



Survey of feeding practices, body condition and faeces consistency in captive ant-eating mammals in the UK



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European Zoo Nutrition Conference Liberec 2017



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Research article

Survey of feeding practices, body condition and faeces consistency in captive ant-eating mammals in the UKAmelia Clark^{1,2*}, Ayona Silva-Fletcher³, Mark Fox⁴, Michael Kreuzer⁵ and Marcus Clauss⁶¹Zoological Society of London, London, United Kingdom²The Royal Veterinary College, London, United Kingdom³Department of Clinical Sciences and Services, The Royal Veterinary College, Hertfordshire, United Kingdom⁴Department of Pathology and Pathogen Biology, The Royal Veterinary College, London, United Kingdom⁵ETH Zurich, Institute of Agricultural Sciences, Zurich, Switzerland⁶Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

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Keywords:

aardvark, armadillo, body condition score, diet survey, faecal score, giant anteater

Article history:

Received: 17 February 2016

Accepted: 4 October 2016

Published online: 3 November 2016

Abstract

A survey was conducted investigating the feeding practices, body condition, and faecal consistency of 26 giant anteaters (*Myrmecophaga tridactyla*), 13 aardvarks (*Orycteropus afer*), and 31 armadillos (*Dasypodidae* spp.) from 20 zoological collections in the UK. For the latter two, scores for body condition (BCS, from 1 – emaciated – to 5 – grossly obese) and faeces (Faecal Score (FS) from 1 – solid – to 5 – diarrhoea-like) were applied. The majority of the UK collections offered a ‘complete’ feed for anteaters and aardvarks as opposed to the traditional ‘gruel’ diet. Armadillos were fed mixed diets of fruits, vegetables, eggs, dog or cat food, and various other items. Grossly obese individuals (BCS >4) were only observed in two armadillo species. The average body mass recorded for giant anteaters was above values reported for wild animals, but this was not the case in aardvarks. Anteaters received on average 75% of the amount of dry matter offered to aardvarks, although their basal metabolism is only 60% that of aardvarks; hence, anteaters might have been offered more food than required. The FS for anteaters were higher than for aardvarks or armadillos. Dietary ash, acid detergent fibre and acid insoluble ash (AIA) levels did not correlate with either FS or faecal dry matter (DM). However, there were negative correlations between faecal ash and AIA content with faecal DM and FS, suggesting that measures increasing AIA intake above that achieved by current diets might beneficially influence FS. Only one anteater had a patent parasite infection; this animal had an FS of 5. Results of this survey will encourage careful monitoring of body mass and diet for giant anteaters and armadillos to avoid obesity. Further studies are needed to investigate the impact of higher levels of indigestible material in anteater diets on faecal consistency, growth, and body condition.

Introduction

Myrmecophagous (ant- and termite-eating) mammals occupy a highly specialised dietary niche with a feeding ecology that is difficult to replicate in captivity. They have a varying range of specialised anatomical adaptations for seizing and ingesting insects, such as a reduction in teeth, pointed snouts, large salivary glands, and anterior extremities designed for digging (Reiss 2001; Taylor et al. 2002; Camilo-Alves and Mourão 2006; Da Silva Anacleto 2007). Free-ranging myrmecophages have been identified as being either opportunistic (e.g. armadillos) or obligatory (e.g. anteaters and aardvarks) feeders of ants or termites (Redford 1986, 1987a; Morford and Meyers 2003a; Valdes and Brenes Soto 2012; Delsuc et al. 2014). Ants and

termites are particularly suitable food sources because their colonial habitats make them available at focal high densities (Redford 1987b).

The nocturnal and solitary ecology of most myrmecophages creates a challenge for observing and understanding their diets and behaviours in the wild (Taylor et al. 2002; Valdes and Brenes Soto 2012). Although the food habits of armadillos (*Dasypodidae*) have been accurately documented as a result of extensive examination of both stomach and faecal contents, there is little information available on the nutritional requirements of giant anteaters (*Myrmecophaga tridactyla*) and aardvarks (*Orycteropus afer*) (Redford 1986). This has made the development of an adequate diet difficult in captivity, especially while trying to provide behavioural enrichment that



Myrmecophages



exclusively



ants, termites



opportunistically

... is this the only item ingested?



