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Utilisation of green plant material in nests of Long-billed Vultures *Gyps indicus* in Bundelkhand Region, India

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Introduction

The Indian or Long-billed Vulture *Gyps indicus* was formerly a common breeding resident in the Indian subcontinent, but the species is now listed as Critically Endangered for a number of reasons that vary locally. In addition to the major declines due to Diclofenac poisoning, low food availability and persecution in the form of shooting and poisoning have contributed to the local depletion of vulture populations. As for Long-billed vultures, found in India and Pakistan, changing land use leading to reduced food supplies and the reduction of suitable habitat for vultures are also concerns (Kushwaha 2014). Long-billed Vultures nest colonially and exclusively use cliffs or buildings (such as old monuments) for their nests and increases in mining activity have caused disturbances to nesting vultures in these areas. Due to the modernisation of abattoirs and slaughterhouses and the closing down of carcass dumps, food supplies for vultures have been reduced, particularly in cities and towns as well as rural areas with civil and military airfields located nearby.

Breeding habitat plays a key role in the fitness of individual birds (Martin 1988) and, for a given species, nest site quality varies in space and time at different scales due to different environmental factors, which affects reproductive success

(Wiens 1976). The reproductive success of vultures depends on features of their breeding biology that include choice of breeding habitat and also breeding strategy. There is remarkable variation in nest construction by bird species and, within species, variability in nest characteristics can be pronounced, which highlights that nest construction is dependent on individual behaviour and ability (Collias & Collias 1984). Most studies regarding nest-building behaviour and the role of nest characteristics have focused on species that build a new nest for each breeding attempt, whereas little is known about species that reuse nests over several breeding seasons, such as raptors (Margalida *et al.* 2000). This study was undertaken to analyse the variety of green nesting material used by Long-billed Vultures breeding in the Bundelkhand Region of India.

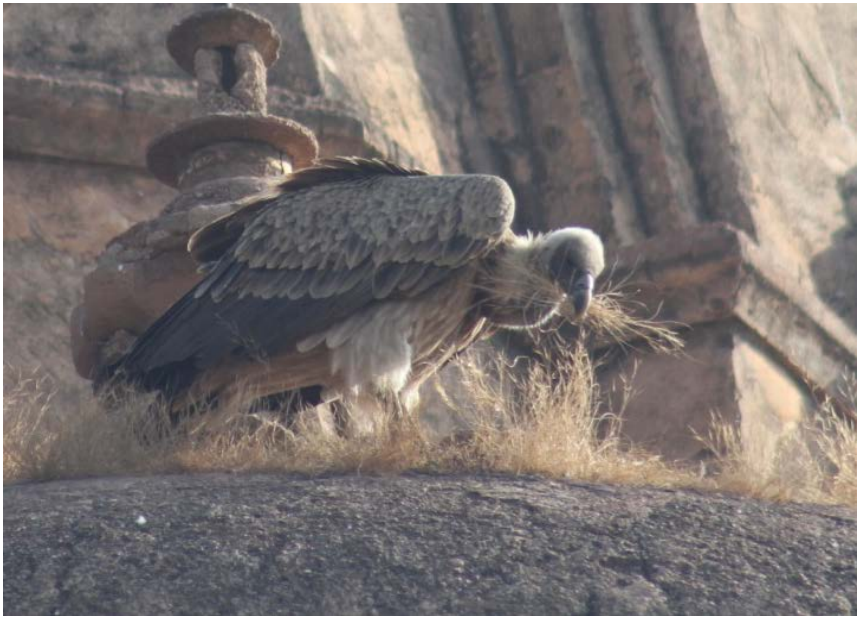
Methods

The breeding biology of *Gyps indicus* was studied in the Bundelkhand Region of India over seven consecutive years (2008-2015). The Bundelkhand Region extends over parts of southern Uttar Pradesh and northern Madhya Pradesh between 23^0 35′-26′ N and 78^0 82′ E. The Bundelkhand Region covers an area of approximately 70,000 km^2. The principal rivers are the Sindh, Betwa, Ken, Bagahin, Tons, Pahuj, Dhasan, and Chambal. Observations of vultures were made using 10x50 binoculars and recorded on data sheets. Photographic and video recordings were done with a digital Kodak 12x zoom camera and 7D SLR Canon camera.

