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Original Research Article

Eco-Biology, Threats and Conservation Problems of Indian Vulture in Southern Rajasthan, India

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ABSTRACT:
Vultures are very efficient and powerful natural scavengers in ecosystem, they usually feed upon carcass of domestic and wild animals. India is a home of nine specie of vultures they are very sensitive towards changes in habitat and climatic conditions. Vultures required large territories, selective diet and unique habitats for its survival. Vulture populations dramatically and rapidly declined from last 30 years due to acute and chronic renal failure and avian gout disease. Major reasons of vulture declined due to extensive use of veterinary drugs like diclofenac, ketofenac, fluxin, carprofen and nimesulide for treatment of domestic animals in various diseases. Other factor also responsible for vulture's population declined due to habitat destruction, lack of roosting and nesting habitat, mortality due to electrocution and collision with wind turbine, road killing and low reproductive success rate responsible for its survival and population decline. Male and female of Indian vultures are morphologically similar in shape and size. Vulture's having slow breeding rate and usually laid single egg per year or in every breeding season. Vultures collectively feed upon carrion and sometime inter & intra specific competition observed at feeding and roosting times. Indian vulture usually construct nest upon rock cliffs and old historical monuments area where cliffs are absent they generally construct nest on large and old trees. GPS tagging and satellite monitoring helpful for finding daily, seasonal, local and global migratory route of species.

Keywords: Indian vulture, Population, Breeding Success, Conservation, Habitat Loss, Threat.

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INTRODUCTION

Birds are an essential part of all ecosystems. Since last decade bird's abundance and diversity declining due to alteration of habitat, destruction and loss of habitat creates unfavorable conditions for bird's survival. The birds are connecting link of food chain and web. They play role of primary and secondary consumer. Birds are directly beneficial for ecosystem (Ali and Futehally, 2008).

Some bird's families play key role in environment cleaning like- vultures, kites and crows. The vultures are top most scavengers of ecosystem. Raptor have a excellent vision for searching food, strong legs for holding prey and strong curved beak for tearing meat. The term "vultures" originated from the Latin word Vultur, which means Vellere, which stand for – Pick and eat fleshy part of dead animals).

Vultures are largest, impressive birds and play key role in ecosystem to cleaning of ecosystem feeds upon dead livestock and wild animals (Newton, 1979; Mundy, 1982; Thakur and Narang, 2012). Their presence and abundances indicate good health of ecosystem and pollution free habitat and less anthropogenic disturb habitat (Bird Life International, 2005). At present 23 species of vultures including old world and new world vultures sustained in worldwide, out of them 14 species are now categorized in threatened, endangered and critically endangered according to IUCN status.

Vulture's population is dramatically decline in south Asian regions were first were recorded in the late 90'S in Bhartpur district Rajasthan (Prakash, 1999). These declines were firstly reported in Gyps genus of vultures like *Gyps bengalensis, Gyps indicus, Gyps tenuirostris* (Prakash et al. 2003; Gilbert, 2006). Finally, a non steroidal anti inflammatory drugs (NSAID) named diclofenac sodium was found to be more concentration in death vulture of Pakistan's Punjab province that died due to renal failure and avian gout disease (Oak *et al.,* 2004).

Further studies provided evidence that diclofenac was main factor of vulture mortality and sharply decline in South Asia (Green et al. 2004; 2006). After the studies diclofenac was banned for veterinary purpose in India and other south Asian region in ordered to protect decreased vulture populations. The results of diclofenac banned vulture population are gradually increased in Pakistan (Chaudhary *et al.,* 2012) and rate of vulture mortality are decline of different *Gyps* species *vulture* in India and Nepal regions (Prakash, 2012a). Vultures are most potent beneficial and economically important scavengers of nature that play an extensive role in ecosystem (Newton, 1979; Mundy, 1982). These are considered divine, economically and environmentally important due to their ability to dispose human and animal's dead bodies.

In 1990'S to present times vultures population dramatically decline in South Asia and other continent of earth. According to BirdLife International (2015a; 2015b), vultures play key role in ecosystem services in broad landscapes. Vultures feed on domestic as well as wild dead animal and keep the environment clean and healthy (Thakur *et al.,* 2012). They are ecologically useful in human-dominated area as a scavenger at slaughter house/ butchery and carcass dump sites (Mundey *et al.,* 1992) and in forest area as a scavenger on carnivore killed large size mammal's carcass (Houston 1974; Majumder *et al.,* 2009).

Vultures are sensitive to environmental changes because their life is long, required large territories have a selective diet and at the top position in food chain and have slow breeding rate.

