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Habitat preference and congregation sites of House sparrow (*Passer domesticus*) in the rural and suburban areas of Ganjam district, Odisha

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Abstract

The bird House sparrow is associated with human habitation. The present study was carried out in different rural and urban areas of Ganjam district of state Odisha, India to find out the preferred habitats and congregation sites. Different environmental factors such as foliage cover, water and food sources, mobile tower and house sparrow number were determined by implementing line transect, quadrate sampling, field observation, direct counting and search and count methods. It has been found that the habitats and congregation sites are present in discrete patches along the rural and urban gradients. The house sparrow inhabiting sites have significantly more thatched houses, water sources and soil arthropods as compared to the non-inhabiting sites. All the inhabiting sites have moderate to high percentage of foliage cover (67.887±2.539%) although there was no significant difference in the mobile tower number between these sites. No significant correlation was found between the population size and different environmental factor except thatched house number which showed a small positive correlation (r^2= 0.3954) being the most influential factor in determining the population size in an area. The mass dispersal or death due to sudden habitat destruction by cyclonic storm has deserted some habitats in spite of the presence of all the supporting environmental factors. The analysis brought the conclusion that the habitat preference is not due to a single factor rather all the factors work together along with an influential factor like thatched house in making the site suitable for the bird to breed and sustain.

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Introduction

House sparrow (*Passer domesticus*) is a well-known bird of family passerdae. It has global distribution with few exceptions. It has been successfully introduced in many parts of the world as its biology is adaptable to a wide range of environmental condition (Martin *et al.,* 2005). It has close association with human habitation and cultivation (Summer-smith, 1988). They avoid dense forest, grass land and deserts away from human development. House sparrow does not confine its habitat to a particular type of human habitation rather it is inhabited in all the three major types of human habitations which include rural, sub urban and urban (Moller *et al.,* 2012). In India House sparrows are seen in varied of habitats around the human habitation. In sub urban and rural areas they are found foraging and roosting in cultivated fields which includes rice, pulse, millets, vegetables and ornamental flower fields. In these areas various species of weeds, shrubs and bushes are also seen. During the harvesting seasons they are commonly seen in the rice and maize fields (Rajasekhar *et al.,* 2008). In villages they are found foraging on the thatched roof and their nest are built in the cavities of thatched roof. In sub urban area they are found feeding near the grocery shop. In urban areas they are found in habiting in factories, ware houses and zoos. They congregate at the grain storehouses and grocery shop (Summer–smith, 1988). Abundance and congregation of house sparrow in a particular area depends on the availability of food sources for both adults and nestlings and essential nest sites around those food sources (Rajasekhar *et al.*, 2008). Heij (1985) has reported the abundance of house sparrow in urbanized environment is positively correlated with building and green space density. This shows the importance of proximity of feeding and nesting sites in determining the abundance of a bird species in a particular area. Building density and green spaces in an urban area are not the only factors that determine the abundance of house sparrow as there is evidence of less significant correlations between these two factors and density of the birds (Mason, 2006). Towns and cities are nowadays the most rapidly developing area in the world. These areas are dominated by the concrete buildings. The urbanization has a profound effect on the wild life (Tamialojc, 1976). In the urbanized area the nesting house sparrows are likely to occur in the older buildings and in medium aged buildings that has not roof repairs (Wooton *et al.,* 2002). It is ascertained that vegetation cover plays important role in determining the density of the house sparrow especially the native species of bushes which may enhances food availability (Wilknson, 2006 and Heij, 1985). Since last one decade the population of house sparrow has declined in almost all part of the world which includes all kinds of habits like urban and rural areas (Clement *et al.,* 1993). Droscher, 1992 has suggested a pattern that the decline is lower in the social deprived areas as compared to the modernized areas. The social deprived areas are occupied by the more waste grounds and gardens that have less management in terms of pesticides input. This resulted in to the greater food availability for the birds on the other hand, in the modernized urban landscapes the density of animal population including birds is limited by the availability of suitable habitat, human disturbances, collision with vehicles and behavioral shyness (Gorski *et al.,* 1999). In rural area the decline is mainly due to the decrease of thatched house numbers and change in the agricultural patterns (Mishra *et al.,* 2017). Occurrence and abundance of a species in a particular area is determined by biotic factors and different habitat variables such as food sources, habitat covers and relative abundance of other bird species (Skorka *et al.,* 2006). Habitat destruction has become a major event in all types of ecosystem due to the anthropogenic impacts. Being the indicator species birds are the first animals to be affected by the habitat destructions (Blair, 1999). It is essential to know the correlation between their abundance with different habitat parameters in order to get the idea about the cause of their decline in a particular area.

