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Species composition, diversity and distribution along an elevational gradient in Oak–dominated forests of Pir Panjal range in Jammu and Kashmir

Mohd Junaid Jazib
[Department of Environmental Sciences, Govt PG College Rajouri, Jammu and Kashmir (India).
Email: junaidjazib@gmail.com]

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Abstract

The study was conducted in Oak-dominated temperate forests of Rajouri district of Jammu and Kashmir (India) to assess the impact of altitude on species composition and diversity. A total of 32 woody species were encountered in the study area lying between 1200m and 2500m elevation. Three species of Oak viz. *Quercus leuchotrichophora, Q. floribunda and Q. semecarpifolia* were found to be dominant or co-dominant in the area. *Q. leuchotrichophora* shared the maximum acreage at all elevations. Its associate species, however, remained changing across the elevational gradient. Results revealed that the phytosociological characteristics of the studied forests vary remarkably in response to changes in altitude. Stem density decreased while total basal area was found to increase with altitude. No of species was maximum at lowest altitude and steeply decreased with rise in altitude. Diversity indices (Margelef Index, Menhinik Index, Shanon Wiener Index, etc.) showed evident decline in their values with altitude. However, an unexpected dip due to anthropogenic pressure at middle elevation range was also observed. These forests demand urgent attention for their conservation and management.

Keywords: Ecosystem, forest, elevation, biodiversity, community composition, environmental factors.

Introduction

Forest ecosystems are believed to be the great storehouses of biodiversity (Thomson et al., 2011). They are evolved and influenced by a multitude of environmental factors. Vegetation in a forest ecosystem is a function of time (Kharakwal, et al., 2005), but its ecological attributes (like community structure, floral

composition, diversity, etc.) are mainly determined by its geographic location, climatic regime, soil conditions and other environmental factors. Vegetation complex, even within a particular region, does not remain uniform in time and space. It fluctuates in a cyclic way with changing seasons and in a succession over the years (Heady, 1958). Flora of a place responds to and gets shaped by the changes in factors like altitude, climate, soil conditions and natural and anthropogenic disturbances. Variation in community characteristics across environmental gradients is a major topic of ecological investigations and has been often described with reference to climate, biotic interaction, habitat heterogeneity and history (Givnish, 1999; Willig et al., 2003; Currie and Francis, 2004; Qian and Ricklefs, 2004; Bohra et al., 2010; Amissah, et al., 2014; Khaine, et al., 2017)). Elevation is recognized as a fundamental factor that influences forest community structure, species composition, diversity, density, regeneration and other ecological attributes of vegetation (Sharma et al., 2009, 2010; Gairola et al., 2011; Kessler 2001; Schmidt et al., 2006; Zhang et al., 2006). It is one of the most important governing factors responsible for regional differences in species composition particularly in the Himalayan region (Sharma et al. 2016). Altitude in itself represents a complex combination of many related factors like topography, water availability, soil characteristics, climate, etc. (Ramsay and Oxley, 1997) which greatly affect floral composition of an area (Holland and Steyn, 1975). As geographic and climatic conditions change abruptly along an altitudinal gradient (Kharkwal, 2005), they affect the presence, density, dominance and distribution of plant species.

Effects of altitude on vegetation have been analyzed by various workers in different parts of the world (Whittaker, 1972; Pavon et al., 2000; Mota, et al., 2017; Acharya et al., 201; Ahmed, 2006) and particularly in the western Himalayas (Saxena et al., 1985; Adhikari et al., 1995; Kharkwal et al., 2005; Singh et a.l, 2009). A great majority of them has confirmed the decline of biodiversity with increasing elevation. Several studies, however, reported peak values of species richness at middle altitudes (Rahbek, 1997; Grytnes and Vetaas, 2002; Kharkwal et al., 2005) yet some other studies have shown a linear relationship between species richness and altitude (Givnish, 1999) and have given other explanations for the same. Changes in forest composition along elevational transects in the western Himalayan region are, thus, evident, but they require proper and detailed measurement (Chitale et al., 2014; Sharma et al., 2014) especially in areas which are ecologically least investigated. Although a good amount of such information is available for rest of the Himalayan region, very few studies were conducted on elevational gradation of vegetation in Jammu and Kashmir. Vegetation composition with reference to altitude has been evaluated by several workers in parts of Jammu province (Raina and Sharma, 2012; Sharma and Raina, 2013), Pak administered parts of J&K (Shaheen et al., 2012) and Kashmir valley forests (Rather, 2014). But No such study has been carried out in the Pir Panjal Himalayan range (Rajouri and Poonch districts of Jammu and Kashmir) which forms a distinct region and is even taxonomically underexplored despite its rich flora (Dar et al., 2014). Present investigation was carried out in temperate broadleaved Oak dominated forests of Rajouri (southern slope of Pir Panjal mountain range) to assess the effects of altitude on stand structure, species composition, diversity, dispersion pattern and other ecological attributes of vegetation. Pure or mixed stands of Oak (*Quercus* sp) form the principal floral group on the southern slopes of the range between 1200m and 3500m elevation. The area is dominated at various altitudinal ranges (1300-3500m) by one or the other species of Oak particularly *Quercus leuchotrichophora* which is, ecologically as well as socio-economically, a highly valued plant of the region. These forests are also the main representatives of the temperate broadleaved Himalayan forests in Jammu and Kashmir. The approach adopted in this investigation is direct gradient analysis in which aspects of community composition, structure, diversity and dynamics are simply analysed with reference to the changes in evident ecological factors. The present work would be helpful and fundamental in generating baseline data and developing sound conservation and management strategies for the region. It may also help in understanding and predicting the biological impacts of the climate change.

Materials and methodology

Study area

Pir Panjal Mountains, extending in a northwest to southeast direction across Jammu and Kashmir in India, form the largest range in the western Himalayas and support wide range of vegetation including grasslands,

scrubs and luxurious coniferous and broadleaved forests. The present study was carried out in Oak-dominated broadleaved mixed forests of Rajouri Forest Division (district Rajouri) of Jammu and Kashmir (India). The division, forming a part of southern slope of the Pir Panjal Himalayan range, lies between 740 11' 03.03"E and 740 40' 21.95"E longitude and 330 08' 47.77"N and 330 35' 05.16"N latitude with its altitude ranging from 1000-6000 m above sea level. Topography of the region is mountainous and varies from gentle slopes to very steep ridges. It is characterized by the presence of rich coniferous and broadleaved forests between 1000m to 3500m elevational range. Fourteen percent (13.96%) of total forest cover in the region (Rajouri Forest Division) comprises of broadleaved forests in which Oak is, by and large, the principal species (Anand, 2014). Major slope of the catchment area is towards south and southwest and is drained by river Ans and other tributaries of the Chenab. Climate is generally mild in lower parts and harsher and cold with heavy snowfall in upper hillocks. Average annual rainfall is 1150 mm which is mainly received through southwest monsoon during July-September. Division is, administratively, divided into three forest ranges viz. Kalakote, Kandi and Rajouri. Kandi forest range, for it sufficiently representing the entire division in terms of topography, soil, climate and vegetation type, is selected for the present work (Figure 1).

Sampling and data collection

After preliminary surveying in the area, three forest sites across a wide altitudinal range (from 1200m to 2500m) were selected for sampling. Sites were named as per their local names (Table 1). Data collection was carried out during 2017-18 using stratified random sampling technique. Twenty quadrates (each measuring 10×10m for trees and 5×5m for shrubs) were laid at each site for collection and subsequent analysis of phytosociological information. Plants with GBH (girth at breast height) >20 cm were considered as trees. Simple measuring tape was used to determine girth of trees. Physiographic features (like elevation, aspect and slope steepness) were recorded using Garmin Etrex 10 GPS device.

Data analysis

Density, frequency and abundance were calculated using standard methods. Basal area was estimated using formula:

Basal area

Where, cbh=circumference at breast height

Basal areas calculated for species were multiplied with densities of the respective species to obtain total basal area (m^2 ha^{-1}). Calculation of Importance Value Index (IVI) for trees and Provenance index (PI) in case of shrub species was done as below:

IVI=Relative Density+ Relative Frequency + Relative Dominance (for tree species)

PI= Relative density + Relative frequency (for shrubs)

Distribution pattern of all the tree species was determined by abundance/frequency (A/F) ratio (also known as Whitford Index) and was categorized as regular (if A/F < 0.025), random (if A/F between 0.025 – 0.05) or contagious (if A/F > 0.05). Number of species present in a forest was taken as Species Richness (SR). Margalef index (MI) and Menhinik index (MeI) of richness were calculated as MI= S-1/ log N and MeI=S/√N where S=number of species and N= total number of individuals. Shannon–Wiener diversity index (H′) and Simpson's diversity index were calculated using the formulae:

Shannon–Wiener diversity index (H′) = $-\sum_{i=1}^{s}$ pi *ln* pi

Simpson index of diversity (SI) = $1-(\sum_{i=1}^{s}$ $(pi)^2)$

where, pi is the proportion of ^{i}th species and S is the number of individuals of all the species. Simpson index of diversity was expressed as 1-Cd to avoid confusion.

Peilou's index of evenness (e) was calculated as e=H′/log N, where H′ is Shannon Wiener index and N is total number of species present.

Results

Composition: A total of 32 species of trees (20) and shrubs (12) belonging to 30 genera were recorded from the entire study area. Three species of Oak viz. *Quercus leuchotriphora, Q. floribunda* and *Q. semecarpifolia* showed their dominance and/or co-dominance all across the study area. 14 species of trees were found growing at site I, 6 at site II and 7 at site III. 8, 6 and 4 species of shrubs were found at sites I, II, III respectively. Total density (individuals/ha) of trees was observed to be 975 at site I, 840 at site II and 770 at site III. Density of shrubs was found 380, 270 and 225 at sites I, II and

III respectively. Total basal area (m²/ha) of trees was calculated to be 68.84, 133.04, 100.33 and 72.66 at sites I, II, III and IV respectively. Whitford Index (Abundance/ Frequency ratio) ranged between 0.01 to 0.20 for trees and 0.03 to 0.69 for shrubs (Table 2, Table 3 and Table 4).

At the lowest altitude i.e. 1200-1600m (Table 2), *Quercus leuchotrichophora* (IVI=148.410) was followed in terms of highest density, frequency and IVI values by *Quercus floribunda* (IVI=16.470), *Pyrus pasia* (16.470), *Rhododendron* (IVI=16.369), *Puma granatum* (IVI=15.146), *Ficus palmate* (IVI=13.103), *Pinus roxburgi* (IVI=11.941), *Zanthoxylum armatum* (IVI=9.004 *), Celtis australis* (IVI=10.772), etc. Among shrubs, *Berberis lyceum* (PV=45.744), *Indigofera heterantha* (PV=34.308), *Rubus ellipticus* (PV=31.839), *Sarcococca salinga* (PV=26.901) were the prominent species.

Mid elevation i.e. 1600-2000m (Table 3) showed *Quercus floribunda* becoming more prominent with IVI=39.216 followed by *Aesculus indica* (IVI=22.882) and *Rhododendron arboreum* (IVI=35.423). *Berberis lyceum* (PV=52.020), *Viburnum grandifolium* (PV=34.848), *Elaeagnus umbellate* (PV=32.492) and *Rosa maschuta* (PV=28.114) were prominent in the shrub layer.

At higher elevation i.e. 200-2500m (Table 4), *Quercus floribunda* (54.399) became even more ubiquitous. *Quercus semecarpifolia* (IVI=11.924) started appearing at this altitudinal range. *Boxus wallichiana* (IVI=31.210) was another important endemic species of this range. Other associate tree species of this altitude included *Pyrus pasia* (19.345), Aesculus indica (11.996) and *Lyonia ovalifolia* (8.259). Vibrnum grandiflora (PV=69.048), *Skimmia laureola* (PV=52.540) and *Berberis aristata* (PV=48.571) were present among shrubs.

Highest density (975) of tree species was observed at lowest altitude (1200-1600m) and it decreased with increase in altitude (lowest recorded equal to 770 individuals/ha). Similar trend existed for shrub layer with maximum 380 at lowest elevation and minimum 225 at highest elevation. Total basal area of tees, however, was found to be lowest (68.84m²/ha) at lower elevational range and highest (133.04m²/ha) at the mid altitude.

Species Diversity

Species richness and diversity indices varied across the stands studied, but not much significantly between middle and higher altitudes (Table 5). Shannon-Wiener Index was highest (1.99 for trees) at lower elevation and almost similar at middle (0.93) and higher altitudes (0.96). However, it gradually decreased (1.93, 1.84 and1.34) for shrub layer moving from lower to higher elevation. Simpson's diversity index was minimum (0.70 for tress and 0.73 for shrubs) at 1200-1600 altitudinal range. Margelef index values ranged from 0.74 to 1.88 for trees and 0.73 to 1.17 for shrubs whereas Menhenick index was found between 0.20 to 0.44 for trees and 0.33 to 0.41 for shrubs, with their maximum values for trees and shrubs at lowest altitude. These values showed a decreasing trend from lower to higher altitudes. Peilou's evenness index (J') was calculated to be highest (1.20) at the middle altitude (0.49 to 0.75 for trees and 0.92 to 1.92 for shrubs).

Highest number of species (SR) for trees (14) and shrubs (08) was found at 1200-1600m elevation. However there was no significant difference in this respect between middle and higher altitudes.

Discussion

Altitude is an important environmental gradient that offers significant variations in vegetation characteristics due to its direct impact on microclimate (Adhikari, 2015), especially in mountain regions for greater and abrupt environmental changes across a relatively small geographic range (Zhang et al., 2006). Studies conducted in various parts of the Himalayas have indicated remarkable differences in species composition, distribution pattern and diversity attributable to altitudinal impact (Adhikari et al, 2015; Sharma et al., 2009, 2010; Gairola et al., 2011; Kharkwal, 2005; Acharya et al, 201; Ahmed, 2006; Kharkwal et al., 2005; Singh et al, 2009). Present study was an attempt to assess the effect of altitude on Oak and its associate species along an elevational gradient in forests of Pir Panjal belt which is ecologically still underexplored. It has revealed that three species of Oak viz. *Quercus leuchotrichophora*, *Q. floribunda* and *Quercus semecarpifolia* grow abundantly between 1300m and 2500m. *Quercus leucotrichophora* exhibiing highest frequency (100%), density (420 to 495 individuals/ha), basal cover (55.61 m²/ha to 87.49 m²/ha) and IVI (148.410 to 167.248), predominates the vegetation at all the three sites. This is in accordance with the characteristic composition of temperate broadleaved forests throughout the western Himalayas where different species of oak often dominate the vegetation **(**Troup, 1921**;** Singh et al., 1984; Singh and Rawat, 2012**).** Values

on phytosociological aspects obtained in the present study are comparable with those observed by other workers for similar vegetations in Uttrakhand (Lal and Laudhiyal, 2016), Kumaon (Singh and Singh, 1986), Gharwal (Singh et al, 2016), parts of Jammu (Sharma and Raina, 2013) and other parts of the Himalayas (Singh and Singh, 1986; Khera et al., 2001; Ahmed et al., 2006: Paul et al., 2018). Although *Quercus leuchotrichophora* was found dominant all across the study area, it varied in its IVI, density, abundance, frequency, etc. at different altitudinal zones. This indicates wider eceological amplitude of the species and its tolerance to biotic pressures. *Quercus floribunda* and *Q. semecarpifolia*, however, became more conspicuous respectively at middle (1600-2000m) and higher (2000-2500m) elevations. *Pinus wallichiana*, *Aescules indica* and *Boxus wallichiana* were the most important co-dominants at lower, middle and higher elevations respectively. Similar characteristics of vegetation have been reported for the western Himalayan temperate forests by other workers (Gairola et al., 2011; Sharma et al., 2009; Singh et al, 2009). Associate species like *Rhododdendron arborium*, *Pyrus pasia*, etc. were found throughout the study area (though exhibiting different values of stem density, frequency and IVI in different stands) and it signifies their wider altitudinal range and greater adaptability to varying situations. Presence of the only conifer species intermixed with Oak at lower altitudinal zone indicated the ecotonal effect which was also responsible for the maximum number of species in this zone. On the contrary certain associate species including endemic *Boxus wallichiana* and *Q. semecarpifolia* were only found at higher altitude owing to their restricted natural range. Decrease in the stem density with a rise in altitude was also in accordance with the trend observed by other workers in the Himalayan region (Gairola, et al., 2011; Acharya, et al., 2011; Shaheen et al., 2012). Basal cover for individual species as well for entire tree vegetation was, however, found maximum at mid elevation and it is due to presence of old growth forests. Majority of plant species in the study area have shown clumped distribution/dispersion (indicated by WI index values) as it is very common in natural ecosystems (Odum, 1972).

