5 DISCUSSION

1. STAGE 1 - FAUNAL ANALYSIS

Stage 1 of this study entailed the analysis of the faunal remains excavated at Kemp's Caves, South Africa. It involved mainly the sorting and identification of fragmented bone pieces. The results were used to confirm the ESR dates of the site, especially with the use of identified extinct animal remains. Five specimens were identified as being representative of *Equus capensis* (Cape horse / zebra). At present, this is the only extinct species that was recovered at Kemp's Caves.

The results of the faunal analysis were also utilized to give insight into environmental changes such as climate and habitat, which may have occurred in the Kemp's Caves area during its existence. The last aim of this stage was to suggest a primary accumulating agent for the caves for better understanding of the caves' taphonomy.

1.1 Faunal assemblage

More than 8000 specimens were sorted and identified to species level where possible. Twelve percent of the elements could be identified to larger mammalian and other categories, while only three percent could be identified to different taxa and species (see Table 4.1). Plug is of opinion that the small amount of identified specimens typically found from sites in South Africa is due to the fact that these excavation sites produce specimens which are fragmented to a large extent [94].

Like most other cave sites, the faunal remains of Kemp's Caves is composed mostly of bovid specimens. More than 85% of the specimens belonged to 13 different bovid species. Bovid size class II and III represented 68% of the bovid sample, suggesting activity of medium to large sized predators.

Only one domestic species, *Bos taurus* (domestic cattle), was identified. The five specimens were modern and not fossilized, suggesting a recent origin. The cave is situated in an environment which had been a game reserve for the past 40 years, which suggests that no domestic cattle have been found here since 1963. This may imply that the specimens were brought in from the outside, probably part of a human meal, when considering that only five specimens were identified. It could also have been scavenged and brought in from a neighbouring farm of an animal that died of natural causes. Another explanation could be that it was washed from a site outside the game reserve into the tunnel of the North-eastern extension. It could also have been washed into the North-eastern tunnel prior to 1963. Brain states that it is not unusual for separate specimens of a skeleton or even a bone to be transported by water before it is deposited as part of the faunal assemblage. It is, however, necessary to keep in mind which parts of the skeleton can be carried away by an aqueous current to establish whether a certain specimen could have been washed in or not [2]. The specimens consisted of four carpals (complete) and the distal articulation of a radius. Studies have shown that structures such as complete skulls, ribs, vertebrae and phalanges were transported by the current, but that teeth, metapodials and tibiae became imbedded within the riverbed [2]. It is however, still unclear whether water could have been responsible for the transportation.

Several carnivore specimens ranging from large species, like leopard, to smaller species, like mongooses, were represented in the sample. Carnivores often prey on other carnivores, thus the fact that carnivore specimens were represented in the assemblage might indicate accumulation by scavenging and hunting of non-human predators. The skeletal representation of the carnivores may, however, also be the result of natural deaths.

Only a few avian and reptilian specimens were represented by either ostrich egg shell or fragmented carapaces. No fish remains except a few crab pinchers were found. This indicates that avian and reptilian fauna might not have been a major part in the diet of either man or animal at Kemp's Caves.

The faunal assemblage of sites with similar dates show several similarities with that of Kemp's Caves (see Table 4.2 for species identified at Kemp's Caves).

Rose Cottage Cave showed many similar macro-mammalian species which included most bovids which were also identified at Kemp's Caves. *Antidorcas marsupialis* (Springbok) were well represented with a high NISP value of 106. The extinct species *Equus capensis* was also identified and was represented by six separate specimens [34].

The faunal sample of Sehonghong is dominated by fish, thus no clear comparison could be made with this site in Lesotho.

Klasies River Mouth yielded similar bovid and carnivorous species, but also had a large quantity of fish and molluscs. Klasies River Mouth further yielded several hominid specimens, which included a fragmentary skull, that appears to be anatomically modern, as well as twenty four MSA dated specimens [56]. *Pelorovis antiquus* (Giant buffalo), which became extinct between 12 000 and 10 000 BP, was the only extinct species identified [95].

Klasies River Mouth and Border Cave are both coastal sites and yielded several hominid specimens regarded as anatomically modern humans. Kemp's Caves fall within this important era of the evolution of anatomical modern humans, but had yielded no hominid specimens which could be associated with the older deposits in the cave. This fact may support the theory that anatomical modern humans had a coastal evolutionary history [41]. However, there has only been a small amount of fossils excavated at the Kemp's Caves site, and it may still yield hominid specimens. This may then contradict this theory, as Kemp's Caves is an inland site.

1.2 Equus capensis

Equus capensis was the first species of fossil horse to be described in South Africa. Broom identified several equid specimens that led him to suggest for some time that an extinct equid may have existed in the Cape Province, but it was only in 1909 that he was able to describe the dentition of this animal [96]. The first fossil (left mandibular ramus) was found in a slab of limestone on a beach at Ysterplaatz in Table Bay [2]. Twenty species of *Equus* were described in South Africa between 1909 and 1950. Five of these were that of several other zebra species, and the rest are considered to all be *E. capensis*. These specimens allowed Broom to describe the species in greater detail.

Although no formal classification is given, Broom describes *E. capensis* as a horse species with a skull considerably larger (10-15%) than *E. caballus*. It had the same pattern of the lower molars of modern horses, but lacked any traces of the protostylid [97]. The animal appeared to be more powerfully built than *E. caballus*, but did not stand very high [2].

Mixed criticism about Broom's identification included that of Wells [98], who considered Broom's type *E. capensis* as indeterminable and suggested that the correct name for the extinct Cape horse should be *E. helmei dreyer*. Churcher, however, supported Broom's identification and applied the type *E. capensis* to the Sterkfontein valley material [2].

Klein suggested that *E. capensis* disappeared from the Southern Cape with other forms such as the giant buffalo *(Pelorovis antiquus)* and giant hartebeest (*Megalotragus*) around 12 000 - 10 000 years BP. These dates coincide with the environmental changes of the terminal Pleistocene. He also suggests that both the environment as well as man's more effective hunting methods could have been responsible for these extinctions [99]. The extinct equids had a larger body-size than the extant equids. This indicates a similarly low metabolic rate and implies that extinct equids like *E. capensis* had the ability to cope with more low quality food. This in turn defines the feeding niche of *E. capensis* as having a larger amount of course grass as part of its diet than extant equids [100]. It is therefore suggested that the giant grazers such as *Megalotragus priscus*, *Pelorovis antiquus* and *Equus capensis* acted as "lawn mowers". This feeding niche stimulated the production of new growth of the grassland herb layer [101].

