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Saving Asia's *Gyps* Vultures: the "Vulture Rescue" Team's Conservation Programme

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ABSTRACT

Populations of three species of griffon vultures *(Gyps bengalensis, G. indicus*, and *G. tenuirostris)* have declined by more than 90% across India during the last two decades. Results from studies by the Bombay Natural History Society suggest the declines in India are not caused by food shortage, habitat loss or persecution. In 2001, a consortium consisting of BNHS and the Poultry Diagnostic & Research Centre in India (PDRC), and the Royal Society for the Protection of Birds (RSPB), the Institute of Zoology of the Zoological Society of London (ZSL/IoZ) and the National Bird of Prey Centre in the UK, obtained British Government funding (under the Darwin Initiative for the Survival of Species) to (i) investigate the causes of decline through setting up a Vulture Care Centre and diagnostic laboratories in India, (ii) conduct annual nationwide surveys and colony monitoring, and (iii) produce a recovery plan.

Nationwide monitoring (so far up to 2002) indicates that *Gyps* vulture numbers continue to decline due to abnormally low reproductive success and abnormally high mortality rates of all age classes; very fresh carcasses have been collected throughout the country and systematically examined; epidemiological and pathological observations indicate the declines to be due to an infectious disease. A Vulture Care Centre, incorporating a diagnostic laboratory, has been built and was inaugurated in February 2003. Preliminary results from sick vultures housed at this centre appear to endorse the infectious disease hypothesis. In recent years, an unprecedented number of migratory Eurasian Griffons *Gyps fulvus* have been found over-wintering in north-west India. If an infectious disease is implicated, these birds may act as a conduit for the rapid spread of the agent causing the *Gyps* declines to countries outside southern Asia. A number of conservation priorities have been identified for an

ongoing *Gyps* conservation programme. These include: documenting migration patterns of Eurasian Griffon vultures between Eastern European, Middle Eastern and Asian populations using satellite tracking, establishing the current status of *Gyps tenuirostris* populations across its range, and setting up captive breeding facilities for *Gyps* species within their historical range.

INTRODUCTION

Within the genus *Gyps,* there are eight species of griffon vultures. Of these, four species are resident in Asia (Indian White-backed Vulture *G. bengalensis,* Long-billed Vulture *G. indicus,* Himalayan Griffon *G. himalayensis,* Slender-billed Vulture *G. tenuirostris*), three are found primarily in Africa (African White-backed Vulture *G. africanus,* Cape Griffon *G. coprotheres,* Rüppell's Griffon *G. rueppellii*) and one breeds in Eurasia but migrates into Africa and south Asia (Eurasian Griffon). However, no *Gyps* species is completely geographically isolated from its congeners (Pain *et al.* 2003).

Griffon vultures are obligate scavengers and perform an important ecological function by stripping the soft tissue from carcasses. *Gyps* vultures are typically widespread and abundant, accounting for the majority of individual vulture sightings in both Africa (ca. 90%) and Asia (ca. 99% (Houston 1983). Their abundance in India, where Hindu religious taboos restrict the consumption of meat, is explained by the role *Gyps* has in consuming cattle carcasses. In the Serengeti of Africa, high population densities of *Gyps* can be explained because they consume more than a quarter of abundantly available ungulate carcasses (Houston 1983). All *Gyps* species are wide-ranging in their foraging behaviour (Houston 1974, 1983) and juveniles may disperse more widely, or be more nomadic, than adults. In some populations, *G. fulvus* juveniles appear to undergo large-scale annual migrations before settling into a resident breeding population (Susic 2000).

Gyps species are large-bodied and long-lived; the maximum recorded life-span of *G. fulvus* in captivity is 37 years (Newton 1979). They reach maturity at 4-6 years, and then produce one egg during each subsequent breeding season (Mendelssohn & Leshem 1983; Simmons 1986; del Hoyo *et al.* 1994). Documented adult survival rates are high in stable or increasing populations. For example, in an increasing *G. fulvus* population in France adult survival estimates are as high as 0.987 ± SE 0.006 (Sarrazin *et al.* 1994).

