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# The physical parameters of Cape Vultures in the Natal Drakensberg and some ideas on large size in mountain habitat

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ABSTRACT

Twelve Cape Vultures *Gyps coprotheres* captured in the Natal Drakensberg were found to be significantly larger and heavier than samples from Zimbabwe and Kimberley. These differences are discussed in terms of Bergmann's law. Windy conditions and mountainous terrain in the Natal-Lesotho highlands provide ideal opportunity for slope soaring. This has probably allowed the Cape Vultures in this area to become larger and heavier. Large size confers the following advantages to the Cape Vulture: 1) a greater ability to withstand low winter temperatures and conserve energy, 2) the ability to build up greater energy reserves and survive for longer periods between meals, and 3) the potential for nesting birds to be able to rely more on reserves so that the maximum quantity of food can be fed to the nestling.

## INTRODUCTION

Few mensural data on Cape Vultures have been published. Seventeen live birds were measured by Mundy (1982), consisting of 12 birds from Zimbabwe and five from the Kimberley area, composed of 15 immature and two juvenile birds (P.J. Mundy in litt.).

While trapping Bearded Vultures *Gypaetus barbatus* in the Giant's Castle Game Reserve (29 19 S, 29 31 E; 2 250 m above sea level), 12 Cape Vultures were incidently captured. This paper presents information on some physical parameters obtained from these birds.

## METHODS

Birds were attracted to the capture site by offal and meaty bones, and were then captured by a cannon net fired electronically from a small stone hide some 30 m away. The birds were immediately removed from the net and placed in separate hessian sacks in the shade. The time between capture and handling varied from 5 min to 2 h. The following measurements were taken:

Mass; measured on a Pesola spring balance to 0,05 kg. The accuracy of the scale was checked before and after the fieldwork. All birds had empty crops when weighed.
Bill length; from the distal dorsal margin of the cere to a line extended vertically from the most distal point of the bill.
Bill width; between the junctions of the cutting edges of the upper mandibles and cere on each side of the gape.
Bill height; from the junction of the bill and cere on the dorsal surface of the upper mandible to the junction of the bill and cere on the ventral surface of the lower mandible, with the bill firmly closed.



Standard wing length; from the front of the folded wrist to the tip of the longest primary, with the wing flattened.
Total wing length; from the proximal edge of the humerus to the longest primary, with the wing stretched out such that the leading edge formed as straight a line as possible.
Wingspan; twice the total wing length plus the distance across the back from the proximal edge of the left humerus to the proximal edge of the right humerus.
Tail central length; from the posterior edge of the uropygial gland to the tip of the longest central rectrix.
Tail outer length; from the posterior edge of the uropygial gland to the tip of one of the outermost rectrices.
Tarsus length; from the tibiotarsal-tarsometatarsal joint to the dorsal base of the central toe, where the crease occurs when the toe is flexed.
Toe lengths; taken along the dorsal surface, from the junction with the tarsometatarsus to the dorsal junction of the claw and skin, with the toe straightened.
Claw lengths; taken along the chord from the dorsal surface of the junction of the skin and claw to the tip of the claw.
Temperature; taken with a 1 min rectal thermometer inserted deeply into the cloaca.
Wing and tail areas; outlines of wing and tail were traced onto high quality paper pinned to a board. The wing was opened so that the leading edge formed as straight a line as possible. The tail was uniformly spread so that the outer tail feathers formed an angle of 60 degrees. Areas were determined by cutting out and weighing the paper.

The presence or absence of an incubation patch was noted and blood smears were taken from five birds. Birds were aged according to characteristics described by Mundy (1982), with particular emphasis on eye colour (yellow in adults, darker in immature birds) and colour of the skin of the head and neck (blue in adults, patches of pink or totally pink in immature birds). Although juvenile (= first year) birds were regularly seen in the Natal Drakensberg, none were captured. All Cape Vultures captured were photographed on colour slides.

## RESULTS

Table 1 lists the statistics describing the mass, measurements and body temperatures of immature and adult Cape Vultures, and compares this total sample, where applicable, with the measurements obtained by Mundy (1982). There was no significant difference in any of the variables between adult and immature birds in the Giant's Castle sample (Students t test), although most adult measurements were on average larger than those of immature birds. An exception was the outer tail length, in which immature birds were 10% longer than adult birds, giving them a larger tail area when spread.