In the present study we have evaluated the habitat patches where house sparrows are found inhabiting in terms of food availability, water sources, vegetation pattern, and numbers of thatched houses, soil

arthropod density and number of mobile tower in a unit area. Correlation was found out between the house sparrow densities with the above mentioned habitat parameters. The main objective of the study was to find out the generality that exist in all the house sparrow inhabiting patches and the correlation that exist between the house sparrow density with different habitat parameters in a unit area. This study would help in preparing the conservation strategies and tracking the different factors which may responsible for declining of house sparrow population.

Materials and methods

The study was conducted in 47 villages and 3 sub urban areas which were comprised of total 50 study sites in the Ganjam district (19.5860°N, 84.6897°E), Odisha (Fig. 1.) from the year 2015 to 2017. All the study areas were of same plot size of 0.5km X 0.5km with in the residential areas of villages and sub urban areas. All the study sites were selected from the residential areas as House sparrows rarely occurs outside the human settlement. All the study areas were regularly observed to trace the presence of the House sparrow with in our study period. After this long observation the presence of the House sparrow in certain areas were ascertained. This long time observation was essential in order to bring reliability regarding their presence in a particular area because House sparrow sometimes takes temporary migration to nearby human settlement (Broun, 1972). After ascertaining their presence in different study areas the birds were counted. The counts were done during favorable weather condition when there was no rain, cloud and heavy wind. The counting was done during the morning and after noon time as the birds are most active during these times of the day. The visit to each plot was lasted for 2 hours. In each plot of the residential areas the birds were counted while walking along the plot visually. When the chirruping of the birds were heard their presence was scanned by the binocular, especially the un assessed spots of the residential areas like roofs and windows were scanned in this way in order to ascertain their presence. The common roosting sites such as bushy trees present in the courtyard were also searched for their presence after prior permission from the house owner. To make the count easy and accurate the number of birds in a large flock was counted by taking the photo graph of the flock by a digital camera, and then after the number was counted on the camera screen.

The following explanatory variables which were supposed to affect the abundance of house sparrow population in a particular area were measured.

Food sources: House sparrows were observed minutely while they were feeding. The food sources were categorized in to three categories.

1. Leftover food: This category includes all types of leftover food which were thrown out from the houses and grocery shops and the left over rice grains present in the rice twigs of thatched roof. The left over foods also constituted the rice, wheat, green gram and black gram grains.

2. Plant buds: Guava (*Psidium guajava*), citrus (*Citrus indica* and *Citrus limon*), Drum stick trees (*Moringa oleifera*) and papayas (*Carica papaya*) are the major sources of buds throughout the years. Birds were observed if they were feeding of buds while roosting in the above mentioned trees.

3. Arthropods: Arthropods form the major constituent of the nestling diet (Vincent, 2005). The average arthropod density was measured in the study areas by quadrate sampling method. 10 quadrates were sampled for each study site. The quadrate size was 25 cm X 25cm. Pearson correlation coefficient r^2 was used to find out the correlation between the house sparrow density and arthropod density in a particular area.

Number of Thatched houses

The number of thatched houses counted in the study areas. Pearson coefficient r^2 was used to find out the correlation between the house sparrow density and number of thatched houses in a particular area.

Concrete road

The concrete cover on the ground affects the arthropod density. Percentage of study area with house sparrow population was calculated with respect to the concrete road.

Vegetation cover

The total vegetation cover in each study site was determined in terms of total foliage cover of the species of plants, trees and shrubs. Foliage play important role in determining the bird density as it provide roosting, feeding and shelter sites for the bird (Skorka *et al.,* 2016). The percentage of the foliage cover was determined by line transect method (Canfled, 1941 and Hanley, 1978). The foliage cover of each tree, plant and shrub along the transect was determined as measure of the shadow cast when the sun was directly overhead. The percentage cover of each transect was calculated by using the following formula.

$$\% \text{ of cover of all the species} = \frac{\text{Total distance of foliage cover}}{\text{Total distance of the Transect}} \text{ X } 100$$

Percentage coverage of each transect was determined, then the average of all the lines were taken together to estimate the total foliage coverage of the study area.

