- Chapter 1-

General introduction

1.1 The honey badger, or ratel, *Mellivora capensis* (Schreber 1776): an overview

The honey badger has not been well studied and there is little information on all aspects of its behaviour, particularly its social organization and breeding biology. Yet the honey badger has a formidable reputation and has attracted superlatives in the popular press as "the meanest animal in the world" (Ruark, 1965), "pound for pound, the most powerful creature in Africa" (Estes, 1991) and the "bravest animal on earth" (Guinness Book of Records, 1999). Contradictory and frequently misleading accounts of the honey badger are common, both within the popular press and contemporary "field guides". An overview of the current state of knowledge of the honey badger is therefore presented here to put this study into perspective.

1.1.1 Phylogenetic relations

Originally described by Schreber as *Viverra capensis*, the generic name *Mellivora* was coined by Gottlieb Storr in 1780, the name being based on the Latin *mel* for honey and *voro,* to devour. Early common names were the honey ratel, honey weasel and in India, the honey bear (Wood, 1876).

The honey badger belongs to the family Mustelidae, which is diagnosed as a monophyletic group on the basis of the loss of the carnassial notch on the upper second molar, as well as enlarged scent glands (Wozencraft, 1989; Dragoo & Honeycutt, 1997). The mustelids have, however, been a difficult group to classify and Dragoo & Honeycutt (1997) suggest that the group is in need of systematic revision, particularly since recent molecular studies of the relationships of carnivores based on DNA hybridisation suggest that the family is polyphyletic (Bininda-Edmonds *et al.*, 1999).

Four to seven subfamilies are currently recognised (Wozencraft, 1989; Dragoo & Honeycutt, 1997; Macdonald & King, 2000). Initially, the honey badger was assigned to the sub-family Melinae because of its superficial resemblance to the true badgers (Rosevear, 1974), but in 1902, it was transferred to the Mustelinae on the basis of skull morphology and teeth. In 1912 its kinship with the wolverine *Gulo gulo* was suggested (Johnstone-Scott, 1981; Harrison & Bates, 1991). Its present position is in its own sub-family Mellivorinae, which contains a single living genus of which it is the only extant species (Wozencraft, 1989). McKenna & Bell (1997) list the genus from the Late Miocene of Europe, the Early Pliocene to Recent of Africa, and the Pliocene and Recent of Asia. Its remarkable similarities to other badgers in form suggest parallel evolution resulting from a comparable way of life (Neal & Cheeseman, 1996). Details of the early classification of honey badgers are provided by Rosevear (1974). The honey badger is one of only five mustelid species known to occur in Southern Africa, and none of these species have been well studied in the wild (Stuart, 1990).

The question of sub species has not yet been resolved. Baryshnikov (1988, 2000) recognizes two groups of subspecies; "*capensis*", which includes all the African subspecies, *M.c. wilsonii* and *M.c. pumilio* from Asia, and "*indica*" which comprises the other Asiatic forms. The African and Indian subspecies groups are distinguished on the basis of mantle colour (the presence of a whiter, border colour in the African subspecies) and skull morphometrics (the correlation of palatal length and condylobasal length; Baryshnikov, 2000). There are suggestions of up to 15 subspecies, with ten subspecies described from Africa alone, based primarily on size and pelage, mainly mantle variation (Rosevear, 1974; Baryshnikov, 2000). Since most type specimens appear to represent individual variants in a polymorphic species, and the white mantle darkens with age (Shortridge, 1934; Rosevear, 1974; pers. obs.), many of these subspecies are of doubtful validity. Genetic analysis is currently in progress (C. Matthee, Stellenbosch University, pers. comm.).

1.1.2. Geographical range and conservation status

The honey badger has an extensive range which extends through most of sub-Saharan Africa from the Cape of Good Hope, South Africa, to southern Morocco and south western Algeria, and outside of Africa through Arabia, Iran and western Asia to Turkmenistan and the Indian peninsula (Skinner & Smithers, 1990; Harrison & Bates, 1991; F. Cuzin, pers. comm.). Historically it is thought to be absent from the driest centre of the Sahara desert, the Mediterranean coast as far as the Nile Valley, and the Free State Province of South Africa (Lynch, 1983; Kingdon, 1989; Skinner & Smithers, 1990; Begg, 2001a). The distribution of the honey badger from southern Africa to India as a single species is exceptional almost rivalling that of the leopard (Rosevear, 1974). It lives in a wide variety of habitats from the dense rain forests of Zaire to the arid deserts on the outskirts of the Sahara and pro-Namib, from sea level to the afro-alpine steppes in the Bale Mountains of Ethiopia (> 4000 m; Sillero-Zubiri, 1996).

