Ela Foundation

Ela Journal of Forestry and Wildlife

ISSN 2319-4361
(Indexed in Google Scholar)

Volume 9 Part 1 | Issue 3
July - September 2020

A quarterly scientific refereed e-Journal of Ela Foundation and Forest Department, Maharashtra for Nature Conservation through Education and Research

Listed in UGC- CARE

Seasonal variation in the occurrence of Grey Francolin *Francolinus pondicerianus* in Bhuj taluka of Kutch district, Gujarat, India.

Devesh Gadhavi[1*], P. P. Dodia[2], Kedar Gore[3], Indra Gadhvi[4]

[1*]Corresponding Author: Research Scholar, Maharaja Krishnakumarsinhji Bhavnagar University (MKBU), Bhavnagar, Gujarat, India. deveshgadhvi@gmail.com
Postal Address: Plot No 27, Swapn-Shilp Society, B/h H. K. Enterprise, Talaja Road, Adhewada, Bhavnagar – 3640002. Contact No: +91 98982 06959/92650 66045.

[2]Associate Professor, Zoology Department, Sir P. P. Institute of Science, MKBU, Bhavnagar, Gujarat.
[3]Director, The Corbett Foundation, Maharashtra.

[4]Dean, Faculty of Science & Head, Department of Marine Science, MKBU, Bhavnagar, Gujarat.

Citation: Gadhavi Devesh, P. P. Dodia, Kedar Gore, Indra Gadhvi (2020), Seasonal variation in the occurrence of Grey *Francolin pondicerianus* in Bhuj taluka of Kutch district, Gujarat, India. *Ela Journal of Forestry and Wildlife* *Vol.9* Part 1 *(3): 688-702*

Date of Publication:
30 September 2020

ISSN 2319-4361

ABSTRACT:

Despite being one of the common species of Francolins, limited studies are available on the Grey Francolin *Francolinus pondicerianus* compared to the other francolins in India. This study highlights the habitat preference of Grey Francolin in a human-dominated landscape in Bhuj taluka, Kutch district, Gujarat. It shows the effect of vegetation cover and its altitude on the occurrence of the species in different seasons. It also highlights the effect of crop pattern, type of agriculture boundary and other agricultural factors on the habitat selection, behaviour and occurrence of the species.

KEYWORDS: Galliformes, *Francolinus pondicerianus*, Francolin, Habitat Preference, Farmland Birds, Kutch, Gujarat.

INTRODUCTION:

The Order Galliformes has about 83 genera and around 300 species globally, of which ~39% are listed as 'threatened' by the International Union for Conservation of Nature (IUCN) Red List (IUCN 2020). India has 43 species of Galliformes (Rasmussen and Anderton, 2012; Praveen *et al.*, 2019). The 'francolins' make the largest genus in this order (Bock and Farrand, 1980; Mandiwana-Neudani *et al.,* 2019). Five species of francolins are reported from India (Ali and Ripley, 1983; Grimmett *et al.*, 2011; Rasmussen & Anderton, 2012). With 609 species of bird specie (Ganpule, 2016;

Ganpule *in print*, 2020; Prasad Ganpule, April 2020, *pers. comm*.) Gujarat is home to ~46% of the avian species found in India (Praveen *et al.*, 2019). Gujarat has three species of francolins (Ganpule, 2016), of which two are found in Kutch district (Ali, 1945; Parasharya *et. al*, 2004; Ganpule, 2016).

Out of the three races described by Ali & Ripley (1983), Grey Francolin *Francolinus pondicerianus interpositus* (Hartert) 1917, henceforth shortly called as 'GF' in this paper, is found in Kutch region of Gujarat, Rajasthan parts of northern India, Sind, eastern Punjab to Bihar and West Bengal (Ali, 1945; Ali & Ripley, 1983). It is a common and abundant species in Kutch (Ali 1945). Outside Kutch, it is found in drier parts of Gujarat (Dharmakumarsinhji, 1955; Balar, 2007; Parasharya *et al.,* 2004; Ganpule, 2016) inhabiting semi-arid open grassland, thorny-scrub country, the neighbourhood of villages and cultivation, occurring up to *c.* 500 meters altitude (Ali & Ripley, 1983). It lives in cultivated areas where it can find cover, food, and ground for nesting (del Hoyo *et al.,* 1994; Fuller *et al.,* 2000).

The United Kingdom witnessed ~80% decline in its grey partridge (*Perdix perdix*) population due to insecticides and pesticides, agriculture intensification, and a rapid rise in mechanised and modern farming practices (Potts and Aebischer, 1995; Sotherton *et al.*, 2010). In Europe, the decline in farmland birds was much higher (44%) than the forest birds (9%) during 1985 to 2005 (PECBMS, 2007). The hedgerows and its vegetative cover on the boundary of agriculture fields was an important habitat for partridge, as it offered safety, shelter, food, and nesting sites, which were vital for chick survival (Meriggi *et al.*, 1990; Aebischer *et al.*, 1994; Potts and Aebischer, 1995; Buner *et al.*, 2005; Bro *et al.*, 2001).

The adverse impact of habitat alteration, agriculture intensification, mechanization and increased use of pesticides was highlighted in earlier studies in India (Kalsi, 2005; Kaul, 2007; Kalsi, 2007; Rana *et al*, 2012). As per Kalsi (2007). Habitat destruction leads to fragmentation of population that ultimately results

in local extinction. The various threats to the species such as habitat loss, disturbance from anthropogenic activities, hunting, poaching, use for falconry and trade for meat have been highlighted in earlier studies from India (Dharmakumarsinhji, 1955; Hilaluddin *et al.*, 2005 a, b; Sathyakumar and Sivakumar, 2007; Sathyakumar *et al.*, 2007; Hilaluddin and Kaul *et al.,* 2007, Kalsi, 2007; Rahmani, 2012; Khalil *et al.*, 2016a,b;). Ahmed (2019) has mentioned it to be one of the top ten traded species in India.

The population decline of GF has been reported earlier (Chaudhary and Bhatti, 1992; Islam, 1999; Khalil *et al.*, 2016b). The speedy decline in the population of francolins and other Galliformes in different parts of Western Ghats due to poaching and habitat degradation is reported by Sathyanaryana *et al.* (2007) and an overall decline of about 79% is reported (Khalil *et al.*, 2016b). The lack of data of various Galliformes makes it difficult to evaluate the impacts of various threats and status of the species in India (Kaul, 2007). Sharma (1983), Kalsi and Rana (2004), Ilyas *et al.* (2005), Rana *et al.* (2007, 2012) and Kidwai (2011, 2013), have studied the GF in India but ecological studies from Gujarat are lacking. In India, a significant population of Galliformes survives outside the Protected Area (PA) network, and alteration/ degradation/loss of habitat, both inside and outside the PAs, is a major threat to them (Roberts, 1991; Sathyakumar *et al.,* 2007). This species is an effective biocontrol agent, as it is known to feed on insects, their eggs and larvae (Beg & Qureshi, 1972; Mian and Wajid, 1994; Mian, 1995; Islam, 1999; Khan and Mian, 2012; Khalil, 2015, Khalil *et al*, 2015a,b). Its abundance can indicate the quality of the habitat (Sathyakumar *et al.,* 2007) but limited information is available from India (Sinha and Chandola, 2007). In this paper we present data on the seasonal variation in the population of GF, its habitat preference and correlation with vegetation height and composition. We also present the impact of crop pattern, type of agriculture boundary and other agriculture-associated factors on the habitat selection and behaviour of the species.

METHODOLOGY:

Sampling Design: The survey was conducted for 24 months, i.e. from January 2015 to December 2016. The study area includes semi-arid zone of Kutch, Gujarat (23°.13' to 23°.12' N; and 69°.36' to 69°.38' E; Fig. 1). The area included habitats such as grassland, bushes (scrub forest), woodland, agriculture fields and human settlements. May is the hottest month in Kutch with a maximum temperature reaching 45 °C. The area receives erratic rainfall between July to September. The major flora of the area includes *Acacia nilotica*, *Prosopis juliflora*, *Ziziphus nummularia* and *Prosopis cineraria*.

The site was selected on the basis of reconnaissance survey, literature review, communication with local farmers and birdwatchers and accessibility during different seasons. A 5 km^2 area was selected and grid cells of 0.05 km^2 (Fig 1) were laid over the area with the help of QGIS 3.0 software. The size of the grid cell (0.05 km^2) was selected as per the home range of the species (~0.05 km^2) described by Rana *et al.* (2012) in a comparable habitat in Haryana. The smaller size of the grid favours the detection of birdcalls within a short distance (not more than 500 meters) to check the cue-based occurrence of the species (Buckland, 2006; Rana *et al.,* 2007; Kasprzykowski and Goławski, 2009).

The data for the occurrence of the species was collected using the line transect sampling method, used by Kidwai (2013) and Dutta *et al.* (2014). As this study had the constraints in the budget, logistics, time and human resource, the method was slightly modified. A randomly selected straight-line transect was walked with handheld GPS during the morning time as the calling activities and the possibility of encounter were more during the morning. At a distance of every 200 meters, data for the vegetation cover, vegetation height and additional agriculture information were collected in the pre-designed datasheet.

SEASONAL VARIATION:

The year was divided into four seasons viz. Summer (March to May), Monsoon (June to August), Post Monsoon (September to November) and Winter (December to February). Minimum three randomly selected line transects per season (one per month) were walked in the study area. **Species Information:** To check the occurrence of the species, the data collection was done by walking along the trails, paths, roads, ridges, *nullahs* or along the available path or boundary of the agriculture field. The start point, endpoint, and total distance travelled were measured by GPS. The occurrence of the species was reported for the direct ocular sighting and for the indirect cue-based sighting (when the birdcall was heard). The

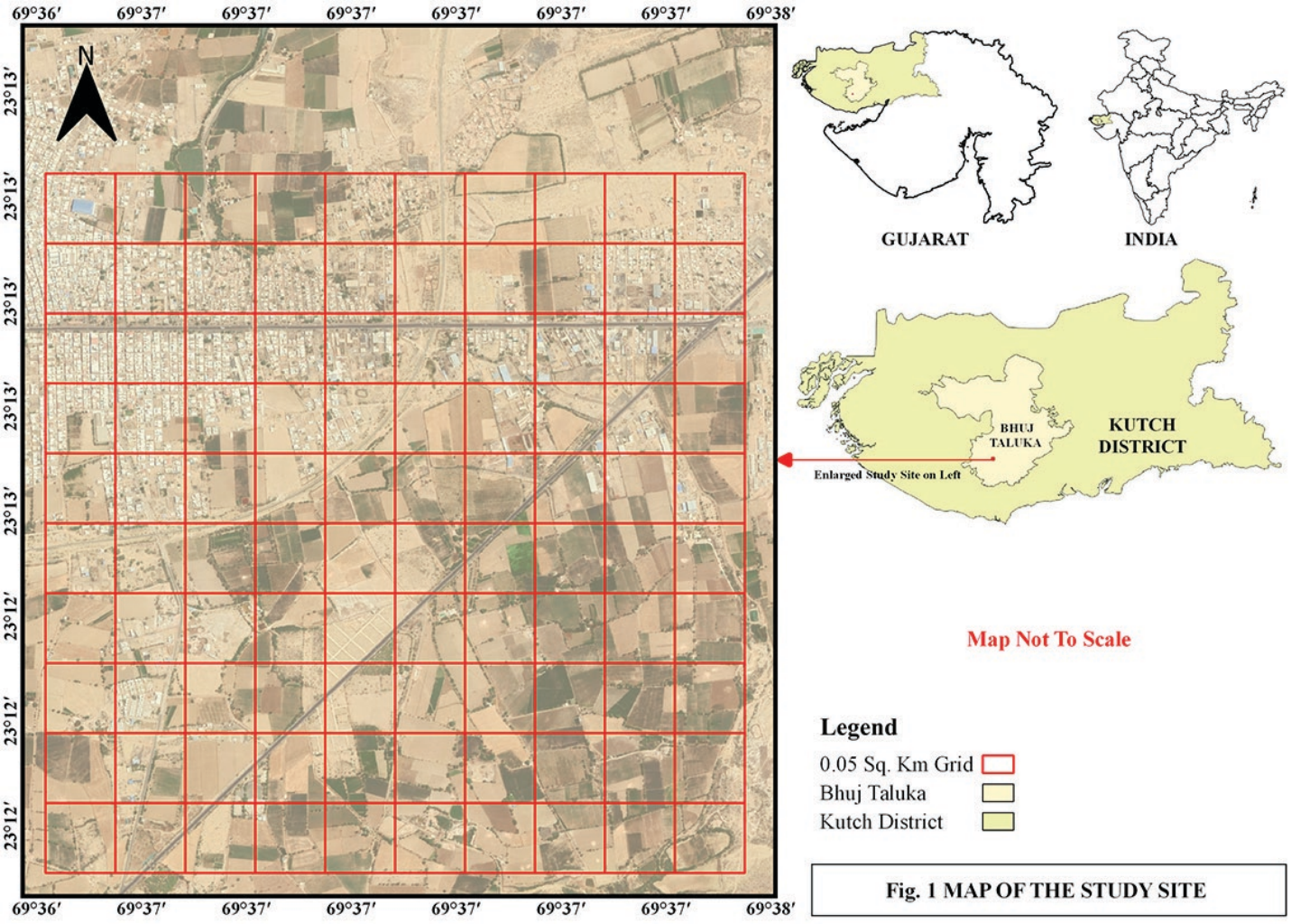


Fig. 1 MAP OF THE STUDY SITE

low-intensity birdcalls coming from a distance were ignored to overcome overlapping of the cue-based detection. In the case of the direct sighting, additional information such as covey size (total numbers in a flock) and (if possible) covey composition (male/ female/sub-adults/chicks) were also recorded. . In Grey Francolin, the presence of the tarsal spur in male, mostly one spur but rarely two, is the only way to visually differentiate the male from the female (Ali & Ripley, 1983; Islam, 1999; Rasmussen and Anderton, 2012). When gender could not be identified, it was recorded as 'unidentified'. **Habitat Information:** The habitat features that could influence the distribution of species, such as vegetation cover and height, type of agriculture crop, type of boundary around the agriculture field, status of the crop (standing/ fallow), agriculture field soil (ploughed/ barren) were recorded at an interval of 200 meters along the transect.
The dominant land-cover type (barren/agriculture/ grassland/bush/woodland and settlement) were recorded within 100 m radius from each sampling point. **Vegetation cover**: The vegetation cover within a 100 m radius of the sampling point was recorded in percentage as per the ground covered by the particular vegetation type. To reduce the discrepancy of observation errors, the vegetation cover was recorded in broad class-intervals (A= Absent, B = Very Low (0-20%), C = Low (21-40%), D = Medium (41-60%), E = High (61-80%) and F = Very High (81-100%). The vegetation type was divided into five different categories viz. 1) **Grass:** an area with grass varying in height (< 60 cm), as the species, avoids tall grasses; 2) **Bush:** an area with ground vegetation (< one meter) but other than grasses; 3) **Woodland:** an area with woody trees (> one meter); 4) A**griculture:** a habitat having agriculture area; 5) **Human Settlements**: an area with more than five constructed houses or a colony of houses; and 6) **Open:** an area with

no vegetation. **Vegetation height**: The vegetation height (height of each vegetation type) within 100 m radius from the sampling point was recorded in broad class intervals (A= Absent, S = Short (0-20 cm), M = Medium (21-40 cm), T = Tall (41- 60 cm), TT = Very Tall (>100 cm**)**. The data about vegetation composition and height from each sampling point was recorded irrespective of the presence or absence of the species. **Information on Agriculture:** As the species is known to occur in agriculture fields (Ali, 1945; Dharmakumarisnhji, 1955; Ali and Ripley, 1983; Rana *et al.*, 2012) more information like the type of boundary (hedge/fence/wall/open), name of the crop, status of the crop (standing/fallow), and status of field (barren/ploughed) were also recorded.

For the precise observation and data collection instruments like Nikon 10x42 Monarch binocular, Garmin GPS Etrex 30X, and Nikon D500 digital SLR camera were used. The data analysis was carried out with the help of the software viz. MS Excel and QGIS as per the standard methods. The Encounter Rate (ER) was calculated as ER = number seen/km walked. Before data analysis, the null hypothesis was tested through ANOVA and Chi-square Test using XLSTAT by Addinsoft.

RESULTS:

Seasonal variation in the encounter rate and the occurrence of the species

During the study, only 87% (4.35 km^2) of the total area could be surveyed due to the limitation of human resources. The habitat information was collected from a total of 383 points. A total of 25 transects having an average length of 2.67±0.50 km were walked during different seasons in the morning to check the occurrence of the species. An average of 3.48±0.44 hours were spent on each transect. To collect the habitat information and other data as mentioned above, a minimum of 15 minutes were spent on each sampling point (n=383). In total, 74 sightings accounting to 484 individuals and 134 indirect sightings through the auditary presence (birdcall) were recorded.

The Encounter Rate (ER), (Fig. 2) of call was highest during post-monsoon (2.26±0.01) and summer (2.18±0.08) respectively, but during monsoon (1.82±0.26) and winter (1.81±0.45), difference was not significant. The ER of sighting was highest in post-monsoon (1.26±0.45) followed by monsoon (1.15±0.14), summer (1.11±0.24) and winter (0.91±0.05). The number of the sighting was highest in summer (10.5±0.71) and lowest in winter (7.0±0.23). The maximum birdcalls (n=134) were reported in summer (19.5±0.77) and they reduced in winter (14±4.24).

