Hyaenids

Hyaenids:
Taphonomy and Implications for the Palaeoenvironment

By

Brian Kuhn

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PREFACE

This book is a culmination of a Masters thesis from the Institute of Archaeology, University College London (Kuhn, 2001) a Doctoral thesis from the University of Pretoria (Kuhn, 2006), (the complete PhD thesis with all appendices can be found on line at: http://upetd.up.ac.za/thesis/available/etd-07312007-162350/) and additional research subsequent to 2006.

This volume is dedicated to three very special ladies, my mother, Bettelene Kuhn, my wife, Katja (Koeppel) Kuhn, and my daughter Katarina Svana Kuhn.

CHAPTER ONE

BACKGROUND ON HYAENIDS, PALAEONTOLOGY AND THE QUESTIONS TODAY

As early as 1821 hyaenids were identified as being responsible for faunal accumulations by the reverend William Buckland in relation to the Kirkdale Cave site in the United Kingdom (Brain, 1981). Spotted hyaenas (*Crocuta crocuta*) were identified as the accumulators of the large quantity of faunal remains discovered within the cave. Ironically Hughes (1954a, 1954b, 1958 & 1961) and subsequently Dart (1956) denied that hyaenas actually collected bones at all. Dart (1956) concluded that hyaenas were not important factors in the accumulation of faunal material. Over a decade later the research by Sutcliffe (1969 & 1970) expanded upon the hypothesis that indeed hyaenas, at least spotted hyaenas, do collect various quantities of bone. Further research by Kruuk (1972) concluded that while spotted hyaenas do not bring bones as food back to their maternity dens, they do bring back faunal remains on which to chew.

In later studies, research began to focus on specific aspects of bone collecting and gnawing; specifically Hill (1989) examined bone modifications by spotted hyaenas. Moreover, and in contrast to the conclusions of Hughes (1954a, 1954b, 1958 & 1961) and Dart (1956), Bearder (1977) examined six spotted hyaena dens in the Transvaal of South Africa which contained a substantial amount of faunal remains, thus concluding once and for all that spotted hyaenas are important accumulators of faunal remains. Henschel *et al.* (1979) substantiated these results and Skinner *et al.* (1986) independently confirmed that spotted hyaena bone collecting behaviours could be responsible for at least a portion of the fossil bone assemblages found in southern Africa.

In 1976 Kruuk expanded his research to include another member of the hyaena family and established that striped hyaenas (*Hyaena hyaena*) in East Africa bring back large quantities of faunal remains to their maternity dens. Expanding further upon the idea of hyaenids as bone collectors Brain (1981) noted that different accumulators might occupy the same dens over short periods of time (e.g. porcupines (*Hystrix cristata*) are commonly found in both spotted hyaena and brown hyaena dens). It was at this time that Brain (1981) examined how various pressures, including carnivore activity, affect the bones in the fossilisation process.

Expanding upon the research of taphonomy and hyaena activity on bone collections Maguire, Pemberton and Collett (1980) listed nine specific taphonomic signatures that they suggested were unique to hyaena activity upon collected bones. The nine characteristics include ragged edge chewing, localized shallow pitting, punctate depressions or perforations, crescent shaped or lunate fracture scars, striations or gouging, irregular or random grooves, scooping or hollowing, acid etching or erosion of bone, and splintering or shattercracking. Haynes (1983) provided insight into the subtle differences between the taphonomic signatures of various extant carnivores and published a brief overview of the patterns of gnawing for spotted hyaenas, wolves (*Canis lupus*), bears (*Ursus arctos* and *U. americanus*), lions (*Panthera leo*), tigers (*P. tigris*), and jaguars (*P. onca*).

In addition to the taphonomic research there have been a number of studies investigating the make up of assemblages and using these data in attempts to determine the collecting agent (Klein 1982; Hill & Behrensmeyer, 1984; Hill, 1984; Stiner, 1991; Cruz-Uribe, 1991; Horwitz, 1998; Pickering, 2002; Lacruz & Maude, 2005; Kuhn, 2005; Kuhn, 2006; Kuhn *et al.*, 2009; Kuhn *et al.*, 2010). The research of Stiner combined with Cruz-Uribe put forward seven criteria that they concluded were indicative of hyaenas being the accumulating agents as opposed to ancient hominids. Of the seven purported ‘criteria’ put forth by Stiner and Cruz-Uribe, Pickering’s (2002) review rejected all but the latter three established by Cruz-Uribe and believed that only they could be used in differentiating between hyaena and hominid accumulated assemblages. More recently work by Kuhn *et al*., (2010) indicated that none of the criteria put forth previously can be used with any confidence to establish hyaena from hominin collected faunal assemblages.

