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Cover Page Footnote

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FEEDING ECOLOGY, BEHAVIOUR AND HABITAT UTILIZATION OF BLACK DRONGO (*DICRURUS MACROCERCUS*) IN POTHWAR PLATEAU, PAKISTAN

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ABSTRACT

Black Drongo is an insectivorous bird native to Pakistan. The present study focused on its feeding preferences, behaviour, ecology and habitat relationships. The study was carried out from first week of December, 2019 to the second week of April, 2020 in the two villages of Rawalpindi named as Daultala (Location-I) and Nata Gujarmall (Location-II). Observations were made by point count method on foot using line transect method. Air (52.27%) was the most commonly used feeding substrate. Aerial feeding mode (52.27%) is preferred over plant or tree gleaning (n=58) and ground feeding (n=47). Most common perching site was man made obstacle, wire (37.72%). Thirteen indigenous tree species and two exotic trees including Eucalyptus (*Eucalyptus camaldulensis*) and Bottle brush (*Callistemon citrinus*) were used as perching site by Black Drongo throughout the study. Black Drongo remained solitary (36.36%) during feeding rituals and shared (63.63%) its intimate habitat with other birds. At Location-I and Location-II, habitat was shared with 12 and 16 bird species, respectively. The mean time of prey capturing attempt was lower at Location-I (1.93±0.17 min) than Location-II (2.16±0.16 min). The time range of prey capturing attempt was (0.1±0.16 min) to (11.5±0.17 min). Black Drongo captured prey successfully by first attempt (59.54%), maximum attempts noted were 6. After preying attempts Black Drongo came back to same perch site (67.27%); which is a representative of resource abundance.

Keywords: Black Drongo, feeding, behaviour, ecology, habitat

INTRODUCTION

Black Drongo (*Dicrurus macrocercus:* family Dicruridae) is an insectivorous bird, found in South Asia and the Indian subcontinent (Grimmett et al., 2009). It is native to Pakistan, present in farms and open grasslands in Sindh and Punjab (Grimmett et al., 2009; BirdLife International, 2020). It is major constituent of agricultural ecosystem and check the build-up of harmful insects of agriculture crops (Kaur and Kler, 2018). Finding a species' resource preference is essential to basic and applied ecology (Charmantier et al., 2008).

Present study sought out to find foraging behaviour, perch site, perch height, inter and intraspecific behaviour, time of recurrent attack to capture prey, number of attempts for successful capture and second perch site (after attack) of Black Drongo in agriculture landscapes of Pothohar plateau (Punjab, Pakistan).

MATERIALS AND METHODS

Study Site

Present study was carried out at two villages of Pothohar plateau, viz. Daultala (33°11'33''NL, 73°08'25''E: scarce vegetation and trees) and Nata Gujarmall (33°10'21''NL 73°09'34''E) (District Rawalpindi: Punjab, Pakistan). Eucalyptus (*Eucalyptus camaldulensis*), pomegranate (*Punica garanatum*), sukh chain (*Pongamia pinnata*), sacred fig (*Ficus religiosa*), bottle brush (*Callistemon rigidus*), guava (*Psidium guavaja*), dhrek (*Melia azendarach*), beri

(*Ziziphus mauritiana*), keekar (*Acacia nilotica*), phulai (*A. modesta*), *Cypress* spp., Java plum (*Syzygium cumini*), neem (*Azadirachta indica*), sheesham (*Dalbergia sissoo*), giant milkweed (*Calotropis gigantea*) are important tree species.

Data Collection

Two workers walked (Jhonson, n.d.) on foot from 06:30 to 10:30 a.m. and from 14:30 to 18:30 p.m. (Verner, 1985) twice a week between November 2019 and April 2020 actively searching Black Drongo until observations on foraging behaviour (aerial, plants/ trees or ground), perch site, perch height, time of recurrent attack to capture prey, second perch site and number of attempts for a successful capture were recorded in the field on data sheet. Black Drongo was observed with naked eyes (Ali, 2002) and by using Russian Tecno Sehfeld Military Binoculars (20x56) without disturbing the animal. Perching height of Black Drongo was found using stick method (Hairiah et al., 2001) and measuring tape to find out distance between observer and perch. Photographs were also taken with the help of camera.

