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Ranging behaviour of Cape Vultures *Gyps coprotheres* from an endangered population in Namibia

ANDREW J. BAMFORD, MARIA DIEKMANN, ARA MONADJEM and JOHN MENDELSOHN

Summary

The Cape Vulture (*Gyps coprotheres*) is an obligate cliff-nesting vulture endemic to southern Africa. Its range and population size have declined markedly over the last century. Namibia has just one colony, located on the cliffs of the Waterberg Plateau, with a population estimated to be eight adult birds, including two females. The species is regarded as Critically Endangered in Namibia, and establishing a secure breeding population may require intensive management. Data on movements, foraging range and behaviour of Cape Vultures, important in any management programme, have been lacking. Five adult males and one immature were captured near the Waterberg site and fitted with satellite-tracking devices. Only two of the adult vultures still roosted on the cliffs and only one of those exclusively; the other individuals roosted in trees. Three individuals were observed building and attending to nests in trees, and, for one of these, the partner was identified as an African White-backed Vulture (*Gyps africanus*). The foraging range of the adult birds was large compared with other studies of this species. Most foraging took place on freehold farms. All adults avoided areas of communally owned land where wild ungulates are uncommon, thus further decreasing their potentially available food supply. Two 'vulture restaurants', feeding sites specifically for vultures, within the foraging range of the adult birds accounted for a large proportion of their time spent on the ground. The ranging behaviour of adult vultures varied throughout the year, and was apparently related to their nesting behaviour.

Introduction

The Cape Vulture (*Gyps coprotheres*) is a large (8–10 kg) obligate cliff-nesting vulture endemic to southern Africa. Over the last century its range has contracted, and it no longer occurs in regions where it was once common, such as much of the former Cape Province of South Africa (Boshoff and Vernon 1980). Current population estimates suggest about 3,000 breeding pairs remain, centred in two large core populations: one around the Drakensberg Mountains in eastern South Africa and Lesotho, the other in the central part of northern South Africa and southern Botswana (Mundy *et al.* 1992, Anderson 2000, Borello and Borello 2002). These core populations show evidence of decline in recent years (e.g. Benson 2004, Rushworth and Piper 2004). There are also small populations in the Western Cape Province of South Africa, southern Mozambique and Namibia. The species is listed as threatened world-wide (Birdlife International 2006) and within South Africa (Anderson 2000) because the major threats to it (which include poison, drowning in reservoirs, use of body parts in traditional medicine, loss of habitat and shortage of food) are still in place.

Namibia has an extremely small population of Cape Vultures, located around the site of a now apparently defunct colony on the cliffs of the Waterberg Plateau in the north-central region of the country. This represents the northern limit of the present distribution of the species. The population of this colony has markedly decreased over the last 60 years, from approximately 500 birds in 1940 to just 13 adults in 1985 (Brown 1985). Sixteen individuals were recorded at a feeding station on top of the plateau in 1988 (Brown and Jones 1989); however, estimates put the current population in the area as low as eight adult birds, including only two females (M. Diekmann pers. obs.). Sightings of young birds in the area suggest there may still be one breeding pair. The species is regarded as Critically Endangered in Namibia (Robertson *et al.* 1998).

The decline of the Cape Vulture in Namibia has been attributed to several factors, of which the most important are likely to be indiscriminate use of poisons by farmers, and bush encroachment (Brown 1985). The majority of the land surrounding the Waterberg is used for cattle farming. Poison, particularly strychnine, is used by farmers to control mammalian predators, and vultures are inadvertent victims. Levels of poison usage cannot be assessed accurately, and vary from farm to farm, but what information there is suggests usage in the area may be high (Brown 1985, M. Diekmann pers. obs.) and that poison has a high impact on raptor populations (Brown 1989). Bush encroachment is caused by overgrazing of grass by cattle, which reduces competition for thorny shrub species left untouched by grazers (such as *Acacia mellifera* and *Dichrostachys cinerea*). This makes it less likely that a vulture will be able to locate a carcass, as they rely on eyesight to locate carcasses from the air, and could cause the vultures to forage over larger areas to fulfil their food requirements (Brown 1985). The use of 'vulture restaurants', where carcasses are placed specifically for scavengers, to provide food for vultures is becoming increasingly common (Piper 2004). Two exist in the Waterberg area, one in the Waterberg Plateau Park and the second on a nearby farm, but it is not known how much use the remaining Cape Vultures make of these.

