Short Communication

Geochemistry of mineral licks at Loskop Dam Nature Reserve, Mpumalanga, South Africa

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Abstract

Although numerous hypotheses have been proposed to explain geophagy, the primary driver of this behaviour remains elusive. Supplementation of scarce nutrients is one commonly cited explanation. We examined the element concentration of three licks relative to adjacent topsoils to infer the possible reasons for geophagy at Loskop Dam Nature Reserve. Lick samples had greater concentrations of B, Co, Zn, Se, Mo and Mn (Loskop Main Lick); Cu (Klopperskloof Lick); and Na (Klopperskloof Lick and Rhenosterhoek Lick) than those of adjacent topsoil. We suggest that supplementation with all or some of these nutrients is a likely driver of geophagy in this fenced reserve, with different licks providing herbivores with different suites of nutrients.

Keywords: geophagy; nutrient supplementation; nutrition; selenium; sodium.

Introduction

Geophagy, the deliberate ingestion of earth, is common among free-ranging mammals (Krishnamani and Mahaney 2000) and rural human populations (Aufreiter et al. 1997). The activity tends to be localised at widely scattered mineral licks (Abrahams 1999). In general, licks are characterised by a moderate to high clay and nutrient content (Klaus and Schmid 1998).

Although geophagy is widespread, the primary drivers of this behaviour remain poorly understood (Abrahams 1999). Lick use is costly for a number of reasons, including the energetic cost of reaching a lick, tooth wear due to sand consumption and the increased predation risk incurred at lick sites (Klaus et al. 1998). Geophagy must thus provide individuals with benefits to offset the costs. Medicinal benefits have been evoked to explain geophagy, including detoxification of secondary plant compounds (Klaus et al. 1998;

Krishnamani and Mahaney 2000), countering the effects of acidosis (Krishnamani and Mahaney 2000) and remediation of diarrhoea (Krishnamani and Mahaney 2000). The most common hypothesis proposed, however, is that of nutrient supplementation (Abrahams 1999; Eksteen and Bornman 1990; Kreulen 1985; Mills and Milewski 2006). Licks vary considerably in their chemical and physical properties and the benefits of geophagy are likely to vary between sites and among species and individuals.

Loskop Dam Nature Reserve, located in Mpumalanga, South Africa, was established in 1942 and encompasses 22 850 ha (including the 2350 ha surface area of the dam). Although clinical nutritional deficiencies have not been recorded at Loskop Dam Nature Reserve, artificial lick blocks, purchased from agricultural suppliers, were provided for two dry seasons in the 1980's. They were under-utilized and consequently removed. However, the almost continual presence of wildlife within the vicinity of natural licks (see Table 1) and the presence of earth within dung (pers. obs) indicates that several natural licks are regularly used by wildlife in the reserve.

Materials and methods

Samples of lick earth (approximately 1m deep in the regolith, n = 3) collected from the exposed face of a geophagic bank and adjacent topsoil (0-5 cm, n = 3) were collected from three sites in the reserve in 2005, namely Main Lick (Lick M), Klopperskloof Lick (Lick KK) and Rhenosterhoek Lick (Lick RH) (Figure 1). [Eksteen and Bornman (1990) reported on results from Lick M and Lick KK]. In addition, kudu (*Tragelaphus strepsiceros*) dung (clayey pellets with no visible macro-organic matter) was collected from the base of the 'lick wall' at Lick M (Figure 2) and earth samples were obtained from a kaolinitic lick (Lick LH) just outside the reserve where local people are known to collect lick earth and practise geophagy. All samples were analysed by ICP-MS (27 elements) at the University of Stellenbosch after a digest in nitric acid and hydrogen peroxide (EPA 2007). The method reports a high average percentage recovery (between 86 – 101 %) for a range of elements. Replicate analyses of standard reference materials and other soil samples from South African savannas had relative standard deviations (calculated as the standard deviation divided by the mean and multiplied by 100) ranging from 0.1 – 29 % across all elements (see Table 2). Given the small sample size, statistical analysis of the data was not appropriate.

Results and discussion

Lick earth was geochemically distinct from the adjacent topsoils (Table 2). Micro-nutrient as well as Na concentration was greater in lick earth than in topsoil (B, Co, Zn, Se, Mo and Mn at Lick M, Cu at Lick KK and Na at both Lick KK and Lick RH). Differences between lick earth and topsoil varied according to site, suggesting that animals practice geophagy for different nutrients at different sites, or for reasons other than nutrition (e.g. antacid or plant toxin binding purposes). The concentrations of B, Co, Zn, Se, Mo and Mn in kudu dung were less than those in the lick earth collected at Lick M, which suggests that these nutrients were assimilated from the earth in the kudu’s gastro-intestinal tract. (This is based on the assumption that the dung samples were comprised predominantly of mineral lick material, a not unreasonable supposition given the absence of macro-organic material in the dung.)