Whenever and wherever Black Drongo was spotted, the behaviour of Black Drongo with conspecifics and with other species present in the vicinity (10 m) and aforementioned parameters were recorded (Verner, 1985; Kaur and Kler, 2018). When a Black Drongo was found it was observed for a maximum of 10 minutes. Observations with respect to other birds (either sharing same perch site or feeding substrate) were recorded within 5 m of radius. The data was collected only once per bird to exclude prejudices, one of them was noted. Within a radius of 10 m no other observations were made to make observations independent of each other. Observations were recorded on each sighted bird and feeding habits were identified by swallowing behaviour (Dinsmore, 1973; Grubb, 1976; Kour and Sahi, 2012). Only dominant vegetation and vegetation used by Black Drongo either directly for perching or indirectly for gleaning was recorded and all others were excluded. To minimize vegetation sampling bias, only the first used vegetation was recorded.

Statistical Analysis

For statistical analysis Past 4.01 was used. Student's t-test was carried out to on the average perching site and average perching height of Black Drongo to find whether there was any significant difference between the perching heights of both locations (Kaur and Kler, 2018) and for the time of recurrent attack. The values obtained are represented in Mean ± SE. Results were tabulated (Sidra et al., 2013) and charts were made by using Microsoft Excel 2010.

RESULTS AND DISSCUSIONS

A total of 220 observations were recorded, 110 from each location and following results were obtained:

Foraging Behaviour

Black Drongo used 3 main foraging substrates named as air, plant or tree and ground at both locations collectively shown in Figure 1. At Location-I air (n=54) was used more than other two substrates with a total of 49.09% times. It was the most used substrate when at the site of feeding there were disturbances in crops or grasses, which caused insects to fly. After aerial feeding the most used foraging substrate was ground (n=35) that is 38.81%, it may be due to the reduced cultivation of fields and presence of only grasses, which are roosting and feeding sites for insects. At Location-I ground feeding and insect picking from ground was more than plant gleaning, this result contradicted with the results find by Kaur and Kler (2018). The plant used (n=21) was least used foraging mode of feeding (19.09%).

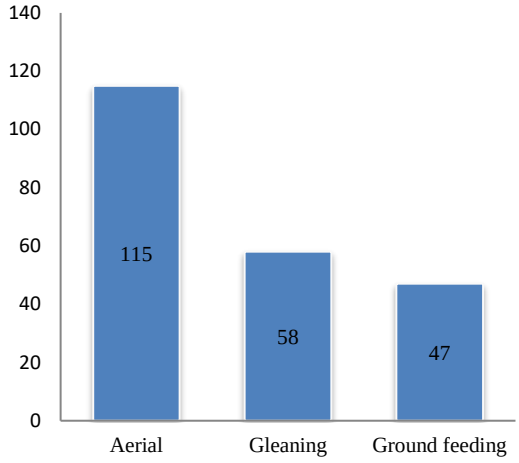

Figure 1: Foraging behaviour of Black Drongo at both locations, showing the total number of observations in comparison with the mode of feeding.

While at Location-II, air (n=61) was used a total of 55.45% time to forage on insects, plant/tree substrate (n=37) was 33.63% of time to catch a prey and ground (n=12) only 10.90%. At location-II the most prevalent feeding substrate was air. Air (52.27%) was the most used substrate for feeding, followed by plants or trees (26.36%) and ground (21.36%) at both locations. It was observed from the results that mostly insects were preyed on when they were flying. This result conforms with the findings by Kaur and Kler (2018). During the whole study, Black Drongo was not seen perching on plants of wheat (*Triticum aestivum*) and Oat (*Avena sativa*) (dominant crops) which contradicts findings from the previous study by Kaur and Kler (2018).

