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Spatiotemporal distribution of red vented bulbul (*Pycononotus cafer*) by GIS application in District Mianwali, Punjab, Pakistan

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Authors' Contribution | **Khan, M. T**, conducted the survey, **A. Ashraf, A. R. Azam, T. Latif, S. Qadeer and M. F. Nasir** designed the GIS maps, **A. Muneeb, S. Ullah** performed the data analysis.

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ABSTRACT

Ecological modelling is very useful tool to evaluate the spatial distribution and breeding biology. In this study GIS mapping was used to study the population of Red Vented Bulbul in Chikrala, Abba Khel, Chiddru, Namal Lake, Musa Khel, Sawans, Bittian, and Gulmeri of the district Mianwali, Punjab, Pakistan. Spatial distribution of specie, their nests structures, total eggs and hatching rate was thoroughly investigated during the survey. Results revealed that mostly this specie was found in continuous circulations around all sites except Gulmeri. Population density was recorded higher from March to July and then starts deceasing. Breeding time started from late February to late July. For nest construction, 42 nests have been investigated from study sites and observed that the Red Vented Bulbul used different plant species, including *Psidium guajava, Zizyphus nummularia, Dodonea viscosa, Dalbergia sissoo, Phoenix dactylifera, Berberis lyceum, Vitis vinifera, and Morus alba.* The incubation time of the eggs range between 11 to 14 days. The incubating and fledgling success was found to be 82 and 87% respectively. The study shows that the Red Vented Bulbul is widely distributed throughout the targeted regions of the district Mianwali.

Keywords: *Cucumis sativus* L, HPLC, dyslipidemia, Triglycerides, Triton X-100, Simvastatin.

INTRODUCTION: The *Pycnonotidae* family is the biggest group of passerine birds. Around the world, 130 Bulbul species were recorded, of which 9% were reported in Pakistan (Lepage, 2007). Bulbuls are mostly tropical and subtropical birds, with populations found in Africa, Asia, and Southeast Asia. Even though many Bulbul species are neighbourhood birds, there are very few northern species that migrate south over the winter. It is consistent over Pakistan's Indus plain and encompasses all vegetative zones, except for Baluchistan and a few desert districts (Mauro and Hardison, 2000). Bulbuls have extremely short, adjustable wings, a long tail, tiny, small legs and feet, a modest, thin beak, and visible fibres at the base of the upper mandible. They have a body length of 15-28cm (6-11 inches) while male and female birds appear to be identical, as do young adult birds, even though their coloration is more muted than that of adults. Bulbuls construct a cup-shaped nest in dense foliage or a tree and lay 2-4 eggs (Lepage, 2007).

Thetechnical name of Red-Vented Bulbul (RVB) is *Pycnonotus cafer* and it is found in a variety of organised living places, ranging from natural land to urban stops and gardens (Bhatt and Kumar, 2001). Typically, it is in the areas with greenery and unpredictable events, where it nests, preferring tree holes and the significance of foliage over exposed branches (Salem, 2003). This persists mostly on natural foods such as lychees, bananas, berries, papaya, creepy crawlies, blossom nectar, buds, and seed (Vander Velde, 2002). Its primary dietary source is soil materials. Regardless, it will consume small reptiles and insects (Islam and Williams, 2000). *Pycnonotus cafer* constructs the nest near the bifurcation or trifurcation point of the branch or on a similar substrate to obtain solid help at the base (Rao *et al.*, 2013). For nest improvement, it is drawn to material like as smooth and very little twigs, grasses, and spices. Similarly, *P. cafer* is observed nesting on polythene fibres. The Geographic Information System (GIS) has played a significant role in ecology, wildlife and biogeography over the last few decades. Significant recent research efforts have been related to some areas of GIS, in particular remote sensing. Remote sensing now regularly offers information about the environment on scales from regional to global, a way of collecting, processing and visualising spatial data. Along with the related advances in computing facilities, GIS makes important contributions to bio-geographical study (Haddad and Anderson, 2008). The multidimensional existence of biodiversity complicates the classification and assessment of biodiversity (Zhang *et al.*, 2017).