Seasonal variation in the population structure:

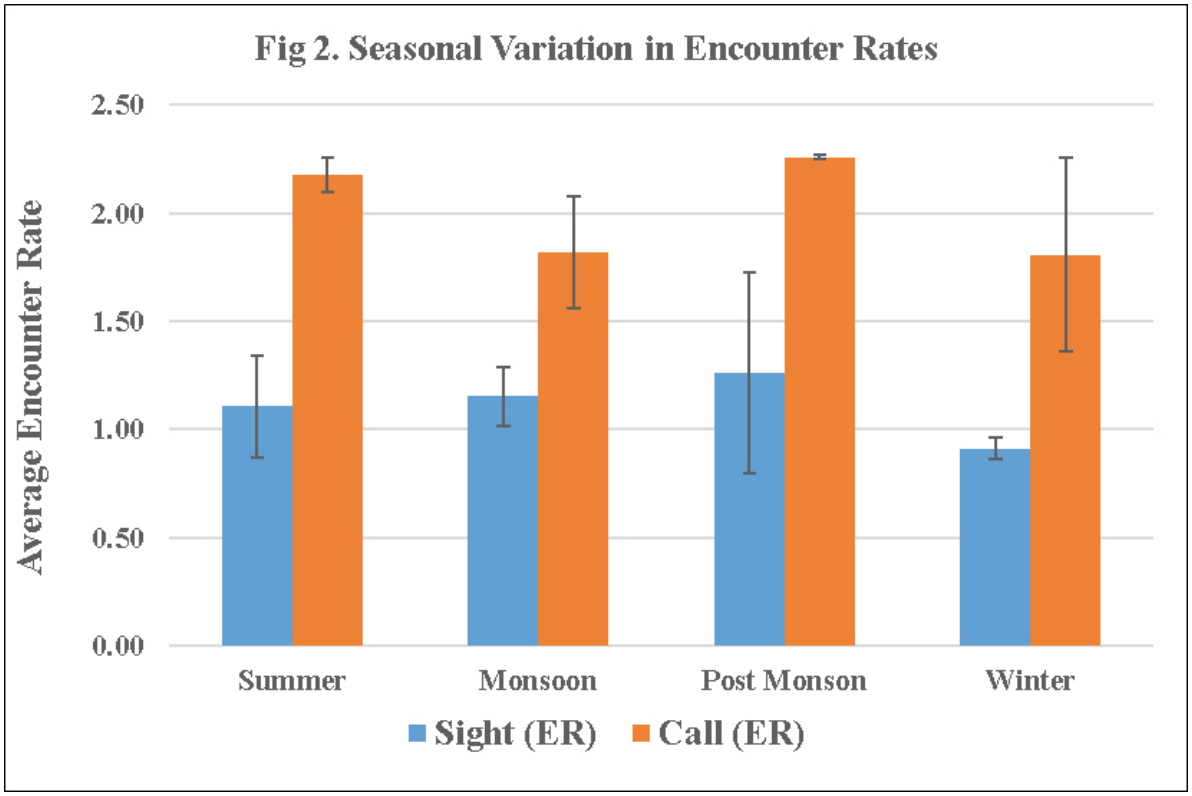
Out of the total individuals sighted (n=484), in 40% the gender could not be identified. In 60%, the individuals were identified as male/female/sub-adults/chicks, of which chicks were 37% followed by sub-adults (10%), female (7%,) and males (6%,). Breeding was recorded in summer (March-May) and post-monsoon (Aug-October) and the latter is the main breeding season. Out of the total chicks observed (n=181), maximum sightings were in summer (35.50±6.36) probably due to higher visibility than in post-monsoon (23.50±2.65).

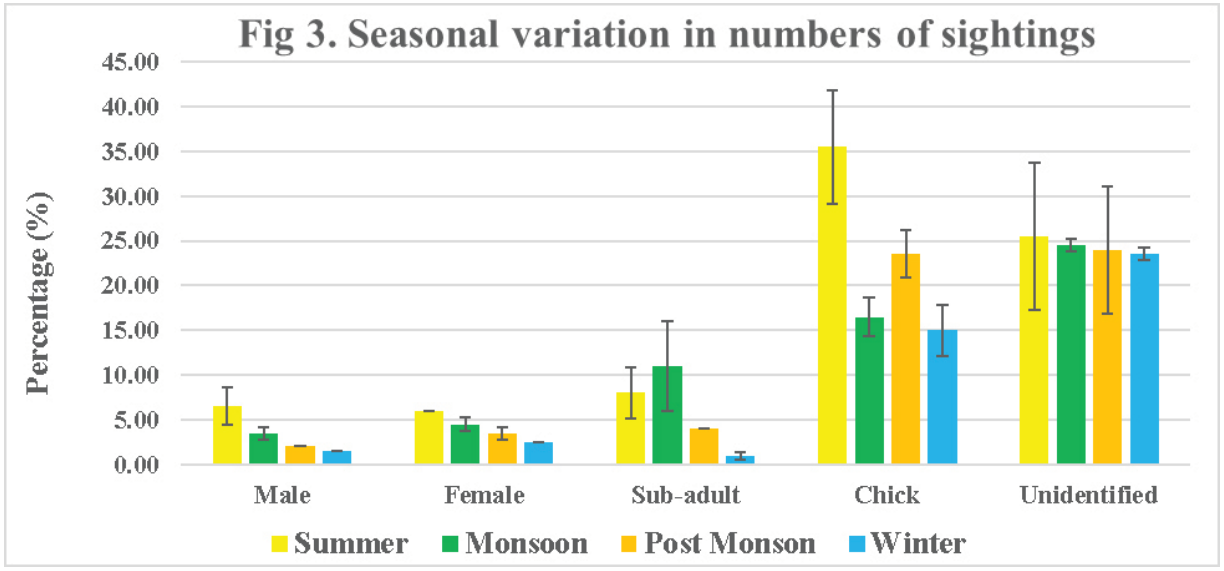
Effect of vegetation cover on the occurrence of the species

The average proportion of occurrence against the vegetation cover was tested for the different season (Fig. 4). The significance of data and null-hypothesis were tested with ANOVA and Chi-square (R^2 0.89, CI 95%, p-value 0.62, alpha 0.95).

In summer, the maximum average occurrence (1.75±1.10) (Mean±SE) was in bushes (0-20%), followed by (1.13±0.74) in agriculture (81-100%), (0.93±0.44) in woodland (0-20%) and (0.50±0.23) in grass (0-20%). In monsoon, the maximum average of occurrence (2.14±1.36) was in bushes (0-20%), followed by (2.04±1.10) in woodland (0-20%), (1.60±0.61) in the grass (0-20%), (1.37±0.94) in agriculture (81-100%). This shows a significant increase in the use of grass in monsoon. During monsoon species also used the low (21-40%) and medium (41-60%) cover of grass which was not used in summer, presumably due to its unavailability. In the season of post-monsoon, the maximum average of occurrence (1.82±1.27) was in woodland (0-20%), followed by (1.16±0.96) in grass-B, (1.10±0.86) in bushes-B and (0.83±0.74) in agriculture-E. In winter, the maximum average of occurrence (1.25±0.90) was in bush-B, followed by (1.17±0.95) in woodland-B, (0.71±0.60) in grass-B and (0.53±0.41) agriculture-E.

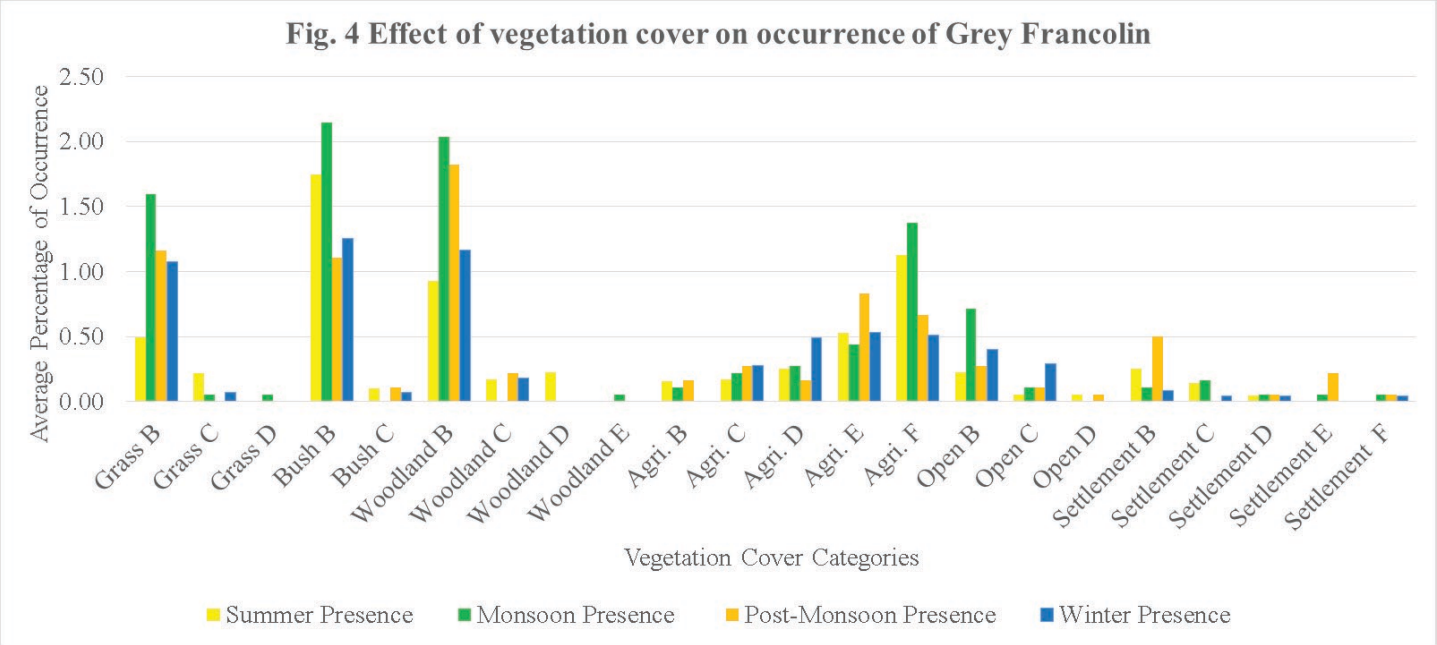
Seasonal variation in the occurrence against varying vegetation height:



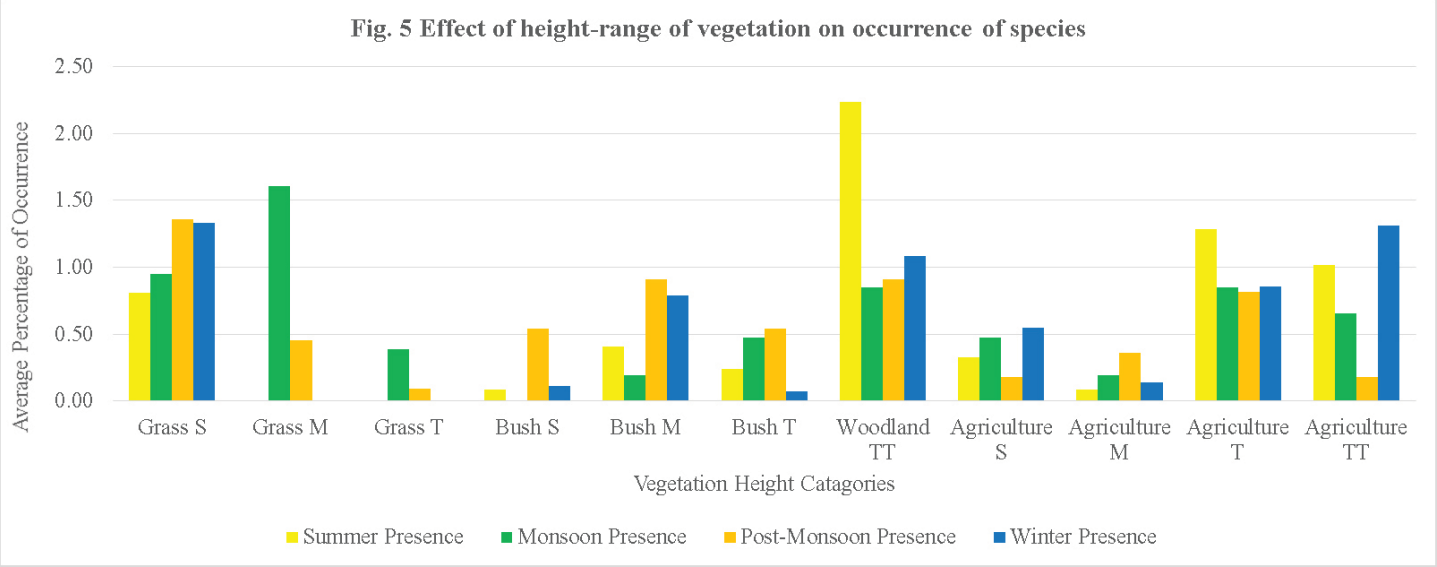


The average occurrence against the height of different vegetation was checked in different seasons (Fig. 5). The significance of data and null-hypothesis were tested with ANOVA and Chi-square (R^2 0.74, CI 95%, p-value 0.86, alpha 0.95).

In winter, the maximum average of occurrence (1.33±0.87) was in grass-S, followed by (1.31±0.97) in agriculture-TT, (1.09±0.18) in woodland-TT and (0.79±0.25) in bush-M. During summer, the maximum average of occurrence (2.24±0.85) was in woodland-T, followed by (1.28±0.29) in agriculture-T, (1.02±0.34) in agriculture-TT and (0.81±0.14) grass-S. In monsoon, the maximum average of occurrence (1.61±0.54) was in grass-M, followed by almost equal occurrence (0.95±0.41) in woodland-T and (0.85±0.12) in agriculture-T. The species (0.39±0.19) was also seen in grass-T and (0.48±0.13) in bush-T. This shows the significant increase in the usage of medium to the tall



B = Very Low (0-20%), C = Low (21-40%), D = Medium(41-60%), E = High(61-80%), F = Very High (81-100%)



S = Short (0-20 cm), M = Medium (21-40 cm), T = Tall (41- 60 cm), TT = Very Tall (>100 cm

grass in monsoon. During post-monsoon, the maximum average of occurrence (1.36±0.75) was in grass-S, followed by (0.91±0.17) in bush-M and (0.91±0.23) in woodland-TT with a very less significant difference, while in agriculture-T it was at average (0.82±0.23).

Usage of different crop pattern

The Grey Francolin is granivorous species and therefore the changes in the crop pattern were likely to affect its occurrence as crops are one of the important food resources for the species, especially in the dry and semi-arid areas like Kutch. We tested the average occurrence of the species in the different crops during different seasons (Fig. 6). The significance of data and null-hypothesis were tested with ANOVA and Chi-square (R^2 0.72, CI 95%, p-value 0.68, alpha 0.95).

The use of alfalfa (*Medicago sativa*) was maximum in summer with an average occurrence (3.54±1.55) which reduced to (2.64±2.22) in monsoon and remained almost constant in post-monsoon (1.81±0.77) and winter

Fig. 6. Seasonal Variation in the crop preference by Grey Francolin

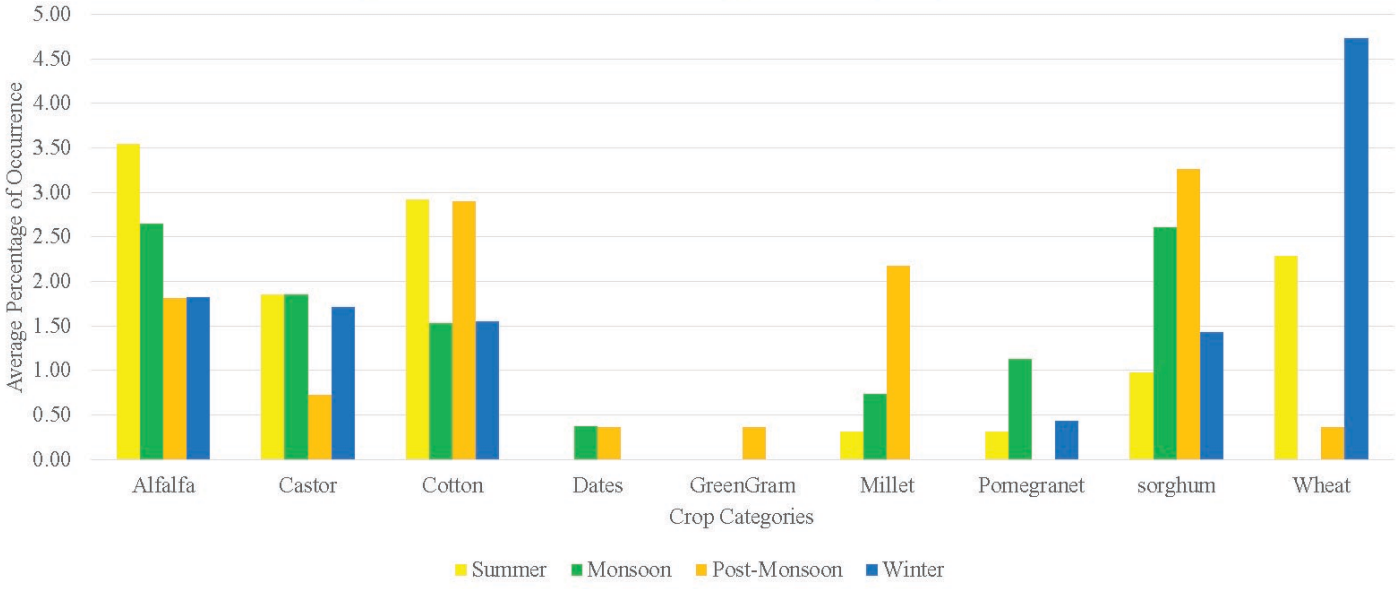
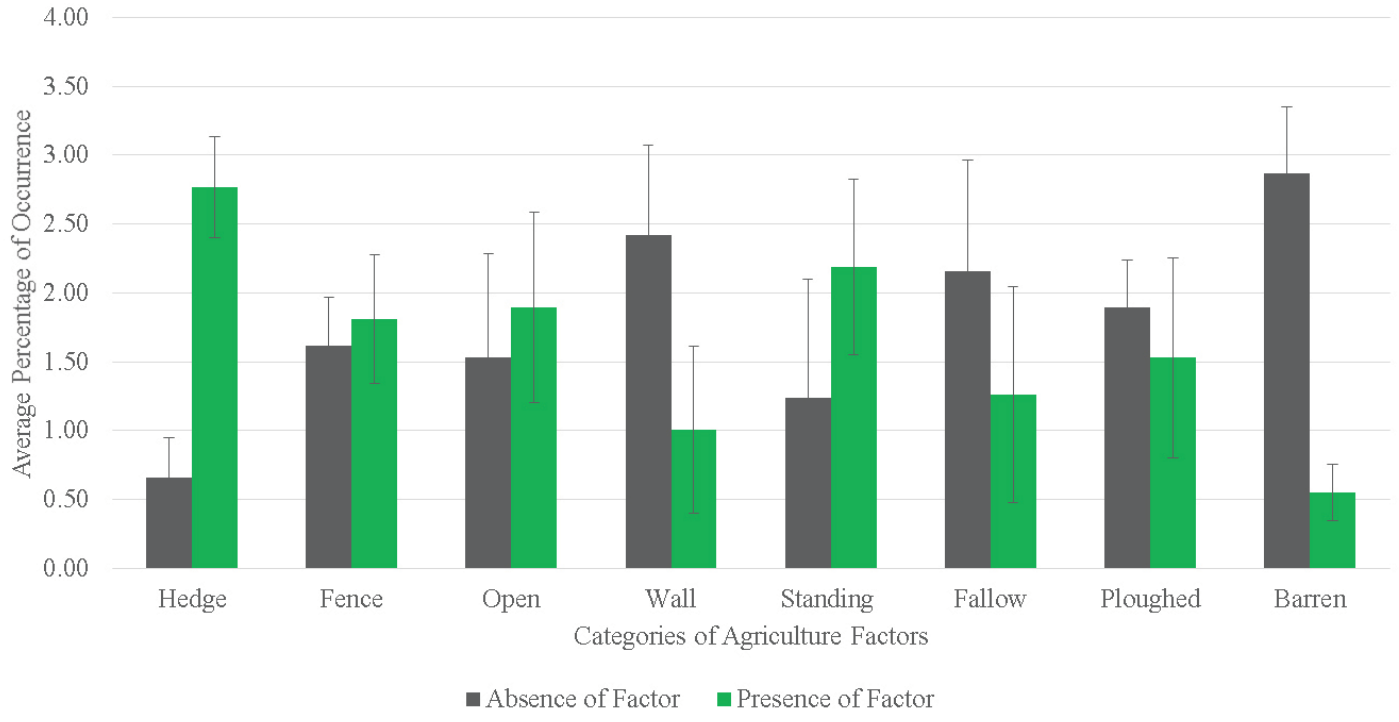


Fig. 7. Effect of different agriculture factors on the occurrence of Grey Francolin



(1.83±0.61). In the case of castor (*Ricinus communis*), its use was maximum during summer and monsoon where it also remained almost constant with an average occurrence (1.85±0.78) and (1.85±0.95) respectively. It reduced significantly in post-monsoon with an average occurrence (0.72±0.58) and again increased during winter with an average occurrence (1.71±1.06). The use of cotton (*Gossypium herbaceum*) was maximum during summer with an average (2.93±1.09) and post-monsoon (2.90±1.23) but the difference was not significant. It reduced significantly in monsoon with an average (1.53±1.19) and winter (1.55±0.98), but the difference was not significant. The use of dates (*Phoenix dactylifera*) and pomegranate (*Punica granatum*)

orchards was higher in monsoon with an average (0.37±0.28) and (1.13±0.65) respectively. Moreover, date fields were also used in post-monsoon with an average occurrence (0.36±0.14) but were completely avoided in summer and winter. Pomegranate fields were used in summer and winter, with an average occurrence (0.31±0.23) and (0.44±0.26) respectively. They were avoided in post-monsoon. The use of the millet (*Pennisetum glaucum*) fields significantly increased from an average occurrence in summer (0.31±0.25) to (0.74±0.18) in monsoon and (2.17±1.37) in post-monsoon. It was absent in winter because it is harvested at the end of post-monsoon. Sorghum (*Sorghum bicolor*) was used in all seasons, but the average occurrence was lowest in summer (0.98±0.52) which significantly increased in monsoon (2.61±1.60), post-monsoon (3.26±1.51) when it was used maximum; and reduced in winter (1.43±1.19). The usage of wheat (*Triticum aestivum*) was lowest in post-monsoon with an average occurrence (0.36±0.28) which increased to (4.74±2.94) in winter and reduced to (2.28±1.63) in summer. Green-gram (*Vigna radiata*) was recorded only once and therefore the average occurrence of species could be noticed only in post-monsoon with an average occurrence (0.36±0.23).

