University of Zurich
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Clinic
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Comparative digestion studies in wild suids at Rotterdam Zoo*

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*published as Clauss et al. (2008) Zoo Biology 27: 305-319

Pigs are understudied

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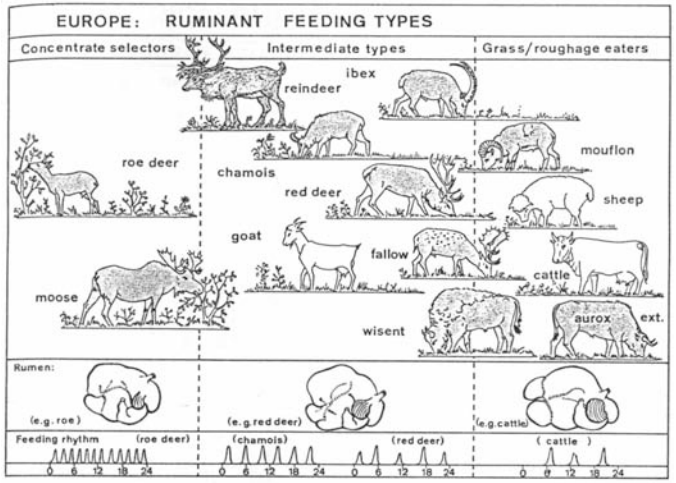
  (Leus & MacDonald 1997)

- Quite often, the resemblance to domestic pigs leads to regarding suids as ‘wastebin’ animals
- Obesity is common in captive wild suids, possibly contributing to locomotor and reproductive problems
  (Leus & MacDonald 1997)

Why are pigs interesting?

- Pigs offer a variety of feeding types

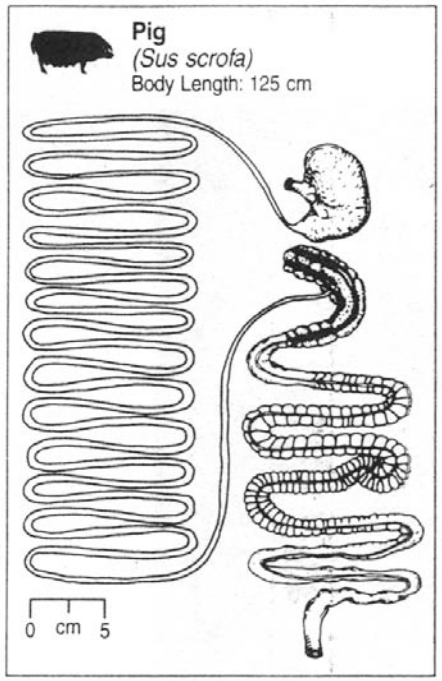


- Grazer: warthog
- Browser: Forest hog
- Mixed feeder/tube feeder/ ‘Omnivore’: most other species

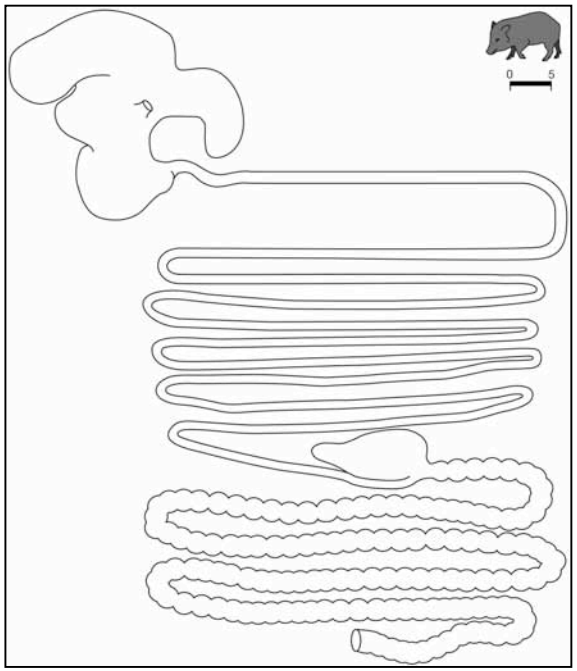
from Hofmann (1998)

Why are pigs interesting?