The higher number of aerial feeding at both locations means more insect consumption (Okosodo et al., 2016; Kaur and Kler, 2018) as shown in Table 1. Black Drongo only foraged from a perch to ground; where it may not be considered as active ground feeding like Common Myna do (Kaur and Kler, 2018). Ground foraging was the least common method of feeding at Location-II. This was due to the more vegetation and prey abundance at Location-II that provides sufficient food in aerial feeding and presumably they did not feed on ground. Thus, prey abundance plays an important role (Park et al., 2008) in determining the foraging mode (Airola and Barrett, 1985).

Table 1: Feeding behaviour of Black Drongo at both locations with inter-site difference.

Feeding Behaviour	Location-I		Location-II		Inter-site Difference
	Numbers	Percentage	Number	Percentage	
Air/ Aerial feeding	54	49.09%	61	55.45%	7
Plants gleaning	21	19.09%	37	33.63%	16
Ground feeding	35	31.81%	12	10.90%	23

Perch Site

The most used perch was electrical wire (37.72%) at Location-I. The results of this investigation are similar to the previous study done by Kaur and Kler (2018). Black Drongo also used roofs and walls (n=10) of un-cemented houses near agricultural fields. The indigenous tree species of Pomegranate Tree (*Punica granatum*) (n=7), Phulai (*Acacia modesta*) (n=6), Gum Arabic Tree (*Acacia nilotica*) (n=5), Sukh Chain (*Pongamia pinnata*) (n=4), Chinaberry Tree (*Melia azedarach*)(n=4), Indian Plum Tree (*Ziziphus mauritiana*) (n=3), Common Guava (*Psidium guajava*) (n=3), Cypress spp. (n=2) and Java Plum (*Syzygium cumini*) (n=1) were used by Black Drongo to perch on. Near human dwellings it was found to be perched dominantly on wire and some accidental perch on Dhrek and Java Plum. Eucalyptus (*Eucalyptus camaldulensis*) (n=17) and Bottle brush

(*Callistemon citrinus*) (n=5) were the two exogenous species selected by Black Drongo for perching.

Figure 2: A Black Drongo perching on a wire.

Due to more tree species present at Location-II, Black Drongo used a variety of perching sites, a total of 13 indigenous tree species namely, Gum Arabic Tree (*Acacia nilotica*) (n=12), Indian Plum tree (*Ziziphus mauritiana*) (n=9), Chinaberry Tree (*Melia azedarach*) (n=7), Indian Lilac (*Azadirachta indica*) (n=4), Indian Rosewood (*Dalbergia sissoo*) (n=3), Pomegranate Tree (*Punica granatum*) (n=2), Sukh Chain (*Pongamia pinnata*) (n=2), Mango Tree (*Mangifera indica*) (n=2), Sacred fig (*Ficus religiosa*) (n=2), Guava (*Psidium guajava*) (n=1), *Cypress* spp. (n=1), Phulai (*Acacia modesta*) (n=6) were used. While 2 species Eucalyptus (*Eucalyptus camaldulensis*) (n=11), Bottle brush (*Callistemon citrinus*) (n=7), were the exotic species used (Table 1). Most widely used perch was wire (n=40). Roofs (n=6) were also used but less than at Location-I due to the presence of more natural perch sites. It was also seen that Black Drongo utilized a greater number of tree species at Location-II. It may be due to undisturbed habitats and less cultivated fields there. The least used trees for perching were Guava, *Cypress* spp. and Phulai (n=1 for each). Similar results were found by previous studies on vegetation preferences by insectivorous birds (Gabbe et al., 2002).

Table 2: tree species utilized by Black Drongo at both locations for perching purposes.

