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COMMUNAL ROOSTING HABITS OF SOME PASSERINE BIRDS IN CENTRAL PUNJAB, PAKISTAN

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Present paper describes the communal roosting of the widely inhabiting four passerine species in Faisalabad. It is regular among birds' and provides significant vision to the evolution, conservation, thermoregulation, enhanced foraging and vigilance against predation. Observations were consecutively conducted in the four closely located roosts in the selected agro-ecosystem of Faisalabad for the 20-minutes time intervals for four hours in the morning. Occurrence of trees as *Salmalia malabarica* (DC*), Dalbergia sissoo (*Roxb) *Ficus bengalensis* (Linn.), *Terminalia arjuna* (Roxb.), *Eugenea cumini (*Linn*.) Cedrella toona (*MR*)* and *Eucalyptus (*LH) species served as main roosts for four passerines. For roost one, in all 39 (±0.37) different trees, 188 (±1.89) total number of cavities, 108 (±1.80) productive nests and 20.19 (±0.39) nests per tree were recorded. Concurrently, from three other roosts, similar numerical counts were also made. Roost behaviour of all four birds was also determined. All of the birds depicted varying numbers of short flights, the calls, mobbing, roost exits and returns and breeding scuffles. Seemingly, the short flights and roost exits were apparent regarding the early intervals. Overall, roosting habits were important for all the birds' in their diurnal activities and for achieving the improved sustainability and endurance in the agro-ecosystems.
Keywords: Communal roosting, behavior, passerines, trees.

INTRODUCTION

Roosting among birds is regular ecological characteristic (Ward and Zahavi, 1973). All of them remain focus of diurnal and nocturnal activities viz. foraging, feeding, nesting, scuffles and to pass through the night (Bijleveled *et al*., 2010). Importantly, main benefit of communal roosting is to inhibit thermoregulation cost, enhance foraging profiles and reduced predation (Eiserer, 1984; Ydenbery and Prince, 1984). Ecological factors as type of avian nutrition preferably close to food resources trigger the communal roosting in small flocks (Coombs, 1978; Newton, 1972). Roosting in birds also promotes altruism to large scale, but also increases possibility of competition for resources (Suzuki and Akiyama, 2008; Conklin and Colwell, 2008). Nonetheless, inclusive fitness and adaptive values among various birds also largely rely on intraspecific competition (Marzluff*et al*., 1996; Wright *et al*., 2003), predatory impacts (Rabenold, 1986; Krause and Ruxton, 2002; Rogers *et al*., 2006).

Avian roosts remain widespread and alike other animal associations have strong effects in developing phenotypic traits, mating systems and population dynamics (Cockburn, 2004; Sussman and Chapman, 2004; Dunbar, 2009; Aplin *et al*., 2015). To assess the various ecological factors influencing the roost behaviour seem somewhat perplexing to quantify the costs and benefits as related to the fluctuations (Aureli *et al*., 2008). Customarily, communal roosts comprise hundreds and thousands of birds which recapitulate resting periods in diurnal and more regularly during nocturnal conditions and maintain their constancy for several years (Barta and Giraldeou, 2001). Comparative bird species study which relies on phylogenies and colonial nesting with cooperative breeding performance presents useful information (Peterson and Butt, 1992; Edwards and Naeem; Rolland et al., 1998; Beauchamp, 1999). Usefulness of the bird related analysis can be quantified in two proportions viz. the phylogenetics provides beneficial approach to assess the impacts of plausible ecological factors on the communal roosting for the different taxonomic groups and that such information also determines why community dispels into solitary state (Wcislo and Danforth, 1997).

Birds of colonial roosts possess single optimality to return, while communal roosts can offer more selection to return either to the same roost or nearby located other roosts at night (Laughlin *et al*., 2014).Lack (1968) reported on predator dilution due to intensive roosting, and information hypothesis to other birds by mobbing patterns (Ward and Zahavi, 1973) and to obtain patch-sitting on certain trees also proves beneficial (Caccamise and Morrison, 1986). It becomes significant to know as of what avian species differences occur regarding their roosts behaviour in both quality and quantity. Most likely behavioural drives in roosts are impacted by neural mechanisms and lured by their conspecifics even from long distances to aggregate at same place for several years (Lewis, 1995; Laughlin *et al*., 2014). It remains pertinent that in selection of roost sites by all birds are influenced by self-organization theory (SOT) whereby, complexities incautious roost selection are involved (Camazine *et al*., 2001). Some of

