

## Demography of migratory vultures in and around Jodhpur, India

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### Introduction

Out of nine species of vultures which occur in India, seven species have been recorded in and around Jodhpur in western Rajasthan, India. These are the King Vulture (*Sarcogyps calvus*), Cinereous Vulture (*Aegypius monachus*), Egyptian Vulture (*Neophron percnopterus*), Eurasian Griffon (*Gyps fulvus*), Himalayan Griffon (*Gyps himalayensis*), Long-billed Vulture (*Gyps indicus*) and White-rumped Vulture (*Gyps bengalensis*) (Chhangani 2002a, 2004, 2005). Four of these, King Vulture, Long-billed Vultures, White-backed Vulture and Egyptian Vulture, are resident and breed in the area. Eurasian Griffon, Himalayan Griffon and Cinereous Vulture are winter visitors, seen in and around Jodhpur city from October to March (sometimes until mid-April), coming from southern Europe, central Asia, China, Tibbat and northern India. The number of migratory vultures gradually starts increasing from October and reaches a peak in January and February. In a discussion of the numbers of Eurasian Griffon wintering in India, Prakash et al. (2003) reported that "Over the past few years, unusually large numbers of *G. fulvus* have been reported wintering in India, and feeding at carcass dumps (e.g. 850 *G. fulvus* were observed at Jor Bir carcass dump in western Rajasthan in January 2002, authors'

unpublished observation). The Eurasian Griffon has undergone a moderate to large decline in most of its eastern range in Europe and the Middle East; whereas a moderate to large increase has occurred in most of its western and southern European range (Donazar & Fernandez 1990, Arroyo 1994, Fernandez *et. al.* 1998, Vaassan 2001, Camina 2004a,b, Camina & Matelio 2006). The cause of the population increase in these areas is reduced persecution (poisoning, shooting and disturbance), protection of the breeding colonies and an abundant supply of food (Camina 2004b, Camin & Montelio 2006). Monitoring of the numbers of vultures wintering in India and documentation of mortalities has therefore become important in estimating future threats to their respective populations. In this paper we present data on the numbers of Eurasian Griffons, Himalayan Griffons and Cinereous Vultures at Jodhpur, Western India, between the winters of 1995 and 2004. These three species of migratory vultures were observed feeding along with resident vultures, *G. indicus*, *G. bengalensis* and *Neophron percnopterus* (and other birds and mammals), at the Keru Municipal Corporation's animal dumping ground, the main feeding site for the vulture population in and around Jodhpur.

**Study area & methods**

This study was conducted from 1995 to 2004 in and around Jodhpur city, an area of over 120 km<sup>2</sup>. It lies at 26°19'N; 73°8'E (240 m a.s.l.) at the eastern fringe of great the Indian desert in Rajasthan, India (Figure 1). The study area consists of open scrub, protected and unprotected forest and

undulating low hillocks. The vegetation of the habitat is broadly arid, with open scrub forest with xerophytic plants such as *Acacia senegal*, *A. nilotica*, *Euphorbia caducifoliya*, *Anogeisus pendula*, *Mytenus emarginata*, *Greioia tenex*, *Ziziphus numularia* and *Prosopis juliflora*. The climate of Jodhpur and its vicinity is