OBJECTIVE OF STUDY

The objective of study was to analyze factor affecting of Indian vulture population and survival in various microhabitat and assessing their threats of survival and conservation problems in southern Rajasthan

MATERIAL AND METHODS

A survey was conducted for three year from (2017 to 2020) with regular observation of different Indian vultures nesting, feeding and roosting sites. To assessing threats and conservation problems were observed on the basis of

regular observation around vultures roosting and nesting places, study were supported by repeated direct observation, binoculars Nikon 8X40, and photography, video-grapey done by Nikon Coolpix P900, P1000, Canon D-60 camera, sigma 150-500 lens for three years regular monitoring of every sites of study area.

RESULT AND DISCUSSION

(I) MORPHOLOGY OF VULTURES- The body structure of vultures is especially adapted according to its feeding habit. The scavengers have nude head and neck *i.e.* feather and hairless. These have adaptive characteristic, allows to insert its head into a carcass baldness reduces risk of dirtying their bodies and parasitic infection. In vulture mandible muscles are highly developed and it can easily tear and open the flesh. Vulture's feet's are weak and poorly padded and have only single curved talons. Their feet are feather and hairless, thus helping in easily cleans up after feeding. They have very slow metabolic rates so they can survive many days without food. Their digestive systems have the unique properties to kill almost all viruses and bacteria's present in carcasses; there stomach acid is very powerful that could digest meat quickly; before any pathogens have a chance of infect it. The pH level of vulture's stomach is ranges from 1 to 2 (Houston and Cooper, 1975). The pH is comparable to gastric and hydrochloric acid from the human stomach and is more acidic than acid rain. Vulture's stomach pH level is higher in contents to other carnivorous birds like herons, kites, harriers and owls. High Acidity is very effective and helpful defense mechanism. Their protective vomit has foul smell that keeps away predators. If competitor reaches to close, the vomit is strong defense mechanism and power to burn predator (Christen, 2009). Vultures have a large wing span so they can easily soar in sky. Flight of vultures is highly specialized and remarkable. They can glide without loss of energy. Vultures urinate on their own legs; it helps to keep cool of their bodies and it's chemically strong so it works as germicide to kill bacteria or parasites present on feet. Vultures lack a voice box so they are generally silent, but some time they produce sounds. Good vision and binocular vision of vulture able to see carcass from several miles. The male and female are morphologically similar.

During copulation we can identify male and female birds other-wise not. Vultures are monogamous *i.e.* they pair up to for a life. Normally vultures lay single egg/year. Vultures have a special feature to take sun bath after feeding. Sunbath helps in maintaining body temperature and protection against infection of viruses and bacteria. They generally consume 300-500 gm carcass/day. All *Gyps* species collectively feed on carcasses (Ali and Ripley, 1983).

Figure 1: Indian vulture breeding pairs opening wings

Figure 2: Indian vultures male and female no morphologically difference

Figure 3: Indian vultures' specialized flight during searching of food

Figure 4: Vultures scat indicate indirect presence in habitat

Figure 5: Indian vulture breeding pair during copulations recognized male (top position) and female

Figure 6: Indian vulture performed thermoregulatory behavior in winter season

(II) POPULATION TRENDS AND CURRENT STATUS- Vulture population is rapidly declining in south Asian regions were first reported in late 90' S in Bharatpur district of Rajasthan (Prakash, 1999). This decline reports in *Gyps* genus of vultures *Gyps africanus*, *Gyps indicus*, and *Gyps tenuirostis* (Prakash 1999, Prakash et al., 2003; Gilbert *et al.,* 2004). Finally, a non-steroidal anti-inflammatory drugs (NSAID) named diclofenac sodium was responsible to be more concentration in death vulture of Pakistan's Punjab province that died from renal failure and avian gout diseases (Oak *et al.,* 2004). Different study shows that diclofenac was the main factor of vulture mortality and sharp population decline in south Asia (Green *et al.,* 2004; 2006). After many study diclofenac was banned for veterinary purpose in India and south Asian region. Positive or significant results obtained banning of diclofenac, vulture's population gradually increase in Pakistan (Chaudhary, 2012) and rate of vulture mortality declined in India and Nepal (Prakash *et al*., 2013). Out of nine species seven species of vulture found in Rajasthan (Naoroji 2006; Ali & Ripley, 1993). Once widely distributed species was oriental white backed, Indian and slender-billed vulture are categorized as critically endangered in IUCN red list of threatened species and are provided highest legal protection in Schedule-1 of Indian wildlife act (WLPA), 1972. An Indian vulture's morphologically different forms a Slender-billed vulture. Indian vulture is larger in size and curved beak and usually construct nest on rock cliffs,

old monuments and where cliffs are absent usually built nest on old historical places and large trees (Naoroji, 2006; Chishty and Choudhary, 2019).The breeding season of Indian vulture starts from October to May/ June (Naoroji, 2006; Choudhary and Chishty, 2020). The environmental factors largely influence vulture distribution and abundance in different geographic region.