OBJECTIVES: The present study was designed to investigate the spatial distribution of RVB using GIS technique and to assess the information of nesting and breeding biology of RV B.

MATERIALS AND METHODS: The flow examination was directed in District Mianwali, having 8 destinations including Chikrala (32.8188° N, 71.8868° E); Sawans (32.7283° N, 71.6288° E); Musa Khel (32.6362° N, 71.7415° E), Namallake (32.69124° N, 71.80342° E); Aba Khel (32.6073° N, 71.6584° E); Bittian (32.5839° N, 71.5370° E); Gulmeri (32.5035° N, 71.5946° E) and Chiddru (32.5477° N, 71.7711° E) to check the ecology of RVB by utilizing GIS-based method. Mianwali is in Pakistan's Northwest Punjab province. This zone is establishing itself as a vital link between Punjab and Khyber Pakhtunkhwa. Mianwali district encompasses a land area of 5,840 square kilometres (2, 250 sq. mi) (figure 1).

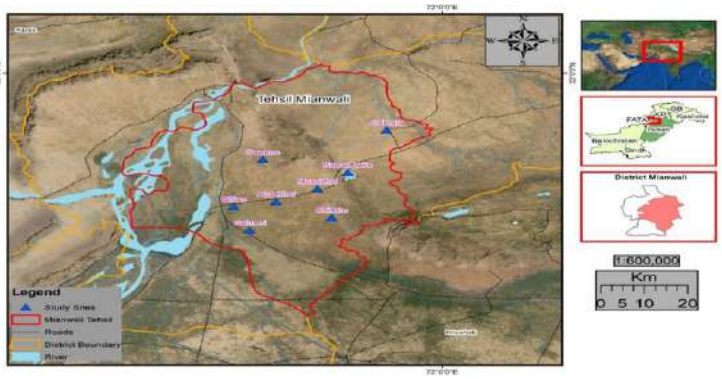

Figure 1: The study area for RVB in north Punjab, Pakistan.

All GIS work was performed utilizing ArcGIS 10.7. The investigation was carried out in 3 stages including (1) observation of ecological behaviour, (2) building of spatial distribution map and (3) identifying the breeding and nesting sites.

Research survey: About 8 stands were established following a preliminary ground survey of various sections of the Mianwali, which were assigned reference numbers and used as a large analysing unit. Line transect method with fixed line (1.5 km) was used to investigate the RVB populace. Each stand was examined by walking around the stand zone utilising all accessible walking parcels, passing through all conceivable microhabitat with the assistance of local inhabitants and farmers and using the sound of callings of RVB. The visits were planned for four consecutive days at dawn and dusk over the course of many months in 2021 (Bibby *et al.*, 2000).

Density measurement and plants identification: Densities of the RVB species (per km^2) were determined independently for each standby dividing the number of nests detected by the area of the fixed line transects. The plant species were confirmed with online key for identification (STUCKY *et al.*, 2006).

Breeding parameters: The RVB were monitored for development, and their behaviour of transferring plant material in their mouths was quietly observed to identify the nest. The creator assigned the nest a field number and observed it on a regular schedule. Field notes were made on the date state of the nest and the actions of the growing juvenile. The eggs were inspected and sized with vernier calliper. The actions at several nests were recorded and utilised to calculate various breeding and hatching success metrics, such as days required for nest formation, egg laying period, clutch size, incubation range, and number of adolescents, among others.

RESULTS: The bord was distributed throughout the study zone. Green star within the map are showing nests while red arrows indicate the circulation of the bird (figure 2).

Population density of RVB: During the morning and evening time of survey the presence of specie and their calls were higher for months (March-July), of the year while the presence of specie and their calls will be lower for January-February. This model was moreover obvious in the presence of bird species, which were basically higher similarly during March-July, and lower during January-February (table 1) .