Influence of other agriculture factors on the occurrence of species:

There are many other factors like boundary type of agriculture field, the status of crop and soil that may influence the occurrence of species, therefore we tested the average occurrence of species in all seasons against the presence and absence of such factors (Fig 7). The significance of data and null-hypothesis were tested with ANOVA and Chi-square (R^2 0.78, CI 95%, p-value 0.57, alpha 0.95).

With respect to the types of boundaries, we found that the occurrence of species was significantly higher in the presence of hedge (2.77±0.37), absence of wall (2.42±0.65), presence of fence (1.81±0.47) and presence of open boundaries (1.89±0.69). The status of the crop (standing/fallow) significantly influences the occurrence of species, as it was higher in the presence of standing crop (2.19±0.63) and absence on fallow land (2.16±0.80). There was no significant difference in the occurrence of species due to presence (1.53±0.73) or absence (1.89±0.35) of the ploughed field, but its occurrence significantly reduced in the presence of the barren field (0.55±0.21).

DISCUSSION:

Higher number of calls was encountered in summer and post-monsoon which is also the breeding season of the species, and it corelates with the season described by Ali (1945). The calling behaviour observed in this study correlates with observations of Himmatsinhji (1959, 1987, 1999) and Rana *et al.* (2007) who found the GF to be more vocal during the breeding season.

In our study, the average encounter rate of calls across all seasons was higher than the direct sighting. It is possibly due to the skulking nature and ability of the GF to camouflage in different conditions (Fuller *et al.*, 2000). The males are known to stay in the proximity of the nest to give alarming calls in case of threat (Khalil *et al.*, 2016 a,b) and they also call from roosting sites (Rana *et al.*, 2007; Khalil, 2015). An earlier study by Khan (1989) from Pakistan also reveals that males call from the dense vegetation. Thus, in areas with more vegetation cover and height, the authors found that the cue-based method was more reliable to check the presence of the species. This suggestion contradicts the result by Khalil (2015) but the difference in habitat types and structure could be responsible for it.

It was found that a very low portion of the total sightings was distinguished as male or female. The authors assume that the lower percentage of male and female in the total data could be due to two reasons 1) shy and skulking nature of the species does not allow longer observation to check the spurs 2) height of ground vegetation, especially from July to November, obstructs the visibility of a male's spur. Moreover, reduction in the sightings of female from summer to winter is possibly due to the nesting/incubation activity in this period, when the females are less active and keep away from covey (Himmatsinhji, 1999). Authors also assume the possibility of female mortality during the incubation period as observed in *P. perdix* by Bro *et al.* (2001, 2005), but it requires further study. It was also observed that the females were more vigilant and skulker, especially in the presence of chicks or juveniles which reduces the possibility of sightings.

During various random visits in Kutch, authors have observed the presence of young chicks with the female outside its known breeding season (Feb-October). It is assumed that a few pairs are breeding in winter either due to the failure of the previous clutch or easy availability of resources, but this requires further study. Two breeding peaks from March to May) and August

to October were observed. The maximum sightings of chicks were in the summer followed by post-monsoon. The results match with the earlier study from Pakistan, where maximum chicks (70-80%) were observed during February to May and breeding activities was observed till August (Khan & Mian, 2013) with a very low density in winter (Khan, 2010).

Our study shows that the overall occurrence of the species was positively influenced by the habitat with a mosaic of bushes, agriculture and grassland. In summer, GF preferred taller vegetation like bushes, woodland and agriculture. It matches with earlier studies in India by Kidwai *et al.* (2011) and in Pakistan by Hussain *et al.* (2012) and Khalil & Anwar (2016), where woodland has been highlighted as a preferred habitat of the species. In this study, *Prosopis juliflora*, *Prosopis cineraria* and *Acacia nilotica* were the major species of woodland. Importance of *P. juliflora* for the Grey Francolin has been highlighted in earlier correspondence by Khan (1989) in Pakistan and Tiwari (1999) in Kutch, while the importance of *A. nilotica* was highlighted in the other studies in India and Pakistan both (Sharma, 1983; Sangha, 1987; Roberts, 1991; Khalil, 2015).

Khan and Mian (2012) studied the species in similar habitat in Pakistan and found that GF prefers insects and a variety of plant matter during summer. The current study also leads to a prediction that such a variety of plant matter and insects can be obtained only in agriculture fields, especially during the dry season of Kutch and therefore is more biased towards agriculture areas in this site. The earlier studies also revealed that the GF does not prefer proximity to water sources as they fulfil their water requirement from dew, insects and juicy vegetation (Yeatter, 1934; Mc Crow, 1982; Ullah, 1991; Mian and Wajid, 1994; Kamal, 2000, Hussain *et al.*, 2012). However, the studies carried out in similar habitat at Pakistan found that GF occurred near permanent water sources in summer during daylight (Roberts, 1991), while Kakakhel (2013) found that more than half of the total population was found near (75-100 m) a permanent water source. In this study, the permanent water sources were either the village ponds or irrigated agriculture fields.

In summer, the use of castor followed by alfalfa was maximum, followed by wheat and cotton. Our result matches with the earlier studies where these crops have been mentioned as one of the most preferred crops by the species (Bump & Bump, 1964; Johnsgard, 1988; Rana *et al.*, 2012). The higher preference for castor is possibly to shelter from heat. Castor cultivation is less dense than alfalfa and wheat, which provides good opportunity to rest on the ground during the afternoon heat as described by Mahmood *et al.* (2010). These circumstances justify the occurrence of species in the proximity of agriculture fields with alfalfa, castor, cotton, sorghum and wheat.

Kutch receives most of its precipitation between July to September when the grass cover and its height will be at maximum, and most of the croplands will also have standing crops. It matches with the grass and agriculture biased preference of the species in monsoon. Secondly, the chicks born in summer also need cover to escape predators, and therefore the skulking mother keeps them in the vicinity of grasslands and agriculture where suitable food and cover are available (Bump & Bump, 1964; Rana *et al.*, 2012). During monsoon, post-monsoon and early winter, species occurred more in woodland, bushes and grassland. The woodland also provides roosting perch which offer safety from the ground predators. Post-monsoon is also the season of crop harvesting that increases anthropogenic activities in the agriculture field. This coincides with the second peak of the breeding season, so birds keep away from the disturbance and prefer to breed in nearby bushes or woodland.

In winter, the higher occurrence in agriculture was possibly due to the presence of crops like wheat, sorghum, castor and alfalfa. The earlier studies also suggest that wheat and sorghum are preferred by the species (Rana *et al.*, 2012; Khalil, 2015). The usage of alfalfa and wheat seems more suitable as the accessibility to the grains in the wheat field and the soft shoots/fresh leaves in the alfalfa field is much higher in comparison to the other crops (DG, 2018, *pers. observ.*). Secondly, the presence of these two crops in winter and summer also plays a pivotal role because during this time few food resources offering grains are available. The usage of sorghum and millet was less due to the lesser availability in summer. In the case of pomegranate orchards, the frequent movement of farmers during summer possibly keeps the birds away (DG, 2018, *pers. observ.*).

During monsoon, the occurrence in agriculture fields with millet, pomegranate, sorghum and dates increased while there was a decline in the usage of alfalfa and castor. This was possibly due to the availability of the

other crops during the season. A sudden rise in the usage of fields having pomegranate and dates was mainly due to the lesser disturbance in these fields because in all the other fields activities like ploughing, levelling, seed sowing etc. was in progress. In post-monsoon, crops like cotton, green-gram, millet and sorghum are grown and therefore, species were found in its vicinity. The month of November has been considered as the post-monsoon season and therefore it shows the presence of wheat in the season. During winter, the occurrence was more around wheat, pomegranate and castor. There is a gradual increase in the pomegranate cultivation since last few years in Kutch, an increase in such monoculture based farming may reduce the overall diversity (DG, 2018, *pers. observ.*), but this requires further study. As the study area had irrigated farming, green-gram was rarely seen and therefore, was not reported except during post-monsoon.

Various factors like presence of agriculture fields, crop pattern, the existence of hedgerows are important for francolin and partridges; alteration in any of these factors and over use of modern and mechanised farming techniques, may affect the partridge population (Henry, 1971; Potts, 1986; Rands, 1986; Meriggi *et al.*, 1990; Aebischer *et al.*, 1994; Potts & Aebischer, 1995; Panek, 1997; Bro *et al.*, 2008). The study by Khalil (2015) has also highlighted agriculture as one of the major threat to the GF in Pakistan. In this study, the species appeared to be biased towards agriculture areas. Therefore, along with the crop pattern, it was important to understand the other factors associated with agriculture which may be responsible for such preference by the species.

The result of this study shows that in context to the type of boundary of the agriculture field, the species occurred more in the areas where the hedge was present. It also preferred open boundary fields. The presence or absence of fence was not affecting the occurrence of the species. Authors assume that this is possibly due to the presence of different vegetation on hedge and fence as well, which becomes an important shelter for the species. Such vegetation is lower in the wall and open boundary, which could be the reason behind avoiding such areas. The presence of wall negatively influenced the occurrence. However, the authors have seen male GF using walls as perch to call and to keep vigilance. It was also observed that predators like dog (*Canis familaris*), cat (*Felis catus*), shikra (*Accipiter badius*), crow (*Corvus splendens*), greater coucal (*Centropus sinensis*), grey mongoose (*Herpestes edwardsii*) and small Indian mongoose (*Herpestes auropunctatus*) were using walls to stalk the prey, including francolins. Therefore, author assumes that the absence of vegetation on the wall, risk of predation, difficulty in ground movement could be some reasons behind the lower preference by the species. Similarly, the standing crop provides food and shelter to the species therefore the occurrence was higher in it than the fallow land. The presence of barren field negatively influenced the occurrence due to the unavailability of food and shelter. The presence and absence of the ploughed field did not show a significant difference on the occurrence, but, birds avoided the ploughed field as it reduced the access to fallen grain and also exposed them to predators. GF prefers to run than fly from the predators, the ploughed field makes it difficult for the birds to run on uneven terrain which also could be a reason behind such preference.

CONCLUSION:

In this study, the occurrence of GF is significantly biased towards bushes, woodland, agriculture areas and grasses. The preference for agriculture is possibly due to the availability of food and water. It showed high preference to farms having crops like wheat, alfalfa, sorghum and millet. The study suggests that the species prefers habitats with hedgerows. The rapid expansion of monoculture system with uncontrolled use of modern machines may result in widespread biodiversity loss. Therefore, the following recommendations are made for the conservation of francolins at such sites. 1) It is important to have areas with a mosaic of habitats like woodland, scrub forest, grassland and cropland 2) The hedgerows with its perennial vegetation/hideout are very crucial for francolins. Replacement of hedgerows with fence or wall may negatively affect the species. Farmers should be promoted to grow hedgerows with some incentive scheme 3) Instead of monoculture of cash-crops, organic farming of traditional crops can be promoted to reduce the negative impact on biodiversity 4) Research on the common farmland birds who play a very important role in the ecosystem should be promoted.

ACKNOWLEDGEMENT:

We thank Dr. Ashish Shukla, Head of Zoology Department, Sir P P Institute of Science, Maharaja Krishnakumarsinhji Bhavnagar University (MKBU) and Dr. Asad Rahmani, Scientific Advisor of The

Corbett Foundation (TCF) for technical support. The authors are grateful to local birdwatchers viz. Shantilal Varu, Prasad Ganpule, Navinbhai Bapat and J. K. Tiwari. We also thank Dhara Dixit, Dr. Sutirtha Dutta, and Dushyantsinh Jhala.

AUTHOR CONTRIBUTION:

Devesh Gadhavi, the Corresponding author, did the majority of the work as part of his PhD research. The original idea, design of the study, field survey, data collection, data analysis and writing of the manuscript were done by the corresponding author under the supervision of Dr. P. P. Dodia. Kedar Gore and Dr P. P. Dodia contributed in writing part of the manuscript and provided valuable guidance during the field survey. Dr Indra Gadhvi shared his knowledge about natural history of GF and contributed in data analysis and manuscript writing.

REFERENCE

- Aebischer, N.J., Blake, K.A., & Boatman, N.D. (1994). Field margins as habitats for game. MONOGRAPHS-BRITISH CROP PROTECTION COUNCIL, 95-95.
- Ahmed, A. (2019). Live Bird Trade in India. *Hornbill* (January-March), Bombay Natural History Society, Mumbai.
- Ali, S. (1945). *The birds of Kutch*. 1st ed. Kutch; Bombay: Government of Kutch; Oxford University Press.
- Ali, S., & Ripley, S.D. (1983). *Handbook of birds of India and Pakistan*.Compact Ed.Oxford University Press, Bombay.
- Balar, R.B. (2007). *A photographic field guide to the birds of Gujarat for amateurs*. Papillion. Pp1-342.
- Beg, M.A., & Qureshi, J.I. (1972). Birds and their habitats in the cultivated areas of Lyallpur district and vicinity. Pakistan *Journal of Agricultural Sciences*, 9, 161-166.
- BirdLife International. (2018). Francolinus pondicerianus. *The IUCN Red List of Threatened Species* 2018: e.T22678728A131904182. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22678728A131904182.en. Downloaded on 23 May 2020.
- Bock, W.J., Farrand J.Jr. (1980). The number of species and genera of recent birds: a contribution to comparative systematics. *American Museum Novitates* 2703: 1–29.
- Bro, E., Reitz, F., & Landry, P. (2005). Grey partridge Perdix perdix population status in central northern France: spatial variability in density and 1994–2004 trend. *Wildlife Biology*, 11(4), 287-298.
- Bro, E., Reitz, F., Clobert, J., Migot, P. & Massot, M. (2001). Diagnosing the environmental causes of the decline in Grey Partridge Perdix perdix survival in France. *Ibis*, 143(1), 120-132.
- Buckland, S.T. (2006). Point-transect surveys for songbirds: robust methodologies. *The Auk,* 123(2), 345-357.
- Bump, G. & Bump, J.W. (1964). A study and review of the black francolin and the grey francolin. *Spec. Sci. Rep. Wildlife.* No. 81. US Department of the Interior, Bureau of Sport Fisheries and Wildlife, Washington, D.C.
- Buner, F., Jenny, M., Zbinden, N., & Naef-Daenzer, B. (2005). Ecologically enhanced areas–a key habitat structure for re-introduced grey partridges Perdix perdix. *Biological Conservation*, 124(3), 373-381.
- Chaudhry, A.A., & Bhatti, M.N. (1992). Biology of Grey Francolin (Francolinus pondicerianus) in the central Punjab plains. *Proc. 12th Pakistan Cong. Zool. Zoological Soci.* Pakistan, Lahore, 161-162.
- Del Hoyo, J., Del Hoyo, J., Elliott, A., & Sargatal, J. (1992). *Handbook of the birds of the world* (Vol. 1, No. 8). Barcelona: Lynx edicions.
- Dharmakumarsinhji, R.S. (1955). *The Birds of Saurashtra*. Times of India Press, Bombay.
- Dutta, S., Bhardwaj, G.S., Bhardwaj, D.K., Jhala, Y.V. (2014). *Status of Great Indian Bustard and Associated Wildlife in Thar.* Wildlife Institute of India, Dehradun and Rajasthan Forest Department, Jaipur.
- Fuller, R.A., Carroll, J.P., & McGowan, P.J. (Eds.). (2000). *Partridges, quails, francolins, snowcocks, guineafowl, and turkeys: status survey and conservation action plan 2000-2004 (Vol. 54)*. IUCN.
- Ganpule, P. (2016). The birds of Gujarat: Status and distribution. *Flamingo* 8 (3)–12 (4): 2–40.
- Grimmett, R., Inskipp, C. & Inskipp, T. (2011). *Birds of the Indian Subcontinent.* 2nd ed. Christopher Helm & Oxford University Press. London. Pp. 1-528
- Henry, G.M. (1971). *A Guide to the Birds of Ceylon,*

