

## Research Article

# Bone Accumulations of Spotted Hyaenas (*Crocuta crocuta*, Erxleben, 1777) as Indicators of Diet and Human Conflict; Mashatu, Botswana

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In a region where free ranging domestic species mix with wildlife, it is imperative to determine what, if any, predation may have occurred on domestic stock. As human settlements continuously encroach upon wild habitats, determining the types of predator-human conflicts that exist can be crucial to conserve numerous predator species. The partial diet of spotted hyaenas (*Crocuta crocuta*) of the Mashatu Game Reserve, Botswana, was established via analyses of faunal remains associated with four dens to determine predation/scavenging on wild or domestic species. Domestic species composed less than 3% of identified faunal remains. We acknowledge that this methodology is biased against small mammals, but, when combined with sociological studies, this methodology will aid in determining alleged predation on domestic stock by spotted hyaenas. Results indicated that the spotted hyaenas in question feed primarily on wild species.

## 1. Introduction

Spotted hyaenas (*Crocuta crocuta*) have long been the source for studies on feeding behaviour [1–12]. Once thought to be primarily a scavenger, more recent studies have shown spotted hyaenas to be consummate hunters, killing up to 95% of the animals consumed [11], and preferring the most abundant prey at a site weighing between 56 and 182 kg [13]. Having a reputation for killing domestic stock [14] but also thought to adjust behavioural patterns to avoid human presence [15, 16], it was uncertain if the resident spotted hyaenas of the Mashatu Game Reserve, Tuli Block, Botswana, were feeding (via predation or scavenging) on domestic animal populations. Reports from the Botswana government do not list hyaenas (they do not appear to differentiate between spotted hyaenas or brown hyaenas (*Parahyaena brunnea*, Thunberg, 1820) in the top five species of problem animals countrywide when it comes to conflicts with humans, but they are listed as potential problem animals. In the Central District (where the Tuli Block is located), hyaenas in general rank fourth, after lion (*Panthera leo*, Linnaeus, 1758), leopard (*Panthera pardus*, Linnaeus, 1758), and elephant (*Loxodonta*

*africana*, Blumenbach, 1797), amongst problem animals [17]. A study in East Africa has shown that lions have a much greater effect on livestock populations than spotted hyaenas, but the local pastoralists have a greater animosity towards hyaenas [18]. In contrast, a survey in Ethiopia indicated that spotted hyaenas are responsible for direct predation on domestic stock [19]. For the most part, studies determining which species has the most detrimental effect on livestock are conducted using scat analyses of said carnivore species and/or interviewing the local population and relying on their identifications and interpretations. It must also be acknowledged until recently that the Botswana government policy was to pay out for livestock killed by lions but not for livestock killed by hyaenas (L. Frank Pers Comm. 2011), which may have influenced the populations' identifications of conflict species.

In addition to the multitude of behavioural and ecological studies on spotted hyaenas, specific taphonomic studies involving extant spotted hyaenas have also been conducted to better understand their role in fossil deposits [20–31]. The taphonomic implications of this study have been previously published [28, 30, 31]; the same data and methodologies

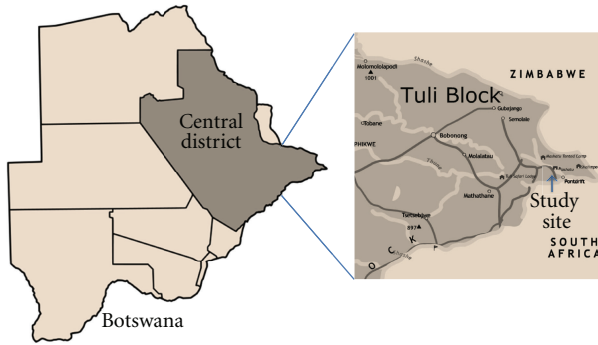


FIGURE 1: Map showing Botswana's Central District, the Tuli Block and study area.

are used to examine patterns of predation/scavenging as documented by skeletal accumulations at den sites. These methodologies, specifically the examination and identification to prey species, of faunal remains accumulated at hyaena dens. Here we demonstrate how methodologies used in taphonomic studies can be implemented in modern human-animal conflict issues to help gauge the amount of predation spotted hyaenas may inflict on domestic stock.