Breeding season and courtship display: The reproducing time of Red Vented Bulbul starts from late February and lasts up to late July. Mostly Red Vented Bulbul females laid their grasp between late February to late July. The first courtship display of Red Vented Bulbul was shown in mid-February.

Nest site selection: The primary nest was recorded on late February. A total number of 42 nests formation was recorded during the study. Out of 42, 9 nests have been seen in Chikrala, 5 in Sawans, 7 in Musa Khel, 4 in Namal lake, 6 in Aba Khel, 5 in Bittian, 6 Chiddru and no nest was found in Gulmeri. In Chikrala, total 9 nests were identified and observed during the study period. This site has greatest number of nests identified and observed (figure 2B). Total number of the nests found in Sawans were 5 having long distance from each other. This may be because of the availability of the preferable trees in that study zone (figure 2C).

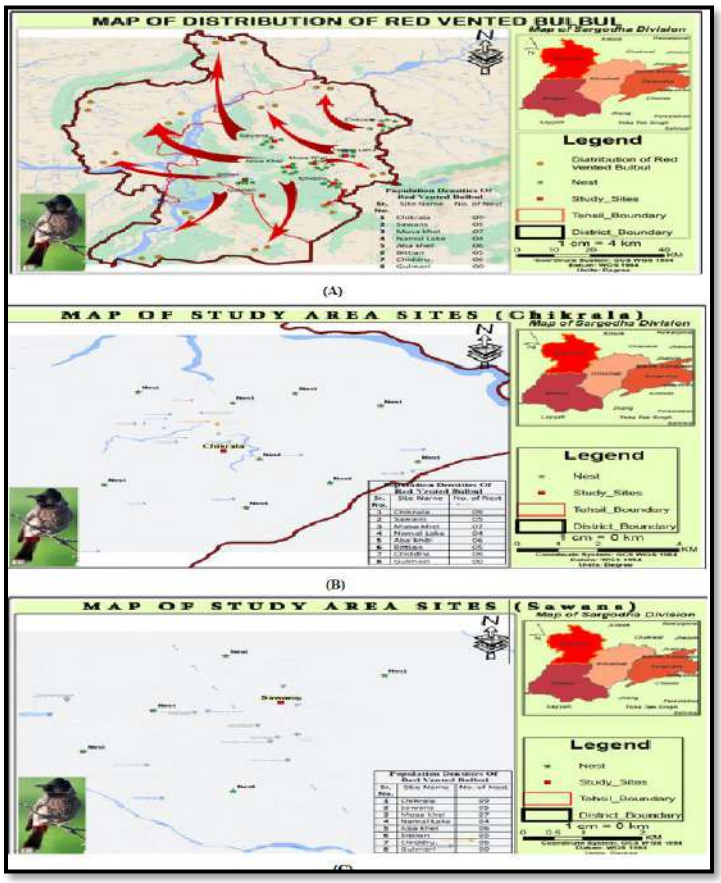

Figure 2: Distribution of RVB in the study zone (A), number of nests identified and observed in Chikrala (B) and Sawans (C).

Months	Morning Session		Evening Session		Overall	
	Calls	**Sightings**	**Calls**	**Sightings**	**Calls**	**Sightings**
January	2	1	1	2	3	3
February	6	4	5	3	11	7
March	9	8	8	7	17	15
April	17	14	15	12	32	26
May	22	18	20	16	42	34
June	25	22	23	19	48	41
July	30	25	26	23	56	48
Overall	111	92	98	82	209	174

Table 1: Population density of RVB as calculated from calls count and physical sighting in the morning and evening during different calendar months.

Total nests identified and observed were 07 in Musa Khel. It was the second largest number of nests identified, further distance of nests was comparable to the site Chikrala (figure 3A). It can be found that very few numbers of nests were identified and observed in Namal Lake (figure 3B). Hence the

lowest number of identified nests were in huge distance from each other (figure 3B). Total nests identified and observed in this site of Abba Khel were 06 with quite long distance. This is the 3rd highest sites in term of nest number (figure 3C).