the birds are considered as 'leaders' and others the 'followers' to maintain roost discipline (Sueur *et al*., 2010).
Thermoregulation in roosts is considered important to all the members. Its significance happens to be more in winter season; but may be predicament in summer due to close association and lack of exchange of gas in outer environment. Nonetheless, the least bioenergetics demands can be useful to communally roosting birds (Du Plessis and Williams, 1994; Putaal*et al*., 1995; Gyllin*et al*., 1977). Avoidance of predators (Elgar, 1989) remains trivial factor in communal roosting at all species levels. Attacking predators can be easily marked and accordingly preparatory steps as mobbing and increased loud calls can trigger to dispel a predator before any damage is done (Eiserer, 1984). As reported by (Weatherhead, 1983), the centrally occupying members are more safe from predatory attacks than towards the corners. Such aggregation of birds forage more effortlessly in nearby cropped habitats before returning to the same in the diurnal periods, while others safeguard the roosts (Mock *et al*., 1988; Thiollay and Julien, 1998). Important factor for communal roost is that it can be wide and accommodates generally similar species conspecifics, whereas, the other distinct species can be located not very far away from it, therefore, rendering a roost as close to the specific food source to facilitate in maximum feeding in diurnal periodicities. Moreover, the nest sites for breeding also occur closely which are utilized by cavity nesting birds preferably in spring season (Richner and Hebb, 1995; Ahmad *et al*., 2012a,b; Khan *et al*., 2004). Main objectives of this study were to assess the differential roosting behaviour elicited by four passerines viz. house crow (*Corvus splendens* Linn.), house sparrow (*Passer domesticus* Linn.), red-vented bulbul (*Pycnonotus cafer* Linn.) and common myna (*Acridotheres tristis* Linn.) in their communal roosts in an agro-ecosystem of Faisalabad.

MATERIALS AND METHODS

Observations on roost composition and behaviour of four important passerines viz. house crow, house sparrow, red-vented bulbul and common myna were studied for a period of six months from February to July (2018) in an agro-ecosystem of Faisalabad.
***Study area*:** Faisalabad (31.45º N and 73.13º E), is ranked third largest city of Pakistan and located in Central Punjab. This division is mainly agricultural and, therefore, contributes about (26%) to the overall agriculture of Pakistan (Qamar, 2012). Predominant agriculture is complex and vibrant (Iftikhar *et al*., 2019) and sufficient to meet the domestic requirements of the country (Rehman *et al*., 2015). Important crops viz. wheat, maize, barley, rice, sugarcane, fodders, millet, chickpea, brassica and canola, coupled with citrus, mango, guava, mulberry and dates are cultivated throughout the year (Pakistan-Agriculture, 2015). The entire region is canal-irrigated with three irrigation canals viz. Jhang, Rakh and Gogera branch and small watered-tributaries for crop irrigation. Occurrences of multiple-cropping systems (MCS) which appear to facilitate the farmers are dominant here with small villages (Taber *et al*., 1967). Climate of Faisalabad remains dry hot and humid hot in summer, fairly cold in winter and moderate during spring and fall seasons (Ali and Khattak, 2015).
***Birds*:** Four passerines viz. house crow (*C. splendens*), house sparrow (*P. domesticus*), red-vented bulbul (*P. cafer*) and common myna (*A. tristis*) which remain widespread among the agro-ecosystems, were extensively studied for their roost behaviour in the well-populated agro-ecosystem of Faisalabad.
***Habitat selection*:** Observations were made consecutively on weekly basis on the occurrence of dominant and co-dominant trees comprising the cavities and tree hollows in the four distinct bird roosts which were spaced about two kilometers apart and located in the canal-irrigated plantations of the designated sites.
***Numerical counts*:** Number of sampled trees viz. *S. malabarica, C. toona, T. arjuna, F. bengalensis, D. sissoo, E. cumini* and *Eucalyptus* species which largely served as roosts of all four passerines were visually counted in all roosts distinctly with the cumulative cavities and nests per tree. Diameter at breast height (DBH) was also determined for each tree species with the measuring tape. It provided the overall thickness of trees which were sub-divided into three categories viz. (DBH < 50cm; 50-70cm and > 70cm).
***Roost behaviour*:** Differential behavioural characteristics elicited by all four passerine species regarding each roosting site were critically determined viz. short flights, mobbing, and intra-specific and inter-specific tussles for four hours consecutively, sub-divided into 20-minutes intervals, after selection of a vantage point near their roosts only for the morning hours to estimate their roost efficiencies.
***Statistical analysis*:** Obtained data were statistically analysed using one-way Analysis of Variance (non-parametric tests) and scatter plots of correlation and regression (SYSTAT, 2004) for interpreting the results.

RESULTS

Observations were made consecutively on the sampled trees with their diameter at breast height which significantly furnished that girth of the tree shoot not only represented its average age, but also number of cavities or groves in them. Few of such groves were subsequently considered as productive nest sites by the four birds' for breeding in spring. It was evident that search for the productive nests started after the fall season by both the partners. Considering the tree hollows as safe were later transformed into nests.
***Roost composition*:** It was evident that in roost one wherein the aggregated observations were incorporated showed that of total 39 comparable trees, maximum diameter at breast height

Table 1. Composition of roost I comprising the predominant trees in the agro-ecosystem of Faisalabad.