Knowledge on the foraging ecology of the Cape Vulture is lacking, largely due to the difficulty in obtaining data. Previous studies have radio-tracked individuals (Boshoff *et al.* 1984) and made extrapolations from re-sightings of colour-ringed individuals (Brown and Piper 1988). These methods are fieldwork-intensive and will only collect data in areas where there are observers. The relatively recent development of satellite-tracking via a platform transmitter terminal (PTT) has opened new possibilities for studying species covering large distances. Satellite-tracking birds from the Waterberg area would provide invaluable data on the behaviour of the remnant population, allowing assessment of the feasibility of intensive population management programmes, such as the release of translocated or captive birds.

This paper presents data from 18 months of PTT satellite-tracking of five adult male and one immature Cape Vultures from the Waterberg colony, from January 2004 to September 2005. This period covers two breeding seasons (beginning in April, nestlings will fledge in November–December; Piper 2005) and two non-breeding seasons.

Methods

Data collection and collation

Five adult (hereafter referred to as *CV1–CV5*) and one immature (*Imm1*) Cape Vultures were captured in a walk-in trap on a farm located near the Waterberg Plateau (20°15′44″S 17°03′42″E), between January 2004 and February 2005. A seventh vulture (*WbV*) captured was possibly a hybrid from a breeding attempt between a Cape Vulture and an African White-backed Vulture, *Gyps africanus* (see Discussion). This identification was based on plumage traits; in the absence of genetic evidence, this bird should be regarded as a White-backed Vulture. All the vultures were fitted with a solar-powered Argos/GPS PTT-100 made by Microwave Telemetry, which was attached with a Teflon ribbon harness (Diekmann *et al.* 2005). This model of PTT uses the GPS system and provides far more accurate positional data than previous satellite-tracking devices. The devices were programmed to send one signal per hour from 04h00 to 19h00 GMT, accurate to ± 10 m, stored on the Argos system. For each location there is also an instantaneous reading of speed, heading and altitude. One transmitter ceased functioning after 9 months (*CV1*), one fell off after 2 months (*CV2*), and one of the immature birds (*WbV*) died from an unknown cause 6 months after the transmitter was fitted. For all other birds, the data analysed here ends in September 2005. The number of fixes per day varied from 0 to a maximum of 16. There was no sign of nocturnal activity in the data, thus all points after sunset and before sunrise were removed from the dataset.

Analysis

Data were analysed using ArcView 3.2 and Animal Movement Analysis v2 (Hooge and Eichenlaub 1997). Statistical analyses were carried out in the statistical package GenStat v8. Home ranges were calculated as minimum convex polygons (MCP). The distance flown each day by a vulture was calculated from the sequential straight-line distance between all the fixes for that day, and therefore represents a minimum estimate of distance flown. The calculated distance correlated strongly with the number of points recorded, therefore distance analysis was restricted to days where more than 14 fixes were collected. Since the locations given by the transmitters are only accurate to within 10 m at best, a vulture not moving from its roost-site can be recorded as having moved a short distance. We therefore only counted the vulture as having left the roost if the total movement for the day was greater than 2 km.

Using the speed reading, each location was categorized as the vulture being in flight or being on the ground/perched in a tree. A subset of this latter category was extracted, using the time of day, to identify the sites the vultures used to roost. The proportion of time spent in flight was estimated by dividing the number of points categorized as in flight by the total number of points. For utilization-availability analysis, only the ground sites were used. These were tested for independence by calculating the ratio t^2/r^2 (where t^2 is the mean squared distance between successive observations and r^2 is the mean squared distance of observations from the centre of activity, defined as the arithmetic mean of all coordinates), which should approach a value of 2.0, meaning that the animal has time to move across its entire range between observations (Swihart and Slade 1985). Points were removed at random if the requirements for independence were not met. The remaining points were analysed by assigning each point to a land type and comparing the number of points in each land type with the area of that type available, by calculating Bonferroni multiple confidence intervals (Byers *et al.* 1984). The study area was divided into four land types: freehold farmland, consisting of privately owned farms; communal land, where the land deeds are owned by no-one but the land is managed by local chiefs; nature reserves, land managed for the benefit of wildlife, the Waterberg Plateau Park being the only reserve in the study area; and other land types, including urban areas. Available habitat was defined as the combined MCP of all the adult birds. The ground sites at the two vulture restaurants in the area were included in this analysis, and these sites may affect the outcome.