de Silva and Sons, Kandy, Sri Lanka, 457 pp.
- Hilaluddin and Kaul, R. (2007). Galliformes Hunting in India : The Bigger Picture. (IN) Sathyakumar, S. and K. Sivakumar (Eds.). Galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas,* Vol. 10 (1). Wildlife Institute of India, Dehradun,India. Pp 165-170.
- Hilaluddin, K.R., & Ghose, D. (2005a). Conservation implications of wild animal biomass extractions in Northeast India. *Animal Biodiversity and Conservation,* 28(2), 169-179.
- Hilaluddin, Kaul, R. and Ghose, D. (2005b). Galliformes extraction and use by indigenous people of Northeast India. In: *Proceedings of 3rd International Galliformes Symposium* (R. A. Fuller and S. Browne eds.). WPA-International, U.K., pp.72-76
- Himmatsinhji M K; (1959), The different calls of the Grey Partridge, Francolinus pondicerianus (Gmelin), *Journal of the Bombay Natural History Society*, 56:3: 632 - 633.
- Himmatsinhji M K; (1987), Partridges, *Newsletter for Birdwatchers*, 27:7-8: 16.
- Himmatsinhji M K; (1999), Koels and Partridges, *Newsletter for Birdwatchers*, 39:2: 24 - 26.
- Hussain, I.; Nisa, A. and Khalil, S. (2012). Population biology of Grey Francolin (Francolinus pondicerianus) in agroecosystem of the pothwar pleatue, Pakistan. *Journal of Chinese Birds* 2012, 3(2):91–102
- Ilyas, O., Pandey, R.K., Khan, J.A. and Shah, J.N. (2005). Impact of grazing on Indian Peafowl Pavo cristatus in Chandraprabha Wildlife Sanctuary, India. (IN): Fuller, R.A. and Browne, S.J. (Eds). *Galliformes 2004. Proceedings of the 3rd international Galliformes Symposium.* World Pheasant Association, Fordingbridge, UK. P.160-167.
- Islam, K. (1999). Erckel's Francolin(Francolinus erckelii), Black Francolin(Francolinus francolinus), Gray Francolin(Francolinus pondicerianus). *The Birds of North America*, (394), 24.
- IUCN (2020). The IUCN Red List of Threatened Species. Version 2020-1. <https://www.iucnredlist.org>
- Johnsgard, P.A., & Jones, H. (1988). *Quails, Partridges, and Francolins of the World*. Oxford University Press. Oxford
- Kakakhel, F.Z. (2013). Habitat selection of Grey Francolin in Sweagali game reserve of Swat district Kyhber Pakhtunkhwa province of Pakistan. *The Pakistan Journal of Forestry* : 63 (1), 37-44.
- Kalsi, R.S. (2005*). Ecology of Grey and Black francolins with special reference to the effect of pesticides and land use practices in northern India.* University Grants Commission, New Delhi, India. 1-167.
- Kalsi, R.S. (2007). *Status, distribution and management of Galliformes in arid and semi-arid zones of India. Galliformes of India*, 101-104.
- Kalsi, R.S. and Rana, S. (2004). *Habitat preferences of breeding Grey francolins in agricultural landscape.* Third International Galliformes Symposium – 2004. April 5 – 10, 2004, Wildlife Institute of India, DehraDun, and Corbett National Park, Uttaranchal, India.
- Kamal, S. (2000). *Population status, distribution pattern and habitat of Grey Partridge (Francolinus pondicerianus) in district Mardan*. Dissertations, Pakistan Forest Institute, Peshwar, p 50.
- Kasprzykowski, Z., & Goławski, A. (2009). Does the use of playback affect the estimates of numbers of grey partridge Perdix perdix?. *Wildlife biology,* 15(2), 123-128.
- Kaul, R. (2007). Conservation of Galliformes in the Indian Himalaya. (IN) Sathyakumar, S. and K. Sivakumar (Eds.). Galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas*, Vol. 10 (1). Wildlife Institute of India, Dehradun, India. Pp 95-99.
- Khalil, S., & Anwar, M. (2016). Habitat preference of Grey Francolin (Francolinus pondicerianus) in Salt Range, Punjab. JAPS, *Journal of Animal and Plant Sciences*, 26(3), 842-849.
- Khalil, S., Anwar, M., & Hussain, I. (2015a). Threats Affecting Grey Francolin (Francolinus pondicerianus) Population in Salt Range, Punjab. Pakistan *International Journal of Sciences: Basic and Applied Research* (IJSBAR) Vol. 24, No 1, pp 386-401
- Khalil, S., Anwar, M., & Hussain, I. (2015b). Population Estimation of Grey Francolin (Francolinus pondicerianus) in Salt Range, Punjab, Pakistan. *Pure and Applied Biology,* 4(4), 584-596
- Khalil, S., Anwar, M., & Hussain, I. (2016a).

Breeding biology of grey francolin (Francolinus pondicerianus) in salt range, Pakistan. *Pakistan Journal of Zoology*, 48(1).

- Khalil, S., Anwar, M., Hussain, T., Rafay, M., Ashraf, I., Abdullah, M., ... & Rasool, A. (2016b). Food Composition of the Grey Francolin Francolinus pondicerianus in the Salt Range, Punjab, Pakistan. Journal homepage: www. wesca. net, 11(1).
- Khalil, Sangam (2015). *Habitat preference and breeding biology of Grey Francolin (Francolinus pondicerianus) in Salt Range, Punjab. PhD Thesis.* Department of Wildlife Management, Faculty of Forestry, Range Management and Wildlife, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan. Downloaded from Pakistan Research Repository (PRR) an initiative of Higher Education Commission, Islamabad. http://prr.hec.gov.pk/jspui/bitstream/123456789/6873/1/Sangam_Khalil_Wildlife_Management_PMAS_2015.pdf
- Khan, R.A. (1989). Status and ecology of Grey and Grey francolins in agricultural land in Pakistan. *Newsletter of the Partridge, quails and Francolins Specialist Group*. 8: P 3-4.
- Khan, W.A. (2010). *Studies on the comparative ecology of the south Persian Black Partridge, Francolinus francolinus henrici, and the northern Grey Partridge, Francolinus pondicerianus interpositus,* in Lal Suhanra National Park, Bahawalpur, Punjab, Pakistan (Doctoral Dissertation, Pir Mehr Ali Shah. Arid Agriculture University Rawalpindi, Pakistan).
- Khan, W.A., & Mian, A. (2012). Food of Grey Francolin (Francolinus pondicerianus interpositus) with Remarks on Competition with Black Francolin (Francolinus francolinus henrici) in Lal Suhanra National Park (Pakistan). *Pakistan J. Zool*, 44(4), 1099-1109.
- Khan, W.A., & Mian, A. (2013). Comparative population biology of black (Francolinus francolinus) and grey (F. pondicerianus) Francolins under Lal Suhanra National Park (Pakistan) conditions. *Pakistan J Zool*, 45, 949-958.
- Kidwai, Z. (2013). Effect of anthropogenic factors on the abundance of Galliformes in Sariska Tiger Reserve, Rajasthan, India. *Avian Ecol. Behav*, 23, 3-13.
- Kidwai, Z., Sankar, K., Qureshi, Q., & Khan, J.A. (2011). Abundance and habitat utilisation by Galliformes in the Sariska Tiger Reserve, Rajasthan, India. *International Journal of Galliformes Conservation,* 2, 54-60.
- Mahmood, S., Mahmood, T., Rais, M., Qureshi, I. & Nadeem, M.(2010). A comparative study on the populations and habitats of the Grey Francolin Francolinus pondicerianus and the Black Francolin Francolinus francolinus in Lehri Nature Park, Punjab, Pakistan. *Podoces*, 5(1), 42-53.
- Mandiwana-Neudani, T. G., Little, R. M., Crowe, T. M. & Bowie R. CK. (2019). Taxonomy, phylogeny and biogeography of African spurfowls Galliformes, Phasianidae, Phasianinae, Coturnicini: Pternistis spp., *Ostrich*, 90:2, 145-172, DOI: 10.2989/00306525.2019.1584925
- Mc Crow VP. (1982). *Grey partridge habitat use and nesting biology in north central Iowa*. Dissertations, Iowa State University, Ames, p 239.
- Meriggi, A., Montagna, D., Zacchetti, D., Matteucci, C., & Toso, S. (1990). Population dynamics of the gray partridge in relation to agriculture and weather in northern Italy. In *Perdix V: gray partridge and ring-necked pheasant workshop*. Kansas Dept. of Wildlife and Parks, Emporia (pp. 241-256).
- Mian, A. (1995). Grey partridge demands intensive study. *WPA News*, 1(2).
- Mian, A., & Wajid, M. M. (1994). Food of grey francolin(Francolinus pondicerianus) in Layyah district(southern Punjab, Pakistan). *Pakistan J. Zool*, , 26(2), 185-187.
- Parasharya, B.M., Borad, C.K. & Rank, D.N. (2004). *A Checklist of Birds of Gujarat*. Bird Conservation Society, Gujarat.
- PECBMS, (2007). *State of Europe's Common Birds*, 2007. CSO/RSPB, Prague, Czech, Republic.
- Potts, G. (1986). *The partridge: pesticides, predation and conservation*. Collins. London. 274 pp.
- Potts, G.R., & Aebischer, N.J. (1995). Population dynamics of the Grey Partridge Perdix perdix 1793–1993: monitoring, modelling and management. *Ibis*, 137, S29-S37.
- Praveen J., Jayapal, R., & Pittie, A., (2019). *Checklist of the birds of India* (v3.1). Website: http://www.indianbirds.in/india/ [Date of publication: 16 December, 2019].
- Rahmani, A.R., Kalra, M., & Khan, N.I.

(2012). *Threatened birds of India: their conservation requirements*. New Delhi, India: Oxford University Press.
- Rana, S. (2012). Home range and habitat selection of Grey francolin (Francolinus pondicerianus) using radiotelemetry. *Indian Journal of Applied Research*, Vol.I, Issue.XI August, 120-122.
- Rana, S., Kalsi, R.S. & and Gupta, R.C. (2007). *Calling behaviour of Grey francolin (Francolinus pondecerianus) in district Yamuna Nagar, Haryana, India*. PQF news: newsletter of the partridge, quail and francolin specialist group, 22: 13-15.
- Rana, S., Kalsi, S., & Burra, M. R. (2012). Home Range Comparison of Male and Female Grey Francolin (Francolinus pondicerianus) Using Radiotelemetry. *Records of the Zoological Survey of India,* 112(3), 13-18.
- Rands, M.R.W. (1986). Effect of hedgerow characteristics on partridge breeding densities. *Journal of Applied Ecology*, 479-487.
- Rasmussen, P.C. & Anderton, J.C. (2012). *Birds of South Asia: the Ripley guide*. 2nd ed. Washington, D.C. and Barcelona: Smithsonian Institution and Lynx Edicions. 2 vols. Pp. 1–378; 1–684.
- Roberts, T. J. (1991). *The Birds of Pakistan. Non-Passeriformes*. Oxford University Press. Karachi, 1, 598.
- Sangha HS; (1987), Roosting habits of Grey Partridge, *Newsletter for Birdwatchers*, 27:7-8: 15.
- Sathyakumar, S., & Sivakumar, K. (2007). galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas,* 10(1), 252.
- Sathyakumar, S., Kaul, R., Kalsi, R. (2007). Techniques for Monitoring Galliformes in India. (IN) Sathyakumar, S. and K. Sivakumar (Eds.). Galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas,* Vol. 10 (1). Wildlife Institute of India, Dehradun, India. Pp 179-184.
- Sharma IK; (1983), The Grey Partridge (Francolinus pondicerianus) in the Rajasthan desert, *Annals Arid Zone*, 22:2: 117 - 120.
- Sinha, S. and Chandola, S. (2007). Status, Distribution and Management of Galliformes in Uttarakhand. (IN) Sathyakumar, S. and K. Sivakumar (Eds.). Galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas*, Vol. 10 (1). Wildlife Institute of India, Dehradun,India. Pp 121-124.
- Sotherton, N. W., Aebischer, N. J., & Ewald, J. A. (2010). *The conservation of the grey partridge. Silent summer: the state of wildlife in Britain and Ireland.* Cambridge University Press, Cambridge, 319-336.
- Tiwari, J. K. (1999). Large clutch size in Grey Francolin (Francolinus pondicerianus). *Newsletter for Birdwatchers,* 38(6), 105.
- Yeatter, R.E. (1934). The Hungarian partridge in the Great Lakes Region. Bull. No. 5. *Ann Arbor: University of Michigan School of Forestry and Conservation*. 92 pp.

Assessment of grass species indices and wild animals occurrence in evacuated site of the Tadoba-Andhari Tiger Reserve, Maharashtra, Central India

Anil Kumar Dashahre[1] Ranu Singh[2] RP Mishra[3]
1& 3- Department of Biological Science, Rani Duragavati University, Jabalpur, Madhya Pradesh -482001.
2- Mata Gujri Mahila Mahavidyalaya, Civil Centre, Marhatal, Jabalpur, Madhya Pradesh – 482001.
Corresponding author email- anildashahre@gmail.com (Anil Kumar Dashahre)

Citation: **Dashahre Anil Kumar, Ranu Singh, RP Mishra**(2020). Assessment of grass species indices and wild animals occurrence in evacuated site of the Tadoba-Andhari Tiger Reserve, Maharashtra. Central India. *Ela Journal of Forestry and Wildlife Vol.9* Part 1 *(3): 703-711*

Date of Publication:
30 September 2020

ISSN 2319-4361

Abstract

Tropical dry grasslands in the central Indian landscape are popularly known as Savana type grasslands. Tadoba-Andhari Tiger Reserve (TATR) with an area of 625.42 sq km along the river Andhari and Erai is a prime tiger habitat of eastern Vidharbh landscape in the state of Maharashtra. Four village evacuated sites from 2 ranges were selected for the present study *i.e.* Jamni, Navegaon, Panderpouni (Tadoba range) and Botezari (Kolsa range). Presence of prey species were assessed using 1-0 sampling method and camera traps were used to enumerate the capture rate of carnivore species using mark- recapture framework in the study sites. 14 grass species communities were identified from the evacuated area of TATR. The Importance value index (IVI) result showed that the grass species with high importance values differs from site to site. It is commonly found (wide niches) in all dry deciduous forests. Hence, the IVI of *Ischaemum indicum, Dichanthium annulatum, Themeda triandra, Cynodon dactylon, Iseilema laxum, Chloris dolichostachya* and *Apluda mutica* was greater than other species across the four sites. Results of camera traps and sign survey revealed that the large carnivores like Tiger, Leopard, Wild dog, and Sloth bear, has occupied sympatrically in these areas. Chital, Sambar and Gaur were the most abundant species in these grasslands and frequently using these grasslands for grazing. Study signifies the elimination of anthropogenic pressure from protected areas as an effective management tool for the sustainable habitat management and wildlife conservation.

Keyword
Grasslands, Habitat, Relocation, Sympatric animals, Tadoba-Andhari Tiger Reserve

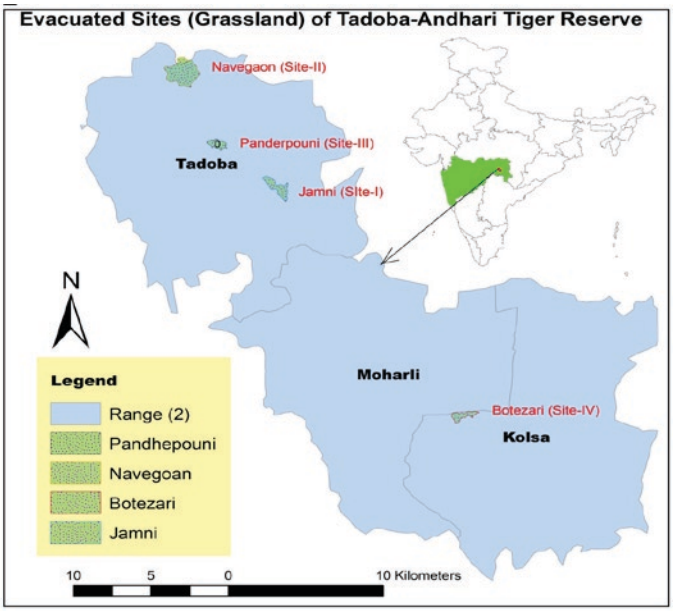


Figure 1. Map showing evacuated sites and Tadoba-Andhari Tiger Reserve in Maharashtra.

1. Introduction- Grasslands advanced under an arrangement of munching, dry spell and occasional fire and, practically all the current grasslands are kept up by both of these or a blend of every one of these variables. The peak grasslands should be missing in India (Whyte, 1974; Champion and Seth, 1968; Blasco, 1983) [35, 6, 2], however grasslands as 'auxiliary seral' stage are normal (Champion and Seth, 1968) [6]. These grasslands can likewise be steady under the impact aggravation factors like grazing, dry season and fire, henceforth, these have been called by various names like disclimax (Misra, 1968) [28], or preclimax (Champion and Seth, 1968) [6] or as subclimax (Singh et al. 1985) [28].The Tadoba-Andhari Tiger Reserve (TATR) has shown a magnificent enhancement in terms of the overall physical condition of a habitat. This is well reflected by the persistent and getting higher sightings of the large cats in the reserve. As a part of the authorization of the National Tiger Conservation Authority, most of the core critical areas should be free from human disturbance. In order to accomplish this goal, the TATR authorities and the Maharashtra Government has been very keen on aiding the relocation of villages from core areas of TATR.

Wildlife conservation planning requires essential data on distribution and abundance of natural resources. Prey and predator species play a vital role in maintenance of grassland ecosystem equilibrium, as they help in shaping its distribution, population and also directly or indirectly affect other animals (Crawley 1983; Kortlandt 1984; Owen & Smith 1987; Naimann 1988) [7, 18,30,29]. Maintaining viable populations of wild ungulates and carnivore species is the goal of protected area management. Ungulates form the major component of the diet of large carnivores, hence are crucial for survival of predators. Proper ungulate management requires a good understanding of all aspects of its population dynamics. Therefore, ecological monitoring of ungulate and carnivores populations is a vital component of any conservation task (Kremen et al., 1994) [19]. Several techniques and procedures are accessible for such checking (Rodgers, 1991; Brochers et al., 2002) [31, 4]. Population, structure and biomass are the measures to analyze the mind boggling connections among species and its condition (Eisenberg & Seidensticker 1976; Brown 1984) [11, 5]. Many studies have been conducted to estimate the prey density and have proposed conservation practices for wild animal species (Berwick 1974, Seidensticker 1976, Johnsingh 1983 and Sankar 1994) [33, 16, 32].

The study area represents a characteristic tropical dry deciduous ecosystem. Earlier attempts have been made on floristic studies, qualitative description of vegetation and ecological interactions between habitat parameters and wild ungulate abundance in TATR (Haines 1916; Malhotra & Moorthy 1972, 1992; Kunhikannan et al. 1993, 1994, 2007, 2013; Kunhikannan 1999; Dubey

& Mathur 1999, 2000) [15, 26, 27, 24, 22, 25, 23, 21, 10, 9]. Present study deals with a detailed study on grass species indices and habitat used by wild animal in evacuated sites of TATR.

2. Material and methods

2.1-Study Area: TATR is situated in the Chandrapur district in the eastern part of Maharashtra state, between 20°04'53"N to 20°25'51"N and 79°13'13"E to 79°33'34"E. It encompasses of a National Park and a wildlife sanctuary that extends over 625 km^2, covering a landscape that is an interspersion of grasslands and grass patches, water bodies and dry tropical deciduous forests along with bamboo thickets. The land vegetation is southern tropical dry deciduous (Champion and Seth, 1968) [6] type having Bamboo (*Dendocalamus strictus*) and Teak (*Tectona grandis*) as dominant species. Some of the other major tree species found within the protected area are Ain (*Terminalia tomentosa*), Arjun (*Terminalia arjuna)*, Behada (*Terminalia bellirica)*, Bija (*Pterocarpus marsupium)*, Bhera (*Chloroxylon swietenia)*, Bor (*Zizyphus mauritiana)*, Bel (*Aegle marmelos)*, Chichwa (*Albizzia labbeck)*, Dhawada (*Anogeissus latifolia)*, Kusum (*Schleichera oleosa)*, Mahua (*Madhuca indica)*, Mowai (*Lannea grandis)*, Rohan (*Soymida febrifuga)*, Salai (*Boswellia serrata)*, Semal (*Bombax ceiba)*, Bija (*Baccnania lenzan)*, Tendu (*Diospyros melanoxylon)* and Kulu *(Sterculia urens*) etc. .