Predominant trees	Numbers	DBH (cm)	Tree cavities	Cavities per tree	Productive nests of all birds	Nests per tree
Salmaliamalabaica	7	75	35	5.00	24	3.42
Cedrellatoona	5	57	28	5.60	12	2.40
Arjunaterminalia	7	78	17	2.42	8	1.14
Ficusbengalensis	4	80	31	7.75	20	5.00
Dalbergia sissoo	6	75	25	6.25	17	2.83
Eucalyptus	5	55	24	4.80	12	2.40
Eugeneacumini	5	52	28	5.60	15	3.00
Total	39	472	188	37.42	108	20.19
Average	5.5714	67.429	26.857	5.3457	15.429	2.8843
S.E	0.3780	4.0500	1.8996	0.5393	1.8039	0.3918

was measured (80 cm) for the *D. sissoo* and least (52 cm) for *E. cumini*. The remaining trees ranged between such numerical values. Highest tree cavities (35) and the productive nests (24) and nests per tree (3.42) were recorded for the *S. malabarica* (Table 1).

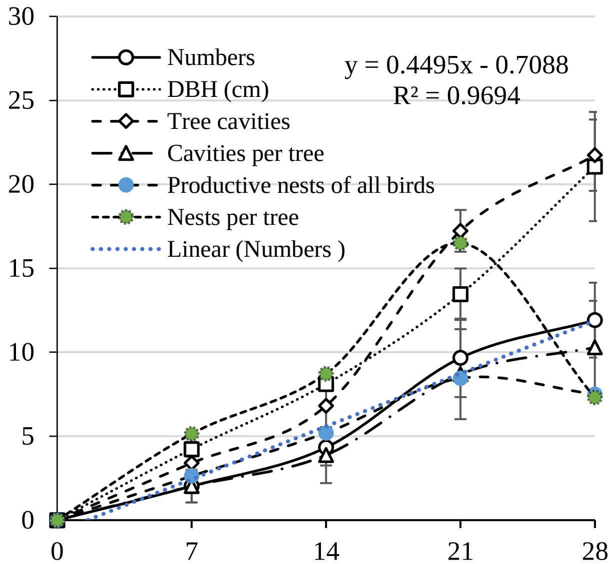

Figure 1. Roost one composition on occurrence of predominant trees in the agro-ecosystem of Faisalabad.

As indicated by Figure 1 of the linear regression which was evinced for the time intervals and trees in roost one that the linear relationship was recorded with the regression equation $Y\ 0.4495 + 0.70X\ w$. Increase of one unit (X), number of trees, would also augment 0.70 units for numbers of tree cavities and impacts the number of nests, while maintaining the even numbers of trees (X), might indicate no effects on number of cavities and productive nests. Nonetheless, coefficient of determination (R^2) suggests positive correlation (greater than 90%) between number of cavities and the nests.

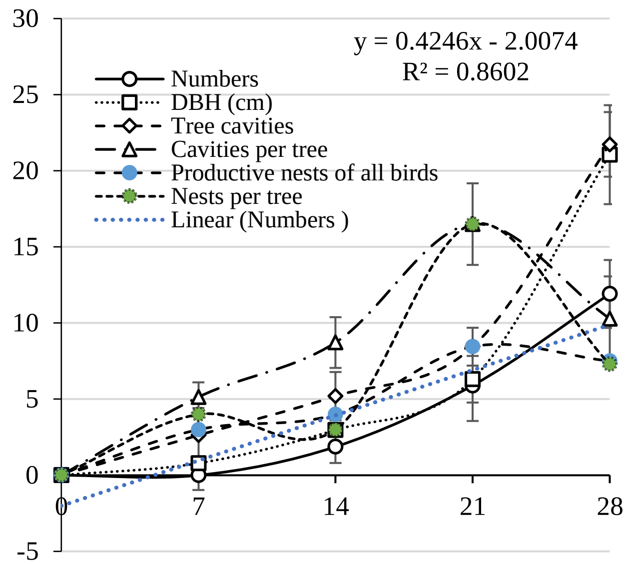

Figure 2. Conformation of important trees to constitute roost two in the agro-ecosystem of Faisalabad.

Fig. 2 describes a linear regression relationship between timing intervals and tree composition with the drawn regression equation Y = 0.4246 + 2.0074 X, such that by increasing single tree unit would cause double unit elevation for number of cavities and nests of the four passerine birds in the study sites. However, no increase in it would, there seemed inert augment for cavities and nests. However, the R^2, yet again indicated higher (positive) correlation of number of trees occurring and tree hollows.

