

# Understanding diet switches in elephants and impala in a mopane woodland



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# Underlying mechanisms for the diet switch?

Grass



Browse

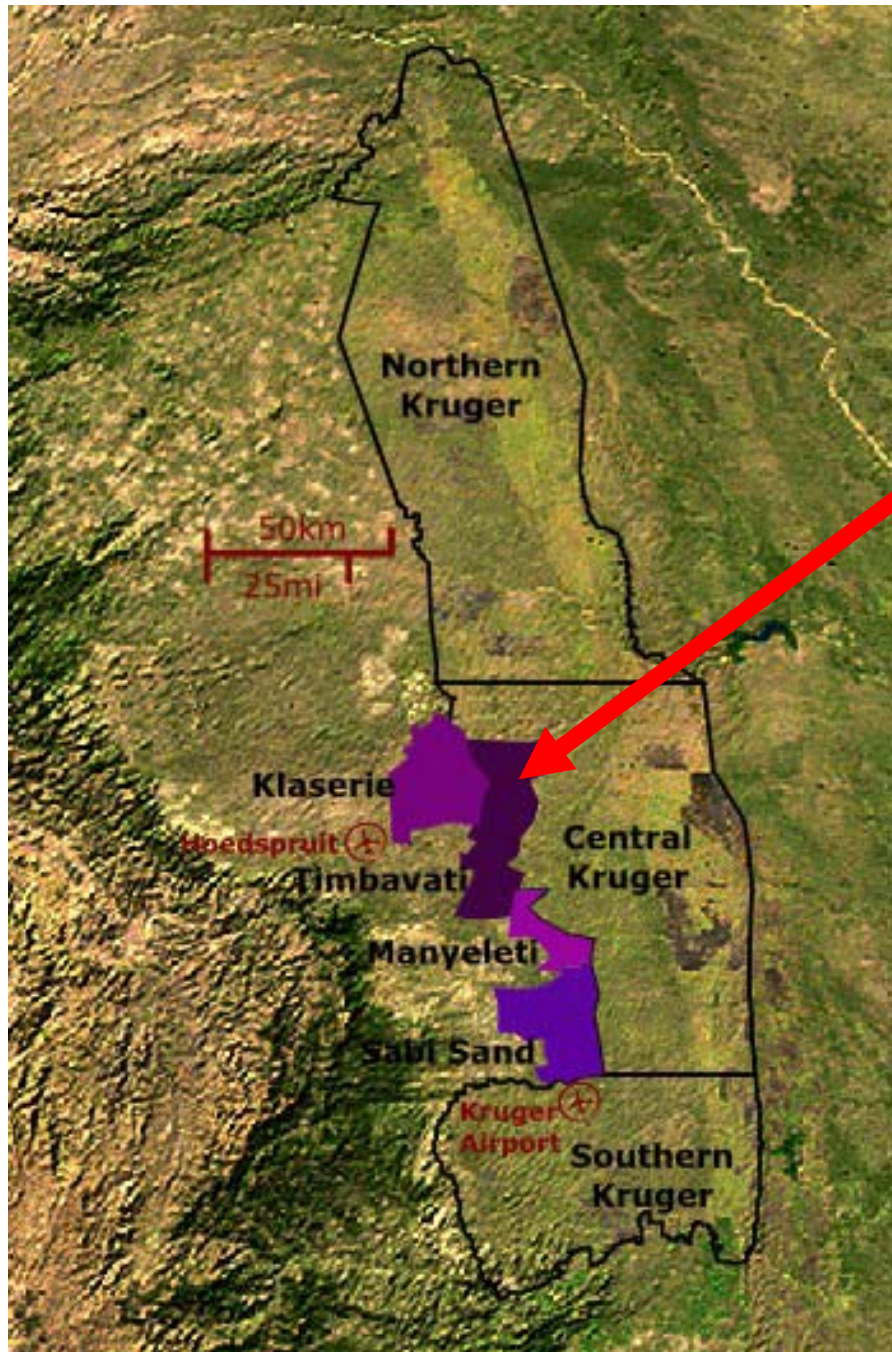


Impala



Elephant





## Study area & period

- APNR
- Mopane woodland
- Wet to dry season:  
February – May 2006



Characteristic	Grasses (monocots)	Browses (dicots)
Cell wall	High cell wall content	Low cell wall content
	Thick	Thin
	Low in lignin	High in lignin
	High digestibility	Low digestibility
Defense	Low chemical defense (silica)	High chemical defence (e.g., tannins, terpenes, alkaloids)

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Wet → Dry	CP ↓ ↓	CP ↓ 0
Season	Digestibility ↓ ↓	Digestibility ↓ 0
	Fibre ↑ ↑	Fibre 0
	-	Tannin ↓