In Bittian only 05 nests were identified and observed, and they are at very long distance from each other (figure 4A). In the study site of Chiddru total 06 nests were identified and observed. This site has equal number of nests as Abba Khel. These nests were located at quite longer distance from each other (figure 4B). The reason behind the absence of nest is due to high populated human area and there was no preferable tree for the construction of nest (figure 4C).

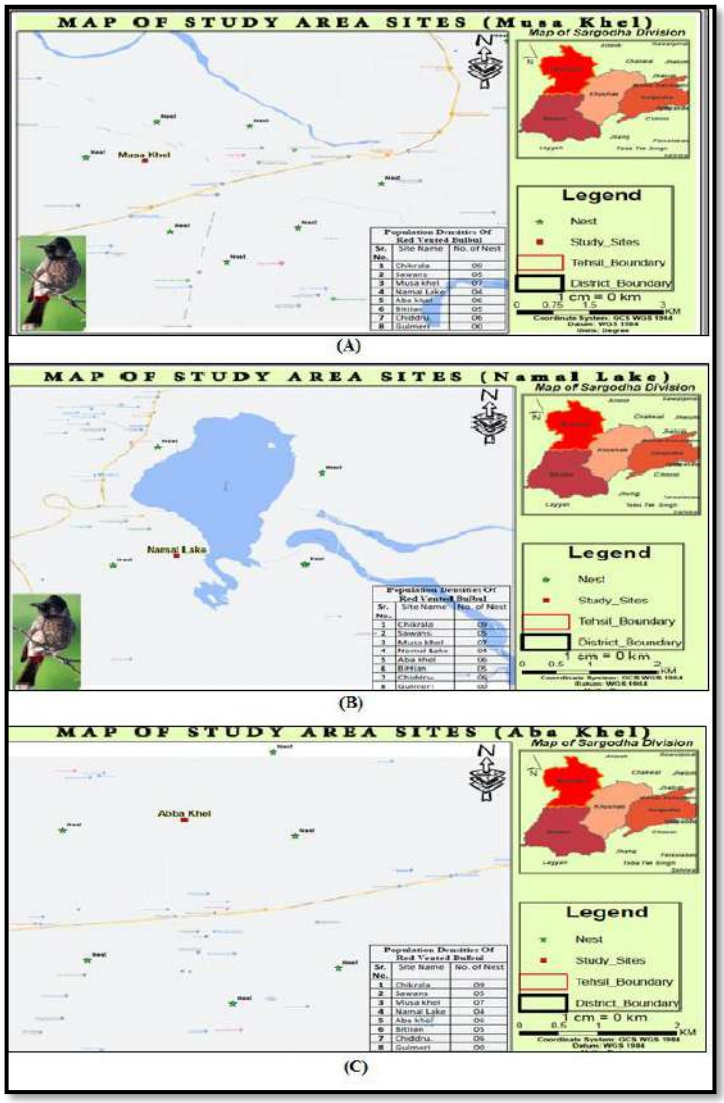

Figure 3: Nests or RVB was identified and observed in Musa Khel (A) Namallake (B) and Aba Khel (C).

Nest construction: It was observed that RVB constructed the nest from late February to July. Bird's primarily utilized plant material which changed from plant strands to twigs of differed sizes and rootlets, grasses and spider webs that was promptly accessible in bird's own domain. About 7 latent and 35 dynamic nests were observed among all 42 nest. This nests were recorded at *Psidium guajava, Zizyphus nummularia, Dodonea viscosa, Dalbergia sissoo, and Phoenix dactylifera, Berberis lyceum, Acacia nilotica, Ziziphus jujuba, Jasminum officinale, Citrus sinensis* and *Morus alba*. The information about nest position, nest height and vegetation prefer for nest construction is represented in table 2 while the dimensions of nest in table 3.