Water sources

During summer and winter House sparrows are frequently seen drinking water from different sources accessible at their convenience. After thorough observation water from the domestic sewage gutter (DW), stagnant water on the ground (SW), tube well points (TP) and Well (W) are found most accessible sources. The percentage of study sites with house sparrow habitat were calculated with respect to each individual water source.

Mobile tower

The numbers of mobile towers in the study area were counted. The squared of Pearson correlation coefficient r^2 was used to find out the correlation between the number of the mobile tower and house sparrow density in a unit area. The study sites were categorized in to house sparrow inhabiting patches and non-inhabiting patches depending on the presence and absence of house sparrow. The students t–test was done to determine the significance of difference between these two categories of sites with respect to various explanatory variables such as vegetation cover, soil arthropod density, number of thatched houses and number of mobile towers.

Results

The percentage of occurrence of different explanatory variables in two categories of study sites are listed in the table 1. This table shows that all the house sparrow inhabiting and congregating sites have the availability of leftover food and plant buds as the major sources of food. The concrete road is present in all the study sites. The two categories of study sites differ from each other with respect to the domestic sewage water and well percentage. The inhabiting areas have high percentage of occurrence of domestic sewage water access points and wells than the non-inhabiting sites. There is no much difference found with the occurrence of tube well points and stagnant water pools across the street. In the house sparrow inhabiting sites these were greatly used by the house sparrows as sources of water especially during summer and winter. The difference between the house sparrow inhabiting sites and non-inhabiting with respect to different habitat factors is depicted in the table 2. The two sites are significantly different from each other with respect to the number of thatched houses present ($P<0.01$). The numbers of thatched houses in the house sparrow inhabiting sites are significantly greater than the non- inhabiting sites ($P<0.005$). The vegetation cover of both the sites doesn't differ significantly although the non-inhabiting area has slightly higher percentage foliage cover (71.692 ± 2.653) in average than the inhabiting areas (67.887 ± 2.539). The soil arthropod density of both these two kinds of sites differ significantly ($P<0.05$). The soil arthropod density in house sparrow inhabiting sites was found significantly greater than the non- inhabiting sites ($P<0.025$). The mobile tower number in both these types sites don't differ significantly. In both these types of habitats telephone towers have been installed by different network service provider (2G/3G). The correlation study between the population of the house sparrow and different habitat factors such as number of thatched houses, foliage cover, arthropod density and number of telephones towers is shown in the table3. The squared value of Pearson coefficient (r^2) or the coefficient of determination is given in each correlation study. The analysis shows that the population of house sparrow does not have a large correlation with different factors

mentioned above. We have got only a small positive correlation with number of thatched houses present in the study areas (r^2 =0.3954).

Table 1. Percentage of two kinds of Study sites having different food and water sources.

S. No.	Explanatory variables	Percentage of Occurrence	
		Non Inhabiting Sites(N=14)	Inhabiting Sites (N=36)
1	Leftover Food(LF)	85.71	100
2	Plant Bud (PB)	100	100
3	Domestic Sewage Water(DW)	71.43	80.55
4	Stagnant Pool of Water (SW)	42.86	41.67
5	Tube well point (TP)	57.14	52.78
6	Well (W)	42.86	61.11
7	Concrete road	100	100

Table 2. Comparision of two kinds of study sites with respect to different habitat factors.

S. No	Habitat factors	Mean Value		Level of significance in difference
		Non-Inhabiting Sites(N=14)	Inhabiting Sites (N=36)	
1	Thatched Houses	7.642±1.427	25±4.33	Differed significantly (P<0.01)
2	Vegetation cover (%)	71.692±2.653	67.887±2.539	No significance difference
3	Arthropod density	1.867±0.246	2.704±0.245	Differed significantly (P<0.05)
4	Mobile Tower	0.357±0.163	0.805±0.179	No significance difference

Table 3. Correlation study between population status and different habitat factors.

S. No.	Parameters		r^2	Inference
1	Population	Thatched house	0.3954	Small positive linear association
2	Population	Vegetation cover	0.0106	Insignificant association
3	Population	Arthropod density	0.1034	Insignificant association
4	Population	Mobile Tower	0.173	Insignificant association

Fig. 1. Study area.

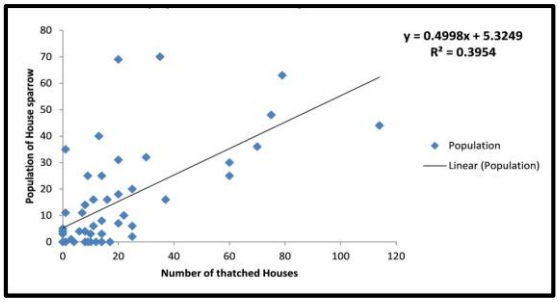

Fig. 2. Correlation between population and Thatched Houses.