Diversity is generally believed to decrease with altitude and a similar trend was found in the present study also. The values of diversity indices (Shanon Wiener index, Simpson index of diversity, Margalef index and Menhinik index) calculated for the study area are similar to those reported by other workers in other parts of the Himalayas (Sharma *et al.,* 2009, 2011; Singh et al, 2016, Sharma et al., 2017). Maximum number of species and diversity indices values at lowest elevation and a steep decline upward was also due to edge effect as it bordered subtropical region. However it did not show much difference at middle and higher altitude in diversity of tree species which can be attributed to intense anthropogenic disturbances at mid elevations in the region.

Conclusion

Information on vegetation characteristics of forest areas is important from research, conservation and management point of view. Forest area investigated in the study is dominantly populated by at least three species of Oak almost all across the altitudinal gradient between 1300 and 2500m. Although *Quercus leuchotrichophora* grows abundantly irrespective of elevational zonation, the associated tree and shrub species keep replacing one another while moving across the elevational gradient. All phytosociological characteristics of the vegetation vary remarkably in response to changes in altitude. Tree species diversity decreased with altitude but an unexpected decrease at the middle range is attributed to anthropogenic pressures.

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Table 1 General profile of study sites

Site	Forest	Elevational range (m)	Aspect	Slope/terrain

Figures and Tables

I	Gadyog-Kanthol	1200-1600	South western	Gentle
II	Jaglaanoo-Perinar	1600-2000	South eastern	Steep
III	Badhal-Nangathub	2000-2500	Western	Gentle

Figure 1 Sampling sites in the study area

Table 2 Vegetation analysis at Site I Gadyog-Kanthol forests

Species	*Density (per ha)*	Total basal cover (m^2/ habasal area)	*Abundance/Frequency* (WI)	*IVI/PV*
Tree species				
Quercus leuocotrichophora	*440*	55.617	0.054	148.410
Quercus floribunda	*40*	4.212	0.064	16.470
Rhododendron	*40*	1.561	0.025	16.369
Bombax ceiba	*20*	0.536	0.200	5.329
Grevia optiva	*25*	0.440	0.063	8.203
Pyrus pashia	*110*	1.696	0.036	27.495
Pinus roxburgii	*50*	1.248	0.125	11.941
Puma granatum	*70*	0.321	0.077	15.146
Ficus palmate	*60*	1.342	0.150	13.103
Zanthoxylum armatum	*35*	0.285	0.088	9.004
Celtis australis	*35*	0.642	0.056	10.772
Morus alba	*10*	0.103	0.100	3.676
Melia azaderachta	*20*	0.382	0.050	7.607
Ulmus wallichiana	*20*	0.464	0.087	6.476
Total	*975*	68.848		

Shrub Species				
Ellaegnus umbellate	*30*		0.075	24.107
Zizipus mauritiana	*25*		0.063	16.699
Berberis lyceum	*100*		0.063	45.744
Carrisa spinarum	*25*		0.125	11.436
Indigofera heterantha	*75*		0.083	34.308
Rosa maschuta	*15*		0.150	8.967
Rubus ellipticus	*65*		0.070	31.839
Sarcococca salinga	*45*		0.050	26.901
Total	*405*		Abundance/Frequency	PV

Table 3 Vegetation analysis at Site II Jaglanoo-Perinar forests

Species	*Density* (per ha)	Total basal cover (m^2/ha)	*Abundance/ Frequency* (WI)	*IVI*
Tree species				
Quercus leuocotrichophora	*495*	87.496	0.010	167.248
Quercus floribunda	*90*	15.274	0.025	39.216
Aesculus indica	*50*	8.370	0.056	22.882
Lyonia ovalifolia	*25*	2.497	0.100	9.108
Rhododendron arboreum	*85*	16.681	0.033	35.423
Pyrus pashia	*95*	2.723	0.033	26.122
Total	*840*	133.041		
Shrub species				
Elaeagnus umbellate	*55*		0.138	32.492
Berberis lyceum	*75*		0.047	52.020
Rubus ellipticus	*40*		0.044	32.997
Viburnum grandifolium	*45*		0.050	34.848
Rosa maschuta	*35*		0.056	28.114
Amelocissus latifolia	*20*		0.050	19.529
Total	*270*			

Table 4 Vegetation analysis at Site III Badhal-Nangathub forests

Species	Density (per ha)	Total basal area (m^2/ha)	Abundance/ Frequency (WI)	IVI
Tree species				
Quercus leuocotrichophora	*420*	75.239	0.052	162.868
Boxus wallichiana	*115*	1.465	0.072	31.210
Pyrus pasia	*55*	1.095	0.061	19.345
Quercus floribunda	*120*	16.647	0.033	54.399
Quercus semecarpifolia	*25*	1.274	0.063	11.924
Aesculus indica	*20*	1.997	0.050	11.996
Lyonia ovalifolia	*15*	2.616	0.100	8.259
Total	*770*	100.333		
Shrub species				
Skimmia laureola	*70*	-	0.072	52.540
Elaeagnus umbellate	*35*	-	0.088	29.841
Vibrnum grandiflora	*75*	-	0.030	69.048
Berberis aristata	*45*	-	0.031	48.571
Total	*225*			

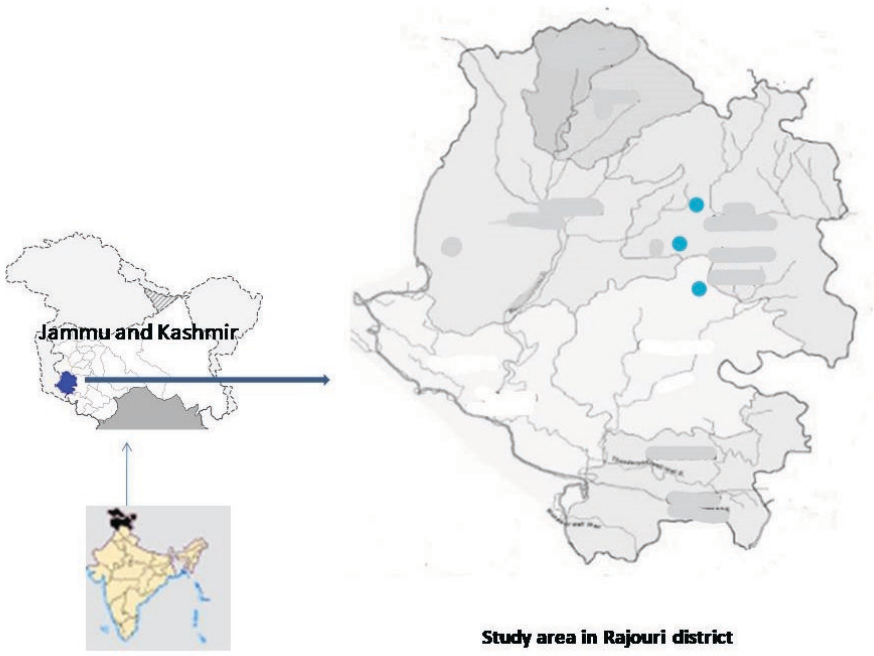

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Table 5 Phytosociological analysis of study sites

Parameter	Site I Gadyog-Kanthol forests		Site II Jaglanoo-Perinar forests		Site III Badhal–Nangathub forests	
	Trees	Shrubs	Trees	Shrubs	Trees	Shrubs
Main (Dominant) species	*Quercus leucotrichophora,* (IVI=148.41)	*Berberis lyceum* (PV=45.74)	*Quercus leucotrichophora,* (IVI=167.24)	*Berberis lyceum* (PV=52.0)	*Quercus leucotrichophora* (IVI=162.86)	*Viburnum grandifolia* (PV=69.04)
Species Richness (Total Number)	14	8	6	6	7	4
Margelef Index	1.88	1.17	0.74	0.89	0.90	0.73
Menhinik Index	0.44	0.41	0.20	0.36	0.25	0.33
Pelio Index (Evenness)	0.75	0.92	0.51	1.02	0.49	0.96
Shanon Wiener Index (H)	1.99	1.93	0.93	1.84	0.96	1.34
Simpson Index of Diversity (SI)	0.77	0.84	0.93	0.73	0.70	0.73
Total Basal area (m^2/ha)	68.84	-	133.04	-	100.33	-
Total Density (indl/ha)	975	380	840	270	770	225

Study on Group Composition of Blue Bull *(Boselaphus Tragocamelus)* In Bhavnagar District, Gujarat, India.

Vaghela V. M.*, Dodia P. P. and Shukla A. H.
Zoology Department, Sir P. P. Institute of Science, MK Bhavnagar University, Bhavnagar- 364001, Gujarat, India.
*Corresponding author's e-mail : viraldncs@gmail.com

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ABSTRACT:

The Blue Bull (*Boselaphus tragocamelus*) is the largest Asian antelope. Blue Bull (*Boselaphus tragocamelus)* is also called "*Nilgai*". Bhavnagar district is located in Saurashtra region of Gujarat near the Gulf of Khambhat. In herbivorous animals, grouping is an essential behaviour for survival, searching of food and protection, and composition of groups differes in different herbivorous animals. This study was carried out during the year 2015 – 2016. Out of total 100 observations on Blue Bull (*Boselaphus tragocamelus*), a maximum of 31 individuals were recorded in a single group, whereas, minimum group size was of a single (01) individual. The frequency of finding male Blue Bull was 39.4 % (SD ±04.02), female 52.7 % (SD ±06.15) and sub adult / juvenile was 07.9 % (SD ±01.29).

KEYWORDS: Blue Bull; Bhavnagar district; Group size; Male; Female; Sub-adult; Juvenile; Behaviour

INTRODUCTION:

In Gujarat, all four (04) species of Antelopes are found i.e. Blackbuck *Antilope cervicapra*, Indian Gazelle (*Gazella bennettii*), Four-horned Antelope (*Tetracerus quadricornis*) and Blue Bull *Boselaphus tragocamelus*. Out of these four antelope species, Blue Bull is widely distributed throughout the state. Except Four-horned Antelope remaining all three species of antelopes are found in Bhavnagar District, Gujarat. Blue Bull is the biggest Asian antelope. and is also called "*Nilgai*". Bhavnagar district is located in Saurashtra region of Gujarat near the Gulf of Khambhat. In herbivorous animal grouping is the main behaviour for survival, searching for food and protection. Group composition and group size are found to vary in various herbivorous animals. In ungulates one male becomes dominant

over the group, such type of grouping phenomena was also observed in Blue Bull; normally the male Blue Bull controlled the group and were dominant over them. Blue Bull is not as gregarious as other herding ungulates like Black Buck but it occurs in small groups throughout the year.

STUDY AREA:

Bhavnagar district is located in Saurashtra peninsula of the Western part of Gujarat state. Bhavnagar district placed at 21^0 – 00' and 22^0 - 30' N. Latitudes and 71^0-15' and 72^0 – 30' E. Longitudes. Bhavnagar is situated 228 Km from the state capital Gandhinagar and to the west of gulf of Khambhat. Bhavnagar is the fifth largest city in Gujarat and the second largest city of Saurashtra region. Bhavnagar district covers over 8579.45 sq. Km area; it includes 269.24 sq. km of forest cover and 985.57sq. Km non agricultural land. It has an average elevation of 24 meters (78 ft). The district covers total 11 Tehsil (Taluka) till 2014, thereafter due to new territorial demarcation, state government declared Botad as new district, so some area of Bhavnagar district went to Botad district, and at present Bhavnagar district covers total 10 Tehsil (Fig. 1). Geographically, Bhavnagar district consists of diverse characteristic like uneven, rocky (basaltic) land surface traversed by mountain ranges/ridges. Soil composition of Bhavnagar district is generally good for crops of commercial value like Onion, Cotton, Groundnuts, vegetables etc. and also for the grains like *Bajara*, *Juwar* (sorghum) and Wheat etc.

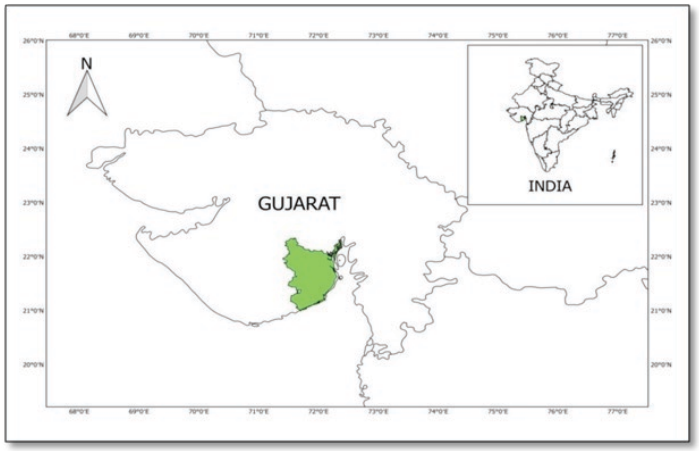

Fig.1. Map of study area.

MATERIALS AND METHODS:

Study area for the grouping behavior of Blue Bull covered Bhavnagar city to Alang ship yard, which is about 55 km. Study was carried out on both sides of Bhavnagar – Hathab - Alang road up to 2 Km in right and left sides of the area having the Agricultural land, Barren land, rural forest area and coastal saline land (Khar). Avania (Khar), Pipaliya pul, Bhumbhali, Ghogha, Kuda, Khadsaliya and Mithiviradi were selected for detailed study. Observations were made by direct method, to avoid disturbances observations were made from a distance with the help of Nikon 8X40 Binocular and Photographs were taken with the help of Sony HX 400 Camera for documentation. Data were analyzed by using standard statistical formulae using Microsoft Excel software.