Large

Size

Small

Non-ruminant

Digestion

Ruminant

Tolerate low quality

Food quality

High quality

High

Food quantity

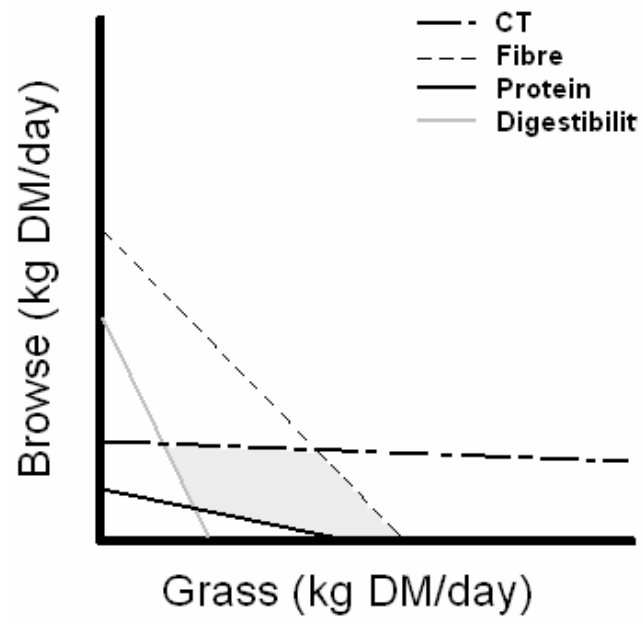
Low

Tolerant

Mopane-tannins

Intolerant

1a Impala - wet season



# Hypotheses

1) Impala and elephants → a diet switch:

mainly grass in the wet season  
more browse in the dry season

2) Elephant, dry season → switch to mopane

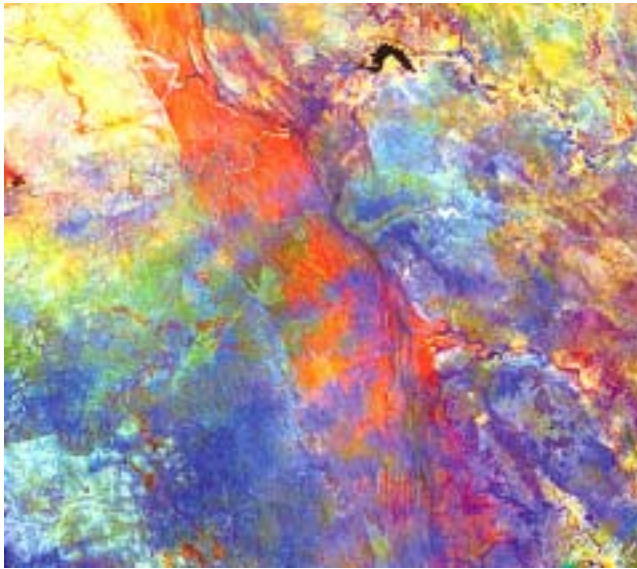
Impala, dry season → switch to other dicots



to cope with changing diet → change gut morphology  
→ 3-4 weeks to complete  
(Klein & Fairall 1986; Hofman 1989)

## Hypothesis

3) The diet switch is quicker in impala than in elephants.