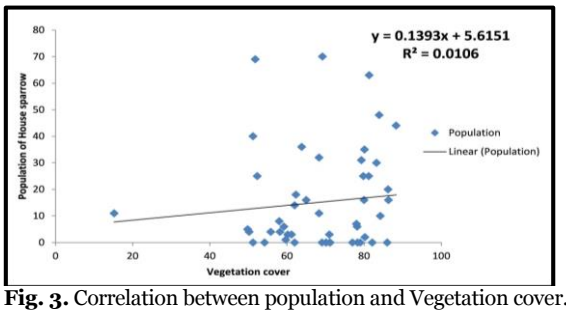

Fig. 3. Correlation between population and Vegetation cover.

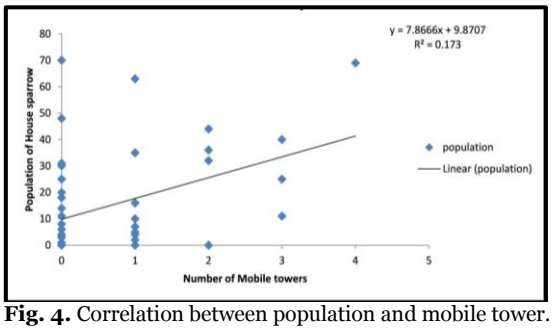

Fig. 4. Correlation between population and mobile tower.

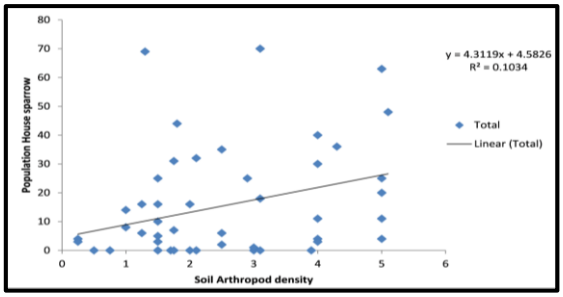

Fig. 5. Correlation between population and Arthropod density.

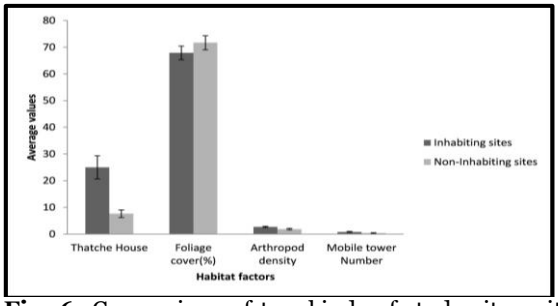

Fig. 6. Comparison of two kinds of study sites with respect to different habitat factors.

Fig. 7. A male house sparrow collecting arthropod diet near a cattle shade.

Fig. 11. A male house sparrow drinking water on the base of a tube well point.

Fig. 8. A female house sparrow feeding up on the flower buds of drumstick tree (*Moringa oleifera*).

Fig. 12. A flock of house sparrow taking water bath in stagnant pool of water across the street of rural area.

Fig. 9. A female house sparrow feeding the fledgling on a thatched roof.

Fig. 13. A male house sparrow taking sand bath on a heap of sand across a rural street.

Fig. 10. A flock of house sparrow feeding in front of a grocery shop in a suburban area.

Fig. 14. a male house sparrow feeding near a domestic gutter.

Fig. 15. A pair of male and female house sparrow roosting on papayas tree (*Carica papaya*).

Fig. 16. A pair of male and female house sparrow looking after the nest made in an artificial nest box.