RESULT:

Table 1 shows the group composition of different groups of Blue Bull in the study area; data represent the number of male, female, sub-adult and juvenile in a single group. Data also show the group size of Blue Bull (minimum to maximum); total 100 observations were taken to determine the group formation of Blue Bull, maximum number in a single group was observed to be 31 individuals and minimum number in a group was observed to be 01 individual. Data show that Blue Bull generally remain in a mixed group (49%), but some time they also form only males (35%) group and only females (16%) group, sub=adults and juveniles preferred to remain with female individuals. It was also observed that most of groups having 1- 5 individuals in a group (56%) and at the same time only few groups were found to have more than 25 individuals in a group (4%). An Average of 3.31(39.4 %,) $\pm$ 4.02 male Blue Bull were found, an average of females was 4.43(52.7%) +6.15 and an average of sub-adults / juveniles was recorded to be 0.67(7.9%) $\pm$ 1.29. Number of male Blue Bull ranged between 0-17, number of female ranged between 0-24 and sub-adults / juveniles were 0-8.

Fig.2. shows the percent of male Blue Bull in different groups, and data shows that 20% groups did not have any male, 20% groups had single male, 19% groups with 2 males, 12% groups with 3 males,12% groups with 4 males, 1 % group with 5 males, 1% group with 7 males, 3% groups with 8 males, 1% group with 9 males, 2% groups with 10 males, 3% groups with 11 males, 1% group with 13 males, 1% group with

Male Blue Bull

Female Blue Bull

14 males, 1% group with 15 males, 2% groups with 16 males and 1% group with 17 males were recorded.

Fig.3. shows the percent of female Blue Bull in different group, data indicate that 37 % groups did not have any female, 7% groups had single female, 17% groups with 2 females, 6% groups with 3 females, 2% groups with 4 females, 3 % groups with 5 females, 5% groups with 6 females, 4% groups with 8 females, 3% groups with 9 females, 1%, group with 11 females, 1% group with 12 females, 1% group with 14 females, 2%. groups with 15 females, 2% groups with 16 females, 3% groups with 17 females, 2% groups with 18 females, 1% groups with 19 females, 1% group with 21 females, 1% group with 22 females and 1% group with 24 females were recorded. Number of female Blue Bull ranged between 0-24.

Fig.4. shows the percent of sub-adult / juvenile Blue Bull in different group, data indicated that 68 % groups did not have any sub adult / juvenile, 14% groups had single sub adult / juvenile, 10% groups with 2 sub adult / juvenile, 4% groups with 3 sub adult / juvenile, 2% groups with 4 sub adult / juvenile, 1% groups with 5 sub adult / juvenile and 1% group with 8 sub adult / juvenile were recorded.

Group composition of male Blue Bull (Fig. 5), shows that 20% groups did not have any male, 35% groups had having only males, 15% groups had having males and females both, 02% groups had sub-adult/ Juveniles with the males and 28% groups composed of females, males and Sub-adult/ Juveniles. Fig. 6 shows group composition of female Blue Bull, data indicate that 38% groups di not have any female, 16% groups had only females, 15% groups had females and males both, 03% groups had Sub-adult/ juvenile with the female and 28% groups composed of female, male and Sub adult/ Juvenile. Fig. 7 indicates group composition of Sub-adult/ Juvenile in the study area, 67% groups did not have any sub adult/ Juvenile, 02% groups had having sub adult/ Juvenile and male, 03% groups had sub adult/ Juvenile and female and 28% groups composed of Sub adult / Juvenile, male and female. Grouping pattern in Blue Bull differs from other ungulates like Blackbuck, Chital, Sambar, and Chinkara. Generally, Blue Bull thrives in small scattered groups and the smallest group of Blue Bull is not more than 1-5 individuals likewise the largest group of Blue Bull is not more than 20 individual often seen in the groups having more than 30 individual in the area during the study period. Presence of male and female individuals in a group is also different from that of other ungulates which normally have one or two males present in a group. But more than two male individuals were present in mixed groups of Blue Bull, likewise the presence of female individuals was two to three in a mixed group of Blue Bull. Juvenile and sub-adult males and females were also found in a group. Out of total 100 groups observed during the study, 32 groups having population of sub adult and juvenile, of which

Juvenile Blue Bull

Mixed herd of Blue Bull

only 3 groups did not have male individuals and 2 groups did not have females, but these groups had sub-adult male and not juveniles. It was also observed that all groups having sub adult and juvenile having mean group size 14.2 was higher than over all mean group size (8.41) and ranged between 3 – 31; group having 31 individual was the largest group. During non-breeding season by the process of segregation only males form a group in which only adult male individuals were found, One unique behavior of Blue Bull which was observed was that during the monsoon Blue Bull moved towards the shrub land from the open land, probably to avoid rain, hence during the monsoon large group were seen occasionally and during the winter and summer they live in open land in scattered groups.

DISCUSSION:

Findings of the study show that there was no specific group composition pattern observed in Blue Bull. According to Bayani and Watve (2016) the group may vary in a single day at different times, and similar behavior was also observed in the present study. Size of the group was also found to be different in agricultural land and forest area; in agricultural land the group remained smaller in size, whereas in forest land it became larger. It is possible that while raiding crops Nilgai herds breaks in to smaller groups which presumably reunite when they take to forest cover again. The smaller groups may have a greater tendency to raid crops (Bayani and Watve 2016).

Generally, Blue Bull are seen scattered in one or two individual's group with 1-2 males or 2-3 females and in mixed group males, females, juveniles and sub-adults are also seen. During the non-breeding season adult and sub adult males segregate and form mixed group, only for some time. Only male group was also observed, whereas, sub-adult male Blue Bull join in to the group and form a mixed group of adults and sub-adults during the breeding season. Interestingly, a group of only adult male Blue Bull was regularly observed at Avania khar area during the study.

Observation of the present study also supports the findings of Dharmakumarsinhji (1959) and Sheffield et al. (1983) that Blue Bull is non-migratory, although individuals and groups are capable of considerable movement if ambient conditions (e.g., drought) ensue. It was observed that the Nilgai remain in the same area for long time and moves in their home range regularly which was recorded up to 8 Km^2. Home range of Blue Bull of the study area was quite similar with findings of Sheffield et al. (1983), home ranges of Blue in a 5,680-ha fenced area in southern Texas averaged 4.3 km^2 (0.6–8.1 km^2).

Blue Bull remains in small groups, the group size varies in different habitat but they rarely form congregations and large groups. According to Dinerstein (1980), Nilgai occur in groups ranging from 01 to 10 individuals, and the mean group size observed in

Total Number of Blue Bull	Male	Female	Juvenile / Sub-adult	
Average of Blue Bull	.31	.43	.67	.41
Range of Blue Bull	-18	-24	-8	-31
Number of groups				--
%	.4	.7	.9	
SD	.02	.15	.29	.26

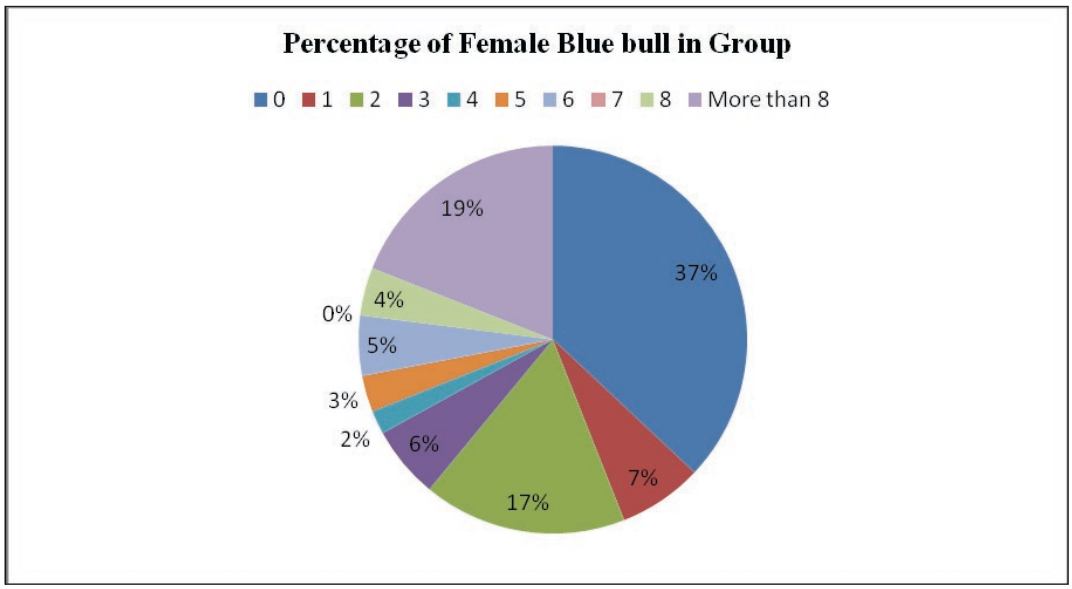

Fig.2 Chart showing the percent of the Male Blue Bull in group.

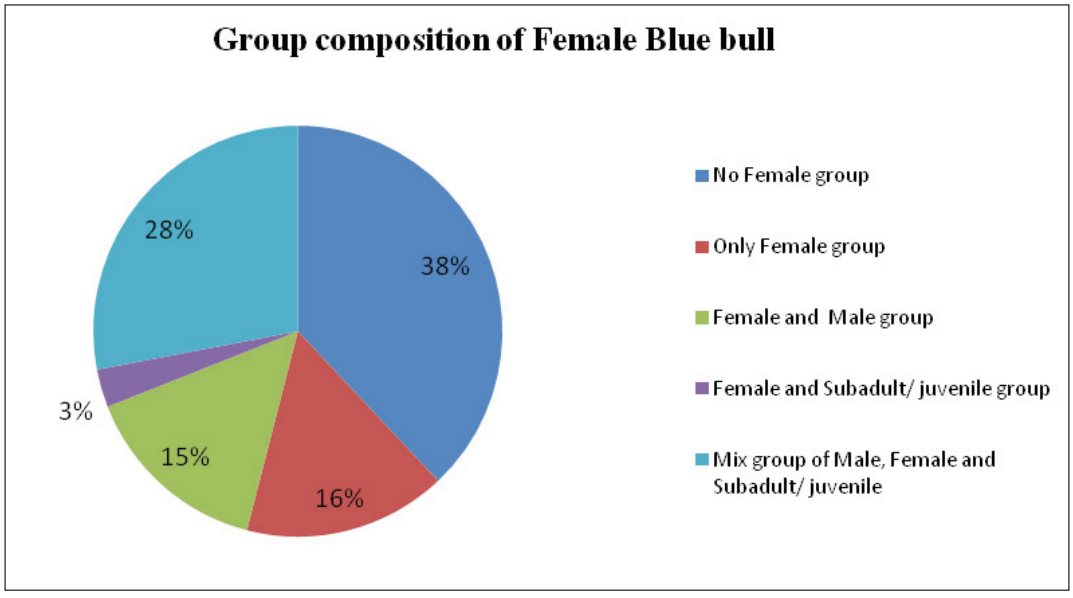

Fig.3 Chart showing the percent of the Female Blue Bull in group.

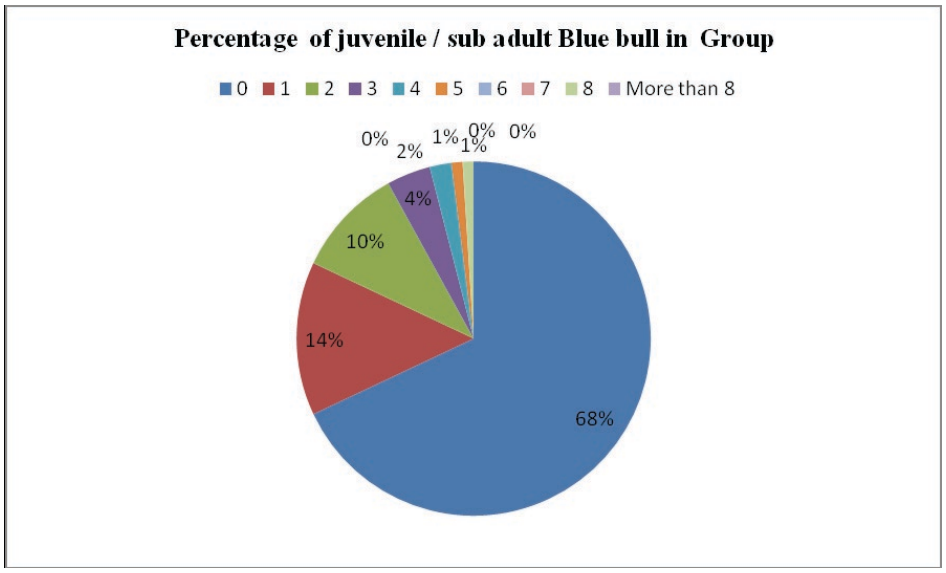

Fig.4 Chart showing the percent of the Juvenile/ Sub adult Blue Bull in group.

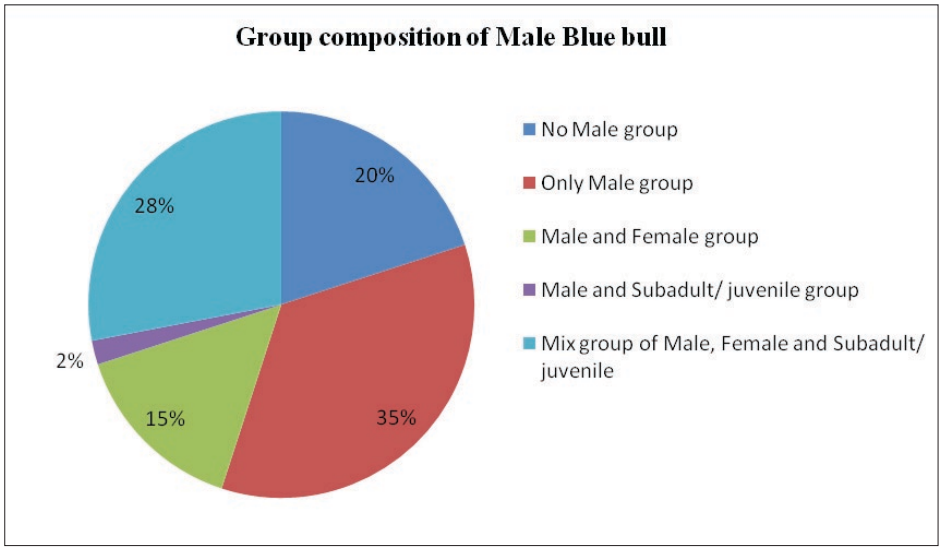

Fig. 5 Chart showing the percent of Male Bull in each group.

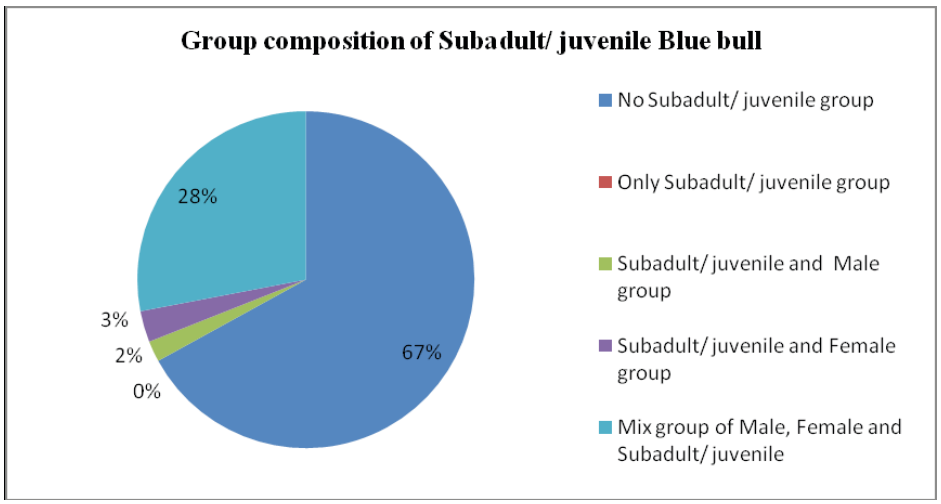

Fig. 6 Chart showing the percent of Female Bull in each group.