Cape Vultures captured in Giant's Castle Game Reserve were significantly larger than the birds measured by Mundy (1982). Mean sample masses differed by 19%, standard wing lengths by 4% and central tail lengths by 11%. Although not statistically significant, the Cape Vultures measured by Mundy in Kimberley were

TABLE 1

SOME PHYSICAL PARAMETERS OF THE CAPE VULTURES CAPTURED IN THE GIANT'S CASTLE GAME RESERVE, AND COMPARATIVE MEASUREMENTS OBTAINED BY MUNDY (1982 AND IN LITT.) DATA ARE PRESENTED AS MEAN ± STANDARD DEVIATION (SAMPLE SIZE).

| Variables | This study: Immature | This study: Adult | This study: Total | P[a] | Mundy (1982) |
|---|---|---|---|---|---|
| Mass (kg) | 9,42 ±0,37 (6) | 9,98 ±0,79 (6) | 9,67 ±0,66 (12) | *** | 7,86 ±0,54 (17) |
| Bill length (mm) | 42,7 ±4,8 (6) | 45,1 ±3,1 (6) | 43,9 ±4,1 (12) | | not comparable |
| Bill width (mm) | 25,0 ±0,6 (6) | 26,2 ±1,7 (6) | 25,6 ±1,3 (12) | | 25,3 ±1,0 (17) |
| Bill height (mm) | 35,9 ±1,9 (6) | 36,8 ±2,4 (6) | 36,3 ±2,1 (12) | ** | 34,1 ±1,3 (17) |
| Std wing length (mm) | 728,0 ±19,4 (6) | 733,0 ±25,8 (6) | 730,8 ±21,9 (12) | *** | 699,7 ±19,6 (17) |
| Total wing length (mm) | 1194,0 ±16,7 (5) | 1198,0 ±60,6 (4) | 1196,1 ±39,0 (9) | | - |
| Wing span (mm) | 2572,0 ±29,5 (5) | 2580,0 ±127,3 (4) | 2575,6 ±80,8 (9) | | - |
| Tail centre length (mm) | 313,0 ±22,0 (6) | 316,0 ±19,6 (6) | 314,2 ±20,1 (12) | *** | 279,1 ±12,4 (17) |
| Tail outer length (mm) | 297,5 ±16,9 (4) | 269,0 ±9,9 (2) | 288,0 ±20,0 (6) | | - |
| Tarsus length (mm) | 113,3 ±7,1 (6) | 115,8 ±4,9 (6) | 114,6 ±6,0 (12) | *** | 105,0 ±3,0 (17) |
| Toe length (mm) | | | | | |
| hind | 31,8 +2,3 (4) | 36,0 +5,9 (5) | 34,2 +4,9 (9) | | - |
| inner | 47,4 +7,8 (4) | 44,0 +5,1 (4) | 45,7 +6,4 (8) | | - |
| middle | 98,0 +3,3 (4) | 97,5 +7,3 (5) | 97,7 +5,5 (9) | | - |
| outer | 60,6 +2,2 (4) | 57,1 +3,5 (4) | 58,8 +3,3 (8) | | - |

TABLE 1 (Continued)

SOME PHYSICAL PARAMETERS OF THE CAPE VULTURES CAPTURED IN THE GIANT'S CASTLE GAME RESERVE, AND COMPARATIVE MEASUREMENTS OBTAINED BY MUNDY (1982 AND IN LITT.) DATA ARE PRESENTED AS MEAN ± STANDARD DEVIATION (SAMPLE SIZE).

| Variables | This study: Immature | This study: Adult | This study: Total | P[a] | Mundy (1982) |
|---|---|---|---|---|---|
| Claw length (mm) | | | | | |
| hind | 31,2 ±0,3 (3) | 30,7 ±3,7 (5) | 30,9 ±2,9 (8) | * | 34,0 ±2,2(17) |
| inner | 26,9 ±3,2 (3) | 31,5 ±4,3 (4) | 29,5 ±4,3 (7) | | - |
| middle | 28,4 ±1,4 (3) | 26,9 ±3,8 (5) | 27,4 ±3,1 (8) | | - |
| outer | 24,7 ±0,7 (3) | 23,8 ±2,3 (4) | 24,2 ±1,7 (7) | | - |
| Temperature (°C) | 40,6 ±0,3 (6) | 40,6 ±0,4 (6) | 40,6 ±0,4 (12) | | - |
| Wing area (sq cm) | 4224,6 ±277,3 (5) | 4376,6 ±333,1 (3) | 4281,6 ±286,1 (8) | | - |
| Aspect ratio:1 | 6,78 ±0,46 (5) | 6,64 ±0,44 (4) | 6,72 ±0,40 (8) | | - |
| Tail area (sq cm) (spread) | 1047,4 (1) | 1003,0 (1) | 1040,2 (2) | | - |
| Wing loading (g/sq cm) | 1,13 ±0,07 (5) | 1,11 ±0,11 (3) | 1,12 ±0,08 (8) | | - |
| Wing & tail loading (g/sq cm) | 0,97 (1) | 0,93 (1) | 0,95 (2) | | - |

P[a] = Student t-test: * p<0,05; **p<0,01; *** p<0,001.

on average 5% heavier than those birds measured in Zimbabwe, with standard wing lengths of about 2% longer (raw data supplied by P.J. Mundy).