It has been well established that along with extinct forms of accumulators, three of the four species of extant hyaenas, plus porcupines (Brain, 1981), leopards (*Panthera pardus*) (Simons, 1966; Brain, 1981; Le Roux & Skinner, 1989; de Ruiter & Berger, 2000, 2001; Pickering *et al.*, 2004; Skinner & Chimimba, 2005), some raptors (Mundy & Ledger, 1976; Mayhew, 1977; Richardson *et al.*, 1986; Davies, 1994; Berger & Clarke, 1995; Cruz-Uribe & Klein, 1998; Robert & Vigne, 2002; Sanders *et al.*, 2003; Berger, 2006; Erlandson *et al., 2007;* Gilbert *et al., 2009*) and ravens (*Corvus corax*) (Laudet & Selva, 2005) are responsible for the collection of significant amounts of bone material in both the modern and fossil record. Today many modern studies have been conducted on all three extant bone collecting hyaenas which has shown all three to collect faunal remains to varying degrees **(**Mills and Mills, 1977; Henschel *et al*., 1979; Skinner and Ilani, 1979; Skinner *et al*., 1980; Brain, 1981; Scott and Klein, 1981; Binford *et al*., 1988; Hill, 1989; Skinner and van Aarde, 1991; Lam, 1992; Kerbis Peterhans and Horwitz, 1992; Leakey *et al*., 1999; Kuhn, 2005; Lacruz and Maude, 2005; Skinner, 2006; Pokines and Kerbis Peterhans, 2007; Faith, 2007; Kuhn *et al*., 2008; Kuhn *et al*., 2009; Lansing *et al*., 2009; Kuhn *et al.,* 2010)**.**

In order to interpret faunal assemblages of unknown origin the possible mode of collection needs to be identified with as much certainty as possible. If the assemblage is due to animal activity the taphonomic signatures left behind by the collector or collectors should be identified to species where possible. Since only a limited percentage of faunal remains in any assemblage will yield diagnostic taphonomic marks, the entire assemblage must be studied and any species-specific signatures as well as the frequency of said marks should be recorded. The work by Faith (2007) and subsequent work by Kuhn *et al*. (2009) illustrate that variations in collection and analyses will yield very different results. Complete analysis of the assemblages, in theory, should identify the collector or possibly collectors involved. However, several questions need to be answered in order for this to be accomplished. Such as can observable differences in the assemblages of striped hyaenas, brown hyaenas and spotted hyaenas be seen? Do spotted hyaenas create smaller assemblages than either striped hyaenas or brown hyaenas? Are the bone fragments left by spotted hyaenas consistently smaller than those of striped hyaenas or brown hyaenas? Are the striped hyaenas and brown hyaenas truly similar in their collecting behaviours as suggested by independent studies of the two species (Owens & Owens, 1978; Skinner, 1976; Kruuk, 1976; Bearder, 1977; Skinner *et al.*, 1980; Skinner & van Aarde, 1991; Leakey *et al.*, 1999; Kuhn, 2001, 2005 & 2006 and Lacruz & Maude, 2005)? Or will there be distinctive patterns established to differentiate between the two species? Are there differences between populations of the same species from different environments? Do spotted hyaenas bring back larger faunal remains than either striped hyaenas or brown hyaenas as hypothesised by numerous previous researchers (Kruuk, 1972; Bearder, 1977; Skinner *et al*, 1986; Cooper *et al.*, 1999)? Which species leaves behind more distinctive taphonomic signatures, and which of these signatures is more prevalent? Are there any distinguishing taphonomic signatures of hyaenids that separate them from other carnivore collectors such as leopards? And how often to other gnawing mammals inhabit the same den space as the collecting mammals? These are just a few of the questions that arise when one tries to differentiate between the assemblages of extant collectors.

In an attempt to find the answers to the above questions faunal analyses were conducted on material collected from dens within the home ranges of the three extant bone-collecting hyaenids. In addition in situ examinations of dens and previously collected assemblages attributed to one of the specific species in question were conducted. The analyses were completed using the reference collections housed at the Bernard Price Institute and the Institute for Human Evolution, University of Witwatersrand, as well as using various manuals and publications. These included *Mrs. Walkers Bone Book: A Guide to Post-Cranial Bones of East African Animals* (Walker, 1985), *Mammal Bones and Teeth* (Hillson, 1992), *A manual to the skeletal measurements of the seal genera* Halichoerus *and Phoca (Mammalia: Pinnipedia)* (Ericson & Stora, 1999), and Schmid's 1972 *Atlas of Animal Bones*. *Syncerus caffer* was distinguished from domestic *Bos* using Peters' 1986 paper.