Major carnivores in the area are Tiger (*Panthera tigris tigris*), Leopard (*Panthera pardus*),and Dhole (*Cuon alpines*). Among ungulates Chital (*Axis axis*), Sambar (*Rusa unicolor*), Gaur (*Bos gaurus*), Barking deer (*Muntiacus muntjak*), Chowsingha (*Tetracerus quadricornis*), Nilgai (*Boselaphus tragocamelus*) and omnivores such as Sloth bear (*Melursus ursinus*) and Wild pig (*Sus scrofa*) are common. The reserve is surrounded by two rivers, the Erai River in the west and the Andhari River in the east. The northern section is undulating in topography, with the foothills of the Chimur range gradually giving way to the plains as one moves south. The tiger reserve is interspersed with water bodies of different size among them Tadoba and Kolsa lake are the largest. Most of the annual rainfall (1175 mm) is received between June and September. Temperature varies from a minimum temperature of about 3°C in December and a maximum of about 48°C in May.

The present study has been conducted in TATR from June 2014 to October 2015. Under the management plan of Tiger reserves, several villages has been relocated from Tadoba and Kolsa ranges of TATR in order to avail more area and protection to wildlife. The objective of the present study was to analyze the occupancy pattern of sympatric carnivores in four major grasslands (3 in Tadoba Range and 1 in Kolsa range) of TATR after the voluntary resettlement of the local communities. Thus, 4 such village evacuated sites were selected for the present study *i.e.* Jamni (Site I), Navegaon (Site II), Panderpouni (Site III, in Tadoba range) and Botezari (Site IV, in Kolsa range) (Fig. 1).

2.2-Sampling technique

2.2.1- Data Collection and analysis: General survey of recently evacuated village sites and some past evacuated village sites of TATR was done during peak growth period of the grassland vegetation i.e., in June 2014 to October, 2015. Since the objective of the survey was to have the general awareness with the vegetation structure of different grasslands in different localities of entire area of TATR. A stratified random sampling procedure was used in this study. Quadrate (1x1m) method (Braun- Blanquet, 1932) [3] was used to collect data for the study sites. Random quadrates were established within each sampling area. Number of grass species present in the quadrate were identified and recorded for analysis.

2.2.2- Vegetation analysis: Density, frequency, abundance of grasses and herbs within the quadrates were calculated. Importance value index from three parameters *viz* Relative abundance, Relative density and Relative frequency were also calculated (Curtis & McIntosh 1950) [8].

Relative Density (RD) = (Density of a species/Total Density of all Species) × 100
Relative Frequency (RF) = (Frequency of occurrence of the specie/Total frequency of all the species) × 100
Relative Abundance (RA) = Total number of individuals of a species in all quadrates /Total number of quadrates in which the species occurred.

2.2.3- Habitat use pattern by wild animals- A study was carried out to estimate the presence of wild animals in the area after relocation of villagers in Tadoba and Kolsa Ranges of TATR. We assessed the presence of prey species using 1-0 sampling and occupancy survey (direct and indirect sampling *i.e* pugmark, scat, scrape, rake, vocalization etc.) for carnivores. Sign surveys though the trails and routes in these grasslands were conducted to obtain indirect evidences about the wild animal's occurrence.

Further 24 pairs of automatic triggered cameras (Cuddle Back Attack and Moultrie D-55) were deployed at the 4 sites of grasslands for 20 days to enumerate the capture rate of carnivore species using mark-recapture framework (Karanth et al., 2005; Kumbhar 2012 ; Habib et. al. 2013 a & b, 2014) [17, 20, 13, 14, 12].

3. Results and discussion

A total of 50 grass species were recorded from the study sites. Jamni (Site I) had the highest number (33) of species, while Site IV and Site III, had the lowest number (23) of species due to degradation. Site III, past relocated site, had the highest value of species loss, followed by Site I and II which are recently relocated. Recently relocated areas were found to have high species diversity compared to the past evacuated areas. The fourteen different grass communities found during the study in TATR are provided in Table-1.

3.1- Importance Value Index- Based on adult population, there was a significant change in the phytosociological parameters of grass species across four sites. Fifty grass species showed high IVI in terms of their overall ecological dominance. It was further observed that the grass species with high importance values differed from site to site. The IVI of *Ischaemum indicum, Dichanthium annulatum, Themeda triandra, Cynodon dactylon, Iseilema laxum, Chloris*

Table- 1: Dominant grass communities present in grasslands of Tadoba-Andhari Tiger Reserve

no.	Dominant community types	grasslands code
1-	*Iseilema laxum- Ischaemum indicum -*	*Jamni, Navegoan,Panderpouni*
2-	*Themeda triandra- Seteria pumila-*	*Jamni, Navegoan*
3-	*Dichanthium annulatum- Iseilema laxum-*	*Jamni, Navegoan, Panderpouni*
4-	*Apluda mutica- Saccharum spontaneum-*	*Jamni*
5-	*Dichanthium annulatum- Heteropogon contrortus-*	*Jamni, Navegoan*
6-	*Cynodon dactylon- Ischaemum indicum-*	*Jamni, Navegoan, Botezari*
7-	*Themeda triandra- Dichanthium annulatum-*	*Navegoan*
8-	*Dichanthium annulatum- Eragrostis species-*	*Navegoan, Panderpouni*
9-	*Cynodon dactylon- Digiteria cliaris-*	*Navegoan, Jamni*
10-	*Imperata cylendrica- Coix Lamarchya jobi-*	*Botezari*
11-	*Chloris dolystyca- Themeda triandra-*	*Panderpouni*
12-	*Aristida stricts- Crysopogon fulvus-*	*Panderpouni*
13-	*Ischaemum indicum- Eragrostis uniloides-*	*Botezari, Navegoan, Panderpouni*
14-	*Coix Lamarchya jobi- Ischaemum indicum-*	*Botezari*

Table- 2: Importance value index (IVI) as obtained from the evacuated sites of TATR.

Sr. No.	Grass Species Name	IVI (Importance Value Index)			
		Jamni	Navegaon	Panderpouni	Botezari
1	*Apluda mutica L.*	9.45	12.62	4.67	-
2	*Aristida redacta Stapf*	-	2.31	-	-
3	*Aristida setacea Retz*	-	-	10.14	-
4	*Arthraxon hispidus (Thunb.)*	1.92	-	-	-
5	*Brachiaria ramosa (L.)*	1.08	-	-	-
6	*Chionachne koenigii (Spreng.) Thw.*	3.66	3.56	9.36	-
7	*Chloris barbata SW.*	1.66	2.67	-	-
8	*Chloris dolichostachya Lag.*	-	-	12.57	-
9	*Chrysopogon fulvus (Spreng.) Chiov.*	-	2.22	5.24	5.84
10	*Coix lacryma-jobi L.*	-	-	7.65	4.86
11	*Cynodon dactylon (L.) Pers.*	10.43	4.36	16.04	15.66
12	*Cyperus difformis L.*	0.61	-	-	-
13	*Cyperus tenuispica Steud.*	0.79	-	4.33	-
14	*Dactyloctenium aegyptium (L.) Willd.*	4.63	4.76	2.14	-
15	*Dichanthium annulatum (Forssk.) Stapf*	8.76	19.34	5.34	15.27
16	*Dichanthium coricosum (L.)*	1.08	2.44	3.71	1.79
17	*Digitaria abludens (Roem.& Schultes)*	-	3.47	-	-
18	*Digitaria bicornis (Lam.) Roem. &Schult.*	-	-	3.47	8.87
19	*Digitariaciliaris (Retz.)*	3.21	5.11	-	-
20	*Dimeria ornithopoda trin*	-	-	11.27	-
21	*Echinochloa colona (L.) Link*	2.60	1.56	-	0.92
22	*Echinochloa crusgalli (L.)*	-	1.29	-	-
23	*Eleocharis atropurpurea (Retz.) J. Presl & C. Presl*	1.30	-	2.46	-
24	*Eleocharis dulcis(Burm.f.) Trin. ex Hensch.*	-	-	6.55	-
25	*Eleusine indica (L.) Gaertn.*	2.53	-	-	-
26	*Eragrostis tenella*	1.34	7.60	3.87	-
27	*Eragrostis unioloides (Retz.) Nees ex Steud*	1.45	-	9.70	2.04
28	*Eragrostis gangetica (Roxb.)*	2.06	-	3.92	9.35
29	*Eriochloa villosa"*	-	4.53	-	-
30	*Eulaliopsis binata (Retz.) C.E. Hubb.*	-	2.13	-	-
31	*Fimbristylis dichotoma (L.)*	-	-	-	2.02
32	*Fimbristylis miliacea(L.) Vahl*	0.61	-	-	-
33	*Heteropogon contort us (L.) P.Beauv.*	4.45	13.78		6.82
34	*Imperata cylindrica (L.) Raeuschal*	-	-	2.14	6.18
35	*Ischaemum indicum (Houtt.) Merr.*	23.02	-	-	11.36
36	*Ischaemum rugosum Salisb.*	4.71	-	-	1.69
37	*Iseilema laxum Hack.*	10.14	12.31	5.64	2.24
38	*Oplismenus composites (L.) P. Beauv.*	-	1.60	-	-

39	*Oryza sativa L*	1.33	-	-	6.14
40	*Paspalidium flavidum Retz.*	-	1.24	3.58	3.74
41	*Paspalum vaginatum Sw., Prodr.*	2.53	-	-	0.92
42	*Pennisetum americanum (L.) Leeke*	-	2.93	-	-
43	*Saccharum spontaneum L.*	3.73	-	-	1.37
44	*Sacciolepis indica (L.) Chase*	3.58	-	-	-
45	*Setaria pumila (Poir) Roem. & Schultes*	0.61	4.89	5.34	7.52
46	*Setaria verticillata (L.) P.Beauv.*	0.90	-	-	2.49
47	*Sorghum halepense (L.) Pers.,*	3.76	-	-	-
48	*Themeda triandra Forssk.*	11.25	17.34	5.48	2.37
49	*Urochloasetigera (Retz.) Stapf*	0.58	-	-	-
50	*Vetiveria zizanioides (L.) Nash*	0.87	-	11.77	1.37

dolichostachya and Apluda mutica was greater than other species across the four sites. The high importance values of such species, indicates their capacity to develop in various conditions as they are the successional and light requesting species. Other species showing significant IVI were also identified. The predominant species with their IVI are given in Table -2.

3.2- Presence of Wild animals at the study sites-The camera traps and sign survey results revealed the presence of large carnivores like Tiger, Leopard, Wild dog, and Sloth bear, and wild prey like Chital, Sambar, Gaur, Wild pig and Nilgai occupying these areas sympatrically. Tigers were capture at12 camera trap locations (n=24) with a higher mean (±SE) capture rate of 0.52 ± 0.05in Panderpouni grassland in the Tadoba range. Leopards were highest captured in Botezari, 0.26±0.3 and Navegaon, 0.23±0.2 grassland while Wild dogs and sloth bears were detected in all the four sites of TATR (Table 3 and 4).

Table 3: Mean (±SE) capture rate of cryptic wild animal species photographed in the TATR.

Name of grassland	Tiger	Leopard	Wild dog	Sloth bear
Jamni	0.49±0.04	0.21±0.1	0.04±0.0	0.09±0.0
Navegaon	0.31±0.03	0.23±0.2	0.09±0.0	0.07±0.0
Panderpouni	0.52±0.05	0.17±0.0	0.10±0.0	0.06±0.0
Botezari	0.26±0.02	0.26±0.3	0.02±0.0	0.10±0.0

Table 4: Mean (±SE) capture rate of non-cryptic wild animal species photographed in the TATR

Name of grassland	Chital	Sambar	Gaur	Wild Pig	Nilgai
Jamni	16.19±1..30	5.06±0.42	2.13±0.15	2.38±0.16	0.98±0.04
Navegaon	14.12±1..12	4.88±0.36	4.38±0.25	2.38±0.30	1.39±0.18
Panderpouni	19.20 ±0.10	5.03±0.32	1.50±0.08	2.25±0.14	0.23±0.02
Botezari	0.7 ±1.0	2.67±0.45	3.08±0.17	1.49±0.27	0.38±0.0

Table 5: Mean (±SE) capture rate of other smaller wild prey and smaller lesser carnivore species photographed in the TATR

Name of the Grassland	Peacock	Porcupine	Common Hare	Common Langur	Grey jungle fowl	Civet
Jamni	0.34±0.06	0.26±0.02	0.29±0.05	5.01±0.38	0.04±0.01	0.03±0.01
Navegaon	0.33±0.08	0.16±0.03	0.10±0.03	3.86±0.24	0.02±0.01	-
Panderpouni	0.31±0.07	0.20±0.04	0.12±0.04	4.013±0.27	-	-
Botezari	0.21±0.11	0.09±0.06	0.07±0.02	2.98±0.47	-	0.05±0.01

Table-5: Encounter rate (/km) of the carnivore species recorded from the study area

Species	Tiger	Leopard	Wild dog		Sloth bear
Sign type	Pugmark	Pugmark	Pugmark Scat	Scrape	Scrape
Encounter Rate	0.63 ± 0.01	0.38 ± 0.09	0.11 ± 0.01 0.16 ± 0.0	0.04 ± 0.0	0.02 ± 0.00

Other species like Porcupine, Small Indian civet, common langur, Common hare and grey jungle fowl were also recorded during the camera trapping (Table-5). In Jamni and Botezari grassland civet were found with the capture of 0.03±0.01 and 0.05±0.01 respectively. Although Porcupines were captured at all sites, but the capture rate was highest in Jamni (0.26±0.02). Among birds peacock and gray jungle fowl were captures.

Signs of tiger, leopard, sloth bear, and wild dogs were found from the grasslands and the results are provided in Table-5. Encounter rate (/km) of the sympatric carnivore species was based on the sign survey. The mean encounter rate of tiger (0.63 ± 1.01) was higher than the other carnivore species. The Gaur, Chital Sambar, Nilgai and Wild pig were detected all the grassland in the study area, and the highest capture rate of chital was found to be 19.20 ± 0.10 in the Panderpouni grassland.

Prey species like Chital, Sambar, Gaur, Nilgai and Wild boar are found to be attracted by rich fodder and enough water sources available in these grasslands and to avoid predation. Chital and Sambar are the most abundant species in these grasslands. The presence of carnivores in this grassland can be attributed to the high density of prey base.

4. Conclusion- The results of the present study revealed the high botanical composition of important grass species in these evacuated sites of TATR. Moreover, the composition of the study area includes predominantly grasses and sedge plant species that are grazed or have potential to be grazed by herbivores. These grasslands are used as a natural ecosystem for the survival of grazing herds of wild ungulates. Occupancy of wild animals in a natural habitat provides a reasonable estimate of their population status and trends, and it also provides an unbiased, cost-effective alternative method for large-scale, multispecies monitoring programs. In this study, we determined the carnivore occupancy and associated environmental factors. The study can be used as a precursor of further long-term of tiger co-predator and prey species in TATR and adjoining landscape Maharashtra monitoring programs. The Tadoba landscape of eastern Vidharbh Maharashtra constitutes a mosaic of human habitation, cultivation, natural and semi-natural vegetation comprising grasslands, grass patches and forests. However, since 1972 settlements start from TATR has been voluntarily relocated and the subsequent strengthening of protection in these parts has resulted. So the results revealed that the wild animals are frequently used these grasslands for grazing. Removal of anthropogenic pressure from such places could be considered as an effective management tool for the sustainable habitat management and wildlife conservation.

5. Acknowledgement- We acknowledge the support from the frontline staff of Tadoba-Andhari Tiger Reserve - The unsung heroes of Tadoba. National Tiger Conservation Authority and Maharashtra Forest

Department for all necessary logistic support including permits. Special thanks to Dr. Bilal Habib, Dr. Parag Nigam, Ganapati Garad, Nilanjan Chatarjee, Vasanta Kaharkar and Madhura Davate for technical supports.

6. Reference

- Berwick, SH. Gir forest: an endangered ecosystem. American Scientist 1974; 64: 38-40.
- Blasco. The transition from open forest to savanna in continental southeast Asia. In Bourliere, F (Ed) Tropical Savannas. Elsevier Scientific Publication, Amsterdam, 1983; 167-181.
- *Braun- Blanquet, J. Plant Sociology. A study of plant communities. Magraw hill Book Co. New York, 1932.*
- Brochers, DL, Buckland ST, Zucchini W. Estimating animal abundance. Springer Verlag, Berlin, Germany, 2002.
- Brown, JH. On the relationship between abundance and distribution of species. American Naturalist, 1984;124: 255-279.
- Champion HG and Seth SK. A Revised Survey of Forest Types of India. Government of India Press, New Delhi, 1968, 404.
- Crawley MJ. Herbivory: the dynamics of animal-plant interactions. University of California Press, Berkeley, 1983, 437.
- Curtis JT. and McIntsh RP. The Interrelation of certain analytic and synthetic phytosociological characters, Ecology, 1950;31(3).
- Dubey Y and Mathur VB. Development of a spatial database in geographical information system (GIS) domain for natural resource assessment and management in Tadoba-Andhari Tiger Reserve, Maharashtra. Indian Forester, 2000, 126:1105-1119.
- Dubey Y and Mathur VB. Establishing computerized wildlife database for conservation, monitoring and evaluation in Tadoba-Andhari Tiger Reserve, Maharashtra. Final project report. Wildlife Institute of India, 1999.
- Eisenberg JF and Seidensticker J. Ungulates in Southern Asia: A consideration of biomass estimates for selected habitats. Biological Conservation, 1976; 10: 293-307
- Habib B, Nigam P, Trivedi M, Chatterjee N, Madhura D, Dashahre A, Garad GP, Sinha, V, Kalaskar AS, and Narwane GP. Status of Tigers, Co-Predator and Prey in Tadoba Andhari Tiger Reserve (TATR) – Phase IV Monitoring Report and Report on Collaring of Leopards, 2014, 26.
- Habib B, Trivedi M, Nigam P, Davate M, Dashahre A. Status of Tiger, Leopard and their Prey in Tadoba-Andhari Tiger Reserve Maharashtra: Phase IV Monitoring Report Summer 2013, Wildlife Institute of India, Dehradun, 2013a.
- Habib B, Trivedi M, Nigam P, Davate M, Dashahre A. Status of Tiger, Leopard and their Prey in Tadoba-Andhari Tiger Reserve Maharashtra: Phase IV Monitoring Report Summer 2013, Wildlife Institute of India, Dehradun, 2013b.
- Haines HH. Descriptive list of trees, shrubs and economic herbs of the Southern Circle, Central Provinces, Allahabad, 1916.
- Johnsingh, AJ. Large mammalian prey-predators in Bandipur. Journal of Bombay Natural History Society, 1983; 80: 1–57.
- Karanth KU and Kumar NS. Distribution and Dynamics of Tiger and Prey Population in Maharashtra, India. Final Technical Report. Centre for Wildlife Studies, Bangalore, India, 2005.
- Kortlandt A. Vegetation research and the 'bull dozer' herbivores of tropical Africa. in A.C. Chadwick and S. L. Sutton (eds). Tropical rainforest: the Leeds symposium. Leeds Philosophical and Library Society, Leeds, 1984: 205-226.
- Kremen C, Merenlender AM, and. Murpy DD. Ecological monitoring: a vital need for integrated conservation and development programmes in the tropics. Conservation Biology, 1984; 8:1-10.
- Kumbhar A, Tiwari V, Vashishtha G. Phase IV tiger monitoring Technical report, Tadoba-andhari Tiger Reserve Maharashtra, 2012,45.
- Kunhikannan C, Rao NR. Grasses and grassland of Tadoba National Park, Chandrapur Maharashtra. J. Econ. Taxon. Bot. 2013; 37(3): 500-512.
- Kunhikannan C, Verma, RK, Illorkar, VM, Totey NG. Plant diversity in and around Tadoba Lake, Maharashtra. Indian Journal of Tropical Biodivesity,1994; 2: 327-330
- Kunhikannan C. Studies on vegetation ecology of Tadoba National Park, Chandrapur, Maharashtra. Report submitted to Tropical Forest Research Institute. Indian Council of Forestry Research and Education, Jabalpur 1999.
- Kunhikannan C, Mohan Varghese, Totey NG, Bisen SS, Khawarey KN. Vegetational diversity in Tadoba

National Park, Chandrapur. Indian Journal of Tropical Biodiversity, 1993; 1: 63-72.

