

A supplementary feeding scheme in the conservation of the Cape Vulture at the Waterberg, South West Africa/Namibia

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ABSTRACT

A supplementary feeding scheme was initiated at the Waterberg Plateau Park, South West Africa/Namibia, in an attempt to reverse the decline in the Cape vulture *Gyps coprotheres* population. Cape vultures were considered to successfully exploit the carcasses provided at the feeding station because: (a) a large proportion of the population (on average about 40%) was present at each carcass (range 0-100%), (b) they were able to dominate whitebacked vultures *Gyps africanus* and sometimes lappetfaced vultures *Torgos tracheliotus*, (c) Cape vultures fed faster and were able to fill their crops more quickly than the other vulture species and had completed their feeding by, on average, 1 min before whitebacked vultures, (e) the feeding site was close (about 5 km) to the Cape vultures' breeding colony, thus these birds were often the first to find the carcass and feed. In addition, during the breeding season, some birds returned to the carcass for a second visit, having regurgitated the first crop-full to the nestling, (f) 88% of Cape vultures left the feeding area with full crops while the other Cape vultures had crops two-thirds full, and (g) it is estimated that Cape vultures could obtain 40% of their food requirements from the feeding station during the non-breeding season and up to 30% during the peak demand period of the breeding season.

INTRODUCTION

The Cape vulture *Gyps coprotheres* is a large (c. 8.6 kg), cliff-nesting griffon, endemic to southern Africa (Steyn 1982; Maclean 1985). It is classed as "vulnerable" in the *South African Red Data Book - Birds*, having "lost much of its population and abandoned many of its traditional breeding sites" (Brooke 1984). In South West Africa/Namibia six of the seven known colonies have become extinct in the past 30 years. At the last remaining colony, at the Waterberg Plateau, the Cape vulture population declined from about 500 birds in 1939 to 13 adults in 1985 (Brown 1985). The use of poisons on farmlands is considered to be the main reason for the decline of this species in South West Africa/Namibia, while at the Waterberg colony the severe bush encroachment in the area has also played an important role (Brown 1985).

In an attempt to counteract the decline in the Cape vulture population, a conservation programme was started in 1984. Educational booklets (Brown undated) were sent to all farmers within about a 120 km radius of the vulture colony, and "Farmers Days" were organised in the Waterberg Plateau Park, to which different local Farmer's Associations were invited. In addition, a weekly feeding scheme for the Cape vultures was initiated (Brown 1985; Brown & Cooper 1987).

The artificial feeding of raptors, particularly vultures, has been used widely as a management method (Pringle 1967; Wilbur 1978; Newton 1979; Friedman & Mundy 1983; Boshoff & Roberston 1985) and has proved to be a highly successful technique in the recovery of a population of European griffon vultures *Gyps fulvus* in the French Pyrenees mountains (Terrasse 1985). The objectives of the feeding scheme at Waterberg were (a) to provide the birds with a regular source

of uncontaminated food in an accessible place, thereby trying to improve the survival of (i) adult birds, (ii) young birds and (iii) nestlings, (b) to keep the birds close to the Waterberg, thereby reducing the likelihood of them feeding on poisoned carcasses and (c) to provide an additional means of monitoring the population.

Data presented in this paper were collected in order to establish whether the Cape vultures were (a) making use of the food provided and (b) able to compete successfully with the large number of other scavenging species feeding on the same food source. The general interactions of vultures at carrion have been extensively studied by other authors (Petrides 1959; Attwell 1963; Kruuk 1967; Houston 1975, 1980; Alvarez *et al.* 1976; König 1976, 1983; Mundy 1982; Richardson 1984), and we do not intend to add yet another general account of vulture feeding behaviour and interactions to the already extensive literature. In this paper we report instead on the use that Cape vultures and other avian scavengers made of the carcasses provided at the Waterberg feeding site and on those aspects of vulture feeding behaviour which are pertinent to the objectives posed above and to the specific study area.

STUDY AREA AND METHODS

The last-remaining Cape vulture colony in SWA/Namibia currently (June 1988) consists of 14 adult birds and 3-5 immature birds. It is situated on northeast facing cliffs of the Karakuwisa mountain range (20 19 S, 17 18 E; 1500 m above sea level), forming part of the Waterberg Plateau (Figure 1). The feeding station is some 5 km east of the colony on top of a gently sloping hill near the edge of the plateau and at approximately the same height as the nesting ledges. An area of about 80 x 60 m is kept cleared of small

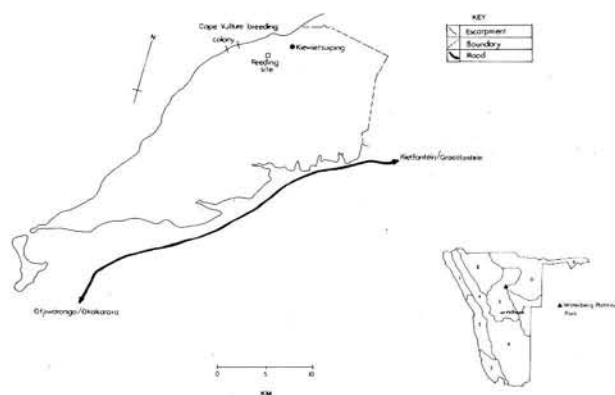


FIGURE 1: The study area at the Waterberg Plateau Park, showing the locality of the Cape vulture colony and the feeding site. The inset map of SWA/Namibia shows the locality of the Waterberg and the bioclimatic regions (after Giess 1977).

shrubs and bushes. The larger trees remain. A small (4 x 2 m), partly sunken hide, connected via a passage to a covered carport, was built on the northern side of the cleared area (Figure 2). In addition to a narrow viewing slit just above ground level at the front and sides of the hide, a window was cut above and behind the hide to provide an elevated view of the cleared area for filming of the vultures' activities.