Figures 3 and 4 depicted situation for roost three and four respectively and wherein, linear regression relationship provided equation as Y=0.3832-1.5823X which explains that increase of single unit on tree numbers would also expand in tree numbers, with their associated DBH, cavities and productive nests, while no impacts were recorded when there remained no increase in tress numerical counts. However, the R^2 still represented positive correlation among all ecological variables and tress composition. Concurrently, regression equation Y= $0.3832 - 1.5823X$ was achieved for roost four, and furthermore, elevation of the trees would certainly result in increased trees with larger 'dbh', cavity and nest numbers to the passerines and also depicted stronger R^2 (77%) correlative value.

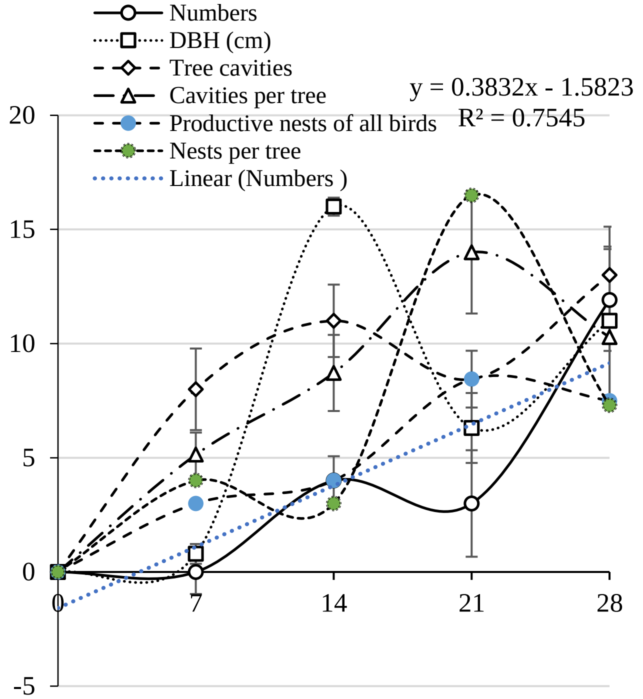

Figure 3. Roost three tree composition with the ecological variables in Faisalabad.

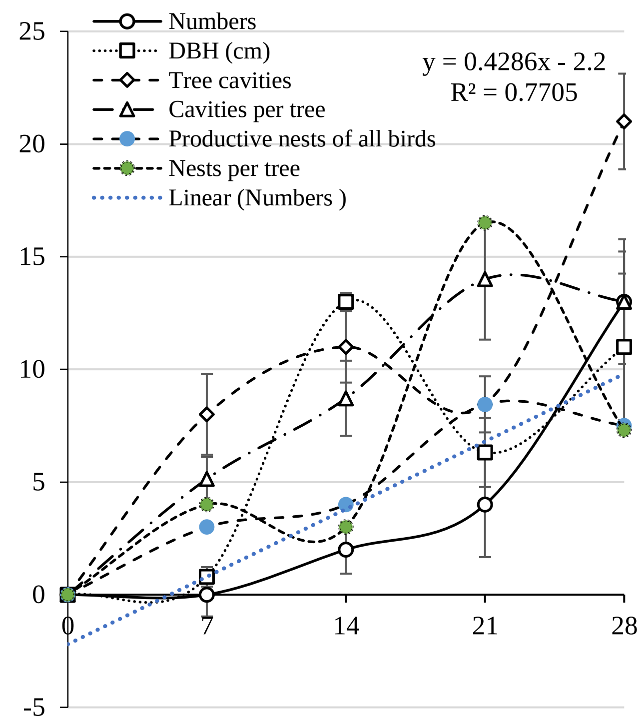

Figure 4. Roosting constitution as recorded for the fourth roost in the study area.

***Roost behaviour*: **Roost displays are important for life history of birds. Of these, short movements within the roost, mobbing for predatory threats, roost exits and returns and breeding scuffles were important. Such patterns were articulately depicted of the four birds in their respective roosts.

Table 2. Roost behaviour of the four passerines in the morning hours (split into 20-minutes) time intervals the roost one.

Time (minutes)	Short flights within the roost of all four birds	Approximate Cumulative Calling notes	Mobbing	Scuffles		Overall movements in roosts	
				Intraspecific	Interspecific	Exits	Returns
0645-0705	20	75	7	0	0	55	0
0705-0725	14	55	11	0	0	25	0
0725-0745	15	40	7	1	4	35	11
0745-0805	10	30	8	3	4	15	14
0805-0825	12	30	4	2	2	12	7
0825-0845	15	25	4	0	5	10	5
0845-0905	7	25	5	1	7	11	8
0905-0925	10	20	7	4	4	8	10
0925-0945	8	15	4	2	5	10	8
0945-1005	8	20	4	0	2	7	5
1005-1025	12	15	7	0	4	4	5
1025-1045	10	15	5	2	0	5	7
Total	141	365	73	15	37	197	80
Average	11.750	30.417	6.083	1.250	3.083	16.417	6.667
S.E.	1.248	6.091	0.717	0.452	0.758	5.010	1.366

Logically, short flights were fairly high in the morning hours with the burst of calls, several mobbing incidences, more inter-specific tussles, and augmented exits from roosts than returns. Therefore, evidently, in the morning durations, varied behavioural patterns were reasonably vociferous (Table 2). Importantly; the Figure 5 also depicts significant roost displays in accordance with the split time intervals (P< 0.5).