- Kunhikannan C, Rama Rao N and Bisen, SS. Diversity of different plant communities in Tadoba National park, Chandrapur, Maharashtra, India, Indian J. Trop. Bio Indian Journal of Tropical Biodivesity, 2007;15(2): 107-115.
- Malhotra SK, Moorthy S. Materials for the flora of Chandrapur district, Maharashtra state. Botanical Survey of India 13 (3and4) 1972; 292-318.
- Malhotra SK, Moorthy S. A Floristic account of Taroba National Park and its Environs, Chandrapur district, Maharashtra state. Botanical Survey of India. Calcutta. 1992.
- Misra R. Ecology Workbook. Oxford & IBH Publishing Co. New Delhi, 1968,244.
- Naimann RJ. Animal influences on ecosystem dynamics. Bioscience, 1988; 38:750-752.
- Owen-Smith N. Pleistocene extinctions: the pivotal role of mega herbivores. Paleobiology, 1987; 13: 351-362.
- Rodgers WA. Techniques for wildlife census in India: A field manual, Wildlife Institute of India, Dehradun, 1991,82.
- Sankar K. The ecology of three large sympatric herbivores (Chital, Sambar, Nilgai) with special reference for reserve management in Sariska Tiger Reserve, Rajasthan, Ph.D. Thesis submitted in University of Rajasthan, Jaipur, 1994.
- Seidensticker J. Ungulate Population in Chitwan valley Nepal. Biological Conservation, 1976; 10:183-209.
- Singh JS, Hanxi Y, and Sajusi PE. Structural and functional aspects of Indian and Southeast Asian Savanna ecosystems. 34-51. In Ecology and Management of the world's Savannas (Eds.), J.C Tothill and JJ. Mott The Australian Academy of Sciences, 1985.
- Whyte RO. The grassland and fodder resources of India (3rd edition). Sc. Monogr. Indian Counc. Agric. Res. New Delhi, 1974.

Physicochemical analysis and diversity of Chlorophyceae in four lakes of Kolhapur District Maharashtra, India.

***Hemant S. Joshi[1], Anuja H. Joshi[1], Amol M. Patil[2], Dr. S. K. Khade[3], Prof. Dr. C. T. Karande[4]**
1 Department of Botany, Bharati Vidyapeeth, M.B.S.K. Kanya Mahavidyalaya, Kadegaon
Email Id: h.joshi18@yahoo.com
2 Department of Botany, Yashwantrao Mohite College of Arts, Science and Commerce, Pune
3 Department of Botany, Padmabhushan Dr. Vasantraodada Patil Mahavidyalaya, Tasgaon.
4 Department of Botany, Miraj Mahavidyalaya, Miraj

Citation: Joshi Hemant S., Anuja H. Joshi, Amol M. Patil, Dr. S. K. Khade, Prof. Dr. C. T. Karande (2020), Physicochemical analysis and diversity of Chlorophyceae in four lakes of Kolhapur District Maharashtra, India. *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 712-717*

Date of Publication:
30 September 2020

ISSN 2319-4361

ABSTRACT:

The diversity in Chlorophyceae (47 spp.) has been studied at four lakes (Khupire, Sawarwadi, Ganeshwadi and Palsambe) in Kolhapur district. Wherein, six orders viz. Chlorococcales (17 sp.), Volvocales (4 spp.), Zygnematales (23 spp.), Siphonales, Chaetophorales and Chladophorales (1 sp. each) have been recorded. Different physicochemical parameters from these lakes also been studied to understand their compatibility in response to algal growth. The Palasambe lake is found to susceptible for algal bloom.

KEYWORDS: Chlorophyceae, parameter, water quality, correlation, diversity

INTRODUCTION:

Contamination of water bodies has become one of the most important and common environmental problems. Two main types of pollution threats can be recognized viz., organic pollution which leads to high organic content in aquatic ecosystems and, resulting into eutrophication. It is a well-known fact that polluted water can hamper the water quality thus limiting the use of water bodies for many purposes.

Organic pollution in lentic water bodies occurs when large quantities of organic compounds from many sources are released into them. Organic pollutants originate from domestic waste, sewage water and farm water. Organic pollution can adversely affect the water quality in many ways. During the decomposition of organic waste, dissolved oxygen in the water may be used up at a greater rate than it can be replenished thus, giving rise to oxygen depletion which causes severe effects on the aquatic community. Organic effluents also commonly contain large quantities of

suspended solid which decrease the light available to photosynthetic organisms especially algae. In addition organic wastes from people and animals are also rich in pathogenic organisms (Altenburger et.al.2000, Xu and Nirmalakhandan 1998).

Algae are the one of the important primary producers in waterbodies and are involved in water pollution significantly. Primarily, addition of the nutrients in water bodies through organic effluents may stimulate the growth of certain algal species which produce larger surface growths or algal blooms which in turn reduce the water quality and affect its use. However, few algae that flourish in these waters play an important part in purification of these water bodies. While some algae are toxic to fish and animals when consumed. Thus, algae can play a significant role in the food chain of aquatic ecosystem, any change in the composition of these algae can direct or indirectly affect the ecosystem.

MATERIAL AND METHODS:

A. Study area:

Four lakes viz., Khupire, Sawarwadi, Ganeshwadi and Palsambe from Karveer tehsil of Kolhapur district were studied in March 2020. Khupire, Sawarwadi and Ganeshwadi lakes being extensively used for household purposes by the adjacent villagers, while Palsambe lake is isolated from the village and has minimal human interference.

B. Collection and evaluation of water samples:

The water samples were collected in 200 ml glass bottles during March 2020. The collected samples were brought to the laboratory for estimation of various physico chemical parameters as per the standard protocols (APHA 1991).

C. Identification of phytoplanktons:

Phytoplankton samples were preserved in 4% Formalin. The algal specimens were identified by using standard literature (Prescott 1954, Randhawa 1959, Philipose 1969) and microphotographs were taken with the help of Dewinter Optical microscope. Algaebase was used for updated nomenclature (http://www.algaebase.org).

RESULT:

The results of the analysis for the four lakes are presented in Table I and Table II.

A. Physico chemical parameters of water:

Temperature, turbidity, transparency, pH, D.O., free CO_2, alkalinity, hardness, phosphates and nitrates have been evaluated. The average value of the parameters have been given in Table no. I.

B. Diversity of phytoplanktons:

Diversity of phytoplanktons (Chlorophyceae) from studied lakes have been tabulated in Table II.

DISCUSSION:

A total six orders in Chlorophyceae have been reported with 32 genera and 47 taxa in the present study. Order Volvocales consists four taxa, whereas, 14 genera and 17 taxa reported in Chlorococcales, Zygnematales consists 11 genera and 23 species, and Siphonales, Chaetophorales and Chladophorales constitutes one species each. Zynematales found most dominant, Siphonales, Chaetophorales and Chladophorales occurs rarest. Palsambe lake shows more abundance of Chlorophyceae (40 taxa) followed by Khupire(30 taxa), Ganeshwadi (27 taxa) and Sawarwadi (17 taxa) respectively. The deviations observed in the abundance of phytoplanktons were due to the conditions and quality of water in the sites of survey.

During the summer (March) the relative temperature in the water bodies is higher. The temperature was measured once a week for the complete month and average is represented in the study. The temperature did not fluctuate too much during the survey. Comparative lowest temperature (C) reported from Palsambe Lake, perhaps it is amidst in the forest. The intensity of sunlight and the increase in temperature both stimulate the growth of planktons. This relation of photoperiod and temperature with the algal density was previously reported by Bhardwaja (1940). Comparatively, turbidity (8.25), alkalinity (126.50) and hardness (95.5) were also lowest in waters of Palsambe Lake. While pH (8.8), transparency (178.90), dissolved oxygen (9.02), and nitrates (0.82) were high as compared to other water bodies in the study. Besides these parameters, free CO_2 and phosphates were also estimated which do not show significant deviations (Fig. No. 1, 2, 3, 4).

Turbidity and transparency both are the measures of water clarity and they are inversely proportional. It depends on the measure of suspended particles in them i.e. organic and inorganic matter. Also it will be affected by the inflow of fresh water in these lakes. Palsambe throughout the summer baring the months of late April, May and early June receives considerable amount of fresh water from the stream which flows

through it. Due to this constant addition of fresh water, thus the transparency and dissolved oxygen is higher in this lake when compared to Khupire, Sawarwadi and Ganeshwadi lakes.

A higher value of alkalinity in the lakes of Khupire, Sawarwadi and Ganeshwadi is may be due to increase in organic decomposition due to which the free CO_2 also increased. This carbon dioxide reacts to form bicarbonates, thus increasing the alkalinity (Mahadev and Hosamani, 2010). The water also has lower amounts of dissolved oxygen. It might be due to higher temperature of water ranging from 28 to 29^0C. The temperature directly impacts the dissolved oxygen in these lakes. As the temperature increase, the metabolic rates of the aquatic community also increase, thus increasing the biochemical oxygen demand. This leads to decrease in dissolved oxygen finally leading to hampering the growth of aquatic plants, algae, etc. pH also influences the planktonic density. pH of range 7.2 – 9.2 is mostly optimum for algal growth. The alkaline pH is favourable for the algal growth (Unni 1984) which shows a positive correlation between them. Nitrates depletion in the three lakes of Khupire, Sawarwadi and Ganeshwadi is may be due to accumulation of organic biomass in the lakes. In such lakes the dead organisms sink to the bottom of the lake. While in healthy ecosystem such as Palsambe Lake, these dead organism are decomposed by decomposers and nitrates are released back into the ecosystem (Freeman, 2002). Hence, the nitrates in Palsambe Lake are more as compared to other three lakes in the survey. In the study, nitrates show positive influence on the planktonic density. Such results were also presented by Senapati T. and co. workers (2011) during their study of species diversity and its relation with the physic chemical factors of a water body in Golapbag, West Bengal. Also alkalinity may indirectly affect the nitrate content. Alkalinity with nitrification causes utilization of bicarbonates (at a very low concentrations) in conversion of ammonia to nitrates. According to Standards ISI 10500:1991- Annexture I the species of *Coelastrum*, *Oocystis*, *Scenedesmus*, *Desmodesmus*, *Chlamydomonas* and *Closterium* are found in polluted waters or waters with higher organic matters. And the presence of these genera in the studied lakes shows their polluted nature. So with the higher pH, high dissolved oxygen content and nitrates, lower alkalinity, Palsambe is the healthiest water body for algal growth.

CONCLUSION:

It is evident that the water parameters under study hugely play role in the presence and growth of algal community. These water parameters are disturbed by the human interferences. Probably it leads to either water pollution or purification. Further studies in interaction of other biogeochemical factors such as carbon, nitrogen, nutrient and oxygen cycles with the algal community are required for better understanding. Also the study of algal density will give a better perspective of the degree of pollution in them.

ACKNOWLEDGEMENT:

Authors are grateful to the Head of Department of Botany of Kanya Mahavidyalaya, Yashwantrao Mohite College of Arts, Science and Commerce, Padmabhushan Dr. Vasantraodada Patil Mahavidyalaya and Miraj Mahavidyalaya for providing research facilities.

REFERENCE:

1. Altenburger, R., Backhaus, T., Boedeker, W., Faust, M.,Scholze, M., Grimme, L.H. (2000). *Predictability of the toxicity of multiple chemical mixtures to Vibrio fischeri: mixtures composed of similarly acting chemicals.* Environmental Toxicol. Chem. 19: 2341-2347.
2. APHA. (1991) *Standard Methods for the Examination of Water and Waste water, American Public Health Association. Inc.* New York. 18th Edition.
3. Bharadwaja, Y. (1940) *Some aspects of the study of Myxophyceae*. Proceedings of the Twenty-Seventh Indian Science Congress, Madras.
4. Freeman, S. (2002) *Biological Sciences.* Upper Saddle River: Prentice Hall.
5. Mahadev. J., Hosmani, S. and Syed, A. (2010) *Statistical multivariate analysis of lakes water quality parameters in Mysore, Karnataka, India.* World applied science Journal 8(11): 1370-1380.
6. ISI. (1991). *Indian standard specification for drinking water* ISO: 10500, ISI, New Delhi.
7. Philipose, M. (1969) *Chlorococcales*. I.C.A.R. Monograph, New Delhi. Based on algae of the Indian region.
8. Prescott, G. (1954) *How to know fresh water algae*. Dubuque Brown Co,Lowa. Pg 224.
9. Randhawa, M. (1959) *Zynemaceae*. ICAR. New Delhi. 19-433.
10. Senapati, T., Ghosh, S. and Tirthankar, M. (2011)

V*ariation in phytoplankton diversity and its relation with physicochemical parameters of a semi lentic water body of Golapbag, West Bengal, India.* International Journal of Current Research 3(7): 53-55.
11. Unni, K. (1984) *Limnology of sewage polluted tank in central India.* International Rew Ges Hydrobiology. 69(4):553-565.
12. Xu, S., Nirmalakhandan, N. (1998) *Use of QSAR models in predicting joint effects in multicomponent mixtures of organic chemicals*. Water Research 32: 2391-2399.

Table No.I. Physico chemical parameters of water.

Parameters	Khupire lake (KL)		Sawarwadi Lake (SL)		Ganeshwadi Lake (GL)		Palsambe Lake (PL)	
Temperature (^{0}C)	28.45	± 0.24	29.01	± 0.22	28.88	± 0.23	24.15	± 0.20
Turbidity (NTU)	10.25	± 0.54	10.02	± 0.52	9.98	± 0.40	8.25	± 0.47
Transparency (cm)	166.54	± 0.97	167.85	± 0.95	169.25	± 0.98	178.90	± 1.01
pH	8.4	± 0.47	8.5	± 0.32	8.4	± 0.38	8.8	± 0.42
D.O. (mg/l)	8.02	± 0.65	8.14	± 0.58	7.89	± 0.52	9.02	± 0.59
Free CO_2 (mg/l)	0.41	± 0.07	0.42	± 0.09	0.41	± 0.10	0.38	± 0.08
Alkalinity (mg/l)	128.24	± 1.02	128.54	± 1.14	129.36	± 0.99	126.50	± 0.92
Hardness (mg/l)	98.02	± 0.85	101.28	± 0.97	99.98	± 0.92	95.05	± 1.01
Phosphate (mg/l)	0.08	± 0.02	0.09	± 0.01	0.08	± 0.02	0.08	± 0.03
Nitrate (mg/l)	0.65	± 0.08	0.72	± 0.07	0.62	± 0.08	0.82	± 0.07

Table No. II. Algal diversity in the Lakes.

Name of Taxa	KL	SL	GL	PL
I. Order- Volvocales				
Chlamydomonas elegans	+	+		+
Sphaerocystis schroetori	+			+
Gonium pectoral		+	+	+
Eudorina elegans	+			+
II. Order- Chlorococcales				
Chlorococcum infusionum			+	+
Monoactinus simplex	+			+
Pediastrum duplex	+		+	
Pediastrum subgranulatum				+
Stauridium tetras	+			+
Tetraedron bifidum		+	+	
Chlorodium ellipsoidea	+			+
Oocystis kolhapurenese			+	+
Gloeocystis major	+	+		+
Ankistrodesmus falcatus var *radiatus*	+		+	+
Ankistrodesmus spiralis	+	+	+	+
Messastrum gracile				+
Coelastrum sphaericum	+		+	+
Desmodesmus armatus	+		+	
Desmodesmus perforates	+		+	+
Scenedesmus quadricauda	+	+	+	
Tetradesmus dimorphus		+		+
III Order Zygnematales				
Cylindrocystis brebisoniii	+		+	
Netrium digitus	+	+		+
Actinotaenium cucurbita		+		+
Closterium lineatum	+		+	+
Closterium venus				+
Cosmarium biretum	+		+	
Cosmarium baileyi	+		+	+
Cosmarium impressulum		+		+
Cosmarium margaritatum				+
Cosmarium margaritiferum	+		+	+
Cosmarium parvulum		+	+	
Cosmarium quadrum	+	+		+
Cosmarium tagmaestrium	+			+
Desmidium quadrum	+		+	+
Desmidium swartzii			+	+
Euastrum ansatum		+		+
Euastrum spinulosum	+		+	+
Penium margaritaceum				+
Pleurotaenium baculoides	+		+	+
Pleurotaenium ehrenbergii	+	+	+	+
Staurastrum brevispina			+	+
Staurastrum iotanum	+		+	+
Xanthidium spinosum				+
IV. Order- Siphonales				
Vaucheria sessilis	+	+	+	+
V. Order- Chaetophorales				
Chaetophora pisiformis	+	+	+	+
VI. Order- Chladophorales				
Chladophora globulina	+	+	+	+
Total	**30**	**17**	**27**	**40**