An adult kudu *Tragelaphus strepsiceros* or gemsbok *Oryx gazella* was shot each week (mean mass of 180 kg, range 120–220 kg, $n = 30$), slit along the belly and placed 20–30 m in front of the hide, usually in the late afternoon. Observations usually began the next morning before 09h00. The time taken for the first bird to find the carcass was taken from sunrise on the day that the observations started. On three occasions the carcass was obtained early in the day. The time was then taken from when the carcass was placed at the feeding site. Observations were made at 26 carcasses, covering the period January 1985 to March 1986. The following information was recorded on data forms: date, weather conditions, carcass species and mass, time that carcass was found by the first scavenging bird, time when first bird landed (and whether this

was in a tree or on the ground) and time that feeding started. A full count of the number of each species present, giving age classes when possible, was made at the end of each 15 min interval from the time that the first bird landed.

The congregations of vultures at six different carcasses were filmed on video tape. The tapes were analysed by selecting a bird at the start of the sequence and recording its activities at 1-min intervals throughout the time it spent in the area of the carcass. The tape was then rewound and another individual was selected for observation. Data on 25 individuals of each of Cape, whitebacked *Gyps africanus* and lappetfaced *Torgos tracheliotus* vultures were analysed, covering over 21 h of vultures at carcasses. The following activities were recorded from the television monitor onto data forms: species, age, crop fullness (when possible), activity, part of carcass on which feeding (where applicable) and interactions with other birds (i.e. whether dominant or submissive).

RESULTS

The average time that it took the first scavenging bird to find the carcass was 2 h 53 min (standard deviation (SD) 96 min, range 0–345 min). On one occasion birds had found the carcass late the previous day and had roosted at the feeding site overnight. The bird that found the carcass came in to land immediately on 74% of occasions. When birds did not land immediately, the mean time between finding the carcass and a bird landing (not necessarily the bird that first found the carcass) was 42 min (range 5–115 min). Birds never began feeding immediately. On average, the time interval between the first bird landing and the first bird feeding was 98 min (SD 88 min, range 4–270 min). Counts of the maximum number of vultures at the feeding site made at 15 min intervals and starting with the first bird to land are shown in Figure 3. The mean time taken to reach the highest vulture count at each carcass was 2 h 34 min (SD 66 min, range 45–225 min).

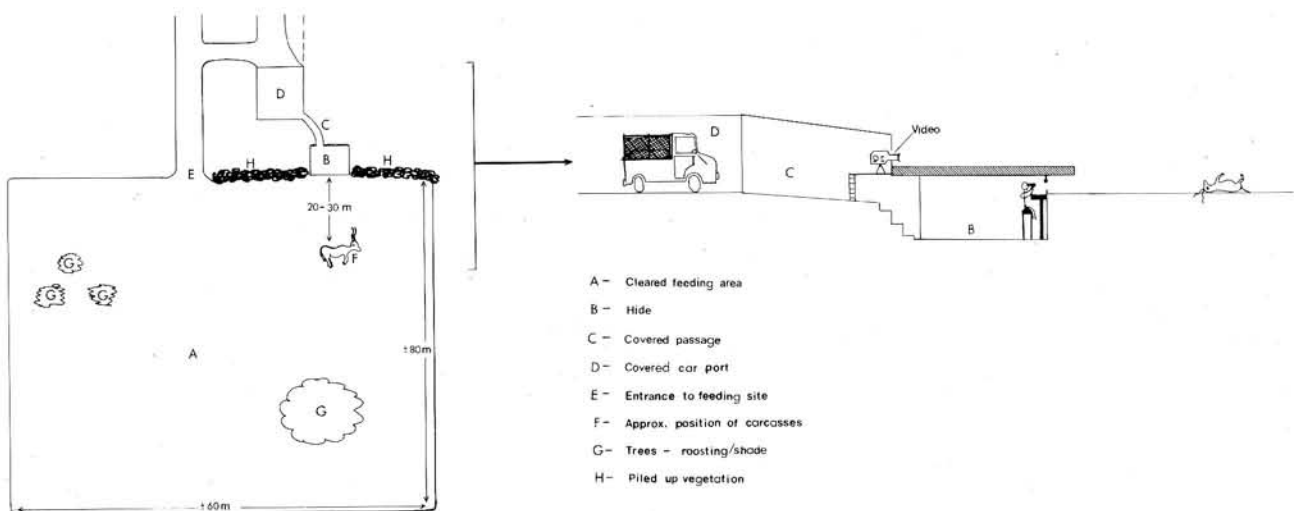


FIGURE 2: Details of the feeding site and the observation hide at the Waterberg.

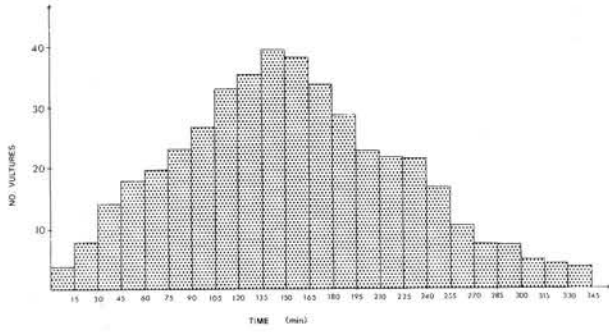


FIGURE 3: The mean number of vultures counted at 15 min intervals at 26 carcasses at the Waterberg feeding site.

