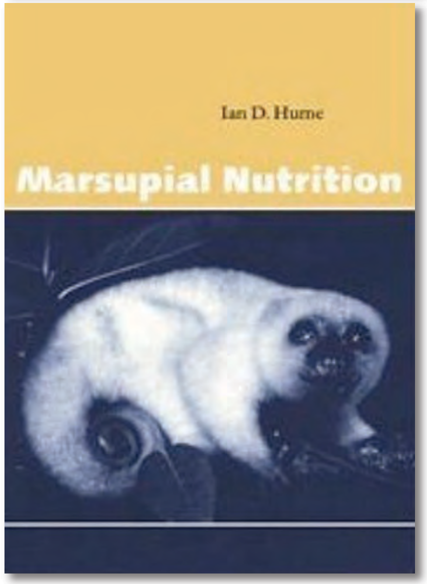

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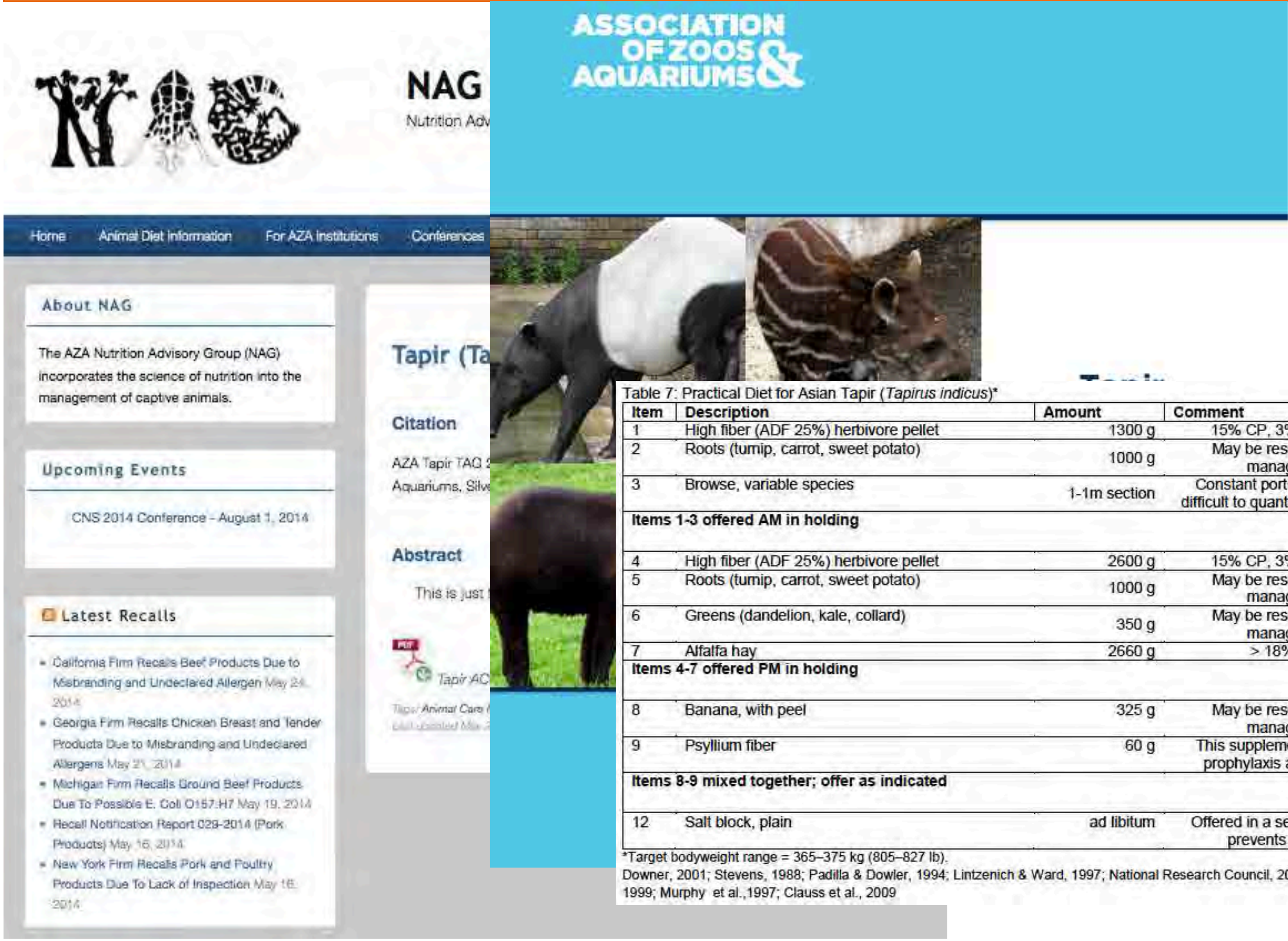