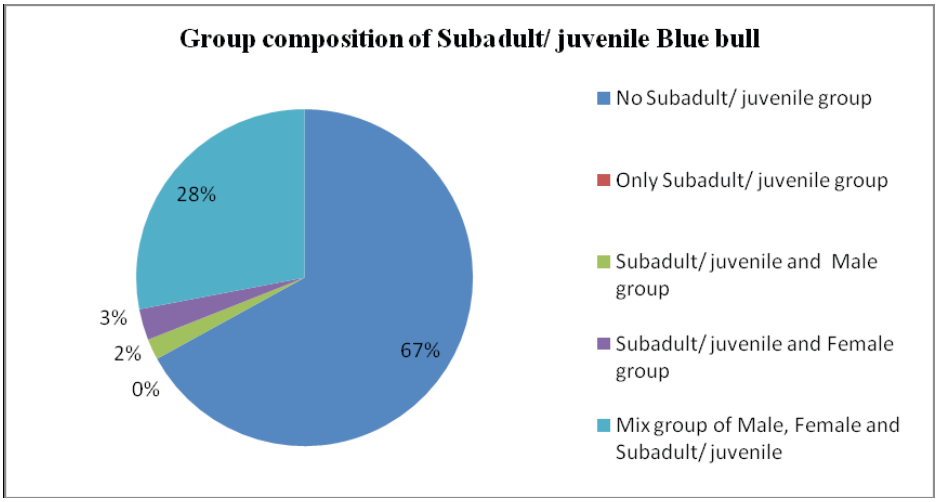

Fig. 7 Chart showing the percent of Sub-adults and juveniles in each group.

Karnali - Bardia in Nepal was 2.9. In Sariska, seasonal group size of Nilgai (excluding single individuals) varied greatly, from 02 to 43 individuals, with a mean group size of 4.0 (Sankar 2004), In Gir, Khan *et al.* (1995) reported mean group size of Nilgai as 2.2, with high seasonal variability in group sizes. In the study area average of group size was found 8.41± 8.26 individual per group which was higher than the above observations, but it was quite low than Khan and Khan (2016), where they recorded total of 108 groups comprising of 1845 individuals and the mean group size was found to be 17.10 ± 4.08. The maximum number of individuals was recorded in Pala sallu (61) while the minimum was seen in Sikandarpur Cherat (1) in Aligarh district, Uttar Pradesh. In Aligarh district the Blue Bull were found to congregate in forest patch due to harassment by farmers. In Bhavnagar district the number of individual in a group varied from minimum 01 to maximum 31 individuals in a group, thereby showing that Blue Bull remain scattered in smaller groups.

Khan and Khan (2016) showed the percentage of animals in different group size categories including 26% groups comprised of 0-5 group category, 22% comprised of 6-10 group category, 20% were in the 11-15 group category, 22% in 16-20 group category and 10% in >21 group category in winter season. While in summer 11% groups comprised of 0-5 group category, 24% comprised were 6-10 group category, 13% were in the 11-15 group category, 22% in 16-20 group category and 30% in >21 group category in Aligarh district, Uttar Pradesh. In Bhavnagar district the percent of animals in different group size category were 56% groups having 1 - 5 individuals, 13% groups having 6 - 10 individuals, 08% groups having 11 -15 individuals, 11% groups having 16 -20 individuals and 12% groups having >21individuals. Blue Bull of the study area preferred to form small groups when animals enter crop fields for foraging.

CONCLUSION:

During the study, maximum 31 individuals were recorded in a single group, whereas minimum group size was a single (01) individual. Percent occurrence data showed that male Blue Bull were 39.4 % (SD ±04.02), female 52.7 % (SD ±06.15) and of sub-adults / juveniles were 07.9 % (SD ±01.29). Data indicated that presence of female individuals was higher than the males. Data also indicated that the group pattern in the Blue Bull was different than for other herbivorous animals like Blackbuck, Spotted Deer and Sambar. Blue Bull of the study area preferred to form small groups, as small group probably because they tend to get benefitted when entering crop fields for foraging.

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Spatial distribution pattern of endangered vultures in Sathyamangalam Tiger reserve, Tamil Nadu.

Brinda.T.[1], Umamaheswari.S.[2], Kumaraguru.A[3] and Satheesh.N[4]

[[1]Research Scholar, National College, Tiruchirappalli; [2] Head of the Department, Post graduate and Research Department of Zoology, Periyar EVR College, Tiruchirappalli; [3] Conservation Scientist, Biodiversity Conservation Foundation, Tiruchirappalli; [4] District Forest Officer, Tamilnadu Forest Department.
[1]Corresponding author: Email ID: brindabio@gmail.com.]

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Photo: Brinda.T.

ABSTRACT:

Vultures are obligate scavengers that play a significant role in an ecosystem as they help in prevention of disease spread. Though rapid decline of vulture population was reported from the northern India in the last decade, information from the southern part is scanty. Hence, in the present study we studied the distribution pattern of vultures in Sathyamangalam Tiger Reserve. Survey of the study area was undertaken from 2015 to 2016 to determine the distribution pattern of three critically endangered and one endangered vulture in the landscape. The distribution profile of vultures in this landscape was of great significance, as the study area lies in the junction of Western and Eastern Ghats landscape. Comparative analysis of the data revealed the highest occurrence of *Gyps bengalensis*, followed by *Gyps indicus, Sacrogyps calvus* and the lowest records of *Neophron percnopterus*. The distribution pattern of these vultures suggests that they prefer moist/dry deciduous forest which enables better visibility. The spatial analysis based on drainage map and land surface temperature reveals that their soaring behaviour was facilitated by this environment leading to habitat preference.

Keywords: Gyps, obligate, scavengers, deciduous.

INTRODUCTION:

Vultures are obligate scavengers belonging to Accipitridae and Catharidae families and are distributed in all the continents except the polar regions. Conservation of raptors is approached with the core understanding of prey-predator relationship, but the perspective of a scavenger is different as the carcass is ephemeral on the spatio-temporal scale. In this scale the availability of live prey is more abundant than carrion due to rapid assimilation of carrion, either by decomposition or scavenging (DeVault *et al*. 2003).

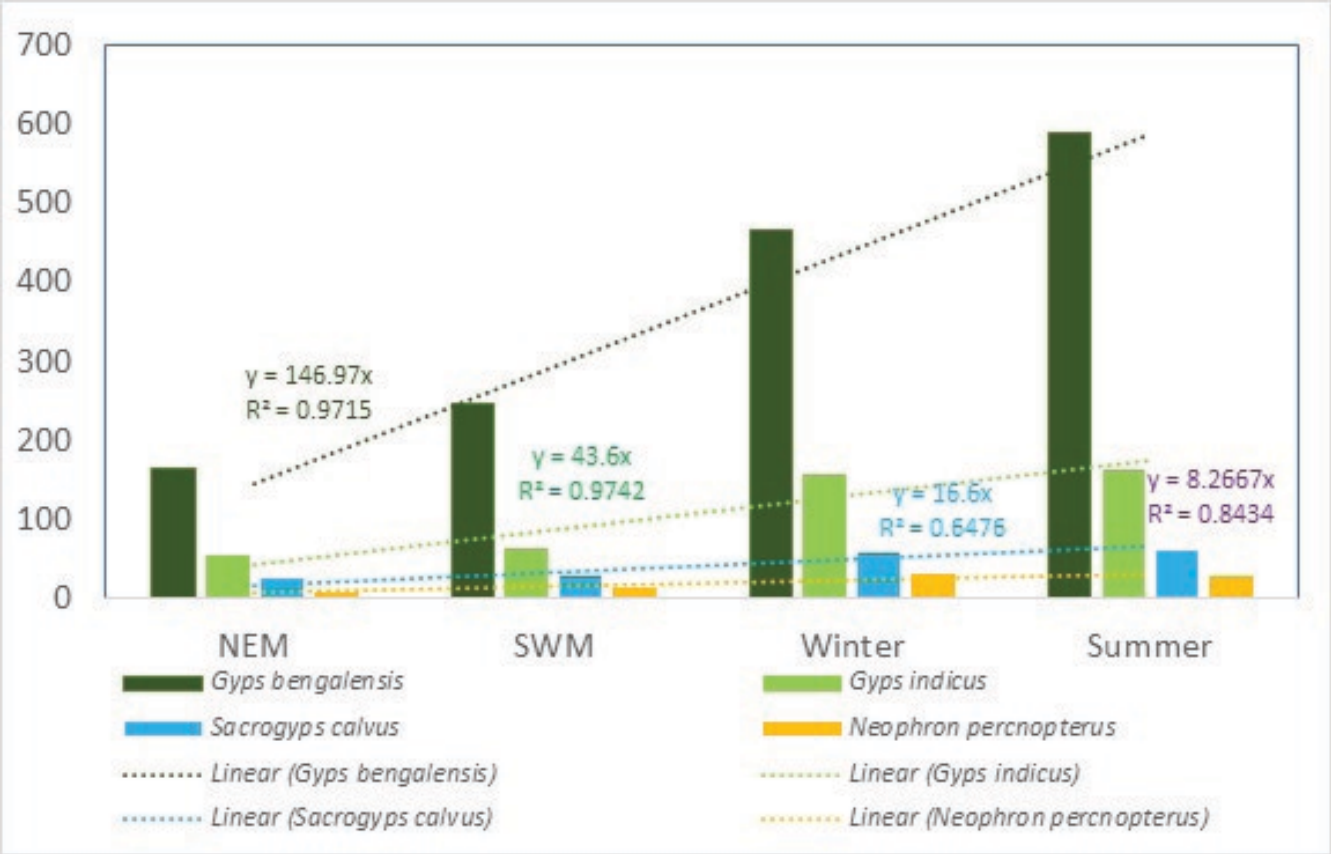


Fig.1.Record of number of individual sightings of the four vultures across the season in Sathyamangalam Tiger Reserve.

Hence, vultures as obligate scavengers exhibit both physiological and behaviour adaptations that foster their ability to locate and use carrion as a food source. Primarily, due to energy constraints they should possess the ability to fly in the soaring mode, an efficient mode of locomotion (Ruxton and Houston 2004).

Vultures by using minimal energy in soaring flight can increase their search area, effectively exchanging the spatial and temporal unpredictability of carrion at local scales for relatively predictable occurrences at much larger scales (DeVault *et al*. 2003; Ruxton and Houston 2004). The obligate scavenging vultures have highly acidic stomachs (as low as pH = 1) that probably help to decrease the pathogenic risk of high microbial loads and few to no feathers on their heads, which reduces fouling (Houston and Cooper 1975).

These adaptations in favour of their survival enabled their distribution across the world in different types of vegetation and habitats. Vultures in India were once common (Ali and Ripley., 1978) and were recorded in varied landscapes such as croplands to cliffs. In spite of the adaptations to these landscapes, vultures had significantly declined and the major reason being the anthropogenic factors. These species are considered to be the most threatened functional group accounting to 61% of them threatened with extinction (Bird Life International, 2015; Ogada *et al*. 2010). In India, there are nine species and the status of the Gyps species (*Gyps bengalensis, Gyps indicus, Gyps tenuirostris*) are critically endangered and categorised in Schedule I under the Indian Wildlife Protection Act (1972). The other species investigated in this study, includes *Sacrogyps calvus* which is regarded as critically endangered and *Neophron percnopterus* as endangered (Bird International, 2015).

In any habitat, these obligate scavengers are inextricably linked to the distribution and availability of carrion. Thus, any shift in the quantity or temporal stability of carrion resources profoundly affects the composition and dynamics of scavenging communities. The availability of carrion is highly modulated by climate (DeVault *et al*. 2003) and trophic integrity (Wilmers *et al*. 2003; Wilmers and Post., 2006). Thus, a critical research priority is to elucidate the impact of environmental factors on the survival of vultures and the anthropogenic pressure on the environmental

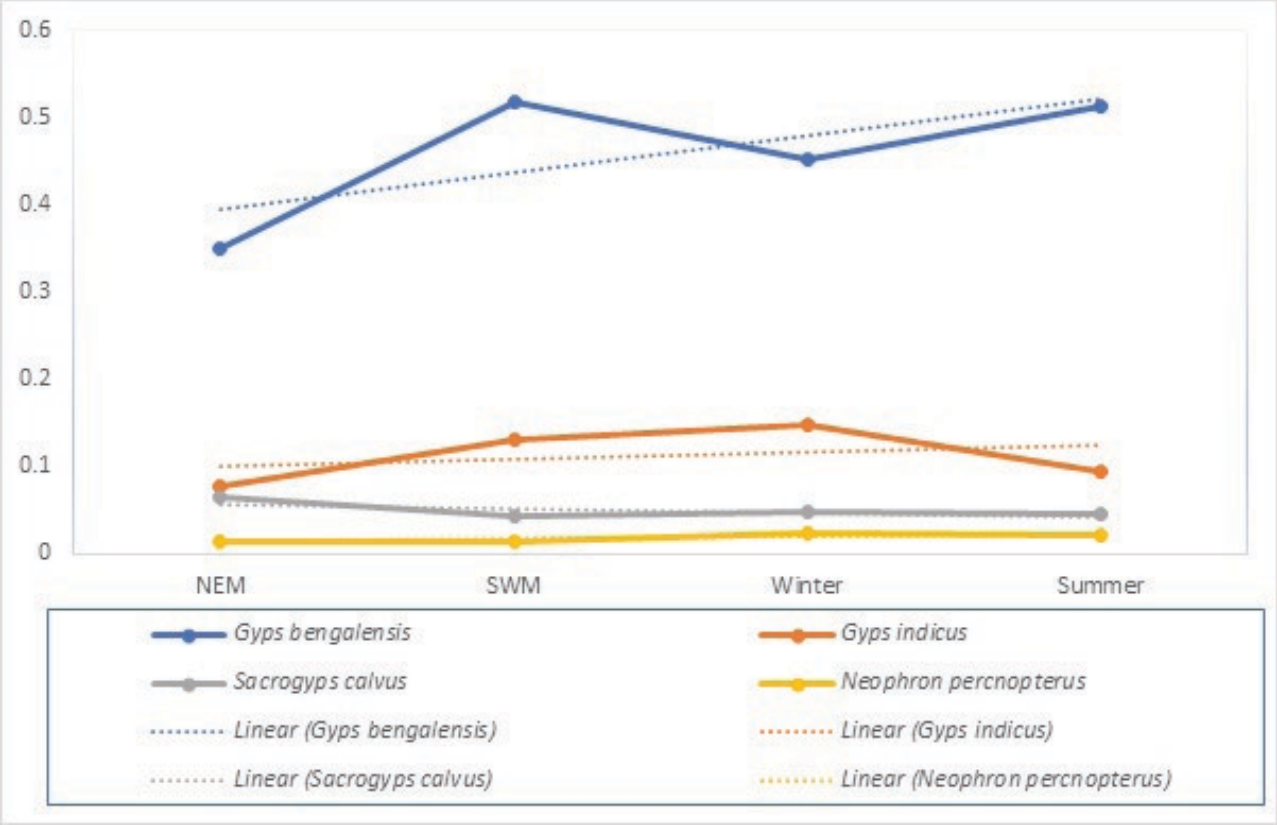


Fig.2: Encounter rates and the linear relationship of the distribution of four vulture species across the seasons