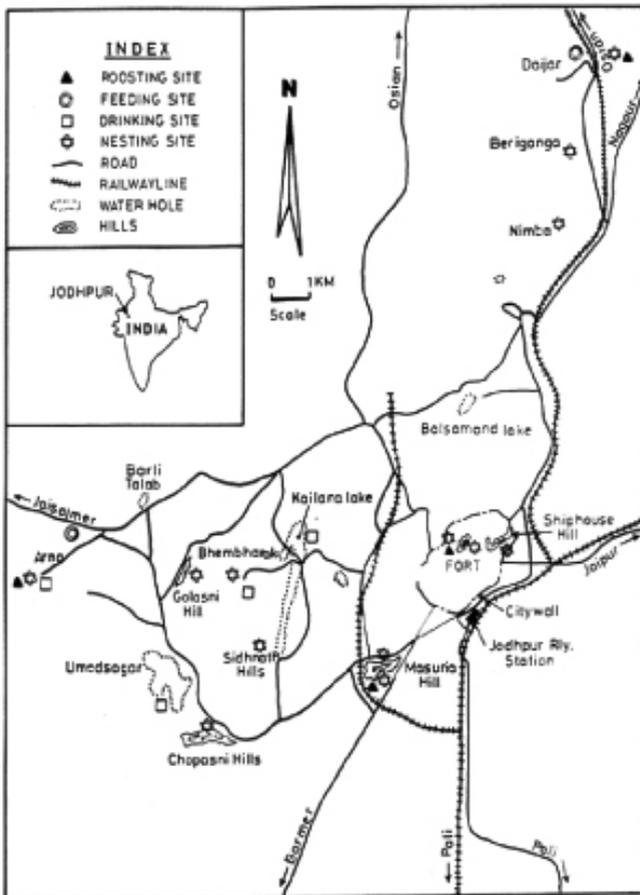


Figure 1. Location of roosting, feeding and drinking sites of migratory vultures in and around Jodhpur, Western India.

mainly arid and dry, characterized by uncertain and variable rains resulting in one lean year out of every three years and one famine year in eight years (Mohnot 1974). The temperature extremes are a striking feature of the region. The mean monthly temperature is about 17°C, with a maximum of up to 48°C in summer and a minimum of 1°C in winter. The average annual rainfall is about 300 mm, and 90% of this falls during the monsoon period from July to September.

A large number of mammals are present in the study area, including Hanuman Langur *Semnopithecus entellus*, Blue Bull *Boselaphus tragocamilus*, Chinkara *Gazella bennetti*, Black Buck *Antilope cervicapra*, Jungle Cat *Felis chaus prateri*, Wolf *Canis lupus*, Jackal *Canis aureas*, Fox *Vulpus bengalensis*, Wild Boar *Sus scrofa*, Common Mongoose *Herpestes edwarsi* and Small Indian Mongoose *H. auropunctatus* with a sizable population of livestock and other domestic animals. It was calculated during the 1997 census that Rajasthan supported 54,627,756 head of livestock, including 16,971,078 goats, 12,141,402 cattle, 14,584,819 sheep, 9,770,490 buffalo, 669,443 camels, 185,604 donkeys, 30,4820 pigs and 24,016 horses, which is about 7% of India's total livestock population. Animal husbandry contributes 19% of the State GDP (as per Government of India Planning Commission Report 2006).

Since 1995, we have been studying the ecology and population dynamics of resident and migratory vultures by monitoring their

nesting sites, collecting data on aspects of their demography, interspecific interactions, seasonal movements, and behaviour in and around Jodhpur (Chhangani 2002a, 2002b, 2003, 2004, 2005, Chhangani & Mohnot 2004).

Vultures were counted at Keru Municipal Corporation's dumping site, the vultures' feeding site, and at Kaylana Lake and Barli Talab, the vultures' drinking site, during the peak hours of feeding (10h00 to 14h00) and drinking (12h00 to 16h00). To avoid duplication, the surveys were done simultaneously at the different localities using 10x50 and 7x35 binoculars. Still images and video footage were used to confirm the counts. The highest number of individuals counted during a monthly survey was considered to be the annual census for the year. Behavioural observations were made by scan and ad libitum sampling (Altmann 1974). Often close observations were made from a hide or vehicle, thus ensuring that the vultures' natural behaviour was not disturbed. Incidental information was also collected on interactions between species and other birds and animals feeding at the dumping site (Chhangani & Mohnot 2001). We recorded information on the species and number of carcasses provided at the feeding sites.

The present study uses the data collected from 1995 to 2004 to determine population trends, and we calculated the rate of population increase using the following formula:

Per capita rate of increase:  $\lambda = \frac{N_{t+1}}{N_t}$

Where  $N_t$  is the number of individuals in the population at time 't', and  $N_{t+1}$  is the number after one year.

The growth rate (or exponential rate of increase) was calculated as  $r = \log_e \lambda$ .