Table 7: Practical Diet for Asian Tapir (*Tapirus indicus*)*

Item	Description	Amount	Comment
1	High fiber (ADF 25%) herbivore pellet	1300 g	15% CP, 3% Fat, 25 ppm Cu
2	Roots (turnip, carrot, sweet potato)	1000 g	May be reserved to reinforce management behaviors
3	Browse, variable species	1-1m section	Constant portion of this diet but difficult to quantify mass provided
Items 1-3 offered AM in holding			
4	High fiber (ADF 25%) herbivore pellet	2600 g	15% CP, 3% Fat, 25 ppm Cu
5	Roots (turnip, carrot, sweet potato)	1000 g	May be reserved to reinforce management behaviors
6	Greens (dandelion, kale, collard)	350 g	May be reserved to reinforce management behaviors
7	Alfalfa hay	2660 g	> 18% CP, < 32% ADF
Items 4-7 offered PM in holding			
8	Banana, with peel	325 g	May be reserved to reinforce management behaviors
9	Psyllium fiber	60 g	This supplement was added as prophylaxis against sand colic
Items 8-9 mixed together; offer as indicated			
12	Salt block, plain	ad libitum	Offered in a secure manner that prevents overconsumption

*Target bodyweight range = 365–375 kg (805–827 lb).
Downer, 2001; Stevens, 1988; Padilla & Dowler, 1994; Lintzenich & Ward, 1997; National Research Council, 2007; Janssen et al., 1999; Murphy et al.,1997; Clauss et al., 2009

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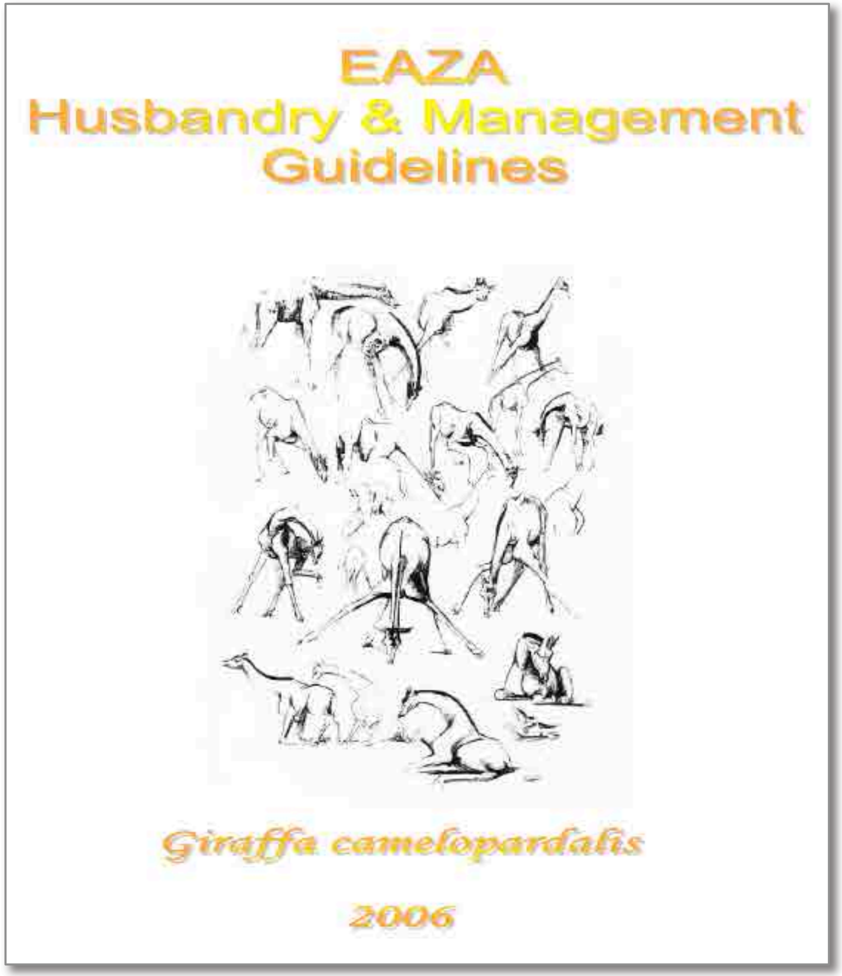