Results

Ranges

There was a large difference in ranging behaviour between adult and immature individuals. The overall foraging range, calculated as MCP, of the five adults was 38,327 km^2, and the mean MCP was 21,320 km^2. For the two juveniles, mean MCP was 482,276 km^2, an order of magnitude larger. The adults remained in the area of the Waterberg Plateau for the duration of the study, while the immature individuals wandered widely. Figure 1 shows the area covered by *Imm1* over a 6 month period. After the tag was fitted, this individual flew to Etosha National Park, where it spent much of the subsequent time, from there making excursions into Angola, and then to the Okavango region of Botswana where it also settled for a short time. It also made a short excursion into Zambia. *WbV* also spent time in Etosha, and made an excursion into Angola.

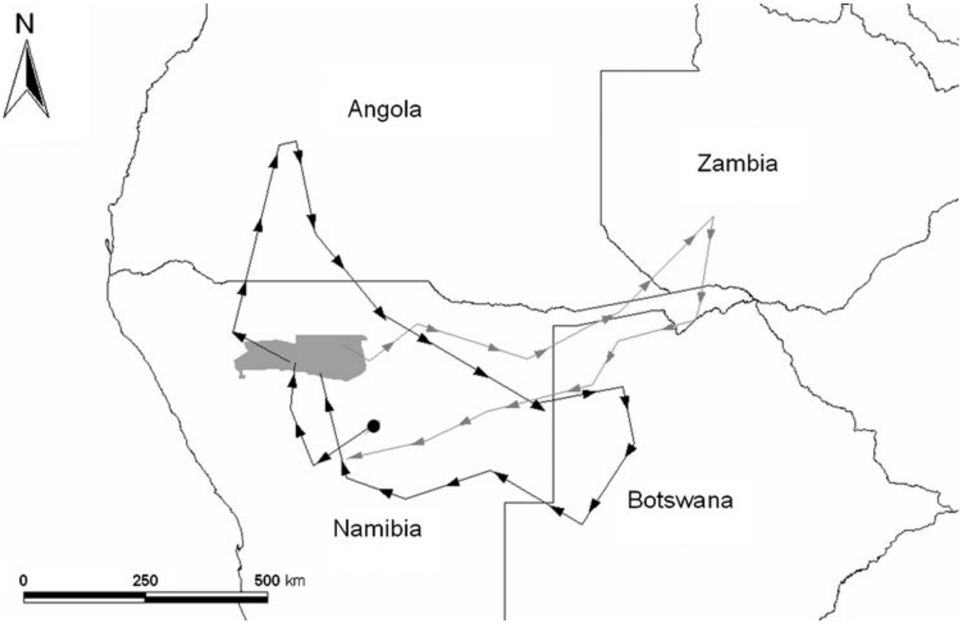

Figure 1. Simplified path taken by one immature Cape Vulture (*Imm1*) between February 2005 and September 2005. The black dot shows the location of the Waterberg Plateau; the shaded area is Etosha National Park.

Roosting and nesting sites

Each adult vulture made use of many roosting sites, but had a small number of main sites that were re-used frequently. The number of main sites varied between one and four. Only two of the vultures regularly roosted on the cliffs of the Waterberg, and only one exclusively used cliff roosts. One of the individuals that frequently re-used a site in a tree, *CV1* was observed nesting at this site with an African White-backed Vulture *Gyps africanus*. This nesting attempt began at the end of April 2004 and was still being attended to when the transmitter ceased functioning in September 2004. In 2005, two individuals, *CV4* and *CV5*, attended to nests in trees, both starting late in March. Neither partner was identified. *CV4* abandoned its nest in mid-August, *CV5* at the end of June. All individuals opportunistically roosted for single nights at other sites.

Other ground sites

Distances from main roosting sites to ground sites were skewed strongly towards nearby sites for all but one of the adults (Figure 2). This pattern was not affected by the removal of the vulture restaurant sites. Distance from roost to ground site showed no significant monthly variation for any individual (ANOVA square root distance: *CV1*: df = 8,93, $P = 0.126$; *CV3*: df = 8,148, $P = 0.077$; *CV4*: df = 9,165, $P = 0.335$; *CV5*: df = 8,114, $P = 0.114$). Figure 3 shows the ground sites, and thus foraging range, of the five adults. In selection of ground sites, all the adults avoided areas of communal land located to the south-east of the Waterberg. Three adults showed a preference for sites within the Waterberg Plateau Park, although the majority of these were accounted for by the vulture restaurant, and the preference did not exist when the vulture restaurant was excluded. The proportions of ground sites at vulture restaurants were 3.7% (CV2), 10.0% (CV1), 11.9% (CV4), 14.4% (CV3) and 17.9% (CV5). Frequency of use of the