## Results and discussion

### Population

The resident vultures were observed throughout the year at the feeding and drinking sites, but migratory Himalayan Griffons, Eurasian Griffons and Cinereous Vultures were only seen during the winter months. Their numbers gradually increased from October and reached a peak during January and February. We observed all age groups of Himalayan Griffons and Cinereous Vulture, i.e. juveniles, subadults and adults. The majority of the Eurasian

Griffons observed in the study area however were immature and subadult birds, and the few adults were presumed to be non-breeding individuals. From March onwards the number of migratory vultures started decreasing and they were then absent from May to September (the period when it is very hot in Jodhpur).

The migratory vulture population increased from about 20% of the total vulture population ( $n=630$ ) in 1995 to about 37% of the total vulture population ( $n=1174$ ) in 2004. There was therefore a 17% increase in the migratory vulture population in the 10 year period. During this time there was a decline in the numbers of the two resident vultures, the Long-billed and White-backed Vultures.

The annual population of these migratory vulture species with resident vulture species is given in Table 1 and Figures 2 and 3.

Table 1. Population data of resident and migratory vulture species observed in and around Jodhpur.

Census year	Himalayan Griffon	Eurasian Griffon	Cinereous Vulture	Total no. of migratory vultures	Per capita rate of increase ( $\lambda$ )	Growth rate $r = \log_e \lambda$
1995	37	68	24	129	–	–
1996	58	86	20	164	1.27	3.45
1997	74	108	25	207	1.26	3.42
1998	86	105	28	219	1.05	2.85
1999	78	95	30	203	0.92	2.50
2000	67	121	38	226	1.11	3.01
2001	83	152	35	270	1.19	3.23
2002	107	179	52	338	1.25	3.39
2003	111	204	67	382	1.13	3.07
2004	127	237	76	440	1.15	3.12

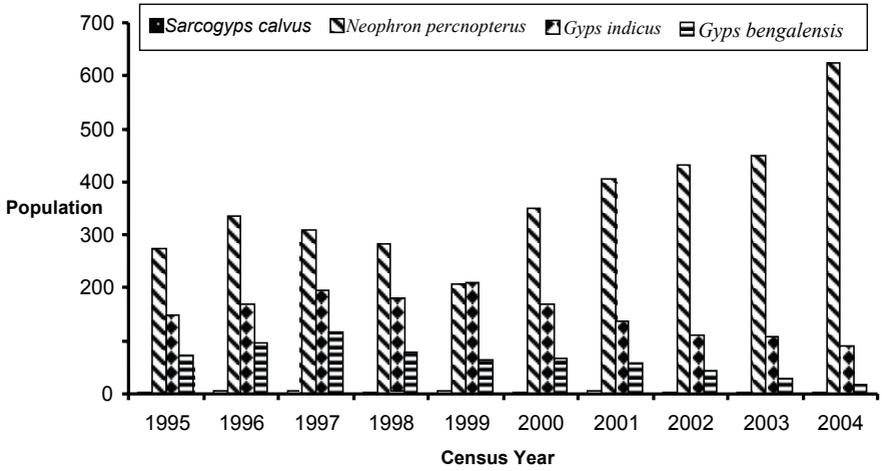


Figure 2. Number of resident vultures in and around Jodhpur.