## Soil type

### Granitic

Sandy  
Poor  
Low  
Not

+

Nutrients  
Water holding capacity  
Burned

Grass quality

### Gabroic

Fe & Mg  
Rich  
High  
Nov '05

++

# Hypotheses

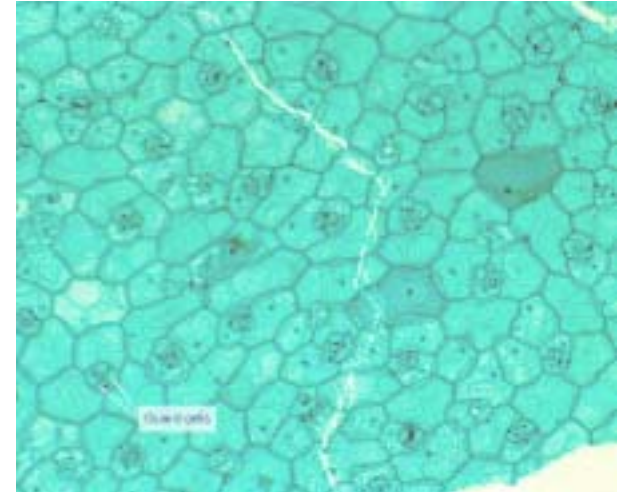
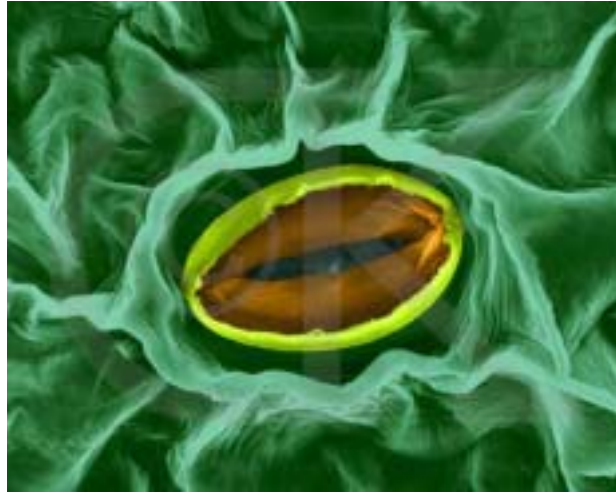
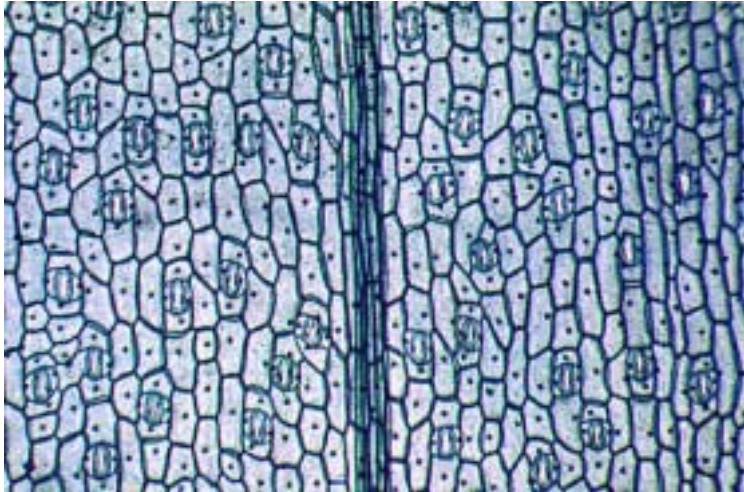
4) Impala on rich soil:

- switch later to browse
- generally consume more grass



# Methods

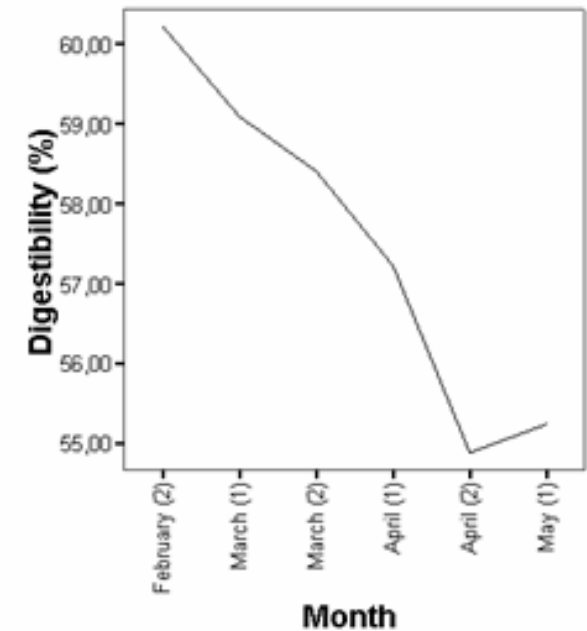
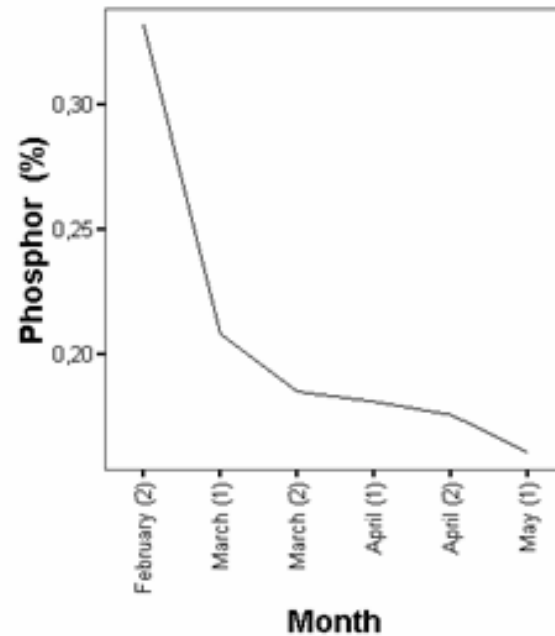
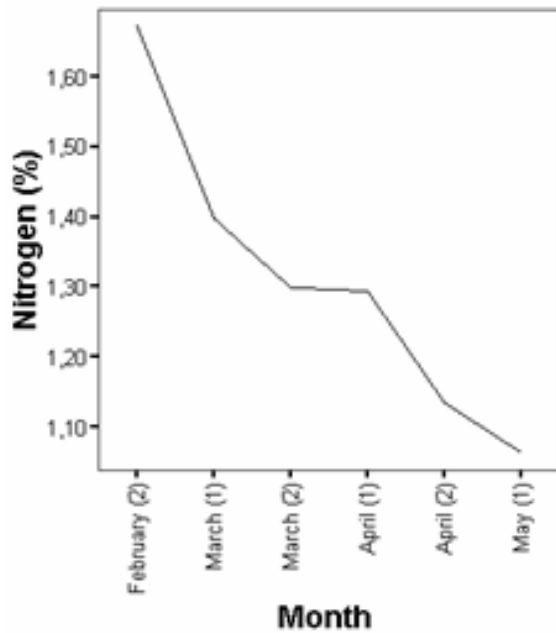
## Diet composition: faecal analysis