GYPS POPULATION DECLINES IN SOUTH ASIA

In the previous decade, populations of *Gyps* vultures throughout the Indian subcontinent have undergone severe declines. In India in the 1970s and 1980s *G. indicus* and *G. bengalensis* were abundant throughout India. In Keoladeo National Park, Rajasthan, the breeding density of *G. bengalensis* was estimated at 12 nests/km^2 (Prakash 1989). However, the population of this species declined by an estimated 97% in the Park between 1985/1986 and 1996/1997 (Prakash 1999). During the same period, the number of recorded nests declined by 95%, from 353 occupied nests in 1987/1988, down to only 20 in 1998/1999; in subsequent years, no breeding pairs have been recorded in the park (Prakash *et al.* 2003). Initial population declines in *G. indicus* are of a similar magnitude,

with survey counts declining by more than 90% over the decade from 1987/1988 to 1998/1999 (Prakash *et al.* 2003). Both of these species, together with the recently separated *G. tenuirostris*, are now listed as critically endangered by the IUCN (Birdlife International 2000, 2001).

In contrast to the normally high adult survivorship in stable *Gyps* populations, adult mortality rates are extremely high in *Gyps* populations undergoing declines. For example, in 1997/1998 in Keoladeo National Park, 83 dead adult and juvenile Indian White-backed Vultures were found, whereas only 25 breeding pairs were recorded. In contrast, during the 1985/1986 survey before the decline, 14 dead adult and juvenile birds were recorded, while the breeding population in the park was estimated at 244 pairs during the same period (Prakash 1999). In Nepal, high adult mortality was recorded in *G. bengalensis* during the 2000-2001 breeding season at Koshi Tappu Wildlife Reserve (eastern Nepal). Within this small breeding colony (67 nests found of which 27 were active), 45 *G. bengalensis* were found dead, of which 34 (75.5%) were adults (Virani *et al.* 2001). In Pakistan, during the 2000/2001 breeding season, Gilbert *et al.* (2002) estimated minimum annual mortality rates in the adult breeding populations of *G. bengalensis* from two colonies to be 11.4% and 18.6%. These mortality estimates are acknowledged underestimates, as the calculations assume that all dead birds were found.

ASSOCIATED IMPACTS OF THE DECLINES

Gyps vulture declines in India have many associated effects, including: economic effects for those engaged in industries such as cattle skinning and bone collecting, and for villagers who have to find alternative means of disposal of carcasses; human, livestock and wildlife disease effects; and cultural/religious effects.

The decline in *Gyps* numbers in India has led to a surplus of unconsumed livestock carcasses at carcass dumps and a resultant increase in the populations of other scavengers, including feral dogs. Over 1,000 dogs have been observed at a single carcass dump in Rajasthan (Cunningham *et al.* 2001). An increase in feral dog populations brings a heightened risk of dog-borne diseases. India has the highest prevalence of rabies in the world, with over 30,000 cases of human infection each year (WHO 1999); feral dog bites are responsible for most of these. Another possible disease threat caused by the accumulation of livestock carcasses is anthrax exposure for the skinners and bone collectors working directly with cattle carcasses. Although not typically a major health risk, anthrax has a sporadic presence in cattle populations in India; in some years the number of reported cases in cattle exceeds 1,000 (Hugh-Jones 1998).

The vulture declines in India have also had profound cultural effects on the Parsi in Mumbai. Their religious beliefs prohibit burying or burning their dead, which instead are placed in the open on the Towers of Silence where vultures come to strip the bodies. The decline in vulture populations has meant that there are insufficient vultures to accomplish this task (Parry-Jones 2001). Thus, the decline in vultures has consequences that far exceed potential losses of biodiversity.

IDENTIFICATION OF THE CAUSE AND EXTENT OF THE DECLINES IN INDIA

The severity and implications of the vulture declines ecologically and for human health led to a successful joint application from the Institute of Zoology, London, Royal Society for the Protection of Birds, National Centre for Birds of Prey in the UK, and the Bombay Natural History Society and Poultry Diagnostic Research Centre in India, for a project grant from the UK government under the Darwin Initiative for the Survival of Species. The project commenced on 1 April 2001 to run for three years. The goals of the project are to: (i) identify the cause(s) of the declines, (ii) establish a captive care facility, (iii) conduct annual nationwide surveys to determine the progress and extent of the declines in India, and (iv) develop a recovery plan for *Gyps* species in India. A summary of the results to date follows.