Eight species of scavenging birds were recorded at the Waterberg feeding station during the study period (Table 1). In addition, four mammalian carnivores, namely the leopard *Panthera pardus*, spotted hyaena *Crocuta crocuta*, brown hyaena *Hyaena brunnea* and blackbacked jackal *Canis mesomelas* visited the feeding site. Leopards and hyaenas fed only at night whereas jackals were recorded on six occasions (23%) feeding during the day. All four mammal species removed only small portions of any carcass, and probably facilitated the vultures' access to the meat and viscera by tearing the skin.

TABLE 1: Species and numbers of scavenging birds recorded at the feeding station in the Waterberg Plateau Park, and the mean number of birds of each species per carcass.

Species	Total no.	%	Number per carcass		
			Mean	S.D.	(range)
Cape vulture <i>Gyps coprotheres</i>	143	8,4	5,5	4,9	(0-16)
Whitebacked vulture <i>Gyps africanus</i>	1 273	75,1	49,0	30,8	(0-109)
Lappetfaced vulture <i>Torgos tracheliotus</i>	257	15,2	9,9	8,4	(0-32)
Whiteheaded vulture <i>Trigonoceps occipitalis</i>	8	0,5	0,3	0,5	(0-1)
Marabou stork <i>Leptoptilos crumeniferus</i>	4	0,2	0,2	0,8	(0-4)
Milvus kites <i>Milvus migrans</i>	5	0,3	0,2	0,6	(0-3)
Tawny eagle <i>Aquila rapax</i>	2	0,1	0,1	0,3	(0-1)
Bateleur <i>Terathopius ecaudatus</i>	2	0,1	0,1	0,3	(0-1)
Totals	1 694	99,9	65,2	38,5	(3-147)

A total of 1694 scavenging birds were recorded at the feeding station during the study period. Whitebacked vultures were the most common (75%) followed by lappetfaced vultures (15%) and Cape vultures (8%) (Figure 4). Other bird species were recorded at an average frequency of less than one bird per carcass. Cape vulture numbers ranged from 4% to 20%, whitebacked vultures 53-84% and lappetfaced vultures 6-29%. The Cape vulture population is small and isolated, while those of the other two species are more

numerous and wide-spread. Thus, at a large congregation of vultures, Cape vultures represent only a small percentage. The actual numbers of Cape vultures recorded per carcass each month are therefore shown in Figure 5.

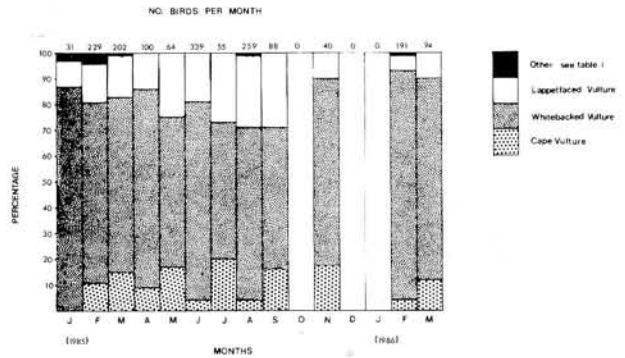


FIGURE 4: The percentage composition of scavenging birds per species, recorded at carcasses at the Waterberg feeding site per month.

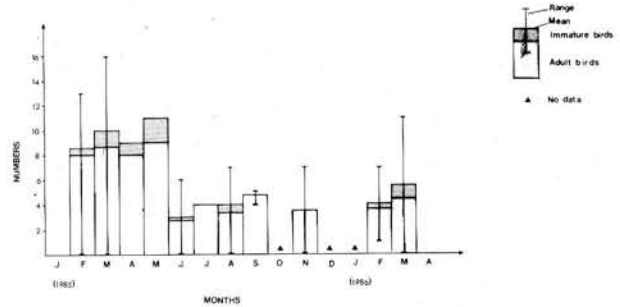


FIGURE 5: The mean number (and range) of adult and immature Cape vultures per carcass, recorded at the Waterberg feeding site per month.

The mean number of vultures attracted to each carcass was 65,2 (S.D. 38,5, range 3-147). There was considerable variation in the numbers recorded, both between months and within months at different carcasses (Figure 6). The mean numbers of birds of each species per carcass is listed in Table 1. This under-represents the numbers of birds present because the populations were not marked and some individuals had usually already left before the highest numbers of birds were reached. Some of these birds undoubtedly returned later to the carcass, but it was not possible to determine how many. Thus a minimum average of 5,5 Cape Vultures were recorded per carcass (range 0-16). This represents a minimum of 40% of the total adult Cape vulture population, and at some carcasses (8%), the entire population was present.