Incubation patches were present on four of the five adult birds captured during the breeding season, and on one of the five immature birds trapped during this period. All blood smears proved negative for blood parasites.

## DISCUSSION

Body size is generally considered to be a fairly variable characteristic, which differs clinally following Bergmann's ecogeographic law; at high latitudes and altitudes animals are larger than their conspecifics living in warmer climates at lower altitudes or nearer to the equator (e.g. Mayr 1956; Kendeigh 1969; Ricklefs 1973). Mayr (1963) states that "races from cooler climates tend to be larger in species of warm-blooded vertebrates than races of the same species living in warmer climates". This trend is seen in the Bearded Vulture, with the largest birds occurring in the Himalayas and the smallest in Ethiopia and East Africa (Delibes et al. 1984). Clinal changes in wing length of some birds studied in North America have been shown to closely follow Bergmann's law, even where environmental changes have been small (James 1970).

One of the major points made by Bergmann (summarized by James 1970 and subsequently modified by later authors) is that when other factors are constant, the smaller species in a genus will occur in a warmer climate. The griffon superspecies formed by the five species of colonial, cliff nesting Gyps vultures (Figure 1) follows the predictions of this law with G. himalayensis being largest and G. rueppellii smallest.

Houston (1983) has suggested that large body size and mass are of selective advantage to the griffon vultures in (i) outcompeting other species at food, (ii) surviving for longer periods between meals than smaller birds (carrion being an unpredictable food source), and (iii) increasing flight speed, which results from increased wing loading (Pennycuick 1972). The limit to body size and mass will be set by aerodynamic considerations, depending on the particular opportunities for soaring flight in the different areas (Houston 1983). For example, the two tree-nesting Gyps species, G. africanus and G. bengalensis are about 30% smaller by mass than the smallest cliff-nesting Gyps. These two species usually live in open savanna areas and rely on thermal soaring. In contrast, the cliff-nesting griffons have considerable height advantage over the tree-nesting species and usually live in mountainous areas in which windy conditions often prevail, making slope soaring an important means of remaining airborne. Houston (1983) has noted that in the Himalayas G. himalayensis relies almost exclusively on the strong slope lift which results from the frequent high winds.

In southern Africa the data presented here suggest a clinal range in body size and mass in Cape Vultures, the smallest birds being those in Zimbabwe and the largest those occurring in the Natal-Lesotho highlands. The Kimberley birds were intermediate in size. It is of interest to note that data based on ring recoveries



and resightings suggests that Cape Vultures raised in the Magaliesberg and Botswana colonies move south and southwest to the mid- and eastcentral Cape Province after becoming independent. This is further supported by a lower than expected number of juvenile and immature birds recorded at these colonies (Mundy 1982). The birds captured near Kimberley were therefore probably birds from colonies to the north in the Transvaal and Botswana, having congregated in "nursery areas" where the food supply was good and where little competition from adult birds was experienced. These birds therefore fit into the expected clinal range of the species.

In contrast, the Natal-Lesotho highlands were found to support a large number of first year and immature birds. Of the 2 076 sightings which could be aged the ratio (first year: immature:adult) was 1:1,54:6,00. No birds ringed outside the Giant's Castle Game Reserve were seen, suggesting that there is little movement of birds into or out of the mountainous regions of the Natal-Lesotho highlands.

The size difference between the birds captured in the Drakensberg and those measured by Mundy (1982), particularly differences in mass (19% heavier in the Drakensberg), is greater than would be expected within a continuous population given the relatively small increases in latitude and altitude of the Drakensberg birds. Non-genetic factors have been shown to have a great influence on size and body proportions, e.g. pigs from the same litter raised at different temperatures responded in accordance with the laws of Bergmann and Allen (Weaver & Ingram 1969) and similar cases of differences in wing length in birds, responding to climatic and trophic factors, have been reported (Selander 1971). Kendeigh (1969) states that "for Bergmann's Rule to become expressed... the physiological advantages must outweigh the ecological disadvantages". In most bird species the most important ecological disadvantage to increased body size is the need to obtain more food from the environment. In the case of large vultures dependent on good soaring conditions, another and vital consideration is the need to remain airborne for long periods each day.