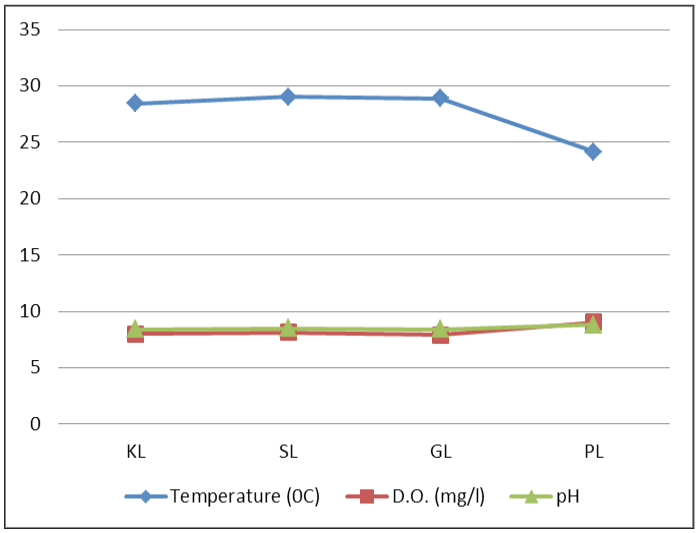


Figure- 1 Graph of temperature, D.O., pH

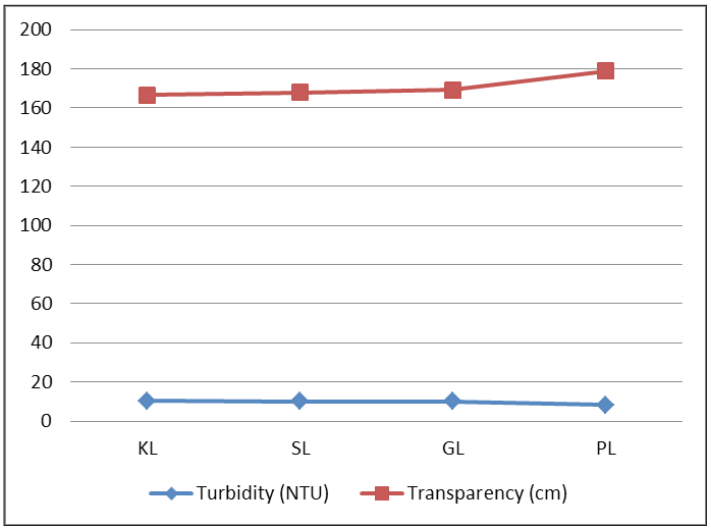


Figure- 2 Graph of turbidity and transparency

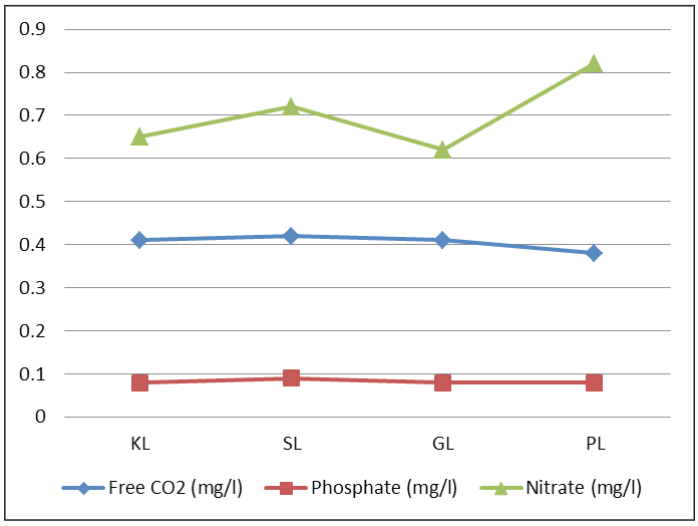


Figure- 3 Graph of free CO2, phosphates and nitrates

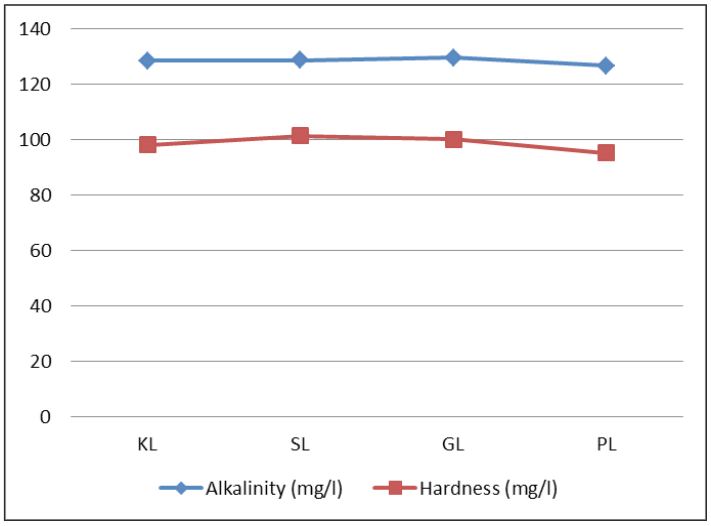


Figure- 4 Graph of alkalinity and hardness

A report of *Luisia tristis* (G.Forst.) Hook. f. in Satpuda hill ranges of Jalgaon district, Maharashtra

Laxminarayan Sonawane[*1], Prasad Sonawane[*2], Chetan Bhavsar[*3], Amol Deshmukh[*4] and Aman Gujar[*5]
(Vanyajeev Sanrakshan Sanstha, Jalgaon, 425001, Maharashtra) *
rahulsonawane1727@gmail.com[1], polarisrahul@gmail.com[2], chetanisbhavsar@gmail.com, deshmukhamol.60@gmail.com[4] , amangujar@gmail.com[5]

Citation: Sonawane Laxminarayan, Prasad Sonawane, Chetan Bhavsar, Amol Deshmukh and Aman Gujar (2020). A report of *Luisia tristis* (G.Forst.) Hook. f. in Satpuda hill ranges of Jalgaon district, Maharashtra *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 718-720*

Date of Publication:
30 September 2020

ISSN 2319-4361

ABSTRACT

Orchid flora of Satpuda hills of Jalgaon district is less explored. Floral explorations in recent times have thrown light on floral wealth of this region. In one such floral exploration, we came across very interesting and rare plant species belonging to the Orchidaceae. This plant is identified as *Luisia tristis* (G.Forst.) Hook. f., a very rare epiphytic orchid. The study provides a detailed taxonomic description, photographs and relevant information of above-mentioned plant species.

INTRODUCTION

Luisia Gaudich. is a small genus in the family Orchidaceae, a taxonomically very difficult genus due to low morphological variations. In Satpuda hills, it is seen growing in the higher canopy of tall trees at 600-800m elevation. During our botanical exploration in Satpuda hills, an attractive *Luisia* Gaudich. orchid was seen growing on *Terminalia bellirica* (Gaertn.) Roxb. tree, which was leaning from the cliff on the stream cascading beneath. The species was found growing in clumps with clumsy looking mass of roots and stems with long green terete leaves. The specimen was photographed to cover all its morphological characters. Detailed morphological examination of the specimen observed with the help of literature confirmed it as *Luisia tristis* (G.Forst.) Hook. f. Close examination with the help of pertinent literature revealed that this species is not recorded earlier from Satpuda hill ranges of Jalgaon district. Occurrence of this rare orchid species clearly highlights the quality of biotope of Satpuda hills.

MATERIALS AND METHODS

- During our biodiversity field visits in Satpuda hill ranges of Jalgaon district we came across this very interesting plant species. The plant was photographed by Prasad Sonawane. As only few specimens of this

rare species were encountered, we have refrained from making any herbarium. The observed specimen was identified with the help of standard literature (Cooke, 1908; Hook, 1890; Lakshminarasimhan et. al., 1996; Jalal 2018; Jalal and Jayanthi 2015; Pande, et. al., 2010; Singh et. al.2019; Ingalhalikar, 2007) and the taxa was confirmed by Dr. R. G. Khose, Ahmednagar. It was identified as *Luisia tristis* (G. Forst.) Hook. f., an epiphytic herb.

Luisia tristis (G. Forst.) Hook. f**.** Fl. Brit India 6: 25. 1890; Singh & al, Orch. India. 358. 2019; Jalal & Jayanthi. Ann. Chklst of Orch. West. Hima. Lankesteriana15(1): 33. 2015; *Luisia zeylanica* Laksmin. in B. D. Sharma & al., Fl. Maharashtra: Monocot. 47. 1996; *Luisia truncata* Blatt. & McC. in J. Bombay nat. Hist. Soc. 35: 491, t. 9. 1932; *Luisia teretifolia* Cook T. Fl. Presi. Bomb. 2: 701. 1908; Santapau & Kapadia, Orch. Bomb. 213. 1966; *Epidendrum triste* G. Forst., Fl. Ins. Austr.:60. 1786. 'Cylindrical-leaf Luisia', 'Karunya Pushp'.

Epiphytic herb. Height up to 40 cm. Roots branched, ash brown. Stem somewhat woody, terete, tufted, nodes 8-15mm, sheathed. Leaves alternate, terete, 6-15cm long, mottled with purple. Inflorescence drooping, extra axillary in condensed raceme, 3-5 flowered. Bracts small, broadly oblong, obtuse. Flowers drooping, fleshy, shortly pedicellate, bracteate, 0.5-0.8cm across. Petals are similar to sepals. Lip 3.5-5mm long, dark maroon, concave towards base; Column reddish yellow, slightly incurved, pollinia 2, ovoid, yellowish. Capsules clavate, erect, ribbed, 2-3 cm.

'Karunya pushp' is a rare epiphytic herb with height up to 40 cm. Roots and stems form an entangled mass. Roots are flattened, ash brown. Stem thick, terete, tufted, covered with truncate sheaths of fallen leaves. Leaves several 6 – 15 × 0.3-0.5 cm, thick with acute apex, mottled with purple dots or patches. Inflorescence 3-5 flowered, extra-axillary in condensed racemes. Flowers green tinged with reddish brown; pedicel short. Sepals

subequal, ovate, obtuse. Petals as long as sepals, oblong, obtuse. Lip 0.3–0.5 × 0.2-0.3 cm, rhomboid, maroon, hypochile maroon, slightly shorter than epichile, thin, erect; epichile maroon fading to reddish yellow at apex, cordate, obscurely three lobed, mid-lobe rhomboid, larger than side lobes. Column reddish yellow, oblong, incurved, clinandrium cordate, rostellum short, broad and blunt. Pollinia 2. Capsules 2-3cm long, strongly ribbed, spindle-shaped, tapering towards base.

- **Flowering and fruiting:** May-June
- **Elevation**- 600-800m.
- **Appearance of leaves**: Throughout the year.

DISTIBUTION

Rare epiphytic herb found in dry deciduous and moist deciduous forests at elevation up to 600-800m. In Maharashtra it is reported from Nasik, Sindhudurg, Amravati etc. In Satpuda hills found along forest paths on tallest trees like *Terminalia bellirica* (Gaertn.) Roxb., *Haldina cordifolia* Roxb., *Lannea coromandelica* (Houtt.) Merr., *Hymenodictyon orixense* (Roxb.) Mabb. forming entangled mass of roots and stems in the higher canopy of these trees.

RESULT

It was observed that *Luisia tristis* (G. Forst.) Hook. f. is not earlier reported from Jalgaon, Dhule and Nandurbar districts (Kshirsagar, 2008; Patil, 2003, Khan, 2019). Thus, this species has been recorded for the first time from Jalgaon district of Maharashtra State. This clearly reveals, this species is rare to flora of Maharashtra and even to the flora of India. Tree felling, encroachment, illicit forest fires are the major threats to this rare orchid species. Even with inadequate staff and difficult terrain, forest department is doing its best to protect the pristine Satpuda hill forests. But involvement of local tribals is necessary for protection and conservation of this floral-diversity hotspot. Effective environmental awareness programmes should be started amongst tribals to wean them away from illegal activities in the forest.

ACKNOWLEDGEMENT

The authors express their gratitude towards Dr. R. G. Khose, (Professor of Botany), Ahmednagar for his kind help in confirming the taxa and Dr. Sudhakar Kurhade (Professor of Zoology), Ahmadnagar, for his help in preparing the manuscript. They are also thankful to the authorities of Forest Department, for consistent support. Special thanks have been expressed for Mayuresh Kulkarni, Sushant More, Gaurav Shinde, Bhushan Chaudhari, Ravindra Phalak, Balkrishna Devre, Rajendra Nannaware, Abhay Ujagare, Satish Kamble, Yogesh Galfade, Hemraj Shinde, Hemraj Sonawane and Nitin Joshi for participation in field visits.

REFERENCES

- Cooke, T (1903). *"Flora of the Presidency of Bombay"*, Taylor and Francis, Red Lion Court, Fleet Steet, London. **2**. 701-702.
- Hook, J. D. (1890). "*Flora of British India"* (L. Reeve and Co, London, UK).**6**. 25.
- Jalal, J. S. (2018). "*Orchids of Maharashtra"*, Botanical Survey of India, Kolkata. pp 163-164.
- Jalal, J. S. and J. Jayanthi (2015). *Journal Lankesteriana*. **15(1):** 33. 2015.
- Ingalhalikar, S (2007). *"Further Flowers of Sahyadri"*, Corolla publication, Pune. pp 434.
- Khan, T. (2019). "*Wild Flowers of Jalgaon District*, *A succinct field guide*", Prashant Publication, Jalgaon. pp 77-79.
- Kshirsagar, S. R. and D. A. Patil (2008). "*Flora of Jalgaon District*, *Maharashtra"* Bishen Singh Mahendra Pal Singh, Dehradun, India. pp 302-303.
- Lakshminarasimhan, P., B. D. Sharma, S. Karthikeyan and N. P. Singh (1996)." *Flora of Maharashtra State"*. (Monocotyledons). Botanical survey of India, Kolkata. **3**. 47.
- Pande, S., Sant, N., Vishwasrao, V. and Datar, M. (2010)." *Wild Orchids of Northern Western Ghats (including Maharashtra, Goa and Belgaum)",* Ela Foundation, Pune. pp 68-69
- Patil, D. A. (2003)." *Flora of Dhule and Nadurbar District (Maharashtra)"* Bishan Singh Mahendra Pal Singh, Deharadun. pp 565-570.
- Santapau, H. and Kapadia, Z. (1966). "*The Orchids of Bombay*" Government of India Press, Calcutta. pp 213-214.
- Singh, S. K., Agrawala, D. K., Jalal, J. S., Dash, S. S. Mao, A. A., Singh, P. (2019). "*Orchids of India, A pictorial guide"*, Botanical Survey of India, Kolkata. pp 358-361.

Rescue of Indian Vulture *Gyps indicus* and Egyptian Vulture *Neophron percnopterus* from a breeding site in Gwalior, Madhya Pradesh, India

Vivek Verma[1], Ruby Yadav[1*]
[1]Vulture Mitra and snake Rescuer, At Gwalior[1]
E.Mail: Vivekvermagwl1@gmail.com

[2]Research scholar, biodiversity and Wildlife Conservation lab,
Department of Zoology, University of Lucknow
E. Mail: yadavruby1992@gmail.com

Citation: Verma Vivek, Ruby Yadav (2020), Rescue of Indian Vulture *Gyps indicus* and Egyptian Vulture *Neophron percnopterus* from a breeding site in Gwalior, Madhya Pradesh, India. *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 721-723*

Date of Publication:
30 September 2020

ISSN 2319-4361

Note:

We rescued one pair of Egyptian Vultures *Neophron percnopterus* on 20 January 2016 from Kila beat Takhiati near Hanuman temple, Sevanagar. In this region, a pair of Egyptian vulture was found drenched due to rain in winters. The next day one individual fell on the ground. It was weak and unable to fly. When we got information through local villagers we rescued cleaned and dried it and fed meat and water. After 4 days it was released at the same breeding habitat from where it was rescued (Table-1) (Fig-1,2,3).

We also rescued one fledgling of Indian Vulture *Gyps indicus* from the Gopachal Parvat, Gwalior on 26 May 2020. We observed that after takeoff it landed after 2-3 min and was unable to fly again. The health appeared good and no injury was seen. We offered water and after some rest it flew away with strong wing beats (Table-1) (Fig-4,5,6).

We also recorded one vulture mortality at the garbage dumping site of Seva Nagar , Gwalior on 02 June 2017. One adult Indian Vulture *Gyps indicus* was found dead. We called the forest department and after postmortem, they informed that the death of this adult was due to dehydration (Table-1). All the three incidences occurred during the breeding season; therefore, we suggest that we should be vigilant during the breeding period of September to May. We also suggest that a pond should be constructed near the vulture breeding colonies in Gwalior (Table-2 (Fig-6,7).

Table 1: Rescued vultures from Gwalior-

S.No.	Common and Scientific Name	Age	Date of rescue	Status when rescued	Status before release
1	Egyptian Vulture *Neophron percnopterus*	Adult	20 January 2016	Sick due to drenching in rain	Flew after 4 days of treatment
2	Indian Vulture *Gyps indicus*	Fledgling	26 May 2020	Sick and thirsty	Flew after 4 hrs after drinking water and rest
3	Indian Vulture *Gyps indicus*	Adult	7 June 2019	Found Dead	

Table 2: Breeding schedule of Indian Vulture and Egyptian Vulture in Gwalior, Madhya Pradesh

S. No	Name of Vulture	Pairing	Nesting Period and place	Egg laying	Incubation	Chick	Juvenile	Fledgling
1	*Gyps indicus* (Colonial)	September-October	September to October Cliff, Monuments	December-January	40-45 days	By January first week	February to March	March onwards till June Learned to fly
2	*Neophron percnopterus* (Colonial)	January-February	Monument, Cliff, Trees	End of March to the beginning of April	42 days	May	June-July	August

Fig-1 Egyptian Vulture after drenched in rain on 20 January 2016

Fig-2 Egyptian Vulture after drying it by a rescuer

Fig-3 Egyptian Vulture released in field by Rescuer on 24 January 2016

Fig-4 Fledgling (*Gyps indicus*) rescued on 26 May 2020

Fig-5: Fledgling (*Gyps indicus)* found in thirsty condition

Fig-6 Fledgling of *Gyps indicus* drinking water

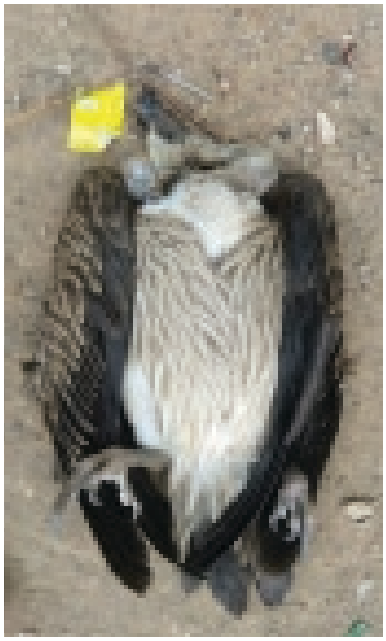


Fig-7 *Gyps indicus* found dead on 2 June 2017

Fig-8 *Gyps indicus* found dead on 2 June 2017

A case of partially naked Red Fox *(Vulpes vulpes)* in Hirpora Wildlife Sanctuary, Jammu and Kashmir

***Hameem Mushtaq Wani[1], Riyaz Ahmad[2], Mustahson F. Fazili[1] and Rouf Ahmad Bhat[1]**
[1]Department of Zoology, University of Kashmir, Srinagar-190006, India.
[2]Wildlife Trust of India, F-13, Sector 8, NCR, Noida-201301, India
Email: *hameem.scholar@kashmiruniversity.net

Citation: Wani Hameem Mushtaq, Riyaz Ahmad, Mustahson F. Fazili and Rouf Ahmad Bhat (2020) A case of partially naked Red Fox *(Vulpes vulpes)* in Hirpora Wildlife Sanctuary, Jammu and Kashmir. *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 724-726*

Date of Publication:
30 September 2020

ISSN 2319-4361

Fig. 1 Partially naked Red Fox

Abstract

The current paper presents an observation of a solitary, partially naked Red Fox (*Vulpes vulpes*) from Hirpora Wildlife Sanctuary of South Kashmir.