Its status in most parts of its extensive range (particularly West and Central Africa) remains uncertain, but there is little doubt that the honey badger is now absent from many areas where it previously occurred e.g. parts of Morocco (F. Cuzin pers. comm.) and parts of Israel (Ben-David, 1990), and populations may be becoming increasingly fragmented throughout its range (Smithers, 1983; Comrie -Grieg, 1985; Cuzin, 1996). Certainly in South Africa, the honey badger is now thought to be absent from large portions of the North West, Gauteng, Mpumalanga, southern Kwazulu Natal and areas of the Northern and Eastern Cape provinces (Coetzee, 1977; Pringle, 1977; Rautenbach, 1982; Smithers, 1986; Skinner & Smithers, 1990; Rowe-Rowe, 1992; Begg, 2001a).

Apart from man, the honey badger is considered the most destructive mammalian predator of honeybees in Africa and conflict between beekeepers and the honey badger has been recorded

throughout their range (Hepburn & Radloff, 1998; Begg, 2001a). Outside of protected areas the honey badger is also actively persecuted by small livestock farmers (Kingdon, 1989; Begg, 2001b; F. Cuzin, pers. comm.), they are killed for traditional medicine (Cunningham & Zondi, 1991) and their pelts appear for sale in traditional markets in South Africa, Swaziland and Zimbabwe (Monadjem, 1998; Mellet pers. comm.; pers. obs.). They are also frequently inadvertently killed by the non-selective use of poisons and gin traps that are used to kill other problem animals of a similar size i.e. caracal *Felis caracal* and black-backed jackal *Canis mesomelas* (F. Cuzin, pers.comm.; Stuart, 1990; Begg, 2001b).

While the honey badger is not listed on the international red data list (IUCN, 1999), it appears on Appendix III of CITES (Ghana & Botswana; Rowe-Rowe, 1992) and is variously protected in specific countries. In South Africa the honey badger is listed as vulnerable in the South Africa Red Data Book (i.e. the species may become endangered if the causal factors for its decline continue; Smithers, 1986), and in the Cape Provinces, it is a schedule 2 protected wild animal (Anon, 1974), which means that a permit is required to kill or move any individual. It is essentially unprotected outside of game reserves and national parks in other provinces (Rowe-Rowe, 1992). The honey badger is legally protected in Israel (Anon, 1986) and Morocco (including the western Sahara) where it is considered "Near Threatened" due to the non-selective use of poison and traps (Cuzin, 1996). It is also considered endangered in Niger and rare in Saudi Arabia, but its status in other countries is unknown.

1.1.3 Fact & Fiction

The early records of the honey badger mention its predilection for honey and honeybee larvae (Anon, 1791; Wood, 1876; Lydekker & Sclater, 1894; Bryden, 1900). One contentious but often repeated tale, is that the honey badger fumigates the bee hive with secretions from its anal glands causing the bees to become moribund, thus allowing it to extract the brood and

honey without being stung (Kingdon, 1989; Estes, 1991; Attenborough, 1998). Kigatiira (1984a; 1984b), in his thesis on the ecology of the honeybee writes that honey badgers "are highly ingenious animals, and can empty a hive at night by repeatedly holding their tail in front of the hive entrance. The bees are disturbed when this happens and attach themselves to its tail, whereupon the badger transports them some distance from the hive, and returns to carry off the unguarded honey and combs". There are however, reports of honey badgers being stung to death by honeybees, particularly when caught in apiary traps (Kingdon, 1989; Begg, 2001a).