# Results-Grass Quality

Monocots: decrease in N, P and digestibility over time



N: Spearman –  $r = -0.436$ ;  $P < 0.05$ ;  $n = 33$ ,  
P: Spearman –  $r = -0.419$ ;  $P < 0.05$ ;  $n = 33$ ,  
Digestibility: Spearman –  $r = -0.401$ ;  $P < 0.05$ ;  $n = 33$

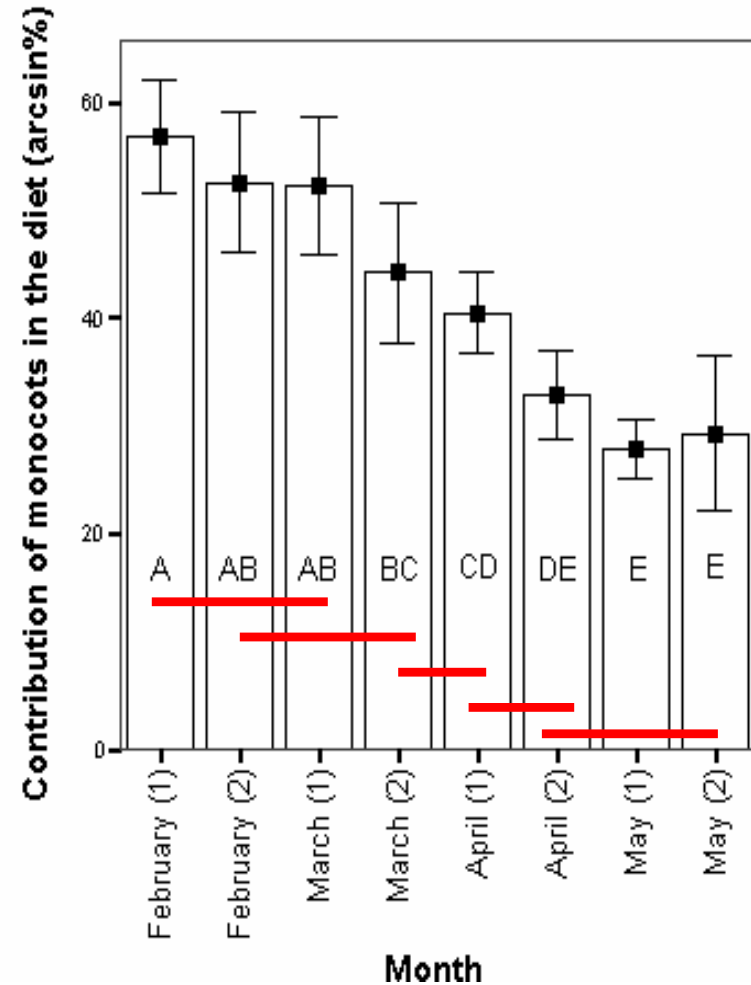
In dicots: no trend



# Results-Elephant

Gradual decrease in %  
monocots

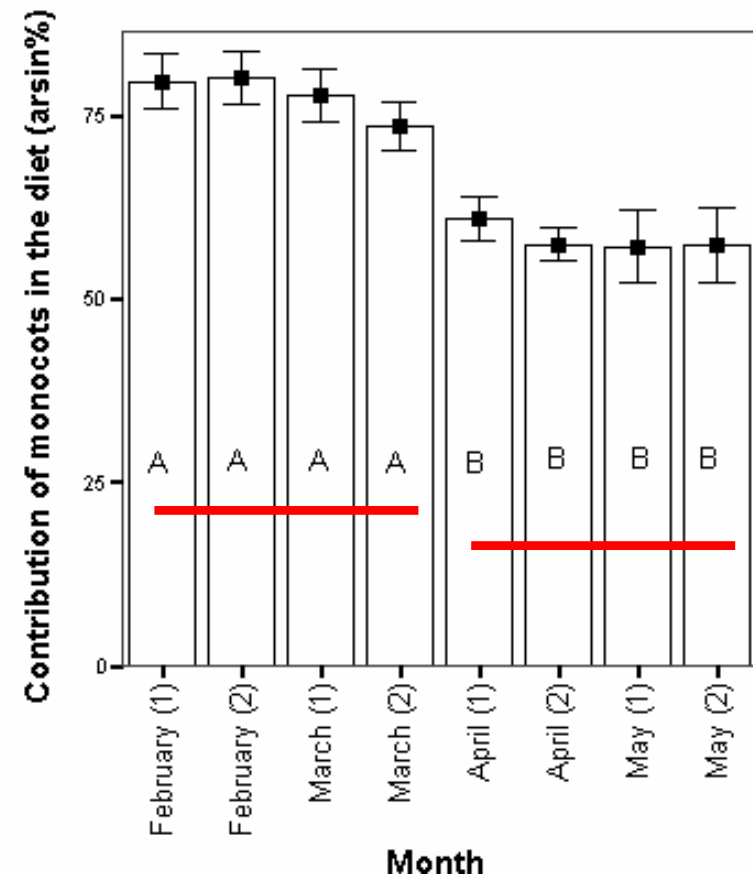