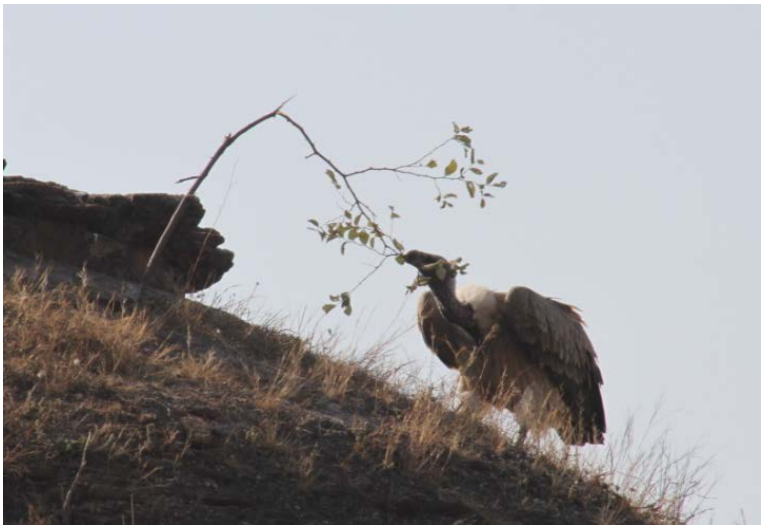
Results and discussion

Breeding colonies were mostly located near sources of water such as rivers, canals, ponds or dams. Nest construction started in September each year. The nests of *Gyps indicus* are built in old monuments and on cliffs that are well-protected and out of human reach. The diameter of a nest is approximately 60-90 cm and a single nest can consist of between 2000 and 4000 sticks, the number varies according to the availability of nesting material as well as the requirement of each breeding pair. Nest construction is time-consuming work for vultures due to their large size and the types and number of sticks and twigs used by them (Figures 1a-h). Vultures may therefore reuse their nests each year

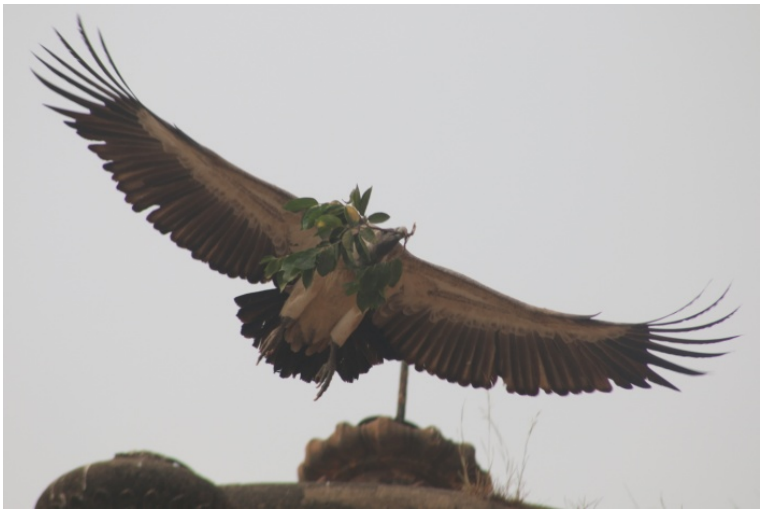
to save energy. During nest-building, nests are not left unguarded. Nest construction activities were mostly recorded during the morning hours. Males are more industrious than females and bring most of the material to the nest. Green plant material is restocked daily during the nest construction period (September-November). Large green twigs are used to line the old nests or to construct new ones. Besides this the vultures also use small twigs of various types or wild grasses that grow around the nesting sites after the monsoon. Vultures also utilize the grasses that grow on monuments (Fig.1a). When dried, the outer foliage of the nest becomes rigid and serves to stabilize the nest while dry grasses form the inner softer portion of the nest structure.



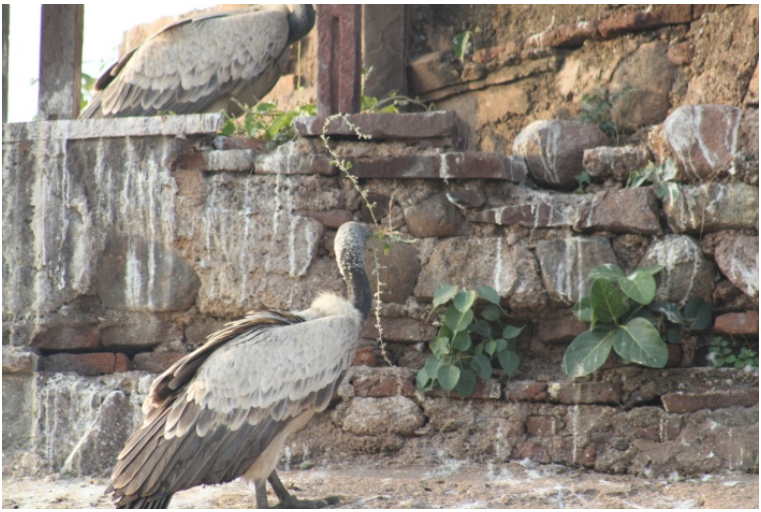
A: Long-billed Vulture collecting dried *Eragrostis tenella* for its nest.