Natural diet of myrmecophages





Natural diet of myrmecophages





Natural diet of myrmecophages



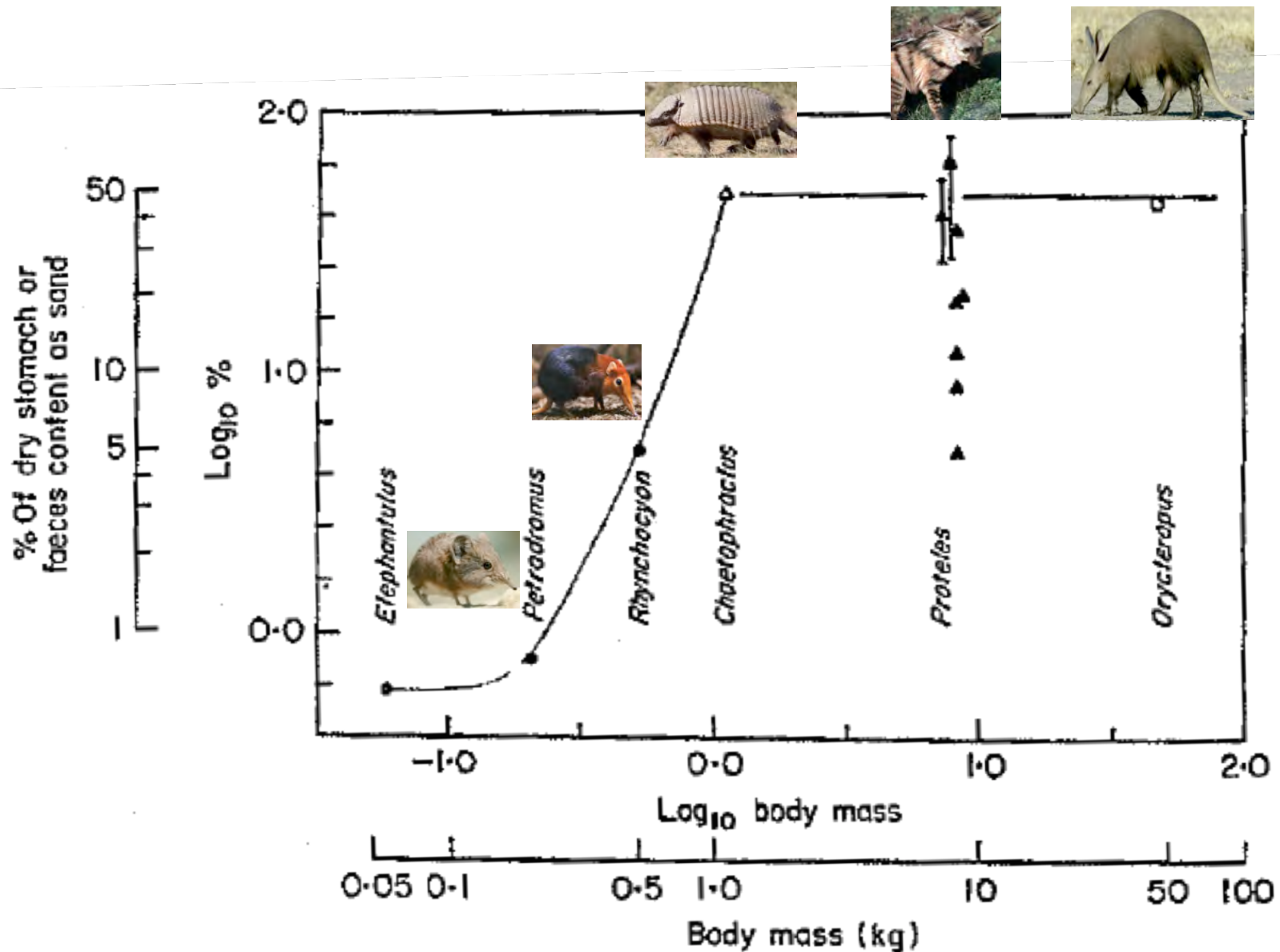


Natural diet of myrmecophages





Unavoidable detritus ingestion in myrmecophages





Myrmecophages



exclusively



ants, termites



opportunistically

Ingestion of indigestible material

- cause for comparatively low metabolism in these species?
- important for GIT health and faeces consistency?

Susceptibility to overfeeding?



Survey

Visits to 20 UK facilities

Collecting

- sample diets
- faecal samples
- photographs of animals
- data on body mass if available

Judging body condition and faeces by photographs

Analysing diet items and faeces for dry matter and acid insoluble ash



Giant anteater diets



Food items	Percentage (number) of collections	
	Giant anteater diet	
Vegetable mix	8%	(1)
Fruit mix	46%	(6)
Eggs	38%	(5)
Day old chick	—	
Dog biscuit	15%	(2)
Beef mince	—	
Cat biscuit	15%	(2)
Zoo "A" pellet ¹	—	
Rice	—	
Termant ¹	92%	(12)
Mice	—	
Older chickens	—	
Mixed nuts	—	
Brown bread	—	
Cheese	—	
Yogurt	15%	(2)
Starch mix	—	
Honey	46%	(6)
Peat	31%	(4)
Beef heart	23%	(3)
Dry shrimp	15%	(2)
Porridge oats	15%	(2)
Dog food (tinned)	8%	(1)
Horse minced meat	8%	(1)
Leaf-Eater Primate Diet ¹	8%	(1)



BCS giant anteater/aardvark

Table 1. Body condition score (BCS) applied to captive giant anteaters (*Myrmecophaga tridactyla*) and aardvarks (*Orycteropus afer*).

