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POPULATION DECLINE OF VULTURES IN THE INDIAN SUBCONTINENT ASSOCIATED WITH SOME SOCIAL ASPECTS

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ABSTRACT
Indian White-backed Vulture was thought likely to be the commonest large bird of prey in the world but the era of abundant *Gyps* vultures in the Indian subcontinent came to a sudden end in the 1990s which was firstly documented in Keoladeo National Park, Bharatpur in eastern Rajasthan. Eight, out of nine species of vultures found in India have been facing problem of existence and therefore declared as threatened. Veterinary use of the non-steroidal anti-inflammatory drug, diclofenac in livestock is the main, cause of the population declines. Other reasons believed to be responsible for the decline are loss of nesting habitat, decreased breeding efficiency, infectious diseases, general environmental pollution etc. Vultures are exposed to toxic levels of diclofenac when they feed on carcasses of livestock which have died within a few days of treatment, and which contain residues of the drug. Vultures provide very important ecological, social and cultural services especially in India by scavenging on animal carcasses of animals and thereby helping to keep the environment clean, and the disposal of dead bodies as per the religious practices of the Parsi community. Vultures are the primary removers of carrion in India and Africa. Removal of a major scavenger from the ecosystem will affect the equilibrium between populations of other scavenging species and will result in increase in putrefying carcasses. The provision of supplementary food is a well-established tool in the conservation of vulture species. General public involvement and supplementary feeding tried in different parts of the world could be successful in conservation of vultures in India.

KEYWORDS: Vultures, Population Decline, Diclofenac, Supplementary Feeding, Indian subcontinent, Conservation measures.

INTRODUCTION
Nine species of vultures are found in India out of which eight have been facing problem of existence and therefore declared as threatened. Of these, four species endemic to South Asia, the Indian White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus*, Slender-billed Vulture *Gyps tenuirostris* and Red-headed Vulture *Sarcogyps calvus* are at high risk of global extinction and are listed as critically endangered because of rapid population declines within the last decade in the Indian subcontinent. Moreover, Egyptian Vulture *Neophron percnopterus* has been categorised as endangered, and Cinereous Vulture *Aegypius monachus*, Himalayan Griffon *Gyps himalayensis* and Bearded Vulture *Gypeatus barbatus* have been placed under near threatened category (Prakash *et al.* 2003; Green *et al.* 2004; IUCN 2014).

Although *Gyps* vulture populations were probably declining slowly in many parts of the world during the 20th century, a very different situation existed in the India subcontinent. In the subcontinent, large populations of Indian White-backed Vulture and Long-billed Vulture remained until the 1990s. Large numbers of Slender-billed Vulture, which was not distinguished as a separate species from Long-billed Vulture until recently (Rasmussen and Parry 2001), were also found in the northeastern parts of the subcontinent (Ali and Ripley 1983; Prakash *et al.* 2007). During the 1980s Indian White-backed Vulture was thought likely to be the commonest large bird of prey in the world (Houston 1985). In India, *Gyps* vulture densities were so high in some areas that they were considered a hazard to aircraft (Grubh *et al.* 1990). This abundance was undoubtedly due to a plentiful food supply, in the form of the carcasses of domesticated ungulates (Pain *et al.* 2008). The era of abundant *Gyps* vultures in the Indian subcontinent came to a sudden end in the 1990s. This was firstly documented in Keoladeo National Park, Bharatpur in eastern Rajasthan (Prakash 1999; Prakash *et al.* 2003). Subsequently, this population crash was documented throughout the Indian subcontinent (Prakash *et al.* 2003, 2005 a & b, 2007; Gilbert *et al.* 2004, 2006; Green *et al.* 2004; Pain *et al.* 2008).

In the initial stages of investigations, some infectious disease was thought to be the likely cause of population decline (Cunningham *et al.* 2003). But it took a little to discover the veterinary use of the non-steroidal anti-inflammatory drug (NSAID) diclofenac in livestock as the main, and perhaps the only, cause of the population declines (Oaks *et al.* 2004; Shultz *et al.* 2004; Green *et al.* 2004, 2007). Other environmental changes have also produced adverse effects on the population of vultures as well. Food shortages, caused by the burial or burning of carcasses to reduce the nuisance and health risks have also contributed to their decline. Other reasons believed to be responsible for the decline are loss of nesting habitat, decreased breeding efficiency, infectious diseases, general environmental pollution etc. (Pain *et al.* 2003, 2008; Oaks *et al.* 2004; Shultz *et al.* 2004; Johnson *et al.* 2006; Green *et al.* 2007; Prakash *et al.* 2007).