In contrast to the above results, the kaolinitic earth collected by the local people (Lick LH) had a lesser nutrient concentration than all topsoils sampled (Table 2). Kaolinite is an effective adsorbent of toxins and lick earths with a great kaolinite concentration are often ingested by humans to relieve gastro-intestinal disorders (Aufreiter et al. 1997). The kaolinitic earth sample was poor in all nutrients, and consumption was thus probably for the gastro-intestinal benefits of the kaolinite.

The results suggest that geophagy at Loskop Dam Nature Reserve may be supplementing animals with: B, Co, Zn, Se, Mo and Mn (at Lick M); Cu (at Lick KK); and Na (at Lick KK and Lick RH). Selenium deficiency may be driving lick use at Lick M. This latter benefit is based on the observation that: i) the Se concentration in topsoil adjacent to Lick M is almost three times less than the global average (0.33 mg kg^{-1}) (Kabata-Pendias and Pendias 2001) suggesting that it is a particularly scarce nutrient; and ii) the Se concentration of Lick M is three-fold that of the adjacent topsoil. This corroborates the findings of Mills and Milewski (2006) in the Ngorongoro Conservation Area, Tanzania, where large licks were exceptionally enriched in Se.

In contrast to our results, Eksteen and Bornman (1990) found that Na was enriched at Lick M as well as Lick KK. We ascribe the different results to variations in extraction methods employed [Eksteen and Bornman (1990) used a 1:2.5 soil to water extract]. Although Mn is enriched in Lick M relative to the adjacent topsoil and the global average (437 mg kg^{-1}) (Kabata-Pendias and Pendias 2001), it is unlikely that Mn deficiency, which is rare in mammals, is driving geophagy at this site (Hurley 1982). Given that Mn oxides are strong adsorbers of a range of elements, the general element enrichment at Lick M may be indicative of a zone of Mn oxide precipitation.

If licks, such as those at Loskop Dam Nature Reserve, are supplementing wildlife with micro-nutrients (as well as Na) important for fecundity and health, they may be important in conservation planning and tourism management (mineral licks could for example be used to provide opportunities for wildlife viewing). It is likely that prior to reserve formation, roaming wildlife had access to various rock and soil types potentially supplying them with a range of scarce nutrients. The present availability of licks within small reserves, such as Loskop Dam Nature Reserve, may consequently be inadequate for conserving viable populations of certain wildlife species. Artificial supplementation of scarce micro-nutrients may therefore be necessary for the long-term management of wildlife.

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Table 1 Wildlife observed at lick sites within Loskop Dam Nature Reserve. Category A denotes wildlife that were observed ingesting lick soils. Category B denotes wildlife that were observed within the vicinity of the lick site, but were not observed actually ingesting lick soils. Observing wildlife at Klopperskloof and Rhenosterhoek Licks is not possible without alarming the wildlife. Observations at these sites are consequently less reliable than those at Main Lick (where researchers are able to observe lick use unnoticed by wildlife)

Feeding Class	Browser						Mixed feeder		Bulk grazer				Selective grazer		
Common name	Kudu	Bushbuck	Grey duiker	Nyala	Klipspringer	Giraffe	Impala	Vervet monkey	White rhino	Buffalo	Zebra	Warthog	Sable	Mountain Reedbuck	Blue wildebeest
Category	A	A	A	A	B	B	A	A	A	A	A	B	A	A	B
Main Lick	x	x	x				x	x	x	x	x		x	x	
Klopperskloof	x	x		x	x							x		x	x
Rhenosterhoek	x	x			x	x	x	x	x			x	x	x	x

Table 2 Element concentration (mg kg^{-1}) of lick earths, adjacent topsoils and kudu dung at Loskop Dam Nature Reserve. Highlighted figures indicate where lick micro-nutrient (as well as Na) concentration is greater than that of the adjacent topsoil