Possible causes of *Gyps* vulture declines

The dramatic declines in the Indian *Gyps* vulture populations are associated with low breeding success coupled with high adult, juvenile and nestling mortality. During initial surveys, it became obvious that there were marked changes in the behaviour of ill vultures, including an increase in 'neck drooping' behaviour and lethargy. Surveys during the declines indicated that there was no change in the abundance of available food; the majority of cattle carcasses recorded during surveys did not have attendant vultures (Prakash *et al.* 2003). The initial working hypotheses for causes of the decline were: direct persecution via shooting or poisoning, the widespread use of a contaminant, or the appearance of an emergent infectious disease. The widespread and rapid nature of the declines, which occurred both in protected and unprotected areas and all habitat types across the country, along with the absence of other affected scavenging species, suggests that persecution was unlikely to be the primary cause. Although pesticide and chemical use is prevalent across India, we know of no evidence for increase in use of a chemical likely to affect only *Gyps* vultures, or the introduction of a novel contaminant, coincident with the decline in vulture populations (Cunningham *et al.* 2003; Pain *et al.* 2003; Prakash *et al.* 2003). Additionally, tissue analyses of vultures in Pakistan undergoing similar declines, and with similar post-mortem findings, have not found toxic concentrations of any of a wide range of contaminants (Virani *et al.* 2001; Oaks *et al.* 2001). Together, the available evidence suggests that neither persecution nor contaminants are likely to be the root cause of the declines. However, we cannot discount the possibility that a contaminant may have played a role in the declines and this warrants further investigation (Cunningham *et al.* 2003, Pain *et al.* 2003)[1].

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[1] Update: Preliminary findings originally presented at this meeting implicated the veterinary drug diclofenacas the cause of the vulture declines in Pakistan; this has now been confirmed (Oaks *et al.* 2004: *Nature* 427: 630-633. As of May 2004 our own preliminary results also indicate that diclofenac is the major cause of the declines across India and Nepal (upubl. data). Ongoing investigations are seeking to identify routes of diclofenac exposure to assess the prevalence of diclofenac in the vultures' environment.

The remaining hypothesis for the cause of the declines is an infectious disease. Diagnostic investigations have been underway since 2000. Across populations, post-mortem analyses have identified renal and visceral gout in the majority of dead birds found in both *G. bengalensis* and *G. indicus* (Cunningham *et al.* 2001, 2003; Pain *et al.* 2002) and *G. bengalensis* from Pakistan (Oaks *et al.* 2001; Gilbert *et al.* 2002). Renal gout is often attributed to kidney disease; however, in these cases the gout was acute (occurring no more than a few hours before death), suggesting that this condition is a consequence of the primary disease and not the disease itself (Cunningham *et al.* 2001, 2003). Few other gross findings are observed consistently. Visceral gout and enteritis are non-specific lesions and could result from, for example, a contaminant insult or an infectious disease process. Additional histological analyses of tissues from Indian birds found inflammation of blood vessel walls (vasculitis) together with a proliferation of glial cells (central nervous system-specific inflammatory cells) in the brain (Cunningham *et al.* 2003). Gliosis is generally associated with viral infection in the absence of findings other than vasculitis.

In addition, the epidemiology of vulture mortality is consistent with an emerging infectious disease. The declines are specific to the *Gyps* genus; there have not been parallel declines in other scavenger species that also feed on cattle tissue (e.g. Egyptian Vultures *Neophron percnopterus*, Steppe Eagles *Aquila nipalensis*, Black Kites *Milvus migrans*, House Crows *Corvus splendens*). The population declines are pandemic, with apparently rapid geographic spread. With the post-mortem findings and the continuous absence of positive toxicological results, infectious disease is currently the most tenable explanation for the declines. Although we cannot be certain that disease is responsible until a causal agent has been identified, it is essential to consider the implications of the possible continuing spread of the declines for *Gyps* populations outside of the Indian subcontinent.