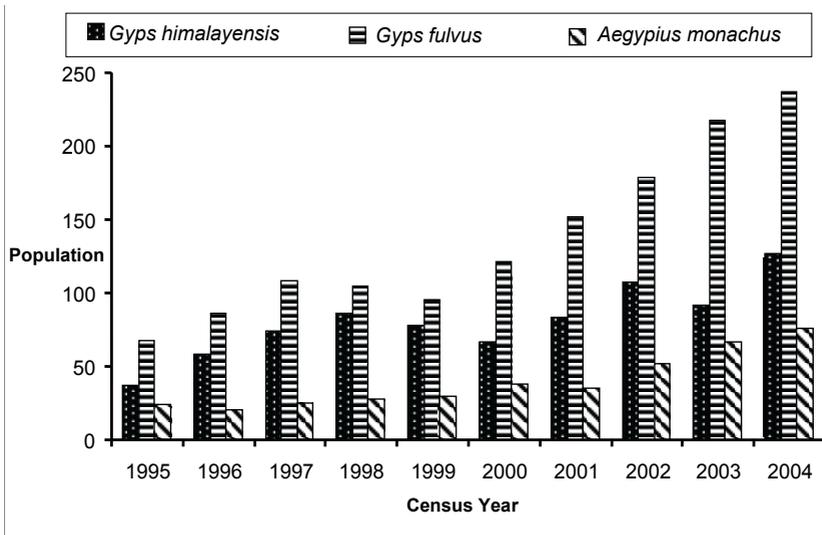


Figure 3. Number of migratory vultures in and around Jodhpur.

The Himalayan Griffon has a very extensive range from Afghanistan, the Himalayas and Tibet to China and Mongolia. It is the largest of all the *Gyps* vultures. It occurs in lower levels in North India, especially during winter (Meyburg 1985). The Cinereous Vulture's range extends from Spain to Mongolia and in the to south in China and Tibet. The Cinereous Vulture is however extinct from many parts its range, including in Morocco, Portugal, Italy and Romania, but it still occurs in Spain, Greece, the Balkans and there is one pair in Bulgaria (Meyburg 1985, Camina 2004a,b, Camina & Matelio 2006).

### Feeding

An average of 10 to 15 carcasses are delivered to the dumping site every day, all year round, with a minimum of five and a maximum of 15 carcasses per day. 80% of these carcasses are of cows, 10% buffalos, 4% goats, 2% donkeys, 2% dogs, and the remaining 2% include camels, horses and pigs. These vultures are therefore mainly consuming the carcasses of domestic animals (Chhangani 2005), meat which may be more digestible than other carrion, as was found in a study conducted in Pennsylvania on Turkey Vulture (*Cathartes aura*) (Coleman & Fraser 1987). Supplementary feeding has significantly increased the population of Eurasian Griffons in Spain, Portugal,

France and former Yugoslavia (Fernandez *et al.* 1998, Leconte 1985, Marinkovic *et al.* 1985, Muntaner & C.R.P.R. 1985, Terrassa 1985, Palma *et al.* 1999, Camina 2004a,b).

We did not examine the carcasses for diclofenac contamination, despite diclofenac being widely and regularly used in Pakistan and India and causing the deaths of many vultures (Risebrough 2006, Swan *et al.* 2006). However, we did not find any dead vultures or any other birds or mammals at the Keru Municipal Corporation dumping ground (Chhangani & Mohnot 2004). It is interesting that, despite diclofenac causing the decline of the *Gyps* vulture population in the Indian subcontinent (Oaks *et al.* 2004, Green *et al.* 2004, Gilbert *et al.* 2006, Swan *et al.* 2006, Cuthbert *et al.* 2006), the migratory *Gyps* vultures do not seem to be affected. Similarly, kites *Milvus migrans*, domestic dogs and other scavengers have not shown a reduction in population numbers (Risebrough 2006).

A variety of birds and mammals feed alongside the vultures at the dumping site (Table 2) (Chhangani *et al.* 2002), including Common Raven *Corvus carax*, House Crow *Corvus splendens*, Cattle Egret *Bubulcus ibis*, Drongo *Dirurus macrocercus*, Green Bee-eaters *Merops philippinus*, Rosy Pastar *Strunus roseus*, Feral Dog *Canis familiaris* and Jackal *Canis aureas*. These have all shown a population increase.

Table 2. Birds and mammals observed at vulture feeding sites in the study area.