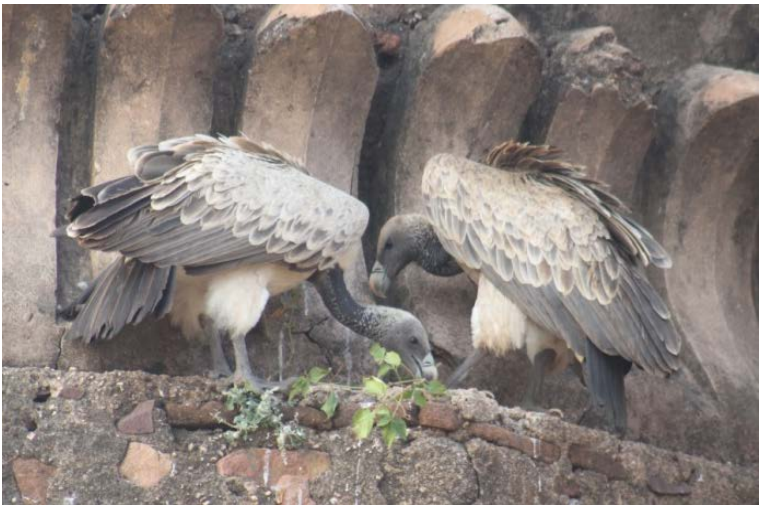
B: Long-billed Vulture collecting nesting material from plants growing on monuments.



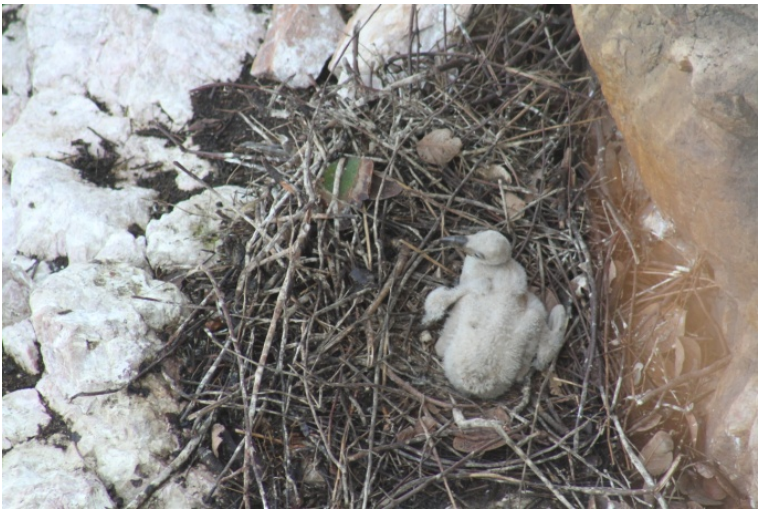
C: Long-billed Vulture flying to its nest with twig of *Anogeissus latifolia.*



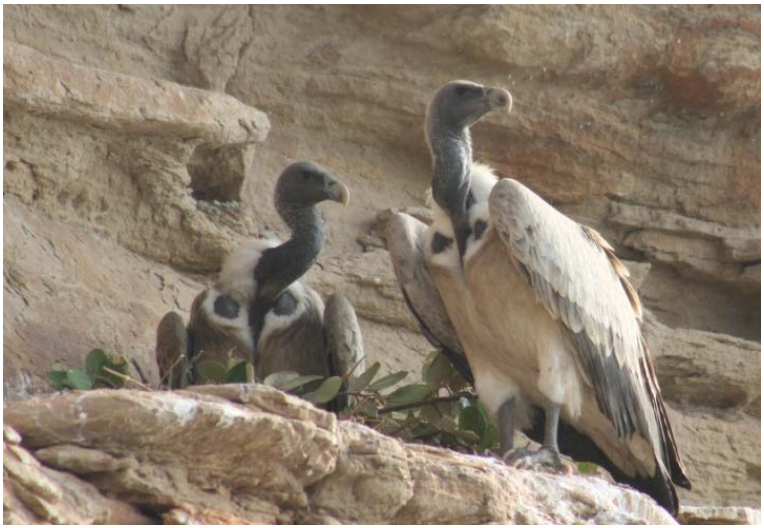
D: *Aerva lanata* collected for nest construction.