- Pigs (suids and peccaries) offer a diversity in digestive anatomy



Hindgut fermenters



Foregut fermenters

Feeding studies at Rotterdam Zoo

- Trials performed in different groups (between 1999 and 2005)
- Weighing of feeds, total faecal collection for 5 successive days
- Usual zoo diet (-> no adaptation period necessary)
- Nutrient analysis of diets and faeces
- Calculation of metabolizable energy (ME) intake as

  ME (kcal/kg DM) = 4167 – 9.1CA + 1.1CP + 4.2EE – 2.6HC – 4.0C – 6.8ADL (Noblet & Perez 1993)

  results converted to joules and compared to mean mammalian BMR of 293 kJ/kg$^{0.75}$/d and the ME maintenance requirement for domestic pigs of 444 kJ/kg$^{0.75}$/d (NRC 1988)

Why study pigs?
Methods
Protein/Fat
Fibre
Energy intake
Summary

Warthog (*Phacochoerus africanus*)

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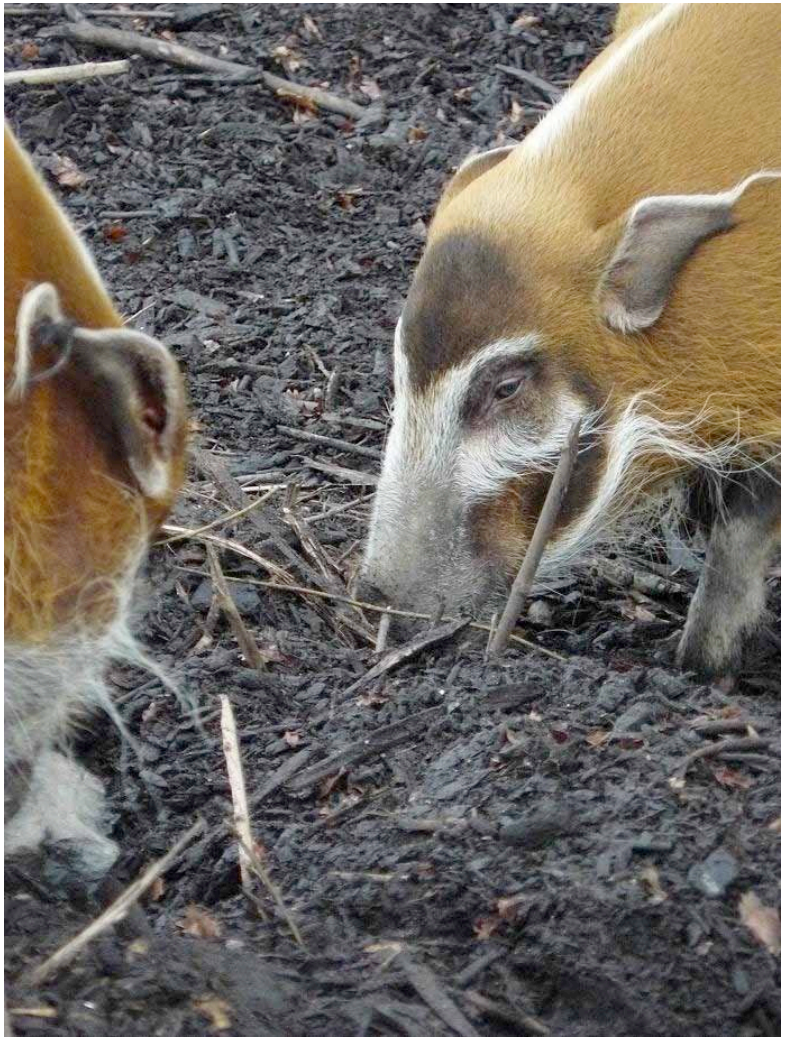
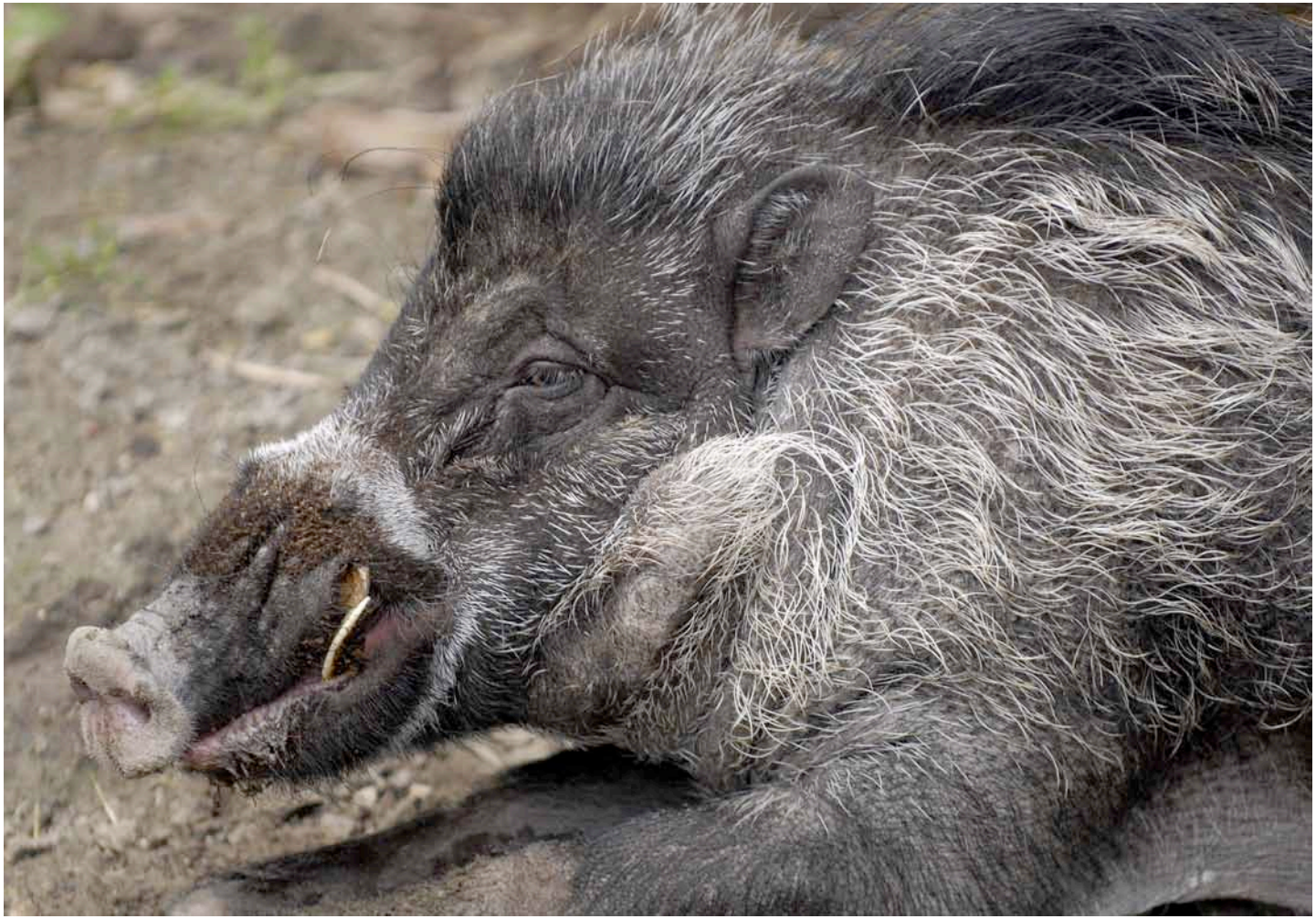
Red river hog (*Potamochoerus porcus*)