CHAPTER TWO

MODERN HOME RANGES, FOSSIL OVERLAP, AND ECOLOGY

The range of extant brown hyaenas (*Parahyaena brunnea*) is confined to areas of southern Africa that includes South Africa, Namibia, Botswana and parts of Zimbabwe, Mozambique and Angola (Skinner & Chimimba, 2005). Spotted hyaenas (*Crocuta crocuta*) are found from south of the Sahara to southern Africa, excluding the Congo and today are conservation dependant in South Africa, thus are not as widespread as they once were (Skinner & Chimimba, 2005). Striped hyaenas (*Hyaena hyaena)* range from as far south as northern Tanzania, across all of North Africa through the Middle East and east as the Gulf of Bengal and north into southern Siberia (Kruuk, 1976; Stuart & Stuart, 1997). Today the only overlaps in the various home ranges that exist are between spotted hyaenas and striped hyaenas in northern Sub-Saharan Africa and spotted hyaenas and brown hyaenas in southern Africa (Figure 1). In the fossil record however, there is an overlap between all three extant species as well as a number of extinct species of hyaenids in southern Africa and other parts of the world (Hughes, 1954a & b; Ewer, 1955a, 1955b; Sutcliffe, 1969; Klein, 1972; Hendey, 1974, 1978; Howell & Petter, 1976; Galliano & Frailey, 1977; Maguire *et al.,* 1980; Berta, 1981; Brain, 1981; Scott & Klein, 1981; Binford *et al.,* 1988; Turner, 1993; Watson, 1993; Boaz & Crochon, 2001; Mutter *et al.,* 2001; Boshoff, 2003; Werdelin and Lewis, 2005). It has been shown that *Hyaena makapani* and *Hyaena hyaena* are very similar, but different species (Mills and Hofer, 1998; Werdelin and Lewis, 2005), and both appear in the South African fossil record, thus establishing the third extant hyaena's presence in southern Africa.

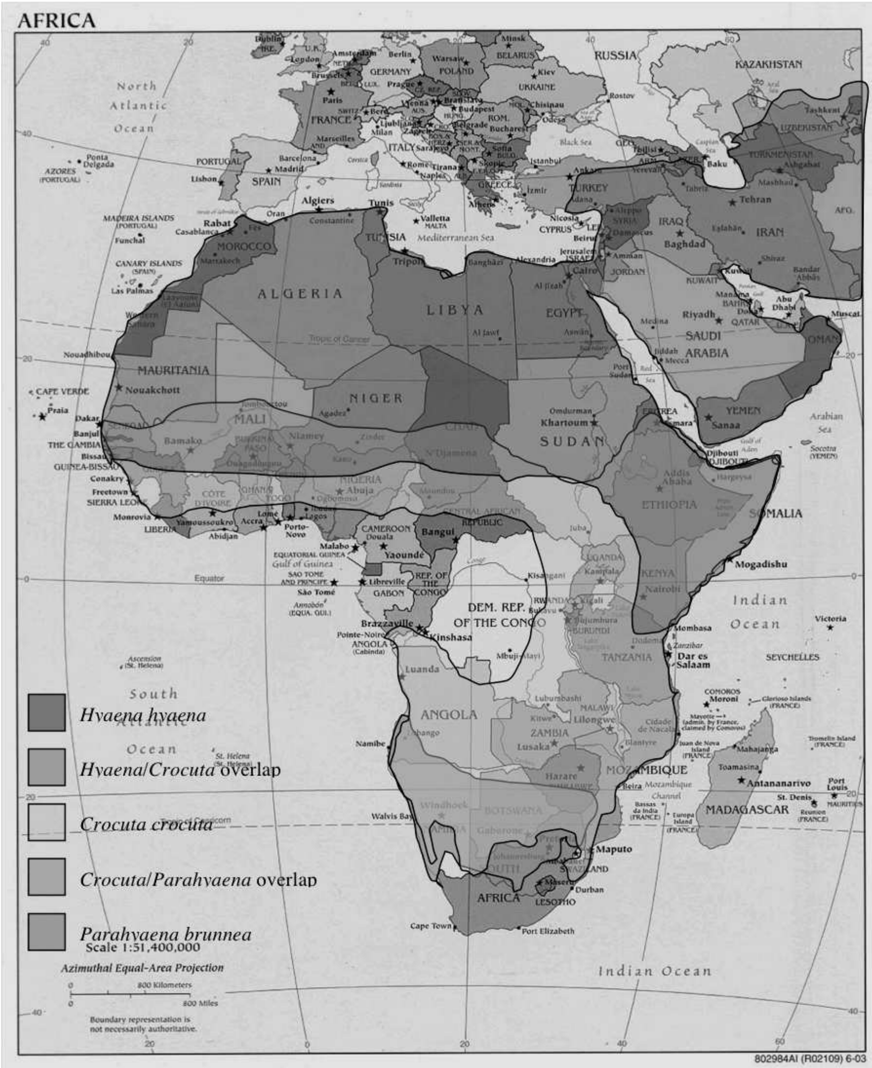

Figure 1: Ranges of *Hyaena*, *Crocuta* and *Parahyaena* (Kuhn, 2006)