(III) NESTING AND ROOSTING HABITAT OF INDIAN VULTURE- The vulture population is declining due to habitat loss as well as disturbance in their feeding habitat due to increase feral dog's population. Gadvi and Dodia (2006) observed cutting larges of trees like coconut in Mahuva (Gujarat) reducing roosting habitat of vultures. According to them vulture tree utilizes as a nesting and roosting, but vulture damage it leaves and flower they negatively affect fruit productivity in areas. To prevent such damage farmer use air rifles, fir cracks and stone etc to prevent vulture to roost on coconut trees.

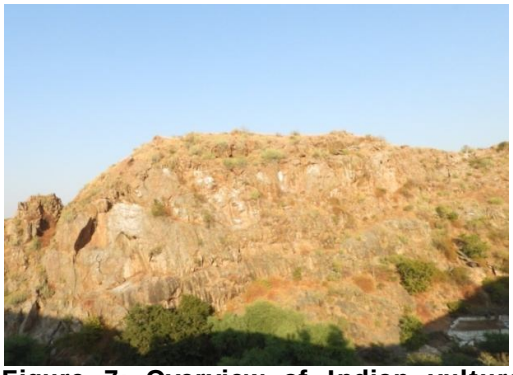

Figure 7: Overview of Indian vulture nesting habitat on cliffs or Aravalli hills in Udaipur

Figure 8: Overview of breeding habitat of Indian Chittorgar fort, southern Rajasthan

Figure 9: Indian vulture both adults participate in nest construction

Figure 10: Inter specific competitions for roosting site between Indian and Griffon vulture

Figure 11: Inter-specific competition between Indian vulture and Eurasian griffon for roosting site

During summer season high temperature becomes limiting factor for vulture survival and nesting and breeding. They construct nests on rocky cliffs of hills region and old historical places (Chishty and Choudhary, 2019). Male and female both participate in nest construction. Nests are constructed on well protected locations. It is generally out of rich of predators, human and monkey. They lay only one egg/year. Egg is oval, white sometime lightly dotted and reddish brown in color. In Indian vulture have approximate 50-60 days of incubation period. Matting is monogamous. The first stage of breeding is nest construction. Nest is constructed with large numbers of sticks on the top of trees, such as Peepal, Neem and banyan.

(IV) PARENTAL CARE IN INDIAN VULTURES -Male and female both participate in parental care of young one. Either of male or female always remains in nests when another one went to search for food from egg laying to first flight of young one. The newly hatchling chicks are nidicolous or helpless at birth. The young once or nestling starts fledge and take first flight after nine to ten weeks of hatchling time. They rapidly grow and within 2-3 month they become large in size. Before sunrise parents leads their nest and returned back during day time. Male and female both involve in parental care and protect their juvenile under their wings to prevent from direct sunlight and natural enemies.

Figure 12: Indian vulture incubated egg during breeding season

Figure 13: Indian vulture nestling and one adult always remain in nests

Figure 14: Indian vulture spreading wings and protect nestling from direct exposure of light

Figure 15: Indian vulture both adults and nestlings in resting position

(V) THREATS - Old world vultures have long life span but slow reproductive rate and high juvenile & adult's survival rate (Wyk *et al*., 2001). They are very sensitive to environmental changes because they long lived, need large territories, have a selective diet and are the top position in