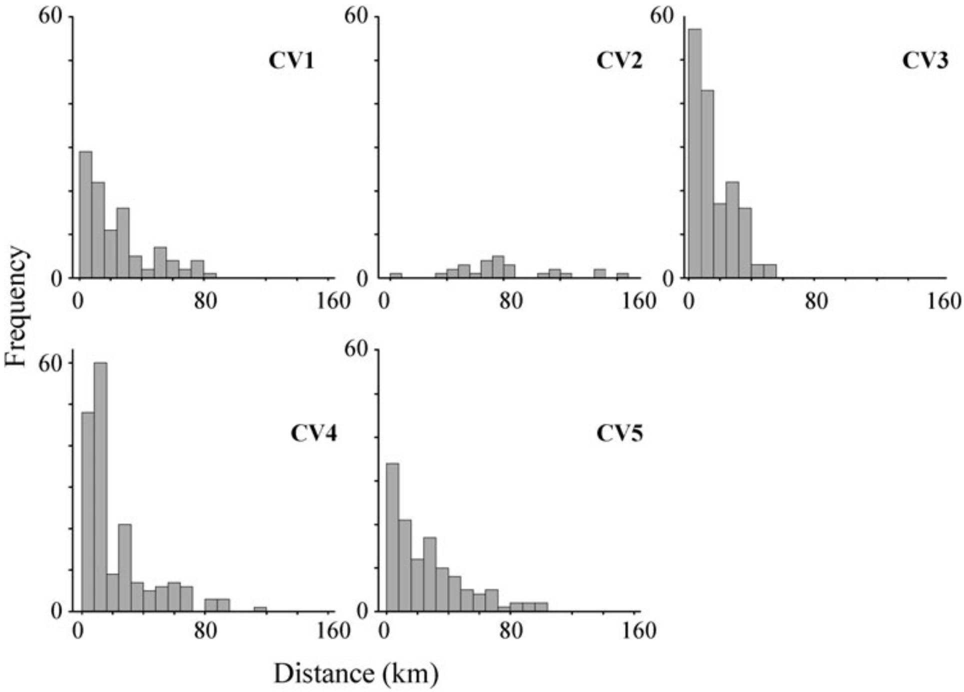

Figure 2. Frequency of distances from main roosting/nesting sites to feeding sites for five adult Cape Vultures.

two restaurants depended on the location of the roosting site, each individual making more use of the restaurant closest to its roost.

Time allocations

Figure 4 shows the average proportion of time spent (a) at main roosts; (b) flying and; (c) on the ground at other sites by each of the adult vultures and one juvenile in each month. The proportion of time spent in flight each day differed between the three individuals being tracked in 2005, and between months (ANOVA: Bird df = 2,297, $P < 0.001$; Month df = 8,297, $P = 0.003$). There is a seasonal difference coinciding with the birds attending to nests: there was a large increase in time spent at the main roost-site, and decrease in time spent flying, by two of the individuals in April, although not by *CV3*. A similar change is shown by *CV1* in 2004, although a month later. This change is matched by a decline in the proportion of days on which the vultures left their roost-sites during those months, with individuals spending 2-3 consecutive days on their nest. Distances flown each month in 2005, not including days when the birds did not leave their roost, were on average greater in February and June-September. To summarize, nesting vultures forage on fewer days, but on days when they do forage they spend more time foraging than non-nesting birds. Despite the greater time spent foraging, nesting birds do not cover a larger area.