Remains of *E. capensis* have been found all over South Africa, and have been the object of rock paintings and engravings of artists that may have seen the horse alive. These artistic records show various differences. Several records show this species with stripes, like a zebra, while other paintings lacks a striped appearance which resembles a horse [2]. Brain [2] illustrated *Equus capensis* as having stripes (Figure 5.1) whereas Maglio and Cooke [97] showed a non-striped species (Figure 5.2).

FIGURE 5.1: *Equus capensis* as illustrated in "The Hunters or the Hunted" [2].

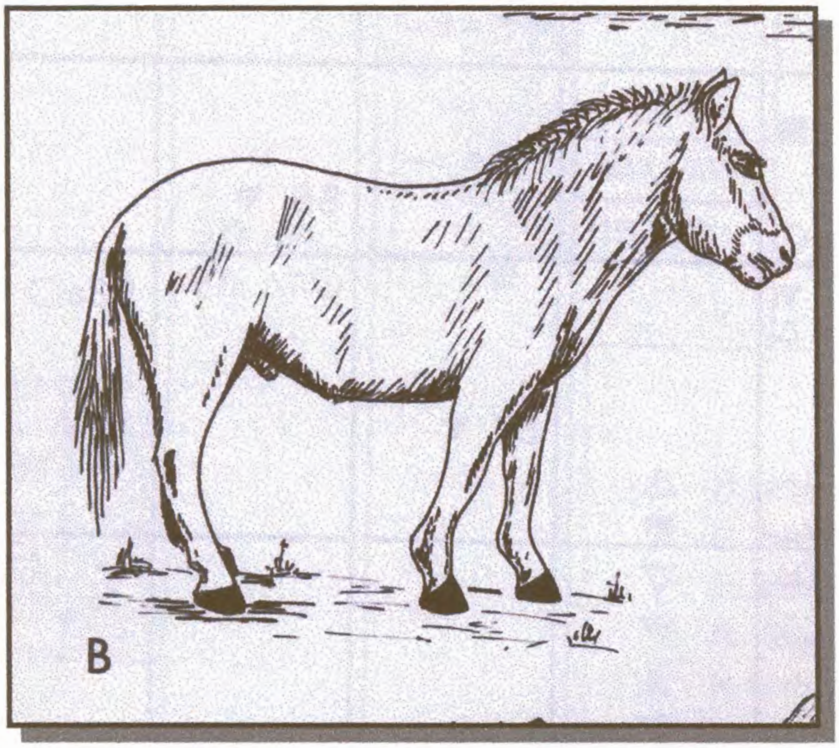
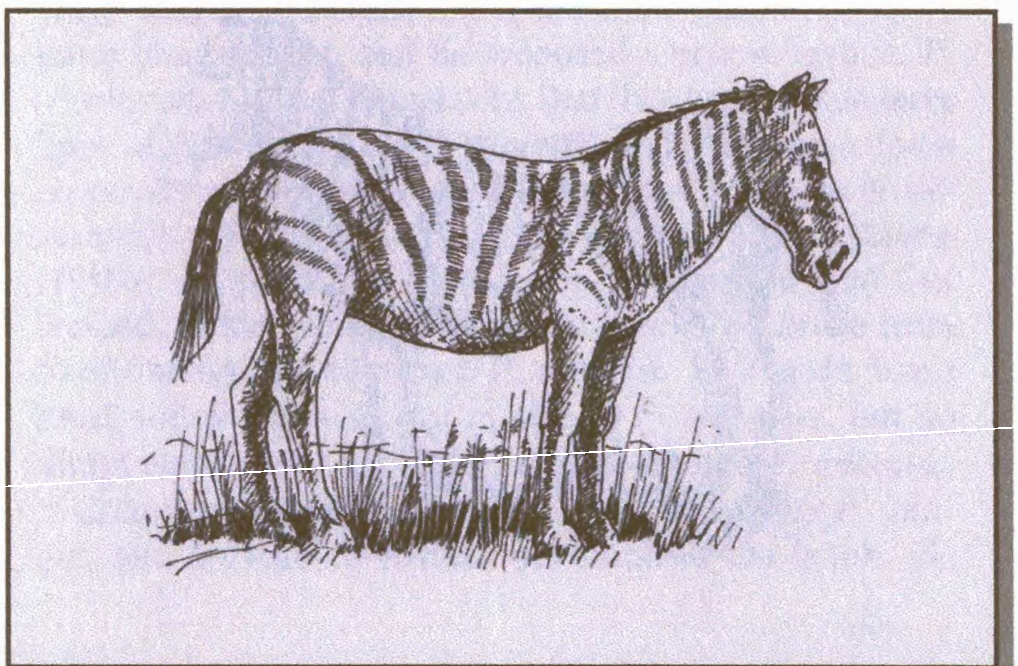


FIGURE 5.2: *Equus capensis* as illustrated in "Evolution of African mammals" [97].