BCS	General	Neck/shoulder	Hip/tailhead*
1	Bony, skeletal	Emaciated, bone structure of scapula easily noticeable; no folds visible on neck	Prominent tailhead, hip, and pelvic bones
2	Thin	Thin neck and shoulder	Flattened tailhead, hip, and pelvic bones
2.5	Slightly underweight	Normal size neck, more visible shoulders	Flatter tailhead, more visible hips and pelvic bones
3	Moderate/Fit	Moderate size neck, flattened shoulders	Moderate fat around tailhead, flattened pelvic and hip bones
3.5	Overweight	Thicker neck with minor and rounded shoulder	More apparent fat around tailhead, slightly rounded pelvic and hip bones
4	Moderately obese	Thick neck, visible folds rounded shoulders	Fat around tailhead, rounded hips
5	Grossly obese	Thick neck with visible folds; bone structure of shoulders not visible	Excessive fat around tailhead, hips and pelvic bones very rounded

*Tailhead was only scored for aardvarks.



BCS giant anteater

Table 1. Body Condition Score (BCS) for giant anteaters

BCS	Grade
1	Below normal
2	Thin
2.5	Slightly thin
3	Normal
3.5	Overweight
4	Obese
5	Extremely obese

*Tailhead was



BCS2



BCS3



bones
ric and
ounded



BCS4



bones



BCS giant anteater



Tab

BC

1

2

2.5

3

3.5

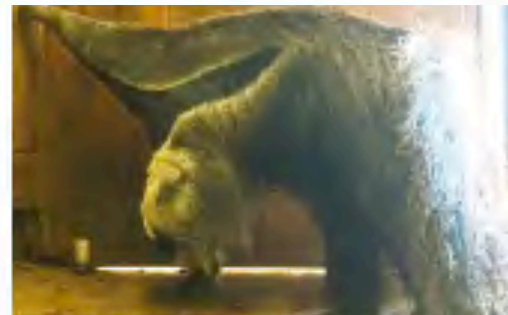
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5

*Ta




BCS4





Results: Body mass, BCS, food offer

Species	Body mass in adult free-ranging individuals, kg	Body mass, kg	BCS	Dry matter offered, g/d	Relative dry matter offered, g/kg ^{0.75} /d
Giant anteater (<i>M. tridactyla</i>) 	31–45 ¹	49.0±7.6 (38.5–62.5) n=12	2.9±0.5 (2.0–4.0) n=26	611±214 (270–1170) n=24	30±12 (16–53) n=10

Zoo giant anteaters:

Higher body masses than in the wild have been reported repeatedly. Does this have relevance?
Wide range of body masses and BCS.

As a guide for Giant Anteaters feed:

For Maintenance 15g of powder/kg BW/d
(BW= Body Weight)

=> 735 g/d



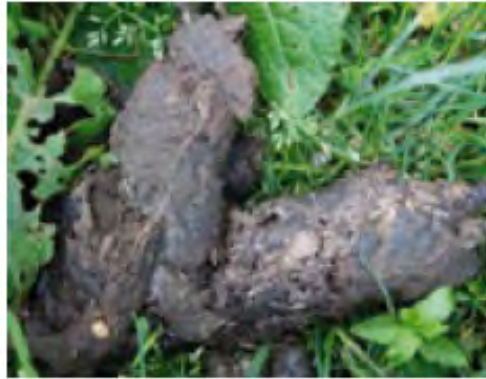
Faecal scoring system

FS	Description
1	Hard and extremely dry – crumbles when pressure applied
1.5	Hard and dry with a distinct shape
2	Well formed without leaving a mark when touched
2.5	Well formed with a moist surface and a mark left when touched
3	Moist and beginning to lose form. Definite mark when picked up
3.5	Very moist with less of a definite form. No longer broken into distinct pieces
4	Most form is lost; poor consistency; difficult to pick up
4.5	Diarrhea with minor areas of solid consistency/shape
5	Watery diarrhoea. No areas of consistency or shape.



Giant anteater faeces

FS 2.5



FS 3.5



FS 4



FS 4.5




FS 5





Results: Faecal measures

Species		Faecal score	DM % of wet weight	Total ash % of DM	AIA % of DM
Giant anteater (<i>M. tridactyla</i>)		3.9±0.8 (2.0–5.0) n=22	30.6±11.4 (16.9–79.8) n=30	28.1±20.3 (10.4–88.6) n=31	17.1±21.5 (1.1–85.1) n=28

Zoo giant anteaters:

Wide range of faecal scores, on average softer than in the wild.



Aardvark diets



Suitable species

Insectivorous animals such as Giant Anteaters and Aardvarks

Benefits

- Designed as a complete diet containing essential vitamins and minerals needed for these species.
- Containing a high level of fibre in the form of Chitin and purified Cellulose to meet the animal's natural requirements.
- Contains Formic Acid to aid digestion.
- Contains Taurine.
- Contains a good supply of fatty acids including Arachidonic acid.
- Economical and easy to feed.
- Significantly reduces feed preparation time.