( $t = -11.926$ ;  $p < 0.001$ ;  $R^2 = 0.647$ ;  $n = 78$ )





# Results-Impala

Sudden diet switch:  
2-4 weeks





# Results-Impala

What triggers the diet switch?

**N** and **digestibility** in monocots significantly higher before this switch

N: Mann Whitney-U – Z = -2.097; P < 0.05; n = 33

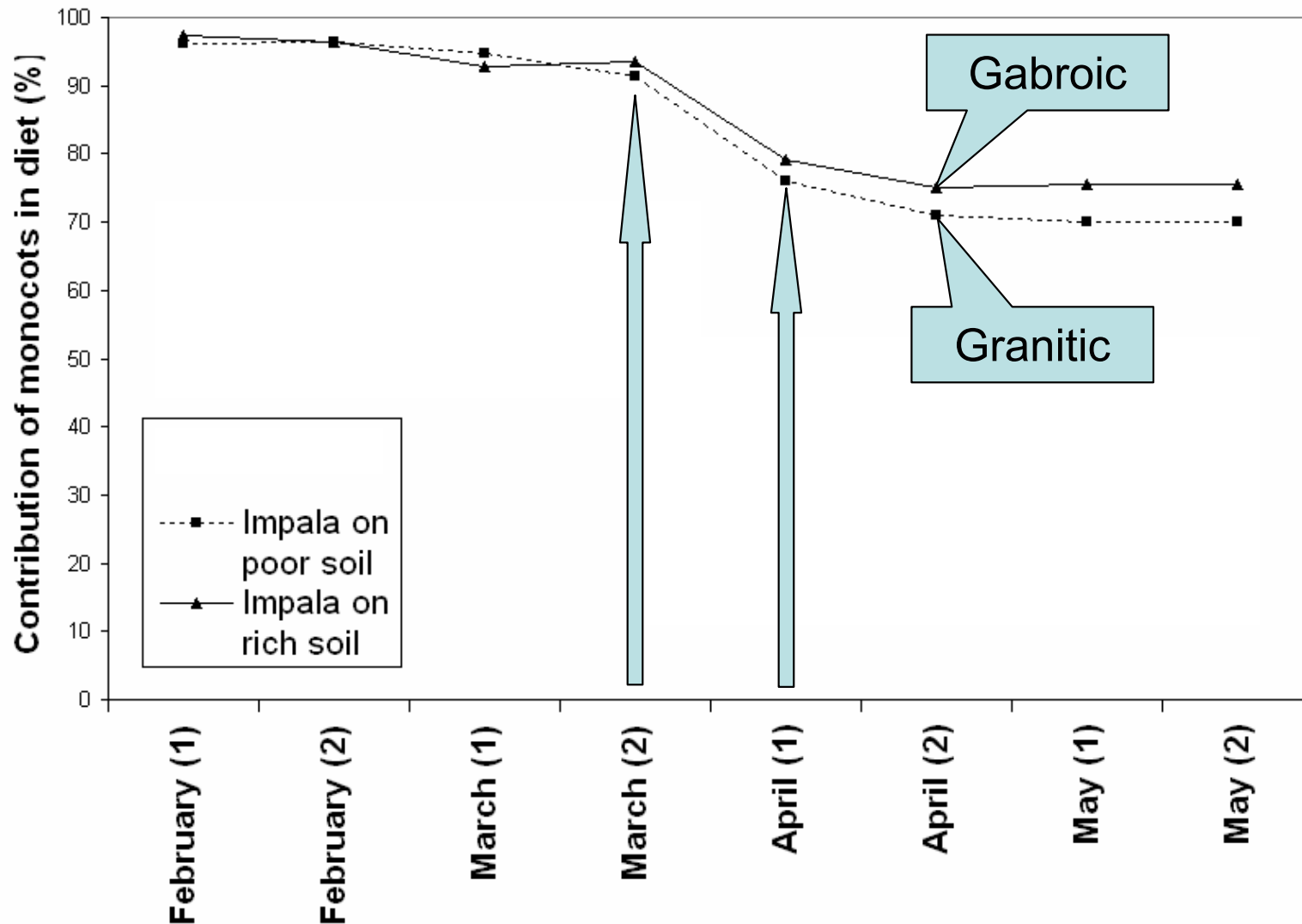
Digestibility: Mann Whitney-U – Z = -2.205; P < 0.05; n = 33