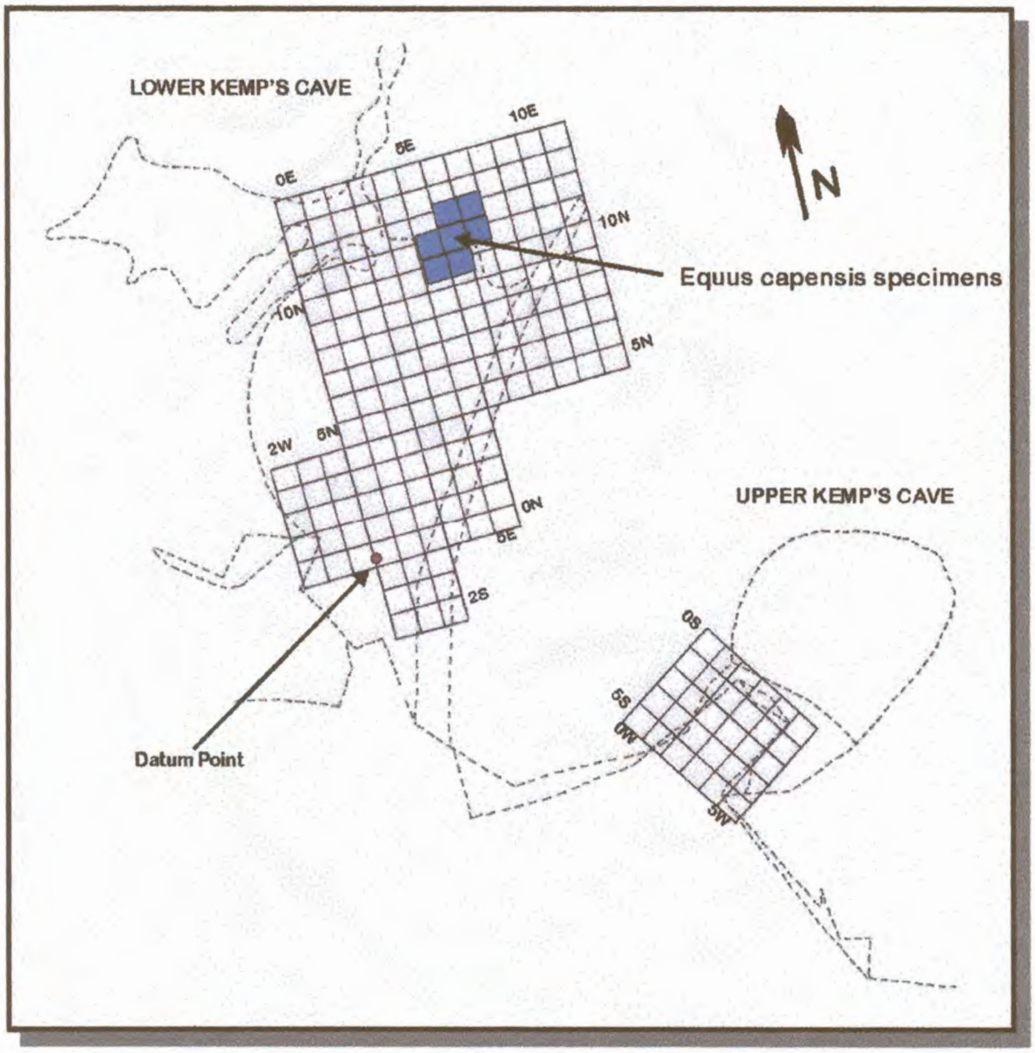
1.3 Dating

Dating of Southern African caves is very difficult due to the fact that no volcanic material are available for absolute dates [27]. Therefore it is essential that other methods of dating are done. Electron Spin Resonance has provided dates for many sites, but is nevertheless dependent on the uptake of uranium. Faunal analysis have thus been the primary means of dating for South African fossil sites [102]. The Taung *Australopithecus* was, for example, assigned to the Pliocene on the basis of the analysed fauna associated with the specimen [103]. The oldest associations are those of Sterkfontein and Makapansgat, but the most recent work has been done by Cooke [95]. Faunal analysis can be used for date confirmation if an extinct species is identified in the faunal remains. Knowledge of the approximate era the extinct animal roamed the earth, may be indicative as to the date of that particular section of the site from which the extinct animal remains originated.

Kemp's Caves produced ESR dates of 11 000 BP to 140 000 BP. All faunal specimens identified in the Kemp's Caves faunal assemblage was of modern species, except one extinct equid. *E. capensis* (Cape zebra / horse) was identified. This animal became extinct approximately 10 000 BP. This species confirms the dates of the Electron Spin Resonance results. Three of the five *E. capensis* specimens were excavated from provenances 5E6E 10N, 5E 11N and 6E7E 11N12N. Unfortunately, no provenance was associated with the other two specimens which were fragments of a left humerus. Therefore, they could not be of use to assist with confirmation of the ESR dates of Kemp's Caves. Wells describes the earlier sites as having a larger amount of extinct species that the later sites such as Florisbad which had a progressively decreasing number of extinct species [104].

Figure 5.3 illustrates the area from which *E. capensis* specimens were excavated, suggesting that this part of the cave has a date of at least 10 000 to 12 000 BP.

FIGURE 5.3: Provenance of the excavated *Equus capensis* specimens.



Other species which became extinct during the last 100 000 years are the giant buffalo (*Pelorovis*), giant hartebeest (*Megalotragus*), giant warthog (*Stylochoerus*), extinct springbuck (*Antidorcas*), three-toed horse (*Hipparion*), short-necked giraffes (*Sivatherium*), sabre-tooth cats (*Megantereon*) and giant baboon (*Theropithicus*) [37]. None of these species were identified, thus the earlier date (140 000 BP) could not be confirmed. Klein does, however, suggest that *E. capensis* may have already existed 1.8 Myr ago [105].

North American vertebrate palaeontologists established the term "Land Mammal Ages" to represent a fauna whose members existed during the same restricted geochronologic interval. Cooke states that our knowledge of the Pleistocene in Africa is not yet adequate to designate Land-Mammal "Ages" and therefore in 1965 proposed the term "Faunal span". This concept describes the duration of existence of a particular faunal assemblage. One of these proposed faunal spans is called the *Florisbad-Vlakkraal Faunal Span*. This span is characterized by an assemblage of living species enriched by surviving extinct forms. Extinct species are not found with the Later Stone Age cultures which began about 12 000 BP and are thus referred to as recent [106]. The identification of *Equus capensis* might then suggest that Kemp's Caves fall partly into the *Florisbad-Vlakkraal Faunal Span*. Hendey describes this similar time-span as the *Florisian Mammal Age*. It is characterized by fauna which was essentially similar to that of the Holocene although many of the mammals excavated showed that the extinct species were larger than their modern counterpart. These species included *E. capensis* [103].

There are, however, very modern specimens identified. With further excavations and possible identification of more extinct species the chronology of Kemp's Caves might become more clear. No faunal specimens were found to contradict the current ESR dates.

1.4 Ecology and environment

Kemp's Caves fall within veldtype 61, Bankenveld. Bankenveld is classified as a grassveld and have soils which are poor and acid. The largest percentage (53%) of species identified in the faunal sample is grazers and 27% is mixed feeders. Both these feeding types has grasses as part of their diet. Only 20% is browsers, which utilize woody vegetation (Figure 4.6). Thus the diet of the species identified correlates with this grassveld veldtype.

Bankenveld is classified as a sourveld which is characterized by plants that become less nutritious and palatable when reaching maturity, thus the plants can only be utilized for parts of the year while the plants are still young. Although some of the grasses which are characteristic of this veld type had a low palatability value, all species identified did have at least one grass or tree species which featured in their preferred diet (Table 5.1). Grass species such as *Panicum maximum* (Buffalo grass), *Cynodon dactylon* (Couch grass) and *Themda triandra* (Red Grass), which were mentioned as some of the main dietary grasses for grazers are however, not characteristic of Bankenveld. The fact that the diets of all species identified did have representation of plants presently occurring in this area, might indicate that the flora did not change much during the formation of the cave deposits. Although animals easily adapt to their environment, certain species do prefer specific plants. Table 5.1 shows which of the species identified utilizes a specific plant species which are characteristic to Bankenveld. This table was compiled from information of Van Oudtshoorn [48] and Smithers [51]. It also gives an indication of its palatability value [48].