Ingredients

Poultry Meat Meal, Maize Gluten Meal, Maize Starch, Soya Hulls, Cellulose, Rice Grain, Wheat, Soya Oil, Prawn Shell Meal, Yeast, Chicken Fat, Fish Oil, Minerals, Formic Acid, Vitamins, Amino Acids, Trace Elements.

Feeding recommendations

Formulated as a complete diet that is supplied in the form of a powder. The powder can be fed dry or mixed with water to achieve a gruel of desired consistency. Fresh gruel should be made up every day.

As a guide for Giant Anteaters feed:

For Maintenance 15g of powder/kg BW/d
(BW= Body Weight)

For Gestation 20g of powder/kg BW/d

For Lactation 45g of powder/kg BW/d

Continued overleaf



SPECIAL DIETS
DATASHEET

73

TERMANT

Calculated analysis

(Unless otherwise stated nutrients are expressed as total calculated levels)

Moisture	%	10.00
Crude Fat	%	10.16
Crude Protein	%	28.32
Crude Fibre	%	10.88
Ash	%	6.07
NFE	%	33.09
Atwater Fuel Energy (AFE)	kJ/Kg	14.09
Lysine	%	1.27
Methionine	%	0.65
Taurine	%	0.19
Calcium	%	1.44
Phosphorus (Total)	%	1.08
Sodium	%	0.37
Magnesium	%	0.12
Copper	mg/Kg	20.02
Vit. A (added as Retinyl Acetate)	IU/g	9.67
Vit. D3 (added as Cholecalciferol)	IU/g	1.93
Vit. E (added as dl-alpha-tocopherol acetate)	IU/Kg	248.27
Vit. K (added as Menadione)	mg/Kg	19.93

For further information

Email: info@mazurifoods.com
Tel: +44 (0)1376 511 260
Fax: +44 (0)1376 511 247
www.mazuri.eu



MazuriTM Zoo Foods

Code	Diet	Pack weight	Form
828560	Termant	10Kg	Powder



BCS aardvark

Table 1. Body condition score (BCS) applied to captive giant anteaters (*Myrmecophaga tridactyla*) and aardvarks (*Orycteropus afer*).

BCS	General	Neck/shoulder	Hip/tailhead*
1			
2			
2			
3			
3			
4			
5			
	not visible	BCS 3	very rounded

*Tailhead was only scored for aardvarks.



BCS aardvark

Table 1. Body condition score (BCS) applied to captive giant anteaters (*Myrmecophaga tridactyla*) and aardvarks (*Orycteropus afer*).



BCS	General	Neck/shoulder	Hip/tailhead*
1			
2			
2			
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3			
4			
5			

*Tailhead was only scored f





Results: Body mass, BCS, food offer

Species		Body mass in adult free-ranging individuals, kg	Body mass, kg	BCS	Dry matter offered, g/d	Relative dry matter offered, g/kg ^{0.75} /d
Giant anteater (<i>M. tridactyla</i>)		31–45 ¹	49.0±7.6 (38.5–62.5) n=12	2.9±0.5 (2.0–4.0) n=26	611±214 (270–1170) n=24	30±12 (16–53) n=10
Aardvark (<i>O. afer</i>)		40–60 ²	44.9 ± 6.9 (28.6–51.5) n=9	3.0±0.0 (3.0–3.0) n=13	636±102 (445–750) n=13	40±7 (31–55) n=9

Zoo aardvarks:
Body masses as in the wild; good BCS.

As a guide for Aardvarks feed:

For Maintenance feed 13g of powder/kg BW/d

=> 583 g/d



Faeces aardvarks

FS 2



FS 3





FS 3.5





Results: Faecal measures

Species		Faecal score	DM % of wet weight	Total ash % of DM	AIA % of DM
Giant anteater (<i>M. tridactyla</i>)		3.9±0.8 (2.0–5.0) n=22	30.6±11.4 (16.9–79.8) n=30	28.1±20.3 (10.4–88.6) n=31	17.1±21.5 (1.1–85.1) n=28
Aardvark (<i>O. afer</i>)		2.8±0.7 (2.0–3.5) n=13	38.1±6.7 (27.2–45.9) n=6	33.5±16.2 (20.3–62.8) n=6	18.2±11.8 (1.9–33.0) n=6

Zoo armadillos:
Good faecal scores.



Armadillo diets



Food items	Percentage (number) of collections
	Armadillo diet
Vegetable mix	88% (15)
Fruit mix	82% (14)
Eggs	59% (10)
Day old chick	53% (9)
Dog biscuit	47% (8)
Beef mince	41% (7)
Cat biscuit	35% (6)
Zoo "A" pellet ²	35% (6)
Rice	29% (5)
Termant ¹	24% (4)
Mice	18% (3)
Older chickens	6% (1)
Mixed nuts	6% (1)
Brown bread	6% (1)
Cheese	6% (1)
Yogurt	6% (1)
Starch mix	6% (1)