Vultures are exposed to toxic levels of diclofenac when they feed on carcasses of livestock which have died within a few days of treatment, and which contain residues of the drug (Oaks *et al.* 2004). Likewise, due to this chemical, vultures suffer from a disease called gout. Vultures that consume sufficient tissue from such carcasses die from the effects of diclofenac induced kidney failure. Shultz *et al.* (2004) found that a high proportion of Indian White-backed Vulture and Long-billed Vultures found dead in the wild had severe visceral gout, consistent with diclofenac poisoning being the main or sole cause of the population declines. Simulation modeling has indicated that less than 1% of the livestock carcasses available to vultures need to contain levels of diclofenac lethal to vultures to cause the recorded rates of decline across the country (Green *et al.* 2004). Green *et al.* (2006) reported that though concentration of diclofenac across all the edible tissues of investigated carcasses was hazardous to the vultures, but the concentration in intestine, kidney and liver had the highest levels which could be the reason for differential rate of population decline in different species of vultures keeping in view the differential foraging behaviour of vulture species found in the Indian subcontinent.

The minimum decline in Indian White-backed vulture numbers in India during the period 1992-2003 was 99.7% and 97.4% for Long-billed/Slender-billed. This corresponds with a minimum estimated rate of decline of 34% per year for White-backed Vultures and 27% per year for the Long-billed/Slender-billed group. In the most recent census, there is evidence that the rate of declines may be increasing with a measured 81% decline between 2002 and 2003 in White-backed vultures, a 59% decline in Long-billed vultures, and a 47% decline for Slender-billed vultures (MoEF 2006).

Vultures are classified into two groups: Old World vultures and New World vultures. World list of living species of Vultures stand at 23, comprising of seven species of New World and 16 Old World species. The similarities between the two different groups are due to convergent evolution. The Old World vultures found in Africa, Asia, and Europe belong to the family Accipitridae, which also includes eagles, kites, buzzards, and hawks. Old World vultures find carcasses exclusively by sight. The New World vultures and condors found in warm and temperate areas of the Americas are not closely related to the superficially similar Accipitridae, but belong in the family Cathartidae, which was once considered to be related to the storks. However, recent DNA evidence suggests that they should be included among the Accipitriformes, along with other birds of prey. However, they are still not directly related to the other vultures. Several species have a good sense of smell, unusual for raptors, and are able to smell the dead they focus upon from great heights, up to a mile away (BirdLife International 2011, Wikipedia 2011).

Both groups (Old World and New World) of vultures have certain characteristics in common-for example a hooked bill, naked or downy head, food-holding crop, therefore, they illustrate the phenomenon of convergent evolution very well (Houston 2001). In addition, within the Old World vultures, there are at least three different evolutionary lines (Seibold and Helbig 1995). Finally, within this group of birds there is a smaller group of five species of super vultures, all of which are called griffons. They exhibit a whole set of adaptations to a life scavenging on the carcasses of large animals (Houston 1983). Vultures are also renowned for congregating in large numbers at a carcass. A dead elephant can attract 1000 birds at a time and for several days, and even a small Impala can bring in up to 250 (Yohannes and Bekele 1998).

Some vultures are among the world's largest flying birds, for example the Cinereous Vulture is said to weigh up to 12.5 kg, and the Lappetfaced Vulture has a wingspan up to 2.9 m. The adult Cape Griffon would probably have a weight of about 9 kg and a wingspan of about 2.5 m and is a considerable flying object. In addition, the griffons are renowned for flying together at their colonies and in particular in thermals over open country. In the latter they would usually be outnumbered by the common White-backed Vultures (av. weight about 5 kg). A thermal of around 100 circling vultures is an awesome sight-but not for an aeroplane pilot in Africa. When foraging, vultures would perhaps usually fly along at about 300 m above ground level and at gliding speeds of up to 96 kph. At times they will fly or soar at very much higher altitudes than 300 m, even up to 11000 m a.g.l., though they have rarely (if ever) been seen by pilots at these phenomenal altitudes. Here, the partial pressure of oxygen is very low, and the cold is very intense, but vultures-at least the Ruppell's Griffon can cope with these well. Among other adaptations, this griffon is so far unique in having four haemoglobins in its blood, with strong affinities for oxygen (Mundy 1982).

A detailed account of vultures in Africa has been published (Mundy *et al.* 1992), but a little is known about Asia or Europe, or for North and South America (Kiff 2000, Satheesan 2000, Schlee 2000). The distributions of each species of Old World vulture shows that four species are found on all three continents, but of these only two i.e. Eurasian Griffon and Egyptian Vulture are strongly migratory. In the former, mostly the juveniles migrate to North Africa and Ethiopia, and even Kenya (Clark 2001), and presumably return in the following spring, while in the latter all ages migrate. As far as is known, all migratory routes are on a north-south axis (Yosef and Alon 1997). All the European vultures are also represented in Asia, and indeed into the Indian subcontinent. But it is not known whether there is any connection or gene flow between India and Europe in these species, and certainly no east-west (or vice versa) movements or migrations have been discovered. In addition, the detailed distributions of vultures from western Pakistan through Afghanistan and Iran to Iraq and Saudi Arabia are not yet known (Mundy 1982).