Cooke states that during the Pleistocene there was a rise of modern species and a decline in the archaic forms. It is therefore demonstrated by the excavated fossil herbivores that the broad ecological conditions did not vary much and that the different regions during Pleistocene times maintained the same distinctive characteristics today [107]. Brink, however suggests that the feeding niche of species like *Antidorcas bondi* who relied on the "lawn mowing" type of grazing done by *Equus capensis* and *Pelorovis antiquus* suggests that the ecology of southern Africa might have been different from present due to the facilitated interaction of grazers. This also suggests that the grasslands of Southern Africa were more productive during the Late Pleistocene than at present [108]. The species that were identified in the faunal sample of Kemp's Caves in the present study were all animals that occurred here in the past or still occurs in the area. This fact may also suggest that the environment and climate have not changed much in the last 100 000 years. Kemp's Caves may still yield a large amount of fossilized material, including hominid remains, which may result in a different interpretation of the historical ecology of the area.

TABLE 5.1: Plant species utilized by identified animal species of Kemp's Caves.

PLANT SPECIES		PALATABILITY	ANIMAL SPECIES
GRASSES			
Trachypogon spicatus	Giant speargrass	Average → Low	Reedbuck
Schizachyrium sanguineum	Red autumngrass	Low → Average	Sable
Panicum natalense	Natal panicum	Low → Average	Blue Wildebeest,Springbuck
Digitaria tricholaenoides	Purple finger grass	High	Blue Wildebeest
Digitaria monodactyla	One-finger grass	Low → Average	Blue Wildebeest
Sporobolus pectinates	Fringed dropseed	Low	Black Wildebeest, Springbuck Red Hartebeest
Ctenium concinnum	Sickle grass	Low	Blesbuck
FORBS			
Variation of palatable forbs		N / A	Steenbok, Grey Rhebuck
WOODY VEGETATION			
Maytenus heterophylla	Common spike-thorn	Average	Impala
Dombeya rotundifolia	Wild pear	Average	Sable
Ziziphus mucronata	Buffalo-thorn	Average	Impala, Sable, Springbuck
Combretum molle	Velvet bushwillow	Average	Impala
Grewia occidentalis	Cross-berry	Average	Impala, Eland, Springbuck

1.5 Taphonomy and Bone accumulations

Caves are commonly used as retreats and breeding sites by several animal species, as well as by humans. Bony food remains accumulate at these sites and may fossilize in certain circumstances. These bone accumulations are useful in identifying the inhabitants of the cave and have therefore been thoroughly researched during the last century [2,3,58].

The three most common agents responsible for bone accumulations are porcupines, humans and carnivores [2,28,109]. Kemp's Caves exhibit a variety of evidence which may conclude that both humans and animals were responsible for the accumulations at this site. Findings of Kemp's Caves that relate to conclusions made in various studies of the different chief accumulating agents, are listed below to give an indication of the varied interpretations:

1.5.1 Porcupine as accumulating agent

The rodent, *Hystrix africauastralis* (Porcupine), is confirmed to be an important bone collector although this species is in fact vegetarian. Brain suggests that porcupines carry more bones to caves than any other accumulating agent [2]. During 1956 a well-known porcupine, by the name of Aristotle, was studied by the zoology department of Rhodes University to establish behaviourial patterns. Observations showed that the porcupine appeared to have no interest in meaty, fresh bones. Dry bones, however were instantly taken to its lair and gnawed. Like other rodents, the porcupine has open-rooted incisors that constantly grow and therefore require regular attrition to keep them at a functional length [2].

Hendey and Singer found that porcupine bone assemblages characteristically display high frequencies of gnawed bone and low percentages of non-identifiable fragments [110]. Carnivores and humans tend to shatter and fragment bones for nutritional value, while porcupines only utilize it as a tool. Porcupine assemblages consequently exhibit mostly non-fragmented bones which are extensively gnawed [28].

Kemp's Caves have a high percentage (88%, see Table 4.1) of non-identifiable, severely fragmented bones, of which only nine percent (see Figure 4.8) were gnawed by various species. Approximately 20 identifiable bones were documented as being modified by porcupines and a few porcupine quills were found in the faunal assemblage. Porcupines may have been responsible for a small percentage of the skeletal remains, but are definitely not considered to be a chief accumulating agent of Kemp's Caves.

1.5.2 Hyaena as accumulating agent

Hyaenas have enormous jaws which explains why they are extremely efficient at crushing bones and therefore leave only tooth row sections and the very robust parts of long bone ends in larger mammals [2,51].

The adaptation of the upper and lower third premolars in conjunction with their powerful jaw muscles establishes effective bone crushing. The anterior and posterior cusps have been reduced while the central cusps enlarged to be converted into conical hammers. The scarcity of gnawed fragments and the high incidence of severely fragmented bones in the present study thus indicate hyaena involvement [3]. Gnawed bones contributed less than nine percent of the bones in Kemp's Caves.

The faunal sample of the Kemp's caves bovids showed varied evidence of long bone fragments of larger mammals. There is, however, a significant amount of long bones where only the proximal or distal extremity survived.

Hyenas are implicated when large amounts of coprolites are present [2,3]. Coprolites can be defined as fossilized droppings. Hyaena droppings resemble those of a large dog in shape and size. It consists of mainly mineral matter derived from bones with sometimes a few hairs. The faecal masses are green but turn white upon drying in air. The coprolites of Kemp's Caves where not tested, but resemble all above descriptions. There were a large amount of coprolites in the sample of Kemp's Caves, which may signify hyaena activity at some point.

Stone artifacts are often found at sites where humans have been involved in the accumulation of an assemblage. The scarcity of stone artifacts at Kemp's Caves suggest hyaena activity [3]. This is attributed to the fact that hyenas and humans do not frequently inhabit the same living space [57]. At a site in Zimbabwe, it was found that coprolites originated in layers where human artifacts and cultural material were low. This may suggest that hyaenas occupied these sites when human residents were elsewhere [2]. Although all archaeological artifacts were removed from the sample, stone artifacts were not found in the Kemp's Caves' excavations.

☞ **Brown hyaena**

The brown hyaena (*Hyaena brunnea*) is typically smaller than the spotted hyaena and is characterized by a sloping back and banding of the front legs. Brown hyaena, similar to spotted hyaena, uses both burrows and caves as breeding and feeding lairs [2].

Research has shown that the brown hyaena tend to collect more bones to dens than Spotted hyaena [3,28]. They prey on springbok-reedbuck size antelope (Bov II), although larger antelope like Blue Wildebeest, zebra and kudu are sometimes hunted. Approximately 39.1% of the Kemp's Cave collection consist of

Bov II size ungulates (see Figure 4.1).