Discussion

Robertson and Boshoff (1986) reported that Cape Vultures from the Potberg colony in South Africa foraged in an area of 1,940 km², a figure arrived at from a survey of 600 farmers near the

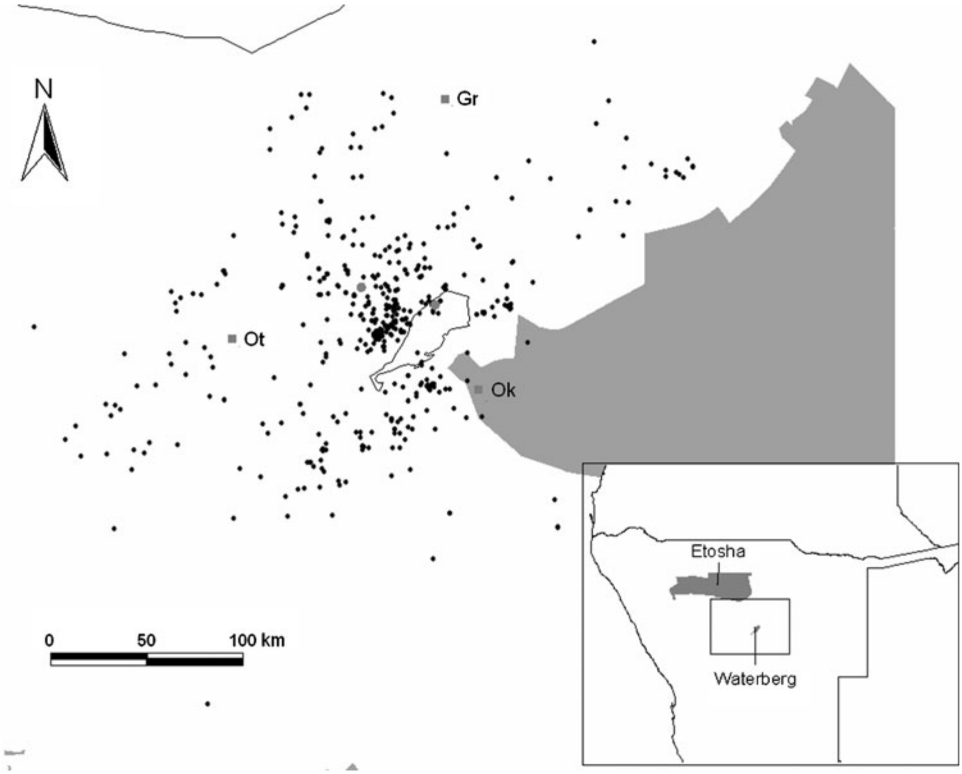

Figure 3. Feeding sites used by five adult Cape Vultures around the Waterberg Plateau. The large dot shows the location of the colony. Shaded areas are communal land, outlines show nature reserves, and other areas are freehold farms. Nearby towns are shown: Ot, Otjiwarongo; Gr, Grootfontein; Ok, Okakakara.

colony who were asked if they ever sighted Cape Vultures on their property. Although there were a few outliers, the boundary between farmers who said they sighted Cape Vultures and those who did not was distinct. This figure was roughly the same as that Boshoff *et al.* (1984) had obtained by radio-tracking. Brown and Piper (1988) estimated the ranges of Cape Vultures in the South African Drakensberg Mountains by capturing and marking a sample of birds and then, using observations of the number of vultures recorded at carcasses, the proportion of marked birds in these congregations, and the known distribution of Cape Vulture colonies in the area, calculated a home range of 9,200 km^2. These figures, based on far fewer data than the current study, are much smaller than the figure reported here. These differences must be at least partly due to the different methods used, which can have a large effect on recorded home ranges (Salamolard 1997). If Brown (1985) is correct that foraging range provides a measure of the ease with which vultures can locate food, the large ranges recorded in this study suggest that the area around the Waterberg may consist of more marginal habitat for Cape Vultures.

Nearly all foraging by these individuals took place on farmland, indicating that the greatest risk of poisoning is in these areas. An important aspect of the conservation of this colony is thus likely to be the education of farmers on responsible usage of poisons. In both this and Robertson and Boshoff's (1986) study the vultures apparently did not make use of all available habitat, in that they did not make use of all the farmland near the colony. It may be that the habitat beyond their normal range is not suitable: the distribution of food available to vultures around the Waterberg is not known. Some patterns are already apparent: all vultures avoided communal