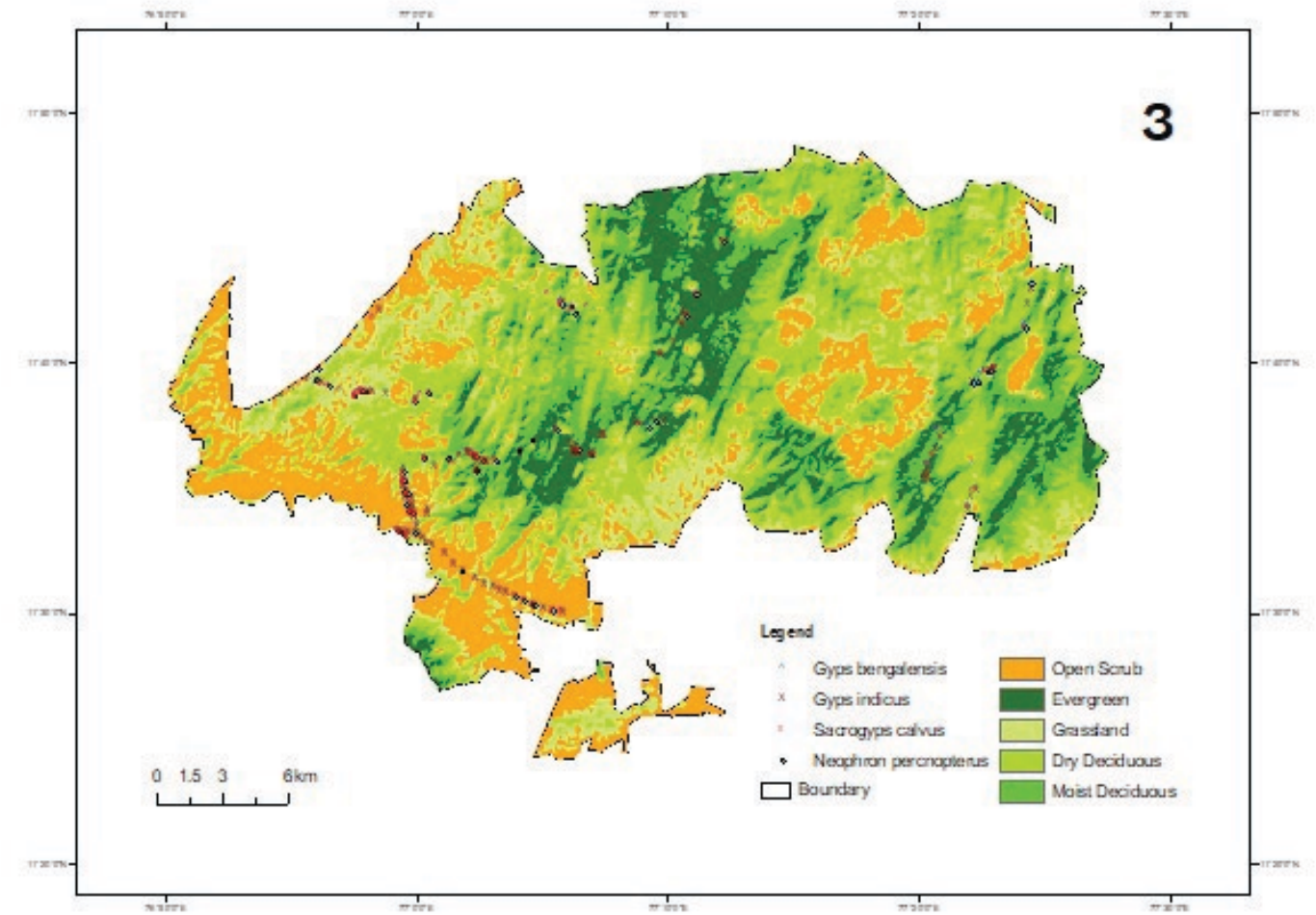
factors. With the number of vulture record in declining trend, status of these scavengers urges more research on distribution with relation to climatic conditions, forest type or vegetation. Hence, in this study, the distribution pattern of four vultures in relation with vegetation, drainage and land surface temperature were analysed using remote sensing data.

STUDY AREA

The study area of the present investigation was Sathyamangalam 10°29'15" to 11°43'11" N latitude and 76°50'46" to 77°27'22" E longitude covers 1408.405 km^2 and located in the Northern Part of Erode District. Sathyamangalam Tiger Reserve is mostly an undulating terrain with deep Moyar valley and located at the confluence of Eastern and Western Ghats of the state of Tamil nadu. Throughout the year, the average temperature ranges from 6°C to 45°C, whereas in May and June it can reach up to 49°C. The perennial Moyar River and Kukkalthorai halla drains entire area, which receive rainfall mostly from the north-eastern monsoon. The annual rainfall is low (400 mm) and the area falls in the rain shadow of Nilgiris hill slopes on the southern side. The altitude ranges from 350 to 1000 m above msl. Sathyamangalam Tiger Reserve (STR) with adjoining forest divisions forms a continuous stretch of forests which provides an extensive and varied habitat for wildlife. The study area was selected because of the wide range of climatic conditions which attracted vulture species in and around STR. The study was carried out during January 2015 to December 2016.

MATERIALS AND METHODS

Study was carried out from January 2015 to December 2016 to determine the distribution pattern of four vulture species across the four seasons – North East Monsoon (NEM) September, October and November), South West Monsoon (SWM) (June, July, August), Summer (March, April, May) and Winter (December, January, February). To assess, roads including tarred and metal were used as transects amounting to a total length of 203.5 km. To record the sightings of the vultures, regular monitoring was conducted, which started from 7 A.M in the morning to till 5P.M in the evening. Sightings of vultures were recorded through GPS location points and represented as distribution



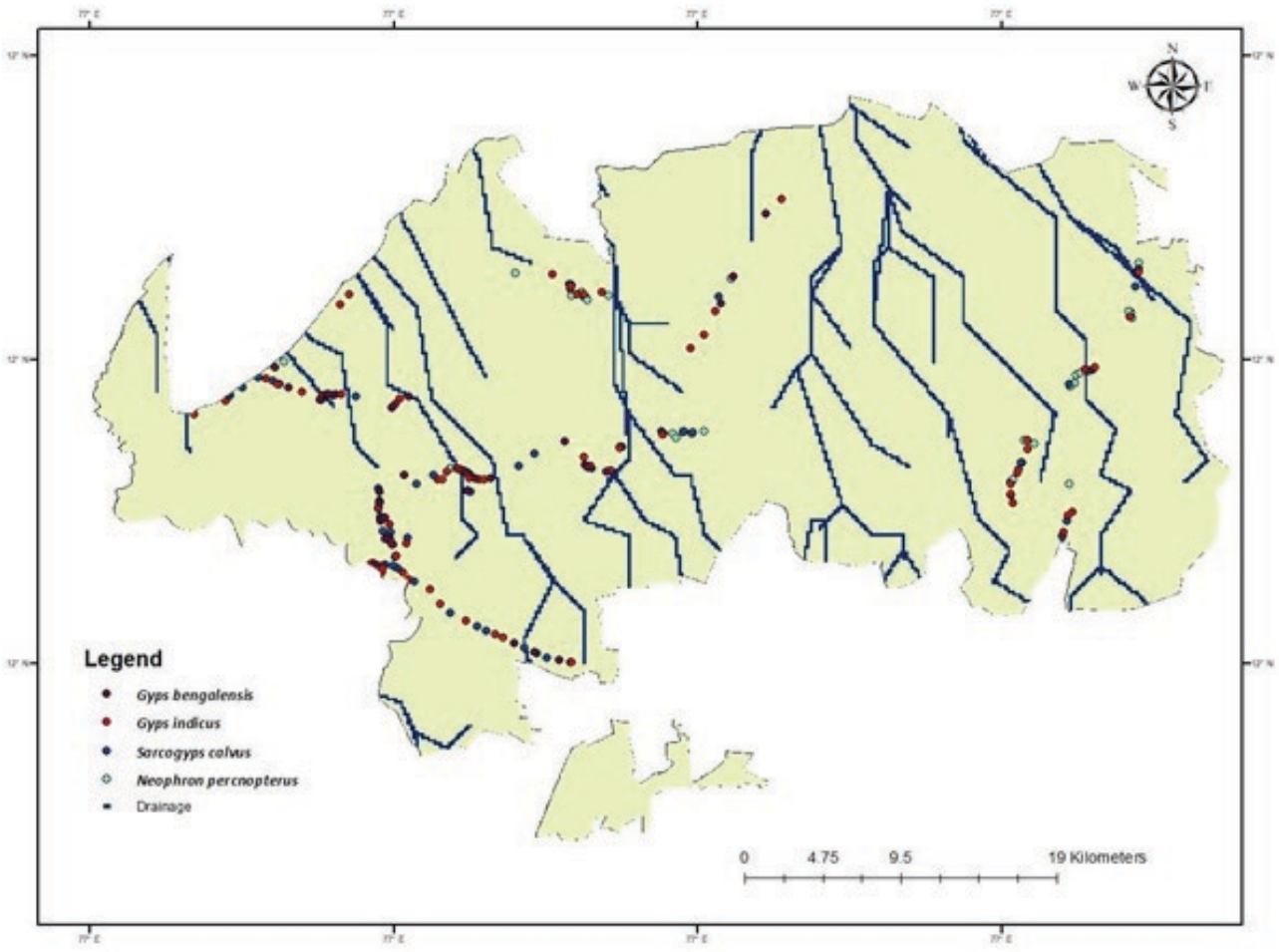
Map 1: Map showing the distribution of the four vulture species in coherence with the different types of vegetation in Sathyamangalam Tiger Reserve.

pattern in the map of Sathyamangalam Tiger Reserve using the software ArcGIS.(V 10). The drainage map of Sathyamangalam Tiger Reserve is downloaded from USGS website, the vegetation and the Land surface temperature map from Copernicus website.

RESULTS:

Neophron percnopterus, with the status of being endangered was the least recorded with a total number of 83 sightings in comparison with the other three critically endangered vultures with 1465 for *Gyps bengalensis*, 439 for *Gyps indicus* and 175 for *Sacrogyps calvus*. Seasonal variations in the number of vultures sighted and encounter rate of four species of vultures varied (Figure 2). The encounter rate of *Gyps bengalensis* 0.4584 (±0.033) was highest in summer as compared to other seasons. Other three vultures were also recorded with a comparatively higher value in summer, with an encounter rate of 0.1126 (±0.014) for *Gyps indicus*, 0.0502 (±0.004) for *Sacrogyps calvus* and 0.01806 (±0.002) for *Neophron percnopterus*. It is significant to note that the distribution pattern of all the four vultures were influenced by the season and the linear relation was observed to follow a similar trend depicted in Figure 1.

The distribution pattern revealed the north-west and south-west part of the reserve dominated by deciduous vegetation was a potential habitat for the scavenger population, harbouring major population of these endangered population in this area as depicted in Map.1. The entire region possesses a network of water drainage system and the proximity of water source clearly influenced the distribution pattern of these vultures is depicted in the Map.2. Distribution of all these four vultures overlaid on the Land surface temperature map was also depicted in Map.3.



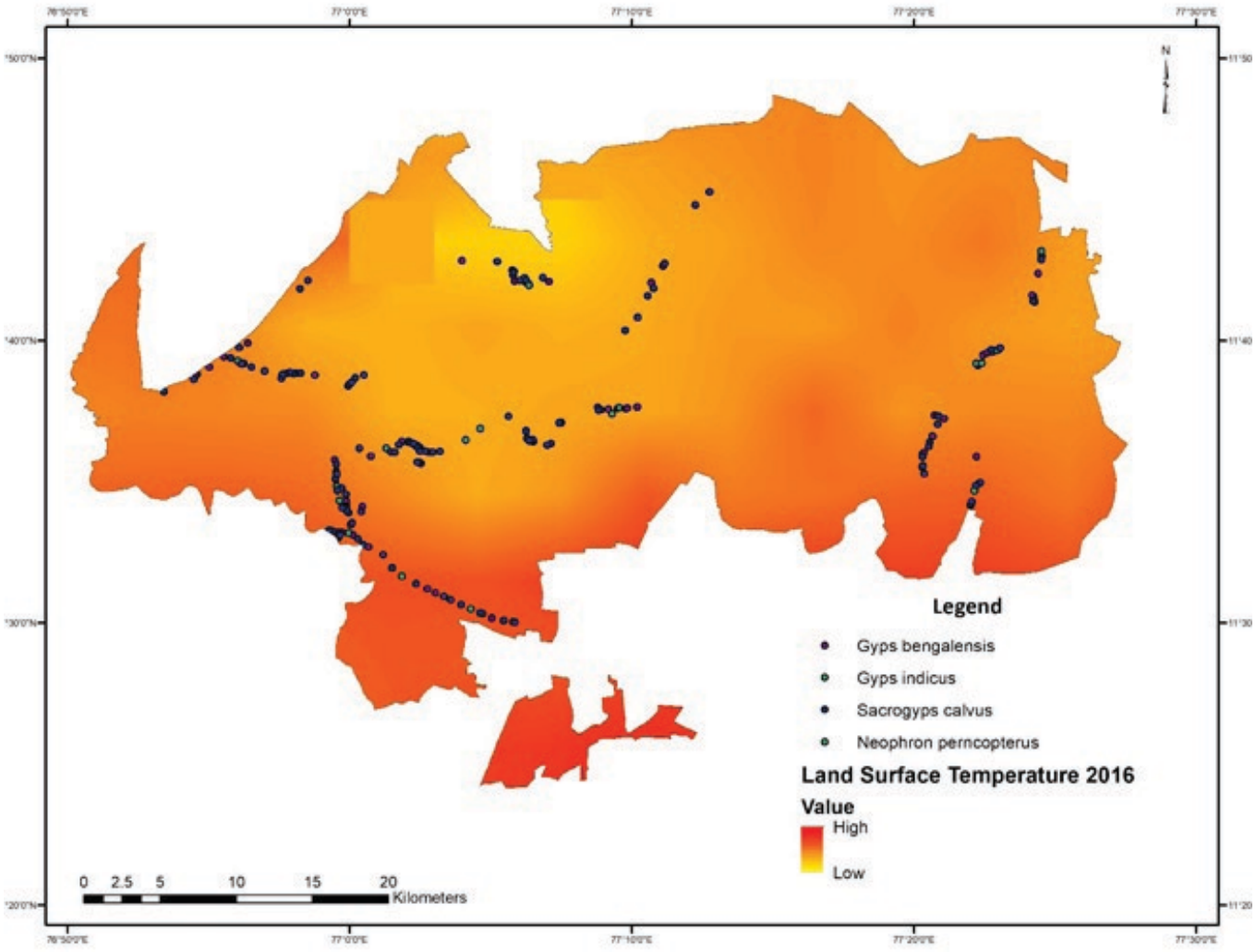
Map 2: Map showing the distribution of the four vulture species in coherence with the drainage network in Sathyamangalam Tiger Reserve.