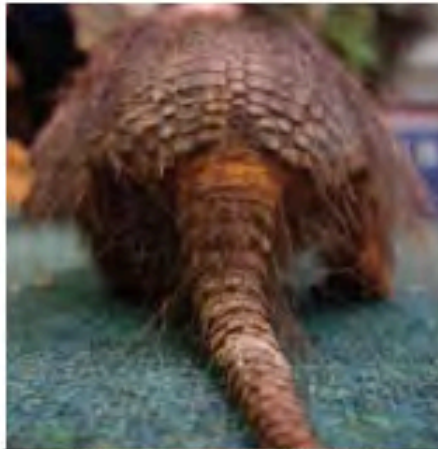
BCS armadillos

BCS	General	Body shell/hips/thighs
1	Bony, skeletal	Defined jaw, no fat on underside of shell, bony
2	Thin	No visibility of fat on underside of shell
3	Moderate/fit	Little to no visibility of fat on underside of shell. From lateral view, shell lays flat against the body
4	Moderately obese	Fat around hips and thighs clearly visible. Slight upward push of shell due to presence of fat.
5	Grossly obese	Excessive fat around hips and thighs. Shell above tail visibly pushed upwards due to presence of fat. Fat folds present on underside



Large hairy armadillo

(*Chaetophractus villosus*)



BCS 3



BCS 4



BCS 5





Large hairy armadillo

(*Chaetophractus villosus*)



BCS 5





Six-banded armadillo

(Euphractus sexcinctus)



BCS 3



BCS 4



BCS 5





Six-banded armadillo

(Euphractus sexcinctus)



BCS 5





Southern three-banded armadillo

(Tolypeutes matacus)



BCS 3








Southern three-banded armadillo

(Tolypeutes matacus)





Results: Body mass, BCS, food offer

Species		Body mass in adult free-ranging individuals, kg	Body mass, kg	BCS	Dry matter offered, g/d	Relative dry matter offered, g/kg ^{0.75} /d
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Aardvark (<i>O. afer</i>)		40–60 ²	44.9 ± 6.9 (28.6–51.5) n=9	3.0±0.0 (3.0–3.0) n=13	636±102 (445–750) n=13	40±7 (31–55) n=9
Larger hairy armadillo (<i>C. villosus</i>)		2.4 (1.0–3.9) ³	3.8±0.8 (3.0–5.4) n=9	3.7±0.6 (3.0–5.0) n=11	177±115 (58–433) n=9	71±41 (23–148) n=7
Six-banded/yellow armadillo (<i>E. sexcinctus</i>)		3.3 ⁴	7.1±1.3 (5.3–9.5) n=7	4.1±1.1 (3.0–5.0) n=9	138±21 (106–157) n=8	32±7 (23–40) n=6
Southern three-banded armadillo (<i>T. matacus</i>)		1.1 (0.8–1.5) ⁵	1.3±0.2 (1.0–1.6) n=10	3.0±0.0 (3.0–3.0) n=10	106±47 (72–157) n=5	90±45 (57–156) n=5

Zoo armadillos:

Body masses higher than in the wild; high BCS (2 out of 3 species).