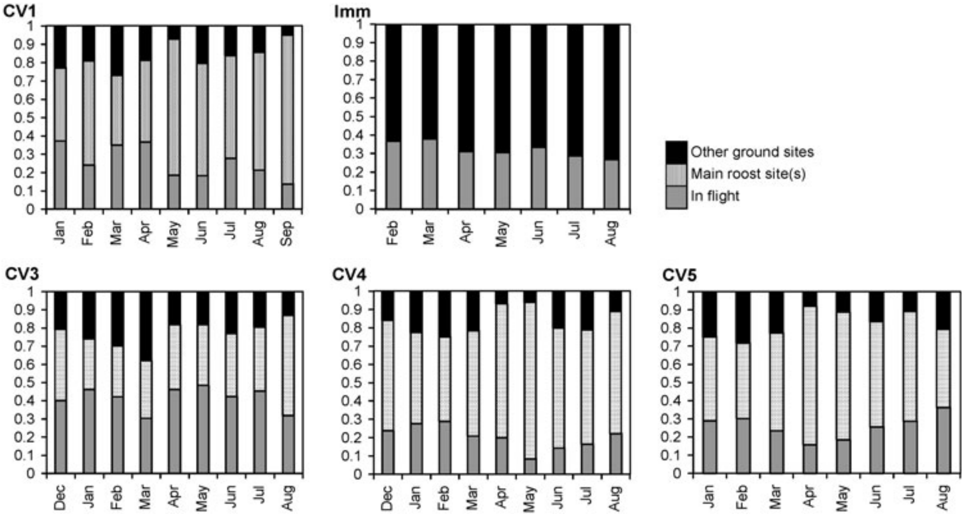

Figure 4. Proportion of time spent flying, on the main roost, or at other ground sites by five adult and one juvenile Cape Vulture.

land, which has fewer large ungulates than the farmland areas (Mendelsohn *et al.* 2002). The Cape Vultures seemed to obtain very little natural food in the Waterberg Plateau Park, but did make extensive use of the vulture restaurant there. The two restaurants accounted for a fairly large proportion of the ground sites used by the vultures, and presumably therefore also of their food supply, suggesting that this is an effective conservation measure. If the restaurants are discounted, nearly all the food obtained by the vultures was on farmland.

Robertson and Boshoff (1986) reported a seasonal effect on foraging range: during winter, when breeding begins, feeding sites were twice the distance from the colony as those visited in summer. The individuals in this study also showed changes in their ranging behaviour during the nesting season, flying greater distances when they left the nest. One weakness of the satellite-tracking method is that the purpose of the vultures landing at each ground site cannot be discerned, so it is not possible to say if this change in ranging behaviour relates to a change in foraging behaviour or a change in other aspects of behaviour, such as the apparent social gatherings observed at waterholes (e.g. Sauer 1973).

No other study has recorded adult Cape Vultures roosting or nesting in trees. This behaviour is unlikely to be exceptional, just unnoticed previously due to the difficulty in monitoring individuals: there are recent reports of adult Cape Vultures in South Africa roosting in trees (e.g. Rushworth and Piper 2004). However, the frequency with which the individuals in this study roosted in trees was unexpected, with three of the five adults never using cliff sites. The potential importance of this is illustrated by an attempt to interbreed with *G. africanus*. This nesting attempt was thought to have produced a hybrid (M. Diekmann pers. obs.), which is likely to have been *WbV* since this individual roosted in the nesting tree for several weeks before starting to wander. Two other individuals attended to nests in trees the following year, although their partners were not identified.

The large range and apparently random movement of both immature birds were expected by Mundy *et al.* (1992), who hypothesized that immature Cape Vultures, unable to compete for food with adults, seek out areas lacking adult Cape Vultures but where other species against which they are able to compete are present. Etosha National Park, where both immature vultures spent large amounts of time, is such an area. However, the competition from the few adult Cape Vultures in the Waterberg region is not likely to affect a young bird much, and this argument does not apply to the White-backed Vulture, which showed the same behaviour yet was moving to an area of roughly equal competition. Another hypothesis is an increase in territoriality at the start of the breeding season, when both individuals began their wanderings. *Imm1* had not returned to the Waterberg area by the end of the period covered by the data analysed here, but had settled close by, outside the range of the adult birds. *WbV* returned to the area on several occasions but again this argument does not seem to apply to this individual, which spent much of the subsequent time in another area with breeding adults. The reasons for the long-distance wanderings of the immature vultures remain obscure.

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ANDREW J. BAMFORD*
School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough, Leicestershire, LE12 5RD, U.K.

MARIA DIEKMANN
Rare and Endangered Species Trust, P. O. Box 178, Otjiwarongo, Namibia.

ARA MONADJEM
Department of Biological Sciences, University of Swaziland, Private Bag 4, Kwaluseni, Swaziland.

JOHN MENDELSOHN
Research and Information Services of Namibia, P. O. Box 1405, Windhoek, Namibia.

**Author for correspondence; e-mail: sbxajb@nottingham.ac.uk*

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