DISCUSSION:

In the Anthropocene era, the risk of extinction of any species greatly depends on the human centred activities and its consequences driven climate change. From various reported evidence from 1999, it is obvious that the human promoted use of diclofenac across the Indian subcontinent had drastically threatened the population of these unique species. Though the total population of the country is decreasing in a long term trend (SoIB, 2020), the information on quantitative assessment on the population in the study area was almost negligible. Nevertheless, in the study area, decreasing population trends were observed due to the lack of nesting habitats in the previously observed areas (Ramakrishnan and Samson, 2019).

As obligate scavengers, prey mortality might play a significant role in their habitat use pattern (Kendall *et al*., 2014). The livestock availability in the villages within the boundary of the reserve also enhanced the carcass availability for the vultures. Religious beliefs of people in this landscape are associated with cattle and hence the dead cattle are thrown at the outskirts of the village. But Gyps vultures found in the Moyar valley were less dependent on carcass of livestock and their major source of food were carcass of wild animals/ungulates (Ramakrishnan *et al*, 2010). This fact favours the only isolated population of vultures in this landscape, after the reported 99% decline of Gyps species reported in the northern part of India (Prakash, 1999). Hence, it is evident that the survival of these vultures is influenced by environmental factors which in turn shape their habitat use pattern.

The habitat of Sathyamangalam is a forest stretch which extends continuously with the adjoining forest areas. In terms of forest types, the landscape is dominated by 46.5% of dry deciduous forest followed by 22.3% of



Map 3: Map showing the distribution of the four vulture species in coherence with the land surface temperature pattern of Sathyamangalam Tiger Reserve.

moist deciduous forest. The other forest types include evergreen with 11.8%, grassland with 11.45% and open scrub with 7.8% (Map.1). The occurrence of vultures in this landscape also supports their requirement of a relict wooded area, mature trees and range of foraging habitat (Fargallo *et al*. 1998; Donazar *et al*. 2002a; Carrete & Donazar 2005).

In this study, vultures were observed to be predominantly distributed along the deciduous vegetation of the STR landscape. Vulture density was higher in the interface of the protected and unprotected area (Herremans & Herremans-Tonnoeyr 2000) was reported from Botswana. The north western side of the STR exhibits the trend of distribution of these vultures in such interface, which might be explained by the presence of adjoining forest regions such as Nilgiri North, enabling vultures to access a wide foraging area across administrative boundaries.

The distribution of these vultures in the proximity of deciduous forests was supported by the fact that they roost on lofty and sparsely branched trees, the reason includes the enhanced visibility of the surroundings and minimum energy expenditure for a takeoff (Yamac 2007). These roosting sites provide favourable microclimate enabled by temperature inversion facilitating thermal regulation of vultures (Thompson *et al*., 1990).

The reason behind the occurrence of these four vultures in the other areas can also be attributed to facilitated thermoregulation. Geographically, land surface temperature varies based on the density of vegetation, presence of water bodies and mountains. As STR is a landscape with all these factors, land surface

temperature varies across the landscape (Map 3). The differential distribution of vultures preferring higher land surface temperature regions might be explained by the proportionality of higher land surface temperature to the thermal uplift, which enables these vultures to soar high with minimum energy expenditure.

Another significant factor is the availability of water in the form of streams and other naturally present water sources in the forest areas of STR as evident in the drainage map (Map.2). The availability of water alters the land surface temperature and lowers the temperature in accordance with the increase in moisture due to evaporation. Hence, the differential land surface temperature across the areas would also be dependent on the availability of water and thus influence thermal uplift of these vultures.

MANAGEMENT RECOMMENDATIONS:

This study also supports that the population of the four vultures in STR was very low, especially the endangered *Neophron percnopterus*. Having the characteristic feature of slow breeders with low growth rates and diclofenac contamination in the other parts of the country, this population of vulture at the junction of Eastern and Western Ghats is the last hope to restore the vulture population. Therefore, there is an urgent need to save the habitat and protect the large trees from all possible threats including forest fire and ensuring safe and sufficient food availability for vultures. Thus, the insights on the correlation between the land surface temperature, water availability and forest type of STR, substantiates the environmental factors as the influential drive for the surviving vulture population and the need to be conserved.

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We acknowledge PCCF, CCF and DFO, Tamil Nadu Forest Department (TNFD), for permitting us to carry out research in protected areas of the forest. We extend our sincere thanks to the TNFD for the guidance and support extended to us during this project. We thank all the forest rangers, foresters and field staff of STR without whom the project could not be completed.

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Avifaunal diversity of Anjaneri Protected Area, Nashik, Maharashtra

Vinaykamal D. Dethe* and Sagar G. Medhe
Department of Zoology, MVP'S Arts, Science and Commerce College. Ozar (MIG), Nashik.
Corresponding author *vinay_dethe@rediffmail.com

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Avifauna; Diversity; Northern- Western Ghats; Anjaneri.

Abstract

Avifaunal diversity of Anjaneri protected area is studied. We report total 98 species birds from 11 orders and 41 families out of which 20 species are winter migrants and 5 species are endemic to Maharashtra. Breeding sites of critically endangered Indian vultures are observed in the the northern-western Ghats a globally important hotspot of biodiversity and our baseline information will helpful for future conservational and management.

Introduction

The biological diversity and resources are important for the world's economy and human needs and the conservation of sites of rich biodiversity is an important strategy to stop loss of biodiversity (Biodiversity Convention 2000). The Western Ghats of India is well known for its biodiversity and endemic species (Padhey and Ghate 2002; Gunawardene et al. 2007; Daniel and Vencatesn 2008). The diversity of birds is vital for pest control, pollination, seed dispersion, and scavenging (Sekercioglu et al. 2017). The destruction of habitat by humans and their activity is the main cause of loss of avifaunal diversity (Bhadja and Vaghela, 2013). For maintaining the diversity of plants and animals the study and protection of bird species is important (Simeone et al. 2002). For understanding the ecology and conservation of an area, the study of the avian community is important (Kati and Sekercioglu 2006).

The Northern Western Ghats (NWG) comprise different types of habitats like forests, grasslands, rocky cliffs, and plateau (Datar and Watve 2018) and this an important habitat for many endemic, rare and endangered species. (Ghate 2015). In Maharashtra, the NWGs passes through 12 districts and the mountain

Figure.1. Anjaneri hills during summer.

ranges of these areas are less studied (Datar 2019). Nashik district of Maharashtra is part of NWGs and it has around 340 species of birds out of which 27 bird species are threatened. (Raha et al. 2004). The Nandurmadhmeshwar wetland, Gangapur dam, Ozar, and Wani adjoining grasslands are Important Bird Areas (IBA's) present in Nashik.

The NWG of Maharashtra includes part of the Trimbakeshwar mountain range situated in Nashik, which shows forest covers, rocky cliffs, and valley (Khairnar 2009). The avian diversity of north Maharashtra has not been well studied (Mahabal et al.2011). The Trymabkeshwar mountain ranges contain the Anjaneri hills located around 20 km from Nashik city. Anjaneri hills are situated at an altitude of 1280 m above sea level. The 5 hills of Trimbakeshwar mountain range forms the Anjaneri hills (Pethe et al. 2015). The southern part of these hills is covered by dense forest. Anjaneri is the birthplace of Lord Hanuman (Anjaneya, son of Sun God) and this protected area is well known for its floristic diversity. The avian diversity and its distribution in Anjaneri has not received scientific consideration. This is the first effort to document avifaunal diversity of this area. Therefore, this paper aims to provide preliminary information on the avifaunal diversity of Anjaneri protected area. This study will help implement conservation and management planning for the area.

Materials and Method

Study area and Habitat

The total area of Anjaneri is 923.68 hectares spread between 19° 55′ 12″ N, 73° 34′ 12″ E and divided into various habitat types like semi-evergreen forest patches, grasslands, riparian patches, agricultural land, rocky lateritic plateau, and human settlements. The Anjaneri area is divided into three wide-ranging plateaus at an elevation of 800 m, 1100 m, and 1200 m above MSL respectively (Jaybhaye et al.2016). The climate is divided into three-seasons, summer (March to May), monsoon (June-October), and winter (November to February). The temperature of Anjaneri ranges between 10°C to 36°C with an annual average rainfall of 2174mm, the temporary water source originates during monsoon whereas in summer the area is dry. (Figure 1- 3).

Vegetation

The vegetation of the area contains major species of trees like *Ficus racemosa, Mangifera indica, Lannea coromandelica, Kydia calycina, Heterophragma*

Figure.2. Anjaneri hills during monsoon.

quadriloculare, Erythrina stricta, Terminalia arjuna, *Terminalia bellirica, Mallotus philippensis, Careya arborea, Lagerstroemia microcarpa, Pterocarpus marsupium*, *Olea dioica.* Shrubs like *Barleria lawii, Dicliptera leonotis, Strobilanthes reticulate, Rauvolfia serpentine, Woodfordia fruticosa, Securinega leucopyrus* and Grasses like *Apluda mutica, Chloris virgata, Dendrocalamus strictus, Coix gigantea.*

Method

The field survey was conducted once in a week of every month from June 2016 to June 2017, from morning 0600hrs till evening. The identification of bird species was done using standard field guides and books (Ali and Ripley 1987; Grimmett et al. 1999; Pande et. al. 2011). The status of the birds is given as per IUCN Red List of Threatened Species (Birdlife International 2017) and classification is given as per Praveen et al. (2020). Percent occurrence of families was calculated by the method of Basavarajappa (2006). The endemic species were recorded according to Jathar and Rahmani (2006).

Result and Discussion:

The study showed a high diversity of birds including critically endangered vultures. Distribution of species with genus, families, orders, Resident and ICUN status recorded at Anjaneri reserved forest is presented in Table 1. This area represents 17.62% avian diversity of Maharashtra (Mahabal et al. 2011)

A total 98 species of birds belonging to 11 orders, 41 families were recorded during the study. Order Passeriformes showed a total 65 species followed by order Accipitriformes with 8 species. The percent occurrence of species in respective orders is given (Table 2). Muscicapidae family showed 10 species, which is the largest number of species from a single-family which includes flycatchers, thrushes and robins. Birds are associated with high vegetation diversity because they provide food and shelter (Koli 2014). Presence of fruit and flower-bearing flora of the area attracts avifauna. The agricultural area is a good food source for birds (Dhindsa and Saini, 1994). Rice is the main crop of this area, and rice field are temporary habitat for many birds like pigeon, myna, sparrow, house crow, cattle egret, heron, and parakeet because these field provide food source before and after harvesting. The most diverse avifauna was observed at an elevation of 800-1100 m probably because of less human disturbance and presence of diverse flora. The distribution of birds mainly depends upon availability of suitable habits for

Figure.3. Anjaneri hills during winter.

breeding, roosting and nesting. (Sharma et al.2018).

The survey showed 20 bird species, which are winter migrants, seven species, are local migrants and two species were vagrants. *Psilopogon viridis* (Boddaert, 1783) *Rhipidura albogularis* (Lesson, 1832) *Galerida malbarica* (Scopoli, 1786), *Galerida deva* (Sykes, 1832) and *Myophonus horsfieldii* (Vigors 1831) were observed during the study and these are endemic to Maharashtra.

Anjaneri is home for of critically endangered Indian Long-billed Vulture and White-backed Vultures. Raha et al.2015 had observed the presence of vultures in this region. The cliff of Anjaneri is an excellent habitat for Indian long-billed Vulture and the trees like *Mangifera indica, Pterocarpus marsupium Terminalia arjuna* provide suitable breeding and nesting sites for White-backed Vultures. This area has a suitable habitat for these threatened vultures. The cattle population in the area is large so monitoring of veterinary drugs from the area is important to know the probable threat to vultures. The programs for awareness need to be conducted in Anjaneri and nearby villages, to save the vulture species. The avian diversity of Anjaneri hill is rich and further study should be focused on ecology, habitat wise distribution and population dynamics for better management and conservation.

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Author's contribution:

Original Idea, Design of the study, data analysis and Manuscript preparation done by V.D. Dethe. Survey and data collection was done by Sagar. G. Medhe.

Table 1. A Checklist of birds with their Resident and ICUN Status.

Sr. No	Common name	Species name	Res. Status	ICUN Status
		Order: Galliformes : Family: Phasianidae		
1.	Indian Peafowl	*Pavo cristatus* (Linnaeus, 1758)	R	LC
2	Painted Francolin	*Francolinus pictus* (Jardine & Selby, 1828)	R	LC
		Order: Columbiformes:Family:Columbidae		
3.	Rock Pigeon	*Columba livia* (J.F.Glemin,1789)	R	LC
4.	Spotted Dove	*Streptopelia chinensis* (Scopoli, 1786)	R	LC
5.	Laughing Dove	*Streptopelia senegalensis* (Linnaeus, 1766)	R	LC
6.	Yellow-footed Green-Pigeon	*Treron phoenicopterus* (Latham, 1790)	R	LC
		Order: Cuculiformes : Family: Cuculidae		
7.	Greater Coucal	*Centropus sinensis (Stephenes,1815)*	R	LC
8.	Asian Koel	*Eudynamys scolopaceus* (Linnaeus, 1758)	R	LC
9.	Common Cuckoo	*Cuculus canorus* (Linnaeus, 1758)	R	LC
		Order: Caprimulgiformes : Family: Apodidae		
10.	Little Swift	*Apus affinis* (J.E.Gray,1830)	R	LC
11.	Asian Palm-Swift	*Cypsiurus balasiensis* (J.E.Gray,1829)	R	LC
		Order: Pelecaniformes : Family: Ardeidae		
12.	Indian pond heron	*Ardeola grayii* (Sykes, 1832)	LM	LC
13.	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	LM	LC
14.	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	LM	LC
		Family: Threskiornithidae		
15.	Indian Black Ibis	*Pseudibis papillosa* (Temminck, 1824)	LM	LC
		Order: Accipitriformes: Family: Accipitridae		
16.	Black Kite	*Milvus migrans (Boddaert, 1783)*	LM	LC
17.	Oriental Honey-buzzard	*Pernis ptilorhyncus* (Temminck, 1821)	LM	LC
18.	Indian long billed Vulture	*Gyps indicus* (Scopoli, 1786)	R	Cr
19.	White -backed Vultures	*Gyps bengalensis* (J.F.Glemin,1788)	R	Cr
20.	Short-toed Eagle	*Circaetus gallicus* (J.F.Glemin,1788)	R	LC
21.	Montagu's Harrier	*Circus pygargus* (Linnaeus, 1758)	WM	LC
22.	Shikra	*Accipiter badius* (J.F.Glemin,1788)	R	LC
23.	Eurasian Sparrow hawk	*Accipiter nisus* (Linnaeus, 1758)	WM	LC
		Order: Coraciformes: Family: Alccedinidae		
24.	Common Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	R	LC
25.	White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	R	LC
		Family: Meropidae		
26.	Green Bee-eater	*Merops orientalis* (Latham, 1801)	R	LC
		Family: Coraciidae		
27.	Indian Roller	*Coracias benghalensis* (Linnaeus, 1758)	LM	LC
28.	European Roller	*Coracias garrulus* (Linnaeus, 1758)	WM	LC