Two South Asian *Gyps* species, Oriental White-backed Vulture and Slender-billed Vulture, were widespread and generally common in Southeast Asia (Cambodia, Vietnam, Laos, Thailand, Malaysia) at the beginning of the 20th century, but by the end of that century only a few small relict populations remained, primarily in Cambodia (Pain *et al.* 2003). Populations remain in Myanmar, but their numbers and status remain uncertain. Whilst factors like persecution may have played a role in the Southeast Asian declines, their main cause is believed to be food shortage. Overhunting resulted in a collapse in the populations of wild ungulates throughout the region (Srikosamatara and Suteethorn 1995, Duckworth *et al.* 1999, Hilton-Taylor 2000), and current livestock husbandry practices appear not to provide a sufficiently large food supply to support large populations (Pain *et al.* 2003).

New World Vultures and their Conservation Status (Family: Cathartidae)
(Source: Bird Life International, 2014)

S.No.	Species	Conservation Status
1.	Turkey Vulture *Cathartes aura* (Linnaeus, 1758)	LC
2.	Lesser Yellow-headed Vulture *Cathartes burrovianus* Cassin, 1845	LC
3.	Greater Yellow-headed Vulture *Cathartes melambrotus* Wetmore, 1964	LC
4.	Black Vulture *Coragyps atratus* (Bechstein, 1783)	LC
5.	King Vulture *Sarcoramphus papa* (Linnaeus, 1758)	LC
6.	California Condor *Gymnogyps californianus* (Shaw, 1797)	CR
7.	Andean Condor *Vultur gryphus* Linnaeus, 1758	NT

Old World Vultures and their Conservation Status (Family: Accipitridae)
(Source: BirdLife International, 2014)

S.No.	Species	Conservation Status
1.	Palm-nut Vulture *Gypohierax angolensis* (Gmelin, 1788)	LC
2.	Lammergeier *Gypaetus barbatus* (Linnaeus, 1758)	NT
3.	Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758)	EN
4.	Hooded Vulture *Necrosyrtes monachus* (Temminck, 1823)	EN
5.	White-backed Vulture *Gyps africanus* Salvadori, 1865	NT
6.	White-rumped Vulture *Gyps bengalensis* (Gmelin, 1788)	CR
7.	Indian Vulture *Gyps indicus* (Scopoli, 1786)	CR
8.	Slender-billed Vulture *Gyps tenuirostris* Gray, 1844	CR
9.	Rueppell's Vulture *Gyps rueppellii* (Brehm, 1852)	NT
10.	Himalayan Vulture *Gyps himalayensis* Hume, 1869	NT
11.	Griffon Vulture *Gyps fulvus* (Hablizl, 1783)	LC
12.	Cape Vulture *Gyps coprotheres* (Forster, 1798)	VU
13.	Red-headed Vulture *Sarcogyps calvus* (Scopoli, 1786)	CR
14.	White-headed Vulture *Trigonoceps occipitalis* (Burchell, 1824)	VU
15.	Cinereous Vulture *Aegypius monachus* (Linnaeus, 1766)	NT
16.	Lappet-faced Vulture *Torgos tracheliotos* (Forster, 1791)	VU

LC= Least Concern EN= Endangered CR= Critical
NT= Near Threatened VU= Vulnerable

Social Perspectives

Vultures are scavenging birds, feeding mostly on the carcasses of dead animals. They seldom attack healthy animals, but may kill the wounded or sick. When a carcass has too thick a hide for its beak to open, it waits for a larger scavenger to eat first. They do not carry food to their young in their claws, but disgorge it from the crop. These birds are of great value as scavengers, especially in hot regions. Vulture stomach acid is exceptionally corrosive, allowing them to safely digest putrid carcasses infected with *Botulinum* toxin, hog cholera, and anthrax bacteria that would be lethal to other scavengers. This also enables them to use their reeking, corrosive vomit as a defensive projectile when threatened. Vultures urinate straight down their legs, the uric acid kills bacteria accumulated from walking through carcasses, and also acts as evaporative cooling (Wikipedia 2011).