The Waterberg Plateau Park is located at the confluence of two bioclimatic regions (Giess 1971), namely the thornveld savanna (region 5) and the broadleaved woodlands (region 6) (Figure 1). The ratios of the vulture species recorded within each of these regions were calculated from 174 417 km of road counts between 1977 and 1984 (Brown 1986) and compared with that obtained at the feeding station (Table

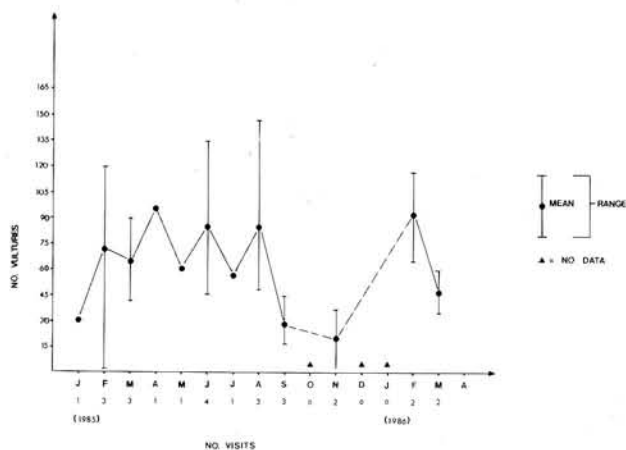


FIGURE 6: The mean number (and range) of all species of vultures per carcass recorded at the Waterberg feeding site per month.

2). The ratios of lappetfaced vultures to whitebacked vultures in the two bioclimatic regions and at the feeding site were very similar (range 1:4,0–1:4,5). The ratio of Cape to other vultures at the feeding site was considerably higher than that obtained from the road counts. This is explained by the fact that the feeding station was deliberately built near to the Cape vulture colony to favour this species, while the road counts cover all areas within each bioclimatic zone, and Cape vultures are concentrated about their only breeding colony.

TABLE 2: Ratio of vultures recorded during 174 417 km of road counts in two bioclimatic regions into which the Waterberg Plateau Park falls, compared to the ratio recorded at the feeding station. C.V. = Cape vulture, Wb.V. = whitebacked vulture, Lf. V. = lappetfaced vulture, Wh.V. = whiteheaded vulture, H.V. = hooded vulture.

Bioclimatic Region	Ratio of vultures					Total No.
	C.V.	Wb.V.	Lf.V.	Wh.V.	H.V.	
5	1	68	17	0,5	0	1 175
6	1	143	33	22	5	396
Mean	1	76	18	3	0,6	
Feeding station	1	9	2	0	0	1 680

The species that (a) first found the carcass, (b) was the first to settle and (c) was the first to feed on each occasion are given in Table 3. Comparing the expected incidence of each of the above per species (based on their relative abundance in the area) with that observed, it is apparent that lappetfaced vultures located the carcasses and was the first species to land significantly more often than would be expected (*Chi*-squared test, $P < 0,01$), whereas the converse was true for the whitebacked vultures ($P < 0,01$). This suggests that whitebacked vultures rely on locating food mainly by watching the activities of other species. Lappetfaced vultures usually waited for other birds to arrive and feed before they approached the carcass. They were the first birds to feed on only 40% of the occasions on which they landed first. Cape vultures found the carcass and landed first significantly more times than did whitebacked vultures (relative to their respective abundances), yet their foraging methods are very similar

(Pennycuik 1972; Houston 1974, 1975). However, as the feeding station is located near the flight path usually used by Cape vultures in the morning when they leave their cliffs, this is to be expected. In addition, Cape vultures started feeding first at 30% of the carcasses, compared to their proportion of 8% of all birds recorded at the feeding station ($P < 0,01$). When Cape vultures were first to arrive at a carcass they landed either in a tree or on the ground (about 30 m from the carcass) at a similar frequency. Whitebacked vultures usually landed in a tree (six out of eight times) while lappetfaced vultures landed on the ground nine out of 10 times.

TABLE 3: Number of occasions that different species of scavenging birds (a) found the carcass first, (b) were the first birds to settle and (c) were the first to start feeding, at the Waterberg feeding station.

Species	No. occasions that each species:		
	Found carcass	Landed first	Fed first
Cape vulture	5	5	6
Whitebacked vulture	7	8	7
Lappetfaced vulture	12	10	4
Whiteheaded vulture	0	1	1
Marabou stork	0	0	0
<i>Milvus</i> kite	1	1	1
Tawny eagle	1	1	1
Bateleur	0	0	0
Totals	26	26	20

Vultures were aged at each carcass when possible. The largest number of adult and immature birds at each carcass was used to calculate the age ratios. Of 143 records of Cape vultures 10% were immature, as were 41% of 791 whitebacked vultures and 21% of 155 lappetfaced vultures. The proportion of immature to adult vultures of each species at a carcass was found to vary with time (Figure 7). When feeding on the carcass first started, the proportions of immature birds in all three species were lowest, and rose to their highest levels at the end of the proceedings. The largest numbers of vultures of each species were reached (from the time that the first vulture started to feed) at, on average, 45 min in Cape vultures, 105 min in whitebacked vultures and 60 min in lappetfaced vultures. The proportion of immature to adult birds in all three species remained remarkably constant between the times when the first vulture began to feed and when the largest number of vultures per species were reached, indicating that birds of different ages were arriving at the carcass in the same ratios. Comparing the actual numbers of immature and adult birds recorded per 15 min interval (Figure 8), three things are apparent:

a) Cape vultures reached a peak in numbers before the other species and then their numbers declined rapidly, whereas those of the other two species remained high for about 2,5 times longer.

b) in the *Gyps* vultures young birds increased in equal proportion to adults until the peak in numbers was reached, but thereafter, adult numbers declined more