Establishment of a captive care facility

A vulture captive care centre that can house up to 35 vultures has been completed and was inaugurated by Elliot Morley, UK Minister for Nature Protection, in February 2003. The facilities now available for the project incountry include a diagnostic laboratory and isolation aviaries. The centre currently houses 12 vultures. The presence of a dedicated facility has enabled the analysis of samples from sick and recently dead birds, which allows for a broader spectrum of post-mortem analyses. The ability to study the disease process in living birds, and evaluate responses of sick birds to different treatment regimes, is an invaluable tool to aid the identification of the underlying cause

Repeat nationwide surveys and annual colony monitoring

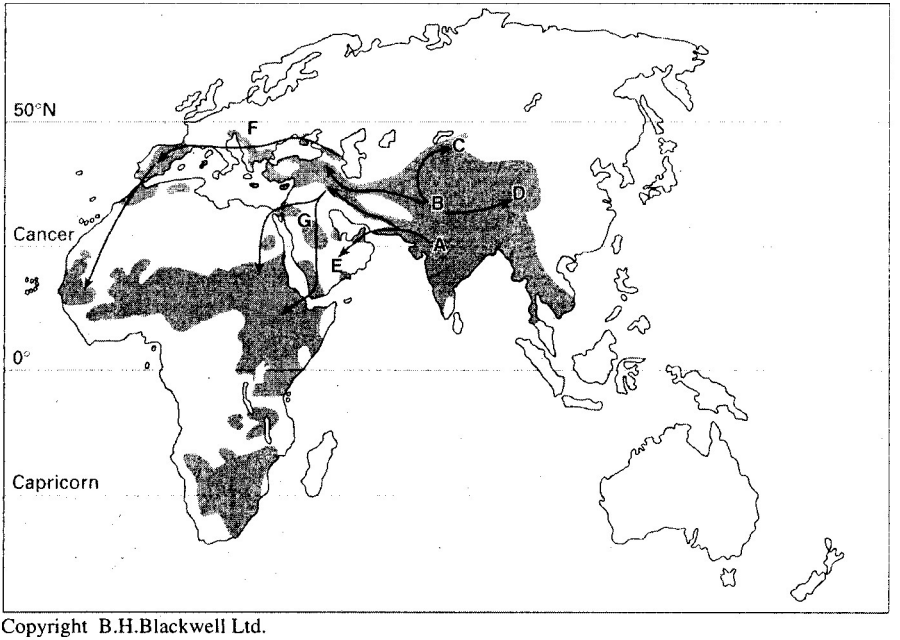
Nationwide surveys, following the same routes and protocol as used in 1990-92 (Samant *et al.* 1995), have been repeated in 2000 and again in 2002. Results indicate that, nationwide, rates of decline do not appear to have decreased over this period (1992-2002) (Prakash *et al.* 2003; Prakash *et al.* unpublished data). Vulture colony monitoring is underway at 17 colonies across India (and two in Nepal). Whilst some colonies have shown protracted declines in numbers, with

high levels of mortality (including adult mortality), this does not appear to be consistent across all colonies. The reasons for this are as yet unclear and continued research and monitoring is underway to help explain this.

PREDICTION AND MANAGEMENT OF POTENTIAL DECLINES IN *GYPS* SPECIES OUTSIDE SOUTHERN ASIA

Evidence from surveys in Nepal and Pakistan suggest that the *Gyps* populations there are already suffering the same declines seen in the Indian populations (e.g.Virani *et al.* 2002; Pain *et al.* 2003). However, the physical symptoms and elevated mortality rates do not appear yet to have affected *Gyps* populations in Central Asia (Katzner & Sklyarenko 2002) or in the Caucasuss (Gavashelishivili & McGrady 2002). It is essential that regional monitoring efforts continue to document the spread of the declines. As part of our conservation programme, annual surveys of the lowlands of Nepal and regular colony monitoring are being conducted by Bird Conservation Nepal.