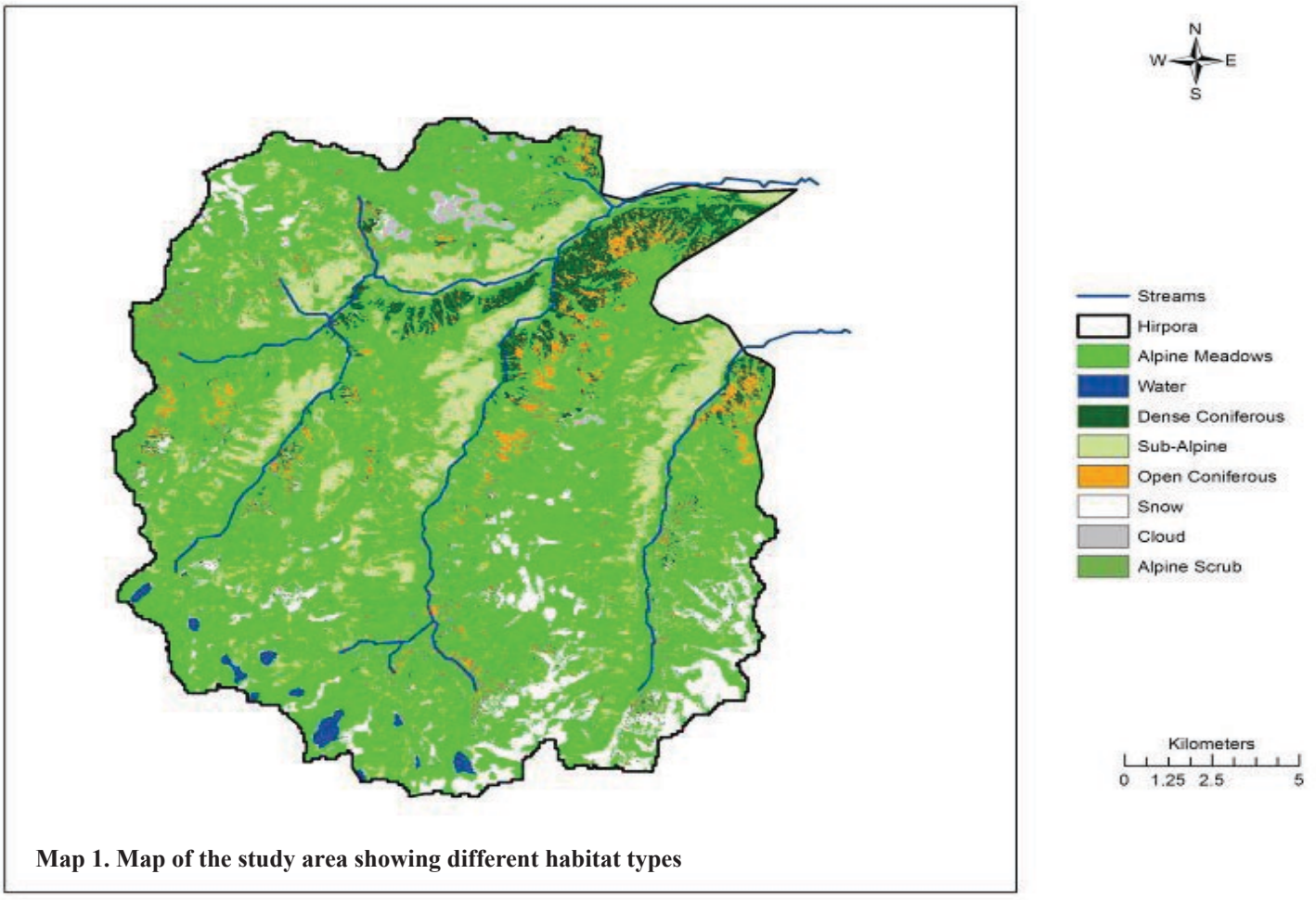
Key words: *Red Fox, naked, Hirpora, Kashmir, mange*

Red Fox (*Vulpes vulpes*) is one of the most widely distributed members of the order Carnivora, being present across the entire Northern hemisphere including North America, Europe and Asia. It has been listed as Least Concern by the International Union for Conservation of Nature (IUCN) (IUCN 2016). It is the largest species of the genus *Vulpes* (Sillero-Zubiri et al. 2004). They display significant individual, sexual, age-related and geographical variations in size. Red Foxes are usually found together in pairs or in small groups consisting of mated pair and their young, or a male with several females having kinship ties (Harris and Yalden 2008). On average, the adult measures 35-50 cm high at shoulders and 45-90 cm in body length with tails measuring 30-55.5 cm. The ears measure 7.7-12.5 cm and the hind feet 12-18.5 cm (Nowak 1999). The winter fur is dense, soft, silky and relatively long. Most of the Eurasian Red Foxes have coarser fur (Bachrach 1953). The fur in thermal windows areas such as the head and the lower legs is dense and short all year round, while fur in other areas changes with the seasons. The foxes actively control the peripheral vasodilation and peripheral vasoconstriction in these areas to regulate heat loss (Klir and Heath 1992).

Moulting, also known as sloughing, shedding is the manner in which an animal routinely casts off a part of its body, either at specific times of the year, or at specific points in its life cycle. It involves shedding the

Fig. 2 Comparing the sighted individual with the available picture of red fox suffering from Sarcoptic mange from literature (MacAulary, 2019).

Fig. 3 Corresponding author while observing the breeding behaviour of Himalayan Vulture *(Gyps himalayensis)* in the area



Map 1. Map of the study area showing different habitat types

epidermis (skin), pelage (hairs, feathers, fur, wool), or other external layers. Moulting or shedding in canids occurs semi-annually, during spring and fall (autumn) (Maurel et al. 1986).

The present paper illustrate an observation of partially naked Red Fox (*Vulpes vulpes*) on 4th April 2020 at Hirpora Wildlife sanctuary (33°39' 55" N latitude and 74°39' 40" E longitude) of Kashmir Himalaya. The partially naked Red fox was sighted while the author was observing the breeding biology of Himalayan

Vulture (*Gyps himalayensis*) in the area. On the first impression it appeaRed like a wild cat (*Felis chaus*) or a domestic dog (*Canis familaris*), however, the size of its tail and shape of its face were different. Closer observation confirmed it to be a Red fox (*Vulpes vulpes*) without fur. It had a pointed snout, a tubular body and a long skinny tail. The nakedness of the body, however, was not complete and about half of dorsal side towards the head was covered with coarse fur (Fig. 1).

Half of the dorsal side towards the back portion and complete tail were completely naked. The lone individual was perhaps searching for food under the snow cover. Nakedness of foxes has been reported (Li Shen 2009).

Several reasons have been attributed to the nakedness of mammals including moulting, disease, genetic disorders, parasitic infestation and nutritional deficiencies (Phillips and Schmidt 1994; Li Shen 2009; Beltran et al. 2018). From the field observation (that the sighted individual suffers from hair loss) and literature consultations (Li Shen 2009), it is predicted that the red fox might have suffered from the terminal stage of Sarcoptic mange where an infected individual suffers from pronounced hair loss around the face, ears, legs and the tail (Pence and Ueckermann 2002; Li Shen 2009). The causal organism is a tiny, eyeless mite, *Sarcoptes scabei*. Mange seems largely confined to individuals or certain fox families. The animal picks up mites in a den used by an infested fox, which drops off the host and can survive for up to three weeks without feeding. Keeping in view that mites are passed from animal to animal by close contact, we recommend that a closer look needs to be taken at the parasitic infestation of mammalian fauna in general and carnivore family in particular in Hirpora Wildlife sanctuary. This is the first case reported from Jammu and Kashmir, India and so far no scientific study has been undertaken in this field in Jammu and Kashmir, which may reveal the exact cause responsible for such cases.

Acknowledgement

The authors are grateful to Mr. Md. Ashraf (employee forest department, J&K) for his help during the observation.

References

- Bachrach, Max (1953). *Fur: A practical Treatise* (3rd eds). New York: Prentice-Hall.
- Beltran, R.S., Burns, J.M. & Breed, G.A. (2018). Convergence of biannual moulting strategies across birds and mammals. *Proc. R. Soc. B.* 285: 20180318. http://dx.doi.org/10.1098/rspb.2018.0318
- Harris, S. and Yalden, D. (2008). *Mammals of the British Isles: Handbook* (4th eds). Southampton: Mammal Society. Pp. 408-422. ISBN 978-0906282656.
- IUCN (2016). *Vulpes vulpes*. IUCN Red List of Threatened Species. E. T23062A46190249.
- Klir, John J. & Heath, James E. (1992). An infrared thermographic study of surface temperature in relation to external thermal stress in three species of Foxes: The red fox (Vulpes vulpes), Arctic fox (Alopex lagopus) and Kit fox (Vulpes macrotis). *Physiological Zoology* 65(5): 1011-1021.
- Li Shen (2009). How Mange, a Terminal Disease, Afflicts Red Fox. http://northernwoodlands.org/outside_story/article
- MacAulary, C. (2019). Mangy red fox trails runner. www.peicanada.com/eastern_graphic/mangy-red-fox-trails-runner/article_6f4bd612-ad73-11e9-8e5c-7bcf4e76990d.html
- Maurel, D., Coutant, C., Agasse-Boissin-Agasse, L., and Boissin, J. (1986). Seasonal moulting patterns in three fur bearing mammals: the European Badger (Meles meles L), the red fox (Vulpes vulpes L.) and the mink (Mustela vison). A morphological and histological study. *Canadian Journal of Zoology* 64(8): 1757-1764.
- Nowak, Ronald M. (1999). *Walker's mammals of the World.* JHU Press. P. 636. ISBN 978-0-8018-5789-8.
- Pence, D.B., and Ueckermann, E. (2002). Sarcoptic mange in wildlife. *Rev. sci. tech. off. Int. Epiz.,* 21 (2), 385-398.
- Phillips, Robert L. & Schmidt, Robert H. (1994). Red Fox. The Handbook: Prevention and control of Wildlife damage. Paper 36. http://digitalcommons.unl.edu/icwdmhandbook/36
- Sillero-Zubiri, Claudio, Hoffmann, Michael & MacDonald, David, W. (2004). Canids: Foxes, Wolves, Jackals and Dogs- 2004 Status Survey and Conservation Action Plan. IUCN Canid Specialist group.

Predating behavior of the Common Kestrel *Falco tinnunculus* on Buff striped Keelback *Amphiesma stolatum* in Blackbuck National Park, Bhavnagar, Gujarat, India

Rajni Trivedi & Devvratsinh Mori

Rajni Trivedi, 20/C Mangaldeep App, Jodhpur Gam Road, Satelite, Ahmedabad 380015, Gujarat, India E-mail: *rajnitrivedi@gmail.com*

Devvratsinh Mori, opp. Darbar gadh, Wadhwan 363030,Gujarat, India. E-mail: *devvratsinhmori@gmail.com*

Citation: Trivedi Rajni & Devvratsinh Mori (2020). Predating behavior of the Common Kestrel *Falco tinnunculus* on Buff striped Keelback *Amphiesma stolatum* in Blackbuck National Park, Bhavnagar, Gujarat, India. *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 727-728*

Date of Publication:
30 September 2020

ISSN 2319-4361

Common Kestrel *Falco tinnunculus* is also known as Eurasian or European Kestrel. It is listed as 'Least Concern' based on its population (Birdlife International 2019). It is a medium sized falcon, and one of the most abundant raptors in urban and suburban environments from family *Falconidae* (Cramp & Simmons 1980). This species is widespread winter visitor, resident in mountains of Pakistan (Baluchistan and outer Himalayas), East Afghanistan Bhutan, Western Ghats in India, and hills of Sri Lanka (Naoroji 2006, Grimmet 2011 & Rasmussen 2012). It's common winter visitor in Gujarat state (Ganpule 2016).

Aspects about the feeding behavior of the Common Kestrel *Falco tinnunculus* with respect to snakes is not known. This falcon eats Insects, rodents, frogs, and many lizards (*Agama himalayana*, *Agama caucasia*, Calotes versicolor), Skink *Leiolopisma* sp. and also snakes (Naoroji 2006). There are no reports of this kestrel feeding on Buff-striped Keelback *Amphiesma stolatum*. I describe this predation event.

On 10 January 2013, around 17:30 hours [RT] observed Common Kestrel female perched on a *prosopis* bush. It took off and came in hunting expression from soaring position and dived in the grass, [RT] approached closer and observed that the Common Kestrel was holding a 1 feet long Buff-striped Keelback snake (*Amphiesma stolatum*) on the a patch of grassland at Blackbuck National Park is located in Bhavnagar district, Gujarat, India.

The kestrel was holding the snake by the head with sharp talons, grasping it with one foot. At that stage no signs of damage were observed on the snake's body. The raptor occasionally started pecking at the head of the snake and its body movements were observed. It was trying to decapitate the snake and eat

it. This continued for a few minutes. Finally the bird decapitated the snake. [RT] took a photograph where the Common Kestrel was seen with the kill of the Buff-striped Keelback. The observation of the Common Kestrel feeding on *Colubridae* family snake species is an interesting addition to the already varied diet of this raptor.

ACKNOWLEDGMENT

We thank Satish Pande & Swapnil Thatte for reviewing the draft manuscript.

REFERENCES

- Birdlife International 2019, Species factsheet, *Falco tinnunculus*: Downloaded from http://www.birlife.org on 04 October 2019.
- Cramp, S. & Simmons, K.E.L. 1980. *Bird of the Western Palearctic.* Volume II. Oxford: Oxford University Press.
- Ganpule, P. (2016) The Birds of Gujarat – Status and Distribution Flamingo VIII 3 – XII 4 : 1-40.
- Naoroji, R., 2006. *Birds of prey of the Indian Subcontinent.* 1st ed. New Delhi: Om Books International.
- Rasmussen, P. C., & Anderton, J. C., 2012. *Birds of South Asia: the Ripley guide.* 2nd ed. Washington, D.C. and Barcelona: Smithsonian Institution and Lynx Edicions. 2 vols. Pp. 1–378; 1–683.

(Note : All the photographs taken by Rajni Trivedi)

Recent Sighting of Indian Pitta *Pitta brachyura* in Nashik, Maharashtra

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

Citation: Gandhi Abhijit, Samaya Gandhi (2020). Recent Sighting of Indian Pitta *Pitta brachyura* in Nashik, Maharashtra. *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 729*

Date of Publication:
30 September 2020

ISSN 2319-4361

- **Name of species**- Indian Pitta
- **Scientific Name-** *Pitta brachyuran*
- **Status**- Least Concern. (IUCN Red List, 2019).
- **Date of sighting**- Latter only on 21st May and prior on 21st , 24th , 27th May 2020.
- **Time of sighting**- 21st - 8:30 AM, 24th – 8 AM, 27th – Morning to late noon.
- **Weather parameters**- Sunny.
- **Number of times sighted**- Pitta Thrice
- **Number of birds**- Single.
- **Gender of bird**- Unidentified.
- **Locality**- Gajapanth Society, Mhasrul, Dindori road, Nashik, Maharashtra, India.
- **Habitat description**- Shady undergrowth, residential area, bungalow society, inside bungalow compound, silent and less disturbed backside of my bungalow.
- **Distance from human habitation**- Within habitation.
- **Any other bird/animal associates**- None.
- **Bird behaviour**- Saw single bird feeding in a shady undergrowth behind my house.
- **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 for this region.

First Sighting record of Australian Pied Stilt or White headed Stilt *Himantopus leucocephalus** in Central India Maharashtra.

Shishir Shendokar and Neenad Abhang

(Email:-shishir.shendokar@gmail.com, neenad.abhang@gmail.com)

Citation: Shendokar Shishir and Neenad Abhang (2020). First Sighting record of Australian Pied Stilt or White headed Stilt *Himantopus leucocephalus** in Central India Maharashtra. *Ela Journal of Forestry and Wildlife* *Vol.9* Part 1 *(3): 730*

Date of Publication:
30 September 2020

ISSN 2319-4361

- **Name of Species -** Australian Pied Stilt or White headed stilt.
- **Scientific Name -**Himantpous leucocephalus*.
- **Status –**Least concern
- **Date of Sighting –** 30 March 2013 and 29 April 2020.
- **Time of Sighting –**8.30 am
- **Weather parameter –**Cold and sunny.
- **Number of Bird -** Single bird in the flock of Black-winged Stilt.
- **Gender of Bird –** Unknown.
- **Locality –** Kekatpur reservoir in Amravati dist and Kumbhari reservoir at Akola dist.
- **Habitat description-** Reservoir surrounded by cultivated land Scrub land.
- **Distance From human habitat-** Around ½ to 1 km.Any other bird/Animal associated – Saw Indian River Tern, Common Pochard, Gargany and Black-winged Stilt and many other water birds.
- **Bird behavior-** The bird was foraging with Black-winged Stilt in shallow water along the bank.
- **Threats –** Habitat modification and destruction.
- **Photograph –** Attached.
- **Previous Records-** This is the first record for Central India and Maharashtra. There are some records found in Gujarat. (Parasharya, D., B. Patel and B. M.Parasharya (2010). Plumage variations in Black-winged Stilt Himantopus himantopus. Indian Birds, 6 (4&5): 98–99.) And Regular winter visitor at Sri-Lanka(De Silva, R. (1996). The Australian Stilt in Sri Lanka. Malkoha, 3(1): 4.).

(*Note: Himantopus leucocephalus is not recognized as a species by BirdLife International and is considered as a sub-species of Himantopus himantopus)

Corneal Opacity with Cataract in Left Eye of Free-Ranging Female Gray Langur *(Semnopithecus entellus)*– A Sighting Record from Pingori, Taluka Purandar, District Pune, Maharashtra

Rushikesh Sankpal[*#], Rahul Lonkar[**], Satish Pande[**]
([*]Department of Environmental Sciences, Savitribai Phule Pune University and [#]Sinhgad College of Science, Pune, [**]Ela foundation, Pune)

Citation: Rushikesh Sankpal, Rahul Lonkar, Satish Pande (2020), Corneal Opacity with Cataract in Left Eye of Free-Ranging Female Gray Langur *(Semnopithecus entellus)*- A Sighting Record from Pingori, Taluka Purandar, District Pune, Maharashtra *Ela Journal of Forestry and Wildlife, Vol.9* Part 1 *(3): 731*

Date of Publication:
30 September 2020

ISSN 2319-4361

- **Name of Species: - Gray Langur/ Hanuman Langur**
- Scientific Name. — *Semnopithecus entellus*
- **Status: -** Resident
- **Date of sighting:-** 21 March, 2019
- **Time of sighting:-** 05. 35 pm
- **Weather parameters: -** Sunny Day
- **Number of times sighted: -** One
- **Gender of the animal:** Female
- Locality: - A/p- Pingori, Tal Purandar, Dist Pune (18°13'16.5"N 74°07'28.1"E)
- **Habitat description:** - Rural, Agricultural.
- **Distance from human habitation:-0** km.
- **Any other bird/animal associates: -** House Crow (*Corvus splendens*), House Sparrow (*Passer domesticus*)
- **Animal Behaviour: -** Feeding, Resting
- **Threats to the habitat: -** Habitat modification.
- **Photographs: -** Attached.
- **Previous records: -** None for this species, but one record for Short-eared Owl
- Mori, Devvratsinh (2017). Corneal opacity with cataract in the left eye of Short-eared Owl *(Asio flammeus)*, Ela Journal of Forestry and Wildlife, 6(2): 402-403.

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

Ela Foundation is a non-government registered charity devoted to nature education and conservation. Since started as a Newslwttwre in 2012.

TABLE OF CONTENTS

ISSN 2319 - 2461

Journal for Private Circulation only

You can contribute to conservation : Please send your reports and research papers to the Editor EJFW (pande.satish@gmail.com)

Ela Foundation

Nature Conservation through Education and Research