Where is the information?

Mammals

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.

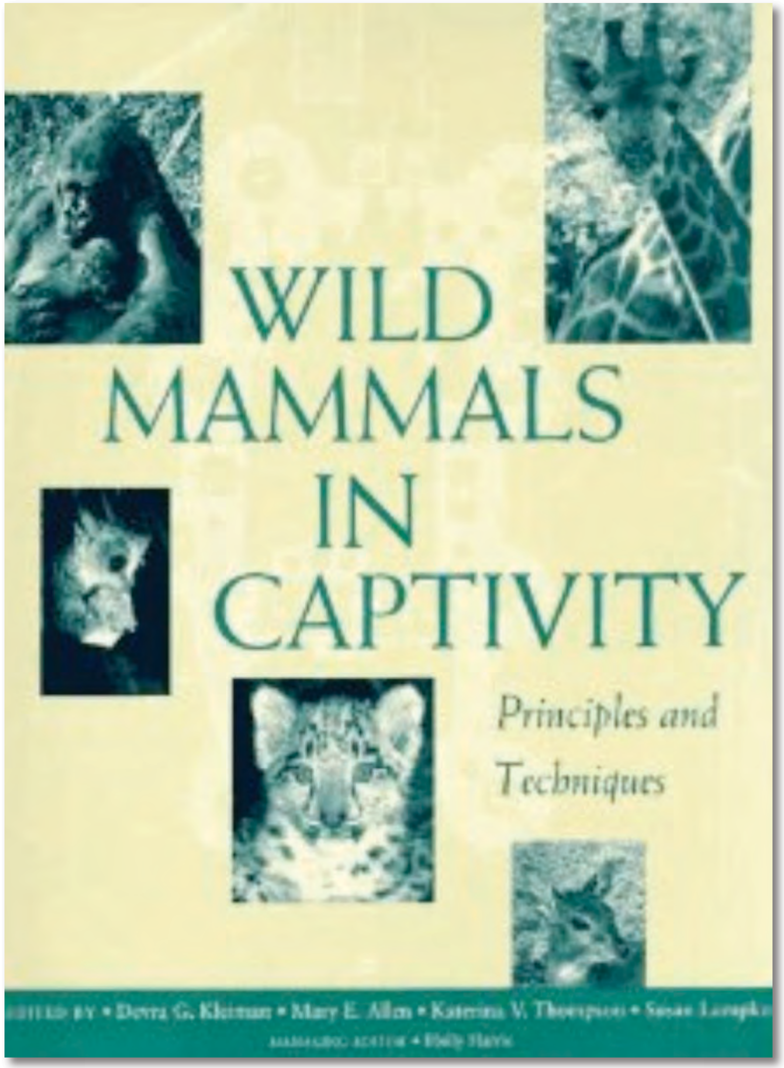
2. The second section provides the contact details for the Husbandry Manuals known to us from the taxonomic group you have selected, listed by Taxonomic Family.

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?



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

Where is the information?

not in any one place

Where is the information?