Figure 1. Likely routes of spread from India of a *Gyps* specific infectious disease. Shaded areas represent *Gyps* distributions. Spread likely to occur from Indian populations west into Iran (A), northwest through Afghanistan and northern Iran into the Caucasu s (B), north into the Tien-Shan mountains (C), and onto the Tibetan plateau (D). From these areas the spread could continue west into southern Europe (F), and south into the Middle East and North Africa (E,G). Figure from Pain *et al.* (2003).



To better understand the potential future spread and implications of the declines, RSPB, IoZ, Natural Research (UK) and the BirdLife International Middle East and Central Asian Division has successfully secured funding under a second Darwin Initiative project. The objectives of this second project are to: (i) establish the current extent of the declines, (ii) determine whether the declines are spreading

westwards, and if so over what routes and at what rates, (iii) predict routes and time periods over which the declines could spread into Africa (and Europe), and (iv) produce an international management plan to arrest or slow the spread of vulture declines and, where this is not possible, to minimise the impacts of the declines on humans, wildlife and domestic livestock.

These objectives will be met through the monitoring of vulture colonies in a range of Central Asian, Middle Eastern and Eastern European countries. Numbers, breeding success and health status of birds will be monitored, and a number of birds will be satellite-tagged to establish dispersal and migratory movements (see below). In addition to the identification of new study colonies in the region, this work will be carried out in collaboration with a wide range of researchers already undertaking related work. The international management plan, scheduled for the final stages of the project, will be produced through collaborative effort involving vulture specialists, government and NGO representatives from the majority of *Gyps* range states in Asia, the Middle East, Europe and Africa.

Known migration patterns for *Gyps fulvus*

The migratory patterns of *Gyps fulvus* are generally poorly known. There is limited information about the migratory patterns of a few European populations derived from observation of known migration routes and ringing studies. *Gyps fulvus* breeding in Turkey are known to be migratory, and in many regions immature birds undergo distinct north-south migrations (del Hoyo *et al.* 1994; Ferguson-Lees & Christie 2000). Birds from Western Europe have been observed to cross the Straits of Gibraltar to North Africa (e.g. 2,160 birds counted in autumn 1993, Griesinger 1996). Ringing of European vultures has provided additional insight into some of the migratory patterns of these individuals. Satellite-tagging studies in Israel have shown movements between Israel and Yemen (Ofer Bahat, pers. comm.; http://www.birds.org.il). Tagged individuals from Croatian breeding populations have been found to follow regular north--west to south-east migratory routes (Susic 2000). One marked individual was sighted in Chad, confirming the predictions that southern European and Middle Eastern populations contact African ones. From such information about the migratory patterns, simple predictions can be made about how a potential infectious agent would spread into Africa from a European population. Hypothetical access routes have been identified using known *Gyps* distribution maps and movement patterns (Anderson & Mundy 2001). However, there still remains a wide gap in our knowledge of dispersal and migratory movements of *Gyps fulvus*. It is especially important to establish the origins of the large numbers of *G. fulvus* wintering in north-west India in recent years (Prakash *et al.* 2003), as these birds could potentially spread an infectious disease agent to other *Gyps* populations outside the region. From information on known breeding sites and regional topography, it is possible to predict possible movement routes (see Pain *et al.* 2003 for details). It is unknown whether these are actual migration routes, or how often they are used. To address migratory patterns and the geographic origin of the *G. fulvus* influxes into India, a wide-ranging satellite-tracking programme will be initiated to study the movements of migrating individuals from breeding populations in the Caucasus, the Middle East and Central Asia. If birds from these populations are travelling east into Northern India, satellite data will provide information on the routes and potential contact points that these birds have with Indian *Gyps* populations.