Common name	Scientific name	Status*	Locality
<b>Birds</b>			
Tawny Eagle	<i>Aquila rapax</i>	C	All the places
Steppe Eagle	<i>Aquila nipalensis</i>	C	All the places
Black Kite	<i>Milvus migrans</i>	C	All the places
Cattle Egret	<i>Bubulcus ibis</i>	VC	All the places
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	C	Keru, Jodhpur
Indian Roller	<i>Coracias benghalensis</i>	O	Keru, Jodhpur
Common Hoopoe	<i>Upupa epops</i>	C	All the places
Black Drongo	<i>Dicrurus macrocercus</i>	VC	All the places
Rosy Starling	<i>Sturnus roseus</i>	C	Keru, Jodhpur
Common Starling	<i>Sturnus vulgaris</i>	O	Keru, Jodhpur
Grey Shrike	<i>Lanius excubitor</i>	O	All the places
Common Myna	<i>Acridotheres tristis</i>	C	All the places
Bank Myna	<i>Acridotheres ginginianus</i>	C	Keru, Jodhpur
House Crow	<i>Corvus splendens</i>	VC	All the places
Common Raven	<i>Corvus corax</i>	VC	Keru, Jodhpur
Large-billed Crow	<i>Corvus macrorhynchos</i>	C	Keru, Jodhpur
Blue-checked Bee-eater	<i>Merops persicus</i>	VC	All the places
Blue-tailed Bee-eater	<i>Merops philippinus</i>	C	Keru, Jodhpur
Green Bee-eater	<i>Merops orientalis</i>	C	All the places
Yellow-headed Wagtail	<i>Motacilla flava</i>	O	Keru, Jodhpur
Grey Wagtail	<i>Motacilla cinerea</i>	O	Keru, Jodhpur
Red-wattled Lapwing	<i>Vanellus indicus</i>	O	Keru, Jodhpur
Indian Robin	<i>Sexicoloides fulicata</i>	C	All the places
<b>Mammals</b>			
Chinkara	<i>Gazella bennettii</i>	C	Jorbeer, Bikaner
Nilgai	<i>Boselaphus tragocamelus</i>	VC	Keru, Jodhpur
Jackal	<i>Canis aureus</i>	C	Akhakhal, Ahmedabad Keru, Jodhpur

Wolf	<i>Canis lupus</i>	O	Jodhpur
Jungle Cat	<i>Felis chaus</i>	R	Keru, Jorbeer
Desert Cat	<i>Felis lybica</i>	R	Jorbeer, Bikaner
Hyaena	<i>Hyaena hyaena</i>	O	Keru, Jodhpur
Porcupine	<i>Hystrix indica</i>	R	Keru, Jodhpur
Grey Mongoose	<i>Herpestes edwardsi</i>	C	Keru, Jodhpur
Small Indian Mongoose	<i>Herpestes auropunctatus</i>	O	Keru, Jodhpur
Hedgehog	<i>Paraechinus micropus</i>	O	Keru, Jorbeer
Wild Boar	<i>Sus scrofa cristatus</i>	O	Keru, Jodhpur



Figure 3. Six species of vultures, *Gyps indicus*, *Gyps bengalensis*, *Gyps fulvus*, *Gyps himalayensis*, *Aegypius monachus* and *Neophron percnopterus* feeding at Keru Dumping Ground, Jodhpur.

Mortality

From 1995 to 2004, a total of 106 dead migratory vultures were found at the different localities (Table 3). All of the eleven cases of mortality at the feeding site were due to feral dog predation. The

cause of death of the 79 vultures at the roost sites is unknown. Of the 16 vultures found dead at other sites, 13 were killed by motorcars in road accidents and the reasons for the deaths of the other three birds is not known.

Table 3. Mortality of migratory vultures at the different sites from 1995 to 2004.

Vulture species	At feeding site	At roosting site	Other sites	Total
Himalayan Griffon	7	47	5	59
Eurasian Griffon	3	29	10	42
Cinereous Vulture	1	3	1	5
Total	11	79	16	106

Although predation of large raptors by predators is usually limited (Prakash 1999), incidents of predation on vultures (incl. eggs, chicks, juveniles and adults) at the feeding, roosting and other sites were well recorded (Coleman & Fraser 1987, Chhangani 2003, 2005).

**Conclusions**

Unfortunately, besides this study, there is limited information about migratory vultures in India. Demographic data are only available for a few sites, including Jodhpur. Monitoring programmes should be extended to other areas, and information should be collected on the exact causes of vulture mortalities. Besides ex situ captive breeding programmes, the in situ management and conservation of the remaining resident

and migratory *Gyps* vulture population is required.