Female brown hyaena bring their young to the den, whereas spotted hyaena takes their young to the field from a very early age [3]. Hence the skeletal representation of the brown hyaena itself will include specimens of all age classes, and the spotted hyaena lairs would mostly be represented by adults only [2,3]. Kemp's Caves yielded several adult specimens of both spotted and brown hyaena as well as one juvenile spotted hyaena specimen (see Table 4.2). The skeletal representation of the hyaena specimens of Kemp's Caves gives therefore no clear evidence whether brown or spotted hyaena, if any, could have been accumulating bones at Kemp's Caves.

Brown hyaena accumulations have been proved to feature a large amount of other carnivores, with Black-backed jackal (*Canis mesomelas*) and bat-eared foxes (*Otocyon megalotis*) being the most numerous [2,3]. The reason is that the female brown hyaena deliberately hunts smaller carnivores as food for their cubs in the breeding dens [2]. The Kemp's Caves assemblage contained approximately 20 separate black-backed jackal skeletons of a minimum of two individuals (see Table 4.2)

The fact that Black-backed jackal specimens were relatively well represented in the assemblage might suggest that the brown hyaena may have played a role as accumulating agent.

☞ **Spotted hyaena**

William Buckland first suggested that *Crocuta crocuta* (Spotted hyaena) may have been responsible for bone accumulations after a cave in Yorkshire revealed an abundance of spotted hyaena remains as well as the skeletal fragments of prey [2]. He concluded that hyaenas are bone collectors and also prey upon each other. This study resulted in the birth of a concept known as the "bone-accumulating, cannibalistic hyaena" [2]. Robert Knox, who extensively traveled South Africa, challenged the accumulating theory of Buckland. He debated that hyaenas bring their young to the field from an early age and was of opinion that there would be no reason to carry a portion of the prey back to their lairs [2]. While Dart was attempting to explain the accumulation at Makapansgat, he undertook a study of modern hyaena lairs. After completion of this study he forcefully rejected the bone collecting theory. Despite this rejection, evidence has shown hyaenas as definite bone collectors [2].

Sutcliffe suggested that there are two kinds of spotted hyaena lairs [103]. The first is characterized by the fragmented gnawed remains of the crocuta species itself. These fragments were represented by different ages and individuals. The second type of lair has less skeletal remains of the species itself and is characterized by an abundance of prey skeletal material. He explained the two lairs as the one being the living quarters and the other the eating quarters [111]. Research by Matthews described that in deep soil habitats, hyaenas prefer burrows, but in rocky or mountainous areas they make use of recesses or caves [112].

Although spotted hyaenas are scavengers, it has been confirmed that they are also avid and effective hunters [2,51]. Hyaenas have been found to successfully hunt prey as large as adult waterbuck, eland and buffalo but mostly prey on wildebeest-zebra size (Bov III) [2,3,28]. If larger predators such as lions were prominent in the area, there would be enough food to scavenge, whereas hunting would take preference if such large predators did not occupy these areas. If it can be established whether the hyaena diet consisted of scavenged or hunted meals it can consequently suggest whether larger predators were inhabitants of the area [2]. It is uncertain whether prey was hunted or scavenged at Kemp's Caves, thus no deductions can be made about the occupancy of larger predators.

Kemp's caves definitely qualify as a breeding lair for any predator, and although deep soiled areas are found in the area, the cave is situated in a rocky habitat. This may suggest that spotted hyaena might have used the cave as a retreat. The faunal analysis of Kemp's caves included 27.9% Bov III size class bovids as well as 2.6% Equids (see Figure 4.1). These are prey and scavenger size animals for the spotted hyaena. Although some evidence may suggest hyaena to have been an accumulating agent at Kemp's Caves, it may have been for short periods when humans or leopards did not occupy the caves.

1.5.3 Leopard as accumulating agent

The species *Panthera pardus* is successful predators due to the fact that they are extremely adaptable, hence they are normally the last of the large predators to disappear under pressure form human encroachment [2]. Brain describes leopards as being secretive in which case a cave plays an important role in their behavioural patterns for retreat, breeding and feeding [2].

Mount Suswa, a dormant volcano near Nairobi, presented the best evidence for leopards' use of caves. Predatory animals normally prefer to take their food to certain definite places. In the case of Mount Suswa, the leopard preferred a very dark recess where no light could penetrate [2].

After making a kill the carcass is dragged up to 2km after which they either hide the prey by covering it with vegetation or lodging it in a tree [113]. Hyaenas tend to be the main culprit in taking prey from leopards. It is thus of great importance to immediately take the prey to an unaccessible spot [2]. Additional evidence from a farm in Namibia showed leopards dragging their prey up a rocky slope into a cave. Hyaenas are absent from this area, thus no competition denotes only a quiet spot for storage [2]. This fact may implicate that either no or few hyaenas are present at times when the leopard only stores prey in the cave and had no reason to hide prey from competition. It may therefore be suggested that a leopard would generally drag it's prey to a distinctive secretive and protected area to be fed upon. Leopards also tend to return to the carcass after the initial feeding [113].

Leopard takes a wider array of prey than does any other large carnivore [113]. This species does, however, mostly prey on Bov II and Bov III size ungulates [51]. Prey are normally eaten from the buttocks and then the shoulder area. The long bones of large leopard prey are not broken and crushed as in hyaena and lion kills [113]. If undisturbed, leopards tend to eat the body, neck and upper parts of the limbs. The head and lower leg segments are rejected [2].

Several breeding lairs have been described as caves leading into one or more tunnel structures [2]. The North-eastern tunnel in Kemp's Caves has been described by the game rangers as being the living quarters of the resident leopard.

Bov II (39.1%) and III (27.9%) dominated the bovid specimens (see Figure 4.1) in the Kemp's caves assemblage. It is also shown in Figure 4.2 to 4.4 that the head (skull and teeth) and lower leg bones, such as the metapodials, carpals, tarsals and phalanges, had the highest frequencies.

It is evident from studies that leopard skeletal remains would also be part of the faunal assemblage in caves inhabited by this species, although it is not a definite indication of their occupation. Leopards living in a cave may be represented by the remains of either mature or young leopard individuals, that succumbed to anything from illness to accidental death and injury during hunting [2]. Two leopard cranial specimens and one leopard-sized 4th metatarsal were identified in the Kemp's Caves assemblage. Further excavations may yield more of these skeletal elements.

During excavations from 1992, a leopard have definitely resided at this site. With above mentioned evidence from the assemblage it is presumed that leopard was largely responsible for the bone accumulations at Kemp's Caves.