→ thresholds?



# Results-Impala

## Granitic ← → Gabroic soil



More grass  
in diet on  
Gabroic soils

Z=-2.100,  
p<0.05

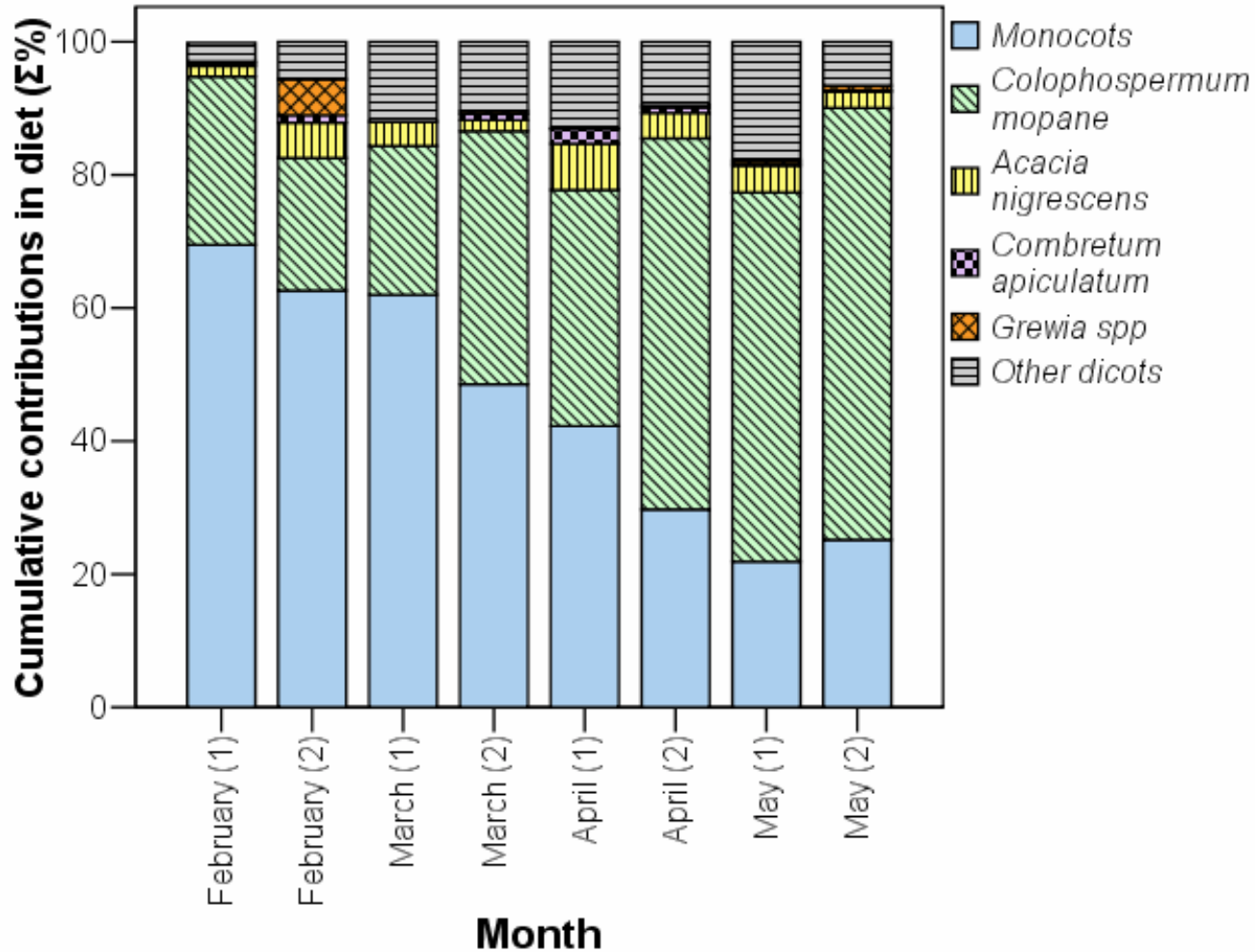


Forage type		Mean (%)		Z-value	n	P-value	Significant difference
		granitic	gabroic				
<b>Monocots</b>	N	1,220	1,254	0,000	15	1,000	ns
	P	0,212	0,151 -	-3,010	15	0,003	**
	Digestibility	54,833	59,105 +	-2,726	15	0,006	**
	NDF	74,430	71,680 -	-2,442	15	0,015	*
	CT	0,009	0,008	-0,140	15	0,889	ns
<b>Dicots</b>	N	2,152	2,304 +	-2,240	20	0,025	*
	P	0,100	0,111 +	-2,725	20	0,006	**
	Digestibility	41,990	43,261	-1,008	20	0,313	ns
	NDF	53,986	55,457 +	-2,016	20	0,044	*
	CT	0,124	0,125	-0,261	20	0,794	ns

Digestibility & NDF: thresholds?