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**References**

- Altmann, J. 1974. Observational study of behaviour: sampling methods. *Behaviour* 49: 227–267.
- Arroyo, B. 1994. Griffon Vulture, *Gyps fulvus*. In: birds in Europe. Their conservation status. Tucker, G.M. & Heath, F.M. (eds). pp 156-157. BirdLife Conservation Series No. 3. BirdLife International.
- Camina, A. 2004a. Consequences of the Bovine Spongiform Encephalopathy (BSE) on breeding success and food availability of Spanish vulture populations. In: Raptors Worldwide. Meyburg B.U., Chancellor R.D. (eds). pp. 27-44. MME-World Working group on Birds of Prey. Hungary
- Camina, A. 2004b. The Eurasian Griffon Vulture *Gyps fulvus* in Spain: current research and conservation programmes. In: Raptors Worldwide. Meyburg B.U., Chancellor R.D. (eds). pp. 45-60. MME-World Working group on Birds of Prey. Hungary
- Camina, A. & Montelio, E. 2006. Griffon vulture *Gyps fulvus* food shortages in the Ebro Valley (NE Spain) caused by regulations against Bovine Spongiform Encephalopathy (BSE). *Acta Ornithologica* 41(1): 7-13.
- Chhangani, A.K. 2002a. Avifauna in and around Jodhpur, Rajasthan, India. *Newsletter for birdwatchers* 42(2): 24-26.
- Chhangani, A.K. 2002b. Successful rescue and rearing of Indian Long-billed vulture (*Gyps bengalensis*) at Jodhpur Zoo, India. *Zoos Print* 17(7): 20-22.
- Chhangani, A.K. 2003. Predation on vultures, their eggs and chicks by different predators in and around Jodhpur, Rajasthan, India. *Newsletter for birdwatchers* 43(3): 38-39.
- Chhangani, A.K. 2004. Status of breeding population of Long-billed Vulture (*Gyps indicus indicus*) in and around Jodhpur (Rajasthan), India. *Vulture News* 50: 15-22.
- Chhangani, A.K. 2005. Population ecology of vultures in the western Rajasthan, India. *Indian Forester* 131(10): 1373-1382.
- Chhangani, A.K. & Mohnot, S.M. 2001. Demography of vulture population around Jodhpur in western Rajasthan (India) (abstract). XXVII International Ethological Congress, Tubingen.
- Chhangani, A.K. & Mohnot, S.M. 2004. Is Diclofenac the only cause of vulture decline. *Current Science* 87(11): 1496-1497.
- Coleman, J.S. & Fraser, J.D. 1987. Food habits of black and turkey vultures in Pennsylvania and Maryland. *Journal of Wildlife Management* 51(4): 733-739.
- Cuthbert, R., Parry-Jones, J., Green, R.E. & Pain, D.J. 2006. NSAIDs and scavenging birds: potential impacts beyond Asia's critically endangered vultures. *Biological Letters* doi: 10.1098/rsbl.2006.0554.