Faeces armadillos

FS 1.5



FS 2.0








Faeces armadillos

FS 1.5





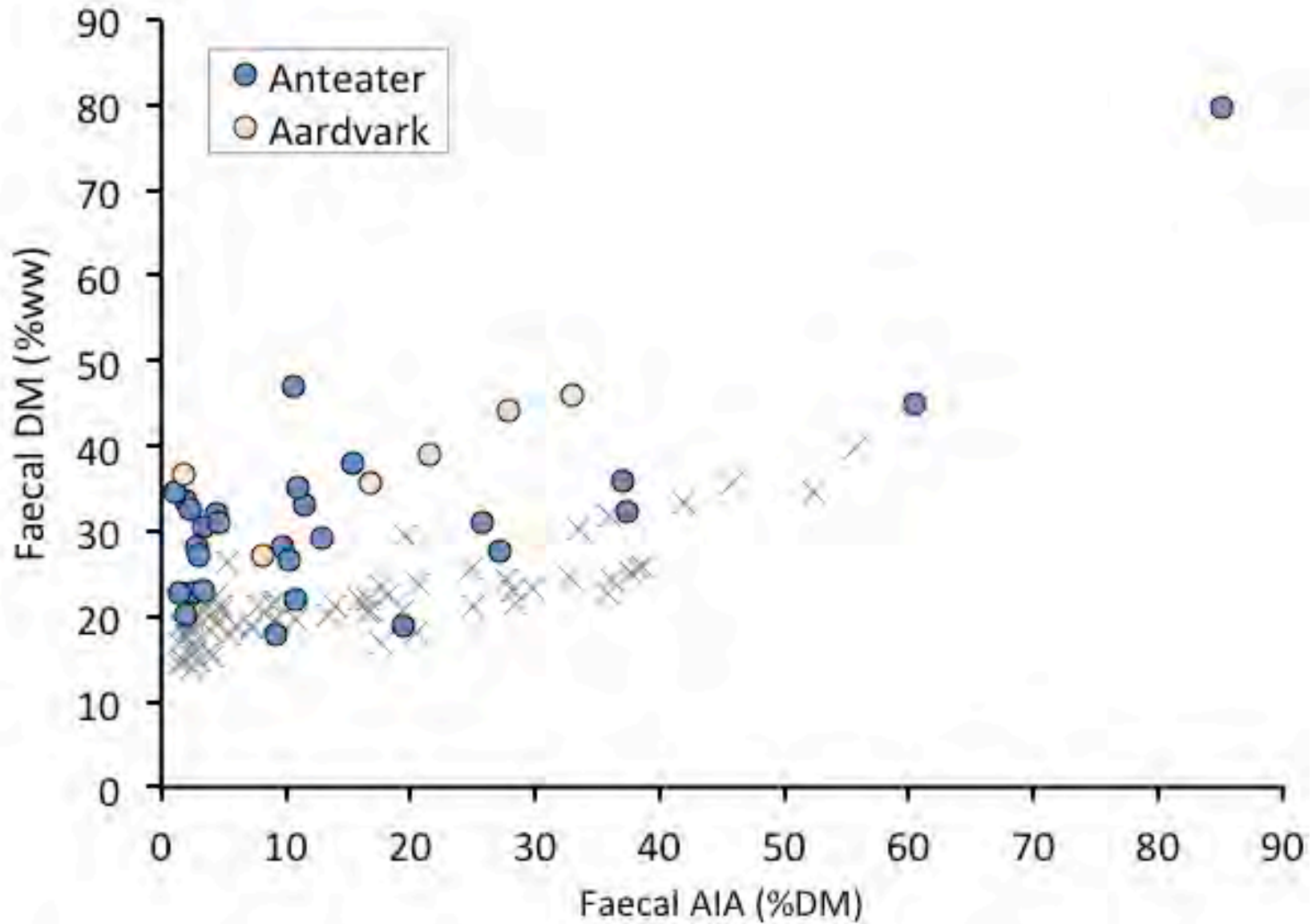
Results: Faecal measures

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Aardvark (<i>O. afer</i>)		2.8±0.7 (2.0–3.5) n=13	38.1±6.7 (27.2–45.9) n=6	33.5±16.2 (20.3–62.8) n=6	18.2±11.8 (1.9–33.0) n=6
Larger hairy armadillo (<i>C. villosus</i>)		1.5±0.0 (1.5–1.5) n=11	49.1±14.3 (35.4–64.0) n=6	45.9±25.5 (19.5–74.8) n=6	N/A
Six-banded/yellow armadillo (<i>E. sexcinctus</i>)		1.7±0.3 (1.5–2.0) n=9	28.6±7.8 (19.0–36.8) n=6	20.6±9.2 (11.2–33.9) n=6	N/A
Southern three-banded armadillo (<i>T. matacus</i>)		1.5±0.0 (1.5–2.0) n=10	42.0 n=1	N/A	N/A

Zoo armadillos:
Good faecal scores.