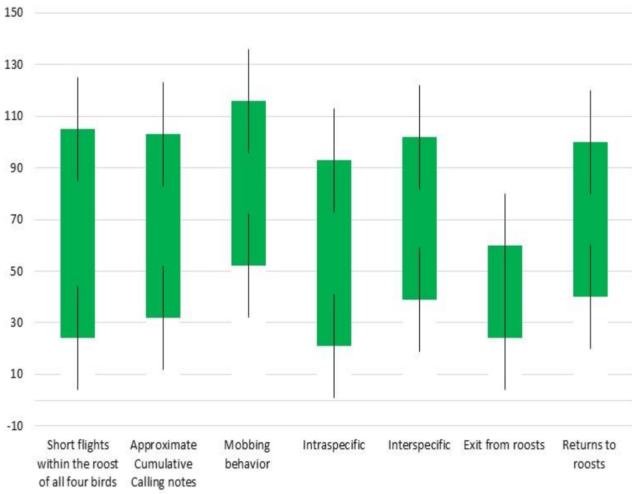

Figure 5. Overall roost behaviour displays by the four passerines in the morning hours.

Considering the Figures 6, 7 and 8 regarding their cumulative roosting behaviour, and invariably with similar ecological conditions, significant proportions occurred of time durations with the differential behaviour patterns in the quantified morning durations (P < 0.5), and that such patterns are impacted by the diurnal conditions. Possibly, more varied results would have been possible in the altered climate conditions.

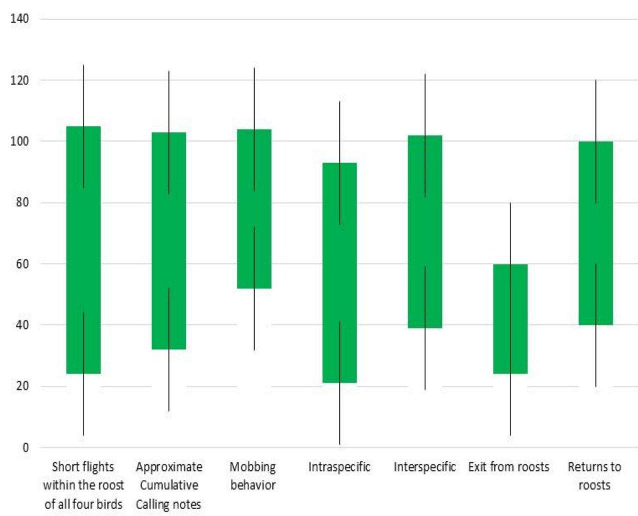

Figure 6. Passerine bird behaviour patterns in the roost two

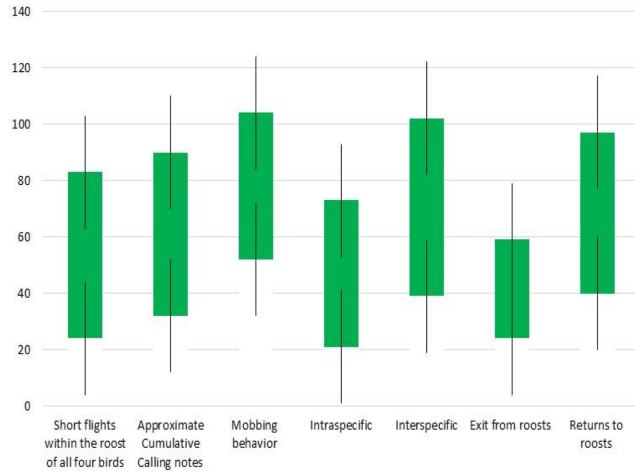

Figure 7. Passerine roosting habits recorded from roost three in the agro-ecosystems of Faisalabad.