- Donazar, J.A. & Fernandez, C. 1990. Population trends of the Griffon Vulture, *Gyps fulvus* in Northern Spain between 1969 and 1989 in relation to conservation measures. *Biological Conservation* 53: 83-91.
- Fernandez, C., Azkona, P. & Donazar, J.A. 1998. Density-dependent effects on productivity in the Griffon Vulture, *Gyps fulvus*: the role of interference and habitat heterogeneity. *Ibis* 140: 64-69.
- Gilbert, M., Watson, R.T., Virani, M.Z., Oaks, J.L., Ahmed, S., Chaudhry, J.I., Arshad, M., Mahmood, S., Ali, A. & Khan, A.A. 2006. Rapid population declines and mortality clusters in three oriental white-backed vulture *Gyps bengalensis* colonies in Pakistan due to diclofenac poisoning. *Oryx* 40: 388-399.
- Green, R.E., Newton, I., Shultz, S., Cunningham, A.A., Gilbert, M., Pain, D.J. & Prakash, V. 2004. Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. *Journal of Applied Ecology* 41: 793-800.
- Leconte, M. 1985. Present status of the Griffon Vulture on the northern slopes of the western Pyrenees. In: Conservation Studies on Raptors. Newton, I. & Chancellor, R.D. (eds). Proceedings of the Second World Conference on Birds of Prey, Thessaloniki, 1982. pp 117- 127. ICBP Technical Publication No. 5, ICBP, Cambridge, UK.
- Marinkovic, S., Susic, G., Grubac, B., Soti, J.P. & Simonov, N. 1985. The Griffon Vulture in Yugoslavia. In: Conservation Studies on Raptors. Newton, I. & Chancellor, R.D. (eds). Proceedings of the Second World Conference on Birds of Prey, Thessaloniki, 1982. pp 131- 135. ICBP Technical Publication No. 5, ICBP, Cambridge, UK.
- Meyburg, B.-U. 1985. Wild Status of old world vulture species. AAZPA Regional Conference Proceedings, 626-631.
- Mohnot, S.M. 1974. Ecology and behaviour of the Common Indian Langur, *Presbytis entellus*. Ph.D. thesis, Univ. of Jodhpur, Jodhpur.
- Muntaner, J. & C.R.P.R. 1985. The status of diurnal birds of prey in Catalonia, Northeastern Spain. In: Conservation Studies on Raptors. Newton, I. & Chancellor, R.D. (eds). Proceedings of the Second World Conference on Birds of Prey, Thessaloniki, 1982. pp 29-44. ICBP Technical Publication No. 5, ICBP, Cambridge, UK.
- Oaks, J.L., Gilbert, M., Virani, M.Z., Watson, R.T., Meteyer, C.U., Rideout, B.A., Shivaprasad, H.L., Ahmed, S., Chaudhry, M.J.L., Arshad, M., Mahmood, S., Ali, A. & Khan, A.A. 2004. Diclofenac residues as the cause of vulture population decline in Pakistan. *Nature* 427: 630-633.
- Palma, L., Onofre, N. & Pombal, E. 1999. Revised distribution and status of diurnal birds of prey in Portugal. *Avocetta* 23(2): 3-18.

- Prakash, V. 1999. Status of vultures in Keoladeo National Park, Bharatpur, Rajasthan, with special reference to population crash in *Gyps* species. *Journal of Bombay Natural History Society* 96(3): 365-378.
- Prakash, V., Pain, D.J., Cunningham, A.A., Donald, P.F., Prakash, N., Verma, A., Gargi, R., Sivakumar, S. & Rahmani, A.R. 2003. Catastrophic collapse of Indian White-backed *Gyps bengalensis* and Long-billed *Gyps indicus* vulture populations. *Biological Conservation* 109: 381-390.
- Risebrough, R.W. 2006. Diclofenac: A new environmental poison in south Asia. *Journal of Bombay Natural History Society* 103(2-3): 57-68.
- Swan, G.E., Cuthbert, R., Quevedo, M., Green, R.E., Pain, D.J., Bartels, P., Cunningham, A.A., Duncan, N., Meharg, A.A., Oaks, J.L., Parry-Jones, J., Shultz, S., Taggart, M.A., Verdoorn, G. & Wolter, K. 2006. Toxicity of diclofenac to *Gyps* vultures. *Biological Letters* 2: 279-282.
- Terrasse, J.F. 1985. The effects of artificial feedings on Griffon, Bearded and Egyptian Vultures in the Pyrenees. In: Conservation Studies on Raptors. Newton, I. & Chancellor, R.D. (eds). Proceedings of the Second World Conference on Birds of Prey, Thessaloniki, 1982. pp 429- 430. ICBP Technical Publication No. 5, ICBP, Cambridge, UK.
- Vaassen, E.W.A.M. 2001. Status of Griffon vulture, *Gyps fulvus* in the central Taurus Region, Southern Turkey- a population estimate. *Vulture News* 44: 3-17.

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