Vultures provide very important ecological, social and cultural services especially in India by scavenging on animal carcasses of animals and thereby helping keep the environment clean, and the disposal of dead bodies as per the religious practices of the Parsi community. Vultures are the primary removers of carrion in India and Africa. Removal of a major scavenger from the ecosystem will affect the equilibrium between populations of other scavenging species and/or result in increase in putrefying carcasses. In the absence of carcass disposing mechanisms, vulture declines may lead to an increase in the number of putrefying animal carcasses in the country side. In some areas the population of feral dogs, being the main scavenging species in the absence of vultures, has been observed to have increased. Both increases in putrefying carcasses and changes in the scavenger populations have associated disease risks for wildlife, livestock and humans. In the absence of any alternative mode of disposal of animal carcasses, they continue to be disposed off in the open, and with increasing numbers of feral dogs, there is increased risk of spread of rabies, and livestock borne diseases like anthrax (Prakash *et al.* 2003). The decline in vultures has also affected the traditional custom of the Parsis of placing their dead in the 'Towers of Silence' for vultures to feed upon (Anonymous 2006).

Community Involvement and Supplementary Feeding

The provision of supplementary food is a well established tool in the conservation of vulture species (Mundy *et al.* 1992). This practice is used to provide a safe food source in the areas where carcasses are commonly baited with poison. Rapid and extensive decline of vultures in the Indian subcontinent has been attributed to the toxic effects of diclofenac, a pharmaceutical used in the treatment of livestock, to which vultures are exposed while feeding on the carcasses of treated animals (Gilbert *et al.* 2007). Supplementary feeding has been shown to increase the survival of Cape Vultures *Gyps caprotheres* in South Africa (Piper *et al.* 1999), has been employed during successful reintroduction programmes (Sarrazin *et al.* 1994; Terrasse *et al.* 1994) and has facilitated the recolonization of abandoned breeding sites (Mundy *et al.* 1992). This method has been used to provide alternative source of diclofenac free (uncontaminated) food (Susic and Pavokovic 2003; Gilbert *et al.* 2007). General public involvement and supplementary feeding tried in different parts of the world could be successful in conservation of vultures India.

Food provisioning near a colony of Oriental White-backed Vulture in Pakistan during the 2003-04 breeding season illustrated that the provision of clean food appeared to be able to reduce, but not eliminate, mortality from diclofenac (Gilbert *et al.* 2007). There was also considerable seasonal variation in the extent to which vultures used the diversionary food, with the vulture restaurant visited on, only 16% of days and by a relatively small number of birds at the end of the breeding season compared with 74% of days by a far larger number of birds earlier in the season. There were significant declines in mortality when vultures were fed clean food, but no reduction in the rate at which numbers of breeding pairs (active nests) declined at the colony in the year following the diversionary feeding (298 nests in 2002-03, 203 nests in 2003-04 and 118 nests in 2004-05, AVPP 2007). These results show that, whilst food provisioning may be of some benefit, it did not prevent the population from declining. Whilst the impact of year-long food provisioning remains untested, it is likely to have a greater impact on vulture survival in areas where alternative food is scarce, in colonies where a high proportion of birds tend to be sedentary, and where local diclofenac use is minimal or non-existent (Pain *et al.* 2008).

Conservation Measures

Keeping in view the level of endangerment mainly due to their population crash, three captive breeding and rescue centres for vultures, one in Haryana, second in West Bengal and third in Assam have been setup in India. Four more are planned, in an attempt to create reservoirs of birds to be re-introduced once the environment is clear of diclofenac.

Identification and monitoring of the locations and number of remaining individuals of vultures in the wild would be effective measure for conservation. Most efficient way to protect these threatened birds would be in-situ approach of conservation. Therefore, protection of nesting and feeding habitat is very essential.

More scientific investigations based on logical data, gathered through standard protocols are required. Information on terrain type, altitude, relief etc.; height, type, density and status of vegetation; nearby human settlements, source of water and food, mortality rate of cattle in nearby villages, socio-cultural practices of disposal of carcasses; vulture species type and richness, population dynamics, habitat-use pattern, breeding ecology and breeding success; human/animal interference needs to be generated. Breeding colonies of vultures should be continuously monitored for any changes in the population size. These records, in the long run would help in the formulation of area/locality based, viable vulture conservation strategies.

Measurement of the amount of diclofenac in carcasses available to vultures in different parts of the state and country should be done to elucidate the level of diclofenac exposure to remaining populations of vultures. In addition, data base on fecal glucocorticoid levels should be investigated, as it has competency in assessment of physiological stress and induction of ovulation in different bird species. Molecular characterization of threatened vultures should be done for molecular identification of different races of vultures and for enlisting some important resistant genes.

Some previous studies have indicated that different species of vultures in Kangra valley get attracted towards easily-available food at some cowsheds therefore these cowsheds can play a key role in providing diclofenac free and continuously available food. Lastly, public support programmes are the most important aspects of any effective conservation and management plan. Therefore, local people should be engaged in the whole process of conservation and management of vultures.

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