There are four extant species in the family hyaenidae, *Crocuta crocuta* (Plate 1), *Hyaena hyaena* (Plate 2), *Parahyaena brunnea* (Plate 3) and *Proteles cristatus*. Of these, aardwolves (*Proteles cristatus*) have evolved into an insectivore, and behaviourally do not have any known influence upon faunal assemblages. Of the other three species, the spotted hyaenas are the largest (males average ca. 59.0kg and females 70.9kg). Brown hyaenas average 49.0 kg for males and 45.6 kg for females (Skinner, 2006) while striped hyaenas average 33.6kg and 30.7 kg for males and females respectively (Skinner & Ilani, 1979; Yom-Tov & Mendelssohn, 2002). Sexual dimorphism favours the females in the spotted hyaenas, while in the brown hyaenas and striped hyaenas males are larger. Brown hyaenas and striped hyaenas are very similar, filling the southern and northern niches respectively. In general appearance they both have shaggy coats, long pointed ears and the typical hyaena build of a stout chest and neck and sloping back. They are so similar that Skinner & Ilani (1979) concluded that '*Parahyaena* is a larger edition of *Hyaena'*.

Studies on their ecology and behaviour indicate that both brown hyaenas and striped hyaenas are also very similar in their feeding/ scavenging and bone collecting behaviours; being solitary foragers (Mills, 1973, 1990; Skinner, 1976; Mills & Mills, 1977; Owens & Owens, 1978; Yom-Tov & Medelssohn, 2002; Maude, 2005; Maude & Mills, 2005; Skinner & Chimimba, 2005; Wiesel, 2006) and both tend to carry large quantities of food back to cubs at their prospective maternity dens (Kruuk, 1976; Bearder, 1977; Owens & Owens, 1978; Skinner *et al.*, 1980; Skinner & van Aarde, 1991; Horwitz & Kerbis, 1991; Leakey *et al.*, 1999; Kuhn, 2001, 2005 & 2006; Lacruz & Maude, 2005; Wiesel, 2006; Kuhn *et al*., 2008; Kuhn *et al*., 2009; Kuhn *et al*., 2010). In contrast, these particular behaviours are not found amongst spotted hyaenas (Kruuk, 1972; Bearder, 1977; Skinner *et al*, 1986; Cooper *et al*., 1999; Kuhn, 2006; Kuhn *et al*., 2009; Kuhn *et al*., 2010). Spotted hyaenas are known to hunt both alone or in clans that can range in size from five or six to over 100 individuals depending upon the region (Kruuk, 1966; Sutcliffe, 1970; Skinner & Chimimba, 2005; Cooper *et al*., 1999).

There is limited evidence that *Parahyaena* and *Hyaena* kill smaller prey species, young seals and occasionally domestic stock, if they kill at all (Kruuk, 1976; Skinner, 1976, 2006; Mills, 1990; Yom-Tov & Mendelssohn, 2002; Kuhn *et al*., 2008). Apart from infrequent reports in Israel that striped hyaenas attack livestock (Yom-Tov & Mendelssohn, 2002) there is little evidence for striped hyaenas making significant kills other than small mammals (Kerbis-Peterhans & Horwitz, 1992). Current research on brown hyaenas in Namibia indicates that they routinely kill young seals during the pupping season (Wiesel, 2006; Kuhn *et al*., 2008; Wiesel, 2010). The few reports of brown hyaenas attacking livestock in South Africa are rare and all occurred on farms where brown hyaenas are common and had no previous history of such attacks (Skinner, 1976;

Skinner & Chimimba, 2005). With the exception of the brown hyaena populations along the southern Namibian coast it appears that both smaller hyaenids are surviving as very efficient scavengers (Mills, 1973; Skinner 1976; Skinner & Ilani, 1979; Skinner & van Aarde, 1981; Skinner *et al.*, 1980; Kerbis-Peterhans & Horwitz, 1992; Kuhn, 2001, 2005, 2006; Maude, 2005), striped hyaenas in Israel are even known to scavenge from human graves (Skinner *et al.,* 1980; Horwitz & Smith, 1988; Kerbis-Peterhans & Horwitz, 1992). In addition to scavenging smaller prey species, research on striped hyaenas in eastern Jordan yielded a high number of adult camel bones, among other larger domestic species (Kuhn, 2001; Kuhn, 2005) thus illustrating the striped hyaenas ability to scavenge from much larger species. Once thought of as pure scavengers, spotted hyaenas are in fact very efficient hunters and, whether foraging alone or in groups, are capable of catching large prey species (Kruuk, 1966; Sutcliffe, 1970; Bearder, 1977; Skinner & Chimimba, 2005; Cooper *et al.,* 1999). It has recently been shown that in the Serengeti that up to 95% of consumed meat is obtained via the successful hunting of medium to large ungulates (Cooper *et al.,* 1999). While the percentage of kills varies throughout the home range the remaining diet not taken via the hunting of larger prey is made up of scavenged material and smaller mammals (Skinner, 2006).