In the mountain massif of the Natal-Lesotho highlands, windy conditions prevail throughout the year. Slope lift is used by Cape Vultures in this area more often than thermal lift, which is comparable with the situation in the Himalayan Griffon (Houston 1983). Cape Vultures were recorded gaining height on 451 occasions, and of these 36% were gliding along escarpments or ridges using slope lift. In addition, on 73% of occasions where birds were seen thermalling (i.e. spiralling upwards), this was dependent on slope lift, where updraughts were channelled and concentrated in gullies and against mountain peaks on the Drakensberg escarpment. Birds could remain in the strongest regions of these updraughts by circling. Slope lift was also used extensively for foraging and cross-country travel. The windy conditions, in conjunction with the mountainous topography, have led to the extensive use of slope lift by Cape Vultures in the highlands region, which has probably allowed these birds to become larger and heavier than their conspecifics. In most other regions of southern Africa, once away from their nesting cliffs, Cape

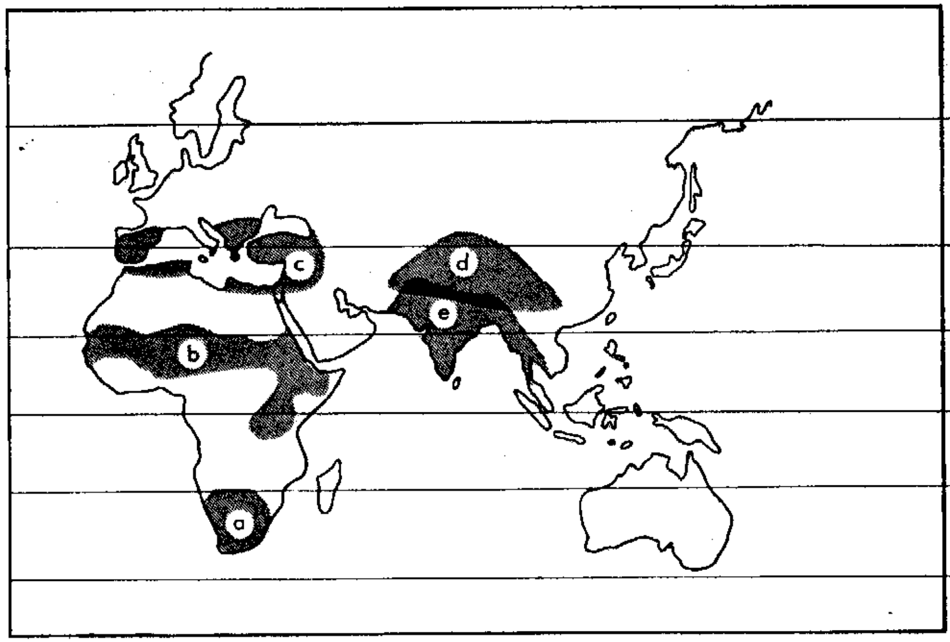


FIGURE 1. Distribution of the five species of cliff-nesting Gyps vultures.

a = G. coprotheres (mean mass 8,6 kg; range 7,3-10,9 kg; Maclean 1985)
b = G. rueppellii (mean mass 7,6 kg; Houston 1983)
c = G. fulvus (mass range 6,2-11,2 kg; Brown et al. 1982)
d = G. himalayensis (mass range 8,0-12,0 kg; Brown & Amadon 1968).
e = G. indicus (no data)



Vultures forage largely over flat terrain in which the main form of lift is thermals. During the winter months the strength of thermal activity may set an upper limit to the birds' size, particularly their mass and wing loading.

Kendeigh (1969) lists the following advantages to be gained by increased size: 1) reduction in relative amount of energy required to exist, 2) lower metabolic stress per degree drop in temperature, 3) extension of zone of thermal neutrality to a lower critical ambient temperature and 4) lower extreme limits of tolerance. The last three points are probably particularly important considerations at high altitudes; in the Natal Drakensberg above 3 000 m, winter ground temperatures can fall below -20°C (Brown & Barnes 1984). The birds are fully exposed to these temperatures because they favour south and southeast facing cliffs for nesting and roosting (Brown & Piper in prep). These sites are in constant shade during the winter months and can remain iced during most of this period.

The large size of Cape Vultures in the Natal-Lesotho highlands has probably not developed in response to competition because they are the only large vulture (apart from the mainly non-aggressive Bearded Vulture) and are not challenged by other scavengers. There are, however, other advantages to be gained from large size. In the Drakensberg birds are sometimes unable to leave their cliffs for continuous periods of up to five days (pers. obs.) or longer (see Killick 1963) because of adverse weather conditions, e.g. thick mist and cloud. Large body size confers 1) a large crop for the storage of more food, 2) the ability to store more energy reserves and therefore to survive for longer periods between meals (Marcastrőm & Kenward 1981; Mendelsohn 1986) and, 3) the ability for nesting birds to rely for longer periods on their energy reserves so that the maximum quantity of food can be fed to the nestling, thereby reducing the effects of sporadic food supply, maintaining growth rates and improving survival chances (Houston 1976; Mendelsohn 1986). It would appear that, in the Natal-Lesotho highlands, the Cape Vulture has been able to achieve a larger body size than conspecifics outside the mountain massif, to take advantage of the positive attributes that larger size confers, because of the availability of strong, reliable slope lift.

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