food chain. Therefore, they are excellent bio-indicator for the health of ecosystems (Bird Life International, 2005). During the last 30 years vulture population has been sharply declined and in many areas of world vultures vanished and some are restricted only in protected areas such as national park and game reserves (Oaks *et al.,* 2004; Rondeau and Thiollay, 2004). These species are reducing and declined due anthropogenic modification and interference of their natural habitats (Bird Life International, 2001; 2003). Vulture populations are continuously declining due to many reasons like high rate of mortality in adults, juvenile and nestling. Sick birds show various sign of illness (dropping of Neck syndrome) for approx. 30 days prior to death. Large no of vultures population found in Rajasthan have many reasons like - climatic and socioeconomic conditions, abundance of live stock and domestic animals, religious belief, History of 'Gaushalas' (Cattle shelter house) is further more Orans (Village forests), Nadis (water bodies) and availability of suitable nesting and breeding site. According to Chhanganni (2010) vultures sighting is more frequent in village organization as compare to other areas. Vulture's population sharply declined due to Diclofenac contamination leads to renal failure. Ketofenac found in carcass (Naidoo *et al.,* 2009; Taggart *et al.,* 2009). Flunixin and Carprofen drugs too may be lethal to scavenging birds (Cuthbert *et al.,* 2006). Study carried out on some other drugs such as Nimesulide may be harm to vultures. Population also declined due to ingestion of infected carcass, habitat destructions and cutting of trees, especially Eucalyptus and Khejri which are preferred by vultures for roosting and nesting, electrocutions, mining of Aravalli, destruction of vulture nesting and roosting sites. Habitat loss creates inter and intra specific competition for roosting and nesting. The vultures breeding success are also declining due to habitat loss as well as disturbance in their feeding habitat and scarcity of food due to exponential growth of feral dog's population. In study area we observed feral dogs largely influence vulture activities where they feed. Throughout study periods maximum times observed only feral dogs consumed carcass and disturb feeding activity of different species of vulture in Udaipur region. Food shortage may be limiting factor for vulture's population and breeding success. Carcass availability and food shortage Reductions in the availability of carcass are become limiting factor for vulture population decline, because abundance of foods plays important role in organism survival and its fitness. During summer seasons high temperature become limiting factor for vulture survival and also affected breeding success. Due to excessive mining of Aravallis and cutting of large trees and expansion of urban areas reduces nesting habitat in southern Rajasthan. Habitat shrinkage increase inter and intra specific competition among different species of vultures for roosting and nesting. Anthropogenic activities like- expansion of agriculture land, settlement of human colonies and town, establishment of industries cause adverse effect on vulture habitat. Lacks of proper and separated disposal mechanisms of disposing households and medical wastes to dead animal by Municipal corporations also responsible for deaths due to unintentional and mass mortalities of vultures and carrion consuming birds. Caracas dumps on open ground where feral dogs mostly feed on same Caracas; they may increase risk of transmission disease and injuries in vultures. We also observed some villagers are used Crackers and loud sounds used near vultures breeding habitat for stooping roosts and nests. We also observed some animal grazer thrown stone where vultures are sitting and roosted. These activities are also creating direct threats for vulture survival in southern Rajasthan. Invasion of *Prosopis juliflora* reduced native flora where vultures make nests and using nest materials. In Udaipur district vultures and large raptors were not observed in *Prosopis juliflora* dominated habitats (Choudhary and Chishty, 2020). Mining and drilling of the Aravallis also responsible for vulture's habitat decline in southern Rajasthan.

Figure 16: Feral dogs dominance at carcass dumping yard at Balicha, Udaipur

Figure 17: Vulture breeding habitat loss and fragmentation due to roads and construction activities

Figure 18: Excessive and uncontrolled mining of Aravallies

Figure 19: Habitat fragmentation due to construction activity of roads

Figure 20: Improper disposal waste management of house hold wastes and carcass dumping in Udaipur

Figure 21: Scattered Indian vulture nest increase risk of egg or hatchling fallen on ground