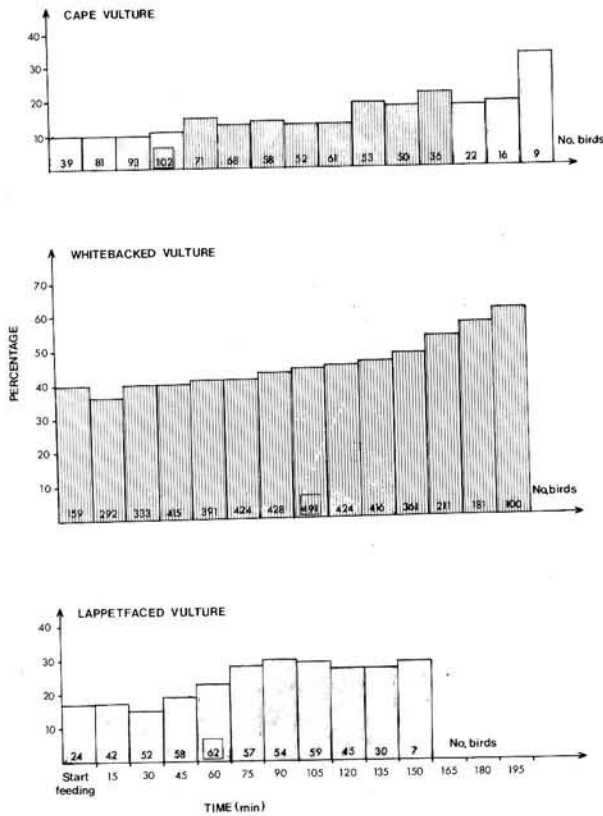


FIGURE 7: The percentage of immature birds per species recorded at the Waterberg feeding site per 15 min intervals, starting with the first vulture to begin feeding. The time when the peak numbers of birds per species was achieved is indicated (figure in the block).

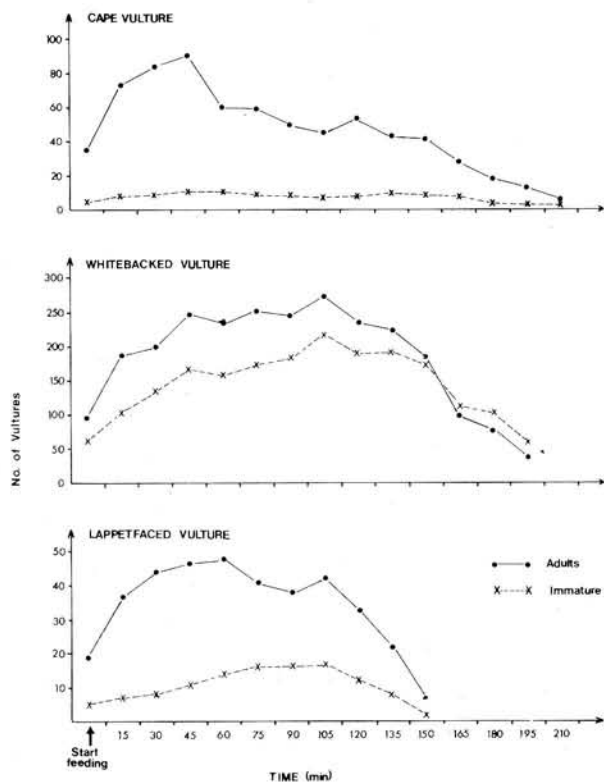


FIGURE 8: The patterns of arrival of adult and immature birds per species to carcasses at the Waterberg feeding site, recorded at 15 min intervals starting with the first vulture to feed.

rapidly than did those of immature birds, and c) in the lappetfaced vultures, immature numbers continued to increase even after adult numbers had started to decline.

From detailed analysis of the video-tapes obtained by filming the activities of vultures at carcasses, it was possible to gather data on some frenetic activities of the birds that would have been difficult to record directly. Individuals of all three species spent a similar amount of time in the vicinity of the carcass (*i.e.* within about 3 m), about 16–17 min (Table 4), but Cape vultures left on average about 1 min before whitebacked vultures. During this time the activities of the birds were divided into three basic classes, (a) feeding, (b) standing or walking and (c) interacting with other birds (whether being attacked or attacking). Cape vultures spent the most time feeding (55%) and lappetfaced vultures the least (41%), while the converse was true for the time spent standing or walking about (Figure 9).

TABLE 4: Time that focal vultures spent within 3 m of the carcass at the Waterberg feeding station.

Species	Sample size	Time (min)		
		Mean	SD	Range
Cape vulture	25	16,3	2,6	8–21
Whitebacked vulture	25	17,4	2,0	13–21
Lappetfaced vulture	25	16,9	3,7	9–22

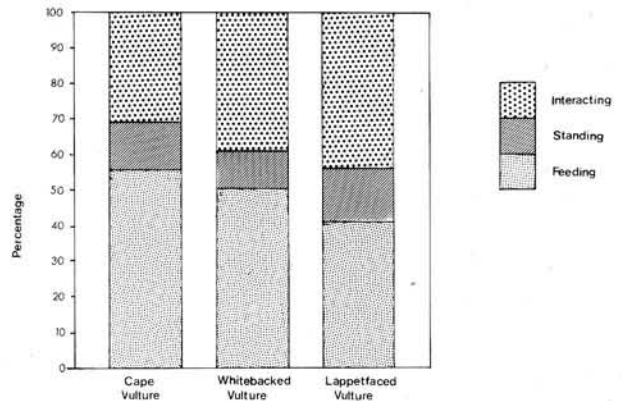


FIGURE 9: The percentage time that 25 focal birds of each vulture species spent (a) feeding, (b) standing or walking about and (c) interacting (either aggressive displays, attacking or being attacked) while at the carcasses at the Waterberg feeding site.