1.5.4 Humans as accumulating agent

Approximately 11% of the bones recovered from Kemp's Caves were severely burnt. The fact that veld fires only scorch the bone and does not enter the bone cavity may suggest human activity, because of their habit of cooking meat. The burnt specimens can, however, be modern, which might indicate that humans occupied Kemp's Caves only recently.

Klein suggests that carnivore and human accumulations can be separated by analyzing the carnivore : ungulate ratio. This is because carnivores more frequently feed upon other carnivores than man does. Thus the higher the ratio between carnivore and ungulate the better the chances that carnivores were responsible for the accumulation [114]. Kemp's Caves show relatively few carnivore specimens which indicates a low carnivore (7.7%) : ungulate (86.8%) ratio (see Figure 4.1). This may also signify human involvement.

Hyaenas do not generally form an association with humans, but it is possible that the carcasses have been scavenged from a settlement [2]. It can therefore be suggested that the evidence which points towards the absence of hyaenas during most of the caves' history, might implicate human presence. However, no stone tools have been found, therefore Kemp's Caves have no concrete evidence to implicate human involvement.

Avery describes the Elandsfontein kill/butchery site (C10) as having a low density of artifacts, with or without a high number of formal tools. It is also recognized by sparse scatter of bones and limited evidence of carnivore activity [115]. Kemp's caves has a low density of artifacts and almost no tools, but there are a number of facts that suggest carnivore activity. This may also be an indication of the absence of human activity.

1.5.5. Conclusion

Brain states that the process of bone accumulation depends greatly on the form of the cave itself, but that any cave that have been open for thousands of years is likely to have had bones brought in by a variety of ways [109]. Considering all the facts and evidence it is therefore suggested that all three agents (hyaena, leopard and human) were responsible for the accumulation of the faunal remains at either the same time, or different periods in the cave's history. Humans may, however, only have occupied Kemp's Caves during recent years.

The Sehonghong faunal assemblage is dominated by fish which suggest that either human or animal could have been involved in the accumulation of this site's excavated faunal specimens.

Regarding the taphonomy of the Klasies River Mouth site, Binford suggested that there was no concrete evidence for hyaena activity and leopard involvement is undetermined [24]. Klasies River Mouth also proved to have been inhabited by porcupines, but they did not substantially modify the character of the faunal assemblage [24]. These results on bone accumulation coincide with the preliminary results of Kemp's Caves.

Although there were other accumulating agents at work at Border Cave, it is clear that humans played a major role in this assemblage. The cave is only accessible from a narrow ledge which may have been for defence and security for these hominids.

1.6 Difficulties experienced in Stage 1

Several problems were encountered during the faunal analysis of Kemps' Caves. The consistency and accuracy of bone removal and excavation methods may have been compromised with the staff and students of two different Universities contributing to the faunal sample. Methods of screening and sorting may have been different and some important fragments may have been sorted as unimportant and discarded. Thus the archaeological activities resulted into the selective recovery or non-recovery of bones. Information regarding specimens, such as provenance, were sometimes inaccurate or missing. Some of the fragments excavated may also have been lost with the moving of specimens from the one university to the other.

Bone preservation can be influenced by several agents such as environmental factors and human activity factors. Processes that involve the movement and destruction of bone before they are finally formed into a deposit, may also give a distorted view of what really expired during the caves' history and development.

This faunal sample is only a fraction of the fossils that may still be excavated at Kemp's Caves. The deductions based on this sample may not be as accurate as the whole representative sample that maystill be excavated.

The faunal sample of Kemp's Caves was relatively small in relation to sites such as Sterkfontein and Makapansgat. With only a limited amount of specimens being identifiable as well as the fact that a large number of specimens were without a provenance, it was difficult to ascertain differences in older and younger deposits.

Excavations are still ongoing at Kemp's Caves and the Northern extension specifically has not been ESR dated. Almost half of the specimens analyzed came from this extension which may contain more modern material. An abundance of fossilized breccia in the roof, floor and walls also still need to be removed and dated.

The area surrounding the Kemp's Caves site has been part of the Ngonyama Game Reserve for the past 40 years. Species that do not occur here naturally may have been introduced by the Game Reserve. An example is *Antidorcas marsupialis* (Springbok). The distribution of this species does not normally include the Kemp's Caves area. All Springbok specimens were fairly modern and may indeed have been the result of the introduction of this species to the Game Reserve.

2. STAGE 2 - OSTEOMETRY

Stage 2 entailed the acquiring of measurements for possible osteometric identification of bones. This included the collecting of data as well as the development of a computer programme using these measurements for identification purposes. The measurement data were statistically analyzed to ascertain whether osteometric identification of bones may be viable.

2.1 Measurements

Approximately 18 000 measurements were taken of 30 Southern African bovid species. Forty-five measurements represented the three hind limb long bones which included the femur, tibia and metatarsal. The data was obtained from the skeletal collections of the National Flagship Institution (Pretoria), National Museum

(Bloemfontein) and the South African Museum (Cape Town). Although most measurements were pre-defined, a few were developed by the author. Almost all the pre-defined measurements were easily measured, while some of the new measurements were more difficult to acquire on all species. These measurements include the T(GDTN), F(SBCF) and F(GBCF) and will be discussed below.

Student's t-tests were done to establish whether a specific species would differ from the species within the same Bovid size class. This was done for every measurement on all three long bones. The result was values representing the average of the specific species, in comparison to the average of all the species within the same Bovid size class. Tsessebe showed no significant differences with any of the measurements, but this may be due to the fact that there was only one specimen available for measurement.

2.1.1 Femur

The femur measurements showed a high percentage of values which significantly differed within the size classes (see Figure 4.9). No femoral measurements showed significant differences within the Bovid I size class. This may be the result of the relatively small sample sizes of the different Bov I species. Due to the limited number of measurements available for the statistical testing, the mean may be less accurate for the specific measurement. Additional skeletal collections of other institutions worldwide, may yield a larger sample size and may clarify this issue.

The Bov II, III and IV size classes showed little significant differences in the Femur (Smallest Breadth Condylar Fossa) and Femur (Greatest Breadth Condylar Fossa) measurements. These measurements indicated the size of the condylar fossa of the femur. It was, however, difficult to obtain these dimensions and they did not show any particular pattern during data collection. It could not be established where the greatest or smallest measurements of the condylar fossa would be on each individual specimen. Every individual specimen within the same species showed a variance. Although these measurements were used in this study, it might be of less significant value in osteometric differentiation in future studies.