Family	Tree Species	Scientific Name	Location-I	Location-II
		Indigenous species		
Fabaceae	Phulai	*Acacia modesta*	5.45%	0.9%
	Indian Rosewood	*Dalbergia sissoo*	-	2.72%
	Gum Arabic Tree	*Acacia nilotica*	4.54%	10.9%
	Sukh Chain	*Pongamia pinnata*	3.63%	1.81%
Myrtaceae	Java Plum	*Syzygium cumini*	0.9%	-
	Guava	*Psidium guajava*	2.72%	0.9%
Meliaceae	Chinaberry Tree	*Melia azedarach*	3.63%	6.36%
Cupressaceae	*Cypress* spp.	-	1.81%	0.9%
Meliaceae	Indian Lilac	*Azadirachta indica*	-	3.63%
Anacardiaceae	Mango Tree	*Mangifera indica*	-	1.81%
Moraceae	Sacred fig	*Ficus religiosa*	-	1.81%
Rhamnaceae	Indian Plum Tree	*Ziziphus mauritiana*	2.72%	8.18%
Punicaceae	Pomegranate Tree	*Punica granatum*	6.36%	1.81%
		Exotic species		
Myrtaceae	Eucalyptus	*Eucalyptus camaldulensis*	15.45%	10.0%
	Bottle Brush	*Callistemon citrinus*	4.54%	6.36%

Perching Height

A total of 220 observations were carried out for perching height utilization at both locations, 110 from each location. The means of perching heights from the two locations were significant (p=0.83). The average perching heights of both locations were not too different (5.88±0.25 m and 5.95±0.23 m respectively). The maximum perching height was observed to be 10 m and 11 m at Location-I and Location-II, respectively.

The minimum height utilized was more at Location-II (1 m) than at Location-I (0.7 m). It may be concluded that Black Drongo is height generalist and can utilize all perches irrespective of their height which ranges from 0.7-11 m. Table 3 shows the maximum utilized height was between 9-11 m with frequencies of 34.54% and 35.45% at Location-I and Location-II, respectively. It possibly depends upon available food, ease of access and vegetation. Black Drongo used wire as a more common perch with average height of 9.5 m a total of 37% time, this finding is consistent with a previous study by Kaur and Kler (2018). During inference strengthening surveys (other than morning and evening) it was observed that Black Drongo perched near the ground within 0.7-2.5 m to pick insects that are disturbed by gardeners when cutting grasses.

Table 3: Height cohorts and perching height frequencies of Black Drongo at both locations with inter-site difference.

Height Cohorts	Frequency at Location-I		Frequency at Location-II		Inter- site Difference
	Number	Percentage	Number	Percentage	
0.7-2 m	4	3.63%	5	4.54%	1
3-5 m	32	29.09%	30	27.27%	2
6-8 m	36	32.72%	36	32.72%	0
9-11 m	38	34.54%	39	35.45%	1

Inter- and Intra-specific Behaviour

The behaviour of Black Drongo with other birds either sharing same site for feeding or perching within 5 m at both locations was observed. Usually Black Drongo is considered an aggressive and partly territorial bird (eBird, n.d.; BirdLife International, 2020), mostly seen perching on telephone and electrical wires (Grimmett et al., 2009). It was seen that Black Drongo preferred to not share its habitat with other birds and remained solitary (n=46) at Location-I. However, during surveys, Black Drongo shared either foraging or perching site with 13 other bird species. It also shared its intimate vicinity with other Drongos along with other bird species. At the Location-I, Black Drongo was found clustered with Jungle Babbler, Crested Lark, White-Browed Wagtail, Bank Myna and Rufous Treepie, these species were not present in close vicinity of Black Drongo at Location-II.