Up until recently research indicated that both striped hyaenas and brown hyaenas tend to be nocturnal or at most crepuscular (Mills, 1973; Skinner, 1976; Yom-Tov & Mendelssohn, 2002; Skinner & Chimimba, 2005). More recent research shows that brown hyaenas (at least along the Namibian coast) are both nocturnal and diurnal and seek out and kill Cape fur seal pups (*Arctocephalus pusillus*) amongst their colonies at all hours, day or night (Wiesel, 2006; Kuhn *et al*., 2008). In contrast, the population of brown hyaenas at the Rietvlei Nature Reserve follows the patterns established by previous research as being strictly nocturnal. This appears to be true on the Malapa Nature Reserve as well, where current research is under way. Spotted hyaenas are principally nocturnal, foraging and hunting at night, although lying up during the hottest portion of the day they are at times active during the day, (Kruuk, 1966, 1972; Sutcliffe, 1970; Skinner & Chimimba, 2005).

In some cultures there are a number of beliefs, superstitions, and erroneous ‘facts’ surrounding hyaenas that perpetuate the misconceptions of hyaenid behaviour. In some circles it is still thought that spotted hyaenas are strictly scavengers, relying entirely upon carrion for survival. Through mainstream media spotted hyaenas have generated an image of being unsavoury thieves amongst the common people, an image perpetuated by movies and theatre like the Lion King. In Arabia the

Bedouin beliefs regarding striped hyaenas give the animal supernatural qualities. One of the many myths claims that the urine of the striped hyaena will turn a person into a hyaena. Another states that the striped hyaena can put a person under a spell with its breath, forcing the victim to follow the hyaena back to its den where the hyaena sucks out their brains and feeds upon them. It is possibly due to the superstitions surrounding the striped hyaena that golden jackal, wolf (*Canis lupus arabs*), and striped hyaenas are all persecuted to this day. Whatever the rationale, the Arab world views striped hyaenas with revulsion and fear and will kill them at any and every opportunity. This is true in Jordan (pers. obs.), Lebanon (A. Garrard, pers. comm.) and Saudi Arabia (H. Bertschinger, pers. comm.) and evident in the United Arab Emirates where the striped hyaena has been all but eradicated as a result (ArabianWildlife.com).

CHAPTER THREE

REGIONS STUDIED

Faunal remains were either collected from, examined in situ, or had been previously collected from five distinct regions (Figure 2). Faunal remains from five striped hyaena dens were collected from extant den sites in three regions of the Badia in eastern Jordan (Kuhn, 2001, 2005). This collection is currently stored at the Council for British Research in the Levant (CBRL) facility in Amman, Jordan. The collected remains from spotted hyaena dens came from one active and three inactive dens on the Mashatu Game Reserve, Botswana, and two inactive locations at the Namib-Naukluft Park, near Gobabeb, Namibia. The remains collected by brown hyaenas came from three dens at Rietvlei Nature Reserve, South Africa. Additional material attributed to brown hyaena was examined in situ at nine dens in Diamond Area No. 1 and adjacent Lüderitz peninsula, Namibia. Additionally, material previously collected by Skinner & van Aarde (1991) and Skinner *et al.* (1998) in Diamond Area No. 1 of Namibia and housed at the University of Witwatersrand were also analysed (Kuhn, 2006).