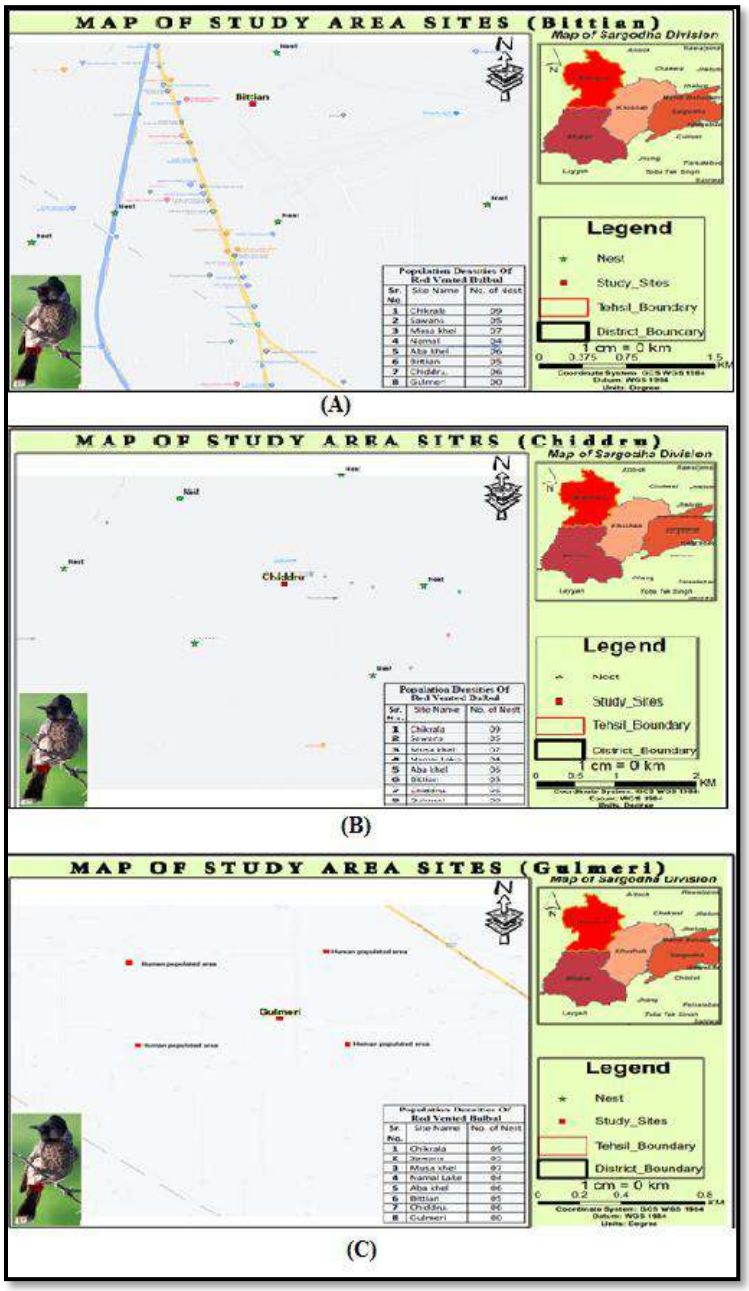

Figure 4: Nests identified and observed during study in Bittian (A) in Chiddru (B) in Gulmeri (C).

Incubation period, Clutch size and reproductive success: It was seen that hatching times of the eggs range between 11-14 days. Mean value is 12.51. In 35 dynamic nests the grasp size goes from 1 to 4. Number of the eggs varied only 1 egg was found in 9 % of nests, 2 eggs in 26 % of nests, 3 eggs in 51% of nests and 4 eggs in 14% of nests. The hatchling achievement in 1-4 eggs was 6, 23, 43 and 11% respectively. The juvenile achievement in 1-4 eggs was 0, 20, 37% and 11% respectively. The Red Vented Bulbul's eggs were smooth and gritty. Red-Vented Bulbul eggs feature darker red dots with a faint pinkish tone and are thick at the broad end. Reproductive parameters including clutch size, total number of nests, hatching success and fledgling success are represented in table 4 while detail of egg length and width in table 3.