In 1785, the Swedish naturalist, Sparrman (1786; in Friedmann, 1954) recorded native accounts of the greater honey guide *Indicator indicator* not only leading men, but also the honey badger, to beehives. This association was referred to in the early descriptions of the honey badger (Anon, 1791; Bryden, 1900; Lydekker, 1917) and has become firmly entrenched in popular texts on ornithology and natural history as an example of coevolved mutualism between birds and mammals (Estes, 1991; Attenborough, 1998). The association has recently been disputed as a myth by some ornithologists, primarily due to a lack of scientific evidence (Dean, 1985; Dean & Macdonald, 1981; Dean *et al.*, 1990; Macdonald, 1994). Yet other foraging associations between the honey badger and the pale chanting goshawk and the black-backed jackal have been widely reported (Cooper, 1974; Lombard, 1989; Mills *et al.*, 1984; Nelson & Nelson, 1987; Paxton, 1988; Borello & Borello, 1986), although the exact nature of this association remains unclear.

Some of the early descriptions commented on the honey badger's loose skin, aggression, and tenacity (Wood, 1876; Bryden, 1900; Pocock, 1920; Skaife, 1920). It has gained an undesirable reputation as a "gravedigger" in India and among the Bedouin tribes due to the belief that it digs up newly interred corpses (Wood, 1876; Blanford, 1891; Lydekker &

Sclater, 1894). In 1935 there was an intense unresolved debate of letters in the Journal of the Bombay Natural History Society about whether this reputation was deserved, as there were few verifiable accounts of exhumation (Champion, 1935, 1936; Clifford-Hurst, 1935; Dunbar & Brander, 1936; Toogood, 1936). Today, the honey badger is still regularly seen in some Muslim cemeteries in India where the dead are simply wrapped in a shroud and buried in shallow graves (M. Jones, pers. comm.). It remains to be verified whether they are actually digging up corpses or are simply eating the beetle larvae that are common in these gravesites (M. Jones, pers. comm.).

In 1947 Stevenson- Hamilton added to the increasingly formidable reputation of the honey badger by reporting that it regularly killed ungulates (buffalo *Syncerus caffer*, waterbuck *Kobus ellipsiprymnus* and wildebeest *Connochaetes taurinus*) by castration and the resulting fatal haemorrhage (Stevenson-Hamilton, 1947). By the 1960's this had become a common feature of species accounts, and the naturalist, George Sweeney (1969 in Johnstone-Scott, 1981) took it a step further by recounting the story of four tribesmen who encountered a honey badger which "hamstrung one of the men, clawed another and castrated him with one clean bite". Some species accounts were then extended to include warnings that "it will attack a human adversary in the same way, swarming up the legs and, it is said, very often attempting to attack the genital organs" (Astley Maberley, 1963; pp 227). Although frequently recounted, no recent (post 1950) or first hand accounts of honey badgers castrating animals (or man) are available, strongly suggesting that this is a myth.

Pocock (1920) and Rosevear (1974) provided detailed descriptions of the external and skeletal structure of the honey badger. The bold, black and white pattern is thought to be aposematic colouring which, with the release of a potent smell from the anal scent glands provides a warning to potential predators (Pocock, 1920; Kingdon, 1989; Ortolani & Caro, 1989). Yet

while they are commonly reported to have no enemies aside from man (Smithers, 1983; Estes, 1991), there are reliable published accounts of honey badgers being killed by large mammalian carnivores (Turnbull-Kemp, 1967; Bailey, 1993; Pienaar, 1964). Eaton (1976) suggested that the these defensive attributes and the warning colouration have resulted in Batesian mimicry by infant cheetah *Acinonyx jubatus* of adult honey badgers. The long, white hair sported by cheetah cubs on their backs might mimic the appearance of honey badger adults from above and thus protect the cheetah cubs from predation, especially by raptors. This is difficult to prove, but certainly no records of large adult raptors predating a honey badger could be found, although Erwee (1988) observed an immature martial eagle *Polemaetus bellicosus* harassing a digging honey badger for 30 min before flying off.

Information from field guides and anecdotal accounts (Kingdon, 1989; Harrison & Bates, 1991; Dragesco-Joffe, 1993; F. Cuzin, *in litt* 2001) as well as stomach analysis (Stuart, 1981; Skinner & Smithers, 1990) suggest that the honey badger is a generalist, opportunistic predator taking a wide range of prey with strong regional differences in diet. Attenborough (1998) suggests that at certain times of the year the honey badger lives on little other than honey and bee grubs, while Hancox (1992) suggested that in central Africa honey badger births coincide with the maximum availability of honey. Yet honey brood only represented 14 % of the food items in the stomachs of seven badgers from Zimbabwe and Botswana (Smithers, 1983).