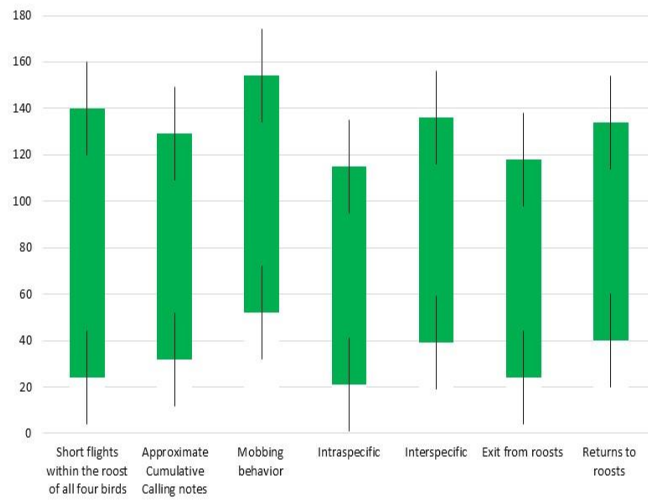

Figure 8. Differential roost behaviour displayed by the four passerine birds.

DISCUSSION

Results of this study demonstrate that the four passerines viz. house sparrow (*P. domesticus*)**,** house crow (*C. splendens*), red-vented bulbul (*P. cafer*) and common myna (*A. tristis*) existed in significant proportions in the study area. Unquestionably, favourable ecological conditions viz. sufficient food resources, old and tall trees to serve as roosts and moisture, supported their roost populations and elicited behaviour performance. Seemingly, the four roosts with the passerines' were approximately 1.5 km apart, therefore, depicting similar ecological conditions. Moreover, they occurred within short distance from the food crops due to multiple cropping systems (MCS) and all were canal-irrigated. Old and tall trees viz. *S. malabarica*, *C. toona*, *T.*

arjuna, D. sissoo, F. bengalensis, E. cumini and *Eucalyptus* species existed in varying numbers. Ironically, they served as major nocturnal, also widely considered as communal roosts to the four passerines. Impact of tree age, shoot thickness and enlarged branches appear to be instrumental in establishing the bird communal roosts.

Significantly, the 'diameter at breast height (DBH)' which was critically ascertained had three categories viz. less than 50 cm, between 50-70 cm and greater than 70 cm. Trees as *S. malabarica, D. sissoo* and *F. benglalensis* comprised sufficient proportions of roosts of the four birds, while they were also occurred in the remaining two 'DBH classes'. Of these, *S. malabarica, D. sissoo, F. bengalensis* and *T. arjuna* not only had maximum number of tree groves but also the productive nests for breeding (Table 1). It is also logical to assume that as most of tree plantations have been fairly old even earlier than partition of the sub-continent, therefore their bark has become soft to enable birds' to excavate it, and also the depressions which have come of age as hollows, become productive nests in spring season for most of the avian fauna (Taber *et al*., 1967; Beg, 1978; Sarwar *et al*., 1989; Khan *et al*., 2004; Ahmad *et al*., 2012). Moreover, it was evident that communal roosts were also important not only to protect the passerines against predatory threat, to formulate mobbing patterns, but also in thermoregulation as have been reported by (Barrows, 1978; Beauchamp, 1999). Present findings also reported that developing linear correlation and regression models also indicated that with one unit increase of differential trees in the habitat would also produce more bird roosts with direct and strong relationship between the trees, cavities, nests and bird breeding performance. Similar results were also reported by Kumar and Balasubramanian (2010) while studying breeding efficiency for grey horn bill (*Ocyceros birostris*) in the urban and rural plantations, and also those Kemp (1995) and Mudappa and Ramen 2009).

Roost behaviour is important in performance of daily periodicities in the diurnal and nocturnal conditions (Khan and Beg, 1998; Gittings, 2017) are significant in their life history. As such behaviour were recorded in the morning hours and sub-divided periods of twenty minutes to gain better incentives, short flights, calling notes, mobbing, breeding scuffles and finally the roost exits and returns provided the information that there were always enhanced numbers of all the four bird species which left their respective roosts per day for varied diurnal activities following the previous night's hiatus. In the same durations, their returns remained limited, but as the daylight increased gradually, the rapidity of movement patterns became slower, but did not cease (Table 2). Generally, the exits were greater than bird returns in the morning which might be reversed in the late evening hours with large returns to their roosts to pass through the nightly periods. Risk of predation remained sufficiently high in all observations with customary mobbing occurring to either chase the predator or to render its impact null and void. Statistically, there were significant proportions (box-plots) regarding the bird movements and differential behavioural displays ($P < 0.05$), and also adjudging that roost characteristics remained pivotal to maintain their roost sustainability. Work done of authors (Speiser and Bosaowski, 1987) on raptors showed that as long as they remained in their roosting sites, no potential threat was recorded to them. Concurrently, Newton (1979) suggested that not only raptors were utilizing their roosts effectively, but also several non-passerines indicated relative safety with short flights and related activities to gain better success and minimum failure in their survival strategies.