In Botswana, total livestock units (LUs) combining wild and domestic species in 2003 were 4.39 LU/Km<sup>2</sup>. Domestic species composed 79% of the total LU biomass (the remaining 21% consisting of wildlife). The Central District, the largest district covering 147,730 km<sup>2</sup>, of which the Tuli Block makes up a very small portion, 300,000 hectares, reported 55.3% of nation-wide problem-animal incidents. Three hundred twenty one of these incidents involved hyaena compared to lions involved in 1,857-recorded incidents [17]. Results indicated that, despite a high number of domestic species available, the spotted hyaenas of the Mashatu Game Reserve appear to be surviving primarily by feeding on wild species.

## 2. Study Site

The Mashatu Game Reserve lies in the eastern portion of the Central District of Botswana in a region known as the Tuli Block. The Tuli Block lies on the eastern central border region of Botswana, bordered by Zimbabwe to the north and north-east and South Africa to the south and southeast (Figure 1). Unfenced, the reserve covers approximately 30,000 ha of semi arid Bushveld receiving approximately 177 mm of rainfall per annum (Mashatu.com 2006). The reserve supports numerous species including large herds of elephants (*Loxodonta africana*, Blumenbach, 1797), kudu (*Tragelaphus strepsiceros*, Pallas, 1766), wildebeest (*Connochaetes taurinus*, Burchell, 1823), zebra (*Equus quagga*, Boddaert, 1785), and impala (*Aepyceros melampus*, Lichtenstein, 1812). In addition to the wide variety of herbivores the area also supports numerous carnivore species such as the aforementioned spotted hyaenas and lions, leopards, caracals (*Caracal caracal*, Schreber, 1776), black-backed jackals (*Canis mesomelas*, Schreber, 1775), and wild dogs (*Lycaon pictus*, Temminck, 1820). The region has a diverse fauna (Table 1). While the region is well

within the natural range of brown hyaenas, there has only been a single confirmed sighting of brown hyaena in the past decade (J. Selier pers. com.). This, combined with observed occurrences of only spotted hyaenas associated with the four dens, enables us to conclude that spotted hyaenas primarily use the dens. All four dens collected from were caves, three of which were located at the base of the escarpment, and the fourth den/cave located just below the top edge of the escarpment. Den 2 had juvenile and adult hyaenas present prior to the study beginning and Den 4 had both adult and juvenile hyaenas present during the study. It has been shown that hyaenas collect bones in greater numbers when young are present thus, we infer that all four dens were used as maternity dens at some point in the recent past [2–4, 6–8, 24, 27, 31]. The condition of the bones collected suggested a time frame of a few months to over six years since the material was deposited at the dens.

The human population of the Tuli Block was recently estimated at 7,954 people [32] and domestic livestock units at approximately 3.4 LU/Km<sup>2</sup> [17]. The present study was based out of the Kgotla camp in the southwest part of the reserve and concentrated on regions adjacent to the Motloutse River and Motloutse archaeology site.

The human populations on the fringes of the reserve are surviving via the farming of livestock. Thus, even though the local populations take care with their livestock by the use of kraals and dogs, livestock is still available for the local carnivores to prey on. During the day it was common to see livestock roaming in the study area. While the hyaenas living deeper inside of the reserves would likely have less contact with domestic species, the clans living in the study area would have greater access to livestock.

## 3. Materials and Methods

In addition to long-term general observations made by staff of the reserve, which identified three dens, our study was conducted over three months (October–December of 2004). During this time dens of spotted hyaenas were identified and observed. Additional dens were located via random searches consisting of hikes up to 20 kilometres, all starting from the Motloutse archaeology site and radiating outward. No two searches covered the same area, and none could maintain a straight line due to the terrain. Most searches formed circular patterns skirting the base of the escarpments or covering the tops of said escarpments where spotted hyaenas were known to frequent. At the end of the study period faunal remains from four of the eight identified dens were collected and transported to lab facilities at the University of the Witwatersrand, Johannesburg, South Africa. The dens collected were chosen purely for logistical reasons as they were within 5–7 kilometres from where I was required to leave my vehicle. Specimens were identified to skeletal element and species or class size where possible, using reference collections housed at the Institute for Human Evolution and the Bernard Price Institute, University of the Witwatersrand. In addition bone identification manuals by Schmid [33], Walker [34], and Hillson [35] were used to

TABLE 1: Mammal species living in Mashatu and surrounds.