MITIGATING IMPACTS

A key objective is to identify the cause of *Gyps* vulture declines, and to identify means of stopping or limiting the spread of declines. However, we cannot gauge the feasibility of this objective until the causal agent has been identified. Should it prove impossible to stem the declines, it is essential that management actions are identified to mitigate against additional problems associated with the spread of vulture declines. As in India, vultures perform an important ecological role throughout Africa by removing carcasses, waste and excrement, and *Gyps* species are particularly important in this role (Mundy *et al.* 1992). Declines in *Gyps* vulture populations across Africa could likewise result in an increase in the populations of other scavengers, such as canids including domestic/feral dogs and jackals, and a corresponding increase in canine-borne diseases, such as rabies or distemper (e.g. Anderson & Mundy 2001). Such an outcome could be catastrophic for threatened species, such as the African wild dog *Lycaon pictus* and the Ethiopian wolf *Canis simensis*, whose populations have already been negatively affected by canine-borne disease (van de Bilt *et al.* 2002; Gascoyne *et al.* 1995), and could affect other wildlife, domestic livestock and humans. Anthrax is endemic across much of the African continent (Hugh-Jones 1998) and an increase in unconsumed and rotting carcasses could potentially spread this disease. Measures such as vaccination of domestic dogs and certain wildlife populations are examples of the kind of mitigation measures that could be taken, but a comprehensive evaluation of these, their feasibility, cost and likely impact is necessary.

ADDITIONAL CONSERVATION PRIORITIES

Little information is available about the status and distribution of the Slender-billed Vulture, as it has only recently been designated as a separate species from *G. indicus* (Rasmussen & Parry 2000). Until recently, surveys of *Gyps* across India had lumped these two species together because their taxonomic status had not been resolved. The total population size of *G. tenuirostris* has been roughly estimated to be as low as 150-200 breeding pairs. It appears that the Slender-billed Vulture has suffered mortality rates as severe as the other two species (Prakash *et al.* 2003). If *G. tenuirostris* is suffering severe declines and already has a very small population size, extinction could be imminent. A major conservation priority in the immediate future will be to assess the approximate population, distribution and status of this Critically Endangered species.

An urgent activity for Asian *Gyps* conservation is the development of captive-breeding programmes for all three currently affected *Gyps* species, with *G. tenuirostris* as a priority. It is important that captive breeding be conducted within the range states (*i.e.* India and Nepal) of the affected species in order to build in-country capacity of such conservation expertise and to ensure that the birds are raised in an environment (climate, pathogen exposure, etc.) conducive to maximising survival of offspring when released. It is also important to ensure that any even *potentially* contaminated birds are not moved outside the current range of the supposed disease to help prevent spread to other *Gyps* species or other genera. As it is important to minimise the risk of disease spreading from wild vultures to the captive birds, captive breeding should be conducted outside areas containing extant *Gyps* vulture populations. The

number of species (three) affected, the requirement for holding enough birds to ensure a viable captive population, and the need to minimise and manage potential disease spread within captive populations demand that at least four separate centres are set-up. We propose, initially, to establish one centre in Nepal (which appears to contain the largest remnant population of the Slender-billed Vulture) and three centres in India. It is likely that just one or two of each of the affected species will be held and bred at each centre. Zoos in India, which already hold small numbers of Indian White-backed Vultures, should be encouraged to breed these birds. However, disease and other risks both to the target species and to other avian species and taxa held within the zoos (Cunningham 1996) should preclude the incorporation of wild-caught birds (or eggs) within these programmes. This situation may change as more becomes known about the causal agent, its mode of transmission and the range of susceptible species.

In addition, it is essential that efforts are made to initiate captive breeding of *G. bengalensis* in Europe using healthy birds exported historically and already present in zoos and other collections. To the best of our knowledge, neither *G. indicus* nor *G. tenuirostris* are held in any zoo. Additionally, isolated wild populations, such as the relict populations of *Gyps* in South-East Asia, should receive immediate conservation attention. These populations are likely to be relatively isolated from the affected populations in the Indian subcontinent, and hence from the causative agent of the declines. Active management of relict populations in South-East Asia is important to help ensure their stability and long-term survival.

If the *Gyps* declines spread into the Middle East and Africa, the consequences could be ecologically devastating. The migratory nature and distribution of *Gyps fulvus* makes this a real possibility if the declines prove to have been caused by infectious disease. The wide geographic area that will potentially be affected means that conservation and mitigation efforts must necessarily be a collaborative endeavour.

To address the scale of this problem, both inside and outside India, a formal collaboration, "Vulture Rescue", has been established between the RSPB, ZSL and BNHS. This is not an exclusive collaboration and we hope that through this venture, awareness and funds will be raised to help address conservation priorities, and that many other organisations will be stimulated to participate in *Gyps* vulture conservation actions.

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