Egg and nestling loss: The incubating achievement in the current examination was 82%. The juvenile accomplishment in the current examination was 87%. The predation pace of eggs and little birds in present examination was 6 and 10% individually. The nest misfortune because of predation and ominous environment was habitually high for eggs and little birds. Only moment level of egg misfortune 3% and nestling 2% happens because of environment condition (table 5).

Nest No.	Months	Nest		Vegetation
		Position	Height (m)	
1.	February	Terminal	3	*Psidium guajava*
2.	February	Fork	1	*Dalbergia sisso*
3.	February	Middle	2	*Zizyphus nummularia*
4.	February	Fork	1	*Dodonea viscosa*
5.	March	Terminal	3	*Phoenix dactylifera*
6.	March	Middle	2	*Berberis lyceum*
7.	March	Terminal	3	*Dalbergia sisso*
8.	March	Fork	2	*Dalbergia sisso*
9.	March	Fork	1	*Citrus sinensis*
10.	April	Middle	2	*Dalbergia sisso*
11.	April	Middle	3	*Morus alba*
12.	April	Fork	1	*Jasminum officinale*
13.	April	Terminal	4	*Dalbergia sisso*
14.	April	Middle	3	*Ziziphus jujuba*
15.	April	Fork	2	*Acacia nilotica*
16.	May	Fork	1	*Psidiumguajava*
17.	May	Terminal	3	*Dalbergia sisso*
18.	May	Fork	1	*Zizyphus nummularia*
19.	May	Middle	2	*Dodonea viscosa*
20.	May	Middle	3	*Phoenix dactylifera*
21.	May	Fork	2	*Berberis lyceum*
22.	May	Fork	1	*Citrus sinensis*
23.	June	Terminal	3	*Morus alba*
24.	June	Terminal	4	*Jasminum officinale*
25.	June	Middle	2	*Ziziphus jujuba*
26.	June	Fork	1	*Acacia nilotica*
27.	June	Fork	2	*Psidium guajava*
28.	June	Middle	3	*Zizyphus nummularia*
29.	July	Terminal	4	*Dodonea viscosa*
30.	July	Fork	2	*Phoenix dactylifera*
31.	July	Terminal	3	*Berberis lyceum*
32.	July	Middle	2	*Citrus sinensis*
33.	July	Fork	1	*Morus alba*
34.	July	Terminal	4	*Jasminum officinale*
35.	July	Middle	2	*Ziziphus jujuba*

Table 2: Summary of RVB's nest observed in the present study.

Particulars	Mean±SD	Range	Particulars	Mean±SD	Range
Nest Dia (cm)	(n = 42)		Eggs (mm)	(n= 35)	
Outer	10.51±1.71	6.2-14	Length	20.96±1.59	18-24.6
Inner	8.17±1.22	6.4-10.9	Width	15.1±1.22	12.7-18

Table 3: Dimensions of nests and eggs of RVB in Mianwali.

Clutch size	No. of Nests		Hatchling success		Fledgling success	
	No.	% age	No.	% age	No.	% age
1	3	9	2	6	0	0
2	9	26	8	23	7	20
3	18	51	15	43	13	37
4	5	14	4	11	4	11
Total	35	100	29	83	24	68

Table 4: Reproductive parameters of RVB in Mianwali).

DISCUSSION: Geographic information systems (GIS), could be used as customized solutions in species conservation program but unfortunately, conservation studies, on the other hand, are the opposite (Brown *et al.*, 2016). They are regularly compelled to labor under severe time and money constraints, making it difficult for them to carry out their duties properly. The GIS approach, which can be utilized even in remote places, is a low-cost and simple tool for guiding sampling of species that have previously been understudied. The model is a simple and has practical application that has proven useful in identifying regions of interest for the conservation of endemic birds in Bioko, as it has been demonstrated in this example.

		No.	%
Egg loss	Eggs	95	100
	Infertile	8	8.4
	Predated	6	6
	Climatic condition	3	3
	Hatched	78	82
Nestling No.	Nestlings	78	100
	Predated	8	10
	Weather condition	2	2.6
	Fledge	68	87

Table 5: The eggs and nestling loss of RVB in Mianwali.