# Results-Elephant



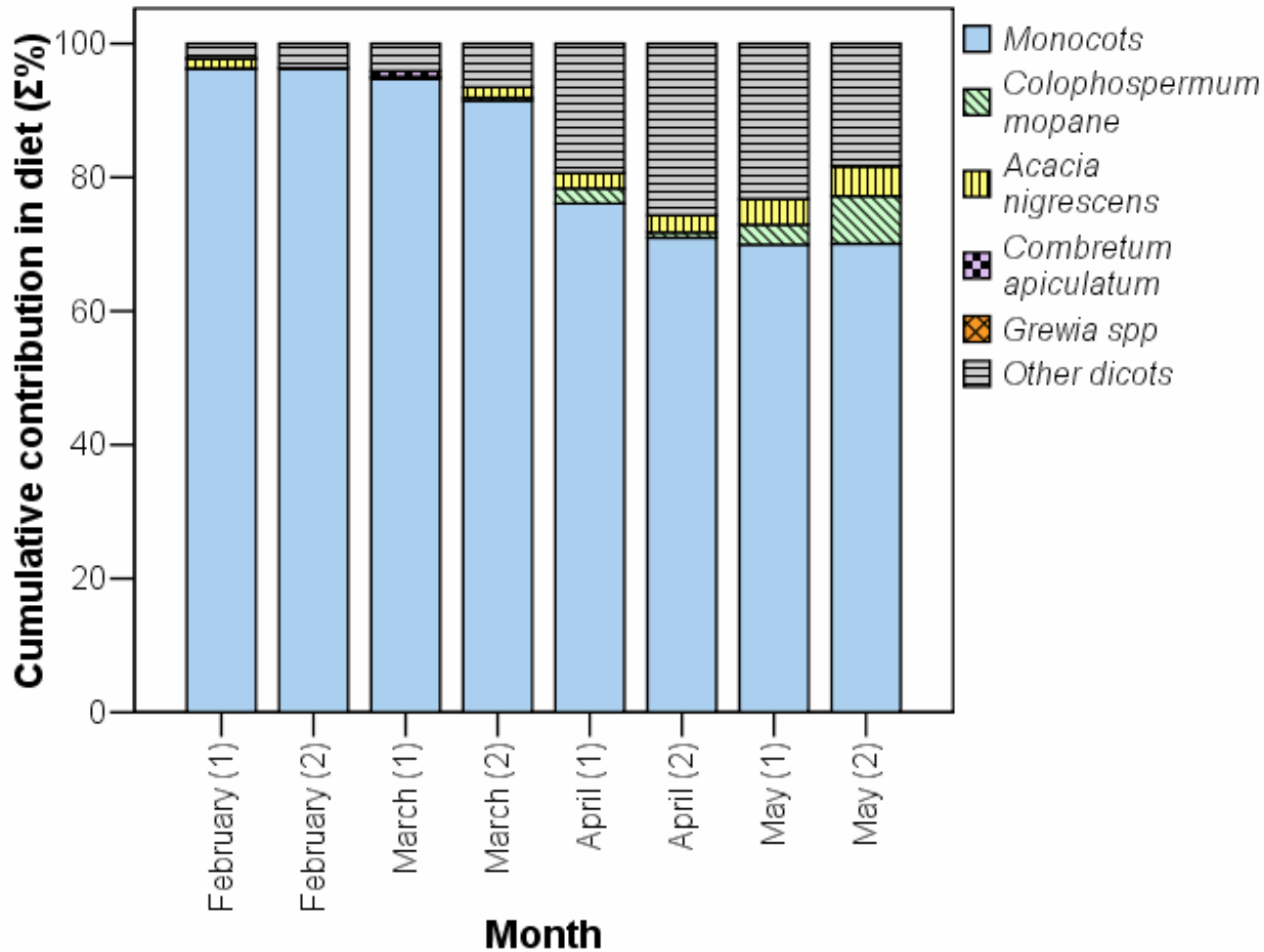
% Mopane increases over time

Spearman –  $r = 0.633$  ;  
 $P < 0.001$ ;  $n = 78$

→ Switch between monocots and mopane



# Results-Impala



Contribution mopane very small

'Other dicot' group large: impala do not feed on abundant browse species

# Mopane?

Species	Mean				
	N	P	Digestibility	NDF	CT
	%	%	%	%	%
<i>Acacia nigrescens</i>	2,79	0,10	42,39	57,91	0,120
<i>Combretum apiculatum</i>	1,81	0,09	43,41	49,44	0,062
<i>Grewia spp.</i>	2,29	0,11	35,65	62,08	0,165
<i>Colophospermum mopane</i>	2,04	0,12	48,44	49,11	0,146
Mopane	CP>7%	+	+	-	-

## Elephant

- High quality (N, P, Digestibility)
- High abundance: bulk food
- Insensitive for high condensed tannins (tolerant, low nutrient requirements)

## Impala

- % Mopane in diet < 5% (although highly abundant)
- Tannin thresholds exceeded

# Hypothesis

From wet to dry season → Monocot quality decreases

- 1) Elephant and impala switch to more dicots
- 2) Elephant switch to Mopane  
Impala switch to other dicot spp.

# Hypothesis



3) Elephant → gradual diet switch

Impala → quick diet switch: 2-4 weeks