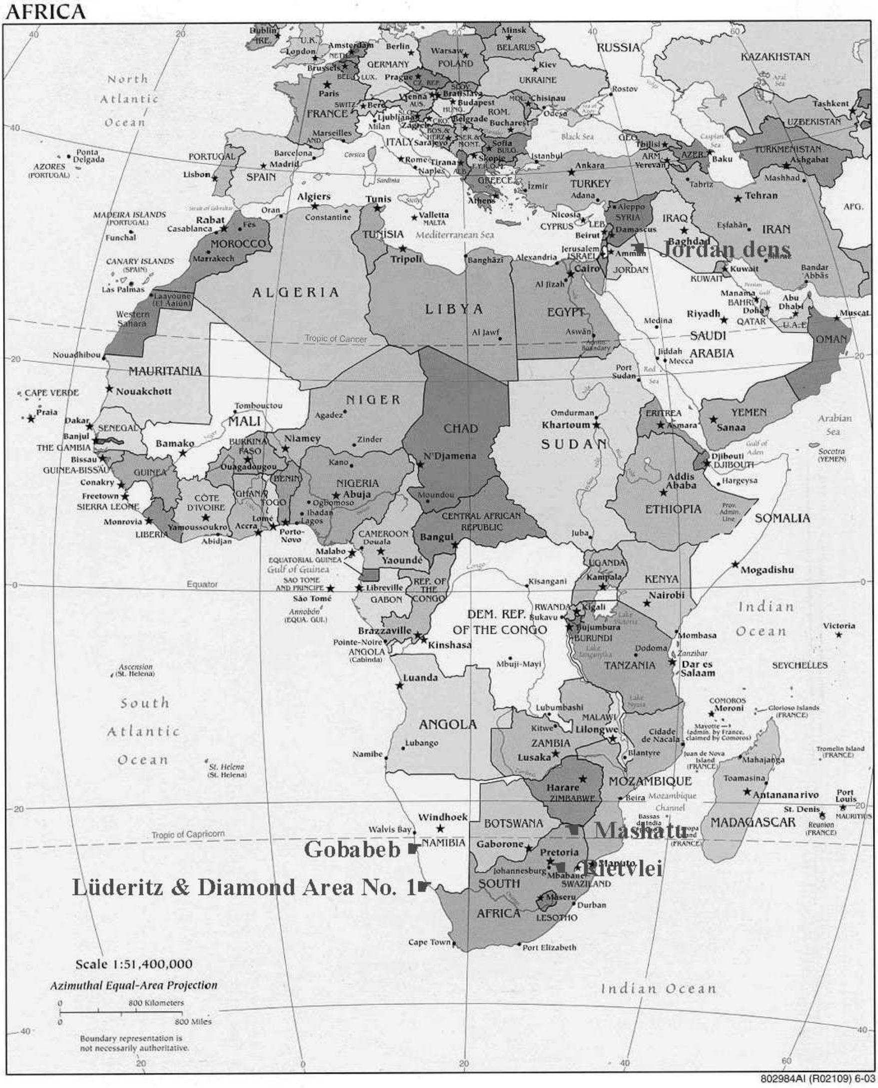

Figure 2: Map showing den localities (Kuhn, 2006)

Jordan

In 2001(May and June) the faunal remains from five dens of striped hyaena in Jordan were collected and analysed as part of an unpublished Masters of Science thesis while at the Institute of Archaeology, University College London (Kuhn, 2001, 2005). Upon completion of a regional survey, three locations in the northern Badia of eastern Jordan were chosen on a basis of den numbers and local knowledge of hyaena activity. The first area was near the Bronze Age city of Jawa, the second located near wadi Al-Arteen, and the third at the Dhahik depression near the border with Saudi Arabia. Both Jawa, and approximately 20 km to the south, Al-Arteen, are in the black basalt desert. Dhahik, 90 km to the south of Al-Arteen, lies outside of the basalt desert and is part of the limestone desert that covers most of Jordan (Figure 3).

Receiving approximately 200 mm of rainfall per annum (Allison *et al*., 1998), the Badia is made up of a series of wadis and depressions. Dhahik is a large depression where the surrounding wadis deposit any rainfall while Jawa and Al-Arteen are both wadis. There is little to no vegetation outside of the wadis and depressions, thus most wildlife in the region can be found concentrated near the numerous wadis and depressions or near the two sources of permanent fresh water, Burqu and Azraq. Up until recently the region had a plethora of wildlife roaming free, while today the native onager (*Equus onager hemippus*) is extinct and the Arabian Oryx (*Oryx leucoryx*) and ostrich (*Struthio camelus*) are on the verge of extinction again after years of existence on the Shaumari Reserve, today there are only a few oryx left on what was once the hope for the species' in Jordan. The majority of larger game species are either extinct or have been reintroduced onto nature reserves. The exceptions are in areas away from permanent occupation where a number of wild species still exist. Aside from a great number of smaller mammals, birds and reptiles, large mammals include, but are not limited to, rheem gazelles (*Gazella subguttursa marica*), dorcas gazelles (*Gazella dorcas*), golden jackals (*Canis aureus*), Arabian wolves (*Canis lupus arabs*), caracal (*Caracal caracal*), African wildcat (*Felis sylvestris*), sand cat (*Felis margarita*) and striped hyaenas.