Discussion

House sparrow population has discontinuous distribution over whole Ganjam district which was our study area. The habitats of the House sparrow are found discontinuous even in a single village or town. There are particular patches along the rural and urban gradients in to which house sparrow habitat sites are confined. The sparrows congregate and make their nest with close proximate to the food sources as Heij (1985) has suggested in his work. The habitat patch selection is also response to food availability and protection against abiotic factors. We support his view as all the house sparrow inhabiting patches in our study area have good sources of food and water such as leftover food, plant buds, soil arthropod , domestic sewage water, stagnant pool of water, tube well and well (Table 1. and Fig. 7 to 16). The domestic sewage water is also good sources of some arthropods which the birds collect for feeding their nestlings during the breeding seasons (Vincent, 2005). The fresh algae and mosses grown on the surface of domestic gutter sites are used as food throughout the year (Fig. 14) In rural habitats the thatched house roofs, bushy trees of courtyard, cattle shades, Sand heaps and verandahs of grocery shops are the most preferred congregating sites (Fig. 9, 15, 7 & 13). Thatched houses are the sources of leftover rice grains and arthropods throughout the year (Personal observation, Fig. 9). The livestock shade sites are good sources of arthropod diet, grains and nest materials (Fig. 7) (Summer-smith, 1963., Dyer *et al.,* 1977 and Kler *et al.,* 2015). In urban and sub urban areas the habitat patches and congregation sites are found along the vegetable market, bus stand, granary, grocery shops, artificial nests and feeding stations, dumping yards and old buildings (Fig. 10 & 16). These habitat patches are responded by the sparrows due to the availability of food sources, artificial nest boxes and cavities in the old buildings for nesting (Monika, 2005 and Lowther *et al.,* 1992).

The habitat factors in terms of food and water are plently available in both the house sparrow inhabiting and non-inhabiting sites. Only the percentage of water well is higher in the inhabiting patches. In spite of the presence of food and water sources some study sites did not have House sparrow (Table 1). To get the insight about the absence of sparrows in these sites we have compared other environmental factors of both the study sites. The two type sites differed significantly in terms of number of thatched houses and soil arthropod density (Table 2). This statistical difference suggests that thatched houses as nest sites and food sources, arthropods as food may be the influential factors in determining the population density of a particular site (Fig. 6).The correlation study shows that except thatched houses numbers all other habitat parameters show insignificant correlation towards the population (Table 3). From both the statistical analysis it may be inferred that the thatched houses are the most preferred and ideal factor for house sparrow habitat in our study sites (Fig. 2). The insignificant correlation of house sparrow towards other factors indicates the behavioral plasticity of House sparrow in selecting the habitat sites (Fig. 3 to 5). They are highly opportunistic in nature and utilize all kinds of

resources available in the area for making it as habitat (Martin *et al.,* 2005 and Anderson, 2006). The analysis also indicates that the habitat patches and congregating sites are not due to a single factor rather all the factor may work together with a most influential factor in determining the habitat of the house sparrow. For example in our study sites the number of thatched houses is the most influential factor. Singh *et al.,* (2013) and Everaert *et al.,* (2007) has suggested the negative impact of mobile base stations on the number of nests and population of House sparrow. But in our study sites no such difference between the inhabiting and non-inhabiting sites or significant negative correlation with population was found (Fig. 6 and 4). In our study sites we have located houses with house sparrow nests close proximate to the mobile towers. To get the deep insight of the effect of mobile towers on the biology of house sparrows a detailed and sophisticated study is required.

Both the study sites have moderate to high percentage of foliage cover (Table 1). The foliage cover is also an influential factor towards bird density as it provides roosting and feeding sites for the birds. At the same time it also protect the birds from potential predators (Skorka *et al.,* 2016). The high percentage of occurrence of community water wells in the house sparrow inhabiting patches and congregating sites (Table 1) attributed to the use of wall crevices of wall as nesting sites by the house sparrow. In rural areas these may be the alternative habitat sites after declining o thatched houses.

The major contradiction we encountered in our study was the absence of House sparrow in certain sites although the sites were characterized by most of the habitat factors that support the sustenance of the sparrows. The field basis investigation and questionaries' with the local people revealed the presence of the sparrows some years ago. In those sites they disappeared suddenly after super cyclone hit Odisha in 1999 and in subsequent years. The cyclonic storm and post cyclone restoration activities had destroyed most of the traditional houses and foliage cover of the affected area. The sudden habitat lost might have led to the few nesting opportunities and reproductive failure (Crick *et al.,* 2002). Even a minimum change in urban areas due to localized development could leads to the loss of whole colony of house sparrow has been seen in urban areas of Europe (Shaw *et al.,* 2008).

Conclusion

House sparrows are discontinuously distributed over particular patches in rural, sub urban and urban areas of the Ganjam district. The frequent cyclonic storm and subsequent house renovation activities led to the habitat destruction. This resulted in to the sudden disappearance of House sparrows from different areas of this district. House sparrow inhabiting areas are characterized by the availability of food and water sources, nest sites, foliage cover and thatched house numbers being the most influential factors.

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