The Bov II class showed no significant differences in the Femur (Smallest Breadth Diaphyses) measurement. Thus the smallest breadth of the diaphyses of these species did not differ significantly to distinguish between them. The F(SBD) was, however, significantly different within the Bov III and IV size classes.

2.1.2 Tibia

None of the tibial measurements of the Bov I size class showed significant differences (see Figure 4.10). This correlates with the femoral measurements and may be due to the same reasons as discussed above. The smallest breadth of the tibial shaft also showed no significant differences between the species of the Bov II size class, while this measurement was notably significant with the Bov III and IV size classes. The Tibia (Greatest Depth Tibial tuberosity from Notch) measurement was developed during the course of this study to ascertain the depth of the tibial tuberosity which might have shown significant differences by reflecting the strength of the muscle attaching to this tuberosity. The T(GDTN) measurement appeared to have no significant differences within the species of Bovid size class I, II and IV. The T(GDTN) was, however, a predicting measurement in the regression analysis and did proved to be of significant value in the Bov III size class. Further analysis of this measurement may shed more light on its effectiveness in osteometric identification. Gemsbuck, Sable and Blue Wildebeest showed no differences in any of the length measurements of the tibia, which might have implications in the computer programme when only these measurements are available on a specimen of either of these species.

2.1.3 Metatarsal

The measurements of the metatarsal showed significant differences in almost all Bovid size classes (see Figure 4.11). Bov I size class showed significant differences in only some of the metatarsal measurements. No significant differences can be seen in any of the greatest lengths, the superior articulating facets or the Metatarsal (Greatest Breadth Distal Extremity). A larger sample size may adjust these results, but presently the metatarsal is the only bone in this study which may be indicative of the different species in Bov I. The Metatarsal (Smallest Breadth Diaphyses) showed significant differences within the Bov II class, in comparison with the femur and tibia diaphyses which showed no significant differences in their breadth measurements. Thus the metatarsal is the only hind limb long bone that will differ sufficiently to distinguish between the Bov II species with regards to the diaphyseal breadth. Further research may shed light on this interesting result. The Metatarsal (Greatest Medial Length) showed very little difference between the species in the Bov III group. Black Wildebeest and Gemsbuck particularly showed little significant differences in the metatarsal measurements. Further studies may shed light on this aspect. Again, the fact that there was only one Tsessebe specimen available for measuring may account for the fact that there were no significant different metatarsal values observed for this species.

2.1.4 Regression analysis

A regression analysis was done to establish measurements with a high probability of being good predictors of the three hind limb long bones (see Table 4.9). As deducted from the t-tests, it can be seen that there are only one femoral and three tibial measurements which are predictors for the Bov I size class. This size class is best identified by measurements of the metatarsal. Bov II, III and IV size classes showed that almost every measurement taken on the femur, tibia and metatarsal could be used for osteometric identification. Most of the measurements developed by the author showed a high probability to be predictive in osteometric identification.

2.1.5 Index calculation and analysis

Three indices were calculated for respectively the femur, tibia and metatarsal. In Figures 4.12 to 4.14, it can be seen that there is a large area of overlap between most of the species on all three bones. The indices are indicative of the robusticity of the specific bone. There are, however, a few species which could be identified purely on their index values if the Bovid size class were known. In Bov III the metatarsal index will clearly identify Waterbuck as it had the highest robusticity value. Sitatunga had the smallest robusticity values of the femur and tibia, with very little overlap (especially on the tibia), if at all. These two indices are therefore very important indicators for this species. The Buffalo showed the most robust bones of all the species. In all three indices it showed almost no overlap, not even with the Eland. These robusticity values can therefore be an important element in the identification of Buffalo remains.

With further studies and a larger specimen database specific values might prove to be important in identifying the different Bovid size classes.

2.2 Development of programme

The programme was developed for the '97 version of Lotus Smartsuite. Three probability values were calculated by the programme on information supplied by the supporting database of measurements. Measurements on 30 bovid species yielded a vast amount of information which were used to metrically distinguish between bovid species. These calculations included the Identification Percentage Probability (IPP), Fractional Percentage Probability (FPP) and Element Percentage Probability (EPP). The programme reacts when only one measurement is entered, but is accuracy increases as more measurements are entered. The EPP may give a misleading probability value when only a few measurements are entered by the user, while the IPP is a weighted value which take into account how many measurements have been entered.

A "MORE INFO" option is available which may assist with further identification of a specimen. The distribution map, for example, can be used to distinguish between similar size species, with different distributions in the Southern African region. Blesbok and Bontebok, for example, are skeletally very similar, but have diverse natural distributions in the Southern African region. The habitat and diet of these species are of importance in the process of faunal analysis.

It was decided to use the median value, rather than the mean, in the computerized database to counteract the extreme measurement values that some of the individual specimens exhibited. A larger sample size of measurement values will better represent the average measurement and the mean value may therefore be more accurate in future studies.

Presently Lotus Smartsuite is still necessary to run this programme. Further development may yield an independent computer programme for the identification of bones.

Even though this is a pilot programme in conceptual phase, there are infinitely more possibilities and applications through programmatic refinements and restructuring such as the use of only the measurements which showed significant differences. However, a larger specimen database is necessary for more accurate osteometric identification. Complex mathematical techniques to analyse metrical data is commonly used with human material, but seldom with faunal remains [81,82,83].

2.3 Difficulties experienced in Stage 2

All measurements frequently used in faunal analysis [72,92,93], (defined by several authors) as well as measurements considered to demonstrate species differences, were obtained from the femur, tibia and metatarsal. This was only a pilot study and it was therefore decided that approximately 15 measurements on a single skeletal element will be sufficient to test the viability of osteometric identification of bones. The femur, tibia and metatarsal were respectively represented by 14, 15 and 16 separate measurements. There may, however, be additional measurements which were not collected in this study which can be vital for inter species differentiation. Further investigation may yield extra measurements which may prove to be more significant. Measurements used in this study may also prove to be insignificant in species differentiation.

Although 34 Southern African bovid species were identified for this study, there were four species which were not represented by any of the skeletal collections. These species included Dik-Dik (*Madoqua kirkii*), Sharp's Grysbuck (*Raphicerus sharpei*), Puku (*Kobus vardonii*) and Lichtensteins Hartebeest

(*Sigmoceros lichtensteinii*). Skeletal fragments that belong to any of these species will therefore not be represented in the measurement database.

The small sample size of certain species did not clearly represent the morphological characteristics of that species. Extreme cases included Tsessebe (one specimen), Suni and Sitatunga (two specimens each) as well as Roan and Klipspringer (three specimens each). The small sample sizes also necessitated that the male and female specimens had to be pooled for statistical analysis. This might have affected the testing of the programme in Stage 3.