***Conclusions*:**

1. Although it was unclear that what factors are responsible for evolution of communal roosting in birds; nonetheless, it is strongly emphasized by authors that, foraging and feeding drives are key reasons to augment the communal roosts located closely to the food resources.
2. Majority of birds seem to establish permanent roosts for multiple years following careful ecological and safety consideration and selecting the old trees with soft bark to refine the already occurring depressions and groves in them.
3. Most plausible factor to develop the roosts is their short foraging distances to and from the specific food source and to enable minimum expenditure of per day visitations toit.
4. All such drives including the beneficial roost behavioural displays are impacted by their strong neural mechanisms to act in the right direction for lest costs and more benefits.

REFERENCES

Agric. Pakistan. 2015. Analysis of agricultural sub-sectors contribution growth rate in agriculture GDP, Pakistan. Int. J. Econ. and Finance 8: 156-161.

Ahmad, I., S. Abbas and H. Tariq. 2019. Soil fertility and soil microbiology, soil analysis for irrigation purpose: establishment of National Collection Culture of Pakistan. Bull. BISMIS, 7: 44-48.

Ahmad, S., H.A. Khan, M. Javed and K.U. Rehman. 2012. An estimation of rose-ringed parakeet (*Psittacula krameri*) depredations on citrus, guava and mango in orchard fruit farm. Int. J. Agric. & Biol. 1: 149-152.

Ahmad, S., H.A. Khan, M. Javed and K.U. Rehman. 2012. Management of maize and sunflower against the depredations of *Psittacula krameri* using mechanical repellents in an agro-ecosystem. Int. J. Agric. & Biol., 2: 396- 400.

Aplin, L.M., D.R. Farine, M.F. Cockburn, T. Thornton and B.C. Sheldon. 2015. Experimentally induced innovations lead to persistent culture via conformity in wild birds. Nature 518: 538-541.

Aureli, M.F., C.M. Schaffner, C.N. Boesch, C. Bearder, S.K. Call and S.P. Henzi. 2008. Fission-fusion dynamics: new research framework. Curr. Anthropol. 49: 627-657.

Balasubramanian, P. and S. Kumar 2010. Final report of the ecology of Indian grey hornbill (*Oceyceros birostris*) with special role in seed dispersal in southern eastern ghats, India. Coimbotore. Pp. 74.

Barrows, C.W. 1978. Roost selection by spotted owls: an adaptation to heat stress. Condor. 83:302-309.

Barta, Z. and L.A. Giraldeou. 2001. Breeding colonies as information centres: a reappraisal of information based hypothesis using the predator scrounger game. Behav. Ecol. 12:121-127.

Beauchamp, G. 1999. The evolution of communal roosting in birds: origin and secondary losses. Behav. Ecol. 6: 675-687.

Beg, M.A. 1978. Some observations on the biology of rose-ringed parakeet in the cultivation of Central Punjab. Proc. First seminar on bird pest problems in agriculture. FAO/Vertebrate Pest Control Centre, Karachi, Pakistan.

Bijleveld, A., M. Egas, J.A. Gils and T. Piersma. 2010. Beyond the information Centre hypothesis: communal roosting for information on food, predators, travel companions and mates. Oikos 199: 277-285.

Caccamise, D.F. and D.W. Morrison. 1986. Avian communal roosting: implications for diurnal activity centers. Amer. Nat. 128:191-198.

Camazine, S., J.L. Deneubourg and N.R. Franks. 2001. Self-organization in biological systems. Princeton Univ. Press, New York, United States. Pp. 320.

Cockburn, A., 2004. Prevalence of different nodes of parental care in birds. Proc. Royal Soc. London 273: 1375-1382.

Conklin, J.R. and M.A. Colwell. 2008. Individual association in a wintering shor-bird population. J. Field Ornithol. 79:32-40.

Coombs, W.P. 1978. Theoretical aspects of cursorial adaptations in dinosaurs. Quart. Review Biol. 53:393-418.

Du Plessis, M.A. and J.B. Williams. 1994. Communal cavity roosting in cooperatively breeding green woodhoopoes: consequences for energy expenditure and the seasonal pattern of mortality. Auk: 111:292-299.

Edwards, S.V. and S. Naeem. 1993. The phylogenetic component of cooperative breeding. Amer. Nat., 141:754-789.

Eiserer, L.A. 1984. Communal roosting in birds. Bird Behav. 5:61-80.

Elgar, M. 1989. Predator vigilance and group size in mammals and birds: a critical review of empirical evidence. Biol. Rev. 1:13-33.

Gittings, T. 2017. Nocturnal communal roosting behavior in great crested grebes (*Podicepscristatus*). Irish birds 10:483-493.

Gyllin, R., H. Kallender and M. Sylven. 1977. The micro-climate explanation of town center roosts of jackdaws (*Corvus monedula*). Ibis, 119:358-361.

Kemp, A. 1995. The hornbills. Oxford Univ. Press, London.

Khan, H.A. and M.A. Beg. 1998. Roosts and roosting habits of rose-ringed parakeet (*Psittacula krameri*) in Central Punjab. Pak. J. Biol. Sci. 1:37-38.