Site	**Sample**	**Li**	**Be**	**B**	**V**	**Cr**	**Co**	**Ni**	**Cu**	**Zn**	**As**	**Se**	**Rb**	**Sr**	**Mo**	**Cd**	**Ba**	**Pb**	**U**	**Al**	**Ca**	**Fe**	**K**	**Mg**	**Mn**	**Na**	**Si**	**Ti**
RSD[a]		10.6	11.7	11.8	1.8	5.5	3.6	4.0	2.5	2.7	3.7	7.1	1.9	3.0	13.6	21.8	15.9	8.0	10.4	1.2	5.6	0.7	0.1	2.9	2.2	0.6	1.0	3.0
Main Lick	Topsoil	8.5	1.1	2.9	99	116	7.6	26	43	23	2.7	0.1	17	40	0.5	0.0	222	42	1.3	10665	9501	53459	1432	1427	236	2795	391	123
Main Lick	Main Lick	12	0.7	7.1	53	52	24	45	36	49	4.7	0.3	41	46	0.7	0.1	551	47	0.6	9872	7038	21447	2160	1263	1019	561	238	77
Main Lick	Kudu Dung	5.9	0.6	3.7	61	46	2.4	17	33	25	4.7	0.1	10	15	0.3	0.0	60	9.6	0.9	7228	2368	29082	2179	714	139	578	148	207
Klopperskloof	Topsoil	3.7	1.2	1.0	77	36	11	13	54	50	2.8	0.3	33	6.5	0.7	0.1	133	17	1.2	13397	970	45102	1236	773	422	599	497	359
Klopperskloof	Lick	4.3	2.4	0.9	112	38	3.6	36	89	61	2.6	0.2	53	7.9	0.5	0.0	170	8.1	1.1	19566	1017	89710	1313	1398	280	1218	447	889
Rhenosterhoek	Topsoil	4.1	1.0	1.7	103	23	26	19	124	51	1.9	0.3	28	21	0.5	0.1	239	32	0.5	15480	3666	56554	2155	2183	946	523	257	347
Rhenosterhoek	Lick	4.3	1.1	1.5	85	16	28	20	125	48	1.2	0.2	25	27	0.5	0.1	303	45	0.5	23200	3282	59229	1922	2818	1080	2221	410	370
Kaolinitic Lick	Human Lick	0.4	0.4	2.1	1.2	1.6	0.5	2.2	3.8	16	0.9	0.2	11	6.8	0.4	0.0	50	13	0.1	1740	436	1404	1267	272	8.2	672	348	3.9

[a] Relative Standard Deviation (%)

Figure Legends

Fig. 1 The geology of the Loskop Dam Nature Reserve and the location of the mineral licks sampled in the study

Fig. 2 The kudu dung collection site at the base of the ‘lick wall’ at Lick M.

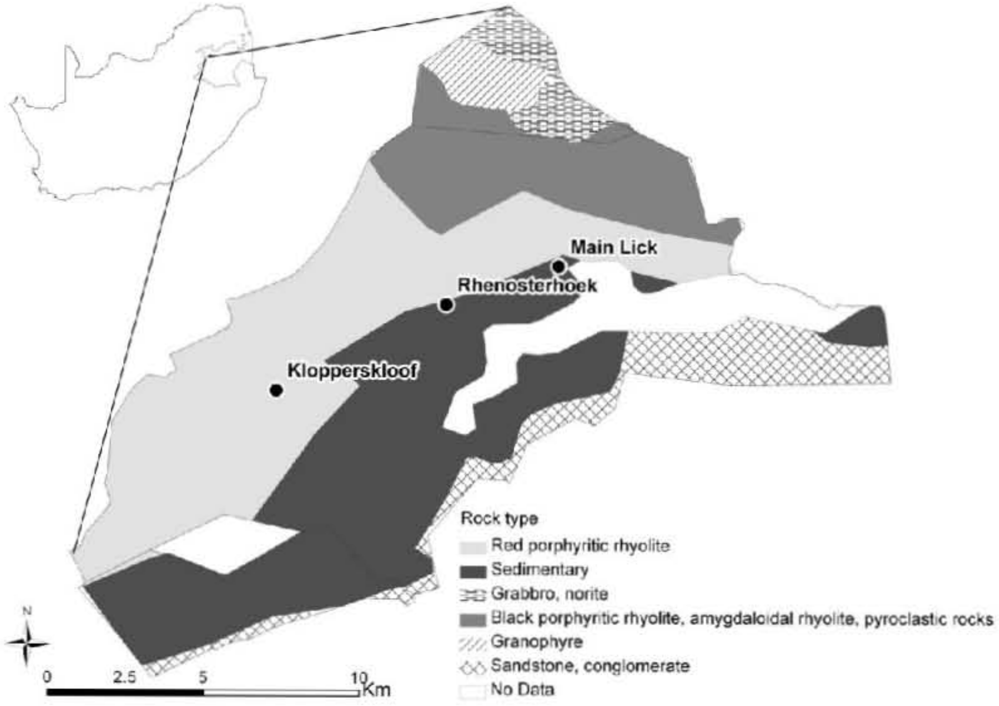
Main Lick
Rhenosterhoek
Kloppersklooof
Rock type
Red porphyritic rhyolite
Sedimentary
Grabbro, norite
Black porphyritic rhyolite, amygdaloidal rhyolite, pyroclastic rocks
Granophyre
Sandstone, conglomerate
No Data
N
0
2.5
5
10
Km

Fig. 1

Fig. 2