	Common name	Latin name
Bovid class 1	Klipspringer	<i>Oreotragus oreotragus</i>
	Steenbok	<i>Raphicerus campestris</i>
	Common duiker	<i>Sylvicapra grimmia</i>
Bovid class 2	Bushbuck	<i>Tragelaphus scriptus</i>
	Impala	<i>Aepyceros melampus</i>
	Goat (domestic)	<i>Capra hircus</i>
Bovid class 3	Kudu	<i>Tragelaphus strepsiceros</i>
	Waterbuck	<i>Kobus ellipsiprymnus</i>
	Blue wildebeest	<i>Connochaetes taurinus</i>
	Cow (domestic)	<i>Bos sp.</i>
Bovid class 4	Eland	<i>Taurotragus oryx</i>
Equid	Burchell's zebra	<i>Equus quagga</i>
	Donkey (domestic)	<i>Equus asinus</i>
Primate	Chacma Baboon	<i>Papio cynocephalus ursinus</i>
	Vervet monkey	<i>Cercopithecus aethiops</i>
	Thick-tailed bushbaby	<i>Galago crassicaudatus</i>
Carnivore	Lion	<i>Panthera leo</i>
	Leopard	<i>Panthera pardus</i>
	Cheetah	<i>Acinonyx jubatus</i>
	Caracal	<i>Caracal caracal</i>
	Serval	<i>Leptailurus serval</i>
	African wild cat	<i>Felis silvestris</i>
	Bat-eared fox	<i>Otocyon megalotis</i>
	Black-backed jackal	<i>Canis mesomelas</i>
	Cape fox	<i>Vulpes chama</i>
	Aardwolf	<i>Proteles cristatus</i>
	Spotted hyaena	<i>Crocuta crocuta</i>
	Brown hyaena	<i>Parahyaena brunnea</i>
	Cape clawless otter	<i>Aonyx capensis</i>
	Honey badger	<i>Mellivora capensis</i>
	Striped polecat	<i>Ictonyx striatus</i>
	African civet	<i>Civettictis civetta</i>
	Large-spotted genet	<i>Genetta tigrina</i>
	Small-spotted genet	<i>Genetta genetta</i>
	Banded mongoose	<i>Mungos mungo</i>
	Selous mongoose	<i>Paracynictis selousi</i>
	Slender mongoose	<i>Galerella sanguinea</i>
	White-tailed mongoose	<i>Ichneumia albicauda</i>
	Suid	Bushpig
Warthog		<i>Phacochoerus africanus</i>
Rodent	Porcupine	<i>Hystrix africaeaustralis</i>
	Springhare	<i>Pedetes capensis</i>
Hyrax	Rock dassie	<i>Procavia capensis</i>
	Yellow-spotted dassie	<i>Heterohyrax brucei</i>
Other	Hippopotamus	<i>Hippopotamus amphibius</i>
	Giraffe	<i>Giraffa camelopardalis</i>
	Elephant	<i>Loxodonta africana</i>
	Aardvark	<i>Orycteropus afer</i>
	Scrub hare	<i>Lepus saxatilis</i>
	Pangolin	<i>Manis temminckii</i>