E: A pair of Long-billed Vultures with *Lantan camara.*



F: Long-billed Vulture chick in nest with dried green plants.



G: Twigs of *Flacourtia indica* arranged in the nest by a breeding pair.

H: Dried green material of *Cordia dichotoma* in the nest of a Long-billed Vulture.

Figure 1 (A - H): *Gyps indicus* using various types of green plant material for nest construction

The addition of fresh green plant material to dry nest material is widespread among birds (Newton 1979, Wimberger 1984, Clark & Mason 1985). The green plant material may serve multiple purposes and depend on what is accessible to the bird (Whittow & Berger 1977, Skowron & Kern 1980). Nests are made of sticks and lined with green leaves, sometimes with the addition of pieces of rags and other rubbish. The sticks commonly used for nest construction by Long-billed Vultures in the Bundelkhand Region are those of the surrounding flora and include Peepal *Ficus religiosa,* Salai *Boswellia serrata,* Seesham *Dalbergia sissoo,* Dhok *Anogeissus latifolia,* Kava *Piper methysticum,* Teak *Tectona grandis,* Chirol *Holoptelea integrifolia,* Mahaarukha/ Mahaneem *Ailanthus excels* etc. (Table 1).

Table 1: Commonly used plants as nesting material by *Gyps indicus* in the Bundelkhand Region of India.

Botanical Name	**Family**	**Local Name**	**Category**	**Use**
Ficus religiosa	Moraceae	Peepal	Tree	Religious
Ficus racemosa	Moraceae	Gular	Tree	Fruit yielding
Azadirachta indica	Meliaceae	Neem	Tree	Medicinal
Eucalyptus umbellata	Myrtaceae	Nilgiri, Safeda	Tree	Oil yielding
Boswellia serrata	Burseraceae	Salai	Tree	Gum, resin
Dalbergia sissoo	Fabaceae	Seesham	Tree	Timber yielding
Butea monosperma	Fabaceae	Palash	Tree	Medicinal
Tectona grandis	Verbenaceae	Sagon/Teak	Tree	Timber yielding
Holoptelea integrifolia	Ulmaceae	Chirol	Tree	Fruit yielding
Ailanthus excels	Simaroubaceae	Mahaarukha	Tree	Timber yielding
Holarrhena pubescens	Apocynaceae	Kulentha	Tree	Medicinal
Wrightia tinctoria var. *rothii*	Apocynaceae	Dudhi	Tree	Medicinal
Bridelia retusa	Euphorbiaceae	Karzaliya	Tree	Timber yielding
Flacourtia indica	Flacourtiaceae	Kakher	Tree	Fuel
Anogeissus latifolia	Combretaceae	Dhok	Tree	Timber yielding
Cordia dichotoma	Boraginaceae	Lasura	Tree	Medicinal
Lantan camara	Verbenaceae	Raimuniya	Shrub	Ornamental
Aerva lanata	Amaranthaceae	Gorakhbuti	Herb	Medicinal

Table 1 – continued

Celosia argentea	Amaranthaceae	Safed murga	Herb	Medicinal
Hyptis suaveolens	Lamiaceae	Ban tulsi	Herb	Medicinal
Parthenium hysterophorus	Asteraceae	Gajar ghas	Herb	----
Atylosia scarabaeoides	Fabaceae	Bankulthi	Herb	Medicinal
Mimulus guttatus	Scrophulariaceae	--	Herb	Medicinal
Eragrostis tenella	Poaceae	Bhurbhusi	Grass	Fodder
Eragrostis ciliaris	Poaceae	--	Grass	Medicinal and as food
Cocculus hirsutus	Menispermaceae	Jamtikibel	Climber	Medicinal