Result of the current study revealed that most of the RVB was found in continuous circulations around these eight sites such as, Chikrala, Abba Khel, Chiddru, Namal Lake, Musa Khel, Sawans and Bittian, except for Site Gulmeri, in this site no feather was found. Population density of the bird was higher from the month of March to the month of July and then starts deceasing overall. Further from the current study, it was also found that breeding time of RVB start from late February to late July. The females (80%) laid their clutch from late February to late July. It suggests that genuine piece of such activities occurs during June and July. Complete 42 nests have been seen during the investigation. Out of 42, 9 nests have been seen in Chikrala, 5 nests in Sawans, 7 nests in Musa Khel, 4 nests in Namal lake, 6 nests in Aba Khel, 5 nests in Bittian, 6 nests in Chiddru. No nest was found in Gulmeri. Awais *et al.* (2015) conducted a study from May to August 2013 on Red-Vented Bulbul in tehsil Mansehra, Khyber PakhtunKhaw, to evaluate their breeding ability. Generally, the RVB breeds between April and September. They can be found in pairs from late March to early April when they begin nest construction. Total of 37 nests were reported with 88 eggs. The RVB favored small, leafy trees and thick bushes for nest building. The average plant and nest height were 2.30.1 and 1.80.2m, respectively. The mean clutch size was 2.3, with a range of 1-4. The egg measured 19.30.5mm in length and 17.00.3mm in width. They noticed an egg with a volume of 20.60.4 cm3 and a shape of 1.250.5. Between length and breadth, a strong connection was discovered. The success of the egg was 54.5% and the nest success was 58.3%. The major reason of the unhitched eggs was weather and disturbed by the people. The breeding season of RVB runs from April to September, with the peak occurring in August and September (Prajapati *et al.*, 2011). Another study conducted by Rao *et al.* (2013) in India revealed the breeding months from March to October with maximum activities noted during September. The study in Haryana and Gujrat of India showed the breeding activities during March to May. During the study on breeding biology of RVB by Zia *et al.* (2014) in the capital territory of Islamabad/Rawalpindi reported a total number of 45 nests, out of these about 35 were in active form. Most nests were in the fork of the trees, 29% in the center, and just 11% in the upper section of the trees. Most favored nests (53%) were 1-3 meters above the ground. The nests were constructed using a variety of

plant materials, including *Z. nonmalaria* (32%), *P. guajava* (21%), *D. sissoo* (17%), *D. viscosa* (18%), and *P. dactyliferai* (18%). The maximum percentage (52%) was recorded of clutch size four. The rate of predation was observed 5% in eggs and 8% in nestlings. Balakrishnan (2010) showed that the nests of about 95% of RVB have only two eggs and the others have about three eggs. Present investigations revealed that RVB primarily utilized plant twigs but of differed sizes and shapes, grasses and spider webs that was accessible in bird's own domain. Absolute nest was noticed 42 out of which 7 were latent and 35 nests were dynamic and majorly select plant species, including *P. guajava, Z. nummularia, D. viscosa, D. sissoo, P. dactylifera, B. lyceum, A. nilotica, Z. jujuba, J. officinale, C. sinensis* and *M. alba* with incubation period of the eggs between 11-14 days. From the present study it is inferred that size of the clutch and success rate was different among all identified nests. Such as some of the nests contain 4 while few of them contain only 1. The Red Vented Bulbul's eggs were smooth and tough having eggs feature darker red dots with a faint pinkish tone and are thick at the broad end (Rao *et al.*, 2013; Zia *et al.*, 2014)

CONCLUSION: From the present study it is concluded that Red Vented Bulbul is widespread across the areas under study. Highest population density was recorded from February to July and breeding starts from the late February and lasts for late July with 80% hatching. The present study will play a vital role towards the development of future conservation initiatives. Additionally, geographic information system mapping (GIS) is a highly effective approach for evaluating the geographical distribution of birds; nevertheless, geographic analysis and decision-making tools.

CONFLICT OF INTEREST: Authors have no conflict of interest.

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