Khan, H.A., M.A. Beg and A.A. Khan 2004. Breeding habitats of rose-ringed parakeet (*Psittacula krameri*) in the cultivations of Central Punjab. Pak. J. Zool. 36:133-138.

Kuause, J. and G. Ruxton. 2002. Living in groups. Oxford Univ. Press, London. Pp. 28.

Lack, D. 1968. Ecological adaptations for breeding in birds. Chapman and Hall, United Kingdom pp 255.

Laughlin, A.J., D.R. Sheldon, D.W. Winkler and C.M. Taylor. 2014. Behavioural drivers of communal roosting. Behav. Ecol., 25:734-743.

Lewis, S.E. 1995. Roost fidelity of bats: a review, J. Mammal. 70:481-496.

Marzluff, J.M. 1996. Worldwide urbanization and its effects on birds. Avian Ecol. and Cons. pp 19-46.

Mock, D.W., T.C. Lamey and D.B.A. Thompson. 1988. Pheasability and the information centre hypothesis. Ornis Scand. 19:231-248.

Mudappa, D. and T.R.S. Ramen. 2009. A conservation status survey of hornbills in Western Ghats, India. Indian birds.Pp. 90-102.

Newton, I. 1972. Notes on finches. Collins Press, London, England. Pp. 52.

Newton, I. 1979. Population ecology of raptors. Wilson Ornithol. Soc. pp. 286-288 .

Peterson, A.T. and D.B. Butt. 1992. Phylogenetic history of social evolution and habitat use in the jays. Anim. Behav. 44:844-859.

Putaal, A., E. Hohtala and R. Hissa. 1995. The efe3ct of group size on metabolism in huddling grey partridge (*Perdix perdix*). Comp. Biochem. Physiol. 111:243-247.

Qamar, A. 2012. Modernizing National Agricultural Extension Systems: A practical guide for policy makers in developing countries, United Nations.

Rabenold, P.P. 1986. Roost attendance and aggregation in black vultures. The Auk, 104:647-652.

Rehman, A., L. Jingdong, B. Shehzad, A.A. Chandio, I. Hussain, G. Nabi and M.S. Iqbal. 2015. Economic perspectives of major field crops of Pakistan: an empirical study. Pac. Sci. Rev.3:145-158.

Richner, H. and P. Hebb. 1995. Communal life: honest signaling and the recruitment centre hypothesis. Behav. Ecol.24:1-45.

Rogers, I.J., P. Zucca and G. Vallortigara. 2006. Advantage of having lateralized brain. Proc. Royal Soc. London. 271:420-422.

Rolland, C., E. Banchin and M. Fraipont. 1998. The evolution of colonialist in birds in relation to food, habitat, predation and life history traits: a comparative analysis. Amer. Nat. 151:514-529.

Sarwar, M., M.A. Beg, D. Shehwar and A.A. Khan. 1989. Breeding behavior and reproduction in rose-ringed parakeet. Pak. J. Zool. 21:131-138.

Speiser, R. and T. Bosakowski. 1987. Nest site selection by Northern goshwaks in New Jersey and New York. Condor. 89:387-394.

Sueur, J., T. Aubin and C. Simonis. 2010. Rapid acoustic survey for biodiversity appraisal. Acta Acoust. , 100:772-780.

Sussman, R.W. and A.R. Chapman. 2004. The origins and Nature of Sociality. New York. Pp. 20

Suzuki, S. and E. Akiyama. 2008. Evolutionary stability of first-order information indirect reciprocity in sizeable groups. Theor. Pop. Biol., 73:426-436.

Taber, R.D., A.N. Sheri and M.S. Ahmad. 1967. Mammals of Lyallpur region, West Pakistan. J. Mammal 48:392-407.

Thiollay, J.M. and M. Julian. 1998. Flocking behaviour of foraging birds in a neo-tropical rain-forest and the anti-predator hypothesis. Ibis. 3:382-394.

Ward, P. and A. Zahavi. 1973. The importance of certain assemblages of birds as information centrefor food finding. Ibis. 3:517-532.

Wcislo, W.T. and B.N. Danforth. 1997. Secondarily solitary: the evolutionary loss of social behaviour. Trends Ecol. Evol. 12:237-243.

Weatherhead, P.J. 1983. Two principal strategies in avian communal roosting. Amer. Nat. 121:237-242.

Wright, T.F., C.A. Toft, E. Enkerlin, J. Gonzalez, V. Sanz, A Trujillo, S.R. Bessinger and A.M. Rodriguez. 2003. Nest-poaching in neo-tropical parrots. Cons. Biol. 15:710-720.

Ydenberg, R.C. and H.H.T. Prins. 1984. Why do birds roost communally? Camb. Univ. Press.pp.123- 139.