The leaves of *Eucalyptus* and Neem *Azadrachta indica* are most commonly seen in nests. The leaves of *Eucalyptus* and *Azadirachta indica* are known to have insect repellent properties. *Holoptelea integrifolia*, the versatile medicinal plant, is the unique source of various types of compounds having a diverse chemical structure and is used traditionally for the treatment of inflammation, gastritis, dyspepsia, colic, intestinal worms, vomiting, wound healing, leprosy, diabetes, haemorrhoids, dysmenorrhoea and rheumatism (Warrier *et al*. 1995). When treating humans, the bark and leaves are used as an astringent, thermogenic, anti-inflammatory, digestive, carminative, laxative, anthelmintic, depurative, urinary astringent and in rheumatism (Prajapati *et al.* 2003). Teak *Tectona grandis* is renowned for its timber value and also for its resistance to decay. This characteristic is due to the occurrence of toxic compounds in the wood (Krishna & Nair 2010). Seesham *Dalbergia sissoo* has a number of well-known medicinal properties and has been used culturally to treat various diseases. Sidana *et al*. (2012) conducted a study on the analgesic and anti-inflammatory properties of *Dalbergia sissoo* leaf extract. They concluded that the extract possesses both analgesic and anti-inflammatory

properties (Bharath *et al.* 2013). The bark of the Salai tree *Boswellia serrata* maintains its green and healthy appearance for several months after it has been felled. During this period, the tree is rarely subject to infestation by insects (Orwa *et al.2009*). This potentially helps reduce insect colonisation of nests during the breeding season. Kakher *Flacourtia indica* is an important traditional medicinal plant in India. It is a valuable resource of distinctive products for the preparation of medicines that target various diseases. Every part of the tree including the leaves, bark, stem, fruits and roots has been verified for a number of pharmacological activities including anti-inflammatory, anti-microbial, anti-oxidant, hepatoprotective, anti-malarial, anti-diabetic, anti-asthmatic and anti-bacterial (Kota *et al.* 2012).

In many avian species, parasites and pathogens lead to nest desertion, egg spoilage, and reduced growth and survival of nestlings (Hitchner 1980, Loye & Zuk 1991, Richner *et al.* 1993, Oppliger *et al.* 1994). The survival and fecundity of breeding adult birds can also be lower due to nest parasites (Richner *et al.* 1993, Møller *et al.* 1990). Birds combat parasites in a variety of ways and adding green vegetation into nests is one way to control nest parasites. Several hypotheses regarding the function of green materials have been proposed. Wimberger (1984) hypothesized that nest greenery use by raptors aids in repelling ectoparasites via secondary compounds with insecticidal properties that are released during drying or decay of the plant material. Subsequently, Clark and Mason (1985) showed that European starlings *Sturnus vulgaris* select species of plants for nests that contain volatile chemicals with anti-bacterial, insecticidal, or miticidal properties. The same authors later showed that nests containing such herbs have lower infestations of blood-sucking mites (Clark 1991, Clark & Mason 1988). More recent research suggests that the addition of herbs to the nest does not necessarily serve to reduce parasite loads, but may help nestlings cope with the detrimental effects of ectoparasites (Clayton and Wolfe 1993).

Species that reuse their nests over successive years or those that may be susceptible to nest parasites in winter use fresh green nest material more often than species that build a new nest each year (Wimberger 1984, Clark & Mason 1985). This study highlights the use of green nesting material by vultures that reuse their

nests. Long-billed Vultures generally use the same nest each year and also breed during the winter months (egg-laying in December, chick in January-February); the addition of green plant material is likely to be effective in reducing nest parasites during winter. Green plant material is added to nests early in the breeding season (September-November), perhaps to reduce parasites during incubation. The vultures do not keep adding the green plants for the complete breeding period as done by Painted Storks *Mycteria leucocephala* and Asian Open-bill Storks *Anastomus oscitans* (Kanaujia *et al.* 2013) and the green material has dried out by the time the chick hatches in January.

Observations as well as discussions with local people during this study revealed that with changing farming practices and the unsustainable use of flora, the availability of nesting material is being affected. This has potential consequences for vultures if nesting material is not readily available near nest sites. Such lack of availability will result in more energy expenditure by breeding vultures during nest construction and potentially the loss of anti-parasitic green nest material during incubation.

Conclusion

Long-billed Vultures start reproduction when they are five years old. They are slow breeders with a single egg laid per year. Thus it is important for the breeding vultures to have a nest that will result in reproductive success and healthy growth of the chick. The study highlights that green plant material is an important component of Long-billed Vulture nests and that some of the species used by vultures are also valued for the preparation of human treatments and medicines. Over time, nesting material that is also used for various medicinal purposes might become a limiting factor and this may affect the breeding success of vultures. It is recommended to protect and promote the trees and native grasses that are required by Critically Endangered vultures for nest construction.

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