Visayan warty pigs (*Sus cebifrons*)



Babirusa (*Babyrousa babyrussa*)

Van Wees et al. (2000); Conklin et al. (1994), Leus (1994)

Peccary (*Tayassu pecari*)

Comizzoli et al. (1997)
Elston et al. (2005)
Nogueira-Filho (2005)

Wild boar (*Sus scrofa*)

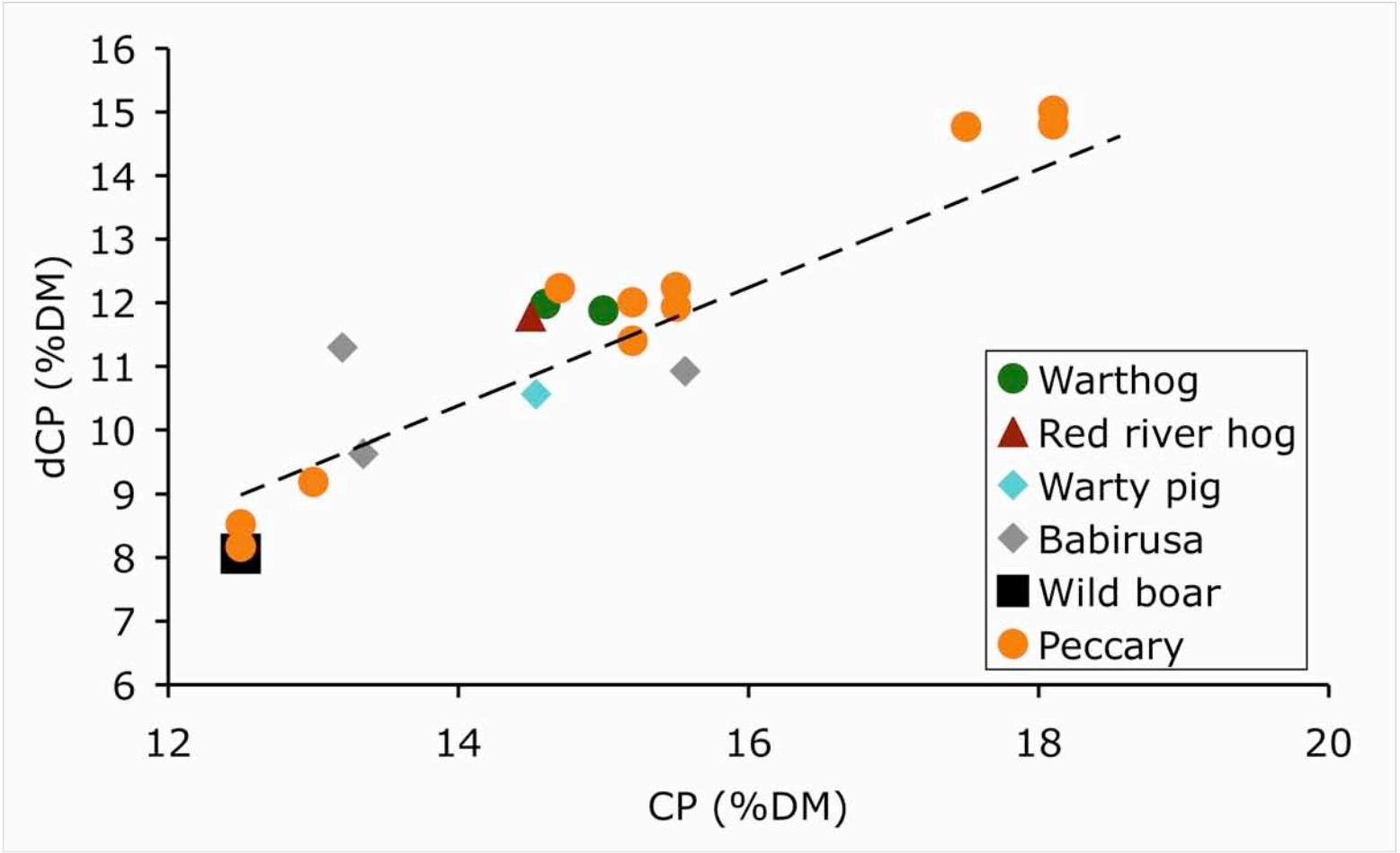
Elston et al. (2005)

Ingredient	Wartho g		RRh	Warty pigs	Babirusa	
	Period 1	Period 2			Period 1	Period 2
Apple (with skin)	582	519	200	100	1000	1000
Banana (without peel)	198	200	63	138	333	333
Raisins	-		17		7	
Potato (boiled with skin)	1048	1107	325		1000	1000
Carrot (boiled)	498	721	350	175	1000	1000
Endive	455	721		250		
Celery	-			250		
Fennel	-			113		
Beet	-			75		
Lettuce	-			163	333	333
Tomato	-		44			
Cucumber	-		8	75		
Dried corn	250	250				
Oatmeal	-		375		100	100
'Muesli' grain mix	-		150			
Maize porridge	-			150	100	100
Cooked rice	-			250		
Bread	-		75		33	200
Peanuts	-				3	3
Horse pellet[1]	286	271	500	250		
Pig pellet[2]	286	271			400	400
Dog food[3]	-			8		
Egg	-		23	18		
Calcium carbonate	-			2	1	1
Vitamin mix[4]	-		8	2		
Grass hay	124	74				
Lucerne	31	64				
Dried blackberry leaves	-			100		