The time-activity patterns of the three vulture species were examined, starting after 1-min of a bird arriving in the immediate proximity of a fleshed carcass, and recording the activity at the end of each minute thereafter, until the bird left the area of the carcass (Figure 10). Both *Gyps* vultures fed most intensively in the first few minutes of arrival. The amount of time spent feeding declined in the Cape vulture after the first 3 min from 68% to 60%, and after a further 2 min it declined again to fluctuate between 52% and 58% for

9 min after which it decreased sharply. During the main period of feeding, aggressive interactions between the focal Cape vulture and other birds remained between 20% and 30%, but after about 11 min this declined rapidly. A similar general trend was found for whitebacked vultures except that, being smaller than Cape vultures, they were displaced more often from the carcass and had to fight more to get back. This is seen in the decrease in time spent feeding after the first 2 min and the corresponding increase in interactions, the generally lower percentage of time spent feeding and more time spent interacting, and the longer overall time spent by them at a carcass. Lappet-faced vultures, by contrast, did not feed most intensively at the beginning, but rather built up to it after 6–7 min. They maintained a relatively high, though protracted feeding level (40–50% of their time at the carcass spent feeding) for over 16 min on average, and they spent more time standing or walking about the carcass than did the *Gyps* species.

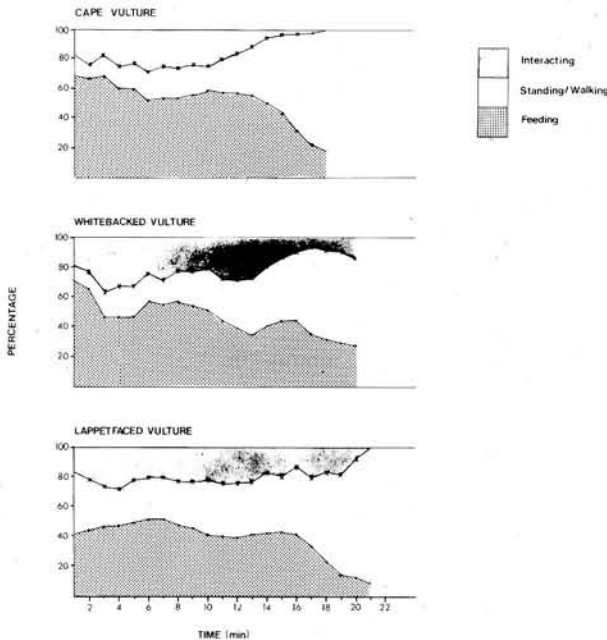


FIGURE 10: Time-activity patterns of 25 focal birds of each vulture species either (a) feeding, (b) standing or walking and (c) interacting while at carcasses at the Waterberg feeding site, recorded at 1 min intervals.

On each occasion that the focal bird was recorded feeding ($n = 604$) the part of the carcass being fed on was noted (Table 5). No clear differences between the species were identified, but Cape and lappetfaced vultures fed more off the head region than did whitebacked vultures, perhaps because the first two are strong and have powerful bills which made it easier for them to obtain food from this rather tough area; both *Gyps* species fed more from the neck region than did lappetfaced vultures, and here the *Gyps* vultures usually inserted the head and neck under the skin and pulled off chunks of meat that were largely inaccessible to lappetfaced vultures; and all three species fed to a large extent from the rump, but this was most marked in lappetfaced vultures.

TABLE 5: Parts of the carcasses that each species of vulture fed on, as a percentage of the choice of each species, at the Waterberg feeding station.

Part of carcass	Species		
	Cape vulture	Whitebacked vulture	Lappetfaced vulture
Head	21	11	21
Neck	15	13	6
Shoulder	5	6	6
Back	4	5	5
Rump	24	30	36
Chest	8	9	7
Viscera	22	22	17
Limbs	0	4	1
Scraps	1	0	1
Total no. records	206	219	179

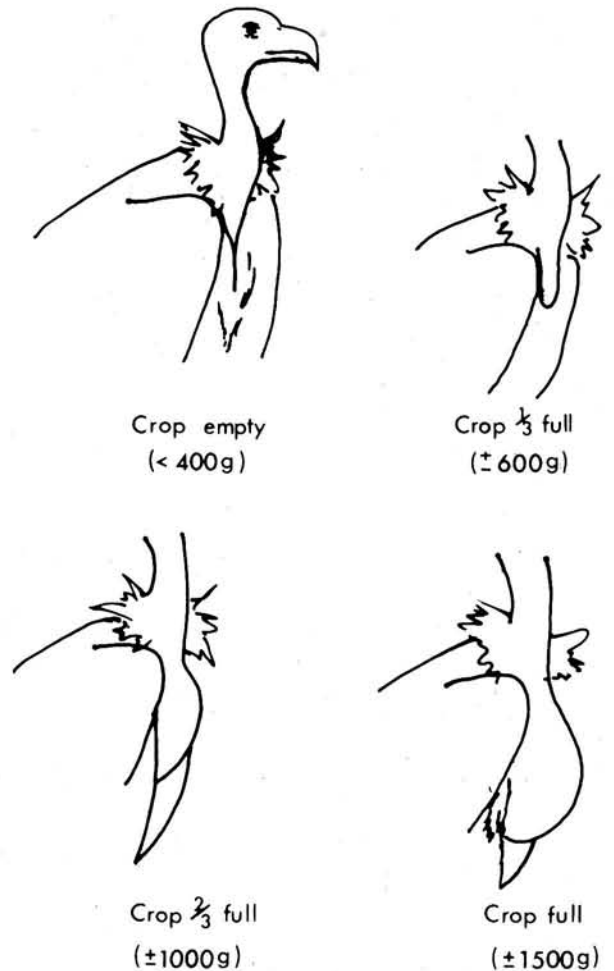


FIGURE 11: Visual estimate of crop contents in Cape vultures based on Houston (1976).