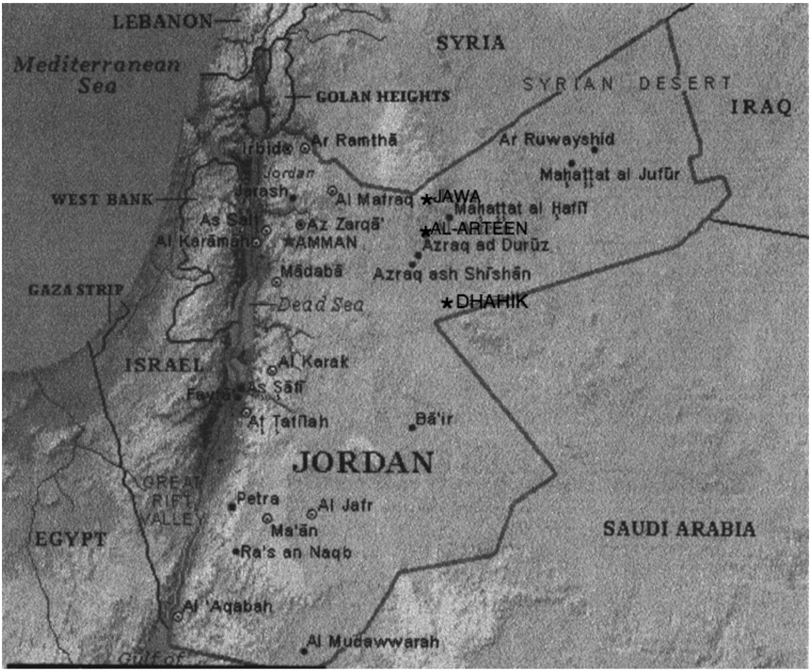

Figure 3: Map of Jordan showing the study areas (Kuhn, 2005)

Rietvlei Nature Reserve, South Africa

Located on the eastern edge of greater Pretoria, the Rietvlei Nature Reserve is situated adjacent to the R21 highway and Irene road (Figure 4). The reserve covers an area of 3800 ha at an altitude of 1525m above sea level and is adjacent to the Rietvlei dam built in 1934. Rietvlei is home to approximately 2000 head of large ungulate species, which include buffaloes (*Syncerus caffer*), eland (*Tragelaphus oryx*), black wildebeest (*Connochaetes gnou*), springbok (*Antidorcas marsupialis*), plains zebras (*Equus burchelli*) and, at the time of the study, white rhinoceroses (*Ceratotherium simum*). The reserve is also home to three larger carnivores, black-backed jackals (*Canis mesomelas*), a pair of cheetahs (*Acinonyx jubatus*), and brown hyaenas as well as numerous small mammals, reptiles, amphibians and birds. The climate is typical of that found throughout the Highveld of South Africa, being cold and dry in the winter months and averaging 724 mm of rainfall during the summer months.

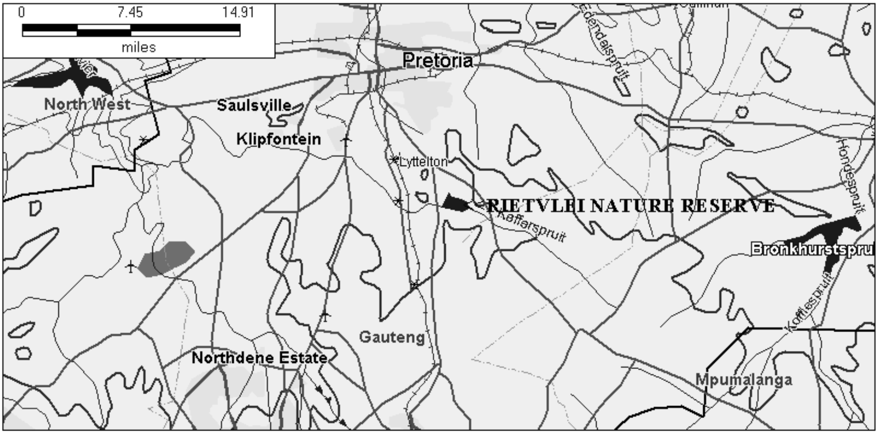

Figure 4: Map showing location of Rietvlei Nature Reserve (Kuhn, 2006)

Mashatu Game Reserve, Botswana

Located in the eastern region of Botswana known as the Tuli Block, the Mashatu Game Reserve covers 30,000 ha of bushveld at the confluence of the Shashe and Limpopo rivers (Figure 5). The region receives approximately 177mm of rainfall over the summer and is cool and dry in the winter months. The specific part of Mashatu surveyed during this study is located at the southwest corner of the reserve near the Motloutse River and Motloutse Archaeology site. In addition to large carnivores such as lions (*Panthera leo*), leopards (*P. pardus*) and spotted hyaenas, the region supports a variety of other wildlife which includes a large population of elephants (*Loxodonta Africana)* in addition to numerous game species including zebras, eland, blue wildebeest (*Connochaetes taurinus*), impala (*Aepyceros melampus*) and kudus (*Tragelaphus strepsiceros*) (statistical information from the website, www.mashatu.com, 2006).