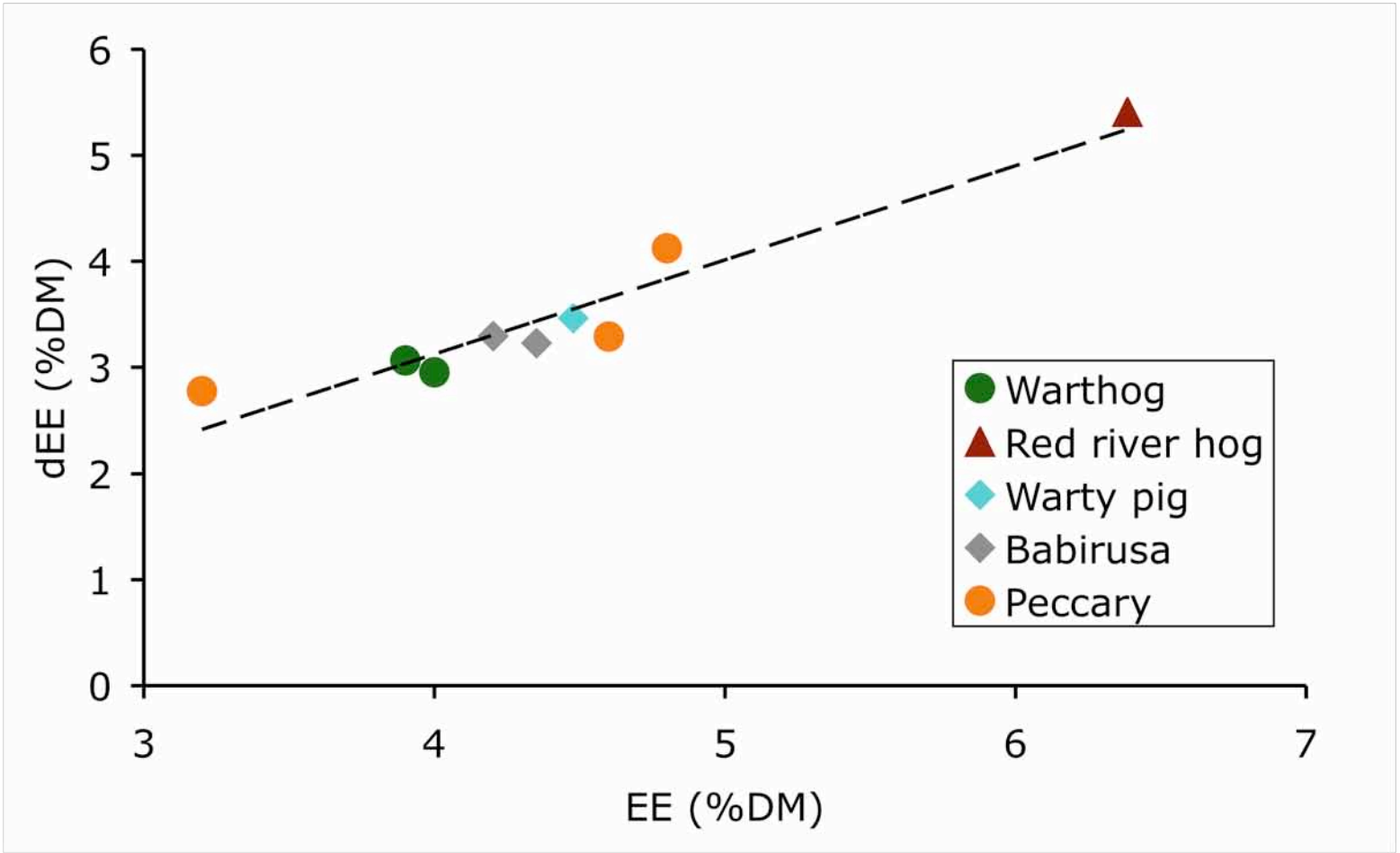
Diet composition

	Warthog[a]		Red river hogs[a]	Warty pigs[a]	Babirusa[b]	
	Period 1	Period 2			Period 1	Period 2
OM	93.8	93.4	93.9	94.0	93.3	94.3
CP	14.6	15	14.5	14.5	15.6	13.3
CF	10.2	10.2	5.3	6.4	7.1	6.0
EE	3.9	4	6.4	4.5	4.4	4.2
CA	6.2	6.6	6.1	6.0	6.7	5.7
NFE	65.1	64.2	67.7	68.6	66.3	70.7
NDF	20.6	21	17.3	20.7	25.7	22.6
ADF	11.6	11.9	5.9	7.6	5.3	5.1
ADL	2.3	2.6	1.4	1.5	0.0	0.0
HC	9.0	9.1	11.4	13.1	20.3	17.5
C	9.3	9.3	4.5	6.1	5.3	5.1