It was often difficult to assess the fullness of the crop of birds on their arrival and departure. In this regard, most effort was spent on the Cape vulture. Crop fullness was divided into four categories after Houston (1976): crop empty (<400 g of food), crop one-third full (about 600 g), crop two-thirds full (1000 g) and crop full (>1500 g) (Figure 11). Most Cape vultures (79%) arrived with an empty crop, 16% with a crop one-third full and 5% with crop two-thirds full (Table

6). No Cape vulture ever left a carcass with an empty crop. 88% left with full crops and the remainder had two-thirds full crops. Although no counts were made, it was apparent that at large congregations of vultures, many whitebacked vultures obtained little or no food. Cape vultures ate on average about 1,36 kg/bird/carcass and, because some birds had arrived with food in the crop, left the feeding site with an average of about 1,44 kg of food per bird. These figures represent the minimum mass of food per bird, because on a number of occasions Cape vultures returned to a carcass for a second helping. Because birds were not marked, the frequency with which this took place is not known, and it is presumably restricted to the nestling period of the breeding season. On two occasions when the majority of Cape vultures (13 or more) had been present at a carcass at one time, had fed and all left with full crops, five and six birds respectively came "back" with empty crops and, after feeding, left again with full crops. Most of these second groups must have consisted of birds returning for a second visit, because the total number exceeded that of the total population. Confirmation of this hypothesis was obtained from observations at nests. Parent birds arrived from the direction of the feeding station with bulging crops, regurgitated to the nestling and flew back towards the feeding site, to return about 25 min later with full crops.

TABLE 6: Estimated fullness of crop in Cape vultures on their arrival at the Waterberg feeding station, and on their departure after having fed.

Crop fullness	On arrival		On departure	
	No. birds	%	No. birds	%
?	2	—	24	—
Empty	64	79	0	0
One-third	13	16	0	0
Two-thirds	4	5	7	12
Full	0	0	52	88
Total	83 (81)		83 (59)	

Cape vultures experienced little difficulty in fighting their way to a place at the carcass and in retaining it, even when over 100 whitebacked vultures were fighting to feed. Cape vultures were the aggressors on 61% of recorded interactions between these and other vul-

tures. Most of these interactions were directed against whitebacked vultures (Table 7). By contrast, whitebacked vultures initiated aggressive interactions on only 26% of occasions in which they were involved in interactions, and most of these (77%) were against conspecifics. Lappetfaced vultures were as aggressive as Cape vultures and directed their aggression mainly against whitebacked vultures.

TABLE 7: Interactions between vultures at the Waterberg feeding station, listing the percentage of occasions on which each species was the aggressor, and the species which was the target of this aggression (= aggressee). Abbreviations as for Table 2.

Species	No. interactions	Aggressor (%)	Aggressee (%)		
			C.V.	Wb.V.	L.F.V.
C.V.	184	61	36	41	23
Wb.V.	184	26	4	77	19
L.F.V.	190	62	24	45	31

DISCUSSION

The proportion of each species of vulture recorded at the Waterberg feeding station is similar to that recorded in other studies in bushveld Africa (Table 8). At the Waterberg, however, lappetfaced vultures constituted a larger percentage of the vulture population than has been recorded elsewhere. This is probably related to the species' preference for arid areas, where it has been found to be more common than in areas of higher rainfall (Brown *et al.* 1982; Brown 1986).

On average, at least 40% of the total Cape vulture population was present at each carcass put out during the study period and, on 8% of occasions, all the birds were there. This emphasises the vulnerability of this small population; one poisoned carcass in the area could kill the last Cape vultures in this country.

Immature birds constituted only 10% of the Cape vulture population at the Waterberg. There are few comparative data for this species from other areas. The only information that we are aware of is for the Natal Drakensberg where young Cape vultures constituted 29,7% of 2076 age-classed birds (Brown 1987). It is not known whether the low percentage of young birds at the Waterberg is due to low breeding success, immature mortality being high or emigration of young birds.

TABLE 8: Comparison between the percentage composition of the different vulture species at carcasses at the Waterberg with those found in other studies in bushveld Africa. Abbreviations as for Table 2. Additional abbreviations are R.G. = Ruppell's griffon vulture, *Gyps* V. = combined total for all the *Gyps* vultures and E.V. = Egyptian vulture. (p = present but not counted per species).