Figure 5: Map showing location of Mashatu Game Reserve (Kuhn, 2006)

Diamond Area No. 1 and the Lüderitz Peninsula, Namibia

Lüderitz and Diamond Area No. 1 are in the southwest of Namibia. The Diamond Area, or Sperrgebiet, extends south of Lüderitz to the South African Border and covers 26,000 km^2 (Figure 6). To the north of Lüderitz and the peninsula is the southern edge of the Namib-Naukluft Park. The region is coastal desert and only receives 2-20 mm of rainfall per annum. Despite the arid conditions the region supports a variety of wildlife such as gemsbok (*Oryx gazella*), springbok, black-backed jackals and numerous small mammals including the recently identified African wildcat (I. Wiesel, pers. comm., 2005), birds and reptiles. In addition to the terrestrial wildlife there is an abundance of marine life, both birds and mammals that occupy the shorelines. These include Cape fur seals and southern African jackass penguins (*Spheniscus demersus*). The fact that the majority of the land around Lüderitz are protected in some way via being declared parks or active diamond areas has benefited the local wildlife, but does not limit the wildlife to said areas as all the species can be found on the peninsula and public beaches and brown hyaenas are routinely sighted within the town itself (Goss, 1986) and are often found as road kill on the one road leading to the area.

Gobabeb, Namib-Naukluft Park, Namibia

The Namib-Naukluft Park covers over 50,000 km^2 along the western edge of Namibia, from Lüderitz in the south to Walvis Bay and Swakopmund in the north (Figure 6). Gobabeb lies in the northwest portion of the park, 55 km from the coast and 70 km from Walvis Bay at the intersection of three major ecosystems. These ecosystems are the Namib Sand Sea, the gravel plains of the Central Namib Desert and the Kuiseb River. Gobabeb receives 0-50 mm of rainfall per annum, the remainder of its moisture requirements coming from the advective fogs that arise from the cold Benguela Current (Louw & Seely, 1982). Gobabeb and the surrounding region supports a diversity of wildlife from Hartmann's mountain zebras (*Equus zebra hartmannae*), gemsbok, springbok, leopards, black-backed jackals and spotted hyaenas to numerous small mammals, birds and reptiles. In addition to the wild populations there are resident populations of domestic goats (*Capra hircus*) and cattle (*Bos spp*) that forage up and down the Kuiseb River.

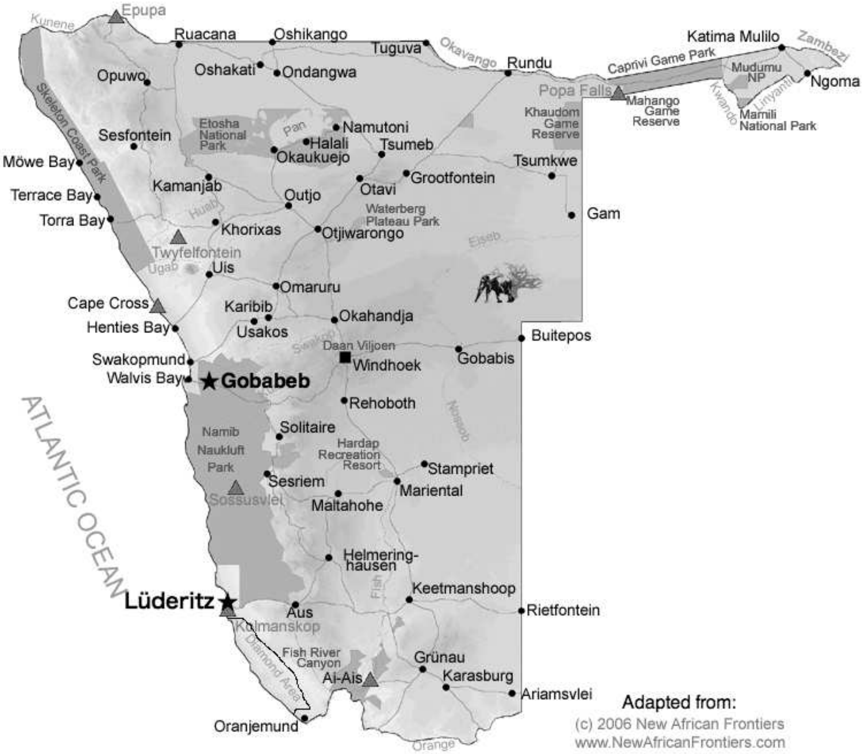

Figure 6: Map showing locations of Lüderitz, Diamond Area 1 and Gobabeb (Kuhn, 2006)

Skinner Collection

The Skinner collection, housed at the University of the Witwatersrand, comprises the combination of two collections that were collected in Diamond Area No. 1, Namibia, in 1991 and 1998 (Skinner & van Aarde, 1991; Skinner *et al*., 1998).