		Order: Piciformes : Family: Rhamphastidae		
29.	Coppersmith Barbet	*Psilopogon haemacephalus* (Statius Muller, 1776)	R	LC
30.	White-cheeked Barbet	*Psilopogon viridis* (Boddaert, 1783)	R*	LC
		Order: Falconiformes: Family: Falconidae		
31.	Common Kestrel	*Falco tinnunculus* (Linnaeus, 1758)	R	LC
32.	Peregrine Falcon	*Falco peregrinus* (Tunstall, 1771)	WM	LC
		Order: Pssitaciformes Family: Psittaculidae		
33.	Rose-ringed Parakeet	*Psittacula krameri* (Scopoli, 1769)	R	LC
		Order: Passeriformes Family: Campephagidae		
34.	Small Minivet	*Pericrocotus cinnamomeus* (Linnaeus, 1758)	R	LC
35.	Orange Minivet	*Pericrocotus flammeus* (J.R.Forster, 1781)	R	LC
		Family: Vengidae		
36.	Common Woodshrike	*Tephrodornis pondicerianus* (G.F.Glemin, 1789)	R	LC
		Family: Aegithinidae		
37.	Common Iora	*Aegithina tiphia* (Linnaeus, 1758)	R	LC
		Family: Rhipiduridae		
38.	White spotted Fantail	*Rhipidura albogularis* (Lesson,1832)	R*	LC
		Family: Dicruridae		
39.	Black Drongo	*Dicrurus macrocercus* (Vieillot,1817)	R	LC
40.	Ashy Drongo	*Dicrurus leucophaeus* (Vieillot,1817)	R	LC
		Family: Monarchidae		
41.	Indian Paradise-Flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	V	LC
		Family: Laniidae		
42.	Bay-backed Shrike	*Lanius vittatus* (Valenciennes, 1826)	R	LC
43.	Long-tailed Shrike	*Lanius schach* (Linnaeus, 1758)	R	LC
		Family: Corvidae		
44.	House Crow	*Corvus splendens* (Vieillot, 1817)	R	LC
45.	Large-billed Crow	*Corvus macrorhynchos* (Wagler, 1827)	R	LC
		Family: Stenostiridae		
46.	Grey-headed Canary-Flycatcher	*Culicicapa ceylonensis* (Swainson, 1820)	R	LC
		Family: Alaudidae		
47.	Malabar Lark	*Galerida malbarica* (Scopoli, 1786)	R*	LC
48.	Tawny Lark	*Galerida deva* (Sykes, 1832)	R*	LC
		Family: Cisticolidae		
49.	Common Tailorbird	*Orthotomus sutorius* (Pennant, 1769)	R	LC
50.	Grey-breasted Prinia	*Prinia hodgsonii* (Blyth, 1844)	R	LC
51	Ashy Prinia	*Prinia socialis* (Sykes, 1832)	R	LC
52	Plain Prinia	*Prinia inornata* (Sykes, 1832)	R	LC
		Family: Acrocephalidae		
53.	Booted Warbler	*Iduna caligata* (M.H.C Lichtenstein, 1823)	WM	LC
54.	Blyth's Reed Warbler	*Acrocephalus dumetorum* (Blyth, 1849)	WM	LC

		Family: Hirundinidae		
55.	Dusky Crag Martin	*Ptyonoprogne concolor* (Sykes, 1832)	R	LC
56.	Barn Swallow	*Hirundo rustica* (Linnaeus, 1758)	R	LC
57.	Wire-tailed Swallow	*Hirundo smithii* (Leach, 1818)	R	LC
58.	Red-rumped Swallow	*Cecropis daurica* (Laxman, 1769)	R	LC
		Family: Pycnonotidae		
59.	Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	R	LC
60	Red-whiskered Bulbul	*Pycnonotus jocosus* (Linnaeus, 1758)	R	LC
		Family: Phylloscipidae		
61.	Sulphur-bellied Warbler	*Phylloscopus griseolus* (Blyth, 1847)	WM	LC
62.	Common Chiffchaff	*Phylloscopus collybita* (Vieillot, 1817)	WM	LC
		Family: Sylviidae		
63.	Lesser Whitethroat	*Sylvia curruca* (Linnaeus ,1758)	WM	LC
64.	Yellow-eyed Babbler	*Chrysomma sinese* (J.F.Glemin,1789)	R	LC
		Family: Leiothrichidae		
65.	Quaker tit Babbler	*Alcippe poioicephala* (Jerdon 1841)	R	LC
66.	Jungle Babbler	*Turdoides striata* (Dumont 1823)	R	LC
		Family: Sturnidae		
67.	Brahminy Starling	*Sturnia pagodarum* (J.F.Glemin,1789)	R	LC
68.	Common Myna	*Acridotheres tristis* (Linnaeus 1758)	R	LC
69.	Bank Myna	*Acridotheres ginginianus* (Latham ,1790)	R	LC
70.	Jungle Myna	*Acridotheres fuscus* (Wagler, 1827)	R	LC
		Family: Turdidae		
71.	Indian Blackbird	*Turdus simillimus* (Jerdon, 1839)		LC
		Family: Muscicapidae		
72.	Indian Robin	*Saxicola fulicates* (Linnaeus 1766)	R	LC
73.	Oriental Magpie-Robin	*Copsychus saularis* (Linnaeus 1758)	R	LC
74.	Tickell's Blue Flycatcher	*Cyornis tickelliae* (Blyth,1843)	R	LC
75.	Malabar Whistling-Thrush	*Myophonus horsfieldii* (Vigors 1831)	R*	LC
76.	Red-breasted Flycatcher	*Ficedula parva* (Bechstein, 1792)	WM	LC
77.	Black Redstart	*Phoenicurus ochruros* (S.G.Glemin,1774)	WM	LC
78.	Blue-capped Rock-Thrush	*Monticola cinclorhynchus* (Vigors 1831)	WM	LC
79.	Blue Rock Thrush	*Monticola solitaries* (Linnaeus 1758)	WM	LC
80.	Pied Bushchat	*Saxicola caprata* (Linnaeus, 1766)	R	LC
81.	Desert Wheatear	*Oenanthe deserti* (Timminck,1825)	WM	LC
		Family: Nectariniidae		
82.	Purple-rumped Sunbird	*Leptocoma zeylonica* (Latham 1790)	R	LC
83.	Purple Sunbird	*Cinnyris asiaticus* (Linnaeus, 1766)	R	LC
		Family: Estrildidae		
84.	Red Avadavat	*Amandava amandava* (Linnaeus, 1758)	R	LC
85.	Indian Silverbill	*Euodice malabarica* (Linnaeus, 1758)	R	LC
86.	Scaly-breasted Munia	*Lonchura punctulata* (Linnaeus, 1758)	R	LC

		Family: Motacillidae		
87.	Grey Wagtail	*Motacilla cinerea* (Tunstall, 1771)	WM	LC
88.	Yellow Wagtail	*Motacilla flava* (Linnaeus, 1758)	WM	LC
89.	Paddyfield Pipit	*Anthus rufulus* (Vieillot,1818)	R	LC
90.	Long-billed Pipit	*Anthus simillis* (Jerdon 1840)	WM	LC
91.	Tawny Pipit	*Anthus capestris* (Vieillot,1818)	WM	LC
92.	Tree Pipit	*Anthus trivialis* (Linnaeus, 1758)	WM	LC
93.	Olived backed Pipit	*Anthus hodgsoni* (Richmond, 1907)	WM	LC
		Family: Diacaedae		
94.	Thick-billed Flowerpecker	*Dicaeum agile* (Tickell, 1833)	R	LC
		Family :Irenidae		
95.	Golden-fronted Leafbird	*Chloropsis aurifrons* (Temminck, 1829)	R	LC
		Family: Ploceidae		
96.	Baya Weaver	*Ploceus philippinus* (Linnaeus, 1766)	R	LC
		Family: Passeridae		
97.	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	R	LC
		Family: Emberizidae		
98.	Crested Bunting	*Melophus lathami* (J.E.Gray, 1831)	V	LC

Abbreviation used: Resident Status: R – Resident; LM - Local Migrant; WM - Winter Migrant and V - Vagrant. R*-Endemic to Maharashtra. ICUN Status: LC- Least concern; Cr- Critically Endangered.

Table 2. Percent occurrence of species in respective orders.

Sr. No	Orders	Family	Species	Percent Occurrence
1.	Galliformes	1	2	2.0
2.	Columbiformes	1	4	4.1
3.	Cuculiformes	1	3	3.1
4.	Caprimulgiforms	1	2	2.0
5.	Pelecaniformes	2	4	4.1
6.	Accipitriformes	1	8	8.1
7.	Coraciformes	3	5	5.1
8.	Piciformes	1	2	2.1
9.	Falconiformes	1	2	2.1
10.	Pssitaciformes	1	1	1.0
11.	Passeriformes	28	65	66.3
Total	**11**	**41**	**98**	**100**

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Status of the Lammergeier *(Gypaetus barbatus)* in Hirpora Wildlife Sanctuary, South Kashmir

[1]Hameem Mushtaq Wani*, [1]Mustahson F. Fazili, and [2]Samina A. Charoo
[1]Department of Zoology, University of Kashmir, Srinagar-190006, India
[2]Department of Wildlife protection, Government of J&K, Srinagar-190006, India
Corresponding author's email: hameem.scholar@kashmiruniversity.net

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ABSTRACT

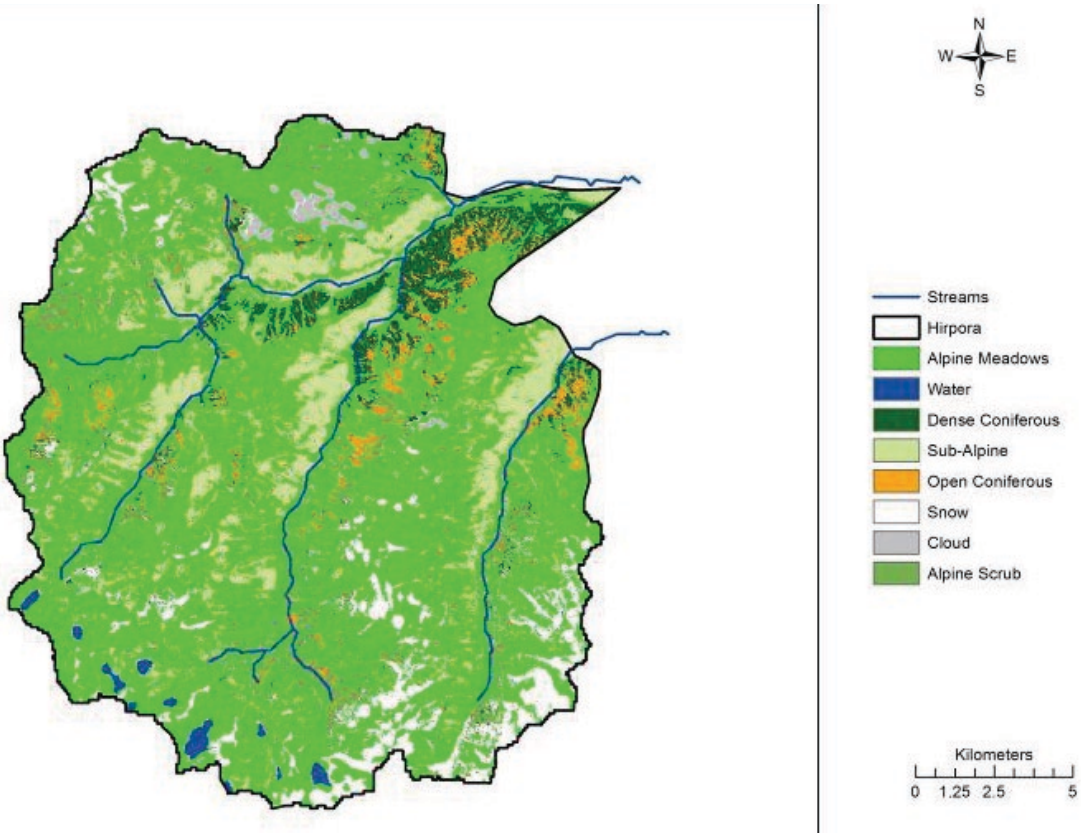
The Lammergeier (*Gypaetus barbatus)* has been uplisted to Near Threatened category of IUCN red list of threatened species due to its declining population. The change in population dynamics of such scavenging birds can lead to an ecological imbalance and increase the chance of disease spread among wildlife and livestock. Keeping in view the absence of baseline data regarding Lammergeier from Kashmir Himalaya, we examined the current status in Hirpora WLS by using Line Transect method to get a population estimate of the vultures in the area. A total of 47 individuals, 39 adults and 8 sub-adults, were observed during four seasons in Hirpora WLS. Kruskal-Wallis ANOVA was used to test the null hypothesis of randomness. The results showed that there is a significant variation ($P<0.05$) in both population status and Encounter rate of Lammergeier in different seasons. Flock size also varied significantly ($P<0.05$) across different months. These variations could be attributed to changes in the availability of day light hours and food in different seasons in Hirpora WLS. We recommend a long term study and conservation programme be undertaken for Lammergeier in the area.

Key words: *Flock size, Encounter rate, Lammergeier, Hirpora, Population, Kashmir*

INTRODUCTION

A species in an ecosystem exists as a population of individuals of the same species that are found in the same geographic or temporal environs (Kumar and Mina 2019). For proper management and conservation of wildlife, the estimation of populations is of the utmost importance. When we know the number of a particular species, then the effectiveness of our conservation strategies for that species can be tested. Therefore, it is a key element in identifying priority areas that need to be conserved. Vultures, an ecologically important scavenging group of birds, are regarded as the key functional species in cleaning the environment by feeding on carcasses (Hussain 2015). They are obligatory scavengers. This helps reduce epidemics and recycles nutrients in the environment. Therefore, the absence or loss of vultures from our ecosystems will result in an increased number of other scavenging agents like feral dogs. This change in population dynamics of scavenging faunal elements will increase the probability of disease spread among wildlife and livestock (Prakash et al. 2003). In a nutshell, their decline or local extinction may directly or indirectly affect the functioning of ecosystems as well as the health of wildlife and associated human populations.

Different vulture species show local seasonal fluctuations, and their number and activity may vary throughout the day or within a season (Newton 1979). The movement of vultures depends on environmental conditions and it is directly related to find food and frequency of thermals and ambient temperatures. The conservation of threatened vulture species requires reliable and robust



assessments of long-term demography so as to visualise proper management. The aim of the present study was to investigate the seasonal variation in population status and encounter rate of Lammergeier in Hirpora WLS because of the paucity of published literature. The surveys of the study area were undertaken from May (2018)-April (2020) to determine the population of Lammergeier.

