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Research Article

COMPARATIVE EXODUS ARCHETYPE OF VULTURES IN RELATION TO ENVIRONMENTAL FACTORS AT JORBEER CONSERVATION RESERVE, BIKANER, RAJASTHAN, INDIA

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ABSTRACT

The purpose of the investigation was to compare the exodus archetype of vultures *viz.*Eurasian griffon (*Gyps fulvus*), cinereous (*Aegypius monachus*) and Himalayan griffon (*Gyps himalayensis*), in relation to environmental factors at Jorbeer conservation reserve, Bikaner, Rajasthan, India (JCRBRI) during period from April 2015 to July 2016. The vultures were studied according to variation in population according to temperature humidity index (THI) values and Eurasian griffon vulture asserted lucid wintering at JCRBRI. Above 25% of Eurasian griffon vulture preferred 56.64-72.5 THI values. However, maximum THI value threshold observed was 82.5 by 0.1% Eurasian griffon vultures. Himalayan griffon vulture showed a different pattern of migration with maximum THI threshold of 79.5. Cinereous vulture's maximum THI threshold was 82.5. At low THI values (57.06-62.07), 100% of Eurasian griffon vulture and cinereous vulture were present. Regarding Himalayan griffon, 100 per cent population was observed at THI value of 76.5. Eurasian griffon vulture, cinereous vulture and Himalayan griffon stayed at reserve during various months of the study when the THI values varied as 56.64-82.5, 56.64-82.5 and 56.64-79.5, respectively. At lowest THI value, population per cent of Eurasian griffon vulture was 95, of cinereous vulture it was 90 and of Himalayan griffon only 20%. Inspection of vultures per cent in addition to the coexisting recording of environmental factors can be utilized for superintending the vulture exodus at the JCRBRI that may have impressive impingement to determine migrant population of vultures. Migration period of vultures vacillated most likely due to environmental vulnerability edge or other unrevealed issues related with the physiological mechanisms and accessibility of food and shelter. It can be inferred that 25% or more population of Eurasian griffon vulture and 20% and more population of cinereous vulture preferred THI values of 72.5 or low whereas 75% to 100% population of Himalayan griffon chose THI values of 75.5-76.5.The exploration carried out is an effort in the course of understanding the natural environment and vulture interface during itinerant forces.

Keywords:- Bikaner, Exodus, Population, Temperature-humidity index, Vultures.

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INTRODUCTION

The investigation on exodus archetype of vultures as a global issue is one of the persuasive and exigent problems of modem biology with major insinuations for human health and bird conservation. Natural variations in the accessibility of critical stopover sites coupled with anthropogenic destruction of wetlands, land-use changes and predicted thrashings due to environment variations present migratory birds with an astounding provocations [1]. Vulture exodus is a regular phenomenon to and from their breeding and wintering grounds each year in large numbers. Recording and comprehending the migration of raptors is important from logistic and technological point of view. Determination of bird population during migratory stopover have historically been used to authenticate the route of migrating birds. Calculating differences in a time-series from one period to the next is a way to make the data stationary and to obtain meaningful correlations among variables. Visual methods provide detailed species information at migratory stopover sites. Scientists have tried to link weather conditions with the migratory traffic rates [2]. Employment of space based expertise in context with bird exodus archetypal and geographical information analysis provides new implements to cast comprehension on the allocation and migration of organisms on the earth and their compassion to human interruptions and environmental variations [3]. The main challenges faced by scavenging raptors are inferior quality of the food and dearth of food [4].

Vultures are featured by intense vision that permits them to identify the prey during flight. Eurasian griffon vulture (*Gyps fulvus*) is a scavenger feeding mostly on dead animals. Cinereous vultures (*Aegypius monachus*) are considered to be largest bird of prey and heaviest flying birds and their other names given are Eurasian black vulture, black vulture or Monk vulture belonging to family Accipitiridae. Himalayan griffon vulture (*Gyps himalayensis*) is known to be an old world vulture belonging to family Accipitridae. Perhaps it is largest and heaviest bird found in Himalayas. Very little is known about vultures migrating to India, their foraging areas and wintering perch. Contemporary research indicates that several inhabitants of a species may exhibit an extensive trophic position or individuals with a narrow trophic niche. Optimal foraging theory envisages that inhabitants will choose the positive and encouraging environment for foraging. A fundamental concept in landscape ecology is that spatial heterogeneity affects ecological systems. Constituents of landscape heterogeneity can sway an array of ecological retorts, including migration of birds. For biodiversity conservation in human-populated areas, it is predominantly imperative to comprehend the association between spatial heterogeneity and biodiversity in agricultural terrains [5]. Landscape hetero-geneity hypothesis envisages a higher number of species in more diverse topographies. It can be expected that inhabitants with a broader identified niche must have foraging areas with higher environmental assortment, evoking that foraging tactics, territory quality and habitat diversity are inter-correlated. Scientists have suggested that niche generalist foraging strategies are based on an active search for different prey species within or between habitats rather than on the selection of territories with high habitat diversity [6]. Agriculture intensification has radically changed farmland medley, whereas semi-natural grasslands have been considerably reduced and fragmented affecting migratory routes. Changes in the environment is developing in the manner that may impose on the biological system unconstructively heading towards ecological unevenness.There are numerous modes by which the environment can maneuver migration of birds. Temperature and humidity are important components of environment which can bang upon heavily on migratory efficiency. Birds migrating larger distances are encountered with assorted spatial information. Looking towards paucity of research on these issues in vultures, the present investigation was instigated with the objective to follow raptors' migration archetype considering environmental temperature and humidity in Jorbeer Conservation Reserve, Bikaner, Rajasthan, India (JCRBRI).

MATERIALS AND METHODS

The exploration was executed to assess movements of vultures in relation to environmental factors at Jorbeer conservation reserve, Bikaner, Rajasthan, India. Study included observations of vultures and documentation of environmental factors from April 2015 to July 2016.The exploration included Eurasian griffon (*Gyps fulvus*), cinereous (*Aegypius monachus*)and Himalayan griffon (*Gyps himalayensis*) vultures at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India (JCRBRI). The area of reserve is56.46 km^{2}positioned south east to Bikaner at a distance of 12 Km with a geographical location of 20'3^0 north latitude and 73'5^0 east longitudes at height of 234.84m mean sea level.To determine comparative migration pattern of vultures and environmental factors, data gathered over a time of 16 months were evaluated. Vulture exodus was noted down by visual observation besides environmental factors including temperature and relative humidity on 1st and 15th day of each month. The environmental factors in the study were recorded by means of portable instrument (Atmospheric Data Centre Pro, Brunton, USA) and THI was calculated as illustrated by Gantner*et al* [7].

RESULTS AND DISCUSSION

Population of vultures (Eurasian griffon vulture, Himalayan griffon and cinereous vulture) in numbers at JCRBRI from April 2015 to July 2016 is depicted in figures1,2 and 3, respectively. From May to September, 2015, only one Eurasian griffon vulture was evidenced. From October 2015, number of bird started increasing and reached a peak value of 2000 in mid of December 2015 and remained same till start of January 2016. Then from the mid of January 2016, the number of Eurasian griffon vulture started decreasing and on May 1, 2016, it became one only. One hundred and fifty and 200 Himalayan griffons were observed on April 1, 2015 and on April 15, 2015, respectively while during May to October, 2015 and May to July, 2016, no Himalayan griffons were spotted at the reserve. In November 2015, 10 Himalayan griffons were counted and number reached to a peak value of 60 in mid February 2016 followed by a gradual decline. On April 15, 2016 only one Himalayan griffon was observed and count became zero in the month of May 2016. On April1, 2015 five and on April 15, 2015 fifteen cinereous vultures were observed. During May to October, 2015 and June to July, 2016, no cinereous vultures were observed. In November 2015, four cinereous vultures were counted and number reached to a peak value of 20 in mid December to early January followed by a gradual decline afterwards. From April to May 15, 2016, only one cinereous vulture was observed and count became zero in the month of June 2016.

Vulture population (%) with average temperature-humidity index values (THI) from April 2015 to July 2016 is depicted in fig.4. From April to September, 2015 the THI values dangled between 75.5 and 82, and per cent population of Eurasian griffon vulture, cinereous vulture and Himalayan griffon varied as 0.05-3.75%, 0-75% and 0-100%, respectively. In October 2015, THI varied between 78.2 and 79 and only Eurasian griffon vulture was present (1-5%). November to February illustrated THI values as 72 and lower, and population per cent of Eurasian griffon vulture, cinereous vulture and Himalayan griffon varied as 25-100%, 20-100%, 5-30%, respectively. In the March 2016,THI varied between 72 and 72.5, and per cent of Eurasian griffon vulture, cinereous vulture and Himalayan griffon varied as 40-45%, 30-50% and15-17.5, respectively. From April to July, 2016, THI varied between 79 and 85, and per cent of Eurasian griffon vulture, cinereous vulture and Himalayan griffon varied as 0-2%, 0-5% and 0-2.5%, respectively.

Representation of 75-100% vultures' population with THI values at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India is there in figure 5. Majority of the vultures preferred to stay at the reserve when the THI values were comparatively lower. At 75-100% population of Eurasian griffon vulture, cinereous vulture and Himalayan griffon vulture, the THI values varied as 56.64-64.76, 56.64-76.5 and 75.5-76.5, respectively. Summer (April, May, June and July) residence per cent population of Eurasian griffon, cinereous and Himalayan griffon for years 2015 and 2016 are depicted in figures 6, 7 and 8, respectively. In comparative terms, population was found higher in summer months of year 2015 than year 2016. Probably it was due to higher environmental temperature in year 2016 than that in 2015 summer months. Summer months of 2016 exhibited higher THI values than that of year 2015.

Figure 9 depicts the comparison of vulture population (%) with maximum environmental temperatures (^{o}C) at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India. Residential population of raptors was dependent upon environmental temperature. When maximum environmental temperature decreased comparatively the per cent of vultures staying at JCRBRI increased. Figure 10 depicts variations in minimum environmental temperature values and total vulture population (%) at the reserve.

The overall picture of vultures' residential period at JCRBRI is shown in fig.11. At various per cent population of Eurasian griffon vulture, cinereous vulture and Himalayan griffon, the THI values varied as 56.64-82.5, 56.64-82.5 and 56.64-79.5, respectively. It was observed that all the vultures were found at THI value of 56.64, but at higher THI values the population differed. Perhaps variation in population showed the threshold of individual vulture or a species to environmental correlates.

Eurasian griffon vulture was observed continuously from April 2015 to July 2016, though population per cent varied. Cinereous vulture was observed in April 2015 and then from November 2015 to May 2016. Himalayan griffon was observed in April 2015 and then from November 2015 to April 2016. Except Eurasian griffon vulture, cinereous vulture and Himalayan griffon were not observed from May 2015 to October 2015. Then again with start of summer months, July 2016 marked the absence of Eurasian griffon vulture, May to July 2016 marked the absence of Himalayan griffon and June to July 2016 marked the absence of cinereous vulture. Residential threshold based upon THI values was variable for different vultures for the study period. It was determined by observing absence of a vulture at higher threshold. Maximum THI value threshold was 82.5 for Eurasian griffon vulture and for cinereous vulture and 79.5 for Himalayan griffon (Fig. 12). Maximum THI values observed during the study period were 84.2 and 85 and all the vultures flew away during this period from the JCRBRI. Temperature humidity index threshold was maximum for Eurasian griffon vulture and cinereous vulture, which was observed throughout the study period except July 2016 for Eurasian griffon vulture and June and July, 2016 for cinereous vulture as THI was much higher in these months as compared to previous months. THI values were consistently higher during summer months of 2016 than that in 2015.

To achieve the expedition, vultures efficiently steer many hindrances together with a vigorous environment.To make proper use of this perpetually changeable location, an instinctive sagacity of the environment and its penchant is essential. Oodles of facts put forward that environmental correlates prickle the migration of vultures from around the world in numerous ways.Instantaneous responses that push the crucial bashes of environmental changes on raptors could cause significant alterations to extents that may possibly be dreadful for various species. Consequently migratory raptors need coordinated reserve [8]. Researchers have put in order the THI values to denote soothing period and stress period. Generally THI value less than 70 reflects soothe zone. Values between 70 and 75 denote warning period for the birds to effectively increase physiological mechanisms for thermoregulation. Values between 76 and 81 are considered as peril to survival. Environmental obstacles encompass important apprehension over existence and prospective reproductive success. Therefore, birds have evolved physiological strategies to combat barriers coming in the way of migrations [9].Archetype of outcome of the endeavor exhibited that environment has tremendous influence on the migratory behaviour of vultures.

Eurasian griffon vulture marked its presence throughout the year except in July, 2016. In year 2015, maximum THI was 81.5 whereas in July 2016, it was 85. This could be the reason of absence of Eurasian griffon vulture in July, 2016. Cinereous vulture was not observed from May to October, 2015 during which THI varied from 76.5 to 82, and from June to July, 2016 when THI varied from 82 to 85. Himalayan griffon was observed from November to April continuously when THI was either 79.5 or lower, however, higher per cent (75 and 100) was observed when THI was 75.5 and 76.5, respectively in the month of April 2015. This was not a consistent feature as in April 2016, per cent was less than five. Our observations suggest that changes in environmental correlates persuaded variation in migration archetype of vultures.Scientists [10] have suggested that migrants have to cope up with environmental threats in unrelated geographies along with never-ending curbs prompted by human aggravated makeover in the track of geographical adaptations and lumpiness of caches.

During the study period, less than 5% of Eurasian griffon vulture population was seen from April to October 2015 and April to June 2016. In rest other months, population percent observed was above 25% with 75% to 100% population from December 2015 to February 2016 asserting lucid wintering at JCRBRI. Above 25% of Eurasian griffon vulture preferred 56.64-72.5 THI values. However, maximum THI value threshold observed was 82.5 by 0.1% Eurasian griffon vultures. Himalayan griffon vulture showed a different pattern. In April 2015, population was between 75 and 100% whereas in April 2016, population declined to 0.5-2.5%. May to October 2015 and May to July 2016 marked absence of this vulture. November 2015 to March 2016, per cent varied between 5 and 30. Maximum THI threshold was 79.5.Cinereous vulture showed its presence in April 2015 (25-75%), then disappeared in consequent months and again present from November 2015 till May 2016.November 2015 to March 2016, percent variation in population was between 20 and 100%. In April-May 2016, only 5% birds were present. Maximum THI threshold was 82.5.At low THI values (57.06-62.07), 100% of Eurasian griffon vulture and cinereous vulture were present. Regarding Himalayan griffon,100% population was observed at THI value of 76.5. Eurasian griffon vulture, cinereous vulture and Himalayan griffon stayed at reserve during various months of the study when the THI values varied as 56.64-82.5, 56.64-82.5 and 56.64-79.5, respectively. At lowest THI value (56.64), population per cent of Eurasian griffon vulture was 95, of cinereous vulture it was 90 and of Himalayan griffon it was only 20%. When THI values varied between 57.06 and 62.07, population per cent of Eurasian griffon vulture and cinereous vulture remained 100% and of Himalayan griffon between 10 and 15%. At THI value 72.5 or below, Eurasian griffon vulture percent varied between 25 and 100%, of cinereous vulture 20 and 100% and of Himalayan griffon between 5 and 30%. At THI values 75.5-76.5, 75 to 100% population of Himalayan griffon was observed. At this range, cinereous vulture was from 25-75%. However, at this range a very low per cent of Eurasian griffon vulture was present. Above discussion reiterated that migration epoch of vultures differed depending upon suitability to environmental factors. It

Fig 1. Eurasian griffon vulture population at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

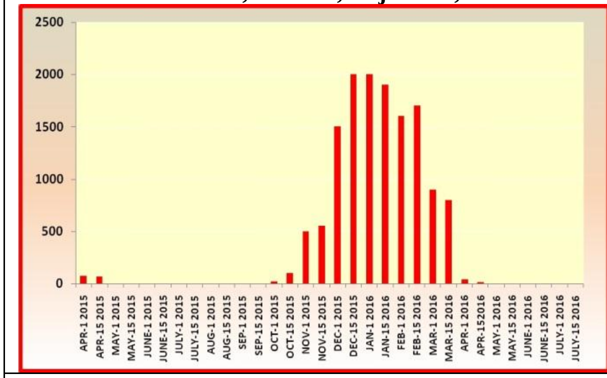


Fig 2. Himalayan griffon vulture population at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

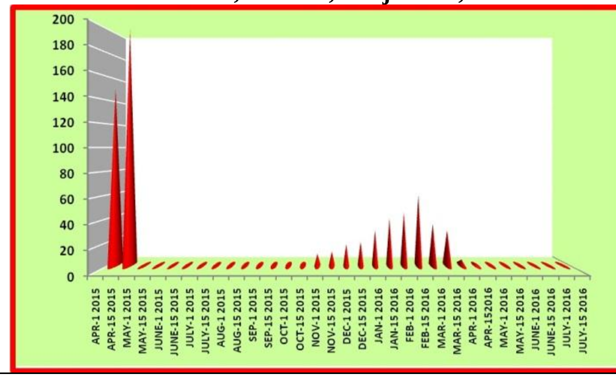


Fig 3. Cinereous vulture population at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

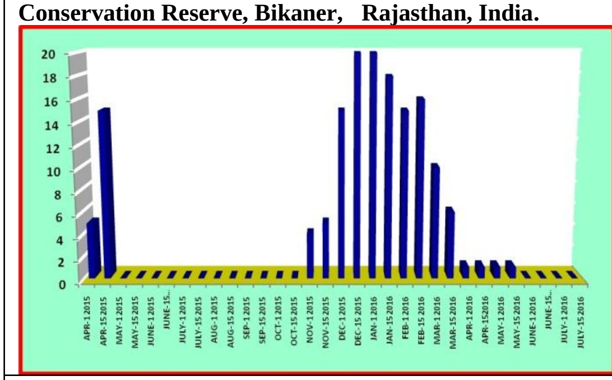


Fig 4. Vulture population (%) versus temperature humidity index values (THI) at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

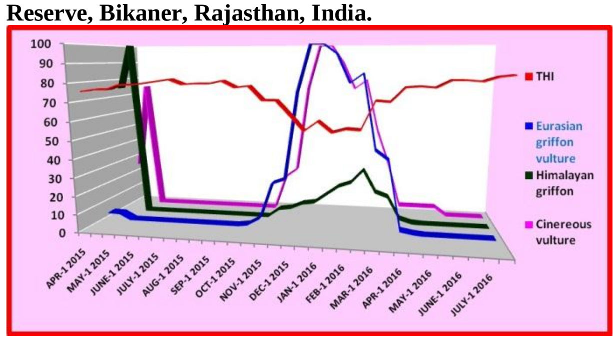


Fig 5. Representation of vultures' population (75-100%) with THI values at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

Months	THI	Eurasian griffon vulture %	Cinereous vulture %	Himalayan griffon vulture %
APR-1 2015	75.5			75
APR-15 2015	76.5		75	100
NOV-1 2015	72			
NOV-15 2015	72			
DEC-1 2015	64.76	75	75	
DEC-15 2015	57.06	100	100	
JAN-1 2016	62.07	100	100	
JAN-15 2016	56.64	95	90	
FEB-1 2016	58.55	80	75	
FEB-15 2016	58.13	85	80	
MAR-1 2016	72.5			
MAR-15 2016	72			

Fig 6. Eurasian griffon vulture population (%) in summer months at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

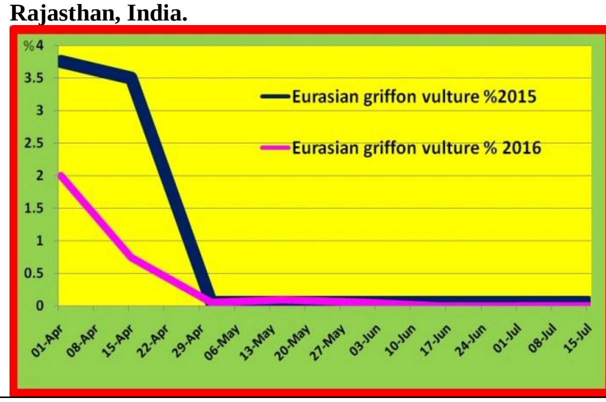


Fig 7. Cinereous vulture population (%) in summer months at Jorbeer Conservation Reserve, Bikaner , Rajasthan, India.

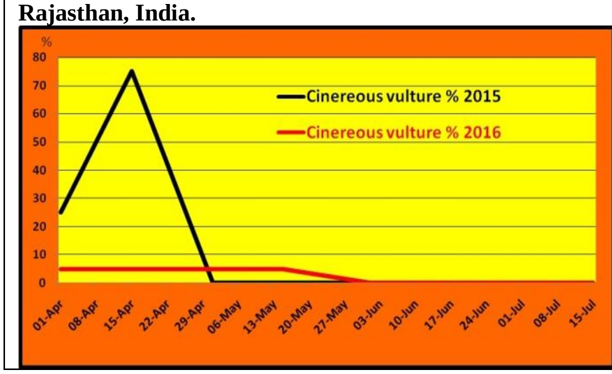


Fig 8. Himalayan griffon population (%) in summer months at Jorbeer Conservation Reserve, Bikaner , Rajasthan, India

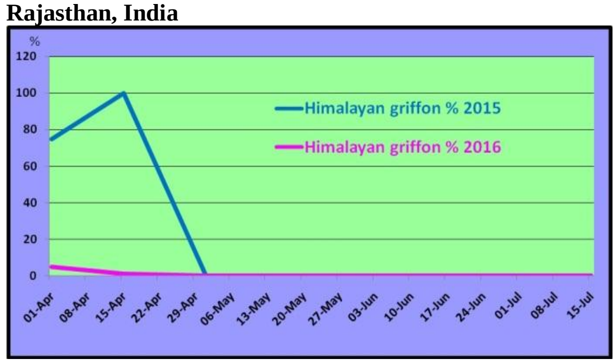


Fig 9. Comparison of vulture population (%) with maximum environmental temperatures (^oC) at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India

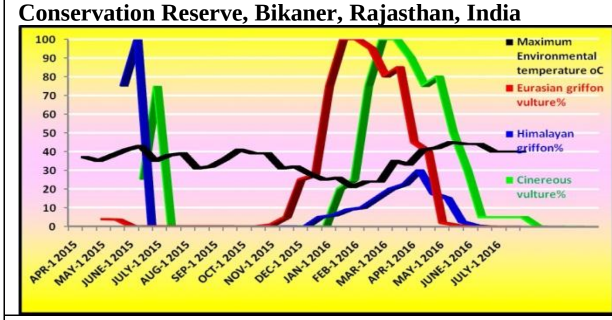


Fig 10. Comparison of vulture population (%) with minimum environmental temperatures (^oC) at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India.

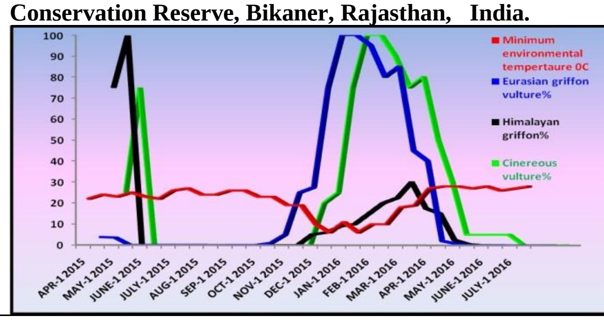


Fig 11. Overall picture of raptors' residential period at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India with months and THI values.

Months	THI
APR-1 2015	75.5
APR-15 2015	76.5
MAY-1 2015	76.5
MAY-15 2015	79
JUNE-1 2015	79
JUNE-15 2015	80
JULY-1 2015	81
JULY-15 2015	82
AUG-1 2015	79.5
AUG-15 2015	80
SEP-1 2015	80
SEP-15 2015	81.5
OCT-1 2015	78.2
OCT-15 2015	79
NOV-1 2015	72
NOV-15 2015	72
DEC-1 2015	64.76
DEC-15 2015	57.06
JAN-1 2016	62.07
JAN-15 2016	56.64
FEB-1 2016	58.55
FEB-15 2016	58.13
MAR-1 2016	72.5
MAR-15 2016	72
APR-1 2016	79
APR-152016	79.5
MAY-1 2016	79
MAY-15 2016	82.5
JUNE-1 2016	82.5
JUNE-15 2016	82
JULY-1 2016	84.2
JULY-15 2016	85

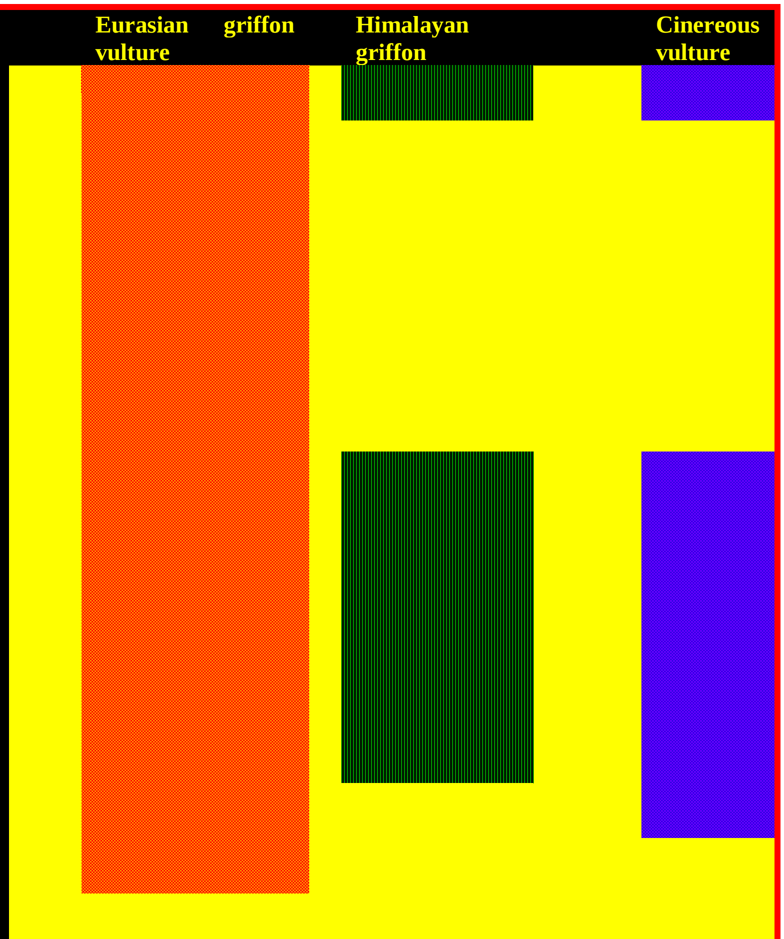
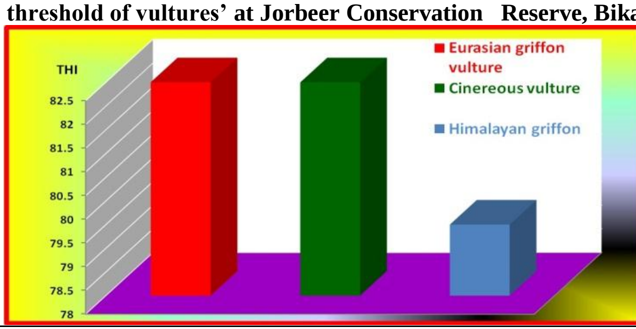


Fig 12. Maximum THI value threshold of vultures' at Jorbeer Conservation Reserve, Bikaner, Rajasthan, India



can be discerned that wandering vultures have adroitness to handle various issues during hot, cold and moderate periods.

CONCLUSIONS

The date wise spotting of vultures as well as the concurrent documentation of environmental factors can be employed for supervising vulture exodus in the region that may have spectacular impingement to guesstimate migrant population of vultures. Immigration time of vultures fluctuated probably due to environmental susceptibility threshold or other unidentified factors associated with the physiological mechanisms and availability of food. It can be inferred that 25% or more population of Eurasian griffon vulture and 20% and more population of cinereous vulture preferred THI values of 72.5 or low whereas 75% to 100% population of Himalayan griffon chose THI values of 75.5-76.5. The investigation carried out is an attempt in the direction of grasping the subtlety of environment and bird interactions during migratory drives.

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CONFLICT OF INTEREST:
The authors declare that they have no conflict of interest.

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