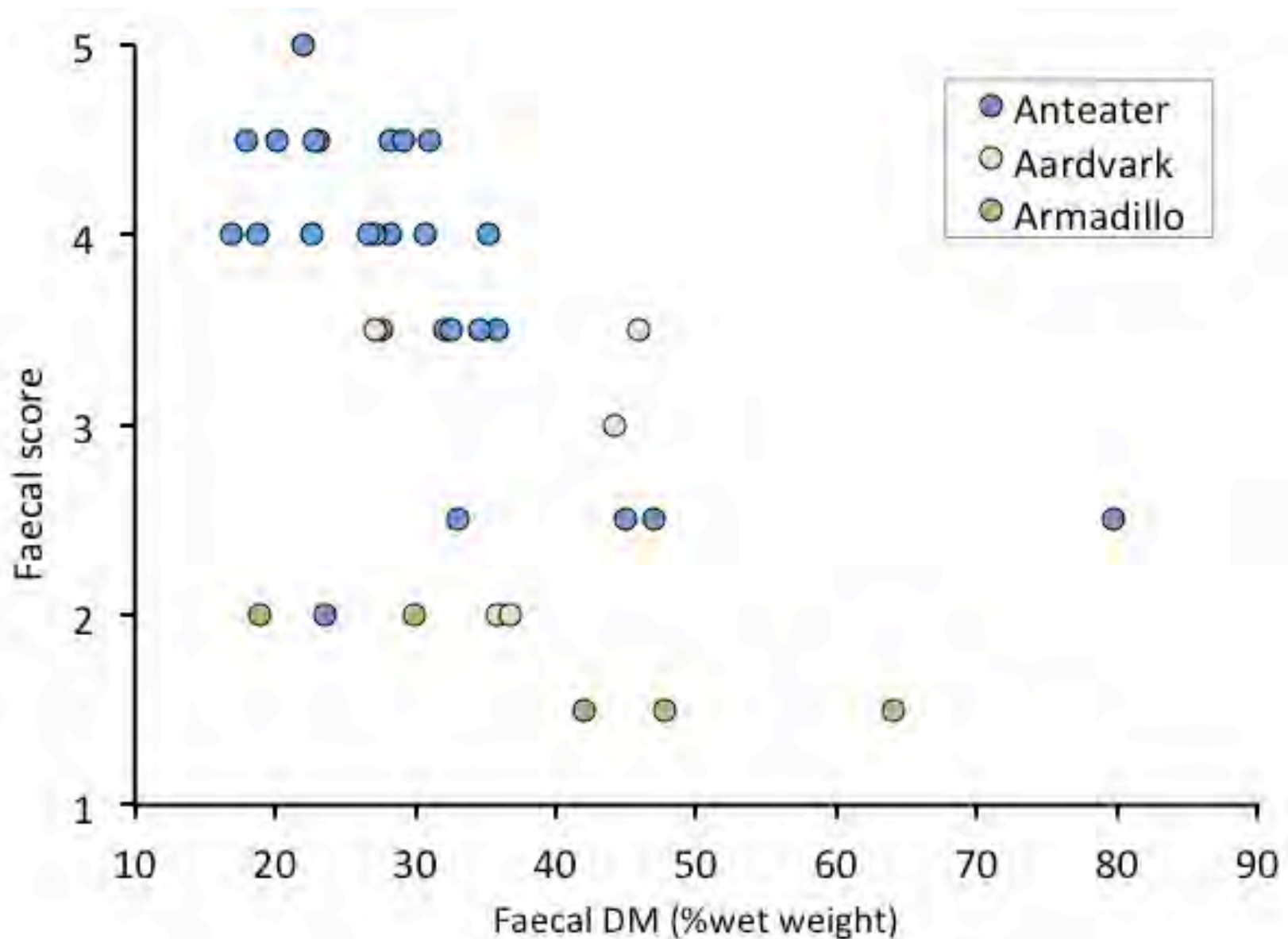


What is it about giant anteater faeces?