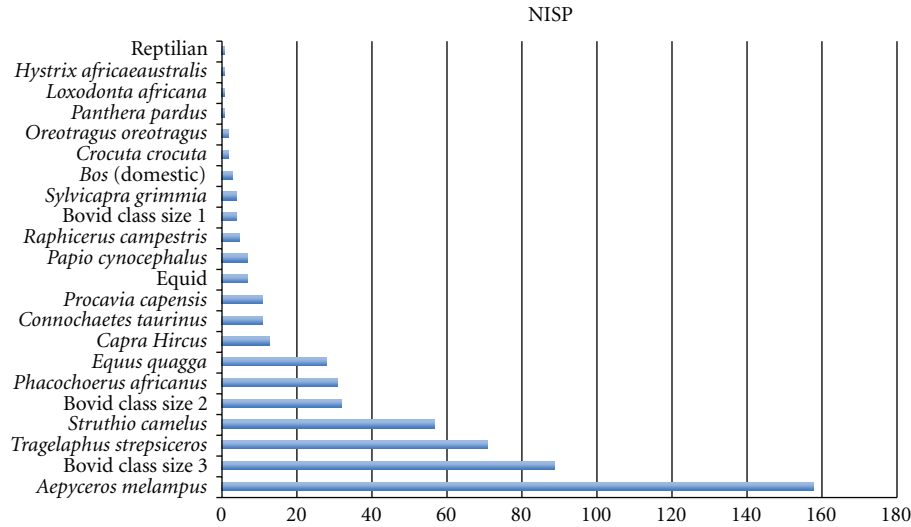


FIGURE 2: Abundance of identified species by NISP (Number of Identified Specimens).

TABLE 2: Identified species or class size, with (number of identified specimens) (NISP), (minimum number of individuals) (MNI) and which dens they were found. Bovid class size based on kilograms and follows Brain [36].

Species	NISP	MNI	Dens
<i>Aepyceros melampus</i>	158	13	1,2,3,4
Bovid class size 3	89	5	1,2,3,4
<i>Tragelaphus strepsiceros</i>	71	4	1,3,4
<i>Struthio camelus</i>	57	4	4
Bovid class size 2	32	2	1,2,3,4
<i>Phacochoerus africanus</i>	31	2	2,3,4
<i>Equus quagga</i>	28	4	1,2,3,4
<i>Capra hircus</i>	13	5	4
<i>Connochaetes taurinus</i>	11	3	2,3,4
<i>Procavia capensis</i>	11	2	1,2,3,4
Equid	7	2	3
<i>Papio cynocephalus</i>	7	2	2,3,4
<i>Raphicerus campestris</i>	5	2	4
Bovid class size 1	4	1	1,4
<i>Sylvicapra grimmia</i>	4	2	1,4
<i>Bos</i> (domestic)	3	1	4
<i>Crocota crocuta</i>	2	1	2
<i>Oreotragus oreotragus</i>	2	1	4
<i>Panthera pardus</i>	1	1	4
<i>Loxodonta africana</i>	1	1	3
<i>Hystrix africaeaustralis</i>	1	1	4
Reptilian	1	1	1
Total	539	60	

aid in the identification of the collected remains. From this the number of identified specimens (NISP) and minimum

number of individuals (MNI) for each den was calculated. All specimens are currently stored at the Palaeosciences Centre, University of the Witwatersrand, Johannesburg, South Africa. Bovid size classes are based on weight and follow Brain [36].

#### 4. Results

We collected 976 specimens of faunal remains from four dens. Of this total, 69.4% of the specimens were identified to skeletal element and 55.2% to species or class size (Table 2, Figure 2). Examination of the faunal remains collected at the den sites indicated that impala (*Aepyceros melampus*) was the most common prey species and consisted of 29.3% of the identified remains. The second most common prey item identified was that of unknown bovid class size 3 (16.5%), followed by kudu (*Tragelaphus strepsiceros*) (13.2%) and ostrich (*Struthio camelus*, Linnaeus, 1758) (10.6%). The remaining identified species composed less than 10% (per species) of identified remains. Combined domestic species identified as cow (*Bos sp.*) and goat (*Capra hircus*, Linnaeus, 1758) composed less than 3% of the total identified remains.

Breakdown of skeletal elements is shown for taxonomically identified family groups, domestic groups, and class size in Table 3. Bovids of class size 2 and 3 show a much greater variety in skeletal elements, with class 2 having at least two samples of each skeletal element listed in Table 3. Domestic *Bos* yielded only three elements, while domestic *Capra* had 12 total identified elements, eight of which were mandibles. Carnivores were the group with the least number of elements, two.

#### 5. Discussion

Considering numbers of domestic species available (79% of the total livestock unit (LU) biomass), results indicate that the spotted hyaenas in the study region are consuming primarily wild species that inhabit the region. Unknown

TABLE 3: Number of select skeletal elements identified for the domestic species, wild bovid class size 1, 2, and 3 [36], equid, carnivore, suid, and primate.