Protein digestion



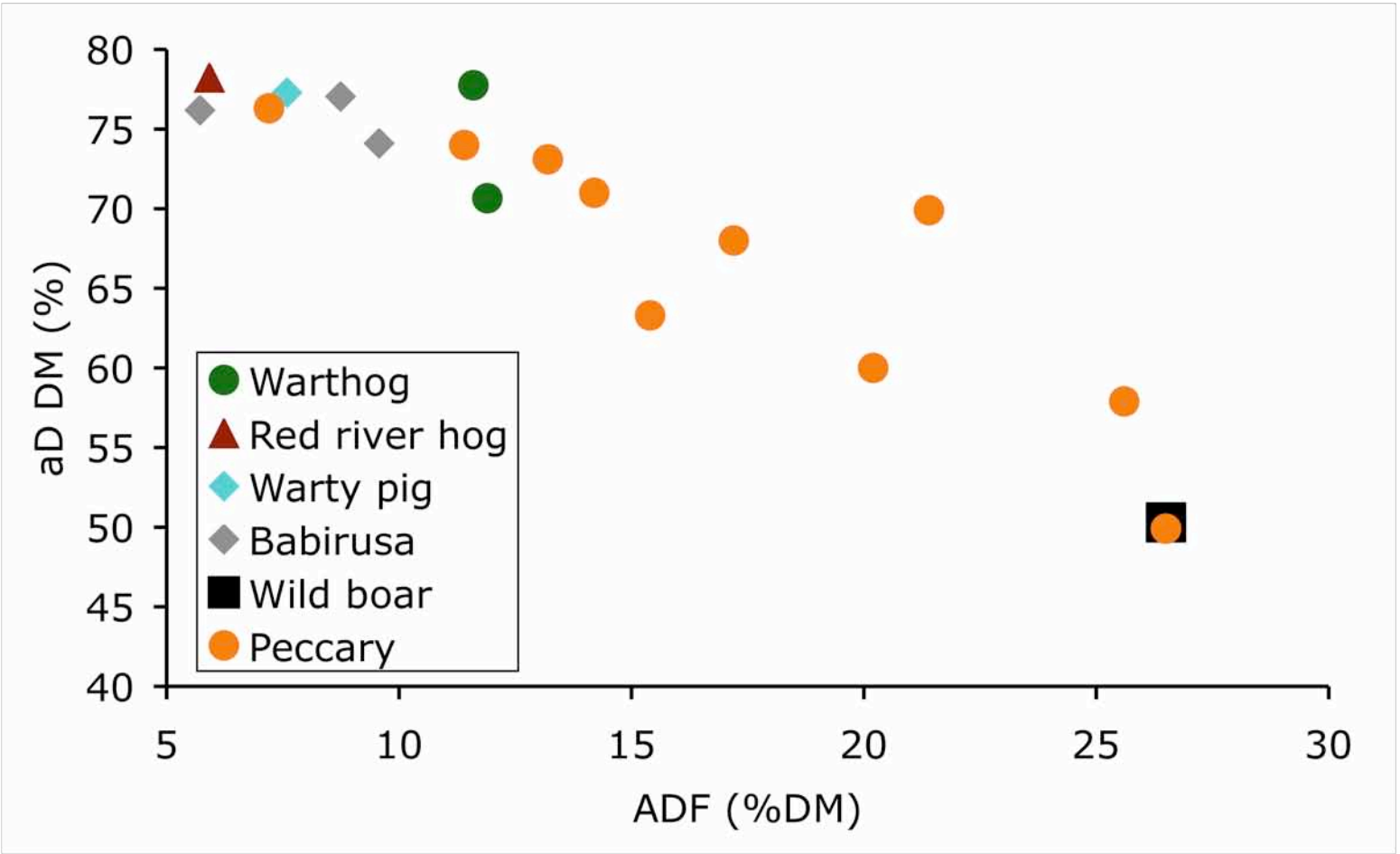
Fat digestion



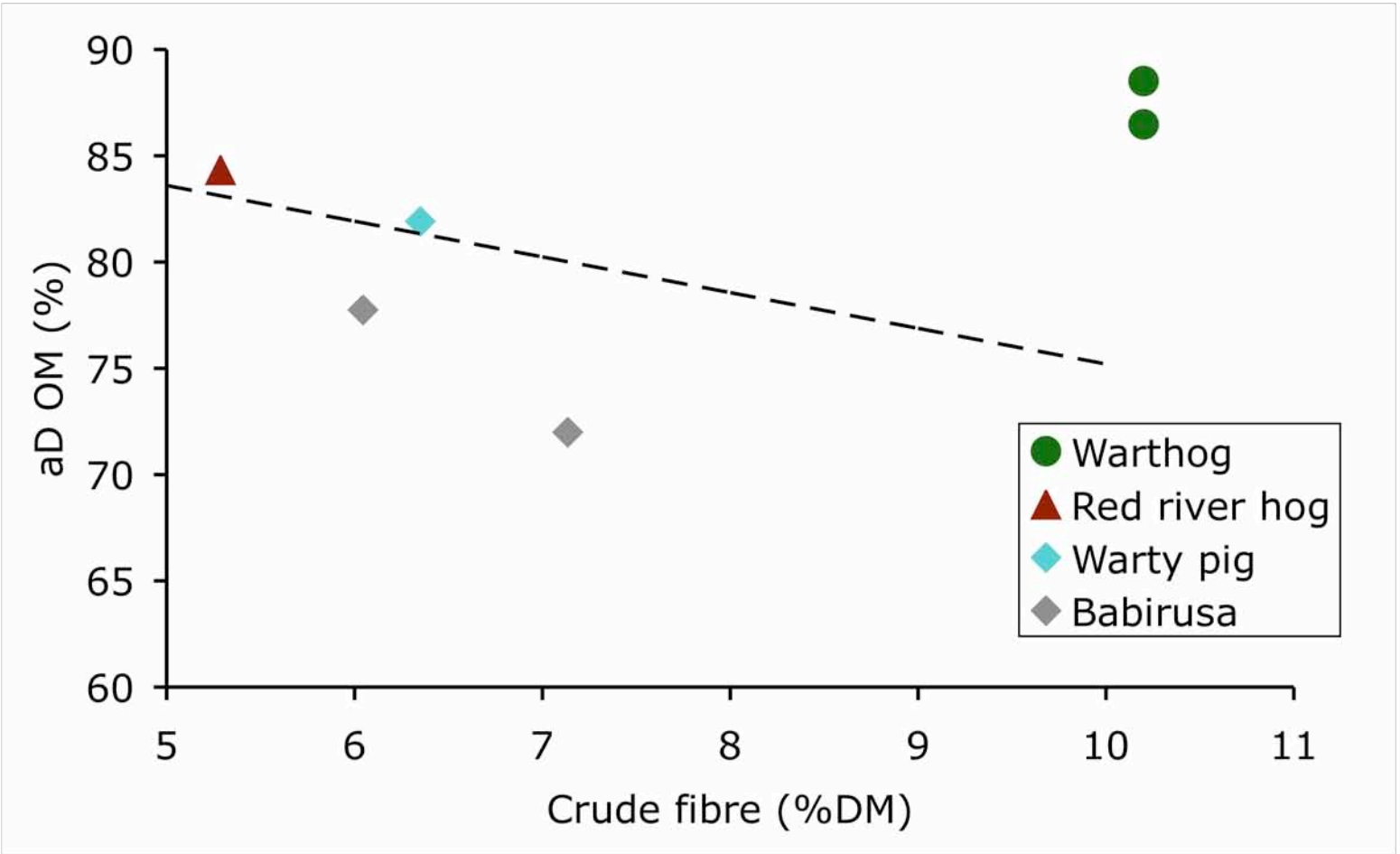
Conclusion I