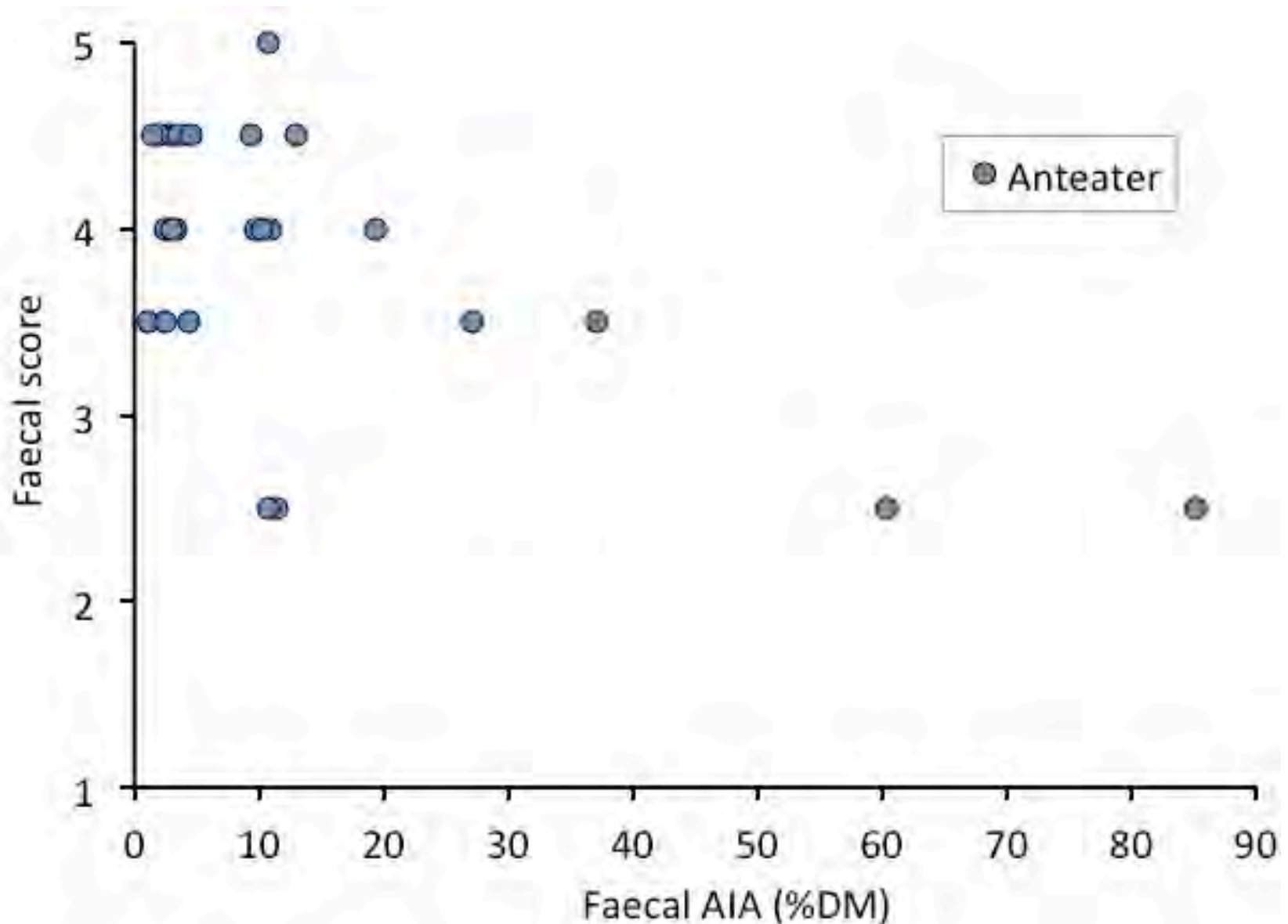


What is it about giant anteater faeces?



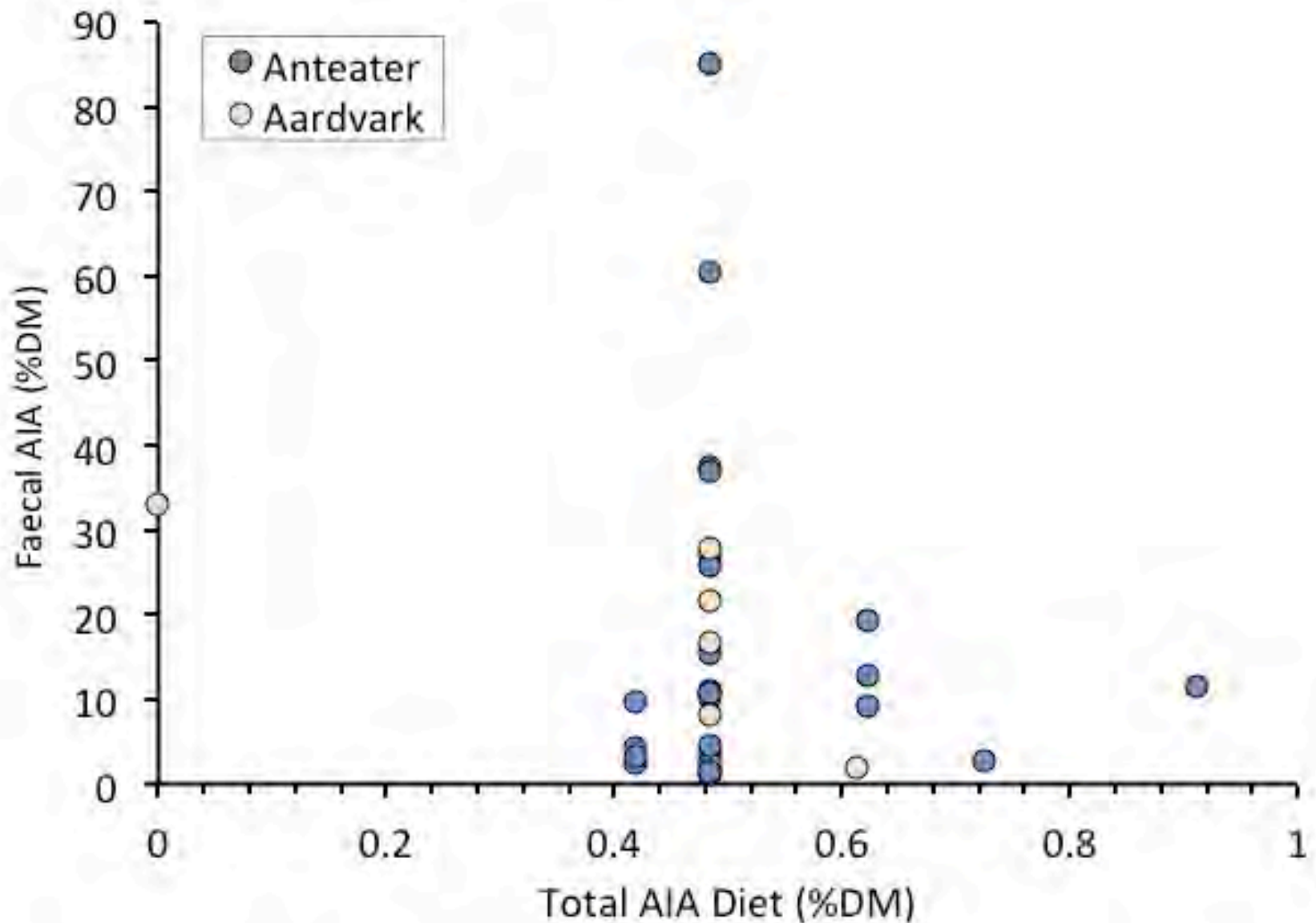


What is it about giant anteater faeces?





AIA does not come from the diet!





Conclusions

Don't overfeed your anteating mammals.

Investigate further the difference in body mass between free-ranging and captive giant anteaters.

Experiment with increasing the acid insoluble ash (=soil) content of your giant anteater diets to improve faecal consistency.



*thank you for your
attention*