	Domestic <i>bos</i>	Domestic <i>Caprid</i>	Wild class 1	Wild class 2	Wild class 3	Equid	Carnivore	Suid	Primate
Skull	0	0	2	3	3	0	1	3	0
Maxilla	0	0	0	2	0	0	0	0	1
Mandible	0	8	0	5	1	1	0	6	0
Pelvic	0	0	1	6	3	3	0	0	0
Scapula	0	1	0	8	8	1	0	0	0
Humerus	1	1	1	20	17	5	0	0	1
Radius	0	0	2	12	8	3	0	2	0
Ulna	0	0	1	5	6	0	1	0	0
Metacarpal	1	0	0	11	7	7	0	2	0
Femur	0	0	2	19	7	3	0	1	2
Tibia	0	0	2	15	11	4	0	2	0
Calcaneus	0	1	0	4	4	0	0	0	0
Astragalus	0	0	0	2	5	0	0	0	0
Metatarsal	1	0	0	8	8	1	0	1	1
Phalanx 1	1	1	1	20	7	5	0	0	0
Phalanx 2	0	0	0	11	4	2	0	0	0
Phalanx 3	0	0	0	7	2	1	0	0	0
Total bones	4	12	12	158	101	36	2	17	5

bovid class 2 (which may include domestic goats and wild bovinds, such as impala) and bovid class 3 (which could have domestic cattle and wild bovinds) combined compose 22.5% of the identified assemblage. While it is acknowledged that some of this 22.5% may include domestic goat or cattle, it is argued here that the ratios of bovid species represented in the unidentifiable remains would likely follow the ratios of identified remains. Thus, the most unknown bovid class 2 would most likely be comprised of impala, and the bulk of unknown bovid class 3 kudu. Of note is that in addition to impala, only zebra (*Equus quagga*), hyrax, and unknown bovinds of class sizes 2 and 3 are present in all four dens. This observation is suggestive that these prey types are in all probability the preferred prey of resident spotted hyaenas.

Examination of the identified skeletal elements indicates that bovid class sizes 2 and 3 (both identified to species as well as those identified only to class size) along with equids (zebra) show the greatest variation of identified elements. Unlike carnivores, domestic species and primates provided relatively few skeletal elements to the hyaena den assemblages. The bovinds and equids illustrate that most body parts are being collected at the den sites. The difference between identified skeletal remains of the wild bovinds and equids compared to the warthogs, domestic species, carnivores, and primates may very well be indicative of the difference between hunted prey and prey which has been scavenged. In particular the wild class 2 and class 3 bovinds that have all major skeletal elements represented in the assemblages, which may infer predation. However, the reduced number of skeletal elements from domestic *Bos*, *Caprid*, carnivore, suid, and primate would suggest scavenging from human settlements or other predator kills.

This study concurs with reports published by the Botswana government [17] in that spotted hyaenas, while potentially a problem species as evidenced by a low percentage of

identified domestic remains at den sites are not a major contributor to predation upon livestock in the Tuli Block. It must also be acknowledged that the remains studied here may or may not have come solely from hyaenid predation but could have been scavenged from the kills of leopard and or lion. Additionally, it must be emphasised that presence of so few domestic remains in the dens suggests that these particular elements were likely scavenged from human settlements.

Whether or not these results are typical of spotted hyaenas across their range is unknown. This study was conducted in a small area on the edge of the reserve. While this area was chosen for known hyaena activity within close proximity to human populations, it cannot be said whether these particular hyaenas are behaving the same as hyaenas from other regions. What has been demonstrated is a methodology from which hyaena-human conflict can be explored beyond and in addition to the previous use of interviewing the local populations. While there will always be conflict between wildlife and humans, especially when it comes to depredation of domestic stock, through bone-based ecological research and education, we should be able to reduce the unwarranted animosity many rural populations have towards spotted hyaenas. This study takes a critical, initial step to demonstrate that spotted hyaenas in the study area are not directly preying on large numbers of domestic stock. In addition we have illustrated another way in which to determine whether or not hyaenas in a given region are indeed problem animals or not.

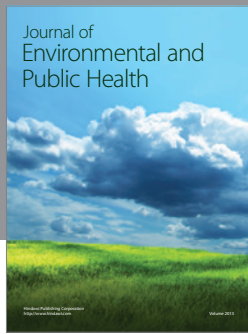
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