At Location-II, it was found with a lower frequency for solitary behaviour (n=34) compared to clustered (n=76) with other species. The frequency to be found with other Black Drongos (n=26) was less than Location-I. It might be due to prey abundance at Location-II that restrained them to be clustered at a place. This resulted in a greater number of sharing of habitat with other 17 species. In these 17 species some were not found with Black Drongo at Location-I e.g. Green Bee-eater, Greater Coucal, Cattle Egret, Brown Rock Chat, House Sparrow, Asian koel, Brahminy Starling, Crested Lark and Barn Swallow. The above mentioned seven species were found within 5 m of either

foraging or perching site. It can be inferred from the data that Black Drongo from this area shared their habitat (n=140) with other species more frequently than remaining solitary (n=80) when either perching or feeding (Table 4). In addition, it was seen that Black Drongo remained relatively less active during the day time with exception of times when special treats of insects given when grass was trimmed.

Table 4: List of bird species found with Black Drongo at either perching site or sharing feeding habitat at both locations.

Order	Common Name	Scientific Name	Location-I	Location-II
Passeriformes	Red vented Bulbul	*Pycnonotus cafer*	5.12%	8.25%
	House Crow	*Corvus splendens*	7.17%	8.71%
	Common Myna	*Acridotheres tristis*	11.28%	11.46%
	Black Drongo	*Dicrurus macrocercus*	18.97%	16.05%
	Bank Myna	*Acridotheres ginginianus*	5.12%	-
	Rufous Treepie	*Dendrocitta vagabunda*	1.25%	-
	Long-tailed Shrike	*Lanius schach*	5.12%	6.42%
	White Wagtail	*Motacilla alba*	3.58%	1.37%
	White-browed Wagtail	*Motacilla maderaspatensis*	1.53%	-
	Brown Rock Chat	*Cercomela fusca*	-	4.12%
	House Sparrow	*Passer domesticus*	8.71%	11.0%
	Brahminy Starling	*Sturnia pagodarum*	-	1.83%
	Jungle Babbler	*Turdoides striatus*	3.58%	-
	Crested Lark	*Galerida cristata*	5.64%	-
	Barn Swallow	*Hirundo rustica*	-	0.92%
Coraciiformes	Green Bee-eater	*Merops orientalis*	-	5.50%
	Indian Roller	*Coracias benghalensis*	2.56%	2.29%
Cuculiformes	Asian Koel	*Eudynamys scolopaceus*	-	0.45%
	Greater Coucal	*Centropus sinensis*	-	0.45%
Columbiformes	Eurasian Collared-Dove	*Streptopelia decaocto*	7.17%	8.25%
Charadriiformes	Red-wattled Lapwing	*Vanellus indicus*	4.10%	3.21%
Ciconiioformes	Cattle Egret	*Bubulcus ibis*	9.23%	9.63%

Time of Recurrent Attack

The successful capturing was confirmed visually by observing the characteristic swallowing movement with binoculars (Dinsmore, 1973; Grubb, 1976). The mean value 1.93±0.17 minutes suggested that Black Drongo used less time to locate and attack a prey at Location-I compared to Location–II (2.16±0.16 min.). The time of attack was significantly less at both Locations on Wheat (*Triticum aestivum*) and Oat (*Avena sativa*).

Minimum time was 0.4±0.17 min and 0.1±0.16 min at Location-I and Location-II, respectively. While the maximum time of attack was 11.5±0.17 min at Location-I and 9±0.16 min at Location-II. As discussed earlier, at Location-I Black Drongo stayed solitary and less competition was seen compared to Location-II. Maximum prey was captured between 0.1-3 minutes with frequency of 74.54% and 88.18% at Location-I and Location-II respectively (Table 5). Minimum inter-site difference was for 8-11.5 m. Hence, it may be inferred that time of attack is determined by prey abundance, vegetation density and less competition with conspecifics and other insectivorous species.

Table 5: Time of recurrent attack of Black Drongo to capture a prey.