4) Impala on Gabroic soils take more grass in their diet, but switch at the same time

# Discussion

## Elephant diet:

- Switches gradually to more dicots
- Mopane contribution increases with decrease in grass quality
- Low nutrient requirements, tolerates high tannin content

# Discussion

Factors that determine impala diet:

Changing over time: N, P, Digestibility

- N: CP > 7% → not limiting
- Switch: → Digestibility lower
- Rich soil: → Digestibility and NDF

→ Digestibility in monocots: important threshold

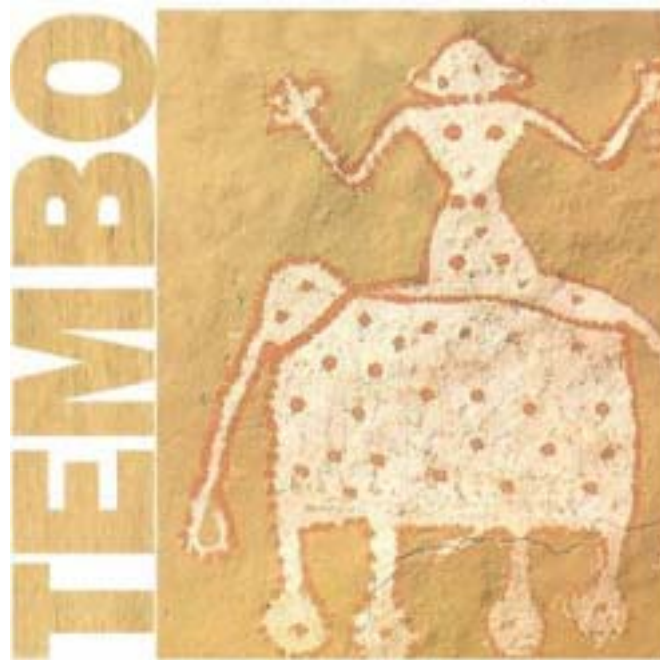
→ Small ruminant: sensitive to low digestibility & digestion inhibiting factors

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TEMBO,

The Elephant Movements and Bio-economic  
Optimality programme

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# Major co-operator: APNR

## Other co-operators:



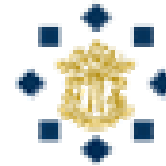
**Scientific Services,  
Kruger National Park**



**International Institute for  
Geo-Information Science  
and Earth Observation**



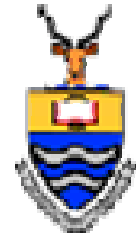
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