- No notable difference in protein and fat digestion between the species

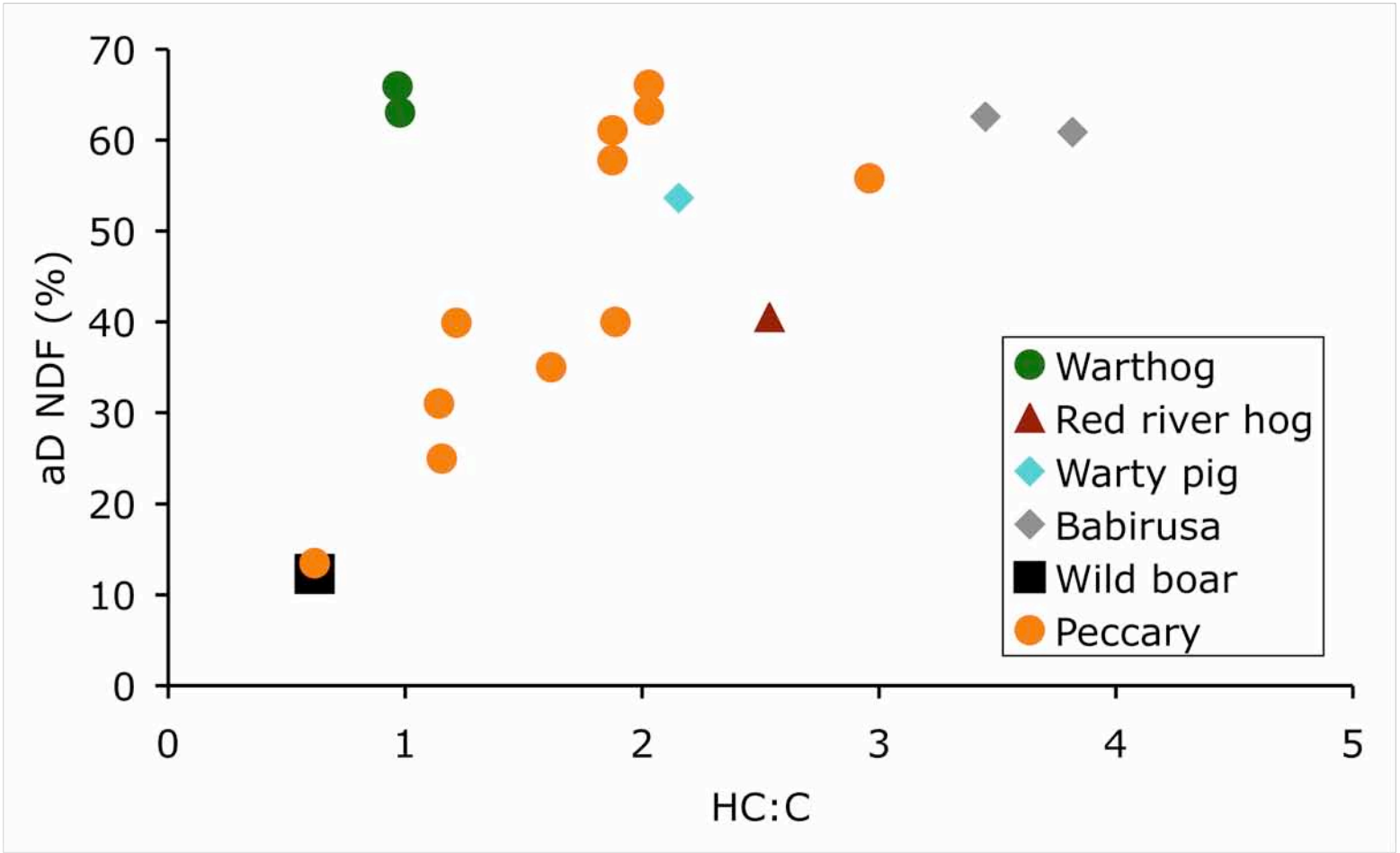
Influence of ADF levels on digestibility among wild pigs