Reproducibility of the measurements, for example the T(GDT), may hinder accuracy. The T(GDT) gives an indication of the size of the tibial tuberosity. Sometimes it may be difficult to allocate certain points where the measurement needs to be taken from. These measurements did prove to be significantly different, and was listed as predictors of the tibial measurements, but may depend on the experience of the analyst. Additional statistical analysis may give a better indication as to which measurements are true predictors. With this information the user would know which measurements will be of greater value for accuracy.

Lotus Smartsuite may prove to have limited use in further studies. Further development may provide an independent computer programme, which will be written specifically according to specifications obtained from this study. Presently it is essential that the user have access to Lotus Smartsuite to utilize the Osteo-ID CD.

3. STAGE 3 - TESTING

Stage 3 comprised of the testing of the computer programme developed in Stage 2. Ten Kemp's Caves specimens, which were conventionally analyzed by comparing the fragment to its modern skeletal part, as well as ten modern skeletal elements not used in the database, were utilized to test the accuracy and viability of the developed programme.

3.1 Results

Only 20% of the Kemp's Cave specimens were correctly identified (see Figures 4.17 to 4.26). Nine of the ten had the conventionally identified species on the chart (in other words indicating it as a possibility) while one specimen, LKC/93/23 (Impala tibia), did not show it at all. This specimen was, however, an unfused distal extremity of the tibia which indicated that it belonged to a juvenile or sub-adult individual. No juvenile or sub-adult individuals were measured for the development of the programme, which explains the absence of the species on the identification chart.

The Kemp's Caves specimens were identified by the author by means of conventional analysis and by an independent expert, but the identifications may still have been inaccurate. The small sample sizes of some of the database species may also have influenced the results. Because only a few measurements were available on these fragmented specimens, it may also indicate that some measurements may not be sufficient for osteometric identification. The IPP and EPP values differed significantly with these test specimens because of the small quantity of measurement available on each fragment.

The modern collection specimens (3 femur, 3 tibia and 4 metatarsal) were that of known species and were complete. All measurements could be obtained from these bones, thus the EPP and IPP values were equivalent. Only 30% of the specimens showed the correct species as having the highest FPP value when all measurements were entered (see Figures 4.27a to 4.36a). All the other identification charts included the correct species, but it had the second or third highest FPP value. The IPP values of all these species, however, were always high, thus indicating a good identification, although it did not have the highest FPP. This could be due to the fact that in a lot of cases a large number of species had measurements which fell within the median value, which in turn affected the FPP values. The results changed, however, when only certain measurements were entered into the developed programme (see Figures 4.27b to 4.36b). The results increased to a 60% accuracy rate when only proximal measurements were entered and a 40% rate when only the shaft measurements were entered (see Table 4.20). This suggests that the proximal measurements of all three long bones may prove to be more important in osteometric identification of animal bones. Further research may shed light on this result. Although the metatarsal measurements showed significant differences in all the Bov size classes, the accuracy rate dropped to 0% (all measurements entered, and only distal measurements entered) with the metatarsal test specimens. This 0% indicated that it was not identified as the most probable species, but it was, nevertheless, listed as one of the species on the identification chart. It did, however, increase to a 50% accuracy rate with only shaft or proximal measurements.

Even though these results seem unsatisfactory, it should be kept in mind that this was only a pilot study. A variety of external factors may have influenced the data collection and programme development. This include the small sample sizes of the database specimens. The database sample size also decreased due to the fact that the male and female specimens had to be combined. This fact may therefore give a false reflection, if the majority of a sample was either sex. In order for a positive identification to be obtained, the entered value should fall within a range which is presently a fluctuation of 10% either side of the median. If the database sample size increases, the current range of 10% may be dropped to 5% or less, which may result in higher FPP values, because fewer species will fall within the median range.

It is therefore the opinion of the author that with further research into the correct measurement collection, and a larger database, computerized osteometric identification of bones will definitely prove to be of value for faunal analysis.

3.2 Difficulties experienced in Stage 3

The few measurements available from the test material of the Kemp's Caves and modern collection specimens could have given a distorted or misleading accuracy rate. More specimens in further research may adjust the accuracy rate. Another excavation site with a larger sample of test specimens could also prove to be more informative.

Although indices were calculated for the three long bones, it was not incorporated in the database, and did therefore not have an influence on the identifications of the species. Although there were overlap of most species, there were certain species which could have been positively influenced by the index value. Further development of the programme should include index values.

6 CONCLUSION

I. STAGE I - FAUNAL ANALYSIS

→ The 34 macro-mammalian species that were identified in the faunal sample, show correlations with that of other sites with similar dates such as Rose Cottage Cave, Klasies River Mouth and Border Cave. Although Kemp's Caves have not yet produced any hominid remains (except modern human material), it may still yield important specimens which might shed light on the evolution of Anatomically Modern Humans.

→ One extinct species, *Equus capensis*, was identified. This species became extinct between 10 000 BP and 12 000 BP, which corresponds with the youngest ESR date of Kemp's Caves.

→ The faunal analysis did not contradict the earlier ESR dates, but ongoing excavations and analysis might assist in further date confirmations.

→ All species identified (except *E. capensis*) either occurred here in the past or still occurs in the Kemp's Caves area. This suggests that the environment did not change drastically over the last 100 000 years.

→ The faunal analysis suggests that porcupine, hyaena, leopard and man may have been responsible for the bone assemblage and accumulations at different stages of the cave's development. The most likely was a combination between hyaena and leopard.

2. STAGE 2 - MEASUREMENTS

→ A total of 18 000 measurements were taken from 30 South African bovid species represented by the modern skeletal collections of three South African museums. A total of 14, 15 and 16 measurements were respectively taken on the femur, tibia and metatarsal.

→ Most measurements taken on the three long bones showed varied significant differences within the Bov II, III and IV size classes. Bov I, however, only showed significant differences in the metatarsal measurement values. Index values showed to be significant in identification for specific species within a Bovid size class.

→ The developed programme calculated three different percentage probabilities to assist in the osteometric identification of bones.

3. STAGE 3 - TESTING

→ An accuracy rate of 20% was obtained for Kemp's Caves specimens. These specimens were, however, exceedingly fragmented and only a few measurements were available on each specimen.

→ An accuracy rate of 30% was the result of the modern collection test specimens. This rate, however, increased to 60% with only proximal measurements entered and to 40% with only shaft measurement entered.

→ The use of the computer programme was, however, only a pilot study and further research on a larger sample for the database, more significant measurements, better statistical analysis and further refinements and restructuring of the programme may yield better results.