Region	Source	Sample size	Species							
			C.V.	R.G.	Wb.V.	<i>Gyps</i> V.	L.F.V.	Wh.V.	H.V.	E.V.
Uganda	Petrides 1959	?	—	2	85	(87)	2	1	10	—
Zambia	Attwell 1963	823	—	—	89	(89)	4	2	5	0,03
Tanzania	Kruuk 1967	1 737	—	13	64	(77)	12	0,3	8	0,1
Tanzania	Houston 1972	6 112	—	18	70	(88)	8	1	3	—
East Africa	Pomeroy 1975	1 501	—	p	p	(93)	2	2	5	—
South Africa	Kemp & Kemp 1975	2 168	13	—	73	(86)	5	6	7	—
Zimbabwe	Mundy 1982	8 381	1	—	77	(77)	5	6	12	—
South Africa	Richardson 1984	795	14	—	77	(91)	5	2	3	—
SWA/Namibia	This study	1 681	9	—	76	(85)	15	0,3	—	—

Cape vulture numbers at carcasses at the feeding site reached a peak considerably before those of white-backed and lappetfaced vultures, and unlike the latter two species, their numbers then declined. This is attributed to the proximity of the feeding site to the Cape vulture colony, the smallness of the Cape vulture population, their efficiency at obtaining food and the fact that, after having fed, they fly back to their cliffs. By contrast, the other two vulture species consist of larger populations spread over a large area. Members of these species continue to arrive in considerable numbers up to 2 h or more after the first vulture has started to feed.

Mundy (1982) states that adult whitebacked vultures generally feed before immatures, and that immatures either arrive at a carcass later, stay longer or both. The data obtained in this study indicate that in the *Gyps* vultures adult and immature birds arrived at similar ratios to each other while overall numbers were increasing. Only once the adult population had started to decline (*i.e.* more adults were leaving the feeding area than were arriving) did the relative proportion of immature birds start to increase. This suggests that immature birds were spending longer at the carcass than adults, not arriving later. This situation would arise if immature birds were less successful at competing for food. A different situation was found in lappetfaced vultures. Immature birds of this species did arrive later than adults. In the gregarious *Gyps* vultures which forage by watching one another, immature birds would be expected to arrive at carcasses in similar proportions to their composition in the overall population, throughout the event. Lappetfaced vultures, however, are far more solitary in their nesting and foraging. They would be less likely to be equally represented in their age class through time at a carcass. It might be expected that the more experienced adult birds would locate the carcass earlier than immature birds.

The chief purpose in establishing the feeding scheme at the Waterberg was to provide an uncontaminated source of carrion in an easily accessible and suitable site, primarily for the Cape vulture. In this assessment of the success of the feeding scheme we are concerned mainly with determining the use that the Cape vultures made of the feeding site and whether they were successful in obtaining food. The above results indicate that Cape vultures do indeed successfully use the carcasses provided. The following criteria have been considered in assessing the success of the project.

(a) *The location of the feeding site.* The Cape vultures usually fly near to the feeding site when leaving their cliffs each morning, and immediately see a carcass. All the foraging members of the colony can therefore be attracted to the feeding site before they have dispersed to forage. The feeding site provides good visibility in all directions, sufficient cleared space for taking off with a full crop and a few trees for perching and shade. The observation hide is unobtrusive and the birds have

shown no undue signs of nervousness. The fact that on average over 40% of the Cape vulture population arrives to feed at the carcasses provided and that up to 147 vultures gather at a time indicates that the location and design of the feeding station is satisfactory.

(b) *Order of arrival and feeding.* Cape vultures arrived first (19% of occasions) and fed first (30% of occasions) more often than would be expected by their abundance (8%) relative to the numbers of other species attracted to the carcasses. Their early arrival is probably related to the position of the feeding site relative to their colony. Contrary to the findings of Mundy (1982), lappetfaced vultures located the carcass first and were the first birds to land most often at the Waterberg.

Mundy found that whiteheaded vultures *Trigonoceps occipitalis*, hooded vultures *Necrosyrtes monachus* and bateleurs *Terathopius ecaudatus* were usually the first species to find the carcasses. These species were relatively abundant in his study areas, whereas at the Waterberg, they are either rare or not present.

(c) *Feeding efficiency.* Cape vultures fed more intensively and quickly than did the other two vulture species. Their large size and aggression meant that they were dominant over whitebacked vultures and even, on a number of occasions, succeeded in dominating lappetfaced vultures. Even when a carcass was covered by over 100 whitebacked vultures, Cape vultures were able to obtain and retain a place. Their success at obtaining food is illustrated by the fact that no Cape vulture was seen leaving the feeding site with a crop less than two-thirds full (*i.e.* containing about 1 kg of food) and 88% of the Cape vultures had full crops (>1.5 kg of food). In addition, during the nestling period of the breeding season, some birds returned for a second crop of food after having regurgitated the first to their nestling. In this regard, the size of the carcass is important, in allowing sufficient time for the Cape vultures to revisit the carcass before the food is finished by the other species.

Komen (1986) has shown that a pair of adult Cape vultures need about 1.03 kg of food per day, and that during the peak demand period of the breeding season, a pair and their nestling need about 2.12 kg per day. For Cape vultures making weekly use of the Waterberg feeding station, a pair of birds could get about 40% of their food requirements during the non-breeding season from the carcasses provided, while during the breeding season (based on one visit per parent) this would be about 20%. However, if one of the parents regurgitated the contents of the first cropful to the nestling and returned for a second visit, then the pair could get up to 30% of their food requirements from the feeding station.

In conclusion, we consider that the artificial feeding scheme at the Waterberg is an efficient means of providing the Cape vultures with a healthy source of food as well as benefitting other carrion-feeding species in the area. The Cape vultures are well able to

compete successfully with other scavenging species and mostly leave the feeding site with full crops. The feeding scheme should therefore be continued for a further period of five years (until the end of 1993) and then be re-evaluated, as preliminary results (Brown & Cooper 1987) indicate that the Cape vulture population has benefitted from this and other conservation action.

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