Influence of crude fibre on digestibility compared to domestic pigs



Cell wall digestibility in relation to dietary hemicellulose:cellulose ratio



Conclusion II

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- While differences in fibre digestion should be further investigated, the available data do not suggest a particular superiority of the foregut fermenting peccaries in this respect
- However, the data suggest that warthogs digest fibre more efficiently than other pigs
- In particular, studies on the digestion of warthogs on roughage-only diets would be interesting

Hemicellulose and cellulose digestion

Species		Digestibility (%) Hemicellulose	Cellulose
Warthog	Period 1	70	71
	Period 2	69	67
Red river hog		59	21
Warty pigs		72	41
Babirusa	Period 1	75	13
	Period 2	74	25
Wild boar		18	10
Peccary		20	12

Conclusion III

- Like domestic pigs, all species digest hemicellulose more efficiently than cellulose, except warthog

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- Vegetables high in hemicellulose (or pectins) might be particularly suitable for the feeding of pigs - like sweet potato, spinach, mushrooms, corn cob with husk, chickpeas, beet pulp, although this is speculative

Conclusion III

- Like domestic pigs, all species digest hemicellulose more efficiently than cellulose, except warthog
- Vegetables high in hemicellulose (or pectins) might be particularly suitable for the feeding of pigs - like sweet potato, spinach, mushrooms, corn cob with husk, chickpeas, beet pulp, although this is speculative
- Fruits and vegetables high in sugar should not be as suitable

Fibre in free-ranging and zoo suids

- Diet of free-ranging bushpigs: 20 % crude fibre in DM (Seydack & Bigalke 1992)
- Diet of pigs in this study: 5-10 % crude fibre in DM

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- Faeces of free-ranging warthogs: app. 60 % NDF in DM (Codron et al. 2007)
- Warthog faeces in this study: app. 25 % NDF in DM

Conclusion IV

- It appears plausible that the fiber levels of zoo diets would need to be increased if they were aimed to resemble the natural diet

Energy intake

- MEI in kJ/kg$^{0.75}$/d and BMR and MR multiples

Species		MEI	BMR x	MR x
Warthog	Period 1	626	2.1	1.4
	Period 2	586	2.0	1.3
Red river hogs		859	2.9	1.9
Warty pigs		508	1.7	1.1
Babirusa	Period 1	585	2.0	1.3
	Period 2	650	2.2	1.5

Conclusion V

- At the amounts fed, the diets used provided more energy than theoretically necessary for the animal groups, with the potential long-term consequence of obesity.

Summary

- It appears reasonable that

  - pig diets could contain more fibre
  - in order to achieve this, less grains, bread, fruits should be fed
  - roughages should be tried out, and especially warthogs should probably be fed with grass hay

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The end

Thank you for your attention