There have only been two previous field studies of the honey badger (Kruuk & Mills, 1983; Begg, 1995) and both were of short duration. A six-week study by Kruuk & Mills (1983) in the southern Kalahari provided preliminary information on the diet and foraging behaviour of individual honey badgers from faecal analysis and spoor tracking. They suggested that the honey badger might show sexual differences in the foraging strategy with males long distance

foragers taking large prey and females short distance foragers eating smaller prey items. In a recent preliminary study in Mana Pools National Park, Zimbabwe, Begg (1995) observed groups of up to five individuals interacting, suggesting that the honey badger may be more social than previously suspected.

Detailed accounts of tame honey badgers (Sikes, 1964; Black, 1988) provided information on cub development and the first indications that scent marking was an important form of communication in the honey badger. While some sources suggest that honey badgers form monogamous pairs (Estes, 1991; Mendelssohn & Yom-Tov, 1999), it has also been suggested that they are polygynous in common with most other mustelids (Kingdon, 1989).

Little is known of the honey badger's reproductive biology or social organization and available data is again contradictory. Both Howletts Zoo, Bristol, England (Johnstone–Scott, 1975) and Tel Aviv University Zoo, Israel (Medelssohn & Yom Tov, 1999) have had some success at breeding honey badgers in captivity. At Howletts Zoo unusually long gestations of 153 and 162 days were recorded and Hancox (1993) suggested that the honey badger shows delayed implantation in common with several other temperate mustelids, including the similarly sized European badger *Meles meles* (Kruuk, 1989) and the American badger *Taxidea taxus* (Neal & Cheeseman, 1996). Yet in Tel Aviv University Zoo gestations of only 62 - 72 days were recorded, and there appeared to be no delayed implantation. To add to the confusion, the honey badger is commonly reported to have 1 - 4 young (Estes, 1991; Hancox, 1993; Neal & Cheeseman, 1996; Johnson *et al.*, 2000), yet in captivity, litter size was generally one with rare cases of two cubs (Johnstone-Scott, 1975; Medelssohn & Yom-Tov, 1999).

1.2 This study

1.2.1. Rationale

The lack of even fundamental biological information on the honey badger was the primary motivating factor behind the study, and in the light of its conservation status an in-depth study was considered both overdue and necessary.

Basic research on the mating system and social organization of a population relates directly to the conservation of a species (Kondeur & Deerenberg, 1997; Parker & Waite, 1997; Macdonald & King, 2000), and this in turn requires an understanding of its feeding ecology and diet (Macdonald, 1983; Kruuk, 1995). There is also little doubt that the formidable reputation of the honey badger has to some extent exacerbated its persecution as it is considered highly aggressive and dangerous to both livestock and man, and reliable information was needed to separate the fact from the myth.

On a more theoretical basis, suggestions of intersexual differences in foraging behaviour (Kruuk & Mills, 1983), social interactions in a presumed solitary species (Begg, 1995), possible delayed implantation in a tropical species (Hancox, 1993), and foraging associations with the pale chanting-goshawk and the black-backed jackal (Dean & Macdonald, 1981), all suggested that the honey badger deserved further study. Its position as the only species, within its own genus and subfamily and the uncertainty of its relationship to other mustelids invited comparisons with other large mustelids i.e. otters, other badgers and the wolverine.

The southern Kalahari was chosen as a study site since a preliminary six-week study of the food habits of honey badgers by Kruuk & Mills (1983) had already been successfully accomplished in this protected area. In addition, the sandy substrate and available skills of

Khomani-San trackers in the area provided a means of finding honey badgers and of obtaining indirect information through interpretation of tracks (Mills, 1990; Stander *et al.*, 1997). The open landscape also made it potentially possible to obtain visual observations of habituated individuals from a vehicle, even at night and, visual observations were considered crucial to gain an understanding of foraging behaviour, scent marking and intra- and interspecific interactions.

1.2.3.Objective

To describe the diet, foraging behaviour and social organization of the honey badger and to compare the behaviour of the honey badger with that of other mustelid species.