Time of attack	At Location-I		At Location-II		Inter-site
	Number	Percentage	Number	Percentage	Difference
0.1-3 min	82	74.54%	97	88.18%	15
3-5 min	17	15.45%	8	7.27%	9
5-8 min	9	8.18%	4	3.63%	5
8-11.5 min	2	1.82%	1	0.90%	1

Number of Attempts

Black Drongo successfully captured the prey by its first attempt, with the overall percentage 59.54% (Table 6). At Location-I the mean value was 1.45±0.07 attempts which is less than 1.75±0.09 attempts at Location-II. It was noted that maximum attempts (n=6) were made at Location-I.

Number of attempts show the relative strength of Black Drongo to capture its prey. A greater number of 1st attempts (Table 6) represent its successful preying. It may be inferred that Black Drongo is adapted to preying on insects. Okosodo et al. (2016) found that diet of Black Drongo constitutes of (86.6%) insects. It was observed that a higher number of attempts showed less target insect concealment and disturbances (that provide stimulus of flight initiation in Black Drongo). Dense vegetation was present at Location-II, which can impact searching of potential prey, Christopher and Whelan (2001) reported similar results where vegetation organization influenced the feeding of insectivorous birds.

Table 6: Number of attempts made to capture prey by Black Drongo at Location-I and Location-II with relation to inter-site difference.

Number of Attempts	At Location-I		At Location-II		Inter- site
	Number	Percentage	Number	Percentage	Difference
1	70	63.64%	61	55.45%	9
2	33	30.0%	31	28.18%	2
3	5	4.54%	8	7.27%	3
4	1	0.90%	7	6.36%	8
5	0	0	3	2.72%	3
6	1	0.90%	0	0	1

Second Perch Site

No previous studies were done on second perch site of Black Drongo. Hence, present study sought to find out the second perch site after effective catching or an unsuccessful attempt. Data showed that out of 220 observations, it returned to the same spot 67.27% times. While failing to retreat on the previous perch site (32.72%) might be due to the unavailability of preferred prey, which compelled them to try for another perch site. At Location-I and Location-II it returned 66.36% and 73.63% of times, respectively.

The success of first attempt may have caused them to perceive the suitability of the site for foraging. Data of Number of Attempts at both locations reinforced the same hypothesis. When Black Drongo attempted more to catch but could not do so, they often retreated on the same spot at Location-II more often than Location-I. The second perch site selection hinges on the availability of potential prey, ease of access, vegetation density (Airola and Barrett, 1985) and competition of feeding (Park et al., 2008). As mentioned earlier there was more potential prey with

ease of access and thus competition was less at Location-II.

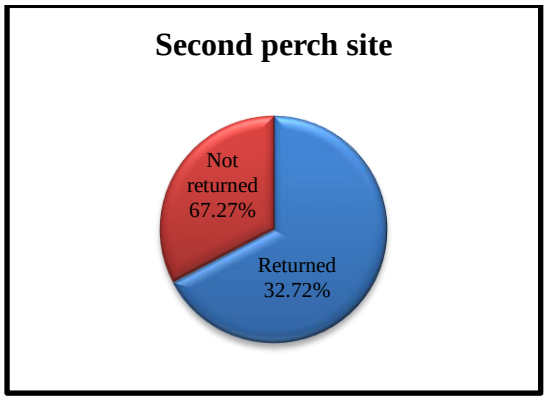

Figure 3: Overall percentage of second perch site of Blaxk drongo at both locations.

CONCLUSION

Black Drongo utilized air as a dominant feeding substrate. While most preferred perching on wire, Black Drongo is height generalist when it comes to perching. It utilizes two exotic tree species namely Eucalyptus and Bottle Brush. Black Drongo can share its intimate vicinal habitat with 19 other bird species, which indicate its behavioural plasticity. Perhaps due to location and availability of prey, Black Drongo was observed to be a competent predator of insects. Perch site specificity, especially at the second location, compels them to come at the same perch after attempts to catch prey, depending upon availability of food and other environmental factors. It may be concluded that Black Drongo can best utilize its ecological niche. This study will provide guidance to future studies on Black Drongo.

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CONFLICT OF INTEREST

Authors declare no conflict of interest in this study.

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