(VI) CONSERVATION OF VULTURES- The population of white backed vulture and Indian vulture has sharply declined due to adult's mortality and failed in breeding success. The following step should be taken for saving vulture from immediate extinction-1. Dead vulture's body's tissues should be histological and pathologically examined for find out various pesticides' persistence in different organs. Carcass should be analyzed before dumping in different geographic region where vulture populations were sharply declined. 2. Genetic diversity study will be helpful to understand declining vulture population. 3. The vulture conservation and breeding center established in India at Pinjor district Haryana. The center established by the RSPB and BNHS, is part of the captive breeding of vultures. Captive breeding programs are helpful for saving from immediate extinction of vultures. 4. In different part of India feeding center for vulture should established that will prevent mortality of vulture due to food scarcity. There have been many examples where "Vulture restaurants" have helped in increasing vulture population (Lu and its student, 2009). Vulture restaurants provided alternative source of uncontaminated food in areas, where vulture restaurants were present. Positive result of vulture restaurants recorded in South Africa was shown increased cape vulture (*Gyps coprotheres*) population in first year (Mundy *et al.,* 1992). In 2007year; a vulture restaurant established in Nawalparasi in Nepal, where diclofenac and drug free carcass were available for vultures. Due to vulture restaurants in Nepal, number of nesting pair surprisingly increased in two yrs [2005-2007] from 17 to 32. Similar result obtained when vultures fed drug free and uncontaminated meat in Gujarat, Seurat nature club 'Vulture feeding site' in Hazira, Gujrat. Recently in 2010 the Maharashtra government open vulture restaurant in Fansad sanctuary in the Raigad district. The animal dumping site in Jorbeer, Rajasthan abodes 3000-4000 vultures (Migratory and residential) in every year, they provided enough food and suitable roosting sites (Kushwaha and Kanaujia, 2011). 5. To Establish hospital and rehabilitation center for injured and sick vultures. 6. The water bodies play important role in breeding success of vultures during summer season, because juvenile required high amount of water with food. Due to anthropogenic activities and water pollution increase risk of disease in vultures. 7. Regular monitoring of Municipal dumping sites and established separate vulture feeding stations and carcass dumped away from household or medical wastes. 8. Regular monitoring required for population and breeding success in each and every vulture's habitat in southern Rajasthan. 9. GPS tracking and satellite monitoring will also help to know daily activities and food searching range away from breeding habitat. 10. Habitat protections also required near vultures breeding sites. Mining and human settlement activities should completely prohibited around breeding sites. Ban of Mining of Aravalli and protection of old and large trees especially (*Eucalyptus, Madhuca longifolia, Ficus religiosa, Ficus bengalensis, Azardirachta indica*) are used by vultures for roosting and resting time in southern Rajasthan. 11. DNA sequencing and molecular levels biodiversity among vulture should be helpful in understanding genetic variability among vulture population. Genetic study should be initiated for purpose of find out genetic variation among particular vulture's spices at regional level and global levels. 12. Measure to mitigate electrocution and collisions include reviewing the placement of new electric lines, removing earth wires or fitting them with markers and changing pylon design. 13. Rajasthan state is in immediate need for vulture conservation plan for captive breeding and vulture rehabilitation center for saving residential and Indian vultures. The vulture awareness conservation programmed should organized by open seminar for villagers, students, workshop, electronic and print media and group of local people for vulture conservation. Habitat protections are also required near vultures breeding sites. Mining and human settlement activities are completely prohibited around five to seven kilometer range of breeding sites. Ban of Mining of Aravalli and protection of old and large trees especially (*Eucalyptus, Madhuca longifolia, Ficus religiosa, Ficus bengalensis, Azardirachta indica*) are used by vultures for roosting and resting time

in southern Rajasthan. Dead animal carcass left/ kept near vulture breeding sites, because food and water availability play crucial role in reproductive success. Control and synchronize mining activities of the Aravalli ranges especially sloppy cliffs and hillocks also become helpful for saving Indian vulture at regional scale. Nest monitoring and reproductive success also helpful in known vulture population status in regional level. Regular need for organization of vulture awareness program and conference with the collaboration of forest department with also helpful in vulture conservation. The vulture awareness conservation programmed organized by open seminar for villagers, workshop and involving the electronic and print media and establishment / making group of local people for vulture conservation like vulture conservation friend club, vulture lower club. They members of local people in clubs regular monitored breeding site during hatchling and nestling and monitored food abundance in vulture habitat. Basis on the analysis of genetic homozygosity and heterozygosity find out valid conclusion for vulture population decline. Genetic and molecular study should be also helpful for vulture conservation and saving from immediate extinction at regional and global levels. Vulture awareness program and scientific study are also helpful for find found other actual reasons of vulture population declining in India with the help of forests department and wildlife researchers.

CONCLUSION

In present time, human population continuously increasing, Urbanization and industrial expansion also responsible for vulture population decline in southern Rajasthan. Establishment of industrialization increase environmental pollution like- air, water and soil they all negatively affect vulture population and breeding success. Expansion of urbanization decrease territory and roosting habitat of vultures. During highways and road establishment large number of old trees are cutting, they reduces vulture roosting habitat. In present time urbanization is major problem for vulture survival in southern Rajasthan. Avian disease play critical role in the decline and limiting of vulture population including raptor species, disease cause mass mortality and becoming dramatic declining of bird's populations. Global warming and climatic variability affect bird's population in several ways like population distribution and dynamic, abundance, behavior, genetic composition and breeding success and migration patterns. Molecular and genetic levels study and captive breeding programs also required for identification of genetic variability and enhancing breeding success in different species of vultures. Establishment of vulture rehabilitation center and vultures feeding stations increase recovery of injured vultures and food availability in study areas. Rajasthan state urgently required vulture recovery action plan in various habitat for saving from immediate extinction.

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