1.2.4 Key questions

Due to the lack of information on all aspects of honey badger ecology, the key questions were necessarily broad:

a) Does the honey badger show sexual size dimorphism and to what extent?

b) What does the honey badger eat and are there sexual and seasonal differences in diet and foraging behaviour?

c) How does the honey badger interact with other species in the Kalahari with particular reference to the reported foraging association with the pale chanting-goshawk *M. canorus* and black backed jackal *C. mesomelas*?

d) Does the honey badger support the typical mustelid pattern of intra-sexual territoriality (Powell, 1979)?

e) How is the spacing pattern maintained?

f) What is the mating system of the honey badger?

1.2.5. Overview of the thesis

This thesis has been written in the form of papers for publication and therefore each chapter is an independent unit, resulting in some repetition in study area and methods. Since so little information was previously available on the honey badger, the chapters frequently refer to each other and the sections have been numbered to facilitate this. The six data chapters have been arranged to answer the key questions in the order that they have been presented above. Appendix A is a detailed evaluation of the techniques of capture, marking and habituation used in the study. To standardize the appearance of the thesis, all references are in the form required for the *African Journal of Ecology*.

A variety of different techniques were used to collect data, but there is little doubt that direct visual observations of nine habituated, radio marked individuals provided the most important insights into foraging behaviour, social interactions, and scent marking behaviour despite relatively small sample sizes, as was found in hyaena studies in the same area (Mills, 1990). More indirect data collected from a larger radio marked population (25 adults) and spoor tracking were important for determining spatial requirements, movement patterns, life history variables and density.

The study is broadly divided into two parts: the feeding ecology and activity patterns (Chapters 2,3,4) of the honey badger and its social organisation and breeding (Chapter 5,6,7). The first step was to determine what the honey badger eats and how it obtains its food and this is presented in Chapter 2. On a more theoretical basis this chapter also investigates sexual and seasonal variation in diet and foraging behaviour in terms of optimal foraging theory (Pyke *et al.*, 1977). In addition, the extent of sexual size dimorphism in honey badgers is assessed and the data are examined for sexual differences in diet and foraging strategy.

Chapter 3, investigates sexual and seasonal differences in the time budgets and activity patterns of the honey badger in the southern Kalahari where it is relatively undisturbed by man. In particular, sexual differences in the amount of time spent engaged on social and foraging activities and the effects of extreme temperature and prey activity schedules on activity patterns are examined.

The relationships between sympatric predators are complex and may involve exploitative and interference competition as well as facilitation (Mills & Biggs, 1993; Creel *et al.*, 2001). Chapter 4 describes interspecific interactions between the honey badger and other predators in the southern Kalahari, particularly intraguild predation and the foraging associations between the honey badger and the black-backed jackal *C. mesomelas* and pale chanting-goshawk *M. canorus*. Negative interactions such as competition and intraguild predation can adversely affect population growth rate and energetic intake of the victim, while positive interactions e.g. foraging associations may increase population growth rate through increased energetic returns, vigilance or breeding success (Palomares & Caro, 1999; Creel *et al.*, 2001).

Chapter 5 begins the second half of the thesis with a description and analysis of the spatial organisation of the honey badger in the southern Kalahari. Age-and sex related differences in home range size and movement patterns are investigated and it is determined whether the honey badger supports the typical mustelid pattern of intrasexual territoriality with overlapping home ranges between the sexes (Powell, 1979; Moors, 1980).

The importance of scent marking in solitary mammalian carnivores has been well documented (Macdonald, 1985) and the function of scent marking has been widely debated over the last two decades (Gosling, 1982; Macdonald, 1985; Gorman & Trowbridge, 1989). In Chapter 6, the scent marking behaviour of the honey badger is described. Direct observations allowed

scent marking events to be described in the environmental and behavioural contexts in which they occurred and the results are compared to predictions from hypotheses on the function of scent marking. Finally, Chapter 7 investigates the breeding system of the honey badger, and answers the question, is the honey badger polygynous? This chapter provides insight into the form and duration of parental care and pair bonds, reproduction, the number of mates, and the form of courtship. In addition, data on standard life history variables (Gittleman, 1986; Johnson *et al.*, 2000) are presented to correct previously contradictory information. Where the data permits more theoretical questions are addressed and the behaviour of the honey badger is compared to that of other mustelids.

1.3. References

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