MATERIALS AND METHODS:

Study area

Hirpora WLS spreads over an area of 341 km^2 in Shopian District, Kashmir. At an altitude of 2546 m from sea level, the sanctuary is located between 33°39' 55" N latitude and 74°39' 40" E longitude. It has forests, pastures, scrub land, waste land and water bodies. To the north, the sanctuary is bound by Lake Gumsar, to the east by Rupri, to the south by Saransar, to the west by the Pir Panjal pass and to northeast by Hirpora village (Ahmad et al. 2015). The slopes are gentle to moderately steep on the eastern aspect and very steep with many cliffs on the upper northern and western portion. The southern and south-eastern portions are moderately steep. The area is renowned for its rich floral and faunal diversity. The main faunal elements of the sanctuary include- Pir Panjal Markhor (*Capra falconeri*), Himalayan musk deer (*Moschus leucogaster*), Himalayan black bear (*Ursus thibetanus*), Himalayan brown bear (*Ursus arctos*), Leopard (*Panthera pardus*), Red fox (*Vulpes vulpes*) and Tibetan wolf (*Canis lupus*). The vegetation of the sanctuary is divided into mixed coniferous forests, deciduous subalpine scrub forests and subalpine pastures. The coniferous forests are dominated by Kail Pine, the sub alpine forests are dominated by fir while the deciduous subalpine scrub forests are dominated by Himalayan birch (*Betual utilis*) and juniper (*Juniperus communis*) (Ahmad et al. 2011).

METHODS

Data collection

Vultures were enumerated by walking over trails in Hirpora wildlife sanctuary. The entire study period was divided into spring (March, April and May), summer (June, July and August), autumn (September, October and November) and winter (December, January and February) seasons. The study area was visited monthly. Vultures were identified by using a field guide (Grimmett and Inskipp 2016). When encountered, their number, activity and the major habitat type in the surrounding area were noted. The geographical coordinates were also recorded with a GPS handset (Samson et al. 2016).

Season	Population (No. of individuals)		Encounter rate (/km)		Group size	
	Total no. of individuals	Mean±SE	Mean	SE	Max.	Min.
Winter	07	2.33±0.33	0.24	0.09	2	1
Spring	12	4.00±0.00	0.38	0.13	2	1
Summer	15	5.00±0.00	0.51	0.14	2	1
Autumn	13	4.33±0.33	0.46	0.14	2	1
Total	47	3.91±0.31	0.40	0.10		-
Kruskall-Wallis ANOVA	H=8.65; df=3; p=0.034		H=8.51; df=3; p=0.037			-

Table 1. Mean population and encounter rate and group size of Lammergeier during different seasons in Hirpora WLS.

STATISTICAL ANALYSIS

Basic statistics such as, mean and standard deviation were calculated for all the variables and are given as X±SE. Statistical analysis were performed by using windows based statistical packages- Microsoft Excel and MINITAB (Ryan et al. 1992). A non-parametric test, Kruskal-Wallis ANOVA was used for testing the null hypothesis at $P<0.05$.

Results

We observed 47 Lammergeier during the study period; and which comprised of 83% adults (n=39) and 17% sub-adults (n=8). Among them 7, 12, 15 and 13 individuals were observed during winter, spring, summer and autumn seasons, respectively. The mean population of Lammergeier was highest for summer, followed by autumn, spring and winter. We found a significant variation ($P<0.05$, Kruskal-Wallis ANOVA) in seasonal populations of Lammergeier in Hirpora WLS. The maximum and minimum group size was 2 and 1 respectively (Table 2). Mean encounter rate (/km) was highest during summer (0.51±0.14) and lowest during winter (0.24±0.09) (Table 1). The average flock size of Lammergeier was highest in March (2.00±0.00) and lowest in December (1.00±0.00) and January (1.00±0.00).

DISCUSSION

The Lammergeier has been uplisted to Near Threatened category of IUCN because of declines throughout most of its fragmented range (Paudel et al. 2016). Yet most studies on vultures in South Asia are focussed on white-rumped (*Gyps bengalensis*) and Slender billed vultures (*Gyps tenuirostris*) at lower altitudes (Prakash et al. 2003; Oaks et al. 2004; Baral et al. 2007) and very few studies are found regarding mountain cliff-breeding Lammergeier. This study presents the first base line data for a long term study of the ecology of this scavenger. The mean population size of Lammergeier varied significantly according to seasons in the study area. Population size of Lammergeier was found to be highest during summer season compared to rest of the three seasons (Table 1). In summer, the high availability of day light hours, and almost continuous formation of thermal updrafts helps breeding as well as non-breeding vultures to disperse and forage (Venkitachalam & Senthilnathan 2016). The vultures start breeding from winter onwards, and variations on the counts could simply reflect less movement by incubating vultures. These findings are similar to studies in Nilgiri North forest division and Sathyamanalam Tiger reserve of Moyar valley, Tamil Nadu showing that there is a seasonal variation in population size of different vulture species in the area (Venkitachalam and Senthilnathan 2016).

The average flock size of Lammergeier was highest for the month of March (2.00±0.00) and lowest for the month of December (1.00±0.00). However, Bhusal (2011) recorded the average flock size of Lammergeier to be 5±3.81. Tryjanowski and Morelli (2018) while studying the effects of habitat and time of the day on flock size of vultures in Cuba found that flock size varied between habitats, reaching a maximum of 43 in valleys and 31 in agricultural landscapes with domestic animal farms suggesting that carrion resources located in agricultural habitats and river valleys is crucial for the continued survival of vultures.

Prakash et al. (2003) surveyed northern, eastern and western India, and calculated the encounter rates of 0.14 and 0.08 individuals per kilometre for white backed and long-billed vultures respectively. Similarly, Umapathy et

al. (2009) studied the status and distribution of vultures in Andhra Pradesh, India and found encounter rates still less (0.003 per kilometre for Long-billed vulture and 0.0002 per kilometre for White-backed vulture). However, than these estimates as 78.16% of the area is composed of rocky habitat (Rather et al. 2016) that provides suitable locations for breeding purpose of these cliff breeders.

During current study, the population and encounter rate of Lammergeier was maximum during summer and minimum during winter months. This is probably due to the availability of food as during summer months thousands of livestock remain present in the sanctuary. Therefore, vultures usually soar more frequently in search of livestock carcasses during these months. However, during winter month the area receives heavy snowfall and is deserted by nomads during late autumn.

CONCLUSION

The current population size of Lammergeier in Hirpora WLS is very small. Keeping in view its declining populations globally, necessary, long term measures need to be taken to save the species in its natural habitat. Moreover, studies on its conservation issues and diet overlap with other vulture species in Hirpora WLS needs to be undertaken to conserve the species from deterioration.

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Indian Fox *(Vulpes bengalensis)* rescued from a well in Walhe, Taluka- Purandar, Pune, Maharashtra, India

Md Zaid Attar, Avishkar Bhujbal, Pandurang Madane, Rahul Lonkar and Satish Pande
(All authors: ETTC, Ela Foundation, Pune)
mdzaidattar8@gmail.com

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Background:

A rescue call was received by the Ela Transit Treatment Centre (ETTC), Ela Habitat, Pingori from a farmer. An Indian Fox (*Vulpesbengalensis* Shaw, 1800) had fallen in a well, on 22 August 2020 at 13.30 hrs. The location was Kamathwadi,Walhe (18.1868 N, 74.1520 E, Altitude 725 m ASL.

Species: *Vulpes bengalensis*(Shaw, 1800); Family: Canidae

Local name: Khokad (Marathi), IUCN status: LC, WPA: Schedule II

Distribution: From the Himalayan foothills throughout India except the North-East & Western Ghats.

Habitat:

Open rocky patches, desert and near human habitation and agricultural fields. Commonly they use complex dens with several openings or the dens under the rock ledges or crevices.

Rescue:

A farmer saw that an animal had fallen in a well around 8.00 AM on 22 Aug 2020. The animal took refuge on a ledge inside the well. Initially, the farmer tried to rescue the fox with the help of a bucket but was not able to do so. Then he informed ETTC about the incident. We immediately reached the spot to carry out the rescue, and forest officials were also informed about the same. We inspected the well which was without railing and the edge was covered by bushes and vegetation. The well was 63 ft. deep and 30 ft. wide, the water level was at 28 feet from the top. We prepared a rescue net with the help of ropes using a volleyball net (Size-length 365cm, width137cm, and mesh size 14*14 cm) and bamboos. We tried to grab the fox in the net, which was difficult as the animal was scared. But finally, after repeated attempts we succeeded in catching the fox. This could be done when one of our volunteers descended in the well with all safety measures and precautions and the volunteer pushed the individual safely in the net. The fox was safely pulled out of the well. The moment it came out of the well the individual immediately escaped from the net and ran away.

The major threats to the Indian Fox (*Vulpes bengalensis*) are habitat loss, road traffic accidents, illegal trapping and poaching, disturbance of den sites, falling in wells, snaring in safety nets, or farm compound nets.

Two rare migratory raptors sharing the same perch

Amit Arun Darunkar
(Email: ar.amitdarunkar@gmail.com)

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- **Name of species-** Eurasian Hobby (*Falco Subbuteo*) and Black Baza (*Aviceda Leufotes*)
- **Scientific Name-** *Falco Subbuteo & Aviceda Leufotes*
- **Status-** Least Concern. (IUCN Red List, 2015).
- **Date of sighting-** 16 nov 19.
- **Time of sighting-** 10.45 AM.
- **Weather parameters-** Sunny.
- **Number of times sighted-** Twice.
- **Number of birds-** Hobby was single ans Baza in pair.
- **Gender of bird-** female hobby and Baza pair.
- **Locality-** 30km before Shibkhola MAHANANDA WILDLIFE SANCTUARY, WEST BENGAL .
- **Habitat description-** Deciduous forest .
- **Distance from human habitation-** Approximately 5km.
- **Any other bird/animal associates-** None.
- **Bird behaviour-** Baza Couple First Attacked Hobby 2-3 Times As They Were In That Area Before Hobby Came . But After Half An Hour They Setteled On Same Tree Quietly And I Got This Momment.
- **Threats to the habitat-** Advancing human habitation and photography tourism .
- **Photographs-** Attached.
- **Previous records-** Multiple Records from Mahananda wildlife sanctuary but unique because of single frame picture of these elusive migratory birds . Eurasian Hobby take a halt in particular area only for few days .

Recent Sighting of Orange-headed thrush *Geokichla citrina* in Nashik, Maharashtra

Abhijit Gandhi, Samaya Gandhi
Email: abhigandhi@gmail.com

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- **Name of species**- Orange-headed thrush.
- **Scientific Name**- *Geokichla citrina.*
- **Status**- Least Concern. (IUCN Red List, 2019).
- **Date of sighting**- 21st May 2020.
- **Time of sighting**- 3:23 PM
- **Weather parameters**- Sunny, dry and hot.
- **Number of times sighted**- Once.
- **Number of birds**- Single.
- **Gender of bird**- Unidentified (probably non-breeding male).
- **Locality**- Gajapanth Society, Mhasrul, Dindori road, Nashik, Maharashtra, India.
- **Habitat description**- Shady undergrowth, residencial area, bungalow society, inside bungalow compound, silent and less disturbed backside of my bungalow.
- **Distance from human habitation**- Not more than 7 feet.
- **Any other bird/animal associates**- On same day (21st May) Indian pitta *Pitta brachyura* was seen.
- **Bird behaviour**- Saw single bird feeding at side margin and a shady undergrowth behind my house. It was seen only once. The bird was panting.
- **Threats to the habitat**- Human disturbance, paver blocks to the ground, frequent 'cleaning' of side margins of bungalows.
- **Photographs**- Attached.
- **Previous records**- After talking to local bird watchers and searching the web no authentic record was found.

Panel of Experts/Referees for Ela Journal of Forestry and Wildlife

S. No.	Name & Designation	Area of Specialization	Address	Telephone No.	Email
1	**Dr. Satish A. Pande** Professor Chief Editor	Ornithology, Medicine	C-9, Bhosale Park, Sahakarnagar No. 2 Pune 411009	+91-020-9822193707	Pande.satish@gmail.com
2	**Jeet Singh** APCCF	Forestry	APCCF-RET, Vanbhavan, Pune	+91-020-9422271814	virk1962@rediffmail.com
3	**Reuven Yosef** Professor	Ornithology, Ecology	Ben Gurion University of the Negev, Eilat Campus P. O. Box 272 Eilat 88106, ISRAEL	+972 53 7671290	ryosef60@gmail.com
4	**Dr. N.R. Karmalkar** Prof. & Vice Chancellor	Geology & Environmental Sciences	Savitribai Phule Pune University (formerly University of Pune), Ganeshkhind, Pune-411007	+91-020-25693868 9823011747	nrkarmalkar@gmail.com
5	**Dr. Kalpana Pai** Professor	Biodiversity & Zooplankton ecology	Centre of Advanced Study, Department of Zoology, Savitribai Phule Pune University (formerly University of Pune), Ganeshkhind Pune-411007	+91-020-25601436 9850936759	kalpanapai@unipune.ac.in drkalpanapai@gmail.com
6	**Dr. N.P. Gramapurohit** Associate Professor	Behavioural ecology of Amphibians	Centre of Advanced Study, Department of Zoology, Savitribai Phule Pune University (formerly University of Pune), Ganeshkhind Pune-411007	+91-020-25601436	naraharipg@gmail.com
7	**Dr. Ramesh D. Gulati** Emeritus Guest Scientist	Limnology Aquatic Ecology	Department of Aquatic Ecology, NIOO/Netherlands Institute of Ecology, 6708 PB Wageningen The Netherlands	+31.317473550	R.Gulati@nioo.knaw.nl
8	**Dr. Aswini Pai** Associate Professor and Co-Chair	Ethnobotanist and plant ecologist	Biology Johnson Hall of Science, Room 227 St. Lawrence University 23 Romoda Drive, Canton, NY 13617, USA	+001-(315) 229-5810 800-285-1856	apai@stlawu.edu |

S. No.	Name & Designation	Area of Specialization	Address	Telephone No.	Email
9	**Dr. Yogesh Shouche** Scientist 'G'	Microbial ecology, Microbial molecular taxonomy and biodiversity	National Centre for Microbial Resource, National Centre for Cell Science, Ganeshkhind Pune-411007	+91-020-25329027	yogesh@nccs.res.in
10	**Dr. Uma Shaanker** Professor in the Department of Agriculture and Life Sciences, Ashoka University, India.	Biodiversity, Endophytes, Plant Evolutionary Biology, Conservation Genetics, Bio-prospecting	R. Uma Shaanker Department of Crop Physiology, University of Agricultural Sciences Bangalore, India	+91- 080-23636713	umashaanker@gmail.com rus@vsnl.com
11	**Suruchi Pande** Head, Dept. Of Ethno-Ornithology, OENSL -Ela Foundation & MES, A.G.College Campus	Ethno-Ornithology	C-9, Bhosale Park, Sahakarnagar No. 2 Pune 411009	+91-020-9881144651	suruchipande@gmail.com
12	**Gombobaatar Sundev** Professor, Department of Biology, National University of Mongolia	Ornithology Taxonomy	Director, Mongolian Ornithological Society P.O.Box 537, Ulaanbaatar 210646A, Ikh surguuli gudamj-1, Ulaanbaatar, MONGOLIA. Tel: Fax: 976-11-320159 E-mail	976-99180148; 976-90112244 (mob.); 976-11-323970 (off.)	info@mos.mn; gomboo@num.edu.mn
13	**Hemant Ghate** Professor	Entomology	Prof. Emiritus, Department of Zoology, Modern College of Arts, Science and Commerce, Off J.M. Road, Pune, 411005	